Evolutionary Economics

and

Equality

An Age of Enlightenment

By Greg Horsman

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Also by Greg Horsman

The Narcissist's Vocation
and the
Economic Debacle

&

Objectivism Lost
and an Age of
Disillusionment

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These books are also available in Kindle.

Dedication

Ray Horsman (1946-2008)

Bruce Johnston (1948-2010)

"Human beings tend almost invariably to be better at remembering evidence that is consistent with their beliefs than evidence that might disconfirm them… Overcoming this mental weakness, known as confirmation bias, is a lifelong struggle; recognizing that we all suffer from it is an important first step."

- Cognitive scientist Gary Marcus, New York University

"The fact, in short, is that freedom, to be meaningful in an organized society, must consist of an amalgam of hierarchy of freedoms and restraints."

- Samuel Hendel (1909-1984)

"Constant development is the law of life, and a man who always tries to maintain his dogmas in order to appear consistent drives himself into a false position."

- Mohandas K. Gandhi (1869-1948)

Forward

Five decades of tax cuts for the rich have been linked to income inequality, but not economic growth. The 2008 economic debacle was the tipping point, accelerating the call for changes, and heralding the lost decade. This highlights the hollowing out of the middle class and the polarization of jobs – job growth for high and low paying jobs. People who want work, but cannot find work suffer greatly, not just from the loss of income, but from the diminished sense of self-worth. The Occupy Wall Street protests began – connected by the anger of the common person against the banks for manipulating the system and tanking the economy. The ongoing widespread unemployment, and the discovery that the economic system is not as good as they once believed, is a source of disillusionment. This is the present state.

Accepted ways of thinking are being challenged – ushering in a new Age of Enlightenment! The Occupy Wall Street protesters challenge the excess of corporations in general, and in particular, a government controlled by corporate money, and increasing inequality – the growing income gap between the very wealthy and the rest of society. In the past decade, the epigenetics revolution has rewritten our understanding of genetics disease and inheritance – challenging the old way of thinking. Individuals are much more sensitive to exposures from their environment, diet and lifestyles than previously thought. Individuals should have an equal chance and freedom to chose among alternative vocations that they could possibly lead, if not fettered by preventable epigenetic burdens.

Many have suggested that banks should not be 'too big to fail' rather be reduced in size. In the past four years reforms have eluded legislators, and banks have become even larger. The sense is that innovation should be redirected from products designed specifically to increase the size of banks' profits, to innovation that produces jobs. Evolutionary economics represents a new mind set to support an approach in a future state to wealth creation through technological innovation. This new system will control the epigenetic harms that have the potential to affect every aspect of our lives. In the future state, the new equality will allow individuals to achieve their full potential with new freedom linked to capabilities. Epigenetics will play a role in controlling the epidemic of chronic disease appearing on the horizon.

Introduction

The shortcoming of mainstream economics as a predictive science, we are told, can be attributed to a need for better analytical tools, better models and better sources of data to provide improved predictive power. Apologists for small government and minimal regulations claim that 'imperfections' in the real world, if corrected, will make it conform more closely to the economist's model. This leaves the cynic to observe, that, with a discrepancy between theory and data, the biologist will declare the *theory* wrong, while the economist will claim the *data* is wrong. However, of all the social sciences, economics most closely resembles the natural sciences. In general, mainstream economics reaches out to alternative theories to support the status quo, as long as it does not clash with dogma.[1]

During the 'Age of Enlightenment,' people believed that the reasoning of men could free them of their ills, and lead to peace, security, and good government. It was believed that reason would ensure the progress of humanity and the entire society, and change the corrupt environment of the 18th century. This included breaking the monopolistic power of the church over people's thinking, and replacing it with an enquiring mind that wanted to know and understand through reason based on evidence and proof. Human reason could be used to combat misguided traditional thinking and old ideas that had kept people subjugated in ignorance, superstition and tyranny. The belief was that 'knowledge shall set you free.' Truth and freedom would enable individuals to build a better world.

The scientific method includes understanding observations are prone to error and bias, so experiments must be replicated by independent researchers. In addition there is a peer review process to ensure that proper documentation of procedures is available for scrutiny. A legacy of the enlightenment that survives today is science, which is ruled by its own internal controls of a rigid and transparent scientific method through rigorous peer review, instead of some arbitrary outside jurisdiction.[2]

The threats to freedom today in the West are not even mainly religious. Reason was opposed to authority; the Enlightenment always connected reason and freedom. The freedoms

identified for individuals during the Enlightenment are now threatened. In the 21st century, corporations undermine movements, such as climate change, not by rejecting science, but by selectively funding it, and distorting reporting of it. This is facilitated by the corporate controlled media. Now reason is used to attack principles of the Enlightenment. In addition, deregulation includes underfunding agencies that require science to monitor the safety of environment and manufactured products.

Corporations have adopted the disinformation programs developed by the tobacco industry over the past fifty years. These tactics include introducing manufactured uncertainty by raising doubts about even the most indisputable scientific evidence, and by setting up so called independent front organizations to publically promote their desired messages. This includes cherry picking scientific spokespeople whose interpretations of the peer-reviewed literature suggest to the media and the public that the debate amongst scientists continues, and the results are not definitive. Industries sponsor sophisticated research activities that include both funding of established research institutions, as well as funding of advocacy and ideological organizations to conduct disinformation campaigns, which will confuse ideas around such issues as global warming.

Isaac Newton's studies of gravitation established the Copernican theory of the Earth revolving around the sun, and introduced to the West the concept of mankind as the centre of the universe, not God. The replacement of the Ptolemaic system (the Earth at the centre of the universe) with the Copernican system (the sun at the centre of the universe) was a paradigm shift. (Paradigms are mental models individuals carry in their minds.) In science, this change introduced Newtonian determinism, the belief that physical systems have an element of predictability. Such regularities in the physical world were regarded as the result of divine order – the implication of uniformity and permanence was readily transferred to ethical laws. Adam Smith's explanation of the 'invisible hand' fell into this category. The neoclassic (economic) theory is a mechanistic metaphor, describing humans as having no choice, and behaving in accordance with physical (deterministic) laws, such as laws of least effort or maximum profit.

The concept of the 'invisible hand' comes from Adam Smith's book, *Wealth of Nations,* written in 1776, which has survived to the present. The individualism that stemmed from the establishment of the Copernican view during the Enlightenment became part of Ayn Rand's philosophy, Objectivism, that blends free market, reason and individualism. These theories support the largest institutions of the 21st century, the corporations and the dynamics of globalization. The most prominent institution of the 21st century, the corporation, needs to ensure the small government, minimal regulation mantra with the purpose of maximizing their power and wealth. The present laissez-faire system allows a few to control the economic system in a democracy. Apologists claim the capitalist system can only function efficiently with minimal government and minimal regulation. They warn that this structure is the basis of jobs and prosperity in the country, and any changes would spell economic disaster. A by-product of this *efficient* system is the widening gap between the rich and the poor. However, the trade off, they claim, is that the system allows everyone a chance. To maintain the status quo, it is necessary to promote a theory of minimal government and regulation to support a system of maximizing returns for stockholders and management.

The recent economic debacle of 2008 illustrated again that economics is not an exact science, as it was not able to project the trajectory of the economy, nor was the system able to

self-correct. Economics is about the use of models to impose a description of the way we think, and to analyse and isolate important economic mechanisms. This drives discussion on the need for change, while the greatest barrier is the inability to see beyond the current models of thinking. New evolutionary economics described in this book are about applying a new economic model to explain economic growth, wealth creation, and technological innovation, while supporting change.

Evolutionary economics is a biological metaphor that includes a description of the world resulting from the interplay between chance and necessity. In this system, simultaneous randomness and choice (determinacy) create irreversible changes. Small (synergistic) changes can provoke wider reverberations throughout the entire system. The dynamics tend toward the best result, which is really a temporary suboptimal result of a constantly evolving, unpredictable process.[3]

The development of the global corporation is supported by many of the followers of Hayek and Friedman who accept every word of their writings in support of laissez-faire economics. This, in turn, is supported by Adam Smith's 'invisible hand' in which a market reaches equilibrium through the rational allocation of scarce resources. With the appearance of the oligarchies, the system is starting to take on the features of the monopolies that Smith spent a great deal of effort denouncing.

The need to control information and incorporate new ideas to support the status quo is not new. During the Middle Ages, the predominate corporation in the West was the Roman Catholic Church. With the rediscovery of Aristotle in the Middle Ages, church scholars developed a system in which Aristotle's writings supported the structure of the church. Every word of Aristotle's writing – or at least every word that did not contradict the Bible – was accepted as eternal truth. Fused and reconciled with Christian doctrine into a philosophical system known as scholasticism, Aristotelian philosophy became the official philosophy of the Roman Catholic Church. As a result of this monopoly on decision-making, some scientific discoveries in the Middle Ages and Renaissance were criticized simply because they were not found in Aristotle. The Medieval Church believed any challenge to its dogma was evil, and justified suppression of any variation, and oppression of the individual. The dogma in the church had nothing to do with spirituality and everything to do with maintaining social and political control.[4]

Institutions (corporations) preserve patterns of behaviour and are designed to resist change. In these settings, people say things and do things over and over again. Introducing change requires a process that makes adherents less satisfied with the status quo and more tolerant for change. Change was a major theme of the Enlightenment during the 18th century. Immanuel Kant (1724-1804), a German philosopher, described the Enlightenment as man's emergence from his self-imposed immaturity, and beginning to think for himself. In Kant's view, one should use his intelligence without being guided by others. Kant addressed his messages to the German bourgeoisie (middle class) who seemed resigned to their fate. Kant challenged them: *Dare to know*! Have the courage to use your own intelligence.[5]

In Germany, during the 15th and 16th centuries, feudal lords transformed themselves into feudal princes. They were able to reduce the freedom (feudal rights) of the people under the explanation that they were defending the people from an outside threat, the Emperor. By

the 18th century the princes across Germany had secured control of various states; the people only had the rights and liberties which their territorial princes gave them. They had given up various freedoms held in medieval times; now the prince had the power to determine the content of their freedom.

In Germany during the Enlightenment, reason became an instrument of the state. In contrast, in France, reason was a weapon wielded by the radicals against the state. The territorial princes imposed rational order on their jurisdictions with the sole purpose of maximizing their power. Rationalism (in Germany) became linked to the power of the princes. Enlightenment became a tool of the state to support the status quo. From a distance the French philosophers of the Enlightenment praised many of the German states because of their rational administration which encouraged science and business, and granted religious freedom. In the 18th century, the German middle class did not feel they could do anything to change their lot, thus they adhered to convention.[6] Then Kant admonished the middle class that only through laziness or cowardice would one allow another to control him. To break out of this rut, Kant claimed, required freedom of discussion.

However, the guardian or person/system controlling the individual is not static. As one prepares to take a step to freedom and maturity, Kant noted, the guardian will identify that the step is very dangerous and difficult to achieve. Once the guardian (system) secures control of an individual he/it will go to great lengths to identify the dangers to him if he should dare do something on his own. Kant claimed that the public could only attain enlightenment slowly.[7]

In the 19th century, there was an attempt by Herbert Spencer to apply biology to support economics. Spencer applied the Lamarckian evolutionary theory to the individual, and developed a subsequent theory that supported laissez-faire capitalism. During the latter half of the 19th century, there were two competing evolutionary theories: Lamarckian and Darwinian. In the late 19th century Thorstein Veblen applied the Darwinian evolutionary theory to societal changes that he called 'institutions,' and found that laissez-faire capitalism created two groups, with the rich getting richer, and the income gap between rich and poor widening. Thorstein Veblen adopted Darwin's theory, in his development of institutional economics, to illustrate the importance of changes in society or institutions with respect to the economy.

There was an attempt to apply Newtonian determinism to the social sciences in the 19th century. Herbert Spencer promoted that the theory 'the survival of the fittest' and non-intervention followed a natural law, and allowing the weak and less intelligent in society to die off would be consistent with the progress of civilization. If government interfered in social affairs, it would upset natural order. He claimed government had no role in the affairs of individuals, except to police the affairs of men.

The adoption by libertarians of Spencer's ideas to support minimal government concepts during the 20th century has been problematic. The last time economic problems occurred similar to the shadow banks of 2008, was the Panic of 1907 created by the trusts. At the turn of the century, the trusts (bank-like institutions that seemed to offer a better deal because they operated outside the regulatory system), grew rapidly, only to become the epicenter of a financial crisis. A century later, the same thing happened; shadow banks kept billions and billions of dollars in potential liability off their balance sheets, while competing with investment banks, an area of their business not under the jurisdiction of the regulators.

Where did the middle class come from? During the 1950s, the gradually expanding economy created prosperity throughout North America. The 1950s are considered the decade that eliminated poverty for the great majority of Americans. The decade was associated with the shift from suburban areas to the suburbs, with the supply of housing increasing 27%.[8] With a shorter workweek and increased disposable income, the middle class adopted conservative values. In America, the 1970s and 1980s belonged to the middle class.

From the 1970s to the 1990s the cult of self-esteem thrived in the school system. Rights replaced responsibilities. Self-criticism, self-denial, self-control, and self-sacrifice were no longer in vogue. Self-expression, self-assertion, self-indulgence, self-realization, and self-approval, all which enhance self-esteem, became important. This coincided with the rise of individualism. The self-esteem movement created a population with an exaggerated sense of entitlement in the system. The world, viewed from an emotional rather than a rational perspective, allowed personal feelings to override the distinction between right and wrong. The cult of self-esteem created a group which made decisions based on emotional factors for short term gain. The cult of self-esteem migrated from schools to the work place.

The last two decades of the 20th century saw other forces at work. The philosophy of Ayn Rand, which consists of reason, individualism, and rational self interest supporting laissez-faire capitalism, went main stream. During the same time, Simon Johnson and James Kwak documented the rise of the Wall Street-Washington corridor that provided bankers access to politicians. It was an oligarchy that cashed in on its power for higher and higher profits and influenced changes to the regulation climate that allowed increased risk taking and growth of the housing bubble.[9] Globalization grew quickly during the last two decades of the 20th century, and there was a corporate strategy to advance the corporate agenda behind globalization – developed around the psychology of the inevitable. Communication was designed to reduce resistance to the process by making it seem both highly beneficial, and unstoppable. This led to the perception that governments were unable to halt the progress of globalization, which further weakened the resistance of the individual.[10]

The self-esteem movement created a milieu for extreme individualism. In the culture of extreme individualism, such an individual does not find a way of life based on reason. The culture of extreme individualism ushered in the narcissism that influenced decision-making and accountability. Following the three decades of growth of the cult of self-esteem, individuals in the financial services industry, with self-tolerance and a sense of personal entitlement leveraged the market, and brought chaos on the world financial system in 2008.

In 1998, Gerald Celente, an American trend forecaster, predicted protesters in the streets at the turn of the millennium, as the rich continued to get richer, while everyone else got poorer.[11] In September 2011, protesters actually appeared in the streets with the message: the income inequality is grinding down the middle class and threatening to create a permanent underclass of people able and willing to work, but unable to find jobs. The economy did not rebound for the middle class like the economic shocks of the previous thirty years. People could not, and still cannot find jobs, and those with jobs often owe more on their homes than they are worth. There is concern over income inequality, as the gap between the rich and the middle class continues to grow. The Occupy Wall Street protest educated many more of the middle class that they have been taken advantage of by a financial system that favors the rich.[12] The

Occupy Wall Street voice calls out to the middle class to have the courage to think for themselves, challenge the blind faith and convictions in the present deregulated market, and support interventions to reduce the influence of the dominant institution, the corporation, and the government. The Occupy Wall Street protesters remind us that, since the 2008 financial debacle, there has been no progress on significant reforms of the financial services industry.

The message from the 18th century – consider new ideas – is alive again. During the 18th and 19th centuries it was believed that increased knowledge would allow humans to control the natural world and their own destiny. In the 19th century, Darwin's theory of Natural Selection changed the fundamental view about humanity, its power and its place in the natural world. Darwin's ideas created a transformation of the Western world-view from the Copernican Earth-centered theory in which the individual is the most important element, to man is not the centre of the Earth; he is the same as the other animals. We still realize 'knowledge is freedom,' although due to 'imperfect rationality' and various determinant factors in our biology and environment, it is a bounded and limited freedom. Darwin's ideas have been elevated to the status of a world-view and continue to influence modern thought.

In the past decade, there has been a new revolution of thought about biology. It started with the genome project, which provided less answers than was hoped, and it became obvious that genes that turned others on and off, were key to understanding molecular biology. The main feature of this new information, called epigenetics, was that humans were more sensitive to environmental forces, such as toxins, than was formerly believed.

In the 21st century, this has created a whole new area in which people need to have the courage to think for themselves and challenge existing ideas. Epigenetics is the study of changes produced in gene expression caused by mechanisms other than changes in the underlying DNA sequences. Cancer has conventionally been considered a genetic disorder. However, recent research has demonstrated epigenetic factors to be important in cancer biology. Processes such as aberrant DNA methylation can result in misregulation of gene expression. This leads to the role that certain foods and environmental toxins have on an individual's health. Epigenetics serves to highlight the effects of inequality in living and working conditions, as well as a range of disparities in access to health care and other societal opportunities. Epigenetic environmental, societal and nutritional exposures have more effect on the individual than previously thought.[13] This topic is discussed in greater detail in Chapter 1.

Tobacco smoke is a well-recognized environmental toxin. These toxins can have multiple effects. Tobacco use is the leading cause of preventable disease,[14] disability, and death in the United States. It is responsible for one in four premature deaths in the US. For every person who dies from smoking, twenty more suffer from at least one serious tobacco-related illness. The main addictive drug, nicotine, stimulates the adrenal glands to release adrenaline, which in turn, stimulates the central nervous system increasing blood pressure, respiration and heart rate.[15]

The present state (Chapter 2) is the product of an increasingly deregulated economic system during the late 20th century, and the effects of globalization. Environmental toxins of today created by corporations, past and present, along with changes in the food supply, exacerbate epigenetic harms. Epigenetic changes are at the heart of normal development, so disruptions in the epigenetic modifications disturb normal developmental processes. The consequences are cancer and adult-onset diseases.

The great revolutionary idea of the 19th century was Darwin's theory of evolution by Natural Selection. It transformed our traditional view of our place in the universe. It received considerable resistance from the church then, which continues into the 21st century. Spencer used Darwin's theory to help promote his ideas around 'survival of the fittest'. On the other hand, Thorstein Veblen applied Darwinian principles to evolutionary economics that focused on the role of consumption for status. Veblen became a leading intellectual of the Progressive era, as individuals searched for an economic model with fairness. His evolutionary approach to the study of economic systems is in vogue again, and his model of recurring conflict between the established existing order and new ways is consistent with the new global economy. These processes are covered in Chapters 3, 4 and 5.

Cooperation is the prerequisite for survival of all social animals. Natural selection was considered harsh by many, but closer observation shows that there is a great deal of cooperation and symbiosis in nature. One of the best examples is the symbiosis between the gut flora of each human, a much underappreciated partnership. Important aspects of cooperation in nature, with respect to humans, are covered in Chapter 6.

The immune system (Chapter 7) has a role in controlling the oxidative stress that has the potential to turn genes on and off, causing chronic disease. Interactions with the two most important factors that affect epigenetics, nutrition, (some foods cause health problems while others make us healthy), and environmental toxins, are the subject of Chapters 8 and 9.

Thirty years of deregulation of the economic system have created expectations for minimal regulations. Globalization leads to competition amongst countries for business, which drives down taxes and weakens health and environmental protection. Chapter 10 is about managing risk. It begins with Secretary of Defence Donald Rumfeld's types of information used to make decisions, 'known knowns', 'known unknowns' and the 'unknown unknowns' that exist. These became part of his famous explanation why the decision to invade Iraq was made with what later appeared to be limited information. The chapter concludes with the fact that epigenetic harms require a precautionary approach to risk management, reflecting the need to take prudent action in the face of potentially serious risk often with limited information, while waiting for science to support the decision.

Chapter 11 explores the definitions of equality that have appeared since the Enlightenment, and the role that evolutionary economics can play within the new institutional economics in creating a new model for economic equality. The epigenetic harms dictate a new equality and justice in the system. The present social contract is the result of individualism that developed in the Enlightenment and organized to support laissez-faire economics. Friedrich Hayek could not separate liberty and responsibility. In his eyes, equality was all about the rule of the law. Epigenetics dictates the establishment of a new social contract, consisting of limited freedom, while providing fairness and justice to secure human potential as a new freedom.

Chapter 12, The Future State, is about applying the full weight of science to decisions to generate evidence-based decision-making. This means re-establishing the freedom of the individual, in order to counter the misinformation created by vested interests. This new freedom incorporates equality of individuals based on epigenetic factors. The future state is about the changes required to support a new social contract to address epigenetic harms which, in turn, will reduce long-term health costs and address economic budgetary pressures.

Individualism that was part of the earlier Copernican breakthrough continued right to the present. By the end of the 20th century, individualism, happiness and capitalism were part of the core values of Western culture, supporting laissez-faire capitalism. The great breakthrough (paradigm shift) from Darwin's Natural Selection, that man was not the centre of the universe, as he was no different than any other animal, introduced the concepts of cooperation and synergies associated with social animals, including humans. However, no parallel theory to compete with individualism developed during the 20th century. No one picked up on Veblen's theme.

In the past decade, epigenetics has created a paradigm shift in the scientific community's previous understanding of human development, environmental exposure and disease causation. In particular, exposure to various toxins, called epigenetic harms, can quickly turn genes on or off – triggering various chronic diseases. Society must now consider the need to provide its members with a core of capabilities such that an individual has freedom to choose among alternative lives that he could possibly lead, if not fettered by preventable epigenetic burdens.[16]

It is now necessary to organize society around scientific data generated from the analysis of epigenetic risks to drive policy making. This includes replacing the mechanistic metaphor with the biological metaphor for economics. Risk management needs to be based on the precautionary principles, which means full scientific certainty is not to be used as a reason for postponing measures that prevent adverse effects on human health, if those effects could be serious or irreversible. The precautionary approach can be complemented with technology-forcing legislation.[17] Technology-forcing regulations require a system to allow interaction between regulators and industry, where both the industry's research and development decisions and the regulators requirements are in sync. The current state reflects the environment, as it exists at the present time. It is necessary to ask questions about the past in order to understand decision-making in the present state. The future state is developed using evidence-based knowledge to focus on preventing epigenetic harms.

Chapter 1 Epigenetics

Epigenetics is a rapidly evolving, scientific field of inquiry examining in what way a wide range of environmental, social, and nutritional exposures can dramatically control how genes are expressed without changing the underlying DNA. Epigenetic control of our genes represents a fundamental shift in the way we understand our world. Epigenetics is about integrating genes, the organism and the environment. It is heritable changes in gene expression that do not involve alteration in the sequence of nucleotides. Epigenetics is about influencing a network of chemical switches, within our cells, collectively known as the epigenome. The epigenome is highly sensitive and responsive to environmental influences, including toxic exposure, dietary factors and behavioural impacts.[18]

It appears that environmental factors, diets and lifestyles can change the expression of our genes. Epigenetic changes are natural and essential to many organism functions, but if they occur improperly, there can be major health and behavior effects. Epigenetic changes occur not only in the womb but over the full course of the human lifespan. These changes are often passed on to offspring, that is, environment affects inheritance. For example, an increase in temperature for a short period during embryogenesis for the drosophila fly changes the color of the eyes. The DNA sequence responsible for the color remains the same. Occasionally epigenetic events are passed on as a heritable event. They are becoming important in understanding disease states and syndromes.[19]

There are several processes involved. In one process, histones, the packing material for DNA, can permanently activate or deactivate genes depending on whether they are acetylated or methylated. It is known that modifications in histones are preserved during cell division and are passed on to daughter cells.

Turning the genes on and off can have a profound impact on the form and function of cells and organisms, without changing the underlying DNA. This new pattern can be passed on to future generations. The acquired traits can become heritable if the changes become hard

wired by subsequent genetic change (i.e. changes become incorporated into the DNA). Natural selection, which affects random errors in transcription caused by a change in nucleic acid that affects the development of a protein, can also influence epigenetic changes, and the changes that are beneficial are selected out.

Epigenetic modification, such as DNA methylation, can change the expression of a gene, which determines whether a gene is to produce or not produce a protein. The switching mechanisms are called epigenetics. Genes respond to messages coming from other genes, hormones and nutritional cues. In this case, inheritance is not about what genes we inherit but whether these are switched on or off.

Epigenetics provides a molecular basis for how heritable information, other than DNA sequence, can influence gene function. It is now believed that epigenetics plays a central role in the cause of many human diseases including cancer and birth defects. At one time it was believed that phenotypic variation (an organisms observable characteristics) only occurred as a result of recombination or genetic mutation. Mis-steps in epigenomic programming have been directly implicated in common human diseases. The dramatic increase in rates of obesity, heart disease and diabetes suggest a different cause from gene mutation. Epigenetic dysfunction can be explained by the level of methylation of DNA; too little leads to activation of oncogenes, too much may cause tumour suppressor genes to be silenced. The epigenetic control of imprinted genes can be susceptible to dysregulation. The individual's susceptibility can be passed on to subsequent progeny – exposures from our grandparents' generation might affect our health now, even if we have not experienced the same exposures.[20]

Charles Darwin was not the first person to think of evolution, but he was the first to illustrate the concept of natural selection through the study of nature. Since the new discoveries of DNA and genetics, it has generally been believed that genetic mutations could support Darwin's observations on evolution.

There have been major challenges to species, known as extinction events. The largest occurred over 251 million years ago and formed the boundary between the Permian and the Triassic geological periods. This event was associated with the disappearance of 83% of all genera, and ushered in the age of the dinosaurs. An extinction event 65.5 million years ago formed the boundary between the Cretaceous and the Paleocene period. It was a mass extinction of animal and plant species in a geologically short period of time. It is associated with the disappearance of the dinosaurs and is explained by a catastrophic event like an asteroid impact. Earth is estimated to be 4.6 billion years old, and the oldest rocks that retain cellular fossils, including bacteria, date back 3.5 billion years. This emphasizes the evolution and adaptability of microbes to select an environment that is conducive to their survival. Bacteria, at one time, were believed to be easily controlled by antimicrobial therapy, adapt to many environments and to have learned to survive and protect themselves through gene selection, just as they have survived extinction events.[21]

New studies of sticklebacks challenge the theory that the evolution of a new species usually takes a million years. Sticklebacks are minnow-like fish, usually not more than seventy millimeters in length at maturity. Typically, marine sticklebacks enter freshwater streams to reproduce. After hatching, young sticklebacks return to the sea to grow and mature. During the last Ice Age, marine sticklebacks likely gained access to, and bred in, new streams as the glaciers receded. Scientists believe that, after awhile, some of the young sticklebacks in each stream no

longer returned to the sea to complete their life cycle, but instead stayed resident in fresh water until their death. This process appears to have been repeated many times along the west coast of North America, with the result that freshwater populations in coastal streams and lakes are now common.

Sanford evolutionary biologist, David Kingsley, reported interesting results on studies on the stickleback. Sticklebacks originated in marine (saltwater) environments where they evolved a pelvis that protected them against predators by pushing out its spines, turning them into a prickly swimming pincushion. Over time, sticklebacks spread to freshwater regions, where the prickles were at a disadvantage. In place of their traditional predators, they now faced large carnivorous insects like dragonflies that used the stickleback's prominent spines to nab them as they swam in shallow waters. The freshwater sticklebacks began to lose their pelvises, an adaptive trick supported by the ideas of Darwin. Kingsley's team investigated this further. They knew that both the marine and freshwater stickleback shared a common gene that coded for the pelvis. They reasoned that non-coding DNA was responsible for the gene's expression. In their lab they cloned a piece of non-coding DNA from a marine stickleback and inserted it into the embryo of a freshwater stickleback; the fresh water stickleback developed a pelvis. This is an example of how evolutionary change might occur without mutations in the familiar protein coding DNA, but to other non-coding DNA that regulates how and where the coding DNA expresses itself.

Observations of sticklebacks in lakes in British Columbia provide further evidence that a species can evolve much more quickly than previously believed. Stickleback species pairs in natural distribution, limited to southwestern British Columbia, have been documented in six scattered lakes. These stickleback pairs are closely related and descended from the three spine stickleback, Gasterosteus spp., but are clearly different species. Each stickleback species pair is made up of a benthic species and a limnetic species, so named because of where each is found in the lake and what they tend to eat. Benthics are associated with the bottom of the lake, and as adults forage along the shallow margins of the lake for larger prey, such as snails, clams, dragon fly nymphs, amphipods and worm-like larvae of midges called chironomids. Limnetics are associated with the water column above the lake bottom and, as adults, live in the offshore regions of the lake where they feed on plankton. Benthics have a larger chunky body compared to limnetics. Benthic armor is much reduced while the limnetics have significant gill rakers which allow them to eat very small plankton.[22]

Scientists believe that the stickleback species pairs evolved since the last glaciation, approximately 12,000 years ago. Kingsley's observation on non-coding DNA offers an explanation for the speed at which these distinct fish species evolved, plus how they could evolve independently in six different lakes. In summary, species appear to evolve much faster than originally speculated.[23]

An example of epigenetic changes associated with environmental toxins is tobacco smoke. Formaldehyde is a by-product found in tobacco smoke. Formaldehyde in cigarette smoke coming off the end of the cigarette is at a level three times the concentration of occupational limits.[24] Over time tobacco poisons can build up to huge levels in the blood. Comparing smokers to non-smokers shows that smokers have ten times as much benzene in their breath and ten times as much arsenic in their blood as non-smokers. Studies have found

that chemicals like arsenic, cadmium, and nickel, found in tobacco smoke, stop cells from repairing damaged DNA. This worsens the effect of chemicals like benzopyrene and makes even more likely that damaged cells will eventually turn cancerous. This is well enough established that geneticists now work at characterizing the mutations and epigenetic events that mediate tobacco attributed cancers.[25]

The first reports that smoking caused a significant increase in lung cancer first came out in the 1950s. The Tobacco Lobby set up the Tobacco Research Council that funded studies which suggested there was no cause and effect between smoking and lung cancer, and suggested that air pollution should be considered. In the 1960s, lung cancer was only a few per 100,000 in non-smokers, but over 300 per hundred thousand in smokers.

A long series of court cases, (all of which the tobacco lobby won) were based on a lack of evidence – the relationship was not causally associated. Cancer results when gene mutation occurs which stimulates cells to divide faster than usual. The first cancer studied in detail, was bladder cancer, which was caused by a point mutation in a gene specifying a protein that was part of a cell division accelerator. The companies continued to reject this because the experiments were done on mice.

In 1998, scientists made key observations while studying the tumor suppressor gene p53, the cell's error detection system, proof reading the DNA before cell division, to make sure there was no damage. When it detects DNA damage, p53 halts cell division and stimulates DNA repair enzymes that fix the trouble. Mutations that inactivate p53 remove a key barrier to unrestricted cell division. P53 is inactivated in 70% of all lung cancers, the mutations in the cancer cells almost always occurring in one of three hot spots within the p53 gene. Benzopyrene is a potent mutagen found in cigarette smoke and is absorbed through the epithelial cells of the lung. In the epithelial cells, benzopyrene is chemically altered to benzopyrene diolepoxide (BPDE). BPDE binds directly to the tumor suppressor gene p53 and mutates it into an inactive form. When these mutations in experiments in p53 were examined, they were found to cluster at precisely the same three specific hot spots seen in lung cancer. This was the link proving chemicals in cigarette smoke cause the mutations causing lung cancer. The tobacco companies abandoned their claim that cigarettes have not been shown to cause cancer after this study.[26] An average marijuana cigarette contains nearly 50% more of the carcinogen, benzopyrene, than a tobacco cigarette.[27]

To understand the evolution of epigenetic harms we will consider polychlorinated biphenyls, PCBs, (a family of over 200 related compounds) which are found in the environment. Low levels are found all over the world in air and water, caused by accidental releases and improper disposal practices in the past. Once PCBs get into the environment they accumulate in the cells of animals. The highest concentrations are found in animals at the top of the food chain, including humans. PCBs are fat soluble, which is why they build up in the food chain. Human exposure is from meat, fish, and poultry. Everyone is exposed to small amounts of PCBs through food, and to a lesser extent, air and water. Everyone has PCBs in their body, as it is very stable and accumulates in the body and remains there for years. PCBs are typically ten times higher in indoor air compared to outdoor. The highest concentrations are found in the liver, fatty tissue, brain and skin. One way to reduce one's exposure is trim the fat when eating steak and, when eating sport fish, discard the inner organs, any fat and skin.

When animals are exposed to low doses of PCBs, it interferes with liver and thyroid function and, in the long term, can lead to liver cancer. Also, exposure is associated with problems with the immune system, as well as reduced fertility. There is concern for marine mammals because PCBs can reach high concentrations and, as such, may affect the survival of the species (through reduced fertility). In man, PCB exposure has been associated with cancers of the digestive system, liver and skin. It is also linked to reduced fertility in women and lower mobile sperm counts in men. Some believe it also has neurological health effects.

It is now believed that the vast majority of cancers are not caused by inherited factors, but by environmental and behavioural factors, such as chemical pollutants and unhealthy lifestyles. In the NCI identical twin study, the identical twin has a 90% chance of *not* getting the same cancer as the affected twin. It is now believed that the Environmental Protection Agency (EPA) underestimated the health effects of eight combined chemicals, which may have had an additive or multiplier effect. In addition, some lab experiments were weak because they did not control for the other toxins that PCB was typically contaminated. It may be harder to estimate cancer rates now, because autopsy rates in Canadian and American hospitals have dropped so low.[28]

There is a complex story behind the rise and fall of PCBs in the world. In the 1930s, the electrical industry began to grow. PCBs became an important component in electrical equipment like transformers and capacitors. It was a story of deception and cover up of the extent of the problem caused by the toxicity of PCBs by Monsanto, GE and Westinghouse. In 1969, the Monsanto plan included "make the government, states and universities prove their case, but avoid as much confrontation as possible."[29] This was at a time when Monsanto had not officially notified all customers of the effects, nor was the proper labelling of the product in place. There was also the disconcerting practice of destroying waste records after four years. Even up to 1973, Monsanto was stating, "PCB has always been considered less hazardous than many of the other chemicals in everyday use."[30]

In 1975, following a two year study of the effects of PCB on rats, Monsanto researchers documented the chemical "had caused some tumors." Monsanto's manager for environmental assessment and toxicology wrote to the lab's director, "May we request that the (PCB) 1254 report be amended to say 'does not appear to be carcinogenic.'" The final report adopted the suggested language from upper management and dropped all reference to tumors. The following year, Congress passed the Toxic Substance Control Act outlawing the manufacture, sale and distribution of PCBs within three years, except in totally controlled systems. PCB became the only chemical that Congress itself had ever banned.[31]

In the 1980s, Monsanto began funding phony 'public interest' groups, such as the American Council on Science and Health, under the umbrella of consumer education, to defend Monsanto's products, including PCBs, the herbicide 2,4,5,T, the artificial sweetener, NutraSweet, and recombinant bovine growth hormone. The herbicide, 2,4,5-T was marketed as a mixture with 2,4, D (and the dioxin, TCCD, a by- product of the manufacture of the weed killer). The product was used as a defoliant in Vietnam under the name of Agent Orange, and for highway maintenance in North America. Agent Orange could have been manufactured with little dioxin contamination, but dioxin was the by-product of the deliberately accelerated production of 2,4,5-T.[32] Veterans of Vietnam have a class action lawsuit over their exposure and

a causal association with various cancers.[33] A Canadian program pays out compensation to personnel (about 5,000 cases) exposed to Agent Orange, sprayed at CFB Gagetown (New Brunswick) in 1966 and 1967 by the U.S. military, with permission from Canada.[34]

NutraSweet has the most controversial history of any food additive in history, but is now found in 5000 foods. It has no calories and has been considered a boon. The G. D. Searle Company held the patent for aspartame, the active ingredient in NutraSweet. In 1973, they applied to the Federal Drug Administration (FDA) to use aspartame in food sweetener. The FDA rejected the request because of inadequate toxicology information. Following a complaint to the FDA, an inspection of Searle labs found testing procedures shoddy, full of inaccuracies and "manipulated test data." This, in turn, triggered an FDA investigation, and the justice department initiated a grand jury probe. In an effort to turn their fortunes around, Searle brought in a Washington insider, Donald Rumsfeld, as the new CEO. Various manoeuvring created numerous delays in the Searle grand jury investigation, such that the statue of limitations ran out on the aspartame charge. In 1980, a Public Board of Inquiry recommended aspartame not be approved pending further investigation of brain tumours in animals.[35] In 1981, Ronald Reagan came to power. Reagan's transition team, which included Rumsfeld, CEO of Searle, hand picked Arthur Hall Hayer, Jr., with background in the defence industry, to be the new FDA chairman. In July of the same year, Hayer ignored advice of internal scientists at the FDA, overruled the Public Board of Inquiry decision, and approved NutraSweet for dry products.[36]

In October 1982, Searle filed a petition with the FDA that aspartame be approved as a sweetener in carbonated beverages and other liquids. In July 1983, the National Soft Drink Association used the FDA to delay approval of aspartame for carbonated beverages pending further testing because it is unstable in liquid form. When liquid aspartame is stored in temperatures above 85 degrees Fahrenheit it breaks down into DKP and formaldehyde, both of which are known toxins. By the fall of 1983, the first carbonated beverages containing aspartame were sold for public consumption. In 1985 Monsanto purchased G. D. Searle & Company, and the aspartame business became a separate Monsanto subsidiary.[37]

There were citizen groups concerned about aspartame's expansion. In April 1986, the US Supreme Court, headed by Justice Clarence Thomas, a former Monsanto attorney, refused to consider arguments from the Community Nutrition Institute and other consumer groups that the FDA had not followed proper procedures in approving aspartame, and that the liquid form of the artificial sweetener may cause brain damage in heavy users of low calorie soft drinks. A 1987 FDA report on adverse reactions associated with aspartame stated that the majority of the complaints, numbering 3,133, referred to neurological effects. By 1994, aspartame accounted for 75% of all complaints sent to the FDA.

In 1998, *The Ecologist,* Britain's leading environmental magazine, noted that, over the years key government figures at FDA and other regulatory bodies have either come from and gone on to hold senior positions at Monsanto. This has greater implications than just the NutraSweet story. For example, the FDA determines the PCB levels allowed in the US food supply. The present standard is 2 ppm PCB for commercial fish, 3 ppm for fish and 1.5 ppm for eggs.[38] The Great Lakes region, with a significant PCB contamination problem, has a much stricter standard set by the region's states. Remediation of the Great Lakes is a major challenge;

the Great Lakes have 20% of the world's fresh water with less than 1% of the water flowing out of them (nearly a closed system).

In 1996, the FDA removed all remaining restrictions on aspartame. The same year, Dr. John Olney, neuroscientist and authority on excitotoxins (substances added to foods and beverages that damage and eventually kill neurons), published a report in a peer reviewed journal on research showing that brain tumor incidences have risen in parallel with aspartame consumption and, during this same period, there has been a significant increase in the conversion of less deadly tumors into much more deadly ones. A *60 Minutes* investigation, in December 1996, reviewed 165 studies over the previous twenty years on aspartame, in peer reviewed medical journals. Seventy-four were industry funded, all of which attested to aspartame's safety. Of the 91 non-industry-funded studies, 84 identified adverse health effects. Six of the seven non-industry-funded studies considered favourable to aspartame were from the FDA. For some reason, the industry-funded studies are given the greatest weight during the approval process and in official safety reviews.[39]

The year 1997 coincides with a study linking PCB to cancer in electric utility workers and Monsanto spinning off the chemistry division to Solutia, Inc. This restructuring allowed Monsanto to divest itself of billions of dollars in environmental clean-up costs and other liabilities. Solutia was set up with a billion dollars in debt and environmental and litigation costs, and eventually was forced to seek Chapter 11 bankruptcy.

In 1999, it came to light that aspartame was being manufactured using genetically engineered bacteria to produce more phenylalanine. Monsanto claimed they did not reveal this previously because no genetically modified DNA remained in the finished product. In May 2000, Monsanto sold NutraSweet to J. W. Childs Associates, a private equity firm composed of former Monsanto managers. This helped stay ahead of the negative publicity over genetic engineering, particularly from Europe. Monsanto completed its metaphorphasis into a biotech company with cash flow from the success of its new herbicide, Round-up (glyphosate). Glyphosate remains the world's greatest herbicide by volume of sales.

By 2004, the US consumers accounted for the majority of the world's aspartame use. In 2005, a Spanish group involved in cancer research, released the results of a large, long-term animal study that showed aspartame causes lymphoma and leukemia in female animals fed daily doses of 20 mg per day per kilogram body weight (around half the accepted daily intake for humans).[40]

Aspartame is classified as a excitotoxin like glutamate, hydrolyzed vegetable protein and cysteine. Excitotoxins are neurotoxins that react with specialized receptors in the brain that can lead to the destruction of certain types of neurons. When subtoxic levels of these neurotoxins are given to animals in divided doses, the animals experience full toxicity (a synergistic effect). The liquid forms of excitotoxins, such as found in soups, gravies and diet soft drinks, is more toxic than those added to solid food. The common glutamate additive, called free glutamate, is mono sodium glutamate, MSG.

Others point out that glutamate is found naturally in food, both as free and bound form. Bound glutamate, found naturally in food, which is less dangerous, is slowly broken down and absorbed by the gut, so it can be used by muscles before toxic levels build up. Hydrolyzed vegetable protein is prepared in such a way that it contains free glutamate and cysteic acid (an

intermediate product in the oxidation of cysteine). When food is flavoured with hydrolyzed vegetable protein, the amount of glutamate does not need to be listed. Glutamate has nothing to do with preserving food or protecting its integrity, only enhancing flavour. There are no long term studies on effects of excitoxins on the brain, or neuro-endocrine effects. No one has done any studies to determine whether or not MSG aggravates neurodegenerative disease.[41]

Dr. Russel Blaylock, a neurosurgeon, put out a pilot aspartame alert warning pilots not to use diet (aspartame) drinks (to control weight in sedentary job), based on anecdotal cases. The common complaints of these cases included disorientation, difficulty thinking and concentrating, visual blurring or even monocular blindness, seizures and heart failure. Aspartame, as well as its metabolic breakdown products, has deleterious effects on the nervous system and retina.

A study in 2005 identified that 287 chemicals, including PCBs, mercury, fire retardants, pesticides and Teflon chemicals (PFOA), have been found in the cord blood of babies in the US. Of these chemicals, 180 of them cause cancer in humans and animals, and 217 are toxic to the brain and nervous system. While many nutrients and toxicants, such as endocrine disrupters (chemicals that are fake hormones which may disrupt or enhance the function of a natural hormone), do not promote genetic mutation or alterations in DNA sequence; they have the capacity to alter the epigenome, in which cases messages become misdirected in cancer and other human disease syndromes. Further studies are needed to determine the extent of an epigenetic link to neurodegenerative diseases.[42]

Epigenetic risk is not merely a medical issue, but more generally implicates the underlying fairness and justice of our social contract. How we develop mentally or physically has a tremendous impact upon our inherent capabilities and our set of life options. It raises questions: (1) what impact does the particular epigenetic risk have on the individual's ability to exercise free choices, (2) are these risks avoidable, (3) how are these risks distributed across society.[43]

There is considerable excitement about using information from epigenetic research to develop drugs for treatment. However, intervention also includes a prevention strategy. Chemicals like PCB and dioxin have been around for a long time. Limiting the current environmental exposure could prevent the harmful epigenetic changes that cause disease. Contaminants like PCBs are one of the toxicants known to cause epigenetic changes in humans. Exposure of the contaminant dioxin to prenatal mice causes improper immune function later in life, and also reprograms the fetal immune system.[44] Further studies in humans are required to elicit the mechanism of toxicity. In addition, further studies are required to determine the contribution of excitotoxins to the burden of neurodegenerative diseases.

In 2011, a study done by a group of researchers from Canada and the United Kingdom analysed the samples of forty people from the UK who were born in 1958. They looked at two cohorts from two economic extremes: children whose fathers were unskilled workers, and those whose dads were company CEOs or Oxford / Cambridge graduates. The study showed significant differences in DNA methylation patterns depending on the standard of living conditions during the subject's childhood. The conclusions – the living conditions in early life can have a lasting widespread effect on epigenetic triggers.[45]

Individuals exposed to environmental toxins will need health-care services to monitor epigenetic effects. Unfortunately, many of the individuals most likely to live and work with

hazardous exposures are the least likely individuals to have regular, timely, and comprehensive health care. In reviewing PCBs and excitotoxins, it is hard to escape the nagging feelings that studies on safety, toxicity, immunology and developmental markers, were inadequate. The epigenome is highly sensitive and responsive to environmental influences, including toxic exposures, dietary factors, and behavioural impacts. Preserving human potential as freedom, and addressing the role epigenetics plays in human development and disease causation, includes a framework for regulating epigenetic harms.[46]

Chapter 2 The Present State

In 1999, the Institute of Medicine (IOM) released a study that estimated the number of deaths and adverse outcomes caused by medical errors. The beneficial result of the IOM study was that health-care workers and health-care providers realized they urgently needed to fully and effectively incorporate 'risk' as a crucial component of their management. Risk is composed of hazard, harm and severity. Hazard is a potential source of harm, like moral hazard. Harm is injury or damage to the system. Severity is the measure of the possible consequences of a hazard. In risk analysis, one makes systematic use of available information to identify hazard and to estimate risk, making use of historical records and information from process mapping. In other words, risk can be detected and managed.

The ideal risk management systems develop a proactive approach. This involves constructing a root cause analysis of systems and structures in advance of risks actually happening. Once risks are identified they must be assessed for their potential severity of impact (generally a negative impact or loss) and to the probability of occurrence. In the assessment process it is critical to make the best-educated decisions in order to properly prioritize the implementation of the risk management plan. Even a short-term positive improvement can have long-term negative impact (on risk reduction). The present state consists of identifying the potential epigenetic risk from food, water and air. It is important to understand the role of industry in this risk.

Let us look at the history of risk reduction with respect to cigarette smoking. Tobacco was first grown in Virginia in 1612, and within seven years became the colony's largest export. Over the next two centuries, the growth of tobacco as a cash crop fuelled the demand in North America for slave labor. Cigarettes did not become popular until the development of automated equipment to make them in the 19th century. The tobacco industry was set up to reap huge profits. During the 1940s, tobacco companies promoted the health benefits of cigarettes – preventing colds and relaxing individuals. Lung cancer was rare in the early 1900s but, by the mid 20th century, it had become an epidemic. A 1950 medical report identified a causal association between the smoking of cigarettes and lung cancer.[47]

In 1952, a *Readers' Digest* article decried the negative health consequences of cigarette smoking. The following year was the first year in two decades that the sale of cigarettes dropped. The tobacco industry responded with the Council for Tobacco Research. This was the

beginning of a survival strategy. This meant denying the health consequences of smoking, deceiving customers about the true nature of cigarettes through marketing and PR, as well as damaging the credibility of industry opponents. This included introducing distractions by drawing attention to other agents like radon gas, asbestos, arsenic, silica, and chromium. From the marketing prospective, this involved the introduction of filters and low tar, emphasizing improvement in taste, while remaining silent on health effects. The tobacco companies joined many associations who typically oppose taxation. The tobacco companies promoted themselves as supporters of freedom of expression, but blocked making available any information linking smoking to death or negative outcomes.

In 1964, the Surgeon General's report summarized the dangers of cigarette smoking: "cigarette smoking is causally related to lung cancer in men."[48] In 1965, there were regulations in place requiring the Surgeon General's warning on all packages. By 1971, TV advertising was banned; initially scheduled for January 1st, it was delayed one day to allow a glut of Super Bowl ads. In the late 1980s, sponsored sporting events were the principle means by which the cigarette companies subverted the 1971 ban on TV advertising. The TV camera picked up the messages many, many times in the background during the events.[49]

The mission of the US based Council for Tobacco Research (CTR) set up in 1954 was to create a body of evidence that the industry could use to keep 'open' the scientific debate. In 1964, the Special Projects division was organized and directed by lawyers. The division provided funds for particularly touchy projects. This arrangement allowed the company to invoke confidentiality of the lawyer-client communication, to keep undesirable results buried. Now the analysis of research results by lawyers determined ongoing funding of projects, rather than being driven by scientific merit. Project results were used to create positive publicity for the industry and to shift attention away from tobacco as a health risk. In this system, all potentially damaging, internal, scientific documents were under lawyer control, thus making them 'privileged' information, unattainable by suing the company. Eventually, important documents were moved off shore and employees instructed to not make lists or notes of the documents being moved.[50]

Anti-smoking lobbies continued to grow. The tobacco companies fought back with an army of PR specialists, lawyers and lobbyists. They developed political connections in the US and donated heavily to members of congress and state legislatures. Also, the companies made significant charitable contributions in an effort to enhance public opinion. Lawyers vigorously defended law suits brought by smokers for smoking-caused disease or death. Even when they lost, they would appeal. This is illustrated by the Cipollone case; the court initially awarded funds, the lawyers for the tobacco companies appealed, the settlement was overturned, the plaintiff died, and the family dropped the suit as they were unable to afford continued litigation. In 1961, a memo to a Phillips Morris executive from a research director identified fifteen compounds in cigarette smoke as carcinogens and two others as cancer promoters. The lawyers involved in health-related research on smoking concealed new information about the health consequences of smoking, and continued to deny that smoking was harmful. There was ongoing public deception as they promoted processes to deny that regulations will reduce smoking.

Another format was to sponsor symposium to which sympathetic scientists were invited to present non-peer reviewed material. One such event was organized to publicize research

denying harm from ETS (environmental smoke or second hand smoke) in 1989. Tobacco companies rented a room at McGill University to hold such an event. The symposium proceedings were published in a book that was referred to as the 'McGill University Symposium'.

The tobacco companies were involved in nicotine manipulation. For decades the industry concealed the knowledge that nicotine was addictive (before it came out from the scientific community), insisting it was involved only in taste. A paper in 1945, supported by the American Tobacco Company (ATC), concluded that "with some individuals nicotine becomes a major factor in the cigarette habit."[51] From 1940 to 1970, the ATC funded research to develop methods to increase nicotine in cigarettes. In Canada, the federal Department of Agriculture conducted research funded by the tobacco companies that successfully bred tobacco plants with much higher nicotine levels than normally found in Canadian crops. A 1995 study found that the concentration of nicotine in Canadian cigarettes had risen substantially over the period 1965 to 1995. Studies by the Royal College of Physicians in the United Kingdom concluded that nicotine causes addiction in much the same way as heroin and cocaine, and is just as addictive, if not more so, than these 'harder' drugs.[52]

In its day, the tobacco industry was one of the most profitable businesses. In 1990, the US realized a $4.2 billion trade surplus in tobacco products. In 1993, cigarette promotion expenditures in the US exceeded $6 billion. In 2002, the Centers for Disease Control and Prevention (CDC) estimated smoking related medical costs of $3.45 per pack, and job productivity lost because of premature death from smoking at $3.73 per pack. The tobacco industry was aggressively moving into developing countries to enhance the industry's future.[53] For the longest time, the tobacco companies countered that statistical associations do not constitute proof, another premise of a lack of proof beyond any doubt that lung cancer is one of the harmful effects of smoking, was their defense. The tobacco industry stance has long represented a legal and political strategy rather than a manifestation of any genuine scientific debate.[54] However, today, the medical proof that tobacco causes cancer consists of the multiple epidemiological studies that have been published in peer reviewed journals.

In 2003, Phillip Morris rebranded to Altria. This followed the failure of a multi-million dollar campaign touting their charitable work. From 1998 to 2004, Altria ranked number two with $101 million contributed in lobby fees, with focused lobbying against price increases (a well known deterrent to smoking).[55]

Today there is concern about the ongoing risk between fat and heart disease. In 1957 the American Heart Association's heart healthy diet recommended the general public limit fat and caloric intake as it may influence heart disease. The report recommended consuming less saturated fat and more unsaturated fat. During the 1960s experts ramped up the message to 'fat is bad.' This ushered in the era of fear of fat in North America. The demand for retail beef dropped 47% from 1970 to 2004. This was associated with the dissemination of health information – the association of red meat consumption on blood cholesterol levels and heart disease. The demand for beef dropped dramatically. The downturn in the market created changes in the cattle industry. The cattle industry responded to the demand for less fat with the introduction of exotic cross breeding of cattle to produce meat with less fat. The industry shrunk and became very competitive. Feeder cattle moved to the corn belt states for feeding.

In the 1970s, this coincided with a switch from grass fed cattle to feedlot fed cattle. This was faster and more profitable, taking an 80 pound calf to 1200 pounds in sixteen months (which can't be done on grass). This is achieved with a combination of corn, protein supplement, antibiotics and growth hormone (maximizing utilization and profit). The result is well marbled flesh, saturated with fat that can be trimmed off. The USDA grading system favors marbling, the intramuscular fat that cannot be trimmed off. Farm subsidies supported the switch from mixed farming to the monoculture of corn.

The challenge is grass fed cattle meat tastes different, and it is more expensive, as the cattle need to be fed for a longer time and a lot more grass. Under present land use, there is not enough pasture to feed 100 million US cattle. Since their availability in the late 1990s, farmers switched to genetically modified corn with increased yields from 100 to 160 bushels an acre. The price of corn remained the same, putting the farmer on a treadmill of increased costs of genetically modified corn and fertilizer. The market pressures at present do not support a change.

From the epigenetic risk aspect for man, this was a bad development. The omega-3s and-6s are types of polyunsaturated fats called essential, because we get them from food; our bodies can't manufacture them from other fats. The switch from grass-fed beef (with a ratio of 3:1) to grain-fed beef (with a ratio of 20:1), created a problem. Scientific experiments determined that if the ratio of omega-6 fats to omega-3 fats exceeds 4:1, people have more health problems.

Consumers can lower their risk of chronic diseases like cardiovascular disease and cancer by eating pasture fed beef. However, the grading system gives higher grades to younger cattle (18-24 months), as well as degree of marbling. This favors cattle raised on corn in feedlots. The USDA gradient system does not even consider grain fed beef; it awards the highest grade to corn fed cattle (that are brought to market sooner containing a higher level of saturated fats marbling).

In the 1970s, another dietary change occurred – high fructose corn syrup (HFCS) came on the market. Archer Daniels Midland (ADM) controlled 35% of the HFCS market. The ADM chairman promoted the company through lobbying and political contributions to both Republicans and Democrats. In 1980s Washington limited the imports of sugar, forcing up the price of sugar. Sugar subsidies were introduced, restricting imports to ensure domestic producers maintained at least 85% of the domestic market. The sugar subsidies were meant to support the sugar cane growers and the sugar beet growers, keeping sugar prices in the US about 50% above world-market prices. Half of the US sugar comes from Florida. With 10,000 sugar cane related jobs in a swing state like Florida, the subsidies remain protected. The price of sugar rose to a level much higher than high fructose corn syrup, causing a whole scale switch to many products containing corn starch, corn flour and corn syrup. In addition, corn syrup was easier to transport and produce, easier to store, easier to mix into food and actually tasted sweeter. HFCS-55 has 55% fructose content and is used in soft drinks, baked goods, candies, candied fruits, jams and dairy products like yogurt and ice cream for thickener.[56]

The increase in the per cent of the population with metabolic syndrome, (a combination of risk factors – abdominal obesity, high triglycerides, high blood pressure and high blood sugar), has paralleled the rise in the use of high fructose corn syrup (HFCS) which, in turn, leads to concern about the risk of sugar. In particular, drinks sweetened with HFCS have high levels of

reactive carbonyls, highly reactive compounds associated with unbound fructose and glucose molecules that are believed to cause tissue damage. Levels of reactive carbonyls tend to be elevated in people with diabetes. Reactive carbonyls are not present in drinks made with (cane) sugar. HFCS does not suppress the appetite as efficiently as cane sugar, is metabolized differently leading to an increase in blood triglycerides level, an indicator for risk for cardiovascular disease.

The most common type of diabetic insulin resistance is due to the build up of body fat. Princeton researchers demonstrated that rats fed equivalent calories gained more weight on HFCS than on regular sugar. In addition, long term feeding of HFCS led to increases in body fat, particularly in the abdominal area of the rats.[57] Both table sugar and high-fructose sweetener contain four calories per gram, so calories alone are not the key problem with high-fructose corn syrup. Rather, metabolism of excess amounts of fructose is the major concern.

While it is derived from a natural source, HFCS is essentially an unnatural product, formed by the enzymatic digestion of corn starch. For most of human history, we consumed no more than about 15 grams of fructose per day (approximately one-half ounce), mostly from fruits and vegetables. In contrast, daily consumption in 1997 was estimated to have increased to 81 grams (nearly three ounces) per day. For the first time in history, humans are consuming fructose at extraordinarily high levels.[58] HFCS accounts for 50% of all added sugars in the US diet.[59]

In the present state genetically modified (GM) foods remain controversial. There has been a flurry of GM crops introduced in the past thirty years – the most predominate one being corn, which is linked to the meat industry and to corn syrup (sugar subsidy). The introduction of GM crops was heralded as a new era for agriculture (based on the public relations program) – crops would be high yield, drought resistant, and salt resistant. After three decades, the only deliverables were two traits: herbicide resistance and insect resistance. Today, two-thirds of the corn crop in the USA is GM, with Monsanto controlling the biggest market share.

Enough time has passed to provide a report card on GM corn; it does not yield more than conventional crops and is associated with a higher incidence of infertility and early term abortion in cattle and hogs fed GM corn. In addition, the heavy use of glyphosate (the main ingredient in Round Up), is toxic to beneficial soil bacteria (that immobilize plant nutrients), and may be causing fungal and root diseases in plants.[60]

The appearance of glyphosate resistant weeds in several states is disconcerting; in the summer of 2010, the identification of rootworm beetles, resistant to the insect killing protein derived from *Bacillus thuringiensis* that is incorporated into the corn plant, is troubling.[61] Growing Round Up ready corn year after year on the same field facilitates the development of super weeds, superbugs and soil depletion. Farmers are ignoring crop rotation, which was introduced during the Middle Ages and responsible for increased agriculture production.

Why were there no warnings? In 1999, British scientists' careers were ruined because they published studies warning of potential health dangers from genetically modified food. These studies identified smaller brain size in rats fed biotech food, were associated with lowered immunity, organ damage and infertility. This information was suppressed for the biotech industry lobby.[62]

There remain unresolved issues in circulation. With the proposed release of GM alfalfa, there is no assurance of cross contamination of natural alfalfa. With the honeybee die offs still unresolved, pesticides remain the main suspect, and one is left wondering who is in charge of keeping an eye on the big picture.

Toxins in the air and water need to be better quantified, and the risks monitored. At the present time there is concern that balancing the fiscal budget of the federal government will leave the FDA and EPA with fewer resources. Some believe that the EPA did an underestimation of the health effects of eight combined chemicals, which may have had an additive, or multiplier effect (some lab experiments did not control for other toxins). The FDA needs further studies on chemicals like excitotoxins to establish the toxicity of exposure to multiple agents at the same time, and the long-term side effects of excitotoxins, in particular, at what level they become a co-factor in neuro-degenerative disease.[63]

With respect to the environment, there are emerging contaminants such as hexavalent chromium. Hexavalent chromium is a human carcinogen when it is inhaled. It may also damage small capillaries in the kidneys and intestines. This chemical is produced during the production of stainless steel, and its anti-rust properties. The Erin Brockovitch story is about a legal clerk coming across some real estate deals in a small town in California (associated with a strange disease). The town was a dump site for toxic chemicals (hexavalent chromium) that were getting into the ground water.[64] There are lawsuits in California from known contamination of groundwater by hexavalent chromium from actions taken by Pacific Gas and Electric. In a recent study, 80% of 35 city water systems found hexavalent chromium concentrations at higher than the 'safe minimum' (0.02 parts per billion) proposed by California regulators.[65] The EPA did not have guidelines concerning the level at which hexavalent chromium becomes a public health hazard. This is an example of the monitoring agencies (EPA) being behind the curve, emphasizing the need for resources, just even to catch up with an event (toxin).[66]

Other emergent contaminants include fluorinated products, used to make fluropolymers. A typical product is perfluorooctanoic acid (PFOA) and fluorinated telomers used in the production of such products as Teflon and Gor-tex. The chemical is also called C8, a synthetic chemical that is very persistent in the environment. It can be found in the environment and blood of the general US population in low levels. The problem is that it remains in people for a very long time and causes developmental and adverse effects in laboratory animals. There is an agreement with the manufacturers to reduce global facility emissions, as well as looking for alternatives to PFOA.[67]

Another emerging contaminant is flame retardant. The chemical for consideration is polybrominated diphenyl ethers (PBDEs), widely used as flame retardants in furniture, carpets, and plastics, up to 2004. This chemical has been found to impair women's fertility, and disrupt children's cognitive development. In studies more than 95% of Americans have PBDEs in their blood . Researchers from CDC and Columbia found that higher concentrations in the umbilical cord blood at birth were associated with impaired psychomotor, impaired mental and verbal development later in life. The EPA is being proactive in reviewing other fire retardants and limiting their role as necessary. One of the problems leading up to this was the chemical industry's use of trade secret rules to obscure the health risks of thousands of chemical products. This barrier has just come down, and the EPA has developed a database that contains

available toxicity reports, and a list of chemicals in various products that toxicologists and scientist can use for studies.[68]

Another group of emerging contaminants is pharmaceuticals and personal care products. These include any products used by individuals for personal health or cosmetic reasons, or used by agribusiness to enhance health or growth of livestock. These chemicals include prescription, over-the-counter therapeutic drugs, veterinary drugs, fragrances and cosmetics. Many pharmaceuticals are present in water systems, and certain drugs can cause ecological damage. These chemicals are easily dissolved, but many are not removed during effluent treatment. There are ongoing studies to determine long-term effects, as well as the levels of many of these chemicals in fish tissues.[69]

Another group of emerging contaminants is endocrine disruptors. Endocrine disrupters are substances that may alter the endocrine system (consisting of glands, hormones, and cellular receptors that control a body's internal functions) and may cause developmental or reproductive disorders. Environmental exposure of these chemicals causes adverse health effects in human and wildlife populations. In 1996, through the Food Quality Protection Act, the US Congress directed the EPA to screen pesticides for estrogenic activity in humans. The same year, the Safe Drinking Water Amendments (SWDA) authorized the EPA to screen drinking water for similar activities. Exposure to endocrine disruptors can occur through direct contact with pesticides and other chemicals, or through ingestion of contaminated water, food, or air. Chemicals suspected of acting as endocrine disruptors are found in insecticides, herbicides, fumigants and fungicides that are used in agriculture, as well as in the home.[70]

In the present state, the economic debacle of 2008, left the impression that an increasingly deregulated financial system was more fragile than believed, especially since it couldn't self-correct as expected.[71] The world economic system remains volatile. The economic downturn has reduced tax revenue putting many governments in increased deficits, and increased deficit reduction strategies. This occurs at the same time as epidemics of obesity and diabetes, if left unchecked, will bring on significant costs of chronic diseases, in the near future. Financial risk reduction must be part of the future state.

The type of risk in the future requires a risk avoidance path to address identified risks to reduce the severity of the loss or the likelihood of the loss occurring. Risk reduction can be done at multiple levels. At one level this includes discontinuing the practice of employees from industry – the big banks, agribusiness – from rotating through agencies that regulate these businesses. These arrangements create issues for risk management of commodities such as pesticides and financial instruments. At another level, this means taking action to assess the environment for potential harms, and in particular, developing processes to avoid harms associated with epigenetic risks.

Risk assessment is the overall process comprising a risk analysis and a risk evaluation. What is 'enough risk reduction?' Risk reduction must include epigenetic data in our risk evaluation. As information on epigenetic risk accrues – risk management includes determining the acceptability of risk. Let us review epigenetic pressures that can cause chronic disease. The process established a significant risk event from tobacco use, corn fed beef, high fructose corn syrup diets, and ongoing chemical contamination of the environment. The risk management

process must include these potential risks, and the subsequent steps to reduce the possibility and/or impact of the risk.

The actions of the tobacco industry provide a window to past history of implementing changes to reduce the risk from an environmental toxin, cigarette smoke. The industry spent a great deal of resources in damaging the credibility of industry opponents, and contributing to lobbying fees against such interventions as tax rate increases in cigarettes. Eventually, public health tobacco reduction strategies led to the reduction of tobacco use, and reduced the burden of lung disease. This is an example of social media and legislation reducing epigenetic harm.

With respect to epigenetic harms four major areas of risk were identified: (1) fats in the diet, (2) sugars in the diet, (3) emerging toxins not monitored adequately., and (4) increased economic challenge due to reduced revenues from recession and onslaught of increased costs from chronic disease.

The consequences of the first two areas of risk include the disease burden from the obesity and diabetes epidemic, and increase in neuro-degenerative disease. Chronic diseases are aggravated by exposure to environmental toxins in food, water and air. Changes need to take into account epigenetics, gene expression modifications that can persist in the absence of the conditions that established them. This can be achieved by reducing the exposure of the human organism to oxidative radicals. In food, this is achieved by such actions as the increased availability more grass fed meat, which has the proper ratio of omega-3 to omega-6.

Changes must address the importance of food in epigenetics and the fact that much of 'food safety' is in the hands of factory farms and corporations. The introduction of change must assure the organization (economy) continues to function.[72] Addressing the root cause of these will reduce both acute and long-term medical costs. A top priority is the existing regulations and controls, assessing their adequacy relative to the potential threats (to the organization). There is a need to change the process of industry employees rotating through management jobs at the government regulatory bodies to reduce the opportunities to influence regulations in favour of industry.

It is not easy to avoid environmental toxins or contaminants. People may have no choice where they live or what water they drink. Toxins in the air or water have the potential to trigger epigenetic events like lung cancer or cancer in electrical workers exposed to PCBs. Air currents can carry toxins large distances, exposing plants, animals and water supplies.

Epigenetics represents a fundamental shift in the way we understand our world. Epigenetic hazards are the main harms identified in the present state. The consequence of the harm is the ongoing epidemic of chronic disease. The plan for addressing epigenetic harm must include providing adequate resources to evaluate and monitor epigenetic risks. History suggests that industry will use disinformation programs to slow down change and maintain the status quo. However, management of risk requires further ongoing evaluation of potential toxicants in food and the environment using sound science. Risk can be managed by changes that include strengthening the role of regulatory agencies, particularly those involved with banking, food, and the environment, in order to keep the whole system moving forward, being productive and profitable. In the long term, they are all inter-related – budget sustainability is achieved by controlling the costs of chronic diseases.

The Occupy Wall Street protesters reminded us that, since the 2008 financial debacle, there has been no progress on significant reforms of the financial services industry (to reduce the risk of reoccurrence). Part of the action plan for a future state is understanding, acting on, and communicating new ideas. This will require a significant change in mindset, in order to move in the direction of the ideal state. The challenge is not to just change a few things within the current process, but to change the process. Lessons on introducing new ideas can be gained by studying the challenges to change that occurred during the Enlightenment. Answers will be found through science rather than opinion or tradition.

Chapter 3 From Enlightenment to Evolution

The Enlightenment era (included some of the 17th century and much of the 18th century) ushered in revolutionary ways of thinking. Following Isaac Newton's discovery of universal gravitation, many believed that by applying reason it would be possible to unlock the laws of the universe. The desire arose to question all established ideas and values and to explore new ideas in many directions. The pervading basic idea was that rational laws could describe social as well as physical behaviour, and that knowledge could be used to improve policy. Enlightenment thinkers felt that change and reason were both possible and desirable for the sake of human liberty. Europeans' thoughts became centered on the belief in reason, science, individual rights, and the progress of civilization. The ability of individual effort to transform the world became Western dogma, lasting to the present day.

Eighteenth century philosophers believed they had discovered the formula for perpetual happiness; on one hand, the pursuit of self-interest would benefit society, while on the other hand, a free human reason would produce sound moral judgement – individual freedom permitted the operation of natural laws. There was a belief that general models of human behaviour could be derived from rational thought. A Scottish writer of this era, Adam Smith, set forth a number of invariable principles of economic behaviour, based on the belief that people act according to their self-interest, but through competition, work to promote general economic advance. In this system, government should avoid regulation in favour of the operation of individual initiative and market forces.

The church was the largest institution during the medieval period. It still wielded considerable power along with the aristocracy in the 18th century. A group of French philosophers developed the *Encyclopedie* to record and spread all known science and information of the day, for all to use, with the goal of changing how men think. The first edition, published in 1751, threatened the governing social classes of France (aristocracy) because it claimed such things as religious tolerance and freedom of thought were normal. Also, it asserted that the main concern of government ought to be the common people. Because of controversy, the *Encyclopedie* was formally repressed to limit the spreading of dangerous ideas, driving it underground.

The freedoms identified for individuals during the Enlightenment are now threatened. It is important to realize that religious challenge is still there. Richard Dawkins, an evolutionary biologist, in his book *The God Delusion*, criticized religion for its intolerance. He argued that the potential dangers of religion include closing people's minds to scientific truths, oppressing women and threatening people with eternal damnation. The power of religion, even moderate religion in which individuals accept information without question, Dawkins claims, is still a problem as it creates a pool of individuals with a belief system who are vulnerable to fundamentalists, both Muslim and Christian, who recruit them into their social networks. Such individuals, who accept information without question, are recruited and manipulated for such things as murdering abortionists and suicide bomb attacks. Darwin published his theory on natural selection in 1859, and it took two decades before it was generally accepted because of resistance from the established church. Established elites, slow to accept radical changes, were wary of new ideas that challenged traditional views of the 'natural order' and mankind's place in it.

What some historians claimed occurred in many cases during the Enlightenment was that Christian interpretations of the world (events) were replaced with new scientific ones. Once consequence of the Enlightenment was the emergence of a largely secular public culture, and a secular scientific class (culture) able to challenge the previously dominant clergy.[73]

One of the products of enlightenment thinking is one of the most important biological books ever written, *On the Origin of Species*, published by Charles Darwin. Many of the ideas came from Darwin's experience as a naturalist, while on a five-year voyage aboard H.M.S. Beagle. During the Beagle voyage, he read the work of Charles Lyell (1797-1875), a geologist who studied fossils, who wrote a dissertation on how Earth was formed through a gradual geological process.[74] Darwin was significantly influenced by Lyell's idea that Earth was much older than previously believed. Data from the trip, and ideas that Earth was millions of years old provided the evidence needed to develop the theory of evolution and natural selection that challenged contemporary beliefs about divine providence and the immutability of species. Darwin was not the first to use the word evolution; others had used it in their writings previously. Darwin introduced a viable process, natural selection, to explain how it works.

Others used Darwin's theories to support their own causes, and in particular, applied it to social issues. Herbert Spencer became a vocal supporter of Darwin's work, because he felt Darwinian natural selection could be used to support his own theory. Herbert Spencer said that it was possible to follow nature's own rules to provide individual happiness, as well as be assured to the progress of the human race. Spencer promoted 'survival of the fittest' which supported the laissez-faire capitalist system of the late 19th century. Darwin's cousin, Francis Galton (1822-1911), was an explorer and anthropologist with an interest in mathematics and techniques of measurement. From Darwin's description of the selection of physical characteristics, Galton set about developing the idea of the ideal man. He became known for his precise quantitative measurements, which led him to develop statistical measurement of hereditary predisposition as a way of predicting and improving the population. His work led to the 'bell curve' being the starting point for modelling many natural processes. This work became an important tool for the eugenics movement.[75] Thorstein Veblen (1857-1929) applied the Darwinian evolutionary theory to societal changes that he called 'institutions' and found that laissez-faire capitalism created two groups, with the rich getting richer and the income gap

between rich and poor widening. Veblen pointed out that Darwinian evolution did not guarantee progress; the leisure class reacted differently than the middle class from the environmental stimuli in a system in which each individual looks after his own interests. Veblen adopted Darwin's theory in his development of institutional economics to illustrate the importance of changes in society or institutions with respect to the economy.

Darwin's theory was responsible for the transformation of Western world view and provided fact-based scientific framework within which to understand life. The Copernican worldview that Earth evolves around the sun allowed humans to think they were the centre of the universe, was replaced with the view that humans were no longer at the centre of the universe, as Darwin's theory applied just as much to humans as to animals. He achieved a radical revolution in modern thought, that history was important in understanding science. Once genetics was added to the body of knowledge, evolution became the main theory underpinning modern biology.

Darwin talked to pigeon breeders and studied the role of artificial selection of farm animals that led to new characteristics, to develop arguments to support his theory. His genius was to point out there was no need for a selecting agent. The choice was made by survival or failure to survive. Survivors (the most fit) count, because only survivors reproduce and pass on the genes. The struggle for existence was not about the struggle between 'groups' of individuals, rather between individuals who possess a certain allele (genetic code).[76]

The vertebral skeleton is invariant in all vertebrate, the crustacean exoskeleton is invariant across all crustaceans, and so the DNA code is invariant across all living creatures, while the individual genes themselves vary. This is consistent with all living creatures descending from a common ancestor.[77] Natural selection is the differential survival of successful genes rather than alternative, less successful genes. Natural selection doesn't chose genes directly; it chooses their proxies, the features of a body based on the probability of survival and reproduction. The gene's ongoing survival is tied to the body that it helped build, disappearing when the body dies. When applied to a population, a gene favouring the survival of the body in which it finds itself will tend to increase in frequency in the gene pool, with the consequences accumulating gradually. A collection of small entities, cells, protein molecules, membranes (each at its own level obeying local rules and influencing others with selection) allow successful products to appear.[78]

At one time it was accepted that evolution and natural selection required millions of years. What has been discovered is that species can evolve at a much faster rate than formerly believed. For example, Lake Victoria, in east central Africa, the world's second largest fresh water lake by area, is extremely young. It is a shallow lake greatly influenced by climatic conditions as it relies on rain over the lake itself for 85% of its supply. Since the 1700s, its depth has fluctuated 100 meters. In the past few centuries, as the water level and size of the lake has increased, multiple species of cichlids, one of the oldest freshwater fish in the world, have evolved in the lake throughout the shallow water formed by rock outcroppings and islands.[79] During the second decade of the 21st century, Lake Victoria became a sick giant. The ecological environment has changed with one of the densest populations in Africa near-by overfishing, dumping of raw sewage in the lake, and the growth of algae. As the economy evolved, the surrounding natural vegetation was cleared, denuding forests and draining swamps, and cash

crops, such as tea, coffee and sugar, were planted. Over the years, cash crop plantations have grown in size and number. Agricultural chemicals applied on these plantations are washed into rivers during the rainy season, and end up in the lake, providing nutrients for unwanted, unsightly algal blooms.

The number of cichlid species has now plunged from over 400 to 200, thanks to the Nile perch. Loss of half of the cichlid species has been termed as "the greatest vertebrate mass extinction in recorded history" by Les Kauffman, a chief scientist at Boston University.[80] Commonly referred to as a voracious predator, the perch can grow to a hefty six-foot, 200-pound giant by feeding primarily on the smaller fish. The introduction of the perch is considered an economic success story by businessmen and government officials. The fish ends up as a delicacy in expensive restaurants of Nairobi, the Middle East and Europe.[81]

Fossils are a record of extinctions throughout time. Fossils were laid down in sedimentary rocks. All fossils occur in the right temporal sequence – no single fossil has been found before it could have evolved. There are gaps, the largest being the Cambrian explosion.[82] Prior to this period, soft-body creatures predominated. An increase in the number of phylum (a grouping of organism that have the same body plan), was associated with the appearance of oxygen. The transition of pre-Cambrian life forms (mainly soft-body impressions in rock) to Cambrian life (shell-bearing fossils and other fossils with hard parts) has been referred to as the 'Cambrian explosion.' All activity occurred in shallow seas around the continents. There was an extinction event prior to the Cambrian explosion that would have opened up areas for new creatures. A glaciation event at the Cambrian-Ordovician boundary accounted for a significant die off. The end of Cambrian period came gradually with falling sea levels and the onset of slightly cooler global temperatures. Trilobites reached their greatest diversity at the end of Cambrian with sixty-three families; after the extinction there were forty-six families, a drop of one third.[83]

Darwin's theory revolutionized all aspects of natural science and our understanding of ourselves in the world. Directional selection through the force of nature was responsible for change – in this way genetic variables that did not improve, or reduced chances of survival were reduced, and the frequency of genetic variants for adaptive traits is increased. In the financial services industry, the many innovations introduced, such as derivatives, can be considered equivalent to genetic variables (mutations).

What do troglobites and the large banks that were bailed out in 2008 have in common? Troglobites are animals that live in only the darkest parts of caves (below the earth's surface), and are so specialized that they can live nowhere else. These adaptations are such that the species would have a great struggle to live outside the cave. This group includes such creatures as salamanders, fish, shrimps, crayfish, millipedes, and spiders. They retain vestigial eyes. A cave salamander lives in perpetual darkness, and has no need for eyes. So why hasn't the cave salamander evolved and sealed up his vestigial eye behind tough body skin? The answer lies in natural selection in which rare beneficial mutations turn up and if they provide any advantage, they will be favored by selection. Most mutations are either bad or neutral, because of randomness, creating more ways of getting worse or staying the same. Natural selection promptly removes the bad mutations. Random mutations, with respect to the cave salamander's eye, become a little less functional with less capability of seeing. In an animal that lives in the light, such deleterious mutations are removed from the gene pool. However, for

animals that live in the dark, vision is impossible, so the mutation reducing vision is inconsequential. [84]

By 2008, shadow banks operating outside the regulated banks had sold many financial instruments that were opaque and hard to value, linked to mortgages and other products leading to the loss in confidence of the market. The big banks were bailed out by the government in 2008. The forces of natural selection were pre-empted by government intervention. Mutations like derivatives and credit swaps could be either neutral or bad (deleterious), but without (natural) selection in place, one can never be sure. Like the troglobites, in a protected environment, a neutral or bad mutation can persist. This is an example of the need to pay close attention when using evolutionary economics to explain macroeconomic activities.

There are other lessons to be learned about the economy by studying evolution. Trees grow tall (by obtaining as much of the sun's rays as possible) in order to gain advantage over neighboring trees. As a consequence of this activity, forest floors tend to be dark. The height of the tree is a balance between the advantage of more sunlight vs. the expenditure of energy and resources to develop the trunk.[85] In the same way, this is how competition (in the economy) is supported. Natural selection supports nature striking a balance between resources devoted to developing the mechanism for speed, balanced against efficiency for reproduction of both the predators and prey. Both escalate for natural advantage, but the advantage is neutralized precisely because the escalation is mutual. Natural selection does not look to the future. The selection occurs between rival individuals within a population, which favors the most competitive, right up to extinction. Even as prey goes to extinction, the natural selection remains right up until the last predator is standing.[86]

During the early 20th century, no one had ever produced solid evidence for the inheritance of acquired characteristics, rather just assumed it would be. The regeneration of earthworms and the propagation in plants suggests characteristics were also transmitted through somatic cells. The debate between Lamarckian and Darwinian inheritance, based on whether mutations were directed or random, continued. The study of bacteria and bacterial viruses became involved in this debate. In 1943, the Luria-Delbrück experiment measured the resistance of a phage (a bacterial virus) in an *Escherichia coli* culture. The distribution pattern was consistent with spontaneous mutation and not the adaptation theory. Bacterial growth in this experiment supported the Neo-Darwinian definition of evolution.

John Cairns and his team at the Harvard School of Public Health believed that Luria and Delbrück had used a much too lethal method to kill the bacteria (*Escherichia coli*) in their experiment. In 1958 they developed an experiment in which the bacteria were killed slowly, and then were given a chance to try to respond to the stress – which would supposedly be closer to conditions in the real world. The organism his team used was a strain of *Escherichia coli* that lacked the enzymes to use lactose as a metabolite. Into the organism they inserted scrambled code for the enzyme necessary to grow. Initially there was no growth, then two days later colonies appeared on the agar plates. Cairns and Hall's work seemed to support the Lamarckian hypothesis of inheritance of acquired characteristics. Lamarck claimed that the inheritance of characteristics was acquired through effort and will. This allowed some social scientists, who were applying evolutionary theory, to analyse problems from a different

perspective (that a learnt trait can be passed on to future generations). The Neo-Lamarckian challenge to Darwin's Theory of Natural Selection, which hinged on whether mutations were directed or random, seemed to swing to the Neo-Lamarckian side (for a while).

Later information on the molecular genetics of bacteria put the argument back into the Neo-Darwinian camp. In order to respond to the stress (of a nutrient poor environment), the bacteria down-regulated their gene repair enzymes, allowing a higher rate of mutation and a higher chance of a population that can overcome the challenge. In stress-enhanced bacteria, mutation is a regulated phenomenon in which the rate of mutation transiently increased (triggered by stress). Starved bacteria (bacteria under antibiotic treatment, or bacteria with the need to colonize a novel environment under the inhibitory effect of host defences) are examples of stress that create mutation rates several orders higher than normal.[87] Subinhibitory levels of antibiotics stress organisms, which in turn increase the mutation rate, as well as select for resistance. This is the result of selective advantage of induction of an error prone DNA polymerase. In this era of antimicrobial resistance and the production of 'superbugs', stop calling bacteria intelligent, and use the opportunity as a teaching moment to discuss the power of natural selection.[88]

Old Social Darwinism fought against institutions that aimed at the equality of opportunity, such as universal free education, child labor laws, and worker compensation. Herbert Spencer noted that social inequality maximized fitness, and to oppose it opposed the natural laws (of evolution). He believed inequality was the engine that drove progress. Galton's work illustrated the usefulness of the bell curve to support inequality, and provided justification of the inequalities of the laissez-faire capitalism of the 19th century.

Statistics can be made to support almost any thesis. The new Social Darwinism of the 21st century is also based on the bell curve. Using IQ scores plotted in Bell Curve distribution, conservative libertarians have been able to claim that inherited difference in intelligence explains economic inequality. The unequal inherited ability supposedly established amongst poor people justifies, for privileged groups, the equality of social position (wealth). Similarly, they believe the income gap can be explained by a difference in intelligence. It appears (to the new Social Darwinists), that it is not necessary to consider people born with unequal life chances, as their disadvantages are innate and, for many people there is nothing they can learn that will repay the cost of teaching. For the new Social Darwinists, this justifies the economic inequalities and eliminating support systems, such as preschool child development programs rich in cognitive interaction between teacher and student (early literacy programs).

In the 21st century, Darwin's theory remains under a steady barrage of attack, as it was the first scientific revolution to challenge Christian faith. Creationists argue that evolution violates the second law of thermodynamics, making it invalid. The Second Law of Thermodynamics, which originated from the 19th century, stated any system, which is free of external influences, becomes more disordered with time (expressed as entropy). They claim the progress of evolution seems to represent a reduction in entropy. According to the theory, as usable energy is irretrievably lost, disorganization, randomness, and chaos increase (which applies to a closed system). However, the fact is that the system, life, is not a closed system – the sun provides energy to drive things. In an open system, the biosphere, this increase of randomness does not necessarily occur locally. Evolution increases entropy – as the second law requires.[89]

Christian fundamentalists have used arguments over fossils to discredit the theory of evolution. The claim is based on the lack of 'intermediate' steps. The multiple extinctions allowed species in low numbers (few early fossils) to take over and predominate a geological era. The other observation is that over time, more and more intermediate type fossils *are* being discovered. However, this claim persists, suggesting there is a flaw in the theory of natural selection.

Creationism and its dressed up version, intelligent design, is an attack on science that needs to be challenged. Intelligent design was developed by creationists in the US in order to use the court system to force schools to provide an alternate to the teaching of Darwin's Theory of Evolution. What the promotion of intelligent design, the claim of incompatibility with the second law of thermodynamics, and the claim of a lack of intermediate fossils, have in common is the desire to sow doubt in the public's mind about Darwin's theory. The creationists have taken a page out of the tobacco industry playbook to try and create doubt and confusion whether there is ongoing evidence to disprove Darwin's theory. This involves instilling enough doubt to get people second-guessing, because it appears the science is not there. The Age of Enlightenment established the role of science and the need to question established ideas and values. The tobacco industry created tools that those in the know can use to undermine the motto, and the truth.

The massive effort behind the genome project mapping out all the human genes provided less answers than hoped. There would not be one gene for each disease, rather human characteristics were encoded by much more complex genetics. A new revolutionary way in thinking in biology appeared, named epigenetics, which began to provide the answers. This illustrates that as our understanding of evolution continues to change (epigenetics makes Darwin's theory more complex), it is not necessary to revise the Theory of Natural Selection. Epigenetic changes that are heritable, would still be subject to natural selection. We now realize that epigenetics plays a key role in how the genetic information in our cells is used. This new way of thinking is rewriting the rules of disease, making it is necessary to question established ideas and values of the largest institution of the 21st century, the corporation, and explore new solutions to every day decisions, because epigenetics affects every aspect of our health.

Chapter 4 On Chance and Choice

Newtonian determinism dominated thinking in the 18th and 19th centuries. In philosophy, determinism identifies that all human action is caused entirely by preceding events, and not by the exercise of the (free) will. Adam Smith set out to do in economics what Newton had done in astronomy. Smith saw the economy being 'controlled by the invisible hand of self-interest.' Smith sought the natural law and harmony of nature in the economic sphere. Equilibrium is equivalent to a market driven by price and quantity. For Newton, equilibrium referred to harmony and balance in the universe, similar to forces that keep the planets in their proper places. Supporters of the Law of Supply and Demand believe this to be a law of nature, supply creates its own demand. These associations are the reason economists claim the neoclassical system is derived from physics. Newton's need to only describe the motion of the planets' centre of gravity was his advantage, while Smith could not describe the behaviour of a market system in terms of its centre of gravity.

In the 18th century, Abraham de Moire (1667-1754), a French mathematician, moved to England to escape persecution after Louis XIV revoked the Edict of Nantes. In London he became a mathematics tutor and enjoyed the support of Newton. He provided mathematical interpretations to gamblers and underwriters. In 1718, he published the *Doctrine of Chance*, using gambling (games of chance) to illustrate the point that based on the number of times an event occurred, the shape of the distribution on a graph would represent a curve. He hoped to use mathematics to prove the so-called "Argument from Design" which maintains that the evidence of order in the universe proves the existence of God.[90]

Carl Friedrich Gauss, (1777-1855) a German mathematician, developed a formula called Gaussian distribution that shows that data clusters around the middle and falls off equally on both side in the shape of a bell curve. Gaussian distribution is used to determine the most likely value of a parameter from a number of measurements that follow a statistical pattern of error. In 1801, the Italian astronomer Joseph Piazzi discovered the dwarf planet, Ceres, in the asteroid belt between Mars and Jupiter. He lost track of it when it disappeared behind the sun. Using Gaussian distribution Gauss was able to predict very closely the orbit of where it would

reappear (from behind the sun) later in the fall.[91] Statisticians use Gaussian distribution for predictions, and the bell curve is used by social scientists.

Jean-Baptiste Lamarck (1744-1829) was a naturalist who, through his studies of the natural history of insects and worms, gained insight into natural diversity. During his classification of invertebrates, he was struck by the similarities of the many animals he studied. Lamarck believed that evolution was a process of increased complexity and perfection, and species did not die out in extinctions, rather, changed into other species. The fact that simple organisms co-exist with complex ones was explained by the continual creation of simple organisms by spontaneous generation. He believed evolution is a process of striving towards greater complexity and perfection. During his lifetime, his theory did not receive wide acceptance.[92]

Lamarck's theory was rediscovered in the middle of the 19th century. By the late 19th century, naturalists viewed the inheritance of acquired characteristics as the most important evolutionary mechanism. Neo-Lamarckism dictated that organisms could effectively drive their own evolution, supporting the idea of continuous progress. This evolutionary theory from the 1860s to the 1880s competed with Darwin's theory on natural selection. Neo-Lamarckists tried to modify Lamarckism to make it acceptable, and proposed that adaptations were universal, arising as a result of casual relationships of structure, function, and environment. As such, environmental conditions alter the habits of organisms and in response to new habits; organisms acquire a new structure in place of old structures. Variations become ingrained in the heredity of the organism. During the 19th century debates on evolution, many believed the ideas of Neo-Lamarckism to be more progressive, thus superior to Darwin's theory on natural selection.[93]

Thomas Malthus (1766-1834), an English clergyman and scholar, argued that increases in population would eventually diminish the ability of the world to feed itself, based on his conclusion that populations expand in such a way as to overtake the development of sufficient land for crops. Malthus advocated welfare reform, and criticised the recent Poor Laws, which provided increased money depending on the number of children in a family. He argued that this only encouraged the poor to give birth to more children, as they had no fear that the increased number of offspring made eating any more difficult. Malthus reasoned that the constant threat of poverty and starvation served to teach the virtues of hard work and virtuous behaviour.[94] His work was incredibly popular and widely read by Social Darwinists.

Herbert Spencer (1820-1903) applied biological evolution to economics and developed the concept of the 'survival of the fittest'. He applied Newtonian determinism to his analysis, making him one of the first people since the Enlightenment to exclude free will from his analysis. Spencer wanted to tap into the belief that progress was real, which pervaded his age. He adopted a 'greatest' happiness principle, that happiness is a surplus of good over pain, promoted by freedom. This involved the adaptation of the organism to its environment. He also incorporated Lamarckian evolution into his theory, and believed that evolution in humans led to the pursuit of whatever would preserve their lives, and consequently, would lead to the characteristics of rational self-interest. Altruism and compassion beyond the family unit, Spencer believed, was a recent development, and did not exist in nature.

Spencer believed that human society reflects the same evolutionary principles as biological organisms do in their development. Following a universal law, social institutions, such as

economics, can function without external control. Progress, Spencer claimed, is achieved through the free exercise of the human facilities, and change in society could only take place once the individual members of that society had changed and developed – based on where one improves every day.

Based on Lamarckian evolutionary theory, Spencer argued that there was nothing unnatural, and therefore wrong (evil), with competing and rising to the top in a cut-throat capitalist world. Captains of industry, in the 19th century, used his words as justification to oppose social reform and government intervention (which would interfere with the natural [hence beneficial] law of survival). This was part of his 'survival of the fittest' mindset that he championed.

Spencer advocated a laissez-faire doctrine, a restriction of government activities to the bare minimal, in fact, a person did not need to participate if he so chose. In his *Social Statics*, Spencer described his principle of equal freedom:

> "If every man has freedom to do all that he wills, provided that he infringes not the equal freedom of any other man, then he is free to drop connection with the state, to relinquish its protection, and to refuse paying towards its support. "[95]

Natural growth of the organism, Spencer believed, requires liberty, which justifies individualism, hence the need to defend the existence of individual human rights. This thinking supports laissez-faire capitalism. For Spencer, "liberty is to be measured not by the nature of the government machinery he lives under... but by the relative paucity of restraints it imposes upon him."[96] This left the only function of government to be policing and protection of individual rights. The belief was what is natural is morally correct, was used by Spencer's followers to justify opposition of support for the poor, as it was believed welfare programs corrupt morals, as well as fitness. [97] Spencer maintained that education, religion, the economy, and care for the sick and indigent were not to be undertaken by the state. Spencer's scepticism about the ability of government to do more good than harm made him an important inspiration to many libertarians.[98]

Spencer claimed social laws are as deterministic as those governing nature. This supported his 'survival of the fittest' theory which defended allowing the least intelligent groups and individuals to die off. This was considered a beneficial evolutionary mechanism which would be fatally upset by government intervention. In the same vein, if government intervention in the form of social welfare was allowed, it would distort the beneficial processes of natural selection. Spencer believed that government interference encourages the multiplication of the reckless and the incompetent. In other words, the intervention of government in social affairs distorts the necessary adaptation of society to its environment. This is akin to man's attempts to influence and control nature.

Neo-Lamarckism continues to have followers in the scientific community. There are political and religious groups who adopt it to support social issues, as directed design creates less dissonance for 'the invisible hand' and intelligent design. The premise of Neo-Lamarckism is behind the idea that man should flourish with as little restriction as possible, as freedom promotes happiness, which consequently leads to rational self-interest. This freedom of the individual supports individualism and the economic policy of 'laissez-faire'. However, the

evidence for Neo-Lamarckism is very limited and has been largely acknowledged as false. All ideas must be challenged by questioning and scepticism to keep them from becoming dogma.

The philosophies of Herbert Spencer and Ayn Rand have considerable overlap. Both philosophies support the rights of individuals to do whatever they want, as long as they do not physically interfere with the freedom of another individual. Both believed in minimal government, and that individuals have no need to connect with their government, if they so choose. By choosing objectivism, (Rand's ideas) one gets around needing to explain Social Darwinism. This became an important aspect of minimal government as conservatives closed in on the entitlements that are provided to the poor.

Ayn Rand described objectivism as a philosophy blending free market, reason and individualism. Rand believed that man should be the beneficiary of his actions, thus she opposed altruist. The support for free market means it supports laissez-faire capitalism, and the free individual can use his time, money, and property as he sees fits. In this system, self-interest helps someone you do not even know. The popularity of Ayn Rand's novels exposed many young people to the ideas of individual liberty and free markets, during the last half of the 20th century.

Freedom is based on individual rights, in which freedom of choice, liberty of ownership of property lead to happiness. The individualism of objectivism deals with the primary importance of the individual, and in the virtues of self-reliance and personal independence. This individualism includes advocating for freedom from government regulation, when in pursuit of a person's economic goals.

Rand adopted the good self-love of Aristotle that included behaving with dignity and not acting on impulses. Rand spoke of the importance of self-esteem, as a justifiable pride in one's accomplishments. Self-esteem was deemed a necessary defense, so people could not be taken advantage of and be bamboozled by false guilt into giving up the fruits of their actions. The cult of self-esteem of the school system in the 1970s has migrated into the workplace today. In this cult of self-esteem, individuals tolerate errors or flaws in their actions, which leads to a sense of entitlement. Entitlement is the feeling that one deserves something, whatever it might be, regardless of what they may or may not have done to earn it. The cult of self-esteem supports extreme individualism; everyone strives to be different, to be original, or stand out from the crowd. In the extreme, this means feeding their narcissism. Creeping traits of narcissism can affect the way an individual responds to their country, community, church and/or friends.[99]

Rational self-interest plays a pivotal role in objectivism, with one's life having the highest value and standard, and one's happiness being one's highest purpose. Knowledge is obtained from reason, which develops into a system of judging right from wrong. This creates a system in which it is moral to act in one's rational self-interest. In the cult of self-esteem of the 21st century, neither reason nor the self-love of Aristotle is in play. A population with an exaggerated sense of entitlement bases decisions on emotional aspects favouring short-term gain, rather than rational perspectives. The extreme individualism of the cult of self-esteem is incompatible with objectivism. Such a person makes decisions based on emotions for short-term gain.

Confirmation bias is a phenomenon wherein decision makers have been shown to actively seek out and assign more weight to evidence that confirms their hypothesis, and ignore or underweight evidence that could disconfirm their hypothesis. In this case, individuals tend to

notice and to look for what confirms their beliefs, and to ignore, not look for, or undervalue the relevance of what contradicts their beliefs; such as the fact that the theory Spencer used to support his ideas on minimal government that was so attractive, followed Newtonian determinism, and was based on a natural law in nature. Today Lamarckian evolution is no longer considered a valid theory, its salient ideas now included in Neo-Darwinism. Ayn Rand's ideas have been around for the past fifty years. With more and more evidence of how readily the environment affects your DNA, the effects of the economy on the environment loom important. It is not the economy that needs to be analysed but the processes that drive the present economy.

Objectivism, the philosophy of Ayn Rand, became popular during the Cold War as a philosophy to defend the capitalist system which seemed to be competing with communism for the minds of workers around the world. Individuals operating under the objectivism mind set of laissez-faire economics and minimal government were expected to use the self-love of Aristotle. Friedrich Hayek had a major influence on market liberalization strategies, which included discrediting government economic planning. Milton Friedman's neo-liberal triumvirate of privatization, deregulation/free trade and drastic cuts to government spending laid the groundwork for Reagan economic policies of deregulation. In the first decade of the 21st century, many educated men believed that the policies of limited government and strong individual liberty, based on reason and rational analysis that supported globalization, could run with minimal oversight. In her theory of objectivism, Rand always had individuals discovering new resources to continue to drive development.[100]

Libertarian philosophy is infamous for not addressing environmental issues. Evidence from epigenetics shows that humans exposed to environmental pollutants can have their DNA altered more readily than previously believed. These environmental contaminants are driving the burden of chronic disease seen today, and there is a need for systems that support the free market system, as well as address environment issues. Economic fundamentalists' supporters of laissez-faire advice to allow underperformers to fall by the wayside is unacceptable, because the environmental damage created while waiting for them to fail is often not reversible.

Confirmation bias prevents individuals from connecting Alan Greenspan's testimony, that there was a 'flaw' in the system that prevented the free market system from self-correcting in 2008, with the fact that theories like objectivism are no longer able to provide explanations on how the markets function. The effects of the cult of self-esteem compounded the flaws in the economic system. The sense of entitlement on Wall Street helped precipitate the problem, and failure to accept responsibility for their actions creates a major obstacle in implementing change.

Immanuel Kant tried to reconcile determinism with the sense of human freedom. He believed that determinism was correct in the physical world, and it was a precondition for rational thought. For Kant, freedom of choice provided the free will that was essential to morality. There could be no morality if man did not have freedom of choice. If you can't make choices, how can you be responsible? If you are not responsible for anything you do, like an animal or a robot, then what you do is neither bad nor good. Kant claimed, "Duty is the necessity to act out of reverence for the law."[101] The ultimate principle of morality must be a moral law conceived so abstractly so that it is capable of guiding us to the right action in

application to every possible set of circumstances and can be applied at all times. For Kant, right actions are those that practical reason would will as a universal law.

During the 19th century, cracks appeared in the wall of belief of determinism. Evolution with natural selection requires real change for change to occur. Boltzmann's second law of thermodynamics could only work with the introduction of chance and treating the motion of atoms statistically. Then, in 1927, Werner Heisenberg formulated the uncertainty principle – occasionally referred to as the Principle of Indeterminancy. It was a revolution in which classical mechanics (that presupposes exact simultaneous values can be assigned to all physical quantities) was replaced with quantum mechanics that denies these possibilities (that the position and momentum of particles cannot be known). The Uncertainty Principle of Quantum Mechanics says one can only predict the path of electrons around an atom; the exact locations of the electrons can only be known within certain limits. This was a case of irreducible randomness, disproving causality.

Determinists believed in strict causality. The libertarians of the 19th century argued that free will is incompatible with determinism. They were unhappy with chance as a source of freedom. In the 1820s the French mathematician, Jean Baptiste Joseph Fourier (1768-1830), noticed that the statistics on the number of births, deaths, marriages, suicides, and various crimes in the city of Paris had stable averages from year to year. The mean averages were distributed in the normal distribution of a bell curve. This was the basis to suggest that determinism was a social law. The Belgian, astronomer and mathematician, Adolphe Quetelet, (1796-1874) observed that even though the fates of individual humans seemed to be governed by their free-will and happenstance; taken en mass they seemed to be governed by social laws. The regularities based on the bell curve were believed to be due to a natural law. His support helped promote this as a form of determinism.[102]

Newtonian determinism explained the equilibrium of the free market system described by Adam Smith. What the efforts of Herbert Spencer, Adolphe Quetelet, and Ayn Rand shared in common was to provide a (moral) justification for the selfishness that supported laissez-faire economics. The work of Ouetelet promoted the idea that social laws could explain the distribution of wealth in the 19th century. Spencer and Rand's ideas supported a freedom of the individual that was best served by a small government and minimal regulation.

In France, two thinkers, Charles Renouvier (1815-1903) and Alfred Foullee (1838-1912), argued for human freedom based on the existence of absolute chance. Renouvier rejected all necessary connection between universal laws and morality, and identified human individuality with self-determination and free will. Renouvier's ultimate foundation for free will was based, like Kant's analysis of practical reason, on the moral requirement of freedom. (Like Kant he connected it to God and immortality.) It was a two-stage process: random possibilities, followed by a choice. Then Charles Darwin's explanation of biological evolution introduced random variation (chance to create variance in the gene pool) followed by natural selection – supported the ideas of human freedom based on the liberating notion of chance.[103]

The chance and choice model had support from other quarters. In *Einstein's Space and Van Gough's Sky* in 1982, Lawrence LeShaun and Henry Margenau described this model:

> "Our thesis is that quantum mechanics leaves our body, our brain, at any moment in a state with numerous (because of its complexity we might say innumerable) possible futures, each with a predetermined possibility.

> Freedom involves two components: chance (the existence of a genuine set of alternatives) and choice. Quantum mechanics provides the chance, and we shall argue that only the mind can make the choice by selecting (not energetically enforcing) among the possible future courses."[104]

This could be considered an application of free-will decisions, there is an elimination of proposals and probabilities which are not acceptable to the mind.

In 1977 in the first Darwin lecture, Karl Popper (1902-1994), a philosopher of logic, accepted random variation and selection of ideas as models of free will, explaining, "A choice process may be a selection process, and the selection may be from some repertoire of random events, without being random in its turn."[105] This ensures that the resolution or decision process is not being random in its turn.

Herbert Spencer contended that when individuals are free to adapt to changing conditions, progress becomes inevitable. He maintained that social evolutionary advancement requires the freedom of actions of autonomous individuals. Spencer's case for freedom rests on the grounds that evolutionary progress requires it. For humans to flourish and develop, there must be as few artificial restrictions as possible. The government cannot reproduce the forces of nature; therefore, this supported his idea that political meddling in voluntary relationships has many unforeseen detrimental effects. In this manner, supporting the unemployed is therefore not only in one's self-interest, but encourages laziness and works against evolution. He justified social inequity by evolutionary principles. Today the Lamarckian theory of evolution that supported such ideas is no longer considered valid. Now is a good time to challenge whether Spencer's conclusions based on evolution remain valid.[106]

Freedom was equated with capitalism during the Cold War. It was believed that for capitalism to flourish, a government needed to provide their citizens with freedom. Objectivism supported this freedom for laissez-faire capitalism. However, the principles of objectivism are being challenged by the expanding growth of China, which has been growing economically at a significantly faster rate than North America markets. It appears that a 'free market' can thrive under the limited freedom of a dictatorship.

What really brought everything to a head, and started people asking questions, was the economic meltdown of 2008. Initially there was a polarized debate with one side claiming that somehow poor people, taking on mortgages they could not afford, had triggered the lack of confidence in the world financial markets, while the other side claimed it was a consequence of a culture that peddles entitlement, greed and self-centeredness. It is now known that individuals in the financial services industry knowingly made decisions that put out too many bundled high-risk investments to maintain a healthy flow of fees, knowing very well that they were making the market sicker and sicker. We don't even want to get into the discussion of the groups who were responsible for oversight of the system, choosing to do nothing because they, or their bosses, believed the system was self-correcting. With the abrupt fall in government revenues, the debacle exposed serious cash flow problems associated with sovereign debt.[107]

The meltdown exposed some clouds on the horizon, and that it will be awhile before a world recovery. The interconnected global economy was only as strong as its weakest link. The

European Union has the largest Gross Domestic Product (GDP) in the world, and was the largest exporter and largest importer of goods and services in 2008. However, any one of the weak economies of Greece, Ireland, Spain or Italy could degrade European banks because of their debt exposure from these countries.

There *are* new ideas to be applied. A new way of thinking, the Scientific Revolution, came out of the efforts of many during the 16th and 17th century, and was key to the new ideas that Darwin put forth in the 19th century. The random possibilities followed by choice introduced by Darwin's theory of natural selection destroyed Newtonian determinism. It introduced a new concept of freedom based on chance, and choice. A new revolutionary idea established in the past decade – epigenetics – influences huge areas of biology. This new system includes preserving human potential as a new freedom, that is, ensuring freedom to choose. This is a limited freedom with restraints, because of the requirement to reduce epigenetic risks that are the consequences of an individual's diet, environmental exposures and social stressors. These new ideas need to replace exiting convictions and be incorporated into a future state.

Chapter 5 Thorstein Veblen

The first era of globalization, the first time the economies of many countries became united and integrated, occurred during the 19th century. At a high level, it was characterized by rapid growth in international trade and investment between European imperial powers and their colonies, and the United States. During this period, the United States rose to the status of a world power on the strength of its economic muscle and competed with Europeans, spurred on by production and technological inventions. People and ideas moved freely, facilitating the outward diffusion of America's political ideals and cultural values.

On the ground level in the US, it was the era when the captains of industry earned the label 'robber barons.' One of the captains of industry in the US during the 19th century was Andrew Carnegie (1835-1919). He helped build the US steel industry. Following the American Civil War he invested in bridge building, replacing wooden bridges with stronger iron bridges. He introduced the earliest steel plant in the US to use the 'Bessemer process', which had been recently developed in Britain, to convert iron to steel. Steel workers were paid to work long hours for low wages. By 1900, his mills produced more steel than the entire production of Great Britain. The next year, he sold his business to American financier and banker, J. P. Morgan (1837-1913), becoming the richest man in the world.

Carnegie read and promoted the writings of Herbert Spencer. Spencer's writings provided the philosophical justification for Carnegie's unabashed pursuit of personal riches in the world of business, freeing him from the moral reservations about financial acquisition that he had inherited from his egalitarian Scottish relatives. Spencer coined the term 'survival of the fittest,' and applied it to laissez-faire capitalist society. He argued that there was nothing unnatural – and therefore wrong – with competing and then rising to the top in a cut- throat capitalist world.[108]

Another captain of industry in the US during the 19th century was John D. Rockefeller (1839-1937). In 1862 (at the age of 21), he went into partnership with Samuel Adams who had just developed a better and cheaper way of refining crude oil. With his partner Samuel Adams, Rockefeller set up a network of kerosene distilleries that would later become known as Standard Oil. In 1865, now at the age of 24, he bought out his partners, and became sole

owner. He developed special relationships with the railways to transport the oil. Within a year, he drove thirty of his competitors out of business. Eventually Standard Oil monopolized oil refining in Cleveland. Then the company expanded across the United States. By 1890, Standard Oil had become an immense monopoly which could fix its own prices and terms of business because it had no competition. At the turn of the century, the muckraking journalists reviled him in print. Theodore Roosevelt, the 26th President of the United States (1901-1909), was unable to reduce Rockefeller's power when he attempted to use the Sherman Anti-Trust Act. It wasn't until 1911 that the Supreme Court dissolved Standard Oil.[109]

In 1899, when asked by the United States Industrial Commission to explain the advantages of industrial combinations (monopolies) to companies such as Standard Oil, John D. Rockefeller replied:

> "It is too late to argue about the advantages of industrial combinations. They are a necessity. And if Americans are to have the privilege of extending their business in all the states of the Union, and into foreign countries as well, they are a necessity on a large scale and require the agency of more than one corporation. Their chief advantages are: (1) command of necessary capital; (2) extension of limits of business; (3) increase of number of persons interested in the business; (4) economy of the business; (5) improvements and economies which are derived from knowledge of many interested persons of wide experience; (6) power to give the public improved products at less prices and still make a profit for stockholders; (7) permanent work and good wages for labourers."[110]

Thorstein Veblen (1857-1929), an American economist and sociologist, provided a contemporary critique (at the turn of the century) of the economic processes in the United States. Veblen rejected neoclassical economic interests (of the individual), as well as socialism (interests of the collective). He believed in evolution and selection of institutions as emergent entities in the socio-economic sphere. Only a social science shaped in the image of post-Darwinian biology, Veblen believed, could lay the claim to being scientific. He introduced evolutionary economics combined with institutional approach to economics (focusing on the individual). In the late 19th century, he warned that small scale, competitive capitalism was giving way to large scale monopoly trusts which were, on one hand, charging what traffic would bear and, on the other hand, limiting product that is available. During the industrialisation of the late 19th century, Veblen described the new emerging ruling class as the 'leisure class' who performed only symbolic work. It had a knock on effect. Poor people, as well as rich, attempted to impress others and seek to gain advantage through what Veblen coined the phrases 'conspicuous consumption' and the ability to engage in 'conspicuous leisure.' The leisure class and conspicuous consumption are two concepts he is known for.

Veblen saw society as a struggle between groups and institutions rather than competition. The struggle for existence (which included institutions) was considered part of the process of selective adaptation. Institutions, Veblen believed, consisted of the ideas and relationships within the community. The external forces affecting the community necessitate the institution to adapt. Institutions, under selective pressure, represent the dominant culture of the community. As institutions changes, the process brings further selective pressure on the individual.

In the 19th century, Velben observed that within the community a certain standard of wealth was "a necessary condition of reputability, and anything in excess of the normal amount is meritorious."[111] Veblen described the effect on one's self-esteem:

> "Those members of the community who fall short of this, somewhat indefinite, normal degree of prowess or property suffer in the esteem of their fellow men; and consequently they suffer also in their own esteem, since the usual basis of self-respect is the respect accorded by one's neighbours."[112]

In the late 20th century self-esteem was woven into the popular psychology of Western culture – that there is a connection between happiness and self-esteem. In the heady days of the 1970s it was suggested that self-esteem was key to success – the higher your self-esteem, the greater the chance of successful relationship, improved work and health. In science, the proof that one can improve performance by enhancing self-esteem is weak.[113]

Veblen claimed ownership was a discriminating factor as communities developed. The poorer members of a community did not impact the development of the (private property) institution. It was driven by the desire of individuals seeking the distinction attached to wealth, and this feature continues to drive it.[114] Property became associated with good standing in the community, synonymous with success, and part of the self-esteem.

Before the Great Reform Bill of 1832, Britain was ruled by an oligarchy of landlords. After 1832, with the enlargement of the franchise in Britain, the middle class had an increasing say, but the working class remained excluded. In 1833, the increased representation of the middle classes in British Parliament made possible the passage of the Emancipation Act that freed 750,000 slaves in the British Empire. There was a much more violent resolution in the US. In that new nation, in 1776, there existed a 700,000 strong slave labour force, which had grown to four million by the mid-nineteenth century. While less than 10% of the southern whites were significant slave holders, the idea that slaves were private property recruited more to oppose emancipation, which conflicted with the right to enjoy private property that was embodied in the constitution. In America, there was also a debate as to where power ultimately resided: was it the federal congress or the state legislatures? The election of Abraham Lincoln, who was opposed to expansion of slavery to any future states admitted to the union, triggered the formation of the fifteen-state Confederacy and the subsequent civil war. When the four-year civil war ended in 1865, 600,000 lives had been lost, abolition of slavery throughout the United States had occurred, and a new single nation emerged between Canada and Mexico.[115]

Veblen pointed out that a decent standing in the community is equated with the acquisition and accumulation of goods. He believed this to be consistent with the predatory nature of early man. This led to comparing ourselves to others. Veblen claimed:

> "In order to gain and hold the esteem of men it is not sufficient to merely possess wealth or power. The wealth or power must be put in evidence, for esteem is awarded only on evidence. And not only does the evidence of wealth serve to impress one's importance on others and to keep their sense of his importance alive and alert, but it is scarcely less use in building up and preserving one's self-complacency."[116]

Conspicuous consumption was the act of purchasing goods and services (such as lavish homes, servants, entertainment) not to survive, but a signal to others as having superior wealth and social standing. Before the 20th century, conspicuous consumption separated the very rich from the rest.

By the last half of the 20th century, individuals no longer bought a product; they bought a life-style. Marketing and advertising fed into the cult of individualism. In the 21st century, individualism is pervasive and has become a source of problems. Self-indulgence has replaced self-control. A consequence of the cult of individualism is everyone strives to be different, to be original or to stand out from the crowd. In the extreme, this means feeding their narcissism.[117]

Conspicuous consumption recruits the inspirational customer in which customers make decisions based on the prominence of the brand's design or logo. This applies to high-visibility products, such as cars, jewellery and fashion. In this case, it is not unusual for companies to 'turn up' the prominence of their brands. With respect to handbags, its signature stitching identifies the $1200 purse, while the $120 purse from the same company has the logo prominently displayed. Both customers are satisfied – one relying on 'those in the know' to recognize her purse is expensive, the other, on the logo.[118]

Leisure, considered a waste of time and effort, and consumption a waste of goods, are both acceptable methods of demonstration of wealth.[119] Veblen explains: "With the exception of the instinct of self-preservation, the propensity for emulation is probably the strongest and most alert and persistent of the economic motives proper."[120] The classes involved in conspicuous consumption or waste) are associated with characteristics, such as low birth rates. Veblen claimed, "The principle of conspicuous waste guides the formation of habits of thought as to what is honest and reputable in life and commodities."[121]

In this system of selective adaptation, society (institutions) can never catch up with the progressively changing situation in which a community finds itself at any given time, for the environment continually changes. Even as today's institution does not entirely fit the situation of today, men's present habit of thought tends to persist indefinitely, except as circumstances enforce a change. The institution, in combination with habits of thoughts, creates a conservative influence, introducing inertia into the social system.[122]

What this says is that men will not change unless the force of change exerted by the environment makes the existing views untenable. The capacity for growth or change in a social system depends on the "degree of freedom with which the situation at any given time acts on the individual members of the community."[123] Members of a community will experience different degrees of exposure from the same event, which varies the forces of change in the environment. Veblen observed, "If any portion or class of society is sheltered from the action of the environment in any essential respect, that portion of the community, or that class, will adapt its views and its scheme of life more tardily to the altered general situation; it will in so far tend to retard the process of social transformation. The wealthy leisure class is in such a sheltered position with respect to the economic forces that make for change and readjustment."[124]

Veblen noted that the wealthy do not respond readily to change, as they have fewer constraints than the middle class to economic pressures. Veblen claimed:

> "The leisure class is in great measure sheltered from the stress of those economic exigencies which prevail in any modern, highly organized

> industrial community. The exigencies of the struggle for the means of life are less exacting for this class than for any other; and as a consequence of this privileged position we should expect to find it one of the least responsive of the classes of society to the demands which the situation makes for a further growth of institutions and a readjustment to an altered industrial situation. The leisure class is the conservative class."[125]

The pressures of a downturn in the economy do not directly impact the wealthy. There is no penalty for not changing, hence no uneasiness with the existing order of things or pressure to change their worldview. This is not a new concept; the wealthy have a history of suppressing or impeding change and conserving ideas from the past. The common view is that the wealthy class is conservative, and it opposes innovations in the economy, because it has a vested interest. From the above explanation it appears that the wealthy class is not that mean-spirited, rather they suffer from the normal fear of change like all men. It's because they have less exposure to the economic forces that drive change, than the middle class.[126]

Wall Street protesters complained that the privileged few in the top 1% are getting a disproportionate share of the nations prosperity. They took a hit in 2008 but have gained back lost ground – while the bottom half of the population continues to struggle.[127] Case in point is the failure of Wall Street bankers to understand why Wall Street protesters are upset. It is cynical of Wall Street bankers who continue to make money to be critical of Wall Street protesters' specific recommendations for changes, for the bankers are the least likely to respond (to a change in the environment).

The conservatism of the wealthy class is a feature that is considered a mark of respectability, Veblen explains. Since conservatism is reputable, others outside the wealthy (class) tend to adhere to conservative views, thus conservatism, an upper class characteristic, is emulated by lower classes. As a consequence, the middle class may desire to side with the wealthy conservative position because new ideas and innovation in economics are considered vulgar or poor form. The fact that the rest of society wants to mimic the views of the well-to-do leisure class creates a prescriptive code of conduct for the rest of society, giving added weight and reach to the conservative influence of the wealthy. Because many others in society want to model their behaviour after the wealthier class, "the wealthier class comes to exert a retarding influence upon social development far in excess of that which the simple numeric strength of the class would assign it."[128] This process creates significant resistance to new ideas and reform, as the wealthy class has other classes supporting institutions from the past. The other power of the wealthy is to respond to minor changes as a constituency, and when they do, to claim the whole system is threatened.[129]

With the alignment of many institutions, the effort for change is even more considerable.[130] Change requires a certain mental effort to comprehend, as well as an ongoing effort to operate under new business rules. In fact, the poor are conservative because their energies are absorbed by their struggle for daily existence, which leaves no extra energy to expend on thoughts for tomorrow. The middle class is conservative because they focus their extra energy pursuing conspicuous consumption. Today, this system is supported by high advertising costs of corporations producing the most at the lowest cost. The wealthy class is able to preserve their conservative ideas, as they have no need to change because they are

protected by their wealth. The middle class emulates their consumption for leisure and, in so doing, adopt their conservative attitude while accumulating personal debt. The concentration of wealth at the top leaves a body of poor people who are unable to adopt any new ideas, because their available energy has been reduced so much.[131] Veblen notes, "the outcome is a strengthening of the general conservative attitude of the community."[132]

Veblen claimed that wealth provided a traditional meritoriousness. The result of this was the more wealthy individual escaped the consequences of white collar crime that a person of less wealth would face.[133] It appears that this aspect remains intact today. Following the economic debacle of 2008 there were no significant arrests for wrong doing in the financial services industry.

The leisure class or the wealthy class has a material interest in leaving things as they are. As they are already operating from a position of privilege, any change in the rules or departure from the existing order would likely be to their detriment. In short, class interest supports leaving things alone. This only reinforces an already conservative attitude. The leisure class always acts to slow down or prevent any social advance or develop any adjustments to the environment. This gets in the way of the evolutionary process influencing the institution by supporting the existing institutions (in part formed from even farther in the past).

Veblen believed economic theory needed to explain ongoing change in customary patterns of economic and social organization. He claimed: "The life of man in society, just as the life of other species, is a struggle for existence, and therefore is a process of selective adaptation. The evolution of social structures has been a process of natural selection of institutions."[134]

The struggle of mankind for existence changed in some degree from the struggle of the group against a non-human environment to a struggle against a human environment. Veblen notes, "This change was accompanied by an increased antagonism and consciousness of antagonism between the individual members of the group. Institutions need to incorporate human nature or habit into their definitions. The processes of modern life come up against these habits that have survived from a much earlier time."[135] Institutions have a role in reducing this tension. The pecuniary aspect of the leisure class is illustrated in the fact that this class does not hesitate to organize monopolies to reduce production and drive up prices to increase profits, rather than increase production and lower prices. Also from this position of advantage they block any competitive movement in wages or salaries.[136]

In summary, it was not that conservatives are so rigid, it is just that they are protected from most environmental pressures, hence they have no need to change. The fact that the middle class emulate the wealthy class creates an even more conservative community. The poor take on this same conservative attitude because the entire energy of the individual is focused on meeting his daily needs, thus he becomes more narrowly focused. In this system, there is an acceptance of conspicuous waste and pecuniary emulation, upon which the institution of the leisure class rests. In the long run, this reduces industrial efficiency of the community and slows adaptation to change in the industrial society.[137]

Today one hears the same rationale from the big bankers that Rockefeller presented for Standard Oil a century earlier: the large size is needed to drive the US economy. Conspicuous consumption of the nouveau rich who made money from the trusts of the 19th century have a counterpart today in the managers at the big banks, who make money from new speculative

instruments like derivatives. The widening gap between the rich and the poor at the turn of the 20th century appears again at the turn of the 21st century. Veblen's ideas on emulation explain the process why middle class people, such as the Tea Party, support the same policies as the rich, even though the economic policies are not to their advantage, but favour the rich.

A new voice, the Occupy Wall Street protesters, challenged the excesses of the corporations in general, and in particular, a government controlled by corporate money and the growing income gap between the very wealthy and the rest of America. There is also a great deal of frustration over the lack of jobs. One of the goals is to get working class people involved in the political process. While the banking crisis was not as severe in Canada, the direction is the same – the income gap between the rich and the poor is now growing at a faster pace in Canada than the US.[138] The discontent with growing economic inequality provides the unifying force behind the presently leaderless group. While their message is unfocused and the goals for change unclear, the protesters challenge established ideas. This process leads to inconsistencies and contradictions that appear in the messages – this is a *new* Age of Enlightenment!

Euphemistic language such as 'free trade' of globalization conceals its true meaning – brings a shift in economic sovereignty from the nation-state where there is hope of democratic participation, to corporate approved international commissions where only the corporate voice holds sway. Multinational corporations are responsible for the removal of traditional government accountability to a fixed population – leaving governments challenged to set the agenda for social responsibility, such as removing a product from market over safety concerns.

The dogma of small government and minimal regulation provides subtle language describing support for an efficient economic system to create jobs, which is really code for small government and minimal regulation. The corporation, the largest institution of the 21st century, supports its profits by attacking science to suggest that the level of scientific certainty is exaggerated, interfering with the public and the regulators understanding of a product, and delaying decision-making on change. In addition, corporations provide funding to 'think tanks' to produce reports that support the principles behind globalization, which is one reason evolutionary economics is at risk for being used to support the status quo. But Veblen illustrated how it could be part of the future, supporting the middle class!

Chapter 6 Cooperation and Survival

Thorstein Veblen, a contemporary of the 'robber barons,' incorporated the theory of natural selection into an economic model during the first era of globalization, when a small group controlled the economy. In this model he saw the rich responding differently than the middle class to changes in the environment. Veblen described society of this time as a tension and antagonism between the wealthy and the workers. Social Darwinism, the popular theory in the late 19th century that life for humans in society was ruled by 'survival of the fittest,' helped advance eugenics into serious scientific study in the early 1900s. Its support waned during the 1930s. Evolution, by far the most important natural process to man, was considered a cruel and wasteful process, thus it never made it into new economic theories of the first half of the 20th century.

After the Second World War, the economy seemed to turn into a system of abundance. There were fewer and fewer farmers growing more and more food. Electronic products, such as refrigerators and TVs, got cheaper each succeeding year. There did not seem to be a role for the theory of natural selection in such an economy. During the last two decades of the 20th century, deregulation of the market place and extreme individualism supported the rapid expansion of globalization. The economic debacle of 2008 identified that there was a flaw in the system, triggering protests against corporate greed and growing economic inequality. This led to a call for change. One of the new ideas that needs to be incorporated into this change is epigenetics. This includes preserving human potential as a freedom to allow the individual to develop and realize their full potential. This requires cooperation to control a wide range of environmental, social and nutritional exposures in order to prevent epigenetic harms.

Natural selection favors some types of cooperative behaviour – natural selection can act on groups. Groups that are more successful, for any reason, will benefit the individuals of the group, even if they are not related. Evolution shows more degrees of collaboration between organisms and species than formerly believed. It is now known that there are many examples of cooperation and partnership throughout nature, ranging from symbiosis to outright social behaviour.

Physiological and behavior traits that enhance an individual's ability to produce more offspring will be favored, and will be selected regardless of the effects on others. This supports inclusive fitness, the theory that says an organism can improve its overall genetic success by co-

operative social behaviour. It is the sum of its own offspring that it produces and supports, plus the number of equivalents of its own offspring that it can add to a population by supporting others. Characteristics favored by natural selection are those which improve the individual's inclusive fitness, which is the sum of the direct and indirect fitness. The easiest and most common way in which indirect fitness benefits can occur is through helping close relatives.

Social behavior seems to provide many benefits to those who practice it. Many animals are more successful in finding food if they search as a group. Especially if the food is clumped together, found only in certain places, then the more individuals cooperating, the greater chance one will find a clump of food. Many animals live in a social group partly for protection – one baboon cannot scare off a leopard, but a troop may be able to. With more individuals cooperating together, some can serve as sentries looking for danger, while the other group members are eating or sleeping.

Lichens are examples of a partnership between two very different organisms, fungus and algae. The fungal partner forms the main part of the organism, with algae cells scattered amongst the fungal hyphae, or arranged in a layer just below the upper surface of the lichen. The fungi provide vital protection and moisture for the algae, the algae nourishes the fungi with photosynthetic nutrients that keep them alive. Neither population could exist without the other; hence the size of each is determined by the other. Because of the partnership they have become enormously successful.

Lichens absorb water and minerals from rain water and directly from the atmosphere over their entire surface area. This makes them extremely sensitive to air pollution. Different lichen species vary in their tolerance to pollution, therefore make very good biological indicators of the level of atmospheric pollution.[139]

Corals are an important component of the sea ecosystem. There are two types of coral: hard coral and soft coral. Hard corals have hard, limestone exoskeletons which form the basis of coral reefs. The majority of the coral reefs are found in tropical waters. Corals are interesting since they consist of both algae and tiny animals called polyps surrounded by tentacles. They feed through ingesting plankton, and also through the association with symbiotic algae called zooxanthellae. Since reef waters tend to be nutritionally poor, corals obtain nutrients through the algae via photosynthesis, and also by extending tentacles (of the polyp) to obtain plankton from the water. Coral polyps secrete calcium carbonate which, over time, forms the geological reef structure.[140]

The algae (zooxanthellae) provide the coral's bright color while also providing the coral with necessary oxygen. The algae's need for sunshine is why coral reefs are found in shallow waters, forming an important habitat for marine life. Nearly 25% of the world's marine species are sustained by shelter and food provided by coral reefs.[141]

Honey bees are an example cooperation and survival through social behaviour. They form complex societies referred to as eusocial, and are characterized by the presence of several generations in the nest at the same time, cooperation of some members of society in caring for offspring that are not their own, division of labor with the queens that reproduce a lot, and workers that reproduce very little, if at all.

Bees have different jobs depending on their age. Young bees (0-3 weeks of age) are homebodies that work in the nest, and older bees (3-7 weeks of age) spend much of their time outside the hive. Bee pressure causes bees to change jobs in response to the needs of the hive.

There is a process in which genes are switched off and on. The job transition, whether triggered by age or social cues, involves changes in thousands of genes in the honey bee brain.[142]

Ants work in colonies with specialized behavior. Their colonies are unique as they utilize moist dark dirt and rotting vegetation for nesting. There are several types of specialization: ants in the colony responsible for feeding; other ants in the colony are responsible for bringing food to the feeders, and still others are responsible for bringing food to the colony. There are advantages to specialized duties. When there are a number of individuals solely responsible for feeding larvae, there is a higher likelihood that larvae will be fed by one of the individuals. Only a small percentage act as foragers, constantly exposed to danger. The majority of the colony is safe in the nest. If every ant in the colony had to forage, then every individual would be exposed to great danger.

In ant colonies, males arise from unfertilized eggs, so they only have half the complement of genes, all from the mother. Female workers arise from fertilized eggs, so they have a full complement of genes, half from their mother and half from their father. The workers always get the exact same half of their gene complement from the father, since he has only half to begin with. For the most part, workers are at least 50% related to each other, since half of their genes come from the same father. All workers are female, so workers are more closely related to each other than their offspring. In this case, natural selection selects genes according to their ability to contribute to the species (with more success from genetically similar individuals helping the colony than by having their own offspring).[143]

Some animals form social groups to make travel easier. Canada geese and other bird species typically fly in V formation. Just like the bicyclists who ride behind one another in order to reduce wind resistance, the geese fly in formation to reduce the wind they must encounter. The lead bird has the most tiring job, so several birds take turn leading the V.[144]

There is a new view developed on human cooperation, established by studies of thirty-two living hunter-gather groups throughout the world. Based on the data analysed, one can assume early human groups were more cooperative and willing to learn from one another than the chimpanzees from which human ancestors split about five million years ago. It was the advantages of cooperation and social learning that allowed early humans to progress along a different evolutionary path.

Anthropologists had previously assumed that hunter-gather bands consist of people closely related to each other, along the lines of chimpanzee groups. The kinship was believed to be the motive behind cooperation within the group. In the study, fewer than 10% of the people in a typical band were close relatives. This supports the concept that cooperative behavior was a major force in human evolution. On the other hand, the chimpanzees respond aggressively to intruders not related to the group.

Modern humans have lived as hunter-gathers for more than 90% of their existence as a species. Tribes existed, consisting of bands of thirty or more individuals. Tribes with highly cooperative members would prevail over those were less cohesive, promoting genes for cooperation. The two distinctive human behaviours, cooperation and social learning, promoted the development of large social networks that were effective in spreading and accumulating knowledge.[145]

Evolutionary psychologists are studying human behaviors that include adaptations and products of natural selection which helped our ancestors get around the world, survive and reproduce. Darwin's studies support the mind being designed by natural selection. Social cooperation improved the chances of survival, hence natural selection imbued our minds with an infrastructure for friendship, including gratitude and trust. We had enemies and social rivals which created situations for anger and anxiety, to discourage repeated behavior and support survival. Studies in evolutionary psychology reveal that emotions like happiness, sadness, fear and anger will always trigger the same facial expression, regardless of their cultural background. Instinctual responses can be largely overridden by learned rules that dictate appropriate ways for people to express their emotions in a particular culture.

In evolutionary psychology, pleasure has an end, an adaptive purpose. The purpose it serves is reproduction. We get pleasure from all the things that helped our ancestors survive and reproduce. Lust and sex fall into the activities that helped survival and reproduction. However, the feelings of pleasure never last. When one is thirsty, he drinks, then he feels the pleasure because his thirst is quenched. If he were to feel that pleasure forever, he would never drink again, and die of thirst. Today, when a person comes across a lot of money, he becomes happier for a while, then his happiness levels out to what it was before, and he wants more money again.

Evolutionary theorists dwell upon the eternal battle between altruistic and selfish behaviours in the Darwinian struggle for existence. Charles Darwin noted that social virtues could spread when evolution favoured, "with a great number of courageous, sympathetic and faithful members"[146] who at times of conflict would readily aide and defend each other. Then the altruistic would gain on the selfish.[147]

Humans have a symbiotic relationship with their gut flora, which is involved in the digestion of food and influences the development of the immune system. There are 93 to 100 trillion bacteria cells in the gut, compared to 10 trillion cells in all the organs and tissues in the average human. Five hundred to 1000 species of bacteria compete and cooperate with each other in a person's gut. They remain relatively stable in a balanced, symbiotic relationship with the host – the rest of the body. These bacteria work as a community; they need to adapt to the host, responding to what it eats. They play a role in helping digest food and synthesize vitamins, such as Vitamin K and biotin.

Recent studies suggest that gut bacteria play a significant and underestimated role in human health. A European group reported in the April 21, 2011 *Nature*, on the analysis of the bacterial composition of the gut flora of about 300 individuals from around the world. The study divided the population studied into three groups: type 1 – high level of the bacteria Bacteroides; type 2 – significant Prevotella, with much less Bacteroides, and type 3 – Ruminococcus predominated. The Bacteroides enterotype is associated with a typical Western diet rich in meat and fat. Prevotella is associated with a high-carbohydrate diet. By aligning genetic markers in bacteria with age gender and body weight, there was an opportunity to diagnose disease and screen for disease.[148]

These studies suggest that there is a relationship with health in such areas as predisposition to disease, progression of disease, and how disease should be treated therapeutically. The question arises whether the gut flora is determined by diet or by random colonization. African Americans have lower levels of Lactobacillus plantarum than native

Africans, likely because of the consumption of more animal products. Animal study models show that diets that are high in omega-6 fatty acids increase colon tumor promotion, while diets rich in omega-3 fatty acid have no such enhancing effect. A recent study in rats fed corn oil showed increased levels of a number of risk factors for colon cancer. This was also associated with higher levels of 7-alpha dehydrogenating bacteria. Now changes in bacteria flora need to be considered in studies for good health. This means each person should have a microbiome, a measure of their gut bacterial flora, for analysis.[149]

Antibiotics can upset this symbiosis. Antibiotic-associated diarrhoea describes frequent, watery bowel movements (diarrhoea) that occur in response to medications (antibiotics) used to treat bacterial infections in another part of the body. The antibiotic alters the intestinal flora, disrupting normal digestive processes causing diarrhoea, without the presence of an infection. It is a frequent hospital complication. Most often, antibiotic-associated diarrhoea is mild and clears up shortly after stopping the antibiotic.

It is possible when antibiotics kill off the good bacteria to get an overgrowth of *Clostridium difficile*, commonly called *C. difficile*, a bacterium that causes diarrhoea and other serious intestinal conditions. It is one of the most common infections found in hospitals and long-term care facilities. *C.difficile* is found in many medical wards, and when patients receive antibiotics, good bacteria in the gut are reduced, which allows an overgrowth of the organism. It produces a toxin that damages the lining of the large intestine. In some cases, discontinuing the antibiotic stops the diarrhoea; in other cases, the patient needs to take additional antibiotics to kill the *C. difficile*.

Since the 1990s, studies in which probiotics, live organisms which when administered in controlled amounts, may confer healthy benefits to patients by improving the microbial balance in the gastro-intestinal tract. Recent studies provide insight on the mechanism on how probiotics affect human health. Jeffrey Gordon, a microbiologist at Washington University in St Louis, and his team fed healthy adult volunteers and mice, that had a subset of bacteria from human gut flora, a commercial yogurt. The yogurt did not change the number of gut flora in either human or mice in the study, but the probiotic bacteria changed the expression of gut microbe genes encoding key metabolic enzymes. This upregulation of genes of bacteria in the gut flora is an example of cooperation amongst bacteria and how bacteria signal or communicate with each other.[150]

Because of the action of the bacterial enzymes, yogurt is easier to digest than milk. Probiotic yogurt can come in the form of single or multiple organisms. There are reports of using eight ounces of yogurt twice a day to prevent antibiotic associated diarrhoea or the reoccurrence of *C. difficile*. This yogurt contains a mixture of organisms such as *Lactobacillus acidophilus, Lactobacillus bulgarius* and *Streptococcus thermophilus* – about one million bacteria per gram. The treatment of last resort to kill *C. difficile* organisms and spores in the gut is a stool enema, typically from a relative.

Another symbiosis can be found in the rumen of cattle. The rumen of cattle are large fermentation chambers with high populations of microorganisms. These bacteria secrete the enzymes necessary for cellulose degradation so that rumens are able to use roughage. The bacteria synthesize nutrients (vitamins) and essential amino acids, that become available to the animal when the micro-organisms die, are digested. As discussed earlier, the change in how

beef cattle are brought to market changed the gut flora of cattle. Up to three decades ago, most cattle coming to market were grass fed. During the 1980s large agribusiness became involved. Corn fed cattle fatten faster (12-13 months) compared to grass fed (18-24 months), which allows the corn fed animals to be brought to market sooner.

A diet consisting of 50-90% grain is more digestible, ferments faster; so animals are presented with nutrients at a faster rate, and they grow faster. This corn diet is very stressful for the animals and it is necessary to use antibiotics to control the rumen flora. That means 70% of the antibiotics being used in the US are being given to healthy animals. This change in diet and antibiotic pressure increases growth of E. coli. The animals also become colonized with an acid resistant E coli, O:157:H7, that can produce a toxin that causes diarrhoea in humans. By the late 1970s, E. coli O:157 was reported as an emerging pathogen in humans, causing diarrhoea and in a subset renal failure. Now approximately 30% of cattle in the feedlot system carry verotoxin-producing E.coli asymptomatically. Ruminant animals are the main reservoir of the pathogenic bacteria, verotoxin-producing E. coli. The manure also contaminates irrigation water and groundwater. The appearance of this pathogen is due to the diet shift in the feedlots and the antibiotic pressure. It is known that switching to high roughage diet one week before slaughter, reduces E. coli counts considerably. However, the feedlot owners would have concern in the drop of quality grade: Prime to Choice, or Choice to Select, with an equivalent significant loss in income.

Consumers could switch to grass fed beef, but at increased cost. There are reasons to switch: meat from grass fed cattle can have as much as one-third less fat when compared to similar cut of grain fed; grass fed cattle have 50 to 85% more of the essential fatty acid omega-3 fatty acid; it provides conjugated linoleic acid, (a healthy ingredient that reduces the risk of cardiovascular disease), improves insulin sensitivity, produces an anti-inflammatory effect, and is higher in Vitamins B, D, E, and beta-carotene.

Soil is the largest terrestrial ecosystem where a wide variety of relationships exists between different types of microorganisms. Human activity in agriculture has had a significant impact on soil bacteria. Glyphosate is a non-selective herbicide produced by Monsanto since 1971. During the last decade, they have focused on glyphosate resistant crops. Of nine herbicides tested for their toxicity to microorganisms, glyphosate was the second most toxic to a range of bacteria, fungi, acetomycetes, and yeast. The herbicide is absorbed onto the foliage and translocated to metabolically active regions of the plants, where it interferes with the shikimic pathway and interfers with protein synthesis. The shikimic pathway exists in higher plants and microorganisms, but not animals. It mobilizes manganese, an essential micronutrient.

More than 80% of the species of higher plants have a symbiotic relationship between fungi called mycorrhizas, and their roots. These fungi hook on the roots and help penetrate soil and function to increase nutrient uptake by plants through a symbiotic association with the roots. This helps mobilize phosphates and nitrates for the plant. In return the mycorrhizas get some plant nutrients flowing through the roots. Mycorrhizae (fungi) have been implicated in the improved resistance to stress, and are necessary for the proper growth and development of most vascular plants. Mycorrhizal fungi act as additional roots for many plants and improve plant nutrition, which is an important part of soil fertility. Glyphosate (the pesticide sold in the

largest volume in the world) blocks phosphate accumulation in a plant, killing non-resistant plants and mycorrhizae.

Another symbiosis is between nitrogen fixing bacteria, Rhizobia, a soil bacterium that attach to the plant root surface, and fix nitrogen in a root nodule. Plants are dependent on the availability of inorganic nitrogen in the soil, so in order to be utilized by plants, nitrogen must be fixed by the addition of oxygen. Nitrification, the oxidative conversion of ammonium ions to nitrate, produces the principle form of nitrogen assimilated by higher plants, and is under control of relatively few species of bacteria.[151] These microbe-plant interactions have a great influence on plant health and soil quality since these root-associated microorganisms are able to help the host plant to deal with stress conditions – drought, and nutritional deficiencies and soil-borne pathogens. Glyphosate destroys nitrogen-fixing bacteria.

Stem cells are cells with the potential to develop into many different types of cells in the body, and can be part of epigenetic treatments in the future. Stem cells can differentiate into any cell; the epigenetic instructions are missing (not yet formed). All sources of stem cells have their pros and cons. In the future, it will be possible to manipulate the existing stem cells and promote them to proliferate and develop while still within the patient. Each cell in the adult body contains exactly the same DNA. The difference between cells then lies in the particular subset of genes used (that is, turned on or off). Embryonic stem cells can be kept in culture for prolonged periods of time. They can be manipulated to self-renew, and can be directed to develop into just about any cell type providing great potential for therapeutic cloning.

Adult stem cells occur in low numbers and their isolation is complex, which gives rise to a limited set of cell types, from either the bone marrow or the umbilical cord. Umbilical cord blood is a richer source than bone marrow. Many parents store umbilical cells in a biobank as a source of self cells to insure against possible future disease. Another source is baby teeth and wisdom teeth. Baby teeth, coming loose and falling out naturally, are a rich source of stem cells. In tooth cell banking, the process consists of harvesting and storing stem cells from the tooth's pulp. Stem cells remain a 100% match for the donor, and a 75% chance for siblings, parents, even grandparents. This is an evolving science that will have an important role in treatment of epigenetic changes.[152]

In November 2011, a group from the Memorial Sloan-Kettering Cancer Center, in New York, reported their success of transplanting stem cells that had been transformed into brain cells to treat Parkinson's Disease in monkeys. This work is early, but stem cells carry the potential to treat and to cure patients with Parkinson's disease.[153] In another test, skin cells were used to prime the immune system to fight cancer. A proof of concept has been achieved in a study by Oxford University scientists. In this process the stem cells were produced from dendidric cells from a biopsy of the patient's own skin. The cells were exposed to components of the tumor, and the dendritic cells were able to mount an immune response against the tumor in cell cultures in the laboratory. In the future, this holds promise to treat cancers in which other therapies have failed.[154]

Isaac Newton's studies of gravitation established the Copernican theory of the Earth revolving around the sun, introduced to the West the concept of mankind as the centre of the universe, establishing individualism as a core value of society. On the other hand, Darwin's Theory of Natural Selection displaced man from the centre of the universe, and made him equal

to the apes. The body has two cognitive systems that archive information from the past to be used to improve future chances of survival: the nervous system and the immune system.[155] The nervous system acquires knowledge and understanding through thought, experience and the senses. The cooperation and social learning between bands of hunter-gathers allowed the effective spreading and accumulation of knowledge, and allowed humans to evolve away from apes.[156] Natural selection selected a very active immune system for vertebrates to defend against infections and other harmful substances, in order to facilitate survival. The symbiotic relationship between humans and their gut flora plays a significant and underestimated role in human health, specifically, in maintaining a healthy immune system. A healthy functioning immune system plays a key function in protecting the body against epigenetic harms.

Chapter 7 The Immune System

One unique aspect of the immune system is the ability for exposure to an infection at a young age to provide life-long immunity. In youth many infections are mild compared to the symptoms seen in adults. The immune system is the body's protective network designed to fend off invasions by harmful substances, including bacteria, viruses and harmful chemicals, and to act as a surveillance system against the development of cancer. Cancer is the result of an immune system that didn't destroy mutant cells.

In the late 19th century, improved housing and nutrition started bringing down the rates of death from tuberculosis. By 1900, 30% of all deaths were attributed to infectious diseases: pneumonia, tuberculosis, diarrhoea and diphtheria. Of these deaths, 40% occurred in children age five years, and younger. In 1997, heart disease and cancer caused 54.7% of all deaths, and deaths in children accounted for less than 1.5%. Cancer was the eighth leading cause of death in 1900, accounting for 4% of the total, but in 1997, it accounts for 25% of all deaths, and is now the second leading cause, behind heart disease.[157]

The human immune system is a very important evolutionary adaptation that allows humans to better cope with an often hostile environment. The immune system protects the body through two processes: the innate immune system and the adaptive immune system. The innate immune system is nonspecific as to the type of organisms it fights. The innate system is associated with phagocytic cells that engulf (eat) pathogens, and other cells that release chemicals that trigger more cells to migrate to the site of the infection. On the other hand, the adaptive immune system launches an attack specific to the invading organism, and requires time to tailor its custom-made response. The adaptive system is associated with antibodies and is composed of lymphocytic cells (B and T cells) that can learn to identify pathogens and provide a specific response to kill pathogens. This process triggers the production of soluble factors or antibodies which neutralize the ability of the pathogen to infect one's body, as well as, enhance antimicrobial activities of phagocytosis. The adaptive system remembers antigens (pathogen) that it has encountered and acts more quickly, and efficiently, the next time that the antigen is found, yet more slowly than the innate system.

Humans evolved to store food and resist disease, not grow old. Evolution selected genes that promote survival and fertility, even if the traits might prove deleterious in post-reproductive years. Because of natural selection, humans evolved to a preference for fat and an aggressive immune system to defend against infection. The free radical theory of aging is based on the accumulated free radical damage over the human lifespan. Free radicals are atoms or groups of atoms with an odd (unpaired) number of electrons and can be formed when oxygen interacts with certain molecules. With the appearance of oxygen, organisms developed antioxidant defences to protect themselves against oxygen toxicity. Living organisms evolved to use oxygen in respiration, an efficient process to deliver more energy from less food. Over 80% of the oxygen that living organisms breath is used in the mitochondria to generate adenosine triphosphate (ADP), the universal cellular energy currency. In order to reduce the damage caused by elevated free radicals and cytokines (which are both part of the natural immune system), the body fights back by producing antioxidants and hormones, such as cortisol to suppress the immune system.

A key component to the immune system is the oxidative burst. The neutrophil surrounds the bacteria and uses lethal oxidative burst to kill the bacteria. Living organisms constantly combat reactive oxygen species which are formed by either endogenous or exogenous mechanisms. Oxidation is a chemical process whereby electrons are removed from molecules and highly reactive free radicals are generated. Exposure to various environmental factors, including tobacco smoke and radiation, can also lead to free radical formation. In humans, the most common form of free radicals is oxygen. When an oxygen molecule (O_2) becomes electrically charged or 'radicalized' it tries to steal electrons from other molecules, causing damage to the DNA and other molecules. Over time, such damage may become irreversible and lead to disease, including cancer. Reactive oxygen species have been implicated in over one hundred diseases that include cancer, cardiovascular disease, neurodegenerative disease and diabetes. There is a connection to space. Space travellers will inevitably encounter increased dosages of ionizing radiation that would produce excess reactive oxygen species. Humans have antioxidant defences to protect against oxidative damage, but it can be overwhelmed in the presence of excess reactive oxygen species. Dietary intake of antioxidants would be important on long voyages. Studies have shown that onions grown under reduced light still develop antioxidant capacity. Onions would be an ideal plant to include on a space trip to Mars.[158]

Oxidation is an important process to understand. In the earth's early history, the dominant gas was methane produced by bacteria. Free oxygen was in short supply, it reacts so easily with other elements that it does not last long in the free state. The great oxidative event took place 2.7 billion years ago. It came from blue-green algae (cyanobacteria), organisms that could photosynthesize and produce oxygen. Even though the blue green algae appeared 2.7 billion years ago, the oxygen they produced was quickly consumed by the methane producing bacteria. For various reasons, the growth of methane producing bacteria dropped dramatically. This led to the rapid expansion of cyanobacteria and the accumulation of oxygen in the atmosphere and oceans.[159] Now anaerobes only exist in airless environments, such as sediments and muskeg.

The oxygen build up in the atmosphere happened 2.4 billion years ago. As gaseous oxygen built up, the atmosphere began to change from one that was chemically reducing to

one that was oxidizing (i.e., rust-forming), like today's. Similarly, the oceans went from reducing to oxidizing. There were two major consequences: the oxygen oxidized atmospheric methane (a strong greenhouse gas) to carbon dioxide (a weaker one) and water, triggering a major glaciation event. Second, the increased oxygen levels provided a new opportunity for biological diversification, as well as tremendous changes in the nature of chemical interactions between rocks, sand, clay, and other geological substrates and the Earth's air, oceans, and other surface waters.[160]

Oxidative stress is considered a leading cause of chronic disease and aging. The process (free radicals) can affect cell membrane proteins, even genes, and occurs when free radicals (toxic oxygen molecules produced by normal body processes), but also by external sources (such as stress and pollution), spiral out of control. Free radicals always exist; the problem occurs when they are out of control.[161]

The production of free radicals is increased by outside environmental sources, such as cigarette smoke, alcohol, automobile exhaust, air pollution, infections, asbestos and radiation. The human body lacks the main compounds needed to fight free radicals – antioxidants. A combination of second hand smoke and alcohol, in combination with a diet that is not the best, exacerbates the production of free radicals. Oxidative stress damages DNA in various ways. DNA consists of four main building blocks or bases: adenine (A), cytosine (C), guanine (G) and thymine (T). Guanine is the nucleotide most susceptible to oxidation, and the most common oxidation product is 8-oxoguanine. The oxidized guanine binds with the 'wrong' base partner, adenine, instead of the usual cytosine. When DNA is replicated during cell division, the result is an A-T pairing in the DNA where there should be a C-G. This is considered the main cause of frequent recombinations and single nucleotide polymorphisms.

Telomeres are formed by non-coding DNA sequences along with specialized proteins that act as protective caps at the physical ends of the chromosomes. Chronic oxidative stress is associated with pre-mature aging and attrition (shortening) of the telomeres. Factors that adversely affect telomeres are: smoking, drinking heavily, obesity and chronic psychological stress. As increasing numbers of cells reach the end of the telomeres and die, physical symptoms of aging appear. These symptoms include weakened muscles, wrinkles, fading eye sight and hearing, organ failure, and diminished thinking ability. Diet and supplements have a role in preserving telomere integrity.[162]

Oxidative stress is implicated in cancer and Alzheimer's disease and has an impact on the body's aging process. External factors, such as pollution, can trigger the production of free radicals, increasing an individual's exposure to free radicals. The body produces some antioxidants to control free radicals, but there are times that the body is not able to produce enough antioxidants to neutralize all the free radicals. In these instances, one can help their body by increasing his dietary intake of antioxidants. There are a variety of anti-oxidant foods. Pomegranates inhibit the oxidation of LDL (the bad cholesterol), which is only a problem in the body when it is oxidized. The consumption of commercial tomato juice increases plasma lycopene levels and the intrinsic resistance of LDL to oxidation almost as effectively as vitamin E. Carotinoids, nutrients that exist in the pigments that color plants, are important antioxidants. The carotinoids found in foods like carrots and tomatoes prevent lipid peroxidation.[163]

In the late 19th century, candle maker William Procter and his brother-in-law, soap-maker James Gamble, joined forces to gain competitive advantage in their respective industries. Since the meat industry controlled the prices for lard and beef tallow (raw materials needed for both candles and soap), they sought control of an alternative product. They purchased eight cotton seed mills in Mississippi. Through research and development, Procter and Gamble developed a process to turn liquid cotton seed oil into a hardened product usable for both candles and soap. The process was called hydrogenation which involved exposing the liquid (unsaturated) oils to hydrogen gas, producing a solid, more stable substrate.

As the electric light became more popular, the candle industry waned. Procter and Gamble looked around for another use for their product. They developed cotton seed oil into a product for baking, Crisco (short for crystallized cotton seed oil). Through an aggressive marketing campaign that began in 1911, the American housewife was persuaded from cooking with animal fats and butter. The new 'vegetable oil' was promoted as healthier than animal fat and cheaper than butter. Fifty years later it, was being added to countless other processed food items. In 2002, Procter and Gamble sold the Crisco brand, along with Jif Peanut Butter brand, to J.M. Smucker for one billion dollars.[164]

The product, called hydrogenated or partially hydrogenated oil, is now found in many baked products, used for flavour and to extend the shelf life. At one time this product was promoted over saturated fats and cholesterol. Then it was discovered that hydrogenated oils contain trans fats which are associated with cardiovascular disease. In 2006, it was required to be listed on all food labels. Vegetable oils were substituted in many products in which partially dehydrogenated oil had previously been used. The vegetable oils opened the discussion on the essentially fatty acids, omega-6 and omega-3.

Omega-3 is a component of certain foods that has become popular recently with respect to heart health by reducing inflammation along with additional benefits. Omega-3 also reduces the stickiness of platelets, reducing their property to coagulate. This reduction in the tendency of platelets clumping together is associated with less heart attacks and strokes. In addition, omega-3 lowers the triglyceride levels in the blood, reducing cholesterol along with the risk of stroke and heart attack. Omega-3 has a role in reducing stress by increasing the release of the hormone serotonin. Serotonin is a happy messenger that sets your body clock and allowing you to obtain a restful sleep. For proper functioning omega-3 must be in the correct ratio with omega-6. Omega-6, which comes from vegetable oil, can cause inflammatory reaction. It is highly reactive and can oxidize cholesterol – making platelets stick together, and oxidize LDL cholesterol (the bad cholesterol), which causes hardening of the arteries. The ideal ratio of omega-3 to omega-6 is 1:2. The average diet contains a ratio of 1:20 to 1:50, with way too much omega-6 and not enough omega-3. Flaxseed oil contains a ratio of 4:1, so it is a good source of omega-3.[165] Omega-3 fatty acids act as immune boosters by increasing the activity of phagocytes, the white cells that eat up bacteria. Individuals consuming diets rich in fruit and vegetables are less likely to get diseases such as cancer, heart disease and stroke.

Small amounts of reactive oxygen species play an important role as signalling molecules for normal cellular function in vascular cells (vasorelaxation). Under normal physiological functions the reactive oxygen species are removed by anti-oxidant enzymes, resulting in a controlled activation of signalling cascades. Excess reactive oxygen species cause damage to biological molecules, such as proteins, lipids and DNA. This includes the endothelial cells that

make up the cell wall lining of the interior wall of arteries. The oxidation of LDL (which is essential to deliver cholesterol to cells) leads to chronic inflammation.[166]

Cholesterol is no longer considered the best indicator for a person's risk for a heart attack or stroke – 50% of people dying from heart attack have normal cholesterol levels. The test, C-reactive protein, that measures inflammation, can predict individuals who are at risk for heart attack better than cholesterol. Medical research is now pointing to the fact that the risk factors for oxidative stress are determined by the size of the lipid particles, and the inflammatory status. If reactive oxygen species are not mopped up by circulating antioxidants, then vessel walls are damaged and plaques can form. The size of LDL is now under consideration – the smaller diameter LDL is strongly correlated with inflammation.

There are situations that aggravate chronic inflammation. Oxidized LDL cholesterol is LDL, that has been exposed to free radicals. Within the endothelium, it triggers an inflammatory response that accelerates vascular disease. An elevated omega-6:omega-3 ratio (high levels of proinflammatory omega-6 fatty acids relative to anti-inflammatory omega-3 fatty acids), creates an environment that fosters inflammation and contributes to vascular disease. It has been shown that lowering the omega-6: omega-3 fatty acid ratio significantly decreased atherosclerotic lesion size and reduced measures of inflammation.[167]

Chronic inflammation is closely associated with oxidative stress, an exaggerated presence of highly reactive molecular species, which leads to potential tissue damage. Reactive species arise as natural by-products of aerobic metabolism and they play a role in numerous signalling cascades and physiological processes, such as phagocytosis and neutophil function. However, excessive oxidation can trigger cytotoxic chain reactions that are damaging to membrane lipids, proteins, nucleic acids and carbohydrates. This means the capacity of the human body to control the production of free radicals determines whether only regular physiological processes in place for natural relations occurs, or whether there is a spill over into other physiological systems to trigger factors that lead to chronic inflammation.

Diabetes is defined as high blood sugar, altered insulin secretion, and insulin resistance – a diminished responsiveness to normal concentrations of circulating insulin. The prevalence of type 2 diabetes is increasing world wide. Formerly considered a disease of adults, it is now appearing in children. The burden imposed by diabetes includes shortened life expectancy, fewer years lived in good health, as well as increased health-care costs.

In diabetes, free radicals activate a number of stress-sensitive kinases whose downstream effects mediate insulin resistance. Specifically, the kinases upregulate pro-inflammatory cytokine genes resulting in the synthesis of acute phase reactants. This, in turn, interferes with the insulin receptor, disrupting insulin signalling, which in turn, increases insulin levels. Excess insulin is associated with significantly greater risk of heart disease. Oxidative stress and chronic inflammation are closely linked via positive feed back mechanisms and are both associated with obesity and the metabolic syndrome.[168] (Metabolic syndrome is the name for a group of risk factors that raises your risk for heart disease and other health problems, such as diabetes and stroke.)

Metabolic syndrome risk factors include high blood pressure, obesity, high cholesterol, and insulin resistance. Weight loss reduces the risk of cardiovascular disease, the risk of diabetes, and strengthens the immune system. Fat is an endocrine organ, secreting many

factors that immune cells respond to. In over-weight individuals, this leads to overstimulation of the immune system, with increased WBC and suppressed immune cell function, leading to chronic systemic inflammation. Calorie reduction in such patients improves immune function and reduces the production of inflammatory cells.

Perfluorinated compounds (such as PFOA), have been used in increasing amounts in such products as grease and water resistant coatings in pizza boxes, fast food wrappers, microwave popcorn bags, rain gear, and water and stain resistant coatings for clothing and carpet. Because they persist in the environment, they have become common around the world. Scientists studied the immune response to vaccine in children in the Faroe Islands between Scotland and Iceland. They found that the level of perfluorinated compound found in the blood of children correlated with the highest blood level with poorer immune response. (The chemical exposure is likely due to high fish intake.) This is the same effect seen in the immune system from individuals exposed to radiation treatment or cancer drugs. Because of concerns over health effects, the production of PFOA will be phased out in the US by 2015. However, the chemical will still be on products imported from countries such as China.[169]

Basic science (research) shows that reactive oxygen species and oxidative damage are important factors in neurodegenerative disease. Aging is also a risk factor, increasing in the incidence of damage to the mitochondria. Mitochondria are power plants that convert nutrients into energy, as well as doing many other specialized tasks. The body's own antioxidant, glutathione, is known to be depleted during stress, illness, exposure to toxins, or aging. Glutathione supports normal cellular detoxification. Antioxidants like vitamin E depend on glutathione to be effective. Oral forms of glutathione are useless, as the digestive tract destroys the nutrient before it can be absorbed. Some specialized clinics provide intravenous glutathione to patients with neurodegenerative disease. A new form of glutathione was developed using liposomal technology – packaged in microscopic pouches called liposomes, which can then enter the blood stream intact. Not all the pathways involved in the neurodegenerative disease are understood. More studies are required to determine the most effective way to address the oxidative features.[170]

A small amount of oxygen, inhaled, converts to oxygen free radicals. If the free radicals are allowed to accumulate in the cells, they cause damage. Human antioxidant defences do not remove all the reactive oxygen species generated in vivo. Co-factors, such as high fat diets, hypertension, high plasma low density lipoprotein (LDL) and cigarette smoking produce atherosclerosis of the arteries. LDL becomes fixed to the arterial wall and, when oxidized by a free radical becomes toxic to the cell, assists in inflammation in the area. Reactive oxygen species also damages DNA, creating mutagenic lesions. A battery of repair mechanisms struggle to keep up with the DNA damage caused by reactive oxygen species and other toxic agents. Over a human lifespan, sufficient damage eludes these repair mechanisms to cause mutations that initiate and promote cancer. Thus towards the end of life, one-third of the population develops cancer, making major cancers age-related diseases.

Why have better anti-oxidant defences to prevent LDL oxidation and DNA damage failed to evolve? Evidence suggests that some free radical production is useful in mounting responses to infections. Natural selection would have picked this essential defence as desirable during evolution. In response, many bacteria defend against cell challenges with up-regulation of antioxidant enzymes, enabling them to resist the host immune defences. At one time, the

excessive damage caused by free radicals leading to cancer in the post-reproductive years was immaterial, because few people lived that long. The association of lower risk for cancer, cardiovascular disease, type 2 diabetes, and perhaps dementia, is associated with diets with high antioxidant content. A study of healthy individuals showed less DNA free radical damage with individuals on a good diet. In this study there was less protection from supplements. The take-home message is that many populations would benefit from eating less fat and more fresh fruits and vegetables, and taking a multivitamin mineral supplement with modest amounts of ingredients.[171]

Vitamin D plays an important role in the immune system. It dramatically stimulates the expression of potent antimicrobial peptides, and enhances the environment in which they function.[172] Vitamin D can act as a potent stimulator on the innate immune system, and the evidence is supported by association studies that link vitamin D deficiency with increased risk or severity of infection. In laboratory studies, vitamin D enhances the killing of Mycobacterium tuberculosis by monocytes. This is consistent with the historical link between UV light exposure and the treatment of tuberculosis – prior to the introduction of drug therapy, patients with tuberculosis spent hours in the sun. Studies in vitamin D deficient mice identify a role for vitamin D in regulating the innate immune response to gut flora. Studies suggest that bowel flora have a role to play in chronic inflammation, and Crohn's disease looks less like an autoimmune disease and more like a defect in the gastrointestinal innate immune function.[173]

Over thousands of years, the immune system evolved to battle the ever-present threat of pathogenic microorganisms. The immune system also removes reactive radicals from oxidative stress. With an increase in life span, the immune system can no longer protect the body if it is not healthy; consequently, older people are more susceptible to infections. The healthy immune system needs to be maintained to be able to kill cells, such as bacteria and viruses and cancer cells. Diet affects immunity; rats maintain their immune system when put on diets to extend longevity (a low calorie, nutritionally optimal). Modern medicine has played less of a role in longevity than previously believed, with increase in life expectancy predating the vaccine era (survival of infectious diseases in Western economy). It was attributed to better food, better water and better housing.

People have become aware of the important role that a proper diet has in maintaining good health. To augment this, many use multivitamins. The components of multivitamims /mineral supplements consist of micronutrients that are known to strengthen the immune system. Various micronutrients can affect the immune system in different ways. Vitamin D 'triggers and arms' the immune system. Specifically vitamin D triggers and arms the body's T cells, the cells in the body that seek and destroy invading bacteria and viruses. Without vitamin D the immune system is unable to react and fight off serious infections in the body.

Vitamin C is the primary hydrophilic antioxidant found in human plasma, and has an important role in immune function and various oxidative/inflammatory processes, such as scavenging reactive species and preventing the initiation of chain reactions that lead to protein glycation. Glycation is a process by which proteins, certain fats, and glucose tangle together. It affects all body tissues, and tends to make them stiff and inflexible. Glycation, and the glycotoxins caused by it, is a major cause of the side-effects of being diabetic – higher levels of heart disease, high blood pressure, kidney disease and eye problems – and is one of the

processes which leads to aging by damaging cells. The daily recommended allowance for vitamin C is 75 mg for women and 90 mg for men, with higher does (additional 35 mg) for smokers. Vitamin C can recycle vitamin E and glutathione back from their oxidized forms. To boost the immune system the daily amount of vitamin C should be increased to 200 mg.[174]

A recent study challenged the utility of vitamin E supplements. Participants, men 50 years of age and older, taking 400 IU (international units) of the alpha-tocoperol form of vitamin E from 2001 to 2008 were studied. The trial was stopped because there was no benefit (i.e. reduction in prostate cancer). The group was reviewed again in 2010 and was found to have a 17% increase in prostate cancer.[175] One explanation is that vitamin E consists of four components: alpha, beta, gamma and delta, and there are two supplements on the market – alpha tocophorol, and alpha-beta-delta-gamma tocopherol complex. Early studies demonstrated alpha tocopherol had a positive effect in rat studies. It is now known that gamma tocopherol exhibits anti-inflammatory effects, and the gamma-delta tocopherol is associated with cell death compared to alpha tocopherol in laboratory experiments. The recommended supplement is to either go with the low dose in your multivitamin, or else the alpha-beta-delta-gamma tocopherol complex, not the less expensive alpha format.

Vitamin E intake increases the rate of lymphocytic proliferation by enhancing the ability of T cells to undergo cell division cycles. Its anti-inflammatory activity has been substantiated from observations of its ability to modulate expression of cytokine genes in animal models.[176] Vitamin E supplements are considered good candidates to reverse some of the decline in the immune response commonly seen in aging. Vitamin E requirements range from 100 to 400 milligrams per day, depending on your general lifestyle. People who don't exercise, who smoke, and consume high amounts of alcoholic beverages, need the higher dosage.

Zinc is a mineral that increases the production of white cells that fight infection and helps them fight more aggressively. Zinc supplements have been shown to slow the growth of cancer. However, too much zinc, such as 75 milligrams daily, can inhibit immune function.[177]

For some micronutrients, it is best to rely on certain foods. Beta carotene increases the number of infection-fighting cells, as well as being a powerful antioxidant that mops up excess free radicals that accelerate aging. This nutrient also protects against cancer by stimulating the immune cells called macrophages to produce tumor necrosis factor, which kills cancer cells. The body converts beta carotene to vitamin A, which itself has anticancer properties and immune boosting functions. But too much vitamin A can be toxic for the body, so it is better to get extra beta carotene from foods and let the body naturally regulate how much of this precursor is converted to immune-fighting vitamin A. Bioflavenoids aid the immune system by protecting the cells of the body against environmental pollutants. Bioflavenoids protect the cell membranes against the pollutants that are trying to attach by blocking receptor sites on the membrane of the cell. The fruits and vegetables in your diet provide the bioflavenoids needed to help your immune system.

One consequence of the human genome project has been the fact that few genes have been identified as leading causes of diseases. The commonest cause of chronic disease is the gene-environment interaction – environmental exposures alter gene functions. The immune system is part of this process. With respect to the reduction of oxidative stress, two important foci are diet choice (leading to deficiencies or imbalances), and exposure to toxins in air, water, food, and household products.

Chapter 8 Diet and Choice

In the 17th century, even though peasants were strong, healthy and robust, they wanted to emulate the powerful and elite and be 'refined' like the rich. This was the milieu in which processed food was born and glorified. Sugar had become the chief crop of the West Indies in the second half of the seventeenth century because of the dramatic fall of tobacco, which had been the main crop of the sixteenth century. (The stiff competition of Virginian tobacco created the downfall of the West Indian tobacco.) The new industrial workers' diet shifted to more fat, sugar, and refined flour. A biscuit or cake is a good example. Flour was refined so that it would not support weevils and, like refined sugar and saturated fat, did not go rancid. These cheap, energy-providing foods were considered 'fuel' for the industrial revolution, in the same way that a car needs petrol. Not surprisingly, health declined during the 19th century.[178]

Studies of recently acculturated hunter-gatherer populations that have adopted western dietary patterns frequently show high levels of hyperglycemia, insulin resistance, hyperinsulinemia and type 2 diabetes. Conversely, hunter-gatherer populations in their native environments rarely exhibit these symptoms. In industrialized countries, this dietary shift from hunter-gatherers to refined foods occurred more slowly over the 200 or so years since the advent of the industrial revolution, as more and more refined sugars were gradually included in the diets, along with increasingly greater levels of refined cereals. The diet of the industrial revolution in Britain became refined flour, refined sugar and saturated fat. These foods needed no digestion time; they became the energy food for the industrial worker. With more and more women working in the factories, it was advantageous to have foods with longer shelf-life and less spoilage. What was branded as 'refined' in the 19th century would be defined as 'junk food' at the end of the 20th century.

The screening of recruits for the Boer War identified the poor health of many British recruits. Over 40% of recruits, in some jurisdictions, were found to be unfit for military service, most suffered from poverty related illnesses, such as rickets. This hidden disease of the 19th century didn't appear among the certified causes of death; not being a killer, it was not on the public health radar. The poor health of recruits focused attention to the state of the poor in Britain and led to the introduction of population screening.

During the 19th century, Britain had become an urban nation. Because of the smoke of the industrial revolution, the working class women and children did not spend a lot of time outdoors, nor were they exposed to much direct sunlight. In addition, they subsided on a diet of bread, tea, sugar and margarine. Even in the 1880s, it was noticed that rickets was absent from small towns, nor was it seen in children in the tropics. Based on folklore from coastal towns of Britain, cod liver oil was recommended in the 1930s to combat rickets. Later that decade, fortification of milk with vitamin D was introduced, which led to the eradication of rickets in the US.[179]

The diet of North Americans has changed more in the past fifty years than the last 5,000 years. The average supermarket carries over 47,000 products. Multi-national corporations are involved in processing food in assembly-line fashion. Choice becomes a challenge for consumers: where is their food coming from, and how it is processed? There are four ways intensive agriculture and the subsequent processing have changed human health: (1) sodium intake has dramatically increased, (2) grains have replaced fruits and vegetables, (3) too much fat in the diet and, (4) the ratio of omega-3 to omega-6 essential fatty acids is not in the proper ratio. Eating a balanced diet will ensure that your body is receiving the essential nutrients that it needs to function at an optimal level. When you don't get these essential nutrients, the body's functioning diminishes. There are many examples that associate various diets with increase or decrease in a disease state.

The Irish Potato Famine carries a couple of messages for today. The Industrial Revolution bypassed the Irish, leaving Ireland an agrarian society during the 19th century. (The potato had been developed by the Incas. The Incas had twenty types of potatoes, while in Ireland in the 19th century only one type was grown, emphasizing the problems of monoculture.) The Irish adopted the potato as a subsistence crop, as one acre of potatoes could feed the same number of people as it took four or five acres of grain to do. However, growing potatoes year after year on the same small plot increased the chances of disease. Potato blight struck in 1845-1846, 1848 and 1851. During this period over one million Irish starved to death. The laissez-faire thinking of the power elite in Britain encouraged self-reliance, and considered support for the poor would only aggravate the problem in the long-term. There was increased migration from Ireland to North America during this period.

The banana variety known to North Americans through their supermarket is a variety called Cavendish. Cavendish bananas account for 45% of the fruit's global crop. It was chosen to replace the Gros Michel variety, which was wiped out by a fungal disease in the first half of the 20th century. Most banana varieties are not viable for international trade. Cavendishes provide farmers with a high yield of palatable fruit that can endure overseas trips without ripening too quickly or bruising too easily. It appears that the Cavendish banana is now susceptible to a fungus, like its predecessor. In the late 1980s the fungus destroyed most of the Cavendish banana crop in Taiwan, and spread to Indonesia, followed by China and the Philippines. It seems only a matter of time before the disease will reach the banana crops in Central America and the Caribbean.[180]

It will be six years before new breeds of bananas will be brought to market, if funding for the necessary research can be found. The solution could be a genetically modified crop, or development of hybrids from the few Cavendish plants that do produce seeds. Banana

researchers agree that the best solution, as is done with potatoes, apples and grapes, is to abandon monoculture that makes the emergence of a disease so devastating.[181]

Corn is the largest crop grown in the US, and now earns significant export dollars. Two-thirds of the corn grown in the US is genetically modified. In 2011, the rootworm beetle, resistant to the Bacillus thuringiensis toxin, started destroying crops in the US. There is a correlation with the number of years corn was grown on a field, with the appearance of rootworm infestation, specifically after three years. This puts companies on the treadmill of ever-increasing DNA manipulation and chemical development to stay ahead of nature, and support monoculture. Integrated pest management can also be achieved by time-honoured crop rotation and the use of hybrids.[182] The GM crops were said to be immune (at one time) to development of resistant insects. When the GM products were launched, it was also said that the proteins would not survive the human digestive tract. New information has appeared that suggests that there are unintended consequences of the new product. In May 2011, a team at the Sherbrook University Hospital in Quebec reported identifying the Bt toxin (along with pesticides) in the blood of pregnant women and newborns. Concerns were raised throughout the world because regulators advised that no proteins should survive intact in the intestinal tract or enter the blood stream when, in fact, the Cry1Ab toxin has been discovered in human blood. The most probable source is GM food consumed as part of the normal diet (GM presence is unlabelled). The Sherbrook study throws into serious doubt the validity of the risk assessment carried out on BT crops, which always assumed it would be destroyed in the gut.[183]

Studies done by the World Health Organization identified that pesticides remain on wheat after harvest, and milling does not remove it. The Sherbrook study identified two pesticides, glyphosate and gluosinate, in the blood of pregnant women and their babies. This means there can be long-term exposure to low levels of pesticides, and now there is a need to know the long-term or cumulative health impacts of long-term exposure in food. These studies need to take into account that glyphosate sequesters in the bone and internal organs. Regulatory bodies raised the maximum permitted residue on crops directly sprayed with glyphosate, such as GM corn, by 200% in the 1990s. These changes coincided with the introduction of glyphosate resistant crops. The result is resistant weeds and increased appearance to a chemical which is very toxic to fish and aquatic life.

There is an obesity epidemic in the developed world. Obesity is part of the metabolic syndrome associated with the risk factors: obesity (weight around the middle), and insulin resistance in which the body cannot use insulin effectively. With insulin resistance, blood sugar cannot get into the cells and the body produces more insulin. Insulin and blood sugar levels rise, affecting kidney function and raising the levels of blood fats, such as triglycerides.

Adipose tissue releases factors that exacerbate these risk factors. This leads to an overload of nonesterfied fatty acids, which overload muscle and liver with lipids and release cytokines causing increased inflammation. This in turn causes increased serum C-reactive protein, elevated PAI-1 which contributes to prothrombotic state, and low adiponectin levels that are associated with coronary artery disease.[184]

Margarine was developed and brought to market in the last half of the 19th century as the 'poor man's butter.' It was made from beef tallow and sold at one-third the cost of butter. By the second decade of the 20th century, hydrogenated oils replaced tallow, freeing production

ties with the meat packing industry. Cottonseed oil was the main vegetable oil. It caught on as there was a growing demand for an alternative to butter among lower income groups. Palm oil was a popular component in the 1930s. Margarine was 80% fat by weight, the same as butter. During the 1940s, a special report declared vitamin-fortified margarine and butter equivalent in food value. After the Second World War cottonseed oils and soy oils were the main ingredients of margarine.

Margarine came into widespread use following the Second World War largely because of the low price and purported health benefits. The partial hydrogenation of the vegetable oils created a product that was solid and less likely to spoil. Hydrogenated vegetable oil replaced saturated fats in processed foods and fast food preparation. However, trans fats are formed during the hydrogenation process. Trans fats increase bad cholesterol, lower healthy cholesterol, and make blood platelets stickier. The risk from trans fats led to development of margarines with trace trans fats, and the introduction of more expensive products with no trans fats in the late 1980s.

Because vegetable oil is high in linoleic acid (omega-6) and low in ALA (omega-3), this shifted the omega-6 to omega-3 fatty acid ratio in a regular diet. This diet can cause epigenetic changes in populations. Researchers exposed four generations of mice to a diet of excess omega-6 to omega-3, and saw the appearance of signs of metabolic disorder, such as insulin resistance and the triggering of the inflammatory gene, involved in obesity. In mice, the diet changes the gene expression in a way that increases the prevalence of obesity.[185]

The general belief is that obesity results from interaction between environment and genetic factors. Epigenetic imprinting can account for variation in gene expression. The environmental factors under suspicion are the facts that the consumption of fast food quadrupled from 1977 to 1995, and from 1970 to 1999 the consumption of high fructose corn syrup soared. The rapid appearance of obesity is consistent with epigenetic changes. The obesity epidemic requires a reduction in the level of omega-6, along with an increase in omega-3 essential fatty acids in the diet. This can be achieved by switching corn oil which is 60% omega-6 to canola oil which is 20%. In addition, canola has the ratio of omega-6 to omega-3 of 2:to 1, compared to a ratio of 46:1 for corn oil.

Colorectal cancer screening programs are about detecting blood or another marker in the stool of patients over fifty years of age, for early detection to prevent deaths from colorectal cancer. The prevention of colorectal cancer deals with lifestyle and eating habits. Lifestyle is about exercise and maintaining a healthy weight. Diet is about increasing the amount of antioxidants to bolster the body's defence against free radicals and reinforce the immune system. The antioxidants are best taken as food, specifically a plant-based diet where the majority of the calories come from minimally processed plant foods, such as vegetables, fruit and whole grains.

The American Dietetic Association notes that vegetarian diets are associated with less heart disease, colon cancer, osteoporosis, diabetes, kidney disease, hypertension and obesity. The call for reduced consumption of red meat appeared an article in the March 23, 2009, *Archives of Internal Medicine*. It should be noted that processed meats have more additives and fat (than pure cuts). A recent study from the Harvard School of Public Health suggests that consumers of processed meats, such as salami, bacon, sausages and corned beef, have 42% high heart disease and 19% higher risk for type 2 diabetes than those consuming fresh meat.

The processed meats are higher in salt and preservatives like nitrates.[186] In the EU, the use of growth hormone is banned in meat production.

How meat is cooked can be a risk factor for cancer. The longer and hotter meat is cooked the more heterocyclic amines, cancer producing compounds are formed. Another cancer causing compound, polycyclic aromatic hydrocarbon, forms while broiling meat over a direct flame, where the fat droppings on a hot fire adhere to the surface of the food.

The trans fat story provides a prototype for change. Liquid fats are made into solid fats by the addition of hydrogenation, originally to increase the shelf life. Today the rule is one should consume as little as possible, because trans fats increase bad cholesterol, low density lipoprotein (LDL), and decreases the so-called good cholesterol, high density lipoproteins, (HDL). The ratio of LDL to HDL dictates health risk. In order to determine whether packaged food contains trans fats, one can read the label. However, processors do not need to list trans fat if the package (single serving) contains less than 0.5 grams. Many products with less than 0.5 grams report 'not a significant source of trans fat.' Some round it down to zero, and report 'zero grams of trans fat,' but on close examination list ingredients such as partially hydrogenated soybean oil. Companies manipulate serving sizes, which enables them to not list trans fat on the package label as long as the total amount is below the 0.5 gram cut-off. With this type of labelling, by consuming three food items with just under half a gram of trans fat, a person could exceed the recommended intake of 1.11 grams daily. An increase in consumption of trans fats from two grams to 4.67 grams daily, increases a person's risk of cardiovascular disease by 30%. These facts have been well established.

In 2003, Demark restricted trans fat to no more than 2% of fats and oils in any food products, which effectively limits people's trans fat intake to less than one gram per day. Switzerland followed in 2008. In 2008, New York City banned trans fats in restaurants. Similarly, the Kellogg company removed trans fats from cereals. Kraft removed trans fats from Oreo cookies. By avoiding food with hydrogenated, or partially hydrogenated oils or shortening, one avoids trans fats. If the trans fats have been replaced by omega-6 fats of corn, soybean or cottonseed oil, it is not ideal. Ideally, consume processed food prepared with omega-3 fats, or associated walnuts or flax seed or mono-saturated fats of other nuts, avocados or olive oil. Products lower in trans fats tend to cost more.

The first literature appeared in 1956 suggesting that trans fat was associated with heart disease, but it took another thirty years for any action. Denmark banned trans fats in 2004. In 2007 Canada was still relying on voluntary industry response, more in response to trade policies with the US. With US legislation, a company can advertise a food product as trans free if the product has less than one-half gram per serving. The new Crisco vegetable oil (shortening) made from fully hydrogenated cotton seed and soybean oil and partially hydrogenated cotton seed and soybean oil, has less than 0.5 grams of trans fat per tablespoon (a twelve gram serving), which allows it to be advertised as trans fat free.

The other significant change to diets over the past thirty years has been the dramatic increase in sugar consumption – some of it as a replacement for fats. This sugar has found its way into Americans' diets in increasing proportions, mostly as high fructose corn syrup (HFCS) – a sweetener which contains between 55 and 90% fructose, and has become a ubiquitous ingredient in an amazing array of food products.[187]

HFCS is found in soft drinks, salad dressings, commercially made cakes and cookies, breakfast cereals, and brand name breads. In the 1970s, HFCS replaced cane sugar as the sweetener of choice. On a per gram basis both contain the same number of calories, but they are metabolized differently. Since the 1970s, an epidemic of obesity and metabolic syndrome has appeared. From 1970 to 1990 the annual intake of HFCS increased 1000 percent, greatly exceeding the change in intake of any other food or food group (in history). HFCS is not a natural food; it is the enzymatic product of cornstarch. Fructose is metabolized differently than glucose. Fructose is more rapidly metabolized in the liver, leading to increased triglyceride synthesis and fat storage in the liver, and this in turn, can cause a rise in serum triglycerides, promoting atherosclerotic profile and elevating cardiovascular risk. Increased fat storage in the liver may lead to an increase incidence in non-alcoholic liver disease (seen in metabolic syndrome).

HFCS contains more simple sugars, hence requires less digestion by the body and is absorbed faster by the body than cane sugar. Fructose is converted in the liver to energy, fat or glucose. Normally, with the accumulation of energy and fat, the body shuts down glucose production. However, this process for fructose is a very inefficient shutdown. Appetite regulation relies on the relay of messages between the brain and the gut. Glucose is part of a messaging system that works on the presence or absence of various nutrients. Fructose is less efficient at regulating these signals.[188]

Fructose has less impact on reducing appetite than glucose, consequently processed foods rich in fructose can contribute to weight gain and obesity. Scientists took two groups of young healthy men and fed one group high glucose diet, while the other received a high fructose diet. At the end of one week, the high fructose feeding was accompanied by a significant reduction in insulin sensitivity and insulin binding, whereas no significant changes were seen in the high glucose group.[189]

The major chronic diseases – dementia, cardiovascular disease, cancer and inflammatory diseases like arthritis – have a connection to one's diet. The major challenge for customers today is to obtain the correct amounts of omega-3 and omega-6 essential fatty acids. In some jurisdictions, this includes advice to limit linoleic acid (omega-6) to reduce heart disease and chronic diseases, as many individuals are taking in too much omega-6 in their diet. The omega-3 and omega-6 fatty acids need to be in a certain ratio to ensure optimal health. An excess of omega-6 tends to have a negative effect on health. The present North American diet provides ten times the proper amount of omega-6. Most processed foods use cheaper (omega-6 fatty acid rich) vegetable oils in their mass production.

In addition, meat from grass fed cattle contains conjugated linoleic acid, a nutrient associated with lower cancer rates. The FDA declared conjugate linoleic acid (CLA), which is naturally occurring in meat, a trans fat. CLA is a combination of cis and trans fatty acid. It has been found to provide protection against cardiovascular disease and cancer. Protection against heart attacks by boosting the anti-oxidant activity of the body's natural anti-oxidant enzymes. CLA protects against cancer by boosting activity of a tumor-suppressing gene. In the 1970s the switch from grass fed beef to corn fed beef made meat a significant source of omega-6 fatty acids, and reduced CLA content. Grass fed meat has greater CLA content than grain fed. Grass fed butter has 3 to 5 times more CLA than grain fed. In North America CLA shows up in the trans fat content of dairy and meat products, while the EU does not include CLA in trans fat labels.

The EU does not consider the natural product, CLA, as having the same unhealthy characteristics as the industrial produced trans fats.

It is necessary to lower omega-6 in the diet before the benefits of increased omega-3 are optimized. To reduce omega-6 in the diet, supplement meat with two servings of fish per week (beware of not increasing your intake of dioxins or mercury), and switch to free range or pasture feed meat, eggs of chickens fed flax seed, and switch to oil or canola oil for cooking. You can use supplements for omega 3 such as fish oil or flax seed oil pills. Flax seed contains alpha-linoleic acid, which the body converts to EPA and DHA (but still need studies to determine the significance of competing with the enzymes converting linoleic acid to omega-6.) Cigarette smoking significantly reduces the cellular conversion of ALA to EPA and DHA. Flax seed is the best plant source of omega-3, with three times as much omega-3 to omega-6 per serving.

Oxidative stress biomarkers have been identified in individuals with dementia. Dementia is a neurodegenerative disease characterized by a decrease in memory, attention and cognitive functions. Seniors put themselves at risk on a diet of roast beef, mashed potatoes, green beans and corn. Nutrients appear to be important in the development of dementia. Diets rich in omega-3 and-6 fatty acids (in the optimal ratio), vitamin E and folate but low in saturated fat and vitamin B12 appear to be best. Experts have long suspected that nutrients might modify dementia risk. Folate reduces circulating levels of the blood amino acid homocysteine which has been linked to Alzheimer's. Similarly, vitamin E might be protective via its strong antioxidant effect, while monounsaturated (high in omega-6) and saturated fatty acids could increase dementia risk by encouraging blood clot formation, say researchers.[190]

Laboratory and animal research have shown that antioxidants help prevent the free radical damage that is associated with cancer. However, studies of antioxidant supplements in people are not consistent. Studies on diet are more specific. Keep your diet low in total fat – eat the right fat. Eating the wrong kinds of fat may be even more cancer-causing than eating too much fat. Oils that contain more omega-3 than omega-6 fatty acids, include flaxseed, pumpkin seed, canola, soybean (not hydrogenated), walnut, safflower, sunflower, sesame, and virgin olive oils. The meat from grass fed cattle has less saturated fat and an ideal ratio of omega-3 to omega-6.

There is a limited choice for the consumer. The marketing system is set up to maximize returns for corn fed beef – creating the marbling, the intramuscular fat, that improves taste, but not health quality. Corn now earns important export dollars as the middle class in China aspire to the refined diet of the West. HFCS is now incorporated into so many products in the super market, that there is little to choose from to avoid it. There is a need to remove HFCS as a source of sugar and replace it with sugar cane or sugar beets.

There is a link between neurodegenerative disease and chronic inflammation. Temporary up regulation of inflammatory events is natural and does not lead to problems. Enhancement (prolongation) of proinflammatory events appears to be a common link in different neurological impairments. Studies have shown a link between exposure to particulate matter present in air pollution, and the enhancement of central nervous system pro-inflammatory markers. The microglial cells, the resident macrophages of the central nervous system, become chronically activated and mediate pathology inducing pro-inflammatory

responses. Studies with omega-3 diets show a reduction of the effects of cardiovascular disease and cognition deficits.

The first legislation brought in to control disease processes because of a poor diet was legislation requiring the fortification of milk with vitamin D. This action removed rickets as a significant childhood disease. The introduction of legislation to discontinue the manufacture of PCBs and proper disposal, and phase out of electrical equipment in service using PCBs, was the first government direct action on a pollutant – the scope of the hazards of this industrial product wasn't fully understood until thirty years following its introduction.

There is an epidemic of obesity, diabetes and neurodegenerative disease in North America. Chronic diseases are complex diseases. That means the intervention must include more than just life style changes. The intervention must use the reduction of chronic disease as its endpoint, and epigenetic harms must be included in the solution. These interventions would reduce the elements that cause the long-term inflammation that trigger chronic disease. It would include the availability of an affordable diet that prevents metabolic syndrome, reverses the present pre-diabetic population, and ensures a healthy immune system. Addressing contemporary health problems such as obesity and diabetes, and by introducing interventions that incorporate our understanding of epigenetic mechanisms will reduce the burden of chronic disease in the next generation, along with health-care costs.

Chapter 9 The Environment

The story of the Tobacco Industry and environmental tobacco smoke (ETS) has some important lessons on how industry with deep pockets can influence the regulation of pollution. As more voices were raised against second-hand smoke, the Tobacco Industry created disinformation programs to discredit research and redirect public opinion. These disinformation programs focused on such topics as indoor air pollution, and perceived risks like chlorination and cell phones. In 1992, the EPA brought forth their landmark work declaring environment tobacco smoke to be a carcinogen. The Tobacco Industry response was to file a lawsuit against the EPA in 1993. In 1998 a study sponsored by WHO showed a statistically significant increased risk of lung cancer among non-smoking spouses of smokers. In July 1998, in a lawsuit filed by a number of tobacco manufacturers against the EPA, U.S. District Judge William Osteen, a former tobacco industry lobbyist, ruled parts of the EPA report invalid. In 2002, the EPA appealed the ruling, sticking by its original conclusions on ETS, and a Court of Appeal threw out the lawsuit against the EPA.[191] The success story of banning second-hand smoke is a public health lesson on the effects of reduced morbidity and mortality by controlling pollution. The Tobacco Industry tried to hide the hazards, but the hard work of public health advocates prevailed. This is only one chapter in the story to control environmental pollutants.

In the 1920s General Motors' marketing plan included larger engines than Ford, who did not bring out new models (but stayed with one color, one engine size). However, the larger engines had problems burning fuel evenly and had a pinging or knocking sound when they ran. In the research done by Chevrolet for an additive to counter the problem, two products were identified that, when added to gasoline, were able to boost 'octane' or anti-knock ratings for the fuel. One was ethyl alcohol and the other was tetra ethyl lead, but tetra-ethyl lead won out because it was the least costly. The company set up to manufacture and distribute the additive was called the Ethyl Corporation. Tetra ethyl lead was promoted as a product to make engines more efficient, enabling the country (USA) to conserve oil. Public health officials flagged a concern as the lead could be readily absorbed into the skin on contact, or the lungs from

automotive exhaust. Lead poisoning was a well-documented, occupational disease in Europe throughout the centuries. The project was allowed to go ahead, and the precautionary principle of public health was ignored because the absence of information on a chemical was mistaken as a 'clean bill of health,' as the Ethyl Corporation claimed the product was.[192]

There was a public controversy in 1924 when five workers at a Standard Oil refinery went insane and many others were hospitalized. Public Health officials spoke out against the use of lead in gasoline because of its toxic effects to the health of communities. Andrew Mellon's Gulf Oil Company had an exclusive contract for the distribution of leaded gasoline in south-eastern US. Mellon was Secretary of the Treasury during this time and in charge of the Public Health Services, which investigated lead gasoline. The 1925 conference convened by the Public Health Services on leaded gasoline was unable to change the course of events.

By 1963, 98% of all gasoline contained the lead additive. Scientists studying ice cores from Greenland noted that lead began to increase in 1924, and lead levels in the ice were one thousand times more than what they were before 1923. With respect to humans, modern bone lead levels were many times greater than pre-1923. This information triggered public alarm. Congress passed the Clean Air Act in 1970 requiring leaded gasoline to be phased out. The decision was delayed by corporations for ten more years by court actions; however, by 1986 leaded gasoline disappeared in US and Canada, but was still being used in the developing world.

The Ethyl Corporation replaced lead with MMT – methylcyclopentadienyl manganese tricarbonyl. The only problem with this decision was manganese in gasoline guarantees manganese in the air. Airborne manganese can reach the brain more rapidly than manganese in the diet. Workers exposed to airborne manganese develop symptoms that are similar to Parkinson's disease. There are no studies on the effects of long-term exposure to low levels. The companies blocked public inquiry into which refineries used MMT. In the mid 1900s, Canada tried to ban MMT, but the Ethyl Corporation sued under a provision of NAFTA and won. Under ongoing lobbying efforts, many companies have turned to ozygenates such as ethanol, rather than MMT.[193] Not all industry is noted for shifting their products in a timely manner.

Atrazine, a chemical used for weed control in such row crops as corn, is known to affect marine life in general, and fertility in particular. It became a poster child of a product swirling in controversy, regulated by the EPA. After its release it was found to be dangerous at lower concentrations than previously thought. Atrazine was banned by the EU as part of a precautionary policy that prohibits pesticides that easily contaminate ground water. The EPA set the maximum accepted level at 3 parts per billion as a yearly average. Because of its agricultural use, it spikes in water supplies in the summer. Some small towns only tested once a year, in the spring. Other communities couldn't afford the test cost, so industry was required to monitor drinking water levels. For various reasons, the industry surveillance showing spikes that should have triggered health messages to the general public did not occur, when, by legislation, they should have.

Studies have reported an increase in birth defects and premature births increased as the concentration of atrazine increased. This study highlights an association, raising a flag, but does not exonerate the weed killer. Rats exposed to atrazine developed mammary tumors, making them vulnerable to cancer in later life. This is an example of competing priorities and insufficient resources preventing the EPA from drilling down deeper in areas like atrazine toxicity. Because of environment concerns, atrazine use in Canada was restricted in 1993, and

by 2011 it was only 50% of the level of use in 1983. Health Canada labels atrazine as a possible carcinogen to humans and warns that excess levels over many years could result in problems with cardiovascular system, and reproductive problems. Homeowners who are aware of any risk could install a granular activated charcoal filter to remove atrazine from their tap water.

Bees appeared about 100 million years ago, and are almost as old as flowering plants. Flowering plants are among the most diverse organisms that have ever existed. This co-dependent relationship is so intricate that should pollinating populations decline, the impact on their plant associates would be immediate and profound. Bees are essential to the stability of the world ecosystem. Eighty percent of the world crop species have become dependent on domestic honey bees. In 2005 and 2006 the population of domestic bees suddenly began to drop, and the phenomenon became known as colony collapse disorder.

In 1993, during the Bush era, managers at the EPA over rode the opinion of their scientists that a new class of pesticide, neonicotinoids, would not significantly affect non-target populations of insects. In fact the scientists specifically warned of the potential effect on bees. This family of pesticides has been widely used throughout the world. The pesticide was important in protecting transgenetic corn hybrids from multiple pests – European corn borer, black cutworm, western bean cutworm, as well as corn root complex. The use of neonicotinoids was driven by GM corn.[194]

In 2009, following Germany, France and Slovenia, Italy banned neonicotinoids because of concerns over the damage to bees. Corn seeds are coated with the pesticide which appears in the tissue of the plants and the dew. Clothianitin, a neonicotinoid, is a systemic pesticide, taken up by plants leaves and roots and transported throughout the plant. Oral uptake of residue may be found in nectar, pollen and gluttation droplets. It remains in the soil for years, accumulates in successive plantings, and can be found in water, where it is moderately toxic to aquatic organisms.

After licking the dew, bees are disoriented and do not find their way back to the hive. In the US, multiple theories about the collapse of the bee colonies still persist. This has all the hallmarks of the disinformation programs of the Tobacco Industry muddying the waters about the association between tobacco and lung cancer fifty years ago.

These pesticides are used on sugar beets, canola, soy beans, sunflowers, wheat and corn, and the pollen rich crop planted more widely in the US than any other (and a favourite of the honey bee), is corn. Now it is believed that low doses of the pesticide weakens the immune system of the bee. Researchers at the USDA exposed bees to low dose imidacloprid, a neonicotinoid pesticide, and to Nosema, a fungal pathogen toxic to honey bees, and found increased levels of the fungus compared to bees that were not exposed.[195] In 2009, this information was available through the USDA for decision-makers.

GM corn and fertilizer use led to less crop rotation and more soil erosion. For feed lot cattle, the corn production requires 284 gallons of oil in a lifetime, which is not necessary in grass fed cattle. The feed lots in the corn-belt states create a waste problem – with the concentrated waste disposal, non-existent in range fed cattle. This makes grass fed cattle more environmentally sustainable. Corn is the number one field crop in the US, leading all other crops in value and volume of production, making the US the largest producer of corn in the world. Hybrid corn is the most greedy of all crops, requiring large amounts of fertilizer and

water, consuming more fertilizer than any other crop in the US. The nitrogen applied to the corn fields eventually finds its way into waterways, degrading water quality and choking out fish. Eventually this nitrogen finds its way out to the oceans, where it causes huge dead zones, large patches of the ocean depleted of oxygen and virtually all life. One example is the dead zone around the mouth of the Mississippi River in the Gulf of Mexico, created by the rising fertilizer run off from farms in the Midwestern US, which consists of six to seven thousand square miles of coastal water stretching from the Mississippi delta back to the coast of Texas.

The need for irrigation is of concern, as corn has driven the rise in use. The Ogullala Aquifer underlies eight states from Texas to South Dakota, and supplies 30% of all water used for irrigation. In addition, corn-based biofuel production requires even more water – three to six gallons per gallon of ethanol. The water in the aquifer has been there for thousands of years, but some estimate that it could be pumped dry in twenty-five years at the present rates of use.

Thousands of US bodies of water are 'impaired' by mercury. Impaired waters are defined as water in rivers or lakes that have pollution in them exceeding the clean water quality standard.[196] Over the past few years warnings about mercury in fish have multiplied. The EPA estimates that 8% of blood samples in women 16 to 49 years of age had mercury concentrations greater than 5.8 ug /L – a level associated with health problems. This means that an estimated 300,000 newborns in the US each year have an increased risk of learning disabilities. In the US there are more warnings about mercury than any other contaminant.

The pollution from coal-fired power plants include mercury, arsenic, lead, nickel chromium and acid gases. Power plants are the largest unregulated source of mercury pollution in the US. Mercury eventually settles in water where it builds up in the ocean and fresh water fish. The coal-fired power plants account for 50% of the mercury released into the air in the US. Other sources include recycled auto scrap (because of mercury switches used in cars prior to 2003), and cement plants. Coal is naturally contaminated with mercury and released into the air through smokestacks. Most of the pollution can removed with pollution control devices. Proposed legislation is aimed at 1,100 coal-fired boilers at more than 460 electric power plants with the goal of a 92% reduction in toxic emissions by 2013.

The extent of mercury pollution is illustrated by the fact that all fifty states have issued consumptive advisories for subsistence and sport fishing, limiting how much of certain types of fish is eaten. Mercury is considered a persistent pollutant because it does not break down. It settles into beds of rivers, lakes, oceans, and is covered by sediment, and eventually the fish no longer come in contact with it. Mercury has neurotoxicity, with infants at greater risk than children.

Because mercury is a naturally occurring and persistent substance, it can never be completely eliminated from the environment. The goal of the Commission for Environmental Cooperation, created between Mexico, the United States and Canada is to identify policies for virtual elimination of new sources of mercury. Successful policies include removal of mercury-based chemicals used in paper production in the 1970s and elimination of mercury in most batteries and paints in the 1980s. Now it is necessary to target over 240 mercury 'hot spots' across North America where the amount of mercury contamination exceeds the background, or naturally occurring, level in the environment.[197]

In an article in *The Wall Street Journal*, Willie Soon and Paul Drieman claimed the risk from mercury is over blown because our bodies have evolved with antioxidants and other

proteins to protect individuals from this and other potential contaminants. This information is misleading. Most people can tolerate low levels of this naturally occurring substance, but mercury pollutants in the air account for increased respiratory illnesses like asthma and premature deaths with respiratory conditions aggravated by the pollution. The increased costs to the system occur in the health care system, such as emergency room visits and lost production when people miss work.[198]

In addition, Soon and Drieman point out that, when compared to the mercury release from forest fires, volcanoes, and China, the US accounts for less than 1% of the total. When you remove the 50% from volcanoes, the remainder is from fossil fuels, with two-thirds coming from China and one-third from North America. Studies show that a significant portion of mercury deposited in the immediate vicinity of coal-fired facilities can be directly attributed to the local point source. The editorials by Soon and Drieman are consistent with the disinformation programs orchestrated by the tobacco industry over four decades to create a lack of understanding of risk from cigarettes.

In water, mercury is converted by bacteria to methyl mercury. In this form, mercury bioaccumulates, like PCBs, dioxin, and DDT, they travel up the food chain, and the toxins become more concentrated in the tissue of aquatic organisms. Water is expected to become the most crucial natural resource issue facing most parts of the world later this century. Much of the fresh water can be found in large fresh water lakes in the world. The pressure is not only from the increase in population, but with the increase water use associated with rising standards of living (diets containing less grain and more meat) and increased irrigation. About 95% of the world's cites still dump raw sewage into their waters.[199]

The story of fresh water describes the challenges facing the environment. Reviewing the health of the four, largest, fresh water lakes in the world will help focus the discussion. The largest fresh water lake in the world is Lake Superior on the boundary between Canada and the US. Lake Superior, the largest by square miles, is 10,000 years old, left over from the retreat of the glaciers from the last Ice Age. The Binational Agreement of 1991 between the US and Canada focused on nine persistent toxic substances, the legacy of development:

(1) The mercury pollution is associated with recreation fish advisories – limiting the amount of fish consumption. The lake was invaded by non-indigenous species, the lamprey, and in combination with overfishing, lake trout and other large fish populations were decimated in the 1930s.

(2) From the 1950s to the 1970s, dieldrin was used extensively as an insecticide on corn and cotton. First the FDA banned it in 1974, except against termites, then a total ban was enforced in 1987 because of concern to the environment and human health. This chemical is bioaccumulative, (doesn't breakdown easily), and becomes more concentrated as it moves up the food chain to humans and other wildlife. Acute exposure affects the nervous system, causing headaches and dizziness. When fed to animals orally over long period of time, it affects the liver and decreases their ability to fight infection. Sources of human exposure are fish, dairy products and meat.[200]

(3) Dioxin is a persistent environment pollutant found throughout the world in the environment. It accumulates in the food chain, mainly in the fatty tissue of animals. It

causes cancer and is a hormone disrupter. Individuals can reduce their exposure to dioxin by trimming fat from their meat.

(4) PCBs stands for polychlorinated biphenyls, a family of 209 chemicals of similar structure. PCBs were detected for the first time in the Great Lakes in 1966. By 1977, concern over the impact of PCBs on the environment led to a North American ban on manufacturing and importation of PCBs. The ban did not cover PCBs that were already in use in electrical applications. These are being phased out now, and the federal government has set strict regulations for the handling, storage and disposal of PCBs. [201] Contamination is due primarily to the long-range transport of PCBs by global air currents. Once they get into the environment, PCBs do not break down, and concentrate in the food chain, including humans.

(5) Toxaphene, which replaced DDT, was one of the most heavily used insecticides in the US before it was banned in 1982. It is one of those contaminants that is carried long distances in the air. As it persist in the environment, the FDA sets limits and monitors the limits in foods, such as soybean oil, grains fruits and vegetables.

(6) DDT is the best known and most widely reported organochlorine found in marine animal tissue. Although it was banned over 20 years ago in the US, it is still found in soil, freshwater sediments and aquatic vertebrates. A 1996 study showed that DDT was still making its way into the St. Lawrence River basin.

(7) Chlordane was developed by Monsanto as an insecticide for use on corn and citrus fruits. All uses were banned in 1983 except for termite control, and a total ban was put in place in April, 1988. This chemical builds up in fatty tissues and is one of the most potent carcinogens tested in animal models.

(8) Hexachlorobenzene is a fungicide used on onions, soybeans, and wheat that was banned in 1986. This chemical is persistent and individuals have low level exposure from eating contaminated foods such as wheat, some vegetables, and fish. It builds up in fish and animals that eat lichens, like caribou.

(9) Octochlorostyrene is a persistent bio-accumulative and toxic halogenated aromatic compound with no known commercial uses. It is an inadvertent by-product of high temperature industrial processes involving chlorine.

Lake Superior contains 10% of the world's supply of fresh water. The toxins in the water, like mercury, dioxin, PCBs are mostly from the air. It takes 191 years for the water in the lake to exchange (for pollutants to be removed.) The remaining Great Lakes are much more contaminated by pollutants than Lake Superior.

Lake Victoria, Africa's largest lake and the second largest fresh water lake in the world, was previously discussed in Chapter 1. It borders three countries: Uganda, Kenya and Tanzania. The invasive species, the Nile perch, creates an economic stimulus to the area. Another invasive species, the water hyacinth, is a fast growing weed making it difficult to fish in parts of the lake. From 2001 to 2006, the fishing catch dropped by one-third because of the weed.[202]

The third largest lake by area, Lake Tanganyika, which borders Tanzania, Zambia, the Democratic Republic of the Congo and Burundi, is the world's second deepest lake. It has over 2000 different species of fish. Its water is being degraded by uncontrolled and unplanned development – sediment from deforestation, abattoirs, breweries, paint industry, and battery

manufacturing. Under the auspices of the International Union for Conservation of Nature (IUCN) there is an effort to start turning around the pollution threats.

The deepest and largest volume of fresh water is Lake Baikal in Russia. It is the oldest and most unique lake in the world, home to 1,500 species found nowhere else in the world. (By contrast Lake Superior has only four.) A Soviet era paper mill has been contaminating it for forty years. The mill was closed down for fifteen months for ecological reasons, but Russian President Putin amended legislation allowing it to reopen in 2010. There is a 200 square kilometre dead zone adjacent to the paper mill (the Soviets originally thought the large size of the lake would disperse the pollutants).

The fresh water systems need stewardship. Lake Superior's large size makes it vulnerable, in a sense that although it can dilute pollutants, because of its size, the water stays in the lake for so long that it means that any pollutant in the lake lasts for a very long time, while, on the other hand, Lake Baikal, containing 20% of the world's fresh water is not large enough to disperse the pollution from one paper mill. Other ecosystems are threatened. The growing sugar cane industry in Florida is responsible for damage to the everglades from phosphorus runoff and restricted water flows. There has been a dramatic effect on wild life in the everglades, with sharp reductions in the wood stock and Cape Sable seaside sparrow populations.

Significant sources of exposure to free radicals are cigarette smoke and air pollution. Both are associated with free radicals. Free radicals enter the body through small particles present in the polluted air, and linger long after the fog has gone. The average person inhales 300 times the free radicals than they would from a equivalent exposure from cigarette smoke. Not surprisingly, 15% of lung cancer occurs in non-smokers. The highest level of free radicals is associated with automobile emissions and industrial gases with heavy metal content. The free radicals created by combustion last much longer than previously thought – they are associated indefinitely with the air pollution and can be carried long distances. Some attribute the free radicals on the small particles present in polluted air with the exacerbation of asthma attacks.

One group to monitor is the hormone disruptors which mimic or disrupt the body's normal function. This group includes dioxin, PCBs, DDT and newly added bisphenol A (banned in baby bottles). A subset includes the sex hormone disrupters atrazine, chlordane and toxaphene. Studies are now linking high blood pressure, metabolic syndrome and obesity to exposure to hormone disruptors. The rise in obesity parallels the rise in the amount of these chemicals used. For example, mice exposed in utero even to low doses of endocrine disruptors appear normal at first, but develop excess abdominal body fat as adults.[203]

Another significant group is the neurotoxins. These include lead, and mercury from industry, which become more complex in the environment. There are the added effects of toxins that we ingest and breathe at home. Manganese is a neurotoxin that was in the anti-knock agent MMT, but is not widespread in North America. However, a small number of sources of well water have manganese that would be considered part of the neurotoxin load. There are other sources near to home. Polystyrene food containers leach the toxin styrene when they come into contact with warm food or drink, alcohol and acid foods causing human contamination and subsequent health risk. Polystyrene is not biodegradable and there is little

recycling. Aluminum is a toxin found in antiperspirants. Then there are small studies suggesting other potential toxins, such as NutraSweet that is used in low calorie foods.

The brain uses 20% of the body's oxygen supply. At the tissue level, dementia is associated with free radical damage. Oxidative stress is the event that precedes the appearance of neurofibrillary tangles, which are the characteristic changes associated with Alzheimer's disease. Studies show that combinations of vitamin E and vitamin C (good antioxidants), slow down the progression of the disease. A study done by Columbia University followed 2,148 individuals with respect to diet. One diet consistently included salads, chicken, fish, nuts compared to another diet that had significant contribution of high fat dairy products, red meats, organ meats and butter. The so-called salad diet had significantly less dementia. This suggests a role for the free radicals created by saturated fats and corn raised beef with the high omega-6 level compared to omega-3. This also suggests that you need to do more than just take vitamin E and vitamin C supplements to prevent dementia.[204]

It is now recognized that there are many chemicals and chemical combinations at low concentrations which have not been studied adequately for health risks. The human genome project indicates that genetics accounts for about 10% of diseases, and the remaining causes appear to be from insults from environmental and occupational sources. Many known, toxic, chemical hazards are now known or expected to act by epigenetic mechanisms. The challenge has been the lack of animal models to test the toxicity to low doses of multiple chemical hazards. This introduces the concept of the 'exposome' to measure the amount of environment exposure to toxins by an individual in a lifetime, and how these exposures relate to health. Because of the logistics of monitoring over many decades, only the critical stages of human life would be assessed, in utero development, puberty, and early adult. In this approach, rather than look at every chemical in the environment, adopt a top down approach.

The challenge is to understand how exposures from our environment, diet and life styles interact with our own genetics – creating epigenetic marks. There is a need to study internal events or biomarkers such as metabolomics and proteomincs, and incorporate the information into a database that can be readily linked and mined. Then it is necessary to maintain a database of external events of environmental stressors that can be linked to the biomarkers – fingerprints of disease. In population studies they could be done at the neighbourhood level.[205]

Data would be analysed to identify associations between health outcomes and biomarkers of exposure, biomarkers of response, or patterns of biomarkers (developed from population studies of exposure-wide association studies). Exposures can predispose an individual to certain chronic diseases in later life. There is an opportunity for prevention. Exposomes will be aligned with epigenetic markers, and after introducing an intervention, follow those that can be reversed. [206] During a lifetime, one is exposed to many toxic chemicals through air, water and food. The exposome will be able to measure exposures and effects of exposures. In the future, biomarkers will be used to determine exposure, effect of exposure, disease progression and susceptibility factors. Until the exposome method becomes part of informed risk assessment, it will still be necessary in risk assessment to err on the side of caution – using evidence of possible harm, even if this evidence does not permit calculation of a safe exposure level.

Chapter 10 The Known Unknowns

While defending the decision to invade Iraq during a news conference in 2002, US Defence Secretary Donald Rumsfeld, explained that the decision was based on three categories of information available for decision-making at the time: (1) the known knowns – these are things we know we know; (2) the known unknowns – these are things that we know we don't know; (3) the unknown unknowns – these are things we do not know we don't know. There was a potential high-risk situation (weapons of mass destruction available to terrorists), thus the decision to invade Iraq was made with the limited known information available. In his risk management system, Rumsfeld emphasized, "because you do not have evidence that something exists, does not mean that you have evidence that it doesn't exist."[207]

Information technology has transformed the way trust and knowledge are produced. Many people now find information on the Internet (websites) and 24-hour cable news shows, that are often viewed as legitimate and reliable sources of information, which they may not be. Even with such a number of sources, it simply provides multiple options to move misinformation around. George Orwell (1903-1950), an English novelist, wrote in *1984*, "Who controls the past controls the future. Who controls the present controls the past."[208] Control of messages through the media is important to a dominant society, a system many people don't know exists, which significantly influences their values and beliefs. Joseph Stiglitz noted, "Those who have contributed great positive innovations to our society, from the pioneers of genetic understanding to the pioneers of the Information Age, have received a pittance compared with those responsible for the financial innovations that brought our global economy to the brink of ruin."[209]

The present economic system is called a trickle down, or a top down system. In the US today the top 1% controls 40% of the financial wealth. A popular theory in the 19th century that was used to account for the disproportionate distribution of wealth was called 'the marginal productivity theory.' This theory associated higher incomes with higher productivity. The recession triggered in 2008 by decision-making of corporate executives relegates this theory to the dustbin of history. Recent bonuses in the financial services industry have gone from 'performance bonuses' to 'retention bonuses.' This is occurring at the same time the majority of citizens are doing worse financially each year since 2008. A cycle is set up: wealth begets power; power begets wealth. The banking oligarchy, consisting of six large banks, Goldman

Saks, Morgan Stanley, J.P.Morgan Chase, Citigroup, Bank of America, and Wells Fargo, dictates what goes on in the US banking industry. The large banks influence nearly every major financial deal that gets done and virtually every major political decision that gets made; and this power continues to grow. Globalization is part of their mind set. Globalization leads to competition amongst countries for business. This, in turn, drives down taxes, and weakens health and environmental protection. As a result of the 2008 recession, to keep the global economy on track, people in the developed world need to work longer before retiring, pay higher taxes, and expect less from government. The new generation, starting in the work place, can expect to earn less than their parents.[210]

The top down system is about cheap money and power staying concentrated with a small group at the top of the economic pyramid. The economic system in the West, in the 21st century, is a top down system. This was emphasized by Milton Friedman's explanation that the system helps poor people by the trickle down effect, and that economic growth flows down from the top to the bottom, indirectly benefiting those who do not directly benefit from the policy changes. This economic theory advocates letting businesses flourish, since their profits will ultimately trickle down to lower-income individuals and the rest of the economy.

The top down concept in the West appeared during the Roman Empire, which maintained strong top down control. Roman religion became a mosaic of belief systems as Roman power grew and expanded through the known world. The Roman Empire came into contact with cultures and religious beliefs of major cultures, and was happy to assimilate any deities they encountered. With the passing of the Roman Republic into an Imperial system, the nature of Roman religion expanded to include the Emperor themselves. The Imperial cult that developed was inseparable from Roman deities. This included top-down favoritism of the Roman gods, which began with the emperor and trickled down, if only feebly, to the lowest of society. Roman civilization consisted of a paternal system within a highly stratified social structure, which gave unswerving allegiance to the Roman system of military pacification as a basis for social cohesion. The divinized emperor was seated in splendour at the high point of the patronage system, and he distributed power and privilege down the system. This trickle down system was legitimized by rites and ceremonies integrating patriotism and religion.[211]

In the 4th century CE, emperors incorporated reforms in the empire that included the Christians. Emperor Constantine issued decrees giving Christians the right to build churches, to accumulate property and to establish courts with jurisdiction over clergy, launching the institutional church. In 380 CE, Emperor Theodosius declared himself a Christian of the Nicene Creed. He outlawed pagan religions and closed pagan temples. Severe punishment was introduced for people who disagreed with the official version of Christianity. Theodosius' two main legacies were decreeing an orthodox Christianity on the empire, and placing his secular power under the church.

With the collapse of the Western Roman Empire in the 5th century, the Catholic Church was the only organized force in western Europe. The church took on the top down power structure of the empire. Richard Tarnas explains:

> "As the Christian religion evolved in the west, its Judaic foundation readily assimilated the kindred juridical and authoritarian qualities of the Roman imperial culture, and much of the Roman church's distinctive character was moulded in those terms: a powerful central hierarchy, a complex judicial

> structure governing ethics and spirituality, the binding spiritual authority of priests and bishops, the demand for obedience from church members and its effective enforcement formalized rituals and institutionalized sacraments, a strenuous defence against any divergence from authorized dogma, and centrifugal and militant expansiveness aimed at converting and civilizing the barbarians..."[212]

Christianity became the state religion of the Roman Empire, and it had the power to suppress dissention and heretics, and organize wealth. Tarnas noted, "leading early Christians concluded that the beliefs of the faithful must be established, disseminated, and sustained by an authoritative church structure."[213] Heretics existed from the early days of the formation of the church, but once religion became tied to the state, the church had the power to systematically persecute them.[214]

The Medieval church was the most dominant institution in western Europe; it was one of the largest landowners of the time and collected rents and many fees for offices and services. Its top down structure facilitated control of information and creation of wealth. People living in towns began to buy their freedom during the feudal system. During 13th and 14th century the autonomous city-states in northern Italy were able to thrive, while the Pope and Holy Roman Emperor manoeuvred for influence. They developed a monopoly on the trade of spices to the rest of Europe. The trading systems in the West became a succession of monopolies. The next most urban area after northern Italy was the Low Countries. In Flanders, Bruges became an important center as part of the Hanseatic League, which had a monopoly on the trade around the Baltic. The Portuguese gained control of the spice trade by aggressively displacing the Muslim middlemen from markets of India and the Far East. In the 17th century the Dutch wrestled the spice trade from the Portuguese and forced the British to focus on India. Control of the Moluccas assured them monopoly of nutmeg, cloves and mace, and control of the cinnamon trade when they ousted the Portuguese from Ceylon. The Dutch monopoly was organized under the control of the Dutch East Indies Company.[215] The British East India Company had monopoly on trade to India, and used its power to essentially take over the sub-continent. One of the irritants that triggered the American War for Independence was the fact that the East India Company had a monopoly for tea in the colonies. Adam Smith, often considered the father of modern economics, actually spent a great deal of time attacking the mercantile system, (the monopoly trade system of his day). His ideal was a system of small buyers and sellers. His epic work, *The Wealth of Nations*, published in 1776, contained a radical condemnation of business monopolies sustained and protected by the state.[216]

By the end of the 18th century, the Industrial Age in Britain was heralded with mechanization of the weaving industry and the invention of the steam engine that allowed more effective pumping of water in coal mines to increase the supplies of coal. The Industrial Age of the 19th century was a top down system. However, during this time, two bottom up theories appeared: one developed by Karl Marx, and one developed by Charles Darwin.

Karl Marx spent much of his life developing an economic analysis that explained the inherent instability of capitalism and provided a scientific basis for the development of the socialist working class movement, that could only evolve out of the political and economic circumstances created by a fully developed capitalism. Lenin adapted Marx's ideas to support

the Russian revolution run by a minority. Lenin inserted a band of revolutionaries at the head of an elitist revolution onto an unwilling populace. They developed a system of differential wages. The surplus capital went to support a bloated bureaucracy, headed by a single dictator. Lenin installed a top down control system in the USSR.

Darwin's bottom up view of evolution is part of the Theory of Natural Selection. Under 'universal Darwinism,' a fundamental paradigm shift, declares any complex system can be understood in terms of the same principles that are the core of Darwin' s Theory of Natural Selection, including socio-economic systems. The predictive power of the theory rests on its specification of systematic selective forces, based on the algorithm of variation, selection and retention. Selection works best on large populations. Market selection would ensure that banks with the best innovations survive. In a world of limited resources, this new theory connects to the social determinants of health, the conditions that influence an individual's opportunities in life. Filtering social and economic policies through the lens of the determinants of health before they are implemented will ensure they support actions that reduce the inequities in the system. It is necessary to include evolutionary economics in the new system and not allow it to be adapted to support the top down system, (i.e. the status quo).

The 'top down' system in the US today is a pyramid with the Fed, the large banks, and a few rich connected individuals at the top, and the workers, the individuals who pay 28% on their credit card debt, at the bottom. Essentially, 95% of the population works to make wealth move up the pyramid. The commercial banks are near the top with the foreign bond holders. More value in the market is likely created by farmers and individuals on the assembly line, but the elite bankers can borrow money more cheaply with greater leverage which translates into more power and control. The middle class have the illusion of money as the system inflates and creates cash for conspicuous consumption. The present top down system is a wealth generator for the top 5%. The big bankers of this top down system are part of a financial oligarchy of the Wall Street-Washington corridor of power.

The Wall Street bankers' power came from the ability to provide campaign contributions to both parties, which allowed them to place key individuals in regulatory positions in Washington. This meant decisions in government were handled from the perspective of the big banks. These activities thrived during the two decades prior to the 2008 meltdown.[217]

Industry influence on government grew during the last three decades of the 20th century. In 1998, the Clinton Administration included Bob Rubin as Treasury Secretary and Larry Summers as Deputy Treasury Secretary. Brooksley Born, head of the Commodities Future Trading Commission, wanted to regulate derivatives. Alan Greenspan, head of the Federal Reserve System (Fed) and Bob Rubin blocked Born's attempt for information gathering (through a concept release), and shut down the process. In 1999, the Gramm-Leach-Biley Act largely repealed the Glass-Steagall Act that had separated commercial and investment banking since the 1930s.[218] Larry Summers, Deputy Secretary Treasurer, declared "With this bill the American financial system takes a major step forward towards the 21st century."[219]

An energy trading company called Enron was established in 1985. Over 15 years it grew into the 7th largest company in the US, with over 21,000 employees in 40 countries. The company developed a unique hiring format. They brought in a stream of the best college MBA graduates they could find, who became stars (performers), who did whatever they wanted. This created a climate for extreme individualism and narcissism. Narcissists typically make

judgements with greater confidence than other people, and the decisions are rendered with such conviction that narcissists become disproportionately more influential in group situations. Enron became a narcissistic company in which workers did not need to acknowledge their faults and deception, and a declining sense of responsibility became a major part of the culture.

Another aspect of self-centeredness is self-tolerance. Such individuals learn to tolerate their errors and personal flaws and come to accept themselves as okay. They feel justified in asserting themselves, defending their perceived rights, believe rules do not apply to them, lack respect for authority, and habitually lie to people.

Kenneth Lay, the CEO of Enron, was a good friend of George W. Bush. This gave Enron access to administration officials (at the top), including Vice President Dick Cheney. These relationships coincided with deregulation of the energy sector by the government. Enron created cash flow through various methods that included creating a phoney California electricity crisis in 2000 and 2001, as well as novel methods of keeping liabilities off the books. Enron shares peaked at $90 in mid 2000. Then the bubble burst; by November 2001, the stock price was $1 a share. The company imploded and legal proceedings commenced. When the company collapsed, many Enron workers found employment in the financial services industry, bringing their culture of narcissism along with them.[220]

The Dot-com bubble reached its peak in March 2000. (The Fed increased interest rates six times from November 17, 1998 to January 3, 2001.) The Internet bubble burst in early 2001. The Fed dropped the interest rate six times between January 3, 2001 and August 21, 2001, from 6.5% to 3.5%. The four plane crashes on September 11, 2001 depressed the market. From September 17, 2001 to January 25, 2006 the Fed dropped the interest rate six more times, from 3.5% to 1%. The low interest rates fed the housing bubble (housing prices in the US peaked in early 2006) that burst in 2007. Some credit Osama bin Laden's attacks of 9 /11 for creating the economic distress; but there were 'flaws' in the market system: workers in the financial services industry who felt entitled to high fees, the consequence of a culture that peddles entitlement, greed and self-centeredness, and a system that could not self-correct from the events, all contributed to the 2008 financial debacle.

The self-esteem movement was introduced into the school system in the 1970s. The world was to be saved from crime, drug abuse and under-achievement through bolstering self-esteem. Accordingly, schools lowered education standards to protect children from failure. An unintended consequence was a culture of extreme individualism that ushered in the narcissism that influenced decision-making and accountability. These individuals are now in the work force. The world viewed from an emotional rather than a rational perspective allows personal feelings to override the distinction between right and wrong. This led to narcissism and a declining sense of responsibility. The decisions of a few managers in the financial services industry with a sense of personal entitlement led to decisions that ultimately created an overleveraged financial market that crashed the world economy. The meltdown of 2008 introduced a wake up call that the status quo was in trouble. Allan Beattie, an economist who writes about globalization, notes that the United States must address the flaws that brought its financial system to crisis; there is a need for long-term financial reform.[221]

Darwinism includes a broad theoretical framework for the analysis of evolution of all open, complex systems, including socioeconomic systems. Detractors counter that natural

selection does not account for human intentionality. The counter is that many choices are not intended, in fact, many intended decisions are under the influence of advertising, which introduces randomness.

'Genetic drift' is the change of gene frequencies in a population from one generation to the next, due to chance events. Drift is only a strong source of evolutionary change in small populations, but is an important example of neutral evolution. In large populations, genetic diversity is fairly constant and the loss or addition of some individuals has little effect on the total gene pool, hence genetic drift has little effect. Genetic drift can cause big losses of genetic variation for small populations. In small populations, this rapid change in gene frequency occurs independently of mutation, recombination and natural selection, and is due solely by chance factors. The process works on all mutations, even those which offer no survival advantage (neutral). In small populations, changes caused by genetic drift accumulate with time.

Core Darwinian principles include variation, inheritance (replication) and selection. For small populations, natural selection is not in play, because natural selection occurs in larger populations. Genetic drift, (a change in the gene pool of a small population that takes place strictly by chance,) can result in genetic traits being lost from a population or becoming widespread in a small population without respect to the survival or reproductive value of the alleles (genes) involved. The change is prompted by random luck, rather than a need for adaption. Genetic drift is the reason why we worry about African cheetahs and other species that have small population sizes. The more variation that exists in a population, the better prepared that population will be to adapt to change when it does occur. Drift is more pronounced in such populations, because smaller populations have less variation and, therefore, a lower ability to respond favorably, that is, adapt to changing conditions. Thus, it's not just the number of cheetahs that is worrying – it's also the decreased variation in those cheetahs.[222]

The reintroduction of the bearded vulture into the Alps is another example of concern over genetic drift being most pronounced in small populations. In the 1970s, biologists from zoos around the world set about to try and re-establish a bearded vulture population by introducing captive-bred birds into the wild. Since 1986, more than 120 bearded vultures have been released from captivity; about two-thirds have survived and many have reproduced. However the problem with the project is not the size of the wild population, rather, it is the size of the captive population. Throughout the world there are about one hundred and twenty bearded vultures kept in zoos and breeding centers across Europe, Asia and the United States. With these low numbers, mathematical models suggest there is not enough genetic variability in the captive birds to keep either the captive or the wild population thriving over the long-term. The population will actually lose genetic variation due to genetic drift. It is important in biology to retain as much genetic diversity in a population as possible. Without sufficient genetic diversity, there is always the risk that a population will not be able to respond very well to new selective pressures caused by environmental change.[223]

Neutral drift can introduce randomness into mutation. With a lot of progeny, there are a lot of varied mutations, random with respect to fitness, as selection sorts and screens out advantages. Random processes can explain most of evolution at the molecular level. Natural selection helps drive most of the beneficial evolutionary changes in DNA, which become fixed in genes because they help the organism adapt.

Johnson and Kwak observe that 'too big to fail' is 'too big to exist'.[224] The large banks on Wall Street and their equivalents around the world are akin to the small isolated populations of organisms in which genetic drift is the predominate process of change. Many of the mutations or changes are neutral and, by definition, do not provide increased advantage. In fact with small populations, natural selection does not occur to weed out the maladapted. Deregulation allowed the big banks to create many financial instruments; however, in a small population, selective pressure doesn't occur. Thus many changes in the large banks can be seen as equivalent to neutral mutations (without selective pressure one cannot tell whether they were beneficial). A larger group of competitors (more banks) will make it harder for banks to direct large bonuses to their staff and, in addition, there will be less money for political contributions. Reducing the size of the banks would restore balance both to the banking system, and to the political system.[225]

For natural selection to work, there needs to be a larger population of relatively big banks. Applying Johnson and Kwak's recommendation, to roll the size of banks back to their 1996-levels, would create a larger population. In this model, the banks could be allowed to fail, with the risk falling to share holders and managers and not to taxpayers.

The 2008 economic debacle was a top down disaster. It was triggered by the consequences of policies championed by small groups of influential people. The financial sector took advantage of the system, empowered by reckless deregulation. The top down economic system includes the Wall Street-Washington corridor that influences legislation – including tax bills. Without increasing the diversity and population of banks, selective pressure will not work, and the taxpayer will continue to bail out the large banks when they make poor decisions.

Evolutionary theory sees the economy as always in a process of change that involves economic actors taking actions that break from previous behavior, and an environment in continuing flux because of innovation. The diversity of individual effort and capabilities with respect to both learning and innovation result at any time in the generation and diffusion of a variety of innovative technologies, institutions and commercial activities that compete with each other. The competition between them, and the economic and social adaptation triggered by that competition, fuels the process of transformation from within the economy.

In the past, the main criticism of Darwin's natural selection was the requirement of multiple generations before change occurred, which did not fit the business model. With the discovery of epigenetics, this thinking has changed. It is now known that genetic change can occur much more quickly that previously thought, responding from messages coming from other genes, hormones, and from nutritional cues and learning. The reactive oxygen radicals can modify, or turn on and off, genes that affect other events further downstream. This can cause chronic diseases within a few decades.

On the other hand, the economic debacle has created a perfect storm for poor health. To keep the global economy on tract, there is a call for less regulation. This political pressure occurs at the same time that we now realize the full consequences of exposure to toxins in our food, air and water. The epidemic of obese children and teenagers (which has more than tripled in the US since 1980), if not addressed, will create a population with poor health throughout their life. A 2012 study from the Medical College of Georgia at Georgia Health Science University reports that high fructose from corn syrup puts teenagers at greater risk for

developing diabetes (insulin resistance) and cardiovascular disease (with high blood pressure and lower levels of HDL).[226] This group will have poorer health as adults, which will affect their economic status as they will earn lower wages as an adult, and this, in turn, will affect the next generation of children who will thus be born into a poorer family. The link from family household income to poorer social and health outcomes is well-documented – the growing income inequality associated with globalization poses a significant threat to health of many in developed countries. The economic and social conditions under which people live, rather than biomedical risk conditions and life-style choices are the major factors determining whether one develops chronic conditions like cardiovascular disease, which develop primarily from material deprivation (of poverty), excessive psychosocial stress, and the adoption of unhealthy coping behaviors. The next generation in the workplace can not only expect to earn less than their parents, but are on track to enjoy poorer health.[227]

Evolutionary economics is about switching from rational choices of profit maximizing, to testing a diversity of ideas leading to innovation, in which adaptive efficiency is the process that defines economic efficiency. Decisions around risk management, where there are threats of serious or irreversible damage, need to employ the precautionary approach. The precautionary principle to protect the environment was defined in 1992 as one of the principles of the Declaration of the Rio Conference on Environment and Development.[228] The accepted principle includes the premise that even if full scientific certainty does not exist (to health or the environment), that shall not be used as a reason for postponing cost-effective measures to prevent adverse health impacts or environmental degradation. That means an activity or product should not be used if it can reasonably be predicted that it will lead to unacceptable consequences. In this instance, the cost effective measure is proportional to the harm. As the scientific certainty of the risk goes up, the justification for costlier measures is similarly increased.[229] This process would include technology-forcing regulations of mandate standards to create alternative products to reduce epigenetic harms. Epigenetic risk is not merely a medical risk, but implicates the fundamental principles of fairness and justice underlying the present social contract.[230]

Chapter 11 A New Social Contract

John Locke (1632-1704) developed a theory of natural laws and natural rights which could be used to distinguish between legitimate and illegitimate government, and to argue for the legitimacy of revolt against a tyrannical government. His philosophy was individualistic; the individual was the judge of all things, and had to relate himself to the universe through knowledge. The individual used his own reason to distinguish truth from opinion, illusion or falsehood. Locke believed that one should use reason to search after truth rather than simply accept the opinion of authorities or be subject to superstition. Used properly, reason could determine the legitimate function of institutions and optimize the function of society with respect to both material and spiritual welfare.

John Locke claimed that individuals had the fundamental natural rights of "life, liberty and property."[231] It was the government's responsibility to protect them. Reason served to control and order political life. Individuals relinquish power, but not rights to government (as the government is supposed to preserve rights). He believed that no one ought to harm another with respect to his life, health, liberty or possessions. For Locke, the role of the 'social contract' that placed authority over people was to protect human equality and freedom; this is why social groups agreed to a 'social contract' that placed an authority over them.[232]

Jean-Jacques Rousseau (1712-1778), a political philosopher and essayist, criticized some features of the Enlightenment; he claimed that Aristotle and Plato were wrong to think that the ability to reason was natural, and wrong to think that the human being was naturally directed by applying reason toward one final and universal state of perfection. Rousseau argued that inequality was not only unnatural, but that – when taken too far – it made decent government impossible. He believed all laws should pursue the principles of freedom and equality.

Rousseau published *Discourse on the Origin of Inequality* (also known as Second Discourse) in 1755, describing an endemic moral inequality that was related to power and wealth. As men come together, Rousseau claimed, there is a drive to compare themselves to others – driving men to seek domination over their fellow beings as a way of augmenting their happiness. This leads to the formation of government in which the property owners (wealthy) trick the poor into creating a government with the sole purpose of protecting their property and locking in moral inequality as a permanent feature of civil society. This contract is

promoted as treating everyone equally, but in reality, it is in the interest of the few who have become stronger and richer through development in their private property.[233]

In 1762, Rousseau published the *Social Contract* in which he defined the ideal social contract, describing how man could be free and still live together in a community (society). At the beginning of the book appears his most famous quote, "Man is born free, and everywhere he is in chains." This statement ties the story back to the moral inequality he described in the *Second Discourse*, seven years prior. By 'equality' Rousseau did not mean that everyone should be exactly the same, but that differences in wealth should not imbalance the state. Equality, it seemed to him, is a necessary condition for the preservation of liberty, while property and material inequality are the root of human misery and evil. Massive material inequality can put liberty up for sale. The poor would be willing to sell their freedom and the rich would be capable of buying it. Both the very rich and the very poor would value money more than liberty. Thus, Rousseau asserts that some level of material equality is necessary to ensure that liberty comes before profit. He defended private property; if everything we did was for the state, we would no longer be free.[234]

Rousseau believed that the role of government should be to secure freedom, equality and justice for all within the state (regardless of the will of the majority). The only reason that human beings agree to be ruled is because they believed that their rights, happiness and property would be better protected under a form of government. Everyone is free because everyone forfeits the same amount of freedom and imposes the same duty on all. If any form of government does not properly see to the rights, liberty and equality of everyone, then that government has broken the social contract that lies at the heart of political authority.[235]

'Free will' is freedom to act. Rousseau believed that one would rely on the general will of the community to control the free will of individuals. Free will leads to the clash of individuals when they are brought together. The individual gives up some freedom to get order, structure and protection. This protects everyone's property from free riders, thieves and con-men. Rousseau didn't support democracy by representation. He believed all members need to participate and hear the evidence. If there is failure to follow the general will, when one follows individual will, then the individual should be punished. The general will represents the whole interests of the people. New freedom occurs as the will of the community is guaranteed. People desire what is good, but they do not always see what is good. You cannot corrupt the people, Rousseau believed, but you can often fool them. This is the only time people appear to do something bad.

From Rousseau, Immanuel Kant accepted the concept that what separated men from animals was free will. To this, Kant added reason. For Kant, freedom of choice provided the free will that was essential to morality. There could be no morality if a man did not have freedom of choice. The ultimate principle of morality must be a moral law conceived so abstractly that it is capable of guiding us to the right action in application to every possible set of circumstances and can be applied at all times. Right actions are those that practical reason identify as a maxim that we will to be a universal law. According to Kant, the purpose of the state was not to make individuals good, but to enforce laws of justice. Accustoming individuals to obey laws that regulate their external relations would impose an outer discipline that prepares the way for an inner discipline of morality.

Kant's description of a civil society included freedom of the individual: equality of each subject in an open civil society, and independence of each member of that society as a citizen. Kant recognized that the combination of freedom and legal equality creates considerable economic variation, as inevitable consequences of unrestricted rights of inheritance produce significant advantage for the affluent and their children – access to education, capital, resources, and reigns of power (both economic and political). Still, in his system, every human being has equal dignity (or absolute worth). Kant's equality consisted of a prohibition on a certain kind of asymmetry of power or hierarchy within the political system. This system prohibits involuntary servitude and relations of dependence on another group. Kant argued that legal rights and the political institutions should aim to protect this freedom and equality.[236]

Herbert Spencer did not see a role for the 'free will' described in the Enlightenment. He chose Newtonian determinism and applied the Lamarckian evolutionary theory to develop the principles or 'law of nature' that he used to support his ideas on economics. Spencer's Lamarckian social interpretation was that individual development is based on characteristics acquired during life being passed along to one's offspring. This theory was believed to follow 'nature law," hence be morally correct. This meant that welfare programs (support for the poor) were unnecessary and would only distort the beneficial progress (only the best should survive), which is consistent with evolutionary biology.

Spencer claimed the source of variation could be explained by developing organisms coming to equilibrium with the surrounding environment. Natural growth of the organism, Spencer believed, required liberty, which justifies individualism, hence the need to defend the existence of individual human rights. This thinking supports a policy of "laissez-faire". Spencer's followers (rich people) did not need to feel ashamed of their advantages because their success was proof that they were most fit in this competition. He used Lamarckian evolutionary theory to justify social and economic inequality.

The Neo-Lamarckian evolutionary theory competed with Darwin's Theory of Natural Selection during the last half of the 19th century. The Neo-Lamarckian theory was a way around Darwin's challenge to religious orthodoxy and supported optimism (that the economic system was evolving towards an improved state). While epigenetic studies can be considered somewhat Lamarckian, the turn genes on or off phenomenon, still follows Darwinian natural selection. The abandonment of the main basis of Lamarckian theory creates problems for Spencer's followers of minimal government and abandonment of the poor – the science behind these theories no longer supported.

Thorstein Veblen observed that the life of man was a struggle for existence, making it a process amendable for selective adaptation. He believed that social structures, which he labelled institutions, were susceptible to evolution. For his analysis he applied Darwin's Theory of Natural Selection. He claimed that in the pre-industrial era, all men were equal in the workplace. Once there was industrial expansion and the system was set up for volume output, inequality appeared as two groups emerged – the workmen and the 'vested interests.'

Veblen described a 'leisure class' that was associated with expenditure of money for status which contributed to economic waste, contributing nothing to productivity. The system, advertising and media, encourages the middle class to emulate the 'leisure class' with conspicuous consumption. Consumption, Veblen believed, was a display of status more than

the satisfaction of genuine needs. This creates inequality in the system as the emulation consumption standard affects the amount of time allocated between labor and leisure (for the middle class). The 21st century counterpart, associated with inequality, is the well-documented, life-style effect of the 99% increasingly living outside their means. The progressive movement that appeared at the turn of the 20th century embraced Veblen's ideas and emphasized equality above individual achievement.

Objectivism, a philosophy developed by Ayn Rand during the Cold War, is the blending of free markets, reason and individualism. In this system, political equality means equal rights that supports rational individualism, and the freedom of the individual. Rights are about how humans ought to be treated in a social context. The moral standard to be followed is for each individual to live a full and complete human life as possible. The natural right based on natural law is the right of an individual to live free from force – which leaves no ethical alternative to limited government. The natural law source is Newtonian determinism that is a natural law, just like the law of gravity.[237] Application of this natural law forms the foundation of the virtue of selfishness. In the 21st century, events disprove Rand's point that less government is best for capitalism. The strongest economies in the past thirty years have been China, India and Thailand – all countries with government-controlled economies.

For Locke, humans entered into social contracts only to help adjudicate disputes between individuals or groups, and the purpose of authority was to protect human equality and freedom; this is why social groups agreed to a 'social contract' that placed an authority over them.

Friedrich Hayek (1899-1992), one of the most important economists of the 20th century, blended the ideas of Locke and Adam Smith to create a social contract that supported laissez-faire capitalism. His writings had a major influence on market liberalization strategies, which included discrediting government economic planning. Hayek observed:

> "Equality of the general rules of law and conduct, however, is the only kind of equality conducive to liberty and the only equality which we can secure without destroying liberty. Not only does liberty have nothing to do with any other sort of equality, but it is even bound to produce inequality in many respects. This is the necessary result and part of the justification of individual liberty: if the result of individual liberty did not demonstrate that some manners of living were more successful than others, much of the case for it would vanish."[238]

Hayek claimed "small government, free markets, low taxes," will provide prosperity in the long-run.[239] He clearly expected the laissez-fire system to create a gap between rich and poor.

John Kenneth Galbraith (1908-2006), one of the most widely-read economists from the 1950s to 1970s in the United States, warned in his writings of the dangers of deregulated markets and corporate. In *Affluent Society,* which came out in 1958, he described the growth model of the economy as being flawed, with inequality – a growing income gap between rich and poor. The economy was based on selling, Galbraith noted, and in order to keep people buying, new wants must be continually created. The media and advertisers played a significant role in this.

This model created a system, Galbraith noted, in which taxes and public spending were considered bad, thus government spending, by necessity, was kept low, so that taxes were at a minimum. This meant affluent people had such public things as polluted cities, crumbling infrastructure, and under resourced schools because these things require public spending, and public spending was bad. In comparison, it appears that economic investments in TVs and cars are more important than schools and roads.[240] Galbraith observed, "Few people at the beginning of the nineteenth century needed an adman to tell them what they wanted."[241]

In a speech in 1994 during a discussion on the economy, Alan Greenspan, Chairman of the Board of Governors of the Federal Reserve from 1987 to 2006, claimed "Income equality is where the capitalist system is most vulnerable. You cannot have the capitalist system if an increasing number of people think it is unjust."[242] The answer at the time to close the gap between skilled and unskilled workers (to address income equality) Greenspan said , is to allow in more immigrants with sought-after skills. (Basically by increasing the number of immigrants with sought-after skills would increase the labor supply of these workers in the US and hold down wage gains of all workers with these skills.) Ten years later, Greenspan's observation (while misdirected), that the capitalist system is vulnerable to income inequality, seems prophetic.[243]

Douglass North, Nobel Prizing winning economist, champions the new institutional economics which focuses on understanding the role of the evolutionary process and the role of institutions in shaping economic behaviour. New institutions need to be developed to establish the "rules of the game" under a new model, using Douglass North's understanding of institutions as the "humanly devised constraints that shape human interaction."[244] Changes are not only required for formal institutions, such as the financial services industry (which are important for the economy), North claimed, but should include both formal and informal institutions (including property rights, rule of law, transparency) which have a strong influence on the efficiency of an economy.

Adam Smith argued for laissez-faire capitalism by claims that if people were allowed to pursue their own interests, an 'invisible hand,' a fundamental law consistent with Newtonian determinism, would regulate society for the general good.[245] North noted that one of the deficiencies of economic theory is that it is static. A theory needs to consider the dynamic world of change, incorporating measurements in time, of the way humans learn, and a feel for history – it's the past that constrains the present and the future.

Income disparity in the US is illustrated by the fact that the income of the top 300,000 equals that of the bottom 150 million. Epigenetics serves to highlight the effects of inequality in living and working conditions, as well as a range of disparities in access to health care and other societal opportunities. It raises the question of individual and societal responsibilities to prevent hazardous exposures, monitor health status, and prevention. Epigenetics requires a different social contract than the existing status quo. How we develop mentally and physically has a tremendous impact upon our inherent capabilities and our set of life options. Because of the role epigenetics plays in human development and in disease causation, there is an important role in regulating epigenetic harms. The regulatory response must include (1) promotion of knowledge (institutions need to catch up), (2) assessment and modifications of

existing regulations to address preventable risk, and (3) protection of human capabilities in an equitable manner.[246]

Some of the institutions identified by North would include the Federal Drugs Administration (FDA) and the Environmental Protection Agency (EPA), the same agencies that come under siege from the laissez-faire crowd as being responsible for the dreaded regulatory and competition costs. With respect to epigenetic events, both institutions could play a significant role in reducing epigenetic harms. Basically, this is about reducing reactive oxygen species in order to reduce the burden of chronic disease. This is a sustainable process because it will reduce the cost of health care of chronic disease that saps industry of workers, and the government of money.

The EPA is charged with protecting human health and the environment in the US, by writing and enforcing regulations based on laws passed by Congress. Set up in 1970, it now runs twenty-seven laboratories across the US, employing many engineers, scientists, and environmental protection specialists. The agency conducts environmental assessment, research, and education. Besides legislation, the EPA is involved in surveillance and research on such chemical groups as endocrine disrupters, and provides enforcement characteristics for other pollutants on its lists.

The FDA promotes public health through the regulation and supervision of food safety, tobacco products, dietary supplements, prescription and over-the-counter pharmaceutical drugs, vaccines, biopharmaceuticals, blood transfusions, medical devices, electronic radiation emitting devices (ERED), veterinary products and cosmetics. They could assume a greater role in addressing such issues as the overload of the regular American diet with omega-6, compared to omega-3, leading to the pre-inflammatory events associated with chronic disease, in general, and cardiovascular disease and diabetes, in particular.

The economic theories of Friedrich Hayek and Milton Friedman (1912-2006), an American economist who taught at the University of Chicago, went mainstream with the economic policies of Reagan and Thatcher. In *The Passion of the Western Mind*, Richard Tarnas (born in 1950), a cultural historian, observes that the modern mind requires a critical independence of judgement rooted in reason. He notes, “The modern emergence of autonomous personal judgement, prototypically incarnated in Luther, Galileo, and Descartes, made increasingly impossible any continuation of the medieval era’s virtually universal intellectual deference to external authorities, such as the church and Aristotle, that had been culturally empowered by tradition.”[247] The small government and minimal regulation debate in response to the economic downturn has been ‘culturally empowered’ since the 1980s by intellectual deference to external authorities, such as Hayek and Friedman. The equality of the social contract from this era embraced Hayek’s definition that laws are to protect the liberty of the individual. This fits nicely with the small government and minimal regulation mindset.

Now it is necessary to factor in the meaning of freedom based on new ideas. Darwin’s Theory of Natural Selection, arrived at upon an empirical basis explaining the role in evolution played by chance, was a complete rejection of Newtonian determinism, the system that supported the invisible hand in Adam Smith’s economic theory. In addition, it was through cooperative and social learning that humans evolved faster than chimpanzees (our closest relatives). For the 90% of human existence as hunter-gatherers, cooperative culture (members) was favored through natural selection. Then the next revolutionary discovery occurred –

epigenetics. In epigenetics the issue is the reactive (oxygen) species that individuals are exposed to that increases their risk to illness, triggered by contaminants in the food and water they ingest, and the air they breathe. These processes are most pronounced when the individual is most vulnerable: the unborn baby, and prior to the age of twenty years. The equality to prevent epigenetic harms is different than the equality that Hayek envisioned to keep communism at bay. Today, the equality of individuals must be based on epigenetic harm. Understanding the mechanisms behind chronic disease, and its subsequent costs to the economy, creates data that can be factored into risk management.

Risk management needs to be based on the precautionary principle, which means full scientific certainty is not to be used as a reason for postponing measures that prevent adverse effects on human health, if those effects could be serious or irreversible. This relies on properly resourced agencies to monitor the situation. For the following discussion, we will apply the risk analysis to a food group and an environmental pollutant.

This first example would fall into the jurisdiction of a newly empowered FDA. To be consistent with the precautionary principle, there would be action in limiting foods associated with chronic disease, even with the lack of full scientific certainty. The use of corn syrup is so pervasive that it is found in many processed foods. In 2007, a research paper associating HFCS (high fructose corn syrup) with reactive carbonyls, which have been linked to tissue damage and complications of diabetes, and are elevated in the blood of patients with diabetes, was published. It appears that a can of soda has five times the concentration of reactive carbonyls found in the blood of diabetics. Soda from ordinary sugar has no carbonyls, while soda made with HFCS does.[248] In 2010, studies showed that when rats were fed equivalent diets of HFCS and table sugar, the rats fed HFCS gained more weight, put on abdominal weight and developed increased serum triglycerides, than those on equal calories of table sugar. A few years ago, Canadians were able to read the labels on the processed foods in the supermarkets and determine whether they contained regular sugar or HFCS. Today, the labels invariably read 'sugar/glucose-fructose,' so Canadians cannot be sure which sweetener has been used, or both. In Europe where the use of HFCS is limited in drinks and processed food, there is less obesity than in America.

In this instance the cost effective measure is proportional to the harm. The harm is the diabetes and obesity appearing in young people. The top down system leaves unaccounted costs when a product is marketed. Corn feeds the profits of agribusiness. The tariffs against imported cane sugar protect two areas: keeping price up for the cane farmers in the US and consequently, keeping the price up for table sugar, favoring the corn processors. The consumption of large amounts of fructose – specifically in the form of HFCS – has been linked to the development of metabolic syndrome, an obesity-related condition. This syndrome, previously known as "pre-diabetes," is believed to exist in 25–50% of the US population. If only 1 in 5 of these individuals goes on to develop diabetes or one of the other complications of metabolic syndrome – stroke, heart attack, hypertension, or cardiovascular disease – their total annual medical costs could top one trillion dollars.[249] There needs to be a partial ban of HHCS or, at best, more food choices with informative food labelling. The FDA must conduct a study in Europe to gain more scientific certainty to drive stricter regulations.

The EPA plays an important role in monitoring and enforcing regulations dealing with various aspects of environmental risk. Their new role would include technology-forcing regulations to mandate standards to create alternative products to create a reduction in epigenetic harms. One of the pollutants that would be controlled is ozone. Ozone is created by a chemical reaction between nitrous oxide and volatile organic compounds (VOCs) in the presence of sunlight. Ozone at ground level is a pollutant. It damages human health, can worsen bronchitis, heart disease and emphysema.

In urban areas, motor vehicle exhaust is a significant contributor to ozone, the key component of smog. A common source for ozone includes the hydraulic fracturing method (fracking) for natural gas wells, gas processing plants, gas compressor stations, storage tanks and well sites. In one Wyoming gas producing area, 94% of VOCs and 60% of the nitrogen oxides are attributable to oil and gas production and development. As ozone is carried world-wide by air currents, it requires a world-wide solution. It requires air quality rules for the reduction of ozone, ones that drive technological innovation.

In this instance the cost effective measure is proportional to the harm. Industry supporters claim it could kill thousands of jobs in an already struggling economy. While industry claims crippling costs (which are considered exaggerated), proponents of ozone reduction claim costs would be offset by recovery of natural gas that previously escaped to the air, plus health benefits. Besides premature deaths, EPA administrator Lisa Jackson declared ozone as "responsible for tens of thousands of visits to emergency rooms by Americans each year for serious bronchial conditions such as asthma. The reduction from 75 parts per billion to 60-65 parts per billion was expected to prevent the loss of 12,000 lives a year in the US to premature deaths."[250]

There is a need to introduce full cost accounting. In the present top down system, society must bear the indirect costs of industrial products like pesticides. These indirect costs include honey bee and pollination costs, damage to the aqua system – fish, fish fry, eliminating essential foods, such as insects, and fish that are unmarketable because of high pesticide residues. There is increased soil erosion with destruction of soil micro-organisms. The indirect costs in some models have shown to be double the direct cost.[251]

The WHO identified that 63% of all chronic diseases can be attributed to cardiovascular disease, diabetes and cancer. The discussion on health-care expenditures turns to balancing affordability with sustainability. Chronic disease, consisting of cardiovascular disease, cancer, chronic respiratory ailments, diabetes, musculoskeletal disorders, diseases of the nervous system and sense organs, and mental illness, accounts for a significant piece of health-care costs. In Canada, chronic disease accounts for 42% of the total direct expenditures. The indirect costs of debilitating illness are particularly high, accounting for over 65% of total indirect costs, are due to productivity losses because cancer and heart disease kill so many at an early age.[252]

The US spends more per capita than any other nation in the world. US health-care costs have been rising for several years, significantly faster than the overall economy, and are considered the worst long-term fiscal crisis facing the nation. It is not possible to sustain the present rate of increase without affecting other programs significantly. Specifically there will be less money for things like education, environmental protection, scientific research and national security. Other items will vie in importance with the health of society. In 2007, chronic diseases

cost the US economy more than $1 trillion dollars, mostly from lost worker productivity, and this could balloon to $6 trillion by mid-century.[253]

The move from risk-based control to technology-based (performance-based) control allows detractors to make the claim that the change is causing unnecessary and harmfully disruptive, economic impacts. Rousseau warned that large income gaps created the opportunity for liberty to be sold. The 21st century equivalent is a government controlled by the use of lobbyist money. As a cultural process gave rise to the inequalities, Rousseau noted, it will take a change in cultural process to reverse the harmful inequalities. The new enlightenment of the 21st century, the Wall Street protests, challenge the intellectual deference to laissez-faire, and drive the change in thinking required to integrate epigenetics into the community, to introduce a new social contract.

Chapter 12 The Future State

In going from the present state (how things are done now) to the future state (how things should be carried out), change is required. Information in the present state informs the future state, and influences choices. The differences between the two models (present vs. future) define the set of changes that need to be enacted in sequence, or parallel. A gap analysis identified barriers to achieving the future state. Basically, these are systemic factors that contributed to the current state, not that anyone was at fault. The Occupy Wall Street protest challenges the status quo and supports change to a future state. The present social contract is an illusion that disguises relationships of the dominant class as a voluntary partnership. Health in general, and chronic disease in particular, is a significant component of the present state. Government remains the only real tool for solving complex social issues.

During the 18th century enlightenment, people criticised anything and everything. There was a climate of critical inquiry under which the rigors of scientific method would appear. Kant's 'dare to know' was about having courage of your convictions to take charge of your situation. The Occupy Wall Street protesters have introduced the enlightenment of the 21st century. They discuss many issues without coming to clarity – connected by the anger of the common person against the banks for manipulating the system and tanking the economy. Their manifesto becomes a list of items for corporations to clean up and become accountable. It's time to roll back the widespread tactics of misinformation that originated with the tobacco industry.

A new social contract would place epigenetics at the center – to address the inequalities of living and working conditions. Society has a responsibility to prevent hazardous exposures. It is necessary to promote knowledge to address the ethical issues that testing will create. Public health laboratories could play a role by testing blood samples sent in for other indications and create a common epigenome of populations in various lneighborhoods. However, this information could be detrimental to employment and insurance purposes for the individual; thus rules respecting ethics will need to be in place. Besides establishing databases, there is a need for a professional civil service to adjudicate between the lobbyists and the politicians.

We need a definition of how to protect human capabilities in an equitable manner. This will include closing the income gap between the very rich and the middle class. It must also include access to health care in order to monitor the consequences of the epigenetic exposures

to date. Changes will include more choices in diet. Human potential is the new freedom requiring laws to protect equality and ensure liberty.

What happened to the old social contract? Hayek equated an equitable system with individual freedom. However, he never criticised the size of government, only what government should be. To Hayek, it was irrelevant how big government was and how fast it grew. What was important was that government actions fulfilled certain formal requirements. It was the character rather than the volume of government activity that was important.[254] Herbert Spencer believed that he had successfully applied biological laws (Lamarckian evolution) to support his economic theory of small government and minimal support for the poor. The Lamarckian theory has been subsequently disproved, but conservative libertarians continue to subscribe to Spencer's idea of small government and minimal regulations: it has become dogma. Ayn Rand championed the American idea of rational selfishness and individualism. Unfortunately, the cult of self-esteem created extreme individualism that resulted in the wrong self-love of Aristotle supporting rationalism. It was replaced by the selfishness of self-centeredness, a consequence of the cult of self-esteem in the school system during the last two decades of the 20th century. In this system individuals do not make decisions on based reason, rather by emotional factors for short-term gains. Rousseau said everyone is free because everyone forfeits the same amount of freedom and imposes the same duties on all; moral inequality relates to differences in power and wealth established by convention. Rousseau, observed that with too much wealth at the top, the wealthy can buy their freedom. In 21st century, the power of money to buy opinions through the media means this observation is still relevant.

The other challenge is to re-establish good science as the source of all information for critical decision-making. The tactics of misinformation programs used to confuse the individual and legislatures – delays key decisions. The other observation is that classical economic theory is not supported by science. Based on rationalism, it can lead to observations such as 'The rich get richer based on merit.' As journalist and political activist, Steve Kangas observes, "The problem with rationalism is that it makes the search for truth a game without rules. Rationalists are free to theorize anything they want without such irritating constrictions as facts, statistics, data, history or experimental confirmation…"[255]

Thorstein Veblen, during the first era of globalization at the turn of the 20th century, noted that the established elites, slow to accept radical changes, were wary of new ideas that challenged traditional views of the 'natural order' and mankind's place in it, while the middle class was closer to events, and needed to adapt to survive. Similarly, at the turn of the 21st century, the wealthy do not see a need to change. Veblen also described a group which aspired to be wealthy and emulate the ways of the wealthy. In the 21st century, there is an equivalent group within the middle class who have adopted conservative values and defend the status quo.

The realization that the epigenome is highly sensitive and responsive to environmental influences, including toxic exposures, dietary factors, and behavioral impacts, serves to focus priorities in the future state. In particular, epigenetic harms have the potential to affect every aspect of our lives. Epigenetics identifies that certain exposures to toxins, especially during periods of developmental vulnerability, can cause long-term harm to exposed individuals, and sometimes their progeny. The present state equality before the law envisioned by Hayek must

be replaced by the equality of gene-environment interaction in diseases defined by epigenetics. Environment and food play key roles in epigenetic changes and in the development of chronic diseases. Control of the causes of chronic diseases will control the cost of chronic diseases which, in turn, will control budget challenges in the future.

Modification of diet has a role in the prevention of chronic disease. In the present state, effective preventative measures to reduce cardiovascular morbidity and mortality include the ABCS program. This consists of aspirin therapy, blood pressure control and smoking cessation. The main problem with the program is under subscription. The other problem is the lack of diet choices to address such issues as reduction of sodium intake, reduction in trans fat intake (with the minimal labelling of food) and the 20% of adults who continue to smoke.[256]

The World Health Organization (WHO) reported that dietary factors account for at least 30% of all cancers in Western countries, and 20% in developing countries. Two significant dietary factors are meat eating and the consumption of processed foods. There are multiple risk factors involved in eating meat. For example, the high fat content of meat increases hormone production which, in turn, increases the risk of hormone-related disease, such as breast cancer and prostate cancer.[257]

The other risk factor, processed food, refers to the use of hydrogenated oils used in baking (commercial goods). The use of hydrogenated oil is driven economically: it significantly increases the shelf-life of food products, and is popular in fast food chains because they can be used for frying. Hydrogenated oils also consist of varying amounts of trans fats. Trans fats are associated with an increase in bad cholesterol and a decrease in good cholesterol. Most European countries have either banned hydrogenated and partially hydrogenated oils altogether or have instituted future dates for elimination of their use in food, but since they are cheap and extend shelf life, many European companies make food with trans fats solely for export to America.[258]

There is an opportunity to counter both dietary challenges with a combination of more food choices and social marketing. The answer to hydrogenated oil has been to consume unsaturated fats, such as olive oil, canola, nuts and omega-3 fatty acids (found in salmon and flaxseed). One key highlight on diets was the seminal paper from a Columbia University study that showed people who consumed salads had less neurological disease than another group whose diet consisted primarily of fatty dairy products, and red meat.[259] Social marketing is required to inform people about the healthy choices, such as the advantage of grass fed meat over corn fed meat. The grass fed meat that has the healthy ratio of omega-3 to omega-6 fatty acids that keeps free radicals under control, disappeared from North American diets in the 1970s. The return to eating healthy fats will reverse the damage of trans fats – weakened immunity and the ability to heal. With a change in diet, the trans fat incorporated into your body cell membranes will be gradually replaced with polyunsaturated fatty acids.

A new social contract exposes significant gaps between present and a desired future state. The gaps will be analysed by reviewing four areas: lessons from the anti-smoking program, man's evolution and the genome project, epigenetics and supplements, and the challenges of a top down economic system.

Epigenetic harm is quantitatively different from other toxic risk that regulatory agencies have historically perceived and addressed. The challenge is more complex than the fact that the

harm occurs long after the causative exposure. Epigenetic marks can have a profound impact on an individual's mental and physical development; thus, many such developmental changes will probably exert a greater impact on an individual's lifelong capabilities compared to harm, like late onset cancer (which would not greatly impact an individual's capabilities or freedom of life choices prior to the manifestation of the disease). It is necessary to adopt the capabilities approach to protect the individual's freedom to choose among alternative lives. The capabilities approach consists of two core claims: the freedom to achieve well-being is of primary moral importance, and the freedom to achieve well-being is to be understood in terms of people's capabilities, that is, their real opportunities to do and be what they have reason to value.[260] The capabilities approach was developed to help individuals think about what it means to live a full life, and how governments can provide the opportunities to help their people do so.

Tobacco use is the leading preventable cause of disease caused by epigenetic harm. The present model of the anti-smoking program to prevent lung cancer is to address the following risk factors: quit smoking, and eat fruits and vegetables rich in antioxidants and flavinoids (which help protect and repair your cell's DNA and repair damaged cells). Smoking causes cancer because of the chemicals and additives in the smoke and tar. Tar, not nicotine, is the cancer causing agent in cigarette smoke. Tar is made up of 4,000 chemicals, sixty of which are known to cause cancer. While lung cancer is the commonest cancer associated with smoking, other cancers are associated with smoking: larynx, mouth, throat, bladder, esophagus, kidney, stomach, pancreas, and even leukemia. The chemicals damage DNA and modify important genes, causing cells to grow abnormally.

The wealthiest countries of the world have made substantial progress in reducing tobacco use at the population level, whereas the opposite is true in many developing countries. Lessons include the implementation of legislation labelling products dangerous, plus taxes to increase the price of products significantly to decrease use, together, helped decrease the use of tobacco significantly. In this case, institutions implemented regulations to reduce the negative effect on health and economy of the population, were effective.

Epidemiologic studies over the last half-century have demonstrated the immense burden of disease caused by tobacco use. The environmental factors that promote tobacco use, economic, social and political, are highly modifiable. In the first decade of 21st century, after 60 years of anti-smoking efforts, 25% of Americans still smoke. In 2003, less than 33% of patients with coronary artery disease are prescribed aspirin. Messaging is not as effective as it could be. Remember smoking is the first epigenetic event in which an intervention was applied to the entire population (i.e. Stop Smoking!) By limiting cigarette use (advertising and increasing the price), the lung cancer rate began to fall, as soon as five years, after smoking rates declined. Research has shown that the longer and more heavily governments invest in comprehensive tobacco control programs, the greater the reduction in smoking, and the greater the subsequent savings from smoking-related health costs. Research also has shown that any slackening of the anti-smoking effort can jeopardize progress.[261]

For 90% of his existence, man has been a hunter-gather. One must take into consideration that mankind's evolution selected characteristics for reproduction that includes an immune system designed to withstand bacterial infections. This process is consistent with Darwin's Theory of Natural Selection. During the 20th century, thirty years was added to the life

span, and now it is necessary to take into account the aging process that results from the oxidation process that, for various reasons, the aging body cannot control.

With the completion of the human genome project in 2003, came the demise of the genetic paradigm and the revival of the epigenetic approach. From believing that our biological fates were written in our genes, it is now recognized that the environment, and more specifically our perception of the environment, directly controls our behavior and genetic activity. Environmental signals 'activate' receptor proteins (which are switches under the control of another gene) that control the cell's behavior. These newly described cell control mechanisms identified the need for a shift in planning population health interventions to address the consequences of epigenetic harms that potentially limit a person's innate capabilities and life options.[262]

Epigenetics refers to the cellular environment of our genes – how the expression of the genes are affected without changing the underlying DNA sequences. 'Oxidative stress' is the state of a cell, which is characterized by excess production of reactive oxygen species (free radicals) and/or a reduction in antioxidant defences responsible for metabolism. Epigenetics identified the role of toxins (reactive oxygen species), by degrading the enzyme systems that repair DNA and allowing the body to be exposed to more free radicals. These toxins can alter DNA much easier than originally thought, and are found in the air we breathe, the water we drink and the food we eat. The cause of the chronic disease is the increased oxidative stress from the free radicals often created by toxins. The sources of the free radicals include such things as the dust from air pollution, the multiple doses of PCB, dioxins, pesticides ingested in the water, saturated fat in foods, and the bad mix of omega-6 to omega-3 essential fatty acids in meat. All are contributing to increased oxidative stress on an individual's immune system.

This information ushered in the era of high dose vitamins and antioxidants, with some people taking over 100 pills a day. The goal was to reduce the onset of chronic disease and aging by helping the body's immune system control free radicals. Studies suggest it is necessary to modify the diet in order to maximize the effects of supplements.

The top down economic system is also known as the trickle down economic system. At the center of this theory is the idea that if you help the wealthy get wealthier, they will create more business and jobs, and therefore everyone will be better off. Following the 2008 economic debacle, corporate profits are higher than ever, while unemployment is as high as it has ever been in the past two decades. Corporations maximize shareholder value which, in turn, maximizes bonuses of the top managers. In this present model, the profits are not necessarily invested in local businesses.

The big hurdle in challenging the trickle down system is political. Resistance to change must be addressed, as vested interests continue to profit from the existing system. The wealthy believe they are entitled to manipulate the system. The self-esteem movement created a population with an exaggerated sense of entitlement. The world is viewed from an emotional rather than a rational perspective allowing personal feelings to override the distinction between right and wrong. When there is too much self-esteem, there are problems of self-tolerance and narcissism. Such individuals learn to tolerate their errors and personal flaws, come to accept themselves as okay, and feel justified in asserting themselves therefore defending their perceived rights. Under the cult of self-esteem, people make decisions based

on emotions and desires. Entitlement becomes part of their belief system – they believe they deserve special treatment.

In the 18th century, the Enlightenment was a movement which displaced dogged adherence to established opinion and customs, and applied critical thinking. In the present top down system, vested interests control the political agenda. The Occupy Wall Street protesters describe their frustration with the status quo of financial greed and corruption and the need to challenge the blind faith and convictions in the present deregulated market. This marks a new Age of Enlightenment. The bottom up system of evolutionary economics changes how most people think. A new system would have an economic theory, the new institutional economics to support the ideas of competition in the present neo-classical system, while providing the framework for "institutions" or rules and regulations to create the climate to less exposure from oxidative stress in the environment. This bottom up system still meets the new definition of capitalism by Lionel Robbins (1898-1984), British economist and head of the economics department of the London School of Economics; "Economics is the science which studies human behavior as a relationship between ends and scarce means which have alternative uses." [263] The application of evolutionary economics will provide the process for the change in mind set to support a new social contract.

The main chronic diseases can be considered epigenetic events. Free radicals can be associated with triggering such illnesses as cardiovascular morbidity, type 2 diabetes and cancer. The challenges with epigenetic risks are multigenerational and multifactorial, and as such, risks cannot be calculated with certainty. Injury can be dealt with through the courts, or as monitoring and prevention through government. The tobacco industry provides the answer based on how the legal system performs. Lawyers vigorously defend lawsuits brought by smokers for smoking-caused disease or death. Even when they lost, they would appeal. This is illustrated by the Rose Cipollone case; the court initially awarded funds, the lawyers for the tobacco companies appealed, the settlement was overturned, the plaintiff died, and the family dropped the suit as they were unable to afford continued litigation. From the 300 confidential documents released over the five years of the trial, the world became aware of the tobacco industry's conspiracy to keep the dangers of cigarettes from becoming public knowledge. With such precedents from lawsuits against the tobacco companies, it is obvious that private citizens are at a disadvantage when challenging companies with deep pockets.

The government needs to become involved, recognize that epigenetic harms are unique and that it is necessary to create institutions with significant authority to meet the challenges. This means the roles of regulatory agencies, such as the FDA and EPA, need to be enhanced in the future state, developed within the new institutional economics model. While the FDA and EPA possess the statutory authority to begin addressing epigenetic harms, there needs to be a paradigm shift to adapt their systems to respond to this type of harm. This cannot take place without a regulatory framework to address epigenetic risk from specific toxins, even if conclusive proof of disease causation cannot be established.[264]

The goal is to reduce the reactive oxygen species in order to reduce chronic disease, which leads to a reduced economic cost of an aging population, while reducing eco-damage. There needs to be action on three fronts: food, water and air.

To create the future state, regulators such as the FDA need to address the lack of choices for healthy diets to counter the chronic disease epidemic. This includes modifying the

grading system to include health value as part of the gradient – providing grass fed meat its own grade in which farmers are rewarded appropriately for the longer period required to feed the cattle. The FDA needs to work with the USDA to adjust the grading system by encouraging more grass fed cattle be brought to market, thereby offering more healthier choices for people – less saturated fat, better ratio of omega-3 to omega-6, a diet that supports good health and a strong immune system. This would be a quick win. In Denmark, where it has been illegal for foods to contain more than 2% trans fats since 2004, deaths from heart disease dropped 20% within five years of implementation.[265]

In the future state, institutions like the EPA will have the resources for timely monitoring of new products and the environment. An example is the PFOAs that were introduced in the 1950s used in the manufacturing of rain gear, stain-resistant carpet, microwave popcorn bags and fast-food packaging. It was a product that did not biodegrade, but accumulated in the environment. POFAs have been found to affect the immune system of children, and will be phased out of industry in 2015. The harm has been done; it will take years for the chemical to leave the body.[266] The new institutions of the future state must ensure manufacturers don't release chemicals to market based on minimal studies, rather with the eye on long-term toxicity and hidden health costs. In the future state, a new chemical policy has five goals:

(1) Industry would bear the legal burden of proving its chemicals are safe. Under the current law, the government must prove harm to health before being able to regulate a chemical.
(2) Information on the health and environmental impacts of chemicals would be developed by companies and disclosed to the public.
(3) Industry would have to immediately reduce exposure to chemicals of greatest concern, including those that are toxic, persist in the environment, and build up in people.
(4) Companies would have to prove that any information kept secret is a legitimate trade secret.[267]
(5) The development of guidelines for measurement of the exposome – the measure of all the exposures of an individual in a lifetime and how those exposures relate to health.[268]

The new system needs technology-forcing regulations that are transparent and provide accountability along with the resources to implement them. This legislation typically dictates the level of control, but not the method of achieving it. The regulatory system needs to be separate from the industry and lobbyists' definition of capitalism. The rotation of industry personnel between regulatory agencies that regulate food, drugs, chemicals and financial services would be discontinued. This means Monsanto mangers would no longer rotate through the EPA and the big Wall Street banks would no longer provide management for bank regulators. Technology-forcing regulations, an important part of the future state, are designed to force the industry to develop new technologies by setting standards beyond industry's current technical capabilities.[269]

The new monitoring system will consist of a series of tests to establish the 'exposome' of the individual. The exposures begin before birth and include environmental and occupational toxins. This system includes (1) measuring the epigenetic exposure (transcriptomics), (2) proteomics (making it happen) and, (3) metabolomics (what did happen – ultimately translates genetic information into biochemical work that supports the function of the body).[270] The

exposome monitors the exposures of an individual at a given time (through out their life) and how those exposures relate to disease.

The exposome will be a measure of an individual's environment, diet and lifestyle. Past exposures will be measured by legacy biomarkers. This system will enable the detection of the effects of multiple low-dose chemical exposures and identify the combinations responsible for chronic disease. It will be necessary to stick to ethical principles, ensuring the rights of individuals are not compromised when determining exposures and relationships to their health. A new professional civil service would be developed without a role for industry rotation. It would have enough resources to research and monitor new chemicals, once they are on the market. This would allow them to partner with researchers at universities to bring the best science to focus on decision-making.

There are two aspects of the top down system that need to be addressed: the large banks that are too big to fail, and the mindset of minimal government regulation. These banks were a problem that both the EU and North America faced. Rolling the big banks back to no larger than what they were in 1996, as recommended by Johnson and Kwak, would create many more investment bank choices. In this format, if the banks failed they could not take down a significant part of the economy. With more competition, fees for services would come down, the reimbursement would no longer be obscene and, with less cash, banks would have less influence in Washington. The number of banks would become large enough for selective pressures to be in play, and remove the banks that are unhealthy.[271]

There is also a need to manage a country's exposure to financial risk. The gap analysis between present state and future state identified underlying structural issues that need to be addressed: the cost of chronic disease, and the cost of a weakened middle class. People have almost forgotten about the money that can be saved with health prevention. In fact, this was the model that illustrated how controlling environmental toxins, like cigarette smoke, can lead to a healthy community and a sustainable future.

Many chronic diseases can be considered epigenetic events. Free radicals can be associated with triggering cardiovascular morbidity, type two diabetes, and cancer. The enhanced roles of agencies, such as the FDA and EPA in the future state, will play a key role in developing sustainable health-care systems. This includes the introduction of processes to reduce reactive oxygen species that are behind the epidemic of chronic disease – in parallel with environmental monitoring to monitor the levels of toxin exposure, and increased number of choices of foods that strengthen the immune system in an aging population. The consequence of this activity will bring the long-term (health) costs of chronic diseases under control, both the costs for treatment and lost work productivity (economies are losing people in their most productive years). This would be part of the bottom up economic model of thinking.

The structural issue is the top down or trickle down economic system, indirectly benefiting those who do not directly benefit from the economic policy changes, such as giving tax breaks to the rich to create jobs from the additional investment. In the present (state) system, the policies of the top down system are policies championed by small groups of influential people. The top down agents fully understand the system and make decisions to optimize their own private welfare (wealth). The improvements in health have not primarily been due to advances in medicine or health care, but rather in the kind of societies in which we live. Today, poverty is defined as having enough resources to participate in society in a

meaningful way. Societies that are economically unequal have higher levels of poverty. It is not about the amount of wealth, but its relative distribution. The growing income gap translates into poorer health for the population. Addressing the income gap will have significant impact on reducing chronic disease.

In the future state, changes will be supported through the introduction of evolutionary economic thinking in combination with new institutional economics format. Evolutionary economics will support a bottom up system in which scarcity drives competition, the key driver for success. New institutional economics will provide the framework for a new civil service and process to support agencies (institutions), such as the FDA and EPA for effective monitoring and enforcement of regulations, without the need for the rotating supervisors from industry. These changes would ensure the equality in the system to support a new social contract for the 21st century and, as a consequence, a healthier future.

Conclusion

How do you measure health today? Social determinants of health are the conditions in which people are born, grow up, live, work and age. These conditions influence a person's opportunity to be healthy, his/her risk of illness, and life expectancy. Social inequalities in health, the unfair and avoidable differences in health status across groups in society are key factors. Differences in health follow a strong social gradient reflecting a population group's position in society which translates into differential access to and security of resources, such as education, employment, housing, as well as differential levels of participation in civil society and control over life.

There is mounting evidence that the contribution of medicine and health care is quite limited in making people healthy. Spending more and more on health care does not get significant, further increases in improvement in the health of the population. Mainstream health care is fully aware that living and working conditions are crucially important for a healthy population. The population health approach focuses on key areas, such as the root cause of the problem with evidence to support the strategy to address the problem, efforts to prevent the problem, improving aggregate health status of the whole society, while considering the special needs and vulnerabilities of sub-populations, and public involvement and community commitment.[272]

There is evidence from the *Second Report on the Health of Canadians* that income gap has a role in the healthy outcomes of individuals. Studies suggest that the distribution of income in a given society may be a more important determinant of health than the total amount of income earned by society members. Large gaps in income distribution lead to increases in social problems and poorer health among the population as a whole. One Canadian study found that men in the top 20% income bracket live an average of six years longer than those in the bottom 20%. For women under the same criteria, the difference is three years. Another measure of health in the community is infant deaths. Babies born in poor neighbourhoods are at greater risk of death than infants born in wealthy neighbourhoods. In one Canadian study, infant death rate is about twice as high for babies in poor neighborhoods, compared to babies from wealthy neighborhoods.[273]

The difference in health between the rich and poor does not just affect those with the highest and lowest incomes; it actually occurs on a gradient. In other words, people in the higher income group are healthier than those at the next level down and this pattern continues to the lowest income group. These gradients have persisted over a long period of time, even though the principle causes of death and disease have changed considerably.

The degree of control people have over their lives is related to their wealth and their health. This is especially true when it comes to dealing with stress that they encounter, and the subsequent choices they make. This effect works biologically, as well as socially. Our bodies are more vulnerable to disease when people have little control and few options, and have trouble coping with the distress as a result. This is because their immune and hormonal systems will weaken in response to these unfavourable conditions.[274]

There is an important lesson to be learned from the story of tobacco control. In early 1950 Ernst Wynder (1922-1999), a researcher and activist, published a report in the *Journal of the American Medical Association*, comparing 649 lung cancer patients with 600 controls; he found lung cancer an incredible forty times higher among smokers, with the risk of cancer increasing with the number of cigarettes smoked. Later that year, Richard Doll, a British scientist, published a prospective study on physicians who developed lung cancer, and the majority of them turned out to be smokers. In response, the Tobacco Research Commission (later to become the Tobacco Research Council) was set up by the tobacco industry to look into the matter. This industry-funded group produced a report claiming there was no compelling evidence of a cause-and-effect relationship between cigarettes and smoking, suggesting that many other factors may contribute, such as air pollution. The era of misinformation on cigarette smoking was officially launched.

The tobacco industry was involved in fifty years of minimizing the hazards of cigarette smoking through various methods, including intentionally concealing from consumers and regulators the toxicity of their products. These activities were responsible for delaying the decisions to intervene with public health programs to reduce smoking in the general public. There is a need to circumvent such activities by industries in the 21st century in order to apply the scientific methods to decision-making. Remember it only took five years of reduced smoking to see lung cancer rates drop.

Industry influence on the risk management of other toxins needs to be controlled. New institutional economics has the tools to deal with this. Understanding that institutions should set the rules and guidelines that provide stability to the market, is part of the change. These will be part of a new professional civil service at arm's length from the politicians, replacing the staff from industry that rotated through the FDA, the EPA and banking regulators. The new system will provide the transparency needed to ensure accountability. Incorporating social media into the system provides more choices for information, empowering people with real information, not the spin from the corporations and the politicians. This will do a great deal to resolve the cynicism associated with the old system (present state).

Creating a sense of urgency is critical to successful change. The misinformation actions have created a sense of complacency in many quarters. For example with climate change, the urgency seems far off in the distance. If the Antarctic and Greenland ice sheets were to melt, the ocean level could rise 80 meters in 100 centuries.[275] However, if the oceans were to rise

three feet (one meter) in 100 years, then dike building around the world would become a major industry within sixty years.[276]

Glaciation has happened seven times over the past 2.2 million years. There were 100,000 year glacial cycles which occurred during the late Pleistocene, about one million to 10,000 years ago. The Earth experiences three types of variation in orbit: tilt of axis which ranges from 22 degrees to 24 degrees every 40,000 years (obliquity cycle); the eccentricity, (the Earth's orbital path varies, it cycles between circular to slightly ellipse every 100,000 years), and wobble (some time pointing at the North Star [Polaris]), every 23,000 years. The tilt of the Earth's axis has the greatest influence on weather, followed a distant second by eccentricity. Ice ages are due to change in the tilt of the planet in relation to the sun, which affects the amount of sunlight each hemisphere receives in its respective summer. The warmest weather occurs when the Earth's tilt is largest. During the late Pleistocene, glaciations did not recede every time the tilt was large but, in fact, glaciers grew over two (80,000) or three (120,000) obliquity cycles before ending (thus the 100,000 year time cycle for glaciations). Milutin Milankovitch (1897-1958), a Serbian astrophysicist, predicted the cycles mathematically in the 1930s based on the shape of the Earth's orbit and the tilt of the axis, and only recently have core samples from ocean floor confirmed them. The Earth's tilt is currently 23.5 degrees and decreasing – moving toward an ice age. With the melting of Greenland and Antarctic glaciers, it may be that climate change *is* over riding the next glaciation cycle.[277]

The Age of Enlightenment instituted the use of reason to determine what was right and good, and aimed at a future for humanity that was characterized by rationality, scientific investigation, improved technology and the progressive improvement of people's lives. This same use of science is now being used to undermine the legacy of the Enlightenment. In an effort to deceive the public about environmental issues, corporations have underwritten sophisticated disinformation campaigns. This has been occurring for years.

Wolfgang Wagner, the editor-in-chief of the climate science journal, *Remote Sensing*, resigned in August 2011 saying it was now apparent to him that a paper entitled *On the Misdiagnosis of Surface Temperature Feedbacks From Variations in the Earth's Radiant Energy Balance*, was "fundamentally flawed and therefore wrongly accepted by the journal." The authors of the paper in question were Roy Spencer and Danny Baswell.[278]

Dr. Spencer is a frequent scientific commentator appearing in the right wing media in the US criticising 'climate alarmism' and is the author of a book called *The Great Global Warming Blunder*. Fox News ran the story under the banner: Does NASA data show global warming lost in space? The controversy surrounding the paper resulted in 56,000 downloads from the Internet within one month of its publication in July 2011. The controversy in the paper was it purported to show how the Earth's atmosphere is more efficient at releasing energy into space than is programmed into the computer models used to forecast climate change.

The controversy around Spencer is illustrated by the following comments of John Abraham from the University of St Thomas's School of Engineering in Minnesota:

> "Spencer and his colleagues have a long history on minimizing the effects of human-caused climate change; they have a long history of making serious technical errors. This latest paper is only one in a decade-long track

record of errors that have forced Spencer to revise his work as the errors are brought to light."[279]

Wagner says he accepts criticism from other climate scientists, not because the paper is a minority view, rather the paper ignored the scientific arguments of its opponents, which is a major flaw in testing the paper's findings. Spencer countered that the controversy was caused by the IPCC (Intergovernmental Panel on Climate Change) putting pressure on the journal. In the end, the paper has not been retracted, but will exist to put pressure on climate change articles.[280]

The dinosaurs were one of the most successful animals to ever live on Earth. About 220 million years ago, at the boundary between the Triassic and the Jurassic ages, there was an extinction event over 10,000 years that opened up the age of dinosaurs. It occurred just before the breakup of the supercontinent, Pangaea, when most of the landmass straddled the equator. The dinosaurs lived on Earth for 165 million years, and, in turn, became extinct 65 million years ago at the end of the Cretaceous period. It is believed the crash of a meteor triggered the onset of this sudden event.

If you compress the time since the appearance of the dinosaurs until today into 365 days (one year), the dinosaurs appeared on January 1st and disappeared the third week of September. In this system, Earth would have been formed 18.5 years earlier. This extinction of the dinosaurs opened up an opportunity for a new wave of mammals which took over and dominated the Cenozoic era. This also coincided with expansion of flowering plants. In this comparison where the dinosaurs, the most successful terrestrial animals, were on Earth for 38 weeks, humans have been on Earth since December 31st, New Year's Eve.[281]

The most recent epoch or age is the Holocene, generally considered the last 11,000 years since the end of the last Ice Age. A group of geologists notes that human activity is responsible for irreversible changes that include habitat destruction and the introduction of invasive species, which are causing widespread extinctions, ocean acidification, (which is changing the chemical makeup of the seas), and urbanization, (which is vastly increasing rates of sedimentation and erosion). Models suggest that species have not disappeared at this rate since the extinction of the dinosaurs. In a paper published in 2010 in *Environmental Science and Technology,* the authors Jan Zalasiewicz, Mark Williams, Will Steffen and Paul Crutzen describe, "human activities are altering the planet on a scale comparable with major events of the ancient past. Some of these changes are now seen as permanent, even on a geological time-scale."[282] Barry Richards of the Geological Survey of Canada notes, "Human activities, particularly since the industrial revolution, are clearly having a major impact on the earth. We are leaving a clear and unique record."[283]

The name for the new era has been 'Anthropocene' coined by Paul Crutzen, 1995 Nobel prize winner for chemistry, in an article in 2000, based on effects of human activity on the planet. The debate is not whether dramatic changes have occurred in the last two hundred years, but where the geological boundary should be. One could use the increased carbon and methane at the beginning of the 18th century trapped in ice as the boundary, or the isotopes from the nuclear blasts of the 1940s, or wait another fifty to one hundred years when the effects on the world will be much more dramatic.[284]

There has been erosion in the genetic diversity of species, which threatens global food security. Biodiversity is essential for ensuring food security. In history several thousand plant

species have been used as human food. But now only 150 species are cultivated and no more than three grasses provide almost 60% of the calories and protein – rice, maize, and wheat.[285]

About 40% of the land in developing countries can be used for forage. Animals directly account for over 19% of the world's food basket. Worldwide the greatest threat to domestic animal diversity is the highly specialized nature of modern livestock production. In the developed world commercial livestock farming is based on very few breeds that have been selected for the intensive production of meat, milk or eggs in highly controlled and regulated conditions. The per capita consumption of pork in China has doubled since 1990. Three animal species account for over 90% of the meat products – pork for 36%, poultry for 33% and beef for 24%.[286]

Privately-owned business corporations are not designed to serve the public good. They are designed to maximize profit for share holders and the incentives are designed for senior executives to maximize their personal compensation. There is a requirement for institutions to be in place to provide rules for the game. The existing regulatory agencies need to focus on epigenetic harm. This means they need more information on the toxins that are in the environment along with genomic data to monitor the exposome. Change is continually occurring in industry, leading to changing pressures on the environment.

Agribusiness lobbied to allow the 'free market' to determine the price of corn and, in 1973, under President Nixon, the corn market was deregulated. During the 1970s with a world food shortage and extensive exports of grains to Russia, the system appeared to be working. Then market conditions changed. Due to the volatility of the price, farmers had to rely on subsidies. The price of corn in 2000 was the same as in 1970. The transition payments (subsidies) were delinked from production and price, which many believed would not distort markets or violate World Trade Organization laws. The Bush administration maintained the supports.

Monopolies occur with economies of scale in production or distribution. Farmers are squeezed by limited sources of corn seed and uncompetitive markets. Two companies dominate the corn seed market, three companies control 90% of the corn market and four companies control 85% of the high fructose corn syrup (HFCS) industry. Corporations made considerable profits processing corn to cattle feed and HFCS. Half of the corn is used for cattle feed. In the US, four companies slaughter 80% of the beef. Subsidies are not the disease, they are the symptoms of a broken system.

Not all socially relevant costs and benefits are taken into account by private decision-makers. The risks of the new system include no corn reserves (storage bins were eliminated in 1970s), leaving the world only one drought away from a seriously destabilized food system; increased speculation in the commodities market, and after two decades of cheap corn, corn is now found in most processed foods and the consumption of HFCS is widespread. The cost of chronic diseases determined with full cost accounting is staggering. Removing subsidies to the farmers will provide agribusiness with an even greater stranglehold on the farmer.[287]

The Enlightenment of the 21st century has re-established the need for questioning and scepticism of the status quo, and the requirement of science and evidenced-based analysis in decision-making. It is necessary to establish associations of outside agencies, such as universities to monitor information to control for the misinformation that corporations have

used in the past. The legacy of the Occupy Wall Street movement has been to identify extreme inequality as the hallmark of a dysfunctional economy, and highlight the failure of the legislators to protect 99% of the people.[288]

One can debate how fast the polar ice caps are melting, however, there is no debate on how fast debt is piling up. There is evidence that a population health intervention can deliver measurable results within five years. Lung cancer rates fell within five years of smoking rates declining. In Denmark, enforcement of a 2% trans fats in food saw deaths from heart disease have drop by 20%.[289] It is necessary to implement programs to control such foodstuffs as partially hydrogenated oil, high fructose corn syrup, excitotoxins and increase the availability of grain fed meat. These measures will start the reduction of cardiovascular diseases, diabetes and cancer rates. The development of the exposome will provide further answers to the epidemic of chronic diseases, including neurodegenerative disease.

The establishment of the exposome requires individuals to be tested at birth, in young adulthood and middle age. This is the preventative medicine of the 21st century. These will require sophisticated bioinformatic databases to determine the epigenetic effects, and would work better with a single payer option in the US. In other words, the collage of health insurance systems may not be the most effective way to introduce such a risk reduction program.

Chronic diseases account for seven out of ten deaths among Americans each year. Heart disease, cancer and stroke account for more than 50% of all deaths each year. In 2005, 133 million Americans – almost one out of every two adults – had at least one chronic illness.[290] The overall population is aging. For the first time in history, and probably for the rest of human history, people over age sixty-five outnumber children under age five. Non-communicable diseases are becoming an increasing burden on the health-care system. Chronic non-communicable diseases are now the major cause of death among older people in both more developed and less developed countries.[291] With an increasing older population, the adoption of changes to reduce the cost to the economy of chronic disease is paramount. These reduced costs will allow control of deficits and free up resources for increased expenditures in other public areas like infrastructure.

Thirty years of misinformation, that the second law of thermodynamics does not support evolution, has allowed the idea that there is still doubt about the theory. Using a law of physics to create uncertainty around evolution allows the introduction of concept control of complexity and aligns intelligent design of the religious right with the 'invisible hand' that directs the economy. This implies two invisible hands. Cognitive dissonance occurs when two unrelated facts are paired. A person desires to minimize their cognitive dissonance. Right wing blogs mention intelligent design and the 'invisible hand' in the same sentence. The close proximity of the remarks is designed to create a correlation in peoples' minds even when the reality is different. By insinuating, people subconsciously take the idea and turn it into a possibility. Through repetition, correlation becomes fact, based upon misinformation. They have succeeded in connecting a belief system that supported charity with a belief system that supports inequality.

There is a need for a clearinghouse of current science-vetted dietary information. The hydrogenated oils were once touted as more healthy than saturated animal fats, but are now known to be associated with chronic diseases. The other challenge is the transparency in packaging. Listing oils such as corn, soy, safflower or sunflower is not key; it is whether it is

partially hydrogenated, or hydrogenated. The other packaging challenge is the fact that food manufacturers can list the food as zero trans fats as long as it contains less than 0.5 grams of trans fats per single serving. However, if the package (of the product) contains six individual (single) servings, and all are consumed during the day, then one would have easily exceeded twice the daily recommendation for trans fats. In this manner a person is always exposed to trans fats when consuming a regular diet. The concern is that studies have associated processed foods containing hydrogenated oil[292] and corn syrup[293] with type 2 diabetes.

Type 2 diabetes was not described in medical literature until 1935. Basically it was diabetes that was not sensitive to insulin. Literature on treatment did not appear until the 1950s with the appearance of medication for treatment. At one time it was a disease of people over fifty years of age. Presently, type 2 diabetes constitutes 90% of the diabetes around the world, typically appearing after ten years of obesity. In the 21st century, type 2 diabetes is now appearing in significant numbers in individuals under thirty years of age. The significance of this is that the longer one has diabetes the more likely complications are to develop. This situation cries out for an immediate intervention.

The key for change is the delivery of a new social contract, along with a change in mindset. On an individual level, the equality of epigenetic actions provides the justice and fairness that allows many more to reach their potential. One of the consequences will be the narrowing of the income gap between rich and poor, with the result of more choices along the road of life in which one is in greater control.

What about the individual? Self care is about making decisions and taking action to improve your health, and to stay healthy. Typically it is about such things as the diet you eat, your physical activity, and nutritional supplements. These choices are not new. Such decisions may already make up 80% of your health care now. Presently, you think of these as helping you perform better on the job and helping avoid burn out.[294] Epigenetics brings another dimension to self care. Behaviour and environment can affect how genes are expressed. Epigenetics empowers people to take control of their health by making choices that may over-ride their genetic code, such as diet, exercise, and personal attitude. An individual needs to access this epigenetic information, thus, he requires access to health care for prevention, monitoring and treatment. Health care needs to be considered a type of protection; it maintains, or restores, functioning (capacity) that is normal for an individual.

Epigenetics is the interface between the environment and the genome. The epigenome highlights the effects of inequality in living and working conditions, as well as a range of disparities in access to health care and other social opportunities. Economic and social variables, more than individual and family behaviour, are the significant factors in determining a child's well-being. Investment in children – addressing toxic chemicals and air pollution – are part of the equation for saving future social dollars. Good equality is about incentives for people to study to work hard, to start risky entrepreneurial projects, while bad equality equates to a large income gap that is associated with more social problems, including poorer health.

The exposome will unravel the mysteries of how to maximize the use of nutrients and supplements for prevention in many cases, and for treatment in others. The data will illustrate the dominant role of environmental toxins as factors in chronic disease development. These observations will re-enforce the activities of environmental protection agencies. Understanding

how to incorporate epigenetics into the economic decision-making will be key to controlling chronic disease and reducing economic costs looming on the horizon.

The guiding principle of globalization is to maximize corporate profits through the promotion of consumerism. The main role of corporations is to reduce taxation while maintaining profits for shareholders. This mindset supports minimal government and regulations, pitting the philosophy of globalization against a new social contract that minimizes epigenetic harms. There is a need to regulate epigenetic harms to ensure fairness and justice of the social contract – everyone is ensured of an opportunity to develop their capabilities and life options.

As stated earlier, Rousseau's statement, "Man is born free, and everywhere he is in chains," is a reference to the social contract of his day.[295] He maintained the wealthy trick the poor into creating a government with the sole purpose of protecting their property and locking in moral inequality as a permanent feature of civil society. In this manner, the social contract is promoted as treating everyone equally, but in reality, it is in the interest of the few who have become stronger and richer. For Rousseau the income gap is a problem – the very rich and the very poor would value money more than liberty.

The increasing income gap between the rich and the middle class has become a source of concern today. Apologists point out that the rich are now paying a greater share of income tax – but that is because they are making more money. In England, it is claimed problems are occurring because of a recent rewrite of the social contract. The government wants people to be more self-reliant, and less reliant on government programs. One measure of this was the 2011 discontinuation of free university education which closed a route out of poverty, while unemployment doubled. The increased income inequality is similar to the US, affecting how people think about each other and society. This was the root cause of riots in August 2011 in England. Elizabeth Warren, a Harvard law professor, campaigning for the US senate in Massachusetts, made a vigorous defence that the rich got rich courtesy of the social contract, that provides society with the rules and laws that allow a functioning society to prosper. The news media on the right accuse her of encouraging class warfare. This is consistent with the observations of Thorstein Veblen, that is, the power of the wealthy to respond to minor challenges from new ideas as a constituency, and when they do, to claim the whole system is threatened. This class warfare label in the media, as such, is engineered over reaction.[296]

Antonio Gramsci (1891-1937), an Italian communist philosopher and thinker, developed the Theory on Cultural Hegemony to explain why workers in industrialized countries of Europe had not risen up in revolt against the capitalist system as predicted by Marx. Gramsci described cultural hegemony as a form of control by the dominant economic and ruling groups that consisted of permeation throughout society of an entire system of values, attitudes beliefs and morality. In industrial countries, hegemonic cultural tools, such as schooling curriculum, mass media, and popular culture, indoctrinate workers to a 'false consciousness.' Veblen described the invidious distinction attached to wealth driven by seeking status. The development of capitalism, Veblen believed, was in the direction of heightening the utility of conspicuous consumption, with the tendency of the middle and lower classes to emulate the rich. This supported the relationship between class, status, private property and social inequality. Occupy Wall Street protesters describe the concentration of wealth at the top as a system taking

advantage of the middle class. They identify the need to rebuild the crumbling social contract, broken by Wall Street.

Evolutionary economics is not to be used to shore up the status quo. Evolutionary economics is to replace the rational choices of profit maximizing and utility maximizing with the idea that firms and individuals make decisions in a habitual manner because their rationality has boundaries. Equality is more than the legal equality that Hayek sought. It is the equality that supports a new social contract to rebuild the middle class and strengthen democracy, with the participation of more individuals. Even in 1998, Gerald Celente, in his predictions in *trends 2000,* saw the increasing income gap being the cause of street unrest at the millennium, and the solution being the return back to a democracy from a plutocracy (government by the wealthy).[297] The debate is not about how fast the level of the ocean is rising, rather, how fast will we rise to the occasion to introduce changes in the new Age of Enlightenment. This is about introducing equality, justice and fairness so that it is not just a perception, but a reality, that the system is no longer gamed for those at the top. When the legislators begin to discuss the omega-6 ratio in food choices and endocrine disrupters in the environment, while addressing the obesity epidemic, we can celebrate that we have broken free from the past, and witnessed the answer: that relevant knowledge will set you free.

Works Cited

Advisory Committe on Popoulation Health. "Strategies for Population Health: Investing in the Health of Canadians." Meeting of the Ministers of Health. Halifax: Publications, Health Canada, 1994. 9-39.

Beattie, Alan. False Economy: A Surprising Economic History of the World. Toronto: Viking Canada 2009.

Bibiana Garcia-Bailo, Ahmed El-Sohemy, Pierre S Haddad, Paul Arora, Firas BenZaied, Mohamed Karmali, Alaa Badawi. "Vitamins D, C and E in the prevention of type 2 diabetes mellitus: modulation of inflammation and oxidative stress." Biologics: Targets and Therapy 5 (2011): 7-19.

Celente, Gerald. trends 2000: How to Prepare for and Profit from the Changes of the 21st Century. New York: Warner Books, Inc., 1997.

Dawkins, Richard. The Greatest Show on Earth: The Evidence for Evolution. New York: FREE PRESS, 2009.

Foster, Harold J., ed. An Outline of European Intellectual History Locke to Hegel. Toronto: Forum House, 1969.

Hewison, Martin. "Antibacterial Effects of Vitamin D." Nat. Rev. Endocrinol 7 (2011): 337-345.

Horsman, Greg. Objectivism Lost: And an Age of Disillusionment. Charlestown:Createspace. 2012.

Horsman, Greg. The Narcissist's Vocation and the Economic Debacle. Charlestown: Createspace. 2011.

Khan, Fazal. "Preserving human potential as freedom: a framework for regulating epigenetic harms." 22 March 2010. The Free Library. 11 October 2011. <http://www.thefreelibrary.com/_/print/PrintArticle.aspx?id=245952197>.

Klein, Naomi. No Logo Taking Aim at the Brand Bullies. Toronto: Vintage Canada Edition, 2000.

Kwak, Johnson Simon and James. 13 Bankers The Wall Street Takeover and the Next Financial Meltdown. New York: Pantheon Books, 2010.

North, Douglass C. "Institutions and Economic Theory." American Economist (1992): 3-6.

North, Douglass C . "Understanding the Process of Economic Change." Forum Series on the Role of Institutions in Promoting Economic Growth. Washington: Mercatus Center at George Mason University, 2003. 1-21.

Tarnas, Richard. The Passion of the Western Mind: Understanding the Ideas That Have Shaped Our World View. New York: Ballantine Books, 1991.

Veblen, Thorstein. The Theory of the Leisure Class: An Economic Study of Institutions. New York: The Macmillan Company, 1912.

Endnotes

[1] Corning, Peter. (1996) "Evolutionary Economics: Metaphor or Unifying Paradigm?" *Journal Of Social And Evolutionary Systems*, 18(4): 421-435 <http://www.complexsystems.org/essays/evolecon.html>.

[2] Lander, Health. (21 July 2011) "What are Enlightenment Values?" <www.dailykos.com/story/2011/07/21/997055/-What-Are-Enlightenment values>.

[3] Sui, D. Z. "Economy as Ecosystems."<http://www.eolss.net/Sample-Chapters/C15/E1-29-04-06.pdf>.

[4] Horsman, Greg. 2011 (242)

[5] Foster, Harold J. (89-90)

[6] Foster, Harold J. (73)

[7] Foster, Harold J. (93)

[8] "US History." <http://elcoushistory.tripod.com/economics1950.html>.

[9] Horsman, Greg. 2012 (39-40)

[10] Horsman. Greg. 2011 (12)

[11] Celente, Gerald. (261-263)

[12] "Protesters Against Wall Street." (9 October 2011) *The New York Times*. Rosenthal, Andrew ed. (p 10)

[13] Rothstein, Mark A, YU Cai and Gary E. Marchant. (1-3. 27)

[14] Horsman, Greg. 2012 (39-40)

[15] Bovard, James. (April 1998) "The Great Sugar Shaft." <http://www.fff.org.freedom/0498d.asp>.

[16] Khan, Fazal. (aug 2009) "Preserving Human Potential As Freedom: A Framework For Regulating Epigenetic Harms." <http://works.bepress.com/fazal_khan/3>.

[17] Khan, Fazal. (3)

[18] Wallis, Paul. (6 Oct 2009) "Epigenetics: A possible 'off switch' for diseases." <http://digitaljournal.com/article/280103 http://digitaljournal.com/article/280103>.

[19] "Epigenetics: DNA Isn't Everything." (12 April 2009) <http://www.sciencedaily.com/releases/2009/04/090412081315.htm>.

[20] The Canadian. (20 Nov 2011) "Epigenetics: Heritable changes in gene expression." <http://www.agoracosmopolitan.com/news/health/2011/11/20/1412.html>.

[21] Choi, Charles Q. (8 August 2007) "Great Mysteries: What causes Mass Extinctions?" <http://www.livescience.com/1752-greatest-mysteries-mass-extinctions.html>.

[22] "Stickleback Species Pairs." <http://www.env.gov.bc.ca/wld/documents/stickleback.pdf>.

[23] Shen, Helen. (04 April 2012) "Stickleback genomes reveal path of evolution." <http://www.nature.com/news/stickleback-genomes-reveal-path-of-evolution-1.10392>.

[24] "Irritants in Cigarette Plumes." *American Journal of Public Health.* Ayer H. E.and D. W. Yeager. 1982 Nov 72(11): 1283-5.

[25] "Tobacco, smoking and cancer: the evidence." <http://info.cancerresearchuk.org/healthyliving/smokingandtobacco/howdoweknow>.

[26] Johnson, George. "A Long Trail of Evidence Links Cigarette Smoking to Lung Cancer." On Science. 07 April 2000. <http://txtwriter.com/onscience/articles/smokingcancer2.html>.

[27] "A Fact Sheet on the Effects of Marijuana." <http://www.pbs.org/wgbh/pages/frontline/shows/dope/body/effects.html>.

[28] "What Causes Cancer?" <http://www.acereport.org/cause>.

[29] "The History of PCBs: When Were Health Problems Detected?" <http://www.foxriverwatch.com/monsanto2b_pcb_pcbs.html>.

[30] ibid

[31] ibid

[32] "Chlorine Gone Wild."<http://www.agentorangerecord.com/information/what_is_dioxin/>.

[33] "The History of PCBs: When Were Health Problems Detected?" <http://www.foxriverwatch.com/monsanto2b_pcb_pcbs.html>.

[34] "Agent Orange Compensation: Ottawa Reversing Rejection Of Dozens Of Rejected Claims After Outcry." <http://www.huffingtonpost.ca/2011/12/30/agent-orange-compensation-claims-ottawa_n_1176548.html>.

[35] ibid

[36] Rich, Murray. (2002) "How Aspartame Became Legal – The Timeline." <http://www.rense.com/general33/legal.htm

[37] "The NutraSweet Company." <http://www.nutrasweet.com/company.asp>.

[38] "The History of PCBs: When Were Health Problems Detected?" <http://www.foxriverwatch.com/monsanto2b_pcb_pcbs.html>.

[39] "Aspartame: The Shocking Story of the World's Best Selling Sweetener." <http://sunilkhemaney.wordpress.com/2009/03/21/aspartame-the-shocking-story-of-the-world%E2%80%99s-bestselling-sweetener/>.

[40] ibid

[41] Blaylock, Russel L. "Food Additive Excitotoxins and Degenerative Brain Disorders." <http://www.pands.org/hacienda/article27.html>.

[42] "Body Burden – The Pollution in Newborns." (14 July 2005) <http://www.icnr.com/articles/pollutioninnewborns.html>.

[43] Khan, Fazal. (17)

[44] Lawrence, B. Paige. "Changes in immune function and cellular development: Activation of the Aryl hydrocarbon receptor (AhR)" <http://lifesciences.envmed.rochester.edu/test/index.html>.

[45] Powers, Chris. "Epigenetic Effects." *International Journal of Epidemiology*. 20 Oct 2011.

[46] Rothstein, Mark A, Yu Cai and Gary E. Marchant. (27)

[47] "History of Lung Cancer." <http://www.lungcancer surgery.org/lung_cancer_history.htm>.

[48] Stocks, Percy. "Lung Cancer And Bronchitis In Relation to Cigarette Smoking And Fuel Consumption In Twenty Countries." *Brit. J. Prev. Soc. Med*. (1967), 21, 181-185.

[49] "A Brief History of Tobacco in Our Culture." <http://www.commed.uchc.edu/healthservices/mediaadvoc/sld006.htm>.

[50] "Masters of Manipulation: Tobacco-industry Tactics." <http://web.idrc.ca/en/ev-28826-201-1-DO_TOPIC.html>.

[51] "Nicotine: 1940s -1960s." <http://www.ash.org.uk/files/documents/ASH_100.pdf>.

[52] "Tobacco, Smoking and Cancer: the Evidence."<http://info.cancerresearchuk.org/healthyliving/smokingandtobacco/howdoweknow/>.

[53] "A Brief History of Tobacco." <http://www.cnn.com/US/9705/tobacco/history>.

[54] Thun, Michael J, S. Jane Henley and Eugenia E. Calle. "Tobacco use and cancer: an epidemiologic perspective for geneticists." *Oncogene* 21 October 2002, Volume 21, Number 48,7307-7325 <http://www.nature.com/?file=/onc/journal/v21/n48/full/1205807a.html>.

[55] "CSR I'M Lovin' It: When Corporate responsibility goes up in smoke." <http://csrimlovinit.weebly.com/phillip-morris.html>.

[56] "Corn Feeds the Profits of Agribusiness." (19 November 2010) <http://www.canadaandtheworld.com/cornsyup.html>.

[57] Parker, Hillary. (22 March 2010) "A sweet problem: Princeton researchers find that high-fructose corn syrup prompts considerably more weight gain." <http://www.princeton.edu/main/news/archive/S26/91/22K07/>.

[58] Flavin, Dana. "Metabolic Danger of High-Fructose Corn Syrup." *Life Extension Magazine.* Dec. 2008. <http://www.lef.org/magazine/mag2008/dec2008_Metabolic-Dangers-of-High-Fructose-Corn-Syrup_01.htm>.

[59] "High Fructose Corn Syrup: Killing Us Softly." <http://www.viewzone.com/highfructose.html>.

[60] Philopt, Tom. (19 August 2011) “USDA Scientist: Monsanto's Roundup Herbicide Damages Soil.” <http://motherjones.com/tom-philpott/2011/08/monsantos-roundup-herbicide-soil-damage>.

[61] Philpott, Tom. (30 August 2011) “Attack of the Monsanto Superinsect.” <http://motherjones.com/tom-philpott/2011/08/monsanto-gm-super-insects>.

[62] “GM food study was 'flawed.'”(18 May 1999) <http://news.bbc.co.uk/2/hi/science/nature/346651.stm>.

[63] Blaylock, Russell L. “Food Additive Excitotoxins and Degenerative Brain Disorders.” <http://www.jpands.org/hacienda/article27.html>.

[64] “Erin Brockovitch.” <http://festivals.iloveindia.com/mothers-day/movies/erin-brockovich.html>.

[65] “NASF Government & Industry Affairs Update.” <http://www.pfonline.com/articles/nasf-government-industry-affairs-update>.

[66] “EPA criticised for hexavalent chromium move.” (12 October 2010) <http://www.rsc.org/chemistryworld/News/2010/October/12101002.asp>.

[67] “Perfluorooctanoic Acid (PFOA) and Fluorinated Telomers.” <http://www.epa.gov/oppt/pfoa/pubs/pfoainfo.html>.

[68] “Toxic Chemicals And Children’s Environmental Health” (26 October 2010) U.S. Senate Committee On Environment And Public Works, Subcommittee On Superfund, Toxics, And Environmental Health. <http://www.hsdl.org/?view&did=14996>.

[69] “Pharmaceuticals and Personal Care Products in the Canadian Environment: Research and Policy Directions.” <http://www.ec.gc.ca/inre-nwri/default.asp?lang=En&n=C00A589F-1&offset=13&toc=show>.

[70] “Endocrine Disrupters.”<http://www.nrdc.org/health/effects/qendoc.asp>.

[71] Horsman, Greg 2012 (73-87)

[72] “Risk Management.” <http://www.drj.com/new2dr/w3_030.htm>.

[73] Wilde, Robert. “The Enlightenment.” <http://europeanhistory.aboutcom/od/thenineteenthcentury/a/eniightenment .htm>.

[74] Wilkins, John. (21 February 2003) “Darwin's Precursors and Influences.” <http://www.talkorigins.org/faqs/precursors/precurstrans.html>.

[75] “Human Intelligence: Francis Galton.” <http://www.indiana.edu/~intell/galton.shtml>.

[76] Dawkins, Richard. (62-63)

[77] Dawkins, Richard. (315)

[78] Dawkins, Richard. (248-250)

[79] Dawkins, Richard. (267)

[80] Chege, Nancy. (1995) “Lake Victoria: A Sick Giant.” <http://www.cichlid-forum.com/articles/lake_victoria_sick.php>.

[81] ibid

[82] Meyer, Stephen C. (18 May 2007) “Intelligent Design: The Origin of Biological Information and the Higher Taxonomic Categories.” <http://www.discovery.org/a/2177>.

[83] “The Fall of the Trilobita: Mass extinction at the end of the Permian.” (Feb. 2010) <http://www.trilobita.de/english/extinct.htm>.

[84] Dawkins, Richard. (352)

[85] Dawkins, Richard. (379)

[86] Dawkins, Richard. (385, 388-390)

[87] Martinez, J. L. and F. Baquero. “Mutation Frequencies and Antibiotic Resistance.” *Antimicrob Agents Chemother.* 2000 July; 44(7): 1771–1777 <http://www.ncbi.nih.gov/pmc/articles/PMC89960/>.

[88] Dawkins, Richard. (132-133)

[89] Rusbult, Craig. “An Introduction to Entropy-and-Evolution and The Second Law of Thermodynamics.” <http://www.asa3.org/ASA/education/origins/thermo.htm>.

[90] “Abraham de Moivre.” <http://www.gap-system.org/~history/Biographies/De_Moivre.html>.

[91] “Carl Friedrich Gauss.” <http://planetmath.org/encyclopedia/CarlFriedrichGauss.html>.

[92] “Jean Baptiste Lamarck.” <http://www.pbs.org/wgbh/evolution/library/02/3/l_023_01.html>.

[93] “On the Origin of Species 1859.” <http://www.integratedsociopsychology.net/Evolutionary_Basics/'OntheOriginofSpecies'1859.html>.

[94] Posenburg, Matt. “Thomas Malthus on Population.” <http://geography.about.com/od/populationgeography/a/malthus.htm>.

[95] “Herbert Spencer (1820-1903).” *Internet Encyclopedia of Philosophy* <http://www.iep.utm.edu/spencer/>.

[96] ibid

[97] Pant, Nalini. “Spencer’s Theory of Rights.” <http://yabaluri.org/TRIVENI/CDWEB/spencerstheoryofrightsapr69.htm>.

[98] “Social Darwinism.” <http://library.thinkquest.org/C004367/eh4.shtml>.

[99] Horsman, Greg 2012 (62)

[100] Horsman, Greg 2012 (85-87)

[101] Foster, Harold J. (104)

[102] "History of the Free Will Problem." <http://www.informationphilosopher.com/freedom/history/>.

[103] ibid

[104] ibid

[105] ibid

[106] Younkins, Edward W. "Herbert Spencer on Liberty and Human Progress" <http://rebirthofreason.com/Articles/Younkins/Herbert_Spencer_on_Liberty_and_Human_Progress.shtml>.

[107] "Economy of the European Union." <http://en.wikipedia.org/wiki/Economy_of_the_European_Union>.

[108] "Herbert Spencer." <http://www.pbs.org/wgbh/amex/carnegie/peopleevents/pande03.html>.

[109] "People & Events: John D. Rockefeller Senior, 1839-1937." <http://www.pbs.org/wgbh/amex/rockefellers/peopleevents/p_rock_jsr.html>.

[110] "John D. Rockefeller." <http://www.spartacus.schoolnet.co.uk./USArockefeller.htm>.

[111] Veblen, Thorstein. (30)

[112] ibid

[113] Horsman, Greg. 2011 (201)

[114] Veblen, Thorstein. (26)

[115] Aydon, Cyrill. "A Brief History of Mankind: 150,000 years of Human History." Running Press Book Publishers: Philadelphia. 2009 (289-290)

[116] Veblen, Thorstein. (36)

[117] Horsman, Greg. 2011 (12)

[118] "Class Act: You Are What You Buy." <http://www.fyiliving.com/mental-health/anxiety/class-act-you-are-what-you-buy/>.

[119] Veblen, Thorstein. (85)

[120] Veblen, Thorstein. (110)

[121] Veblen, Thorstein. (116)

[122] Veblen, Thorstein. (191)

[123] Veblen, Thorstein. (192-193)

[124] Veblen, Thorstein (193)

[125] Veblen, Thorstein. (198)

[126] Veblen, Thorstein. (199)

[127] Porter, Eduardo. (29 Oct 2011) "Wall Street Protesters Hit the Bull's-Eye" <http://www.nytimes.com/2011/10/30/opinion/sunday/wall-street-protesters-hit-the-bulls-eye.html>.

[128] Veblen, Thorstein. (200)

[129] Veblen, Thorstein. (201-202)

[130] Veblen, Thorstein. (203)

[131] Veblen, Thorstein. (204)

[132] Veblen, Thorstein. (205)

[133] Veblen, Thorstein. (117-118)

[134] Veblen, Thorstein. (188)

[135] Veblen, Thorstein. (221)

[136] Veblen, Thorstein. (233)

[137] Veblen, Thorstein. (243-244)

[138] Grant, Tavia. 13 Sept 2011 "Income inequality rising quickly in Canada." <http://www.theglobeandmail.com/report-on-business/economy/economy-lab/daily-mix/income-inequality-rising-quickly-in-canada/article2163938/>.

[139] "Lichens." <http://www.countrysideinfo.co.uk/fungi/lichens.htm>.

[140] "Zooxanthellae and Corals." <http://www.algone.com/aquarium-articles/saltwater-aquarium/zooxanthellae-and-corals>.

[141] ibid

[142] "The Social Lives of Bees." <http://beespotter.mste.illinois.edu/topics/social/>

[143] "Behavior of Ants." <http://biology.arizona.edu/sciconn/lessons2/shindelman/background.html>.

[144] "Canada Goose." <http://www.allaboutbirds.org/guide/Canada_Goose/lifehistory/ac>.

[145] Wade, Nicholas. "New View of How Humans Moved Away From Apes." 10 March 2001 *The New York Times* Reprint <http://www.nytimes.com/2011/03/11/science/11kin.html>.

[146] Kiem, Brandon. (June 24, 2009) "Altruism's Bloody Roots." <http://www.wired.com/wiredscience/2009/06/altruism/#>.

[147] ibid

[148] Keim, Brandon. (20 April 2011) “Gut-Bacteria: Mapping Finds Three Global Varieties.“ <http://www.wired.com/wiredscience/2011/04/gut-bacteria-types/>.

[149] O’Keefe, Stephen J. et al. “Why Do African Americans Get More Colon Cancer than Native Africans?” The American Society for Nutrition *J. Nutrition*. 137:175S-182S, January 2007.

[150] Grant, Bob. (26 October 2011) “How Probiotic Yogurt Works.” *The Scientist.* <http://the-scientist.com/2011/10/26/how-probiotic-yogurt-works/>.

[151] “Pesticide Profile – Glyphosate.” <http://www.abcbirds.org/abcprograms/policy/toxins/profiles/glyphosate.html>.

[152] Tasker, Fred. “Pulled Teeth Stored for Stem Cells.” <http://www.miamiherald.com/2011/01/17/2020617/pulled-teeth-stored-for-stem-cells.html>.

[153] Fleming, Nic and Ian Sample. (6 November 2011) “Stem Cells Transformed into Brain Cells to Treat Parkinson's Disease” <http://www.guardian.co.uk/science/2011/nov/06/stem-cells-brain-parkinsons-disease?newsfeed=true>.

[154] “Stem Cell Approach Primes Immune System to Fight Cancer.” <http://medicalxpress.com/news/2011-11-stem-cell-approach-primes-immune.html

[155] Dawkins, Richard. (406-407)

[156] Wade, Nicholas. (10 March 2011) “New View of How Humans Moved Away From Apes.” <http://www.nytimes.com/2011/03/11/science/11kin.html>.

[157] MMWR July 30, 1999. 48(29) 621-629.

[158] Murray, Josh. “Space Age Terra Firma.” <http://www.depts.ttu.edu/communications/vistas/archive/01-summer/stories/space.php>.

[159] Cobb, Matthew. “Why Evolution is True: The Great Oxidation Event.” <http://whyevolutionistrue.wordpress.com/2009/04/12/the-great-oxidation-event/>

[160] “Great Oxidation Event.” <http://en.wikipedia.org/wiki/Great_Oxygenation_Event>.

[161] “Micronutients – Maintaining the Oxygen Balance in your Brain.” <http://www.fi.edu/learn/brain/micro.html>>

[162] Brégeon D,Peignon, PA, Sarasin A. “Transcriptional Mutagenesis Induced by 8-Oxoguanine in Mammalian Cells.” PLoS Genet 5(7): e1000577. doi:10.1371/journal.pgen.1000577 <http://www.plosgenetics.org/article/info%3Adoi%2F10.1371%2Fjournal.pgen.1000577>.

[163] Krinsky, Norman I. “Overview of Lycopene, Carotenoids, and Disease Prevention.” <http://ebm.rsmjournals.com/content/218/2/95.extract>.

[164] “What the Trans Fat Story Can Teach Us About Oxidized Cholesterol.> <http://www.integratedsupplements.com/articles/Newsletter200701.pdf>.

[165] "Flaxseed and Health." <http://www.healingdaily.com/detoxification-diet/flaxseed.htm>.

[166] "Preventing Heart Disease." (7 Sept 2011) <http//www.rootnaturalhealth.wordpress.com/2011/09/07/.pdf

[167] "Atherosclerosis and Cardiovascular Disease."<http//www.lef.org/protocols/heart_circulatory?coronary-artery-disease-atherosclerosis_01.htm>.

[168] Garcio-Bailo, Bibiana. et al. (8-9)

[169] Akst, Jef. (27 January 2012) "Chemicals Undermine Vaccine?" <http://the-scientist.com/2012/01/27/chemicals-undermine-vaccines/>.

[170] "Glutathione Therapy." <http://www.drhoffman.com/page.cfm/197>.

[171] Hallwell, Barry. "Aging and Disease: from Darwinian Medicine to Antioxidants." *The Singapore Magazine of Research, Technology and Education,* vol. 4 No. 2. <www.inovationmagazine.com/innovation/V4N2/coverstory1.shtml>.

[172] Hewison, Martin. (337-338)

[173] Hewison, Martin. (340-343)

[174] Garcia-Bailo, Bibiana, El-Sohemy, Ahmed, Haddad, Pierre S. et al. (12)

[175] Beck, Leslie. (11 October 2011) "Vitamin-E Supplements Linked to Prostate Cancer." <http://www.theglobeandmail.com/life/health/new-health/health-nutrition/leslie-beck/vitamin-e-supplements-linked-to-prostate-cancer/article2197389/>.

[176] Garcia-Bailo, Bibiana, El-Sohemy, Ahmed, Haddad, Pierre S. Et al. (13)

[177] "Foods that Boost Immunity." <http://www.askdrsears.com/topics/family-nytrition/foods-boost-immunity/>.

[178] "Why Did Sugar Became the Chief Crop of the West Indies in the Second Half of the Seventh century?" <http://wiki.answers.com/Q/Why_did_sugar_became_the_chief_crop_of_the_west_indies__in_the_second_half_of_the_seventh_century#ixzz1iKZzuaP6>.

[179] Holick, Micheal F. "The Vitamin D Deficiency Pandemic: a Forgotten Hormone Important for Health." *Public Health Reviews.* 2010;32:267-283.<http://www.publichealthreviews.eu/show/f/35>.

[180] Peed, Mike. "(10 January 20110 "We Have No Bananas." <http://www.newyorker.com/reporting/2011/01/10/110110fa_fact_peed>.

[181] Koeppel, Dan. (22 July 2011) "The Beginning of the End for Bananas?" <http://the-scientist.com/2011/07/22/the-beginning-of the-end-for-bananas>.

[182] Ananda, Randy, (24 August 2011) "Monsanto GM corn in peril: Beetle develops Bt resistance." <http://www.thepeoplesvoice.org/TPV3/Voices.php/2011/08/24/monsanto-gm-corn-in-peril-beetle-develop>.

[183] Poulter Sean (20 May 2011) “GM food toxins found in the blood of 93% of unborn babies.” <http://www.dailymail.co.uk/health/article-1388888/GM-food-toxins-blood-93-unborn-babies.html#ixzz1iKrMPFhn>.

[184] Garcia-Bailo, Bibiana. (8)

[185] “Excessive Intake of Omega 6 and Deficiencies in Omega 3 Induce Obesity Down the Generations.” (26 July 2010) <http://www.sciencedaily.com/releases/2010/07/100726221737.htm>.

[186] “Eating Processed Meats, but Not Unprocessed Red Meats, May Raise Risk of Heart Disease and Diabetes.” (17 May 2010) <http://www.hsph.harvard.edu/news/press-releases/2010-releases/processed-meats-unprocessed-heart-disease-diabetes.html>.

[187] Christensen, Stephen Allan. (2 Aug 2010) “High Fructose Corn Syrup, Metabolic Syndrome, and Obesity.” <http://www.suite101.com/content/high-fructose-corn-syrup-metabolic-syndrome-and-obesity-a270149#ixzz1NVxlf3oq>.

[188] Yang, Gary. “Our Sweet Ending: Health Consequences With High Fructose Corn Syrup Consumption.” (2011) <http://www.scq.ubc.ca/our-sweet-ending-healthconsequences-with-high-fructose-corn-syrop>.

[189] Flavin, Dana. “Metabolic Danger of High-Fructose Corn Syrup.” (December 2008) <http://www.lef.org.magazine/may2008/dec2008Metabolic-Dangers-of-High-Fructose-Corn-Syrup_01.htm>.

[190] “Diets may determine dementia risk.” (12 April 2010) <http://news.bbc.co.uk/2/hi/8615456.stm>.

[191] “Secondhand Smoke: Tobacco Industry Attacks.” (August 2004) <http://www.no-smoke.org/document.php?id=278>.

[192] Kovarik, William. (26 March 2003) “ Ethyl: The 1920s Environmental Conflict Over Leaded Gasoline and Alternative Fuels.” <http://www.radford.edu/%7Ewkovarik/papers/ethylconflict.html#_ftn8>.

[193] “Tetraethyllead.” *Wikepedia The Free Encyclopedia.* <http://en.wikipedia.org/wiki/Tetraethyllead>.

[194] “About Bees, Habitat and Coevolution.” <http://resonatingbodies.wordpress.com/resources/intro-to-bees>.

[195] Philapot, Tom. (21 Jan 11) “Top USDA bee researcher also found Bayer pesticide harmful to honeybees.” <http://www.grist.org/article/2011-01-21-top-USDA-bee-researcher-also-found-Bayer-pesticide-harmful>.

[196] “Impaired Waters.” <http://checkmylake.org/lake/facts/?id=170>.

[197] “Mercury Hot Spots of North America.” <http://www.cec.org/Page.asp?PageID=122&ContentID=2500&SiteNodeID=457>.

[198] Austin, Paul. (31 may 2001) “Less Mercury and Less Asthma.” *StarTribune*. <http://www.startribune.com/local/yourvoices/122869978.html>.

[199] “Global Water Shortage Looms In New Century.” <http://ag.arizona.edu/AZWATER/ awr/dec99/Feature2.htm>.

[200] “Aldrin / Dieldrin.” <http://www.epa.gov/pbt/pubs/aldrin.htm>.

[201] "PCBs." <http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/pcb-bpc-eng.php>.

[202] Tarantino, John. (5 April 07) "Lake Victoria, Africa's Largest freshwater Lake suffering from Overfishing." <http://www.theenvironmentalblog.org/2007/04/lake-victoria-africas-largest-freshwater-lake-suffering-from-overfishing/>.

[203] Kristoff, Nicholas D. (27 June 09) "It's Time to Learn From Frogs." <http://www.nytimes.com/2009/06/28/opinion/28kristof.html?_r=1>.

[204] Beck, Leslie. (26 May 2001) "Eat more salads – your brain will thank you." *Globe and Mail* <http://www.theglobeandmail.com/life/health/new-health/conditions/brain-health/eat-more-salads-your-brain-will-thank-you/article1534048/print/>.

[205] "Exposome and Exposomics." <http://www.cdc.gov.niosh/topics/exposome/>.

[206] ibid

[207] "Donald Rumsfeld, and the infamous "known knowns, known unknowns, and unknown unknowns" quotation." (8 November 2006) <http://stevespeeves.wordpress.com/2006/11/09/donald-rumsfeld-and-the-infamous-known-knowns-known-unknowns-and-unknown-unknowns-quotation/>.

[208] Bennet, John. "Orwell's 1984: Was Orwell Right?" <http://www.ihr.org/jhr/v06/v06p--9_Bennett.html>.

[209] Stiglitz, Joseph. "Inequality: Of the 1%, by the 1%, for the 1%." <http://www.vanityfair.com/society/features/2011/05/top-one-percent-201105>.

[210] Stiglitz, Joseph E. (May 2011) "Inequality Of the 1%, by the 1%, for the 1%." <http://www.vanityfair.com/society/features/2011/05/top-one-percent-201105>.

[211] "Roman Religion." <http://www.unrv.com/culture/roman-religion.php>.

[212] Tarnas, Richard. (158-160)

[213] Tarnas, Richard. (118)

[214] Horsman, Greg 2010 (52)

[215] "VOC Organization." <http://www.tanap.net/content/voc/organization/organization_intro.htm>.

[216] "The Betrayal of Adam Smith." <http://deoxy.org/korten_betrayal.htm>.

[217] Johnson, Simon and James Kwak. (92-93)

[218] Johnson, Simon and James Kwak. (92)

[219] "Clinton Signs Legislation Overhauling Banking Laws." (13 November 1999) *The New York Times.* <http://www.nytimes.com/1999/11/13/business/clinton-signs-legislation-overhauling-banking-laws.html>.

[220] "Enron." *New World Encyclopaedia.* <http://www.newworldencyclopedia.org/entry/Enron>.

[221] Beattie, Alan. (300-301)

[222] Kliman, Richard, Bob Sheehy and Joanna Schultz. “Genetic Drift and Effective Population Size.” <http://www.nature.com/scitable/topicpage/genetic-drift-and-effective-population-size-772523>.

[223] Pray, L. (2008) “Genetic drift: bottleneck effect and the case of the bearded vulture.” *Nature Education* 1(1) <http://www.nature.com/scitable/topicpage/genetic-drift-bottleneck-effect-and-the-case-1118>.

[224]Johnson, Simon and James Kwak. (220-221)

[225] Johnson, Simon and James Kwak. (219-220).

[226] Curley, Chris. (26 January 2012) “Study Bolsters Link Between Fructose and Teens’ Cardiovascular Risk.” <http://wellbeingwire.meyouhealth.com/physical-health/study-bolsters-link-between-fructose-and-teens-cardiovascular-risk/>.

[227] “Equality, Inclusion and the Health of Canadians Submission to the Commission on the Future of Health Care in Canada.” Canadian Council on Social Development November 15, 2001.

[228] “Rio Declaration on Environment and Development.” <http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163>.

[229] “Canadian Environmental Protection Act, 1999.” <http://ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=24374285-1&offset=1&toc=show>

[230] Khan, Fazal. (17)

[231] “The Declaration of Independence and Natural Rights.” <http://www.crf-usa.org/foundations-of-our-constitution/natural-rights.html>.

[232] Horsman, Greg. 2012 (55)

[233] “Social Contract Theory.” <http://www.iep.utm.edu/soc-cont/>.

[234] “The Social Contract: Jean-Jacques Rousseau.” <http://www.sparknotes.com/philosophy/socialconteact/section6.rhtml>.

[235] “Jean-Jacques Rousseau.” <http://www.malaspina.org/rousseauj.htm>.

[236] Verhaegh, Marcus. (2004) “Kant and Property Rights.” <http://mises.org/journals/jls/18_3/18_3_2.pdf - United States>.

[237] “What is the Myth of ‘Natural Law’?” <http://anarchism.pageabode.com/afaq/append1311.html>.

[238] Hayek, Friedrich A. “Equality, Value and Merit.” <http://www.woldww.net/classes/General_Philosophy/Hayek-equality.htm>.

[239] ibid

[240] “The Affluent Society, by John Kenneth Galbraith.” <http://makewealthhistory.org/2008/06/24/the-affluent-society-by-john-kenneth-galbraith>.

[241] "John Kenneth Galbraith, 1908-2006." <http://www.qotd.org/search/search.html?aid=3171&page=2>.

[242] Furman, Jason. (12 June 2007) "Interrogating inequality." *The Economist.* <http://www.economist.com/blogs/freeexchange/2007/06/interrogating_inequality_1>.

[243] ibid

[244] North, Douglass C. "Institutions, Institutional Change, and Economic Performance." <http://www.gotterdammerung.org/books/reviews/i/institutions-institutional-change-and-economic-performance.html>.

[245] Rosenblum, Bruce and Fred Kutter. *Quantum Enigma: Physics Encounters Consciousness*. Oxford University Press: Oxford, p. 37.

[246] Khan, Fazal. (1)

[247] Tarnas, Richard. (320)

[248] Von Wartburg, Linda. (12 September 2007) "Another Link in the Chain to Type 2 Diabetes." <http://www.diabeteshealth.com/read/2007/09/11/5430/high-fructose-corn-syrup-another-link-in-the-chain-to-type-2-diabetes/>.

[249] Christensen, Stephen Allan (4 Aug 2010) "High Fructose Corn Syrup, Metabolic Syndrome, and Obesity " Suite101.com <http://www.suite101.com/content/high-fructose-corn-syrup-metabolic-syndrome-and-obesity-a270149#ixzz1NVvyRpZK>.

[250] Solomon, Deborah, Tracy, Tennille and Jared A Favole. "Obama asks EPA to backtrack on ozone rule." *Globe and Mail: Report on Business*. 3 September 2011 (B4)

[251] Evans, Edward W. (Feb 1993) "What are the indirect costs of Pesticide Use?" <http://extension.usu.edu/files/factsheets/indirect.pdf>.

[252] Mirolla, Michael. "The Cost of Chronic Disease in Canada." (2004) <http://www.gpiatlantic.org/pdf/health/chroniccanada.pdf>.

[253] "The High Cost of Health Care." (Nov 25 2007) <http://www.nytimes.com/2007/11/25/opinion/25sun1.html?pagewanted=1>.

[254] Horsman, Greg. 2011 (124)

[255] "A Critique of the Austrian School of Economics: The Scientific method." Kingas, Steve (ed.) <http://www.huppi.com/kangaroo/L-aussm.htm>.

[256] "Million Hearts: Strategies to Reduce the Prevalence of Leading Cardiovascular risk factors – United States, 2011." *MMWR*. 16 September 2011 Vol. 60 No. 36 (p 1248-1251)

[257] "Meat Consumption and Cancer Risk." <http://www.cancerproject.org>.

[258] "Trans Fatty Acids Hydrogenated & Partially Hydrogenated Oils: Proven Serious Health Effects." <http://www.purica.com/holistic_living/healthy_lifestyle/diet_and_nutrition/hydrogenated_oils.htm>.

[259] Beck, Leslie. (26 May 2001) "Eat more salads – your brain will thank you." *Globe and Mail* <http://www.theglobeandmail.com/life/health/new-health/conditions/brain-health/eat-more-salads-your-brain-will-thank-you/article1534048/print/>.

[260] "The Capability Approach." (14 April 2011) *Standford Encyclopedia of Philosophy.* <http://plato.stanford.edu/entries/capability-approach/>.

[261] "State-specific Trends In Lung Cancer Incidence and Smoking – United States, 1990-2008." *MMWR* 16 September 2011 Vol. 60 No. 36. (p 1243-1247)

[262] Lipton, Bruce H. "The Human Genome Project." <http://www.money-health-relationships.com/human-genome-project.html>.

[263] "Lionel Robbins, Baron Robbins." <http://en.wikipedia.org/wiki/Lionel_Robbins,_Baron_Robbins>.

[264] Khan, Fasal. (22 March 2010) "Preserving human potential as freedom: a framework for regulating epigenetic harms." <http://www.threfreelibrary.com/_/print/PrintArticle.aspx?id=245952197>.

[265] Scott-Thomas, Caroline. (26 April 2010) <http://www.foodnavigator-usa.com/Business/Foods-with-artificial-trans-fats-should-be-considered-adulterated>.

[266] Askt, Jef. (27 January 2012) "Chemicals Undermine Vaccines?" <http://the-scientist.com2012/01/27/chemicals-undermine-vaccines/>.

[267] "Is Toxic Chemicals Reform on the Horizon?" <http://www.edf.org/health/chemicals/our-scientist-works-reform-chemicals-policy>.

[268] "Exposome and Exposomics." <http://www.cdc.gov/niosh/topics/exposome/>.

[269] Glicksman, Robert L. (September 2009) "The Advantages of Technology-Based Standards in Protecting Health, Safety, and the Environment." <http://www.progressivereform.org/perspstatutory.cfm>.

[270] Daniells, Stephen. (25 March 2011) "Is Epigenetics the 'Means' to Achieving Nutrition's Potential?" <http://www.nutraingredients-usa.com/Research/Is-epigenetics-the-means-to-achieving-nutrition-s-potential>.

[271] Johnson, Simon and James Kwak. (214-218)

[272] "What Determines Health?" <http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php>.

[273] Strategies for Population Health (12)

[274] "Are poor people less likely to be healthy than rich people?" <http://www.phac-aspc.gc.ca/ph-sp/determinants/qa-qr1-eng.php>.

[275] Poore, Richard Z, Richarrd S. Williams and Christopher Tracy. (Sept 2011) "Sea Level and Climate." <http://pubs.usgs.gov/fs/fs2-00/>.

[276] "Global Warming and Rising Sea Levels." <http://factsanddetails.com/world.php?itemid=2102&catid=52&subcatid=328>.

[277] Dawicki, Shelly (28 March 2005) “Changes in Earth's Tilt Control When Glacial Cycles End: Tilt is a 100.000-year Planetary Pacemaker.” <http://www.whoi.edu/page.do?pid=9779&tid=282&cid=3638&ct=162>.

[278] Hickman, Leo. (2 September 2011) “Journal editor resigns over 'flawed' paper co-authored by climate sceptic.” <http://www.guardian.co.uk/environment/2011/sep/02/journal-editor-resigns-climate-sceptic-paper>.

[279] ibid

[280] Hickman, Leo. “Editor resigns over ‘flawed’ paper.” *The Globe and Mail* 3 September 2011 (a15).

[281] “Are All Fossil Animals Dinosaurs?” <http://www.scienceviews.com/dinosaurs/dinofacts.html>.

[282] Kolbert, Elizabeth. (17 May 2010) “The Anthropocene Debate: Marking Humanity’s Impact.” <http://e360.yale.edu/content/print.msp?id=2274>.

[283] ibid

[284] ibid

[285] Tillman, Dave. “Global environmental impacts of agricultural expansion: The need for sustainable and efficient practices.” <http://www.pnas.org/content/96/11/5995.full>.

[286] “Sources of Meat.” <http://www.fao.org/ag/againfo/themes/en/meat/backgr_sources.html>.

[287] “The Facts Behind King Corn.” <http://www.nffc.net/Learn/Fact%20Sheets/King%20Corn%20Fact%20Sheet.pdf>.

[288] “Protesters Against Wall Street.” *The New York Times*, 9 October 2011 (p 10)

[289] Scott-Thomas, Caroline. (26 April 2010) “Foods With Artificial Trans fats Should be Considered Adulterated.” <http://www.foodnavigator-usa.com/Business/Foods-with-artificial-trans-fats-should-be-considered-adulterated>.

[290] “Chronic Disease and Health Promotion.” <http://www.cdc.gov/chronicdisease/overview/index.htm>.

[291] “Why Population Aging Matters: A Global Perspective.” Summit on Global Aging March 15, 2007. National Institute on Aging NIH U.S. Department of Health and Human Services.

[292] Dewey, David Lawrence. “Hydrogenated Oils-Silent Killers.” (1998) <http://everist.org/archives/conspiracy/medical/Hydrogenated_oils/20070102_Hydrogenated%20Oils-The%20Silent%20Killers.htm>.

[293] “Increased consumption of refined carbohydrates and the epidemic of type 2 diabetes in the United States: an ecologic assessment.” *American Journal of Clinical Nutrition.* Vol. 79, No. 5, 774-779, May 2004 <http://www.ajcn.org/content/79/5/774.long>.

[294] Horsman, Greg (2011) (212-213)

[295] “The Social Contract: Jean-Jacques Rousseau.” <http://www.sparknotes.com/philosophy/socialconteact/section6.rhtml>.

[296] Veblen, Thorstein. (201-202)

[297] Celente, Gerald. (265)