Wells, Spencer. *Pandora's Seed: The Unforeseen Cost of Civilization*. New York: Random House, 2010.

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[Pandora]. From Olympus, Pandora received a box into which each god had put something injurious. They bade her never to open it. Epimethius took Pandora as wife from Zeus, though Prometheus warned Epimethius to take nothing from the chief of gods. Pandora opened the box and the world's suffering and misery escaped to hide in every crook of the earth. Hope was the only good the box contained. That, after Pandora's foolishness, is mankind's solace.

Foreword. Humans emerged as a species in Africa less than 200,000 years ago, and migrated to the rest of the world within the last 60,000 years. Wells researches how humans populated the planet. Our world is in flux; there is a great deal of disease. We may not have adapted well when we domesticated our food supply.

One: Mystery in the Map. Wells traveled to Chicago to speak with Jonathan Pritchard about his new method for examining evolutionary selection in the human genome. Genes resembled beads on a string. When passed from parent to child, the beads shuffle (recombine). In recombination, some genes are mis-copied leading to genetic variation. Some of these variations help the child live to reproduce; most do not. Pritchard's new method identifies gene combinations that should have been recombining, but are not. These sections appear fixed, which means they have been recently selected. All such sections have fixed in the last 10,000 years, which means the period of domestication has been a period of strong evolutionary selection.

Humans are a new species, only 195,000 years old. Human population was stable until 80,000 years ago, at which time it plummeted. Around 70,000 years ago, the global human population averaged around 2,000 people. At 60,000 years ago, the population started growing. In the next 45,000 years humans populated the globe. Then, 10,000 years ago, population spiked with the introduction of agriculture.

The plants and animals we modified appear to have modified us, even at the genetic level. Our skin pigmentation has diversified, the ability to metabolize milk as adults has spread, and the ability to metabolize alcohol spread. Many of our chronic diseases (hypertension, diabetes) may relate to the transition from hunting to agriculture. Using pelvic index, height, and life span as measures, Paleolithic hunter-gatherers' health was twenty-two percent better than Neolithic farmers. Why did the farmers prevail?

Two: Growing a New Culture. Wells visits a Norwegian Atlantic salmon farm where the fish flesh is stained with astaxanthin, a complex chemical, to make it look pink like the flesh of wild Atlantic salmon. Aquaculture is the last great domestication wave; what is happening now mirrors what happened in the Neolithic agricultural revolution. Wells tells of the crash of global fish populations due to over-fishing by telling of the catch of the fishing people of the Mediterranean island, Kerkennah. Their take has fallen ninety percent in the last twenty years. Fish farming produces only a quarter of all seafood consumed. We are still hunter-gatherers in the oceans. Twenty-nine percent of ocean fisheries are in collapse. Aquaculture will soon, of necessity, replace hunting and gathering fish.

Agriculture emerged when the Middle East became warmer and wetter at the end of the last ice age (Childe). We now know that the period 10,000 to 15,000 years ago vacillated warmer and colder. The longest cold spell in Europe, a thousand years commencing around 12,700 years ago, is named the Younger Dryas, which was caused by the collapse of the ice dam in North America that held back the waters of Lake Agassiz, covering much of central Canada. The vast volume of fresh water disrupted the Gulf Stream, leaving Europe colder. Wells speculates that the Middle Eastern Natufian culture had grown too populous to return to hunting and gathering, and so someone (probably a woman around 12,000 years ago) thought to plant next to the village

rather than roam the highlands (to which the natural grains were retreating as the land dried). Humans pressed the large mammals to extinction in each region they entered. Agriculture emerged independently at several mountainous global locations: south China, Mesoamerica, New Guinea, as well as the Fertile Crescent. Skeletal remains show, in their carbon 13 ratios, the arrival of domesticated corn. Rice shows the same pattern as barley and corn. At the end of the ice age, the grains were plentiful in valleys. Human populations expanded in the favorable conditions. The Younger Dryas chilled and dried the valley environments. Grains retreated to mountains where rains fell. Valley-dwelling humans planted what they formerly gathered. Agriculture ensued. The final step of agriculture is domestication, which consists in the ability to grow more of a crop without inputs from wild stocks and improve the qualities of the stock that make it a good food source.

Wells describes innovations in cultivating halibut. Wheat, rice, and corn have been adaptable to domestication for several reasons. First, they have duplicate chromosomes (polyploidy). Second, they have high rates of natural mutation, leading to many variations from which a farmer might choose. Wells illustrates the tremendous energy ancient farmers invested in making corn from teosinte. In changing the human diet, we unleashed strong selection pressures upon ourselves, with some fateful results.

Agriculture increased food, which increased population. The settled life meant one could not solve conflicts by leaving, so governments arose. Hunter-gatherer societies were relatively egalitarian. As numbers increased, so too did formal religion and social stratification. Venus figurines abounded in the Upper Paleolithic communities, perhaps honoring women's role in birth and domestication. Larger scale agriculture required moving to plains and building irrigation systems, a communal labor-intensive exercise requiring administration and maintenance efforts. Wealthy sedentary villages would present a target for predatory neighbors. Armies emerged to protect accumulations. Fighting would have elevated the status of men.

With agriculture came the ability to affect the distant future, which Wells calls transgenerational power. As historical time passed, rigid stratification gave way to trade relations. Innovations spread rapidly as communications improved and the number of languages fell. With the internet, communications became almost instantaneous. This should be the best of times, but is not. The path down which agriculture launched mankind is mismatched to our human capabilities.

Three: Diseased. Wells travels to Arkansas's Dollywood, where he notes high levels of clinical obesity. The worst of American obesity clusters in states of the south and Midwest. Some of this effect may be economic; these are among the poorest states. But, perhaps, our food is killing us. Overall, obesity is more widespread in poorer nations. When a country has enough money to increase caloric intake and generate service jobs, rather than farming and manufacturing jobs, then obesity rages. We are genetically programmed to eat fatty foods and seek inactivity.

James Neel studied the Yanomami Indians of the Amazon in mid-20th century, purported to be in an unaltered hunter-gatherer society. He learned that their diet differed from agricultural diets. Neel suggested that diabetes is a result of a metabolism geared to low carbohydrates and high protein meeting a glut of sugars and starches. Diabetes sufferers have a "thrifty genotype," which enables them to survive periods of starvation, but makes them susceptible to diabetes. Doctors say we should eat less and exercise more and never smoke. Our deep drives advise us to eat when it is available and exercise less, because burned calories must be replaced. Tobacco nicotine evolved to protect tobacco plants from their insect predators. It just happens that nicotine also stimulates human neurons, and so addicts. The CDC blames some health care cost increases on obesity.

How did our food become an enemy?

First, diseases spread into the human population from our domesticated animals, including measles, tuberculosis, smallpox, and influenza. This process commenced with the advent of Neolithic farming. Before agriculture, humans died primarily of traumatic injuries: wounds, falls, drowning, bacterial infection of wounds. With the advent of antibiotics, the threat of infectious disease fell, and people began living long enough to experience chronic systemic diseases: cancer, hypertension, diabetes, strokes, dementia. Angkor Wat, the ancient Cambodian city and religious center, was abandoned in part because they abandoned rice paddies that bred

mosquitoes. As more people left the area, more paddies were left fallow. Epidemic ensued. Genetic studies of the malaria parasite indicate that it has become a serious problem to humans only since agriculture. Our farming creates good environments for the malaria parasite vector, mosquitoes, to breed.

Second, as humans lived longer, chronic diseases became more prevalent. People in the Neolithic village of Mehrgarh had cavities in much greater frequency than their predecessors. As carbohydrates increased, so did tooth disease. Our culture adds sucrose to many foods, and sugar and starch are our primary calorie source. Our taste for rich and sweet (fat and sugar) served ancestors: fat was high in calories and sweet meant energy with no poisons. Added sugars make us believe food that is killing us is good for us. The World Health Organization predicts that by 2020 seventy-five percent of all disease will be noncommunicable.

Our agricultural lifestyle creates the diseases that are killing us. We can poorly project the results of decisions we make today, decisions with transgenerational implications. One of the emerging trends is widespread mental illness.

Four: Demented. Wells travels to Maria Gugging, Austria, site of the Lower Austrian Psychiatric Hospital. Wells meets the staff of Leo Navratil's House of Artists, a workplace for the Center for Art and Psychotherapy. August Walla, a schizophrenic resident, sells much art. Walla grew up isolated in a small shed with his isolating mother. He spoke with none but his mother. After Walla's mother died, he suddenly opened up, speaking with anyone who would listen. But his art stopped. The current House of Artists staff rejects Navratil's insistence that schizophrenics are specially gift artists. Artists occur among the mentally ill at approximately the same frequency as in the general population. The House of Artists artisans have scant interest in the work of others; they are self-absorbed and unschooled.

What does art tell us about human consciousness? A Pakistani family (the KE family) could not speak because of inability to control the lower half of their faces. Researchers discovered that they had a mutated version of the gene FOXP2, which regulates the expression of other genes (a transcription factor). Was FOXP2 a key evolutionary development in human speech capability? Speech was probably present in hominids by 500,000 years ago. Neanderthals have the modern form of FOXP2, but still probably did not speak as does homo sapiens. Neanderthals were extinct shortly after modern humans entered Europe. The climate and hunting grounds were changing to Neanderthals' disadvantage. Homo sapiens began making much better tools around 60,000 years ago, and by 20,000 years ago had expanded throughout the globe. The human brain was the difference. Communication mattered. But neither is the unique possession of humans. What differs most about humans is cultural transmission of ideas and innovation. Our environment fluctuated with climatic changes, primary among which was the advance and retreat of glacial ice sheets. Mount Toba (in Indonesia) erupted 75,000 years ago (or so) and set off the drying cycle in central Africa, with the long term cooling trend of the most intense portion of the last Ice Age, that nearly drove humanity to extinction. As numbers fell, perhaps as low as 2,000 individuals, culture changed. First art enters the archeological record. And complex thought must have undergirded that development. With strong selection pressure and the right random genetic changes, the environment could select for abstract intelligence. Humans evolved the ability around 70,000 years ago to adapt by cultural change. This required imagining novel solution (through abstract thoughts) and communicating those innovations to others (through human social intensity).

Social structures necessarily reduced individual freedom to explore and rest. That creates stress. Noise has become constant. We are awash in advertisements. Chronic stress overstimulates the immune system. But, given the population, there is nowhere to "leave" to, as a Paleolithic hunter would have done. One fights for scarce resources only when one cannot walk away and find other resources. Humans naturally group in troops of around 150 members, which may be related to brain capacity. 150 may be the number of meaningful social relationships of which a human brain can keep track. Beyond 150, we dehumanize others to stay sane. All this leads to increasing mental illness in the global population, another effect of the Neolithic population explosion. Many of us now drug ourselves just to feel normal.

Genomics promises not to treat our diseases and dis-ease, but to remove them by changing us at the genetic level.

Five: Fast-Forward. Whitaker's child, Jason, was born with Diamond-Blackfan anemia, a fatal genetic blood disease. No donor of bone marrow was available, so Whitakers sought to make a fetus that could serve as a bone marrow donor for Jason by *in vitro* fertilization. Whitakers wanted to confirm the baby's suitability before implantation by genetic diagnosis. Britain declined to permit this. So Whitakers traveled to the United States, got the genetic analysis done, and bore Jamie, their second son. His cord blood served as a bone marrow transplant for Jason, who is now healthy. *In vitro* fertilization is increasing, due to improved technology and the later age at which women bear children. This story touches our future, the future in which we will have increasing control over our own genetic future.

We are learning the genetic basis of our diseases. We may soon be able to marshal a series of technologies to address diseases with a genetic fundament. As we correlate genotype with phenotype (genes with the physical structures those genes create in living beings), we learn pleiotropy (the effect of a single gene on an organism's structure). Examples of pleiotropy are: 1) sickle cell anemia, in which a single base pair in the hemoglobin genes creates a difficult blood disease and partial immunity to malaria, 2) Down's Syndrome, caused by having three chromosomes number 21, 3) heart disease associates with dozens of mutations throughout the genome. The complexity of these diseases shows that genes affect one's health but do not predestine it. Early genetic testing offers insight into one's disease possibilities which may affect choices one makes in life.

The human genome project has accelerated research on pleiotropy. It is likely genetic testing will in the future be done at birth. Also, pre-natal testing would help the mother alter her behaviors during pregnancy to help avoid triggering the fetus's disease potentials. Parents are presently able to choose an infant's genetic profile, terminating fetuses with genetic disorders (such as Downs Syndrome). Humans are genetically mismatched with modern culture. Perhaps we can select traits for our future generations better adapted to the circumstances of civilization.

Jazz prodigies often die early from lifestyle excesses. Brain scans show that the portions of their brains that inhibit behavior are turned off during improvisation. The disinhibition that makes them jazz greats may be killing them. There may exist a correlation between creativity and mental illness. David Horrobin argues that the genes for schizophrenia are identical with those generating creativity. If our genetic knowledge were put to editing such genetic variants from the human genome, creativity might plummet. If we edit out genes that make us fat, will we make ourselves less able to deal with future famines?

Techniques for genetically altering existing individuals are growing. A four year old, Ashanthi, suffered an inherited immune collapse. A researcher combined her missing gene with a retrovirus and infected Ashanthi with the result, hoping to introduce a functional version of the missing gene into her genome. She survived. Others have not. The pleiotropic effects of gene changes are difficult to predict. Our bodies are part of complex ecological systems. We understand neither how genes are turned off and on, nor consciousness, nor the immune system. All are fabulously complex. We need some caution. Leon Kass suggests that we trust our gut reactions to technologies. If it feels wrong, it may be wrong. Wells lightly endorses this view, and encourages society-wide debate and consensus on the ethical implications of changing our genetics.

Six: Heated Argument. Tuvalu is an archipelago of nine coral islands 650 miles north of Fiji. The highest point on Tuvalu is fifteen feet above sea level. So, much of Tuvalu will be inundated as Pacific waters rise in the current global warming. By the end of this century, Tuvalu will be uninhabited, as the local government plans to move everyone to New Zealand.

The Kyoto Accords, aimed to cap and reduce carbon emissions by country, failed to address the cost to developed nations and failed to include developing nations at all. Its regime has failed; emissions from the United States, China, India, and Brazil remain unrestrained.

The science of global warming is complex and disputed. The Intergovernmental Panel on Climate Change issued a report concluding that the planet is warming and human action is the primary cause. Wells asserts that carbon dioxide emissions are the most important contributor to global warming. Wells acknowledges that there is extensive debate about the role of humans in the current warming trend, but relies on scientific consensus for his conclusion. This scientific

consensus asserts that climate warming will affect the planet for at least one thousand years, regardless what steps we now take.

In 1815, the Indonesian island of Tambora, then 14,000 feet high, erupted. At eruption's end, the mountain was 9,350 feet high, and had emitted twenty-five cubic miles of ash and debris. 70,000 Indonesians died. 1816 was the year without a summer. Crops failed in the United States and Europe. Perhaps 200,000 European deaths were attributed to the cold weather.

Humans adapt best when circumstances demand change. We can hope that our genius for innovation will come into play as our current crises develop. Alternatives to oil-energy can be created: efficient solar cells, safe nuclear, and better batteries.

Fresh water supplies will be strained as the continental interiors become hotter and drier. People will move to urban areas, which are mostly on coastlines. Desalination technologies may help. Conservation will be required under all scenarios.

We can make these changes, from consumption to sustainability, if we change our view of life.

Seven: Toward a New *Mythos*. Wells tells of his wanderings with and instruction by Julius, a member of the semi-nomadic tribe of Hadzabe in Tanzania. Semi-nomadism was well-adapted to savannah life until modern society impinged. The Hadzabe way of life is collapsing. Until recently, social evolutionary thought argued that progress dictated progression from hunting and gathering to agriculture to urbanism. Perhaps we now better appreciate the independent value of hunter-gatherer cultures. How has modern society, so mis-fitted to our evolutionary roots, affected our moral sensitivities?

Wells begins with speculations about how modern man got from where he began to cities. Game theory's prisoner's dilemma demonstrates that fear of retaliation restrains much anti-social behavior. Philosophy and sociology indicate that some moral universals probably exist among humankind. In all human circumstances and at all times, one's actions and inactions impact the well-being of others. Religious prohibitions boil down to a few rules concerning laziness, sexual desire, anger, and possessions. Rules about things warn against excess possessions and concomitant pride. But modern society is premised on the ability to acquire excess. We do not value hand-to-mouth existence, though it is the natural human state. Jean Jacques Rousseau argued for the noble savage, that modern man has been corrupted by civilization. To be shed of its strictures would return one to a state of grace. Modern anthropological research has countered Rousseau. War has characterized most pre-modern societies, and the likelihood of dying by murder or war in modern society is far smaller than for pre-industrial males. The results are less compelling when the research sample is restricted to hunter-gatherer populations, but still equivocal. When resources are not localized or scarce, it would seem humans war little. But when agriculture and population density increase, the investment in creating necessities, fighting to protect those goods increases. Many protest modern acquisitiveness: counter-culture of the 1960s, Luddites, Romantics, Amish, Marxists, anti-globalization forces, and fundamentalists, to mention a few.

Muslim Brotherhood's Sayyid Qutb reinterpreted Islam in his manifesto, *Milestones*, as a militant world religion, devoted to jihad, holy war to impose Islamic law (Shariah) on Muslim regions, and eventually, the whole world. Karen Armstrong differentiates *mythos*, which concerns the spiritual aspects of existence, from *logos*, the human penchant for inquiring and understanding. Qutb sought to use logos to defend his mythos; modern insurgency techniques will bring his desired mythos. Christian fundamentalism in America employs the same tactic, using mass media as a tool. Its jihad is family values. Common to all the fundamentalist militants is a sense that their murderous acts are dictated by God, and therefore are morally justified. As Christian fundamentalism has risen, acceptance of evolutionary theory has plummeted. All fundamentalists seek to build an alternative society, one outside and different from Western modernity. But, regardless, societies are mixing and traveling more than ever. In 1500, fifteen thousand languages were spoken globally; today fewer than six thousand remain, and probably only three thousand will survive to 2200.

Seeking a small neighborhood within larger society is a universal human activity, all apart from fundamentalism. Millions of people are experimenting with online communities, such

as Facebook. Their average number of friends is 130, similar to the maximum number of relationships possible for the human neocortex (see Chapter 4).

The Hadzabe do not bury their dead. Hyenas eat them. All their Tanzanian land is a burial ground, and hence sacred. Hunter-gatherers, generally, feel connected to their land. Agriculturalists view land as a tool by which to acquire food. Ultimately, the agricultural utilitarian view must cease, because there will be no new land available.

We can, however, seek a new mythos, a view of the world filled with significance in which we teach ourselves to want less. Wanting less is inevitable, since the planet has insufficient resources for everyone to live American lifestyles. We can drive less, live in smaller houses, eat local foods. We have a biological essence and many tools available at present. We can know ourselves and redesign a society in which real humans can live comfortably. We can only do so, however, by redefining what it means to live well. Perpetual economic growth, consumerism, and the quest for perfection cannot rule, if mankind is to survive. We must seek the wisdom in our hunter-gatherer past if humans are to persevere far into the future.