This book unveils the journey of human evolution from single cell life to the trillion cell masterpieces we now are. It also examines the conscious and subliminal makeup of our behavior, and how this influenced our existence.

Heirs of the Big Bang

By William T. Beran

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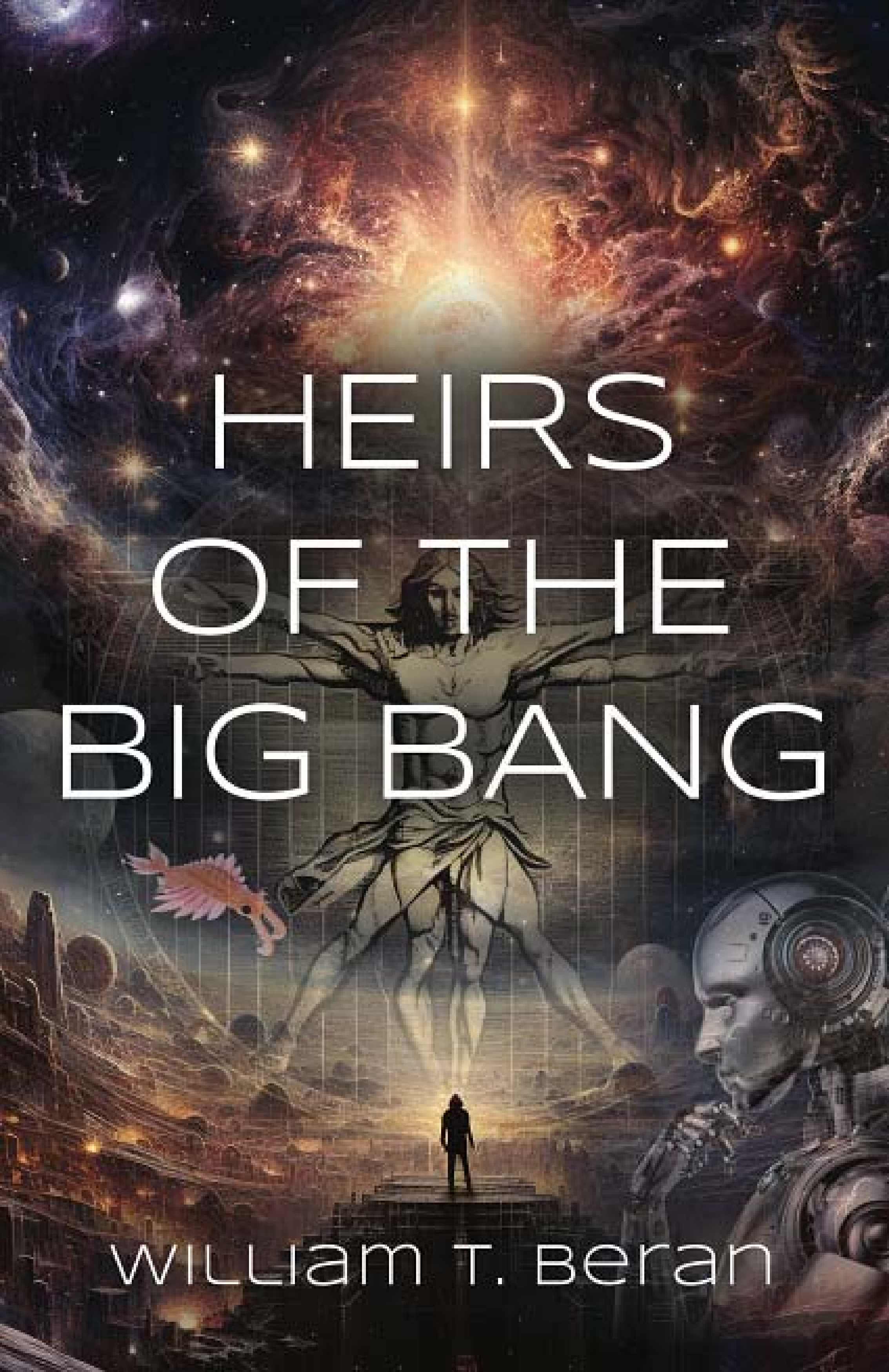
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Chapter 1 – The Dawning

Looking up into a cloudless night sky we view the magnificent debris field consisting of planets, stars, and galaxies that accumulated following the *Big Bang*….an event that cosmologists tell us occurred around 14 billion years ago. As the theory goes, emanating from an inscrutably small, hot, dense source, was a rapid and continuous expansion of time, matter, space, and energy culminating in the monumental universe we see today.

Like many theories, there are still a number technical issues that dog Big Bang's credibility; for example, the requirement for the yet elusive *dark matter* and *dark energy* which would have to comprise a majority of the universe. The theory also leaves unanswered crucial questions regarding what constituted the universe <u>prior</u> to the "bang". Instead, it focuses only on the universe's expansion following that incredibly miniscule beginning.

Questions and answers (or guesses) related to this and life's other enigmas weren't likely postulated until man's abstract thought processes were honed, and survival threats diminished, perhaps around 10 thousand years ago or so. As early cities arose and society became somewhat ordered, the more aristocratic citizenry had time to contemplate our place and purpose in the universe. Eventually, written theories began to emerge regarding the origins of the earth and life, usually under the purview of reigning societal rulers or religious authorities. Some theories were humorously off the mark, but others displayed a theme underlying many current religious beliefs, i.e., an Almighty Maker of heaven and earth.

In recent centuries, the science community entered the picture and eagerly addressed these questions. Scientists who were engaged in geology, archeology, biology, and astronomy found a trove of physical evidence which inspired new thinking as to our origins. Many theories have since been advanced, but most recently the science of genetics has gleaned even more remarkable insight to our beginnings from a relatively new type of research called *gene sequencing.* This has evidently permitted us to discover a common chemical structure and basic genetic similarity in all living plants and animals.

Public interest runs high with such discoveries. Many people are convinced of the credibility of the resulting evolutionary theories because it's evident that the physical evidence supporting the claims is painstakingly acquired and analyzed, as well as openly debated. But, on certain matters, these findings may also cause an uncomfortable feeling that they run afoul of our religious teachings. Some folks may feel that theories promoting evolution of earth, and especially the evolution of mankind, are the antithesis of the role Devine Agency had in our creation. However, a belief in Devine Agency and a belief in evolution are not mutually exclusive, as many scientists will attest and will be seen from discussions in the following pages.

Religious entities have historically taken a rather simple overview of the creation process and the possible ways by which Devine Agency operates. They understandably don't have the same interest as science does regarding the intricacies of cells, molecules, and other fundamental forms of life's building blocks. Despite the differences in focus, science has certainly not claimed to have now found all the answers. What they do lay claim to is a seemingly unending trail of incredibly complicated biological/chemical processes, many of which remain an enigma. At the same time, these mysteries vexing our brightest scientific minds sometimes seem to, ironically, beg for the involvement of a Super-Intelligent Entity.

In a cursory sense, religion and science both approach the mysteries of life with a prodigious amount of serious contemplation, and both often seek a higher authority for guidance or confirmation. There are major differences in the way their findings are revealed, however.

Religious entities express their beliefs as positively and simplistically as possible so that the tenets are abundantly clear to the general public. And while the entities do hold debates within their own hierarchy, the agreed tenets are ultimately presented quite definitively in order to minimize doubt and distraction among their followers. Religious doctrines are naturally instilled with spiritual overtones and are typically accepted by the devout on faith alone. Occasionally, some religious doctrines do get reassessed, reinterpreted, and/or restated to align more closely with broadly-accepted scientific theory.

The science community, on the other hand, usually presents their conclusions in language purposely infused with technical jargon and aimed at a limited audience who're uniquely qualified to actually grasp their significance. Scientific conclusions are customarily more open-ended (less dogmatic) than religious doctrine, even inviting debate or additional research on the matter. The findings are often so esoteric that subsequent translation by media experts into more simple layman's terms is required in order to acquire the general public's interest and appreciation.

Whichever way they are expressed, both religious and scientific explanations can still evoke doubts and questions, however. Science, in particular, seems to open a door of enlightenment only to reveal a room full of new puzzles and unanswered questions.

Scientists do generally agree that the primordial chemical soup of cosmic debris, mixed in a primitive ocean found on early Earth had all the elements necessary to form "protocells" of life. Some of the important life-sustaining chemicals in abundance at the time included carbon, hydrogen, nitrogen, ammonia, sulfur, and phosphorus; free oxygen was, as yet, in short supply. The forming of a protective enclosure, a cell membrane, was the critical first step. This enclosure prevented the encapsulated chemicals from drifting away or becoming diluted by the surrounding environment so they could be subsequently processed as a specific group.

Each protocell is thus visualized as simply being a primitive cell wall (perhaps just a thickened envelope) for containing and isolating a plasma of raw chemical molecules. While an accepted scientific definition of "life" still befuddles us, these early concentrations of chemicals within the protocells were unquestionably life<u>less</u>. For one thing, beyond just the right mix of chemicals, a source of energy was needed to further process them into the more complex molecular structures that are the real keystones of actual life.

Such energy was readily available in the forms of electricity (lightening), ionizing radiation (sunlight), and heat (geothermal effects or volcanoes). Having then been exposed to this energy the proto-cells might become micro-sized homes to concentrations of the four main complex chemical building blocks of life: proteins, lipids, carbohydrates, and nucleic acids.

We now know quite a bit about the physical makeup and complex functions required by these building blocks to eventually be transformed into what's understood as being "alive". A number of lab experiments have duplicated several different combinations of appropriate elements and energy sources to actually produce those building blocks and transform them into living cells. We've even fiddled with a cell's DNA makeup; for instance, we've modified a bacteria's DNA to form a different DNA makeup of our own choosing (e.g., JCVI-syn3A).

Scientists generally agree, as noted earlier, that early Earth had the right inert ingredients for eventual conversion to life, and they have even proven it in the lab. Yet, the actual process of how these inanimate leftovers from the "Big Bang" arranged themselves into the well-ordered molecules needed to become even the simplest living cells is yet a mystery. In other words, we've witnessed a chemical aggregation miraculously turning into organized biological life, but lack the knowledge to understand how it was done.

The earth's early protocells may have actually taken an intermediate first step by evolving from truly lifeless into a family of "life-like" cells. Modern c*oacervates* (koe-asser-vates) and, by some accounts, even *viruses* fall into that very category…somewhere between lifeless and alive. One important condition for "life" requires that cells are able to reproduce (make copies of themselves on their own). Coacervates do this but in a very unpredictable and unconventional manner. Viruses need to invade a living cell and steal the host's reproductive "equipment" to perform that function. But, in the virus' case, living cells had to have preceded them, so they couldn't have been the first intermediate step towards the creation of reproducing living cells.

For our purposes from now on, we'll simply accept that, however accomplished, the evolution of cellular life began over 3 billion years ago and go from there. We can discuss what the fossil record and other direct or indirect genealogical findings tells us about our evolution from these sources. The evolutionary trail is becoming increasingly discernible with new-found physical evidence, so we're getting a much better handle on what occurred even though, as stated above, we don't always know how it occurred.

The earliest true cellular life was a microscopic group called *prokaryotes* (pro·carry·oats), primarily consisting of two domains; namely, *archaea* (are·kee·ah) and *bacteria*. Originally, both these single-cell domains inhabited the early oceans and other bodies of water throughout their entire life cycle. They have since expanded their habitat to include not only everywhere in the world, but also on and in all plants and animals today. Every adult human being, for example, hosts at least 30 trillion such hitch-hiking primitive cells comprised of many different species!

Because they are so small and yet so ubiquitous, they may have formed various species in different places on the planet early on, from whatever the local chemistry offered. They could also have been transported throughout the world by ocean currents, by air currents driving moisture-laden atmospheric clouds, hitching a ride in or on their migrating hosts, and, over the very long term, by earth's crustal (*tectonic plate*) movement.

Amazingly, these tiny entities do leave fossil evidence in the form of chemical fingerprints. These are hard-to-find traces of the most ancient prokaryotes and are referred to as *molecular fossils.* These have been found in the most ancient sediments on earth, more than 3½ billion years old.

The lesser-known prokaryotes, archaea, are single-celled tough guys that could thrive where no other life forms dared to go, like high temperature/high pressure subsea thermal vents, low temperature ice fields, harsh chemical sites, and high radiation environments. Thus, they apparently were able to flourish when earth was young and basically uninhabitable for any other aspiring, but less-durable, life-forms. Having no known progenitors for the accepted biological definition of "life", the family tree starts with them for our purposes here.

Their initial energy sources (i.e., food supplies) were wildly unappetizing; it included metallic ions, ammonia, and gaseous hydrogen. As the earth cooled over many millions of years, this diet evolved to seemingly more palatable and nutritious organic (carbon-based) compounds. The earliest archaea were also *anaerobic* since little free oxygen was initially available; most of the oxygen around was chemically tied up in metallic oxides of one sort or another, or with hydrogen in the form of water. Later on, when oxide formation had literally saturated the earth, free oxygen molecules began accumulating and *aerobic* archaea species also evolved to capitalize on its benefits.

The reason oxygen's arrival as a free molecule was important to life is that oxygen-based cell respiration is over 15 times more efficient in terms of energy production compared to anaerobic respiration. However, oxygen is useless and often lethal to the <u>anaerobic</u> type of cell structure. This required the cells to evolve enzymes and antioxidants to capitalize on the advantages of oxygen and protect against its deadly effects. How they accomplished this isn't fully understood, but with this new capability, archaea species came to inhabit nearly the entire world for over the past 3 billion years.

Bacteria, the other family branch, also developed about the same time as archaea. They likewise prevailed in the hostile, anaerobic environments that typified earth's early days. As the planet became more hospitable and oxygen made its appearance, bacteria also adapted accordingly and flourished. They eventually evolved far more species than the archaea and led in the number of all live cells on earth, a status still held to this day.

Some early forms of anaerobic bacteria actually became the source of free oxygen molecules (O_2) eventually found in abundance throughout the world's soils, oceans, and atmosphere. Called *cyanobacteria,* they evolved a process enabling them to metabolize the abundant CO2 and water as a food source. That process is one form of *photosynthesis* which uses sunlight for energy and, in this case, releases oxygen molecules as a "waste" product. Similar to archaea, bacteria evolved aerobic species to exploit oxygen's energy-boosting power.

Still other survival traits materialized as the world's environmental conditions improved and the neighborhood became more crowded and competitive. To improve the likelihood of surviving long enough to multiply, some cells would mature and reproduce very quickly, say, within 20 minutes compared to a more typical couple of hours. Other innovations included some chemical or physical measures of self-defense to ward off assaults by parasitic or predator cells. Furthermore, when changing environmental conditions threatened their long-term well-being, some cells would go into extended hibernation, becoming dormant even for centuries if need be, waiting for favorable conditions before returning to "normal" life.

Some strains of bacteria were (and still are) parasitic or predatory, and this lifestyle eventually got them a bad name when modern humans discovered they were responsible for lots of nasty infections and disease. (Archaea have remained seemingly benign throughout the ages and never achieved similar notoriety.) Of course, we now know that there are many more species of bacteria that are decidedly good for us. Through the ages and up to modern times, all animal and plant life have evolved one sort or another *symbiotic* relationship with many types of bacteria and couldn't otherwise survive without them.

In addition to the foregoing two prokaryote clans – archaea and bacteria – there is a third very early domain of life called *eukaryotes* (you·carry·oats). This domain consists of essentially everything else currently alive on earth, including all plants, animals, fungi, and the incredibly diverse *protists*. They began appearing around a billion years or so after the prokaryotes made their debut. At that time, the planet was beginning to accumulate substantial amounts of free oxygen, so all the eukaryotes were inherently endowed with aerobic (oxygen-based) metabolism.

Eukaryotes also started out as single cell entities; some theories suggest they were actually mutated archaea but somehow evolved up to 1000 times larger in size than bacteria. Being significantly larger also handicapped them with a much greater volume-to-surface-area ratio for the cell. This worked to their disadvantage in terms of the added time and energy needed for diffusing food and waste molecules throughout the much larger volume of cell plasma and across the proportionately smaller cell wall area.

These drawbacks to larger cell size presumably invited an innovative change in cell form and function - the engulfing of a bacterium by a single-cell eukaryote, after which the two organisms somehow developed an *endosymbiotic* relationship. One theory has it that the engulfed bacterium avoided becoming just another snack by providing a different function that was more beneficial to the eukaryote predator than just its food value. Perhaps the bacterium improved the cell’s oxygen uptake or enabled some other boost to its host’s metabolic efficiency. The bacterium itself benefitted by now surviving better in a more hospitable and protective environment.

Gradually, the eukaryotic cells complexity increased as the number of internal *symbionts* and their special functions became more numerous and sophisticated. Incidentally, these small symbionts are called *organelles* because they function much like miniature versions of our own body's specialized internal organs. (Keep in mind we are still talking about the "innards" of a microscopic <u>single</u> cell.)

The physical makeup and functional behavior of the living cell is orchestrated by instructional codes implanted in the cell's *DNA (deoxyribonucleic acid)*. There are just four different chemicals - *adenine*, *cytosine*, *guanine*, and *thymine* - required for all these instructions. Each chemical is individually married to a sugar molecule (*deoxyribose*) and a phosphate molecule, with the resulting threesome called a *nucleotide*. (To get an idea of their size, there over <u>3 billion</u> nucleotides in the nucleus of just a <u>single human cell</u>.)

By repeatedly stringing these nucleotides together in various sequences, they become a linear length of code known as a *gene*. In turn, many genes are strung together to form a very long, skinny molecule - the now familiar double-helix DNA strand.

The simpler life forms (prokaryotes as well as the eukaryote's internal organelles) usually have the ends of their much shorter DNA strands brought together, forming one or two circular shapes. These circles are actually twisted into a tight ball and occupy a sort of pseudo-nucleus area, called a *nucleoid*, within the cell's wall (in other words, their DNA is simply immersed in the cell's *cytoplasm*).

Conversely, the much larger, more complex eukaryote cell comes equipped with much longer and many more DNA strands. Short segments of these eukaryotes DNA strands are wound around individual *histones* (hiss-tones). Because their DNA molecules are so long, there is a huge number of histones required for each molecule. The histones keep the DNA in an orderly and accessible configuration to make possible the essential role of reading a gene's code - a process known as *transcription*.

Each DNA strand and its histones are carefully "squashed" into a compact package called a *chromatin* (kroe-mah-tin); all the chromatins reside within the eukaryote cell's nucleus. When it becomes time for the eukaryote cell to asexually divide, each chromatin further compresses itself into what's familiarly known as a *chromosome* group. In the beginning phase of reproduction, the chromosome groups duplicate themselves to form new identical groups. These two new groups migrate across the cell and becomes situated well apart from each other. Then the cell itself divides down the middle to break up into two identical *daughter cells*.

Throughout the eukaryote cell's life, a communication system is required to convey the protein building and energy producing instructions from the DNA in its nucleus to the multitude of organelles spread throughout the cell's cytoplasm. This starts with the synthesis of *messenger ribonucleic acid molecules* (mRNA) by a most remarkable enzyme called *RNA polymerase* (RNAP).

The ability to transcribe the DNA code by way of mRNA turns out to be a rather mind-numbing multi-step progression. It involves the RNAP first finding the right genes among the myriad of those stored in the nucleus. It then enters the DNA at the precise location to unzip the helix just far enough to acquire the intended gene instruction, copy the complementary code on a string of mRNA, and then zip the helix back up in order to leave the DNA unscathed!

The mRNA also goes through a procedure (*RNA splicing*) to clear out the unneeded remnants of uncoded genes usually left residing therein. A final surveillance system makes sure the RNA instructions are unadulterated before leaving the nucleus to seek out the intended ribosome or mitochondrial organelle in the cell's cytoplasm. Once the mRNA reaches the correct ribosome or organelle, still another very complex process passes on the gene's instruction. This journey ends up prompting creation of either the correct *protein* by the correct ribosome organelle, or production of the *adenosine triphosphate* (ATP) energy by the correct mitochondria organelle, as required by the host cell.

All of the eukaryote's organelles still reproduce in their old-fashioned prokaryotic way, by simple *binary fission.* Their reproduction is timed to coincide with the host cell's own reproduction schedule. Thus, when the host reproduces, the organelles also replicate at the same time which ensure that all genetic material within the eukaryotic parent cell is faithfully passed on to each of the *daughter* cells. There can be thousands of organelles that undergo such orchestrated reproduction in each cell.

Single cell eukaryotes usually reproduce asexually, but we now have observed that they also reproduce sexually! Normally, these single cell entities pass each other like two (very small) ships in the night, paying no attention to each other. Occasionally, possibly by way of pheromone (odor) attraction, two of the same species will be attracted to each other and engage in "cooperative" reproduction. In order for that to happen, it means that sexually-oriented genes were available to undergo that process. This further means that their DNA was already hard-wired for such activity long before we originally thought sex was first "invented"!

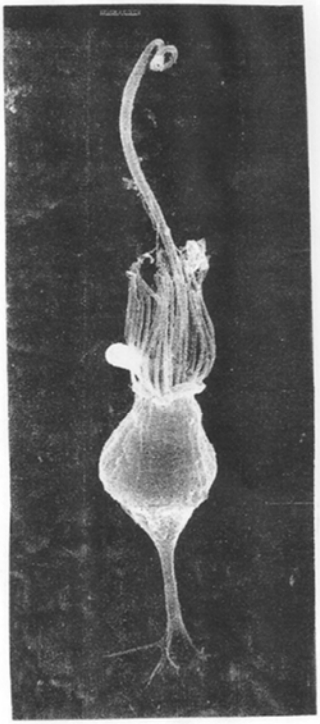
With all the complexity involved, one might expect there will be screw-ups in the process now and then. This does happen, and the consequences can range all the way from virtually nothing to life-threatening implications. Also, the chromosomes themselves can become damaged, with a similar range of results.

Although individual eukaryotic cells are quite large as microorganisms go, they are still constrained in the size they can attain even with the help of all the imported organelles. Consequently, only a few modern species of single-cell microorganisms can be seen with the naked eye. Their miniscule size has obviously not hampered their survivability - in fact, it has probably enhanced it. By now, they have the unrivaled distinction of roaming the earth for over several billion years and are far more numerous than the total number of all the living cells in all the multicellular organisms on earth combined.

Looking at all the processes and instructions wrapped up in that micro-sized single-cell lifeform certainly make them appear as if they are endowed with, or designed by, highly advanced intelligence. The coordinated actions needed for sustenance, reproduction, and repelling pathogens still boggles the brightest scientific minds, much less the general public. Unraveling the secrets of these microscopic enigmas remains high priority because such information will likely help us prevent or overcome human disease and inherited disabilities.

But beyond that, one might wonder if these individual and seemingly insignificant unicellular life forms have any further relevance to our existence…their lifestyles would seem to be so purposeless to the average man-on-the-street. A few considerations to that question are: 1) they were here first and have demonstrated more sustained durability than any other living species on the planet; 2) they underpinned the development of multicellular life without which we wouldn’t be here discussing the matter; 3) they are at the very bottom of the food chain and thus form the foundation of the world’s food pyramid; 4) they perform the role of decomposers and recyclers of all organic leftovers following the death of living organisms; and 5) in the event of a major environmental or man-made global catastrophe, they could well be the only survivors available to restart the new beginnings of advanced life.

A First Stab at Multicellular Life



Source: Mark Dayel (mark@dayel.com)

A unique switch-hitter, this microscopic-sized, single-cell choanoflagellate could gang up with others of its species to form a colonized multicellular organism when conditions permitted; it's the first known predecessor to animal life.

Chapter 4 – Rise of Dominance

So, one might ask, how did an extraordinarily complex specimen of life like ourselves evolve from the likes of, say, a nearly inanimate, simple sea sponge? The flippant, but honest answer is: slowly and painfully. Many intervening species have evolved which were losers in the survival sense…our family tree is full of many lifeless limbs.

The DNA pathway leading to our human existence had many mis-directions and dead-ends; nevertheless, the "losers" were still instrumental to our success. Their ultimate sacrifices were the genetic competition that steered evolutionary outcomes in the successful direction from which we now reap the benefits. For that matter, even the "winners" (the successful animal species preceding us) didn't lead particularly productive lives by our standards, but they were still vital in the sense of simply surviving so that we could eventually become their posterity.

It's understandable that many of us feel uncomfortable with this foregoing portrayal of human creation. Based on our religious upbringing, man was created in a much faster and tidier manner than this evolutionary journey that sounds way too slow, way too haphazard, and way too complicated. Nor does the idea of having genetic ties to one-celled micro-dots of life going back billions of years sit well with some folks. However, we generally do concede that Devine Agency can act in ways and on a timetable not necessarily commensurate with our own.

Current archeological and genetic evidence reveals that our creation wasn't quick, simple, nor otherwise well-organized, at least by human standards. Our elders would never have envisioned a messy journey through a drawn-out evolutionary progression as the way we gained our exulted presence on earth. But we must keep in mind that the simpler, neater explanations they offered many years ago came from a knowledge base far less developed than that we now possess.

We've now uncovered an extraordinary evolutionary trail beginning many billions of years ago from the extreme perspectives of both our immense universe down to the smallest living cell. Our relatively simple yet organized human mindset is suddenly beginning to see the intricacies of life in a light previously not available. It's become increasingly evident that our presence in this world didn't stem from a single miraculous act, but rather from an extended series of miracles that's ongoing even to this day.

The highly-accepted theory expounded by Charles Darwin suggests that we are the ultimate survivors in a long string of genetic "experiments". His survival-of-the-fittest theory features a modus operandi that isn't neat, quick, or pretty, but at the same time, it eventually resulted in a collective gene pool that enables us to sit here and intelligently discuss it. As earlier stated, this genetic culling process was a fairly slow process even by geologic time-standards…it took billions of years. Even when "real" animals started taking shape during the relatively recent Cambrian geologic period, it still took another half a billion years of genetic evolution before modern humans, such as you and I, were born.

During that Cambrian period, both plants and animals made genetic changes that enabled them to live on land rather than exclusively in water. The incentives to abandon the water environment likely included a better energy (food) source and fewer predators, but it probably also offered better access to the vital oxygen supply which was then rapidly increasing in the earth's atmosphere.

The first animals to gain land access were the *arachnids* (spiders, scorpions, and mites) and *myriapods* (centipedes and millipedes), who'd evolved from the marine family of *arthropods* (crustaceans). On their heels came the incomparable insect clan, who not only made landfall, but soon took to the air. They, along with a medley of primitive land plants, had found their terrestrial paradise millions of years before the other main player, the amphibians, got a foothold on solid ground.

Amphibians started out as bottom-feeding fish whose fins evolved to function more like legs for navigating in shallow water where their food was prevalent. Still more major modifications in body shape along with an air breathing capability allowed them to roam on land as well as in the water. They achieved body plans much like we see in our modern world…four legs, a belly and a back, a neck supporting a head, plus rudimentary lungs, heart, and alimentary canal. These amphibians were still biologically tethered to the marine environment, however, having to frequently return to avoid dehydration as well as to lay their soft-shelled eggs in water.

Soon evolving from the amphibians were the *reptile* species who were much more acclimated to dry conditions…some eventually became adept at surviving desert-like conditions. Later on, some reptile species even turned evolution around and returned back to the sea (although they remained air-breathers). They reinstated aquatic reptilian species that persist to this day, e.g., crocodiles, sea turtles, and sea snakes. Some intrepid reptile species took to the air and thus gained a huge advantage in the ability to locate food sources.

The reptiles' skeletal and muscle structures generally evolved toward ever-increasing size, strength, and body motion dexterity. In fact, one reptile species became the largest flying creature ever, with fossil evidence of a 30-foot wingspan and an estimated 500-pound weight! These genetic innovations were to their species' benefit as long as the environment they inhabited remained compatible. However, inevitable changes to the environment meant that certain body-types, even once very successful, could actually become a detriment to their survival. Species so handicapped, like the huge flying reptile, eventually landed in history's trash heap.

Out of this reptile development came two important concurrent branches of the family tree: *dinosaurs* and *mammals*. Both of these branches emerged about the time the so-called *Age of Dinosaurs* began, some 250 million years ago. The early mammalians resembled very small shrews or mice. They lived underground, essentially staying out of sight of their reptilian relatives who were also running and flying around at the time. These mice-like critters were very quick – not only to flee predators when out and about scrounging for food, but also to reproduce…traits that were largely responsible for their survival.

About 150 million years went by with our small mammal ancestors not able to do much in the way of genetic innovation; they were largely confined to just hunkering down to stay clear of the remarkably well-adapted and imposing dinosaur clan. Then, by sheer luck (actually, bad luck for many) a big extinction event engulfed the entire world that ultimately freed up the genetic advancement of lowly mammals. You probably recall this occurrence starting as a colossal asteroid impact on what's now the Yucatan Peninsula of Mexico. It caused immediate death of many millions of plants and animals in the immediate area from the sheer magnitude of the blast, shock wave, fires, and falling debris.

As dramatic was that initial explosion, much more damage occurred over the long run from the ash blasted into the atmosphere which soon encircled the world and caused a drastic change in climate. Over time, the resulting lack of sunlight along with falling temperatures caused a large proportion of world's terrestrial and marine plant life to die out. This disruption in food source dealt a fatal blow to the plant eaters, which in turn, also spelled the end for their predators. The entire dinosaur clan, except for just a few species of what's now become our bird family, eventually perished as a result of this catastrophe.

Some of our mammalian ancestors survived this event and its grim aftermath. By living underground, being small and thus requiring little food, they eked out an existence and managed to survive throughout the time it took the earth to rebound back to a more hospitable environment. This demise of the once indominable dinosaurs permitted some of the insignificant mammals to break out of their claustrophobic nesting habitats and live above ground.

Throughout their life on earth, animal species focused on: a) acquiring food and water; b) seeking hiding places and honing defenses against predators or hostile climatic conditions; and c) reproduction. You might call it the ABC's of life that our forebears religiously followed and whose success at that regimen enabled the likes of us to be their descendants.

The food sources available to animals throughout time have primarily consisted of both plants and other animals. Those that lived off plant life are called *herbivores* while those preferring meat are called *carnivores*. Because carnivore's digestive system is simpler than herbivores, they may have been the earliest to have evolved (it takes a lot more gastrointestinal "equipment" to digest a plant's cellulose and obtain all the necessary nourishment it offers). Some species, like our stone age ancestors, had a diet consisting mainly of meat and a few veggies tossed in, are called *omnivores*.

Thus, the earliest terrestrial animals probably had little choice but to prey on other carnivores for their primary food supply. Unless the prey was the size of a bug, this carnivore life-style could be very hazardous…prey often fought back and, even in defeat, could inflict serious wounds on its assailant. While a better option might be found in seeking out the lame, or the smaller and younger prey, even that sometimes riled the adults of the herd sufficiently to retaliate and attack the attacker.

The safest thing was to evolve digestive tracts that could break down the tough plant cellulose to obtain the necessary protein, calcium and other essential nutrients it contained. Herbivores did just that and reveled in not only having an abundant source of food, but one you needn’t stalk or run after. Even more importantly, it didn’t fight back. Herbivores prospered on this diet and soon greatly outnumbered their meat-eating counterparts.

In response to the carnivore predation, some herbivores evolved defensive refinements such as camouflage, repugnant odors, and even effective armor and formidable appendages to help ward off attacks. Carnivores facing the prospect of a dangerous prey could lower their sights somewhat and go after ever smaller animals to reduce these hunting hazards. The problem with that strategy was the likelihood it would wind up taking more time and energy than the calories it provided. Hence, some carnivores skirted those dangers altogether and evolved the stomach acidity and gut configuration to comfortably eat already dead and decaying animals; that approach also worked quite well and many became our all-important *scavengers*.

Humans apparently developed rudimentary plant-eating capability early on, but were meat-lovers at heart. Thus, they often scavenged recently-killed animals as well as hunted live animals.

Killing live animals and subsequently fighting off other scavengers for the red meat was risky business. The more easily acquired scavenged food was actually the brains inside skulls and the marrow inside long bones that only a few other animals could access, or even wanted to access. The bi-pedal humans could quickly take these bony leftovers in their arms and hi-tail it back home. Back with the clan, they could break open these bones with their stone age mallets, and share a relatively peaceful meal. Even today these particular body parts remain prized nourishment in some parts of the world.

Carnivores ultimately came out on top with regard to mental acuity. It took more savvy to stalk and take down another live animal, or even scavenge meat from recent kills, than to find and munch on stationary plant life. But the price of all this brain power was the higher energy requirement to support its function. (In fact, our human brain is a veritable energy hog, requiring 20% of all our energy requirements when the body's muscles are resting.)

Though the herbivores were thus handicapped brain-wise, their species consistently outnumbered their predators by a wide margin, often one hundred to one. In so doing, they also unwittingly secured their predators' survival…a carnivore's best interest is served when they have an ample and healthy food supply. While food availability normally has its ups and downs, the ideal situation for all concerned is when the predator's appetite and the prey's reproduction rates end up in a sort of natural equilibrium, or a "balance of nature".

The well-earned image of a big T. rex dinosaur chomping down on a hapless herbivore often comes to mind when the subject of successful predators comes up. In our current day and age, predators such as wolves, lions, hawks, etc., seek out prey in the form of rabbits, squirrels, and fish, for example, to satisfy their meat-eater palates. Humans also find this same wild prey quite appetizing in addition to their abundant stocks of cattle and other farm-raised meat. But, the vast majority of carnivores occupying our planet were and still are the size of mice and smaller, and routinely prey on bugs or some other equally unappetizing morsels.

In the later stages of the *Age of Mammals*, some of our ancestors took to living in arboreal habitats and slowly evolved into the *primate* or ape family. You've heard many times that apes, particularly the chimpanzee or bonobo family, are the closest relatives to Humans. That's been true for the past 50,000 years, but for a long time prior to that, a more advanced species of primates existed that were even more genetically closer to us than the ape family. While they and we are all in the family known as *hominins,* they sort of resembled a cross between apes and humans; all were bipedal (standing, walking, and running on legs only) and had the mental acuity comparable our own at that time.

The earliest species from which we hominins shared this common ancestry appears to be *Homo heidelbergensis,* whose origins go back perhaps half a million years. Living in southern Africa, this species was part of the Stone Age crowd that found a way to attach a wooden handle to an oval rock to make a rudimentary hammer. Although they may have also used these implements to settle arguments, the most likely application was to break open long bones and skulls of animals to access the food within.

A number of other hominin species evolved over the millennia since then, ending with the evolution of us Homo sapiens. Eventually, all the other hominins went extinct, leaving just Homo sapiens as the single remaining species of the bunch…a rather unique situation in the animal world.

There is much conjecture as to why these hominin extinctions took place. Possibly, the ice age in which they evolved, or some other environmental hardship simply had been too much to successfully endure over the long run. A popular notion is that Homo sapiens slowly did them in over competition for food and habitat. Perhaps a sudden eradication did occasionally occur from outright war between species over a territorial dispute. Another contributing factor may be that their gene pool became too weakened from excessive inbreeding that likely occurred within the small-sized social tribes common at the time. Endemic diseases might've also have depleted their ranks to unsustainable levels. All such possibilities may have played a role at one time or another.

That ice age period during which some hominins evolved and died out, produced one of the more advanced and robust species of the time known as *Homo neanderthalensis*. The Neanderthals, a name with whom most of us are quite familiar, were the consummate cavemen of our history books. Beginning 400,000 years ago or so, they lived in the Eurasian area north of the Mediterranean Sea, and sought out the many limestone caves to seek shelter from the particularly frigid climate at the time.

In many respects, the Neanderthals were on a par with early Homo sapiens, insofar as their mastery of fire and their tool-making skills. It also appears that they had mental acuity nearly comparable to Homo sapiens. However, they originally evolved in that northern geographic area far distant from Homo sapiens who resided in southern Africa at the time and had obvious physical differences in their stockier build and facial features. They probably weren't as articulate as their African-based counterparts and it's likely they had less communication and organizing skills. However, the verdict is still out regarding the level of language sophistication they may have actually possessed.

About 50,000 years ago, the Neanderthal’s eventually encountered a group of hominins that fossil finders originally referred to as the *Cro-Magnon Man*. Now referred to by the science community as *Early Modern Humans* (EMH) these were likely remnants of one of the last waves of Homo sapiens to have migrated out of Africa and roamed over to western Europe. At the time these two species encountered one another, the climate in northern Europe was undergoing unusual sporadic cooling trends and food availability was becoming scarce for the Neanderthals. The Cro-Magnons and the other more easternly migrating Homo sapiens stayed in the warmer southern European and mid-Eastern areas where the food supply was more predictable.

While the two species co-existed in relatively close proximity for about 10,000 years, it may be that the Homo sapiens kept the Neanderthals at bay in regard to access to the higher caliber food supply in the warmer south and, in effect, slowly starved them out of existence. The Neanderthals eventually went extinct about 40,000 years ago while the Cro-Magnons remained part of the Homo sapiens genetic melting pot that carries on to this day. (The Neanderthals survived as a species for at least 350,000 years, or about 50,000 years longer than we Homo sapiens have been around, so far!)

Another hominin species, *Homo floresiensis*, also prevailed until only 50,000 years ago on the island of Flores in Indonesia, about the same time Homo sapiens had migrated to their general area. These “Hobbits”, as they are now nicknamed because of their diminutive 3½-foot-tall stature, may have been an evolutionary ancestor of the much earlier *Homo erectus* species found in that same locale. There is no direct evidence of confrontation between Homo sapiens and the

Hobbits, so their demise apparently stemmed from a series of major volcanic eruptions that decimated their food supply. Being isolated on an island, they may have also been suffering from so-called *inbreeding depression*, making them more fatally susceptible to whatever hardships confronted them.

The evolutionary roots of the ultimate human species thus seem to have emanated from the mild southern African climate. Very early Homo sapiens made their appearance as long as 300,000 years ago, but a big surge of modern Homo sapiens' fossils starts showing up 150,000 years ago. This later group now appears to have been the product of a rather piecemeal evolutionary journey, with their ancestors regularly roaming around a large geographical area of the southern African continent.

As a result of all that wandering, fossil evidence shows that a lot of gene exchanging went on between other hominins concurrently living in south Africa. This activity finally concluded with our signature Homo sapiens species emerging in the last 100,000 years and remaining genetically identifiable as a single species thenceforth. The wholesale hominin gene-mixing activity is seen as being very healthy and productive; it rapidly expanded our gene pool and created the unique changes that forever isolated humans from all other hominins.

The most profound change that occurred was the sudden advancement in Homo sapiens' cognitive skills. One amazing development was the physical change to the brain's neurons (the information/action centers) whereby their miniaturization allowed many more to occupy the available space in the human skull than ever before possible. Other ground-breaking refinements appeared in the brain's axons (communication grid) and the synapses (the components interconnecting axons with neurons). These remarkable changes evolved quite rapidly and contributed to an unprecedented leap in Homo sapiens cognitive performance.

Other changes included increased size of the skull, hence size of the brain (to which there were limitations imposed during birthing) and shape of skull (which allowed more development in certain critical areas of the brain). It's been postulated that humans relatively weak physique compared to that of our primate cousins was not only influenced by lifestyle but was also in part an energy consumption tradeoff…it permitted our brain's high energy needs to be met at the expense of our musculature.

Out of these changes came a greatly refined ability to communicate, plan, perform cooperative undertakings with diverse groups of individuals, and exhibit abstract thinking. This incomparable mental capability, combined with our versatile physical capabilities, elevated humans to a role that had, and still has, no rivals on the planet.

This heightened cognitive capability enabled invention of tools and weapons that were no match for any other hominins, or any other animal species for that matter. It raised our position in the food chain to that comparable of an Apex Predator…many animals that were once our predators now found humans too dangerous to attack. Our ferocity in combat combined with the ability to strategize, cooperate, and organize also produced an unbeatable force against all the other less well-endowed species.

Homo sapiens also possessed two rather extremely opposite innate personalities which regularly play out to this day: a friendly cooperative nature coupled with a devastating aggressive streak. The former trait saw us engage in mutually beneficial activities with diverse human groups in order to attain levels of achievement that could have never been accomplished alone. The latter aggressive trait regularly gave an edge in battle that led to decisive victory. The two behaviors are combined and displayed in one of our regular activities - warfare - where we achieve harmonious relations with friendly forces while coordinating fierce assaults against the common enemy.

Both the early hominin contingent and later Homo sapiens exhibited a migratory nature. Food supply and climate issues may have been some incentive, but there was probably also an innate drive we carry with us to this day - a built-in curiosity and need for adventure. We are curious as a cat and get quickly bored with the status quo. These factors, combined with our mental supremacy, drove us to successfully explore and eventually become the sole animal species to occupy and dominate the entire planet.

Refinements in Homo sapiens' inventory of stone weapons added to their assurance that they could advance into new territory and still acquire an adequate food supply. By now, they possessed sharp-tipped, hand-casted spears, and maybe even bows and arrows. This allowed them to encroach on the foreign and inferior armed hominins' territory with relative impunity. In some of the colder areas, skills were developed for making warm clothing and footwear from animal hides. Coupled with their ability to start a fire for personal comfort as well as to cook food, they were adequately equipped for confidently exploring new and potentially hostile areas.

The earliest group of African-based Homo sapiens to migrate north out of Africa began about 200,000 years ago, but that excursion was relatively unremarkable. As time went by, our itchy feet apparently instigated a number of other similarly unspectacular migrations as well. The last and <u>very</u> noteworthy migration began about 60,000 years ago. These Homo sapiens first moved north into the middle east and then into Europe, where (noted earlier) they encountered the

Neanderthals. Turning east, they roamed present day India, China, Southeast Asia, and eventually Australia. Demonstrating some boat building and navigation skills, they even settled on several South Pacific islands. From the China/Russia regions, they traversed the land bridge that, at the time, led from Asia to present-day Alaska in North America. They eventually continued down into South America to cap-off an incredible exploration and occupation of six of the world's seven continents over the course of about 50,000 years.

Apparently, our gene pool broadened a bit throughout our nomadic excursions as we encountered the various earlier itinerant hominin populations along the way. Some of these were ancestors of those who settled in the areas nearly 2 million years prior! Other encounters may have involved "locally-grown" hominin species. They must've been relatively few in number and simply absorbed into the Homo sapiens culture with evidently little or no genetic trace, or possibly they were killed off if hostilities arose.

With regard to Homo sapiens move into Europe, much has been said about their role in "out-competing" the Neanderthals for food and space, with the Cro-Magnon/EMH group purportedly causing their eventual extinction. At the same time, there is some genetic evidence in modern humans revealing that limited mating between these two species may have taken place sometime along the way…DNA from persons of European descent typically contains what appears to be 1% to 4% Neanderthal DNA. A similar content of DNA but from a hominin species known as *Denisovans* are also apparently embedded in some genomes of the modern southeast Asian populace.

This theory of our genetic connection with the Neanderthals or Denisovans is based on recent DNA investigations known as *DNA sequencing.* Although it's generally inferred that different species cannot interbreed, this is only half true; it's clearly evident that horses and donkeys can produce offspring, a mule. It seems that the ability for different species to successfully crossbreed lies with the amount of time the two had split from a common ancestor. The less time that accrued allows better opportunity for successful reproduction. So, finding genetic evidence of our own species crossbreeding with others hominin species shouldn't be particularly surprising.

One question is whether these crossbreeds are fertile and able to reproduce themselves. Sometimes the offspring is reproductively sterile, but sterility and fertility can vary. An example of that are Tigons or Ligers, which are the hybrid results of crossing tigers and lions (the names depending on which species was the male). In this combination, the male hybrids are sterile, but the females are fertile. As to polar bear and grizzly bear hybrids, both sexes are fertile. The crossbreeding of horses and donkeys produce mules which are totally sterile.

The ability for hybrids to foster fertile offspring adds another dimension regarding the speed in which a vibrant new species can evolve – it takes only <u>one</u> generation! This is in distinct contradiction to the classical view of a much slower-paced evolution of plants and animals. It's the fastest means of evolving a new species even compared to the fast changes seen possible with the epigenetic process mentioned in Chapter 2.

Distinct from cross-breeding is <u>in-breeding</u>, whereby immediate family members (first cousins or closer) become parents. Now legally referred to as *consanguineous* unions, the object was to preserve a "blood line" for legal inheritance purposes as well as to perpetuate the combined good qualities of the individuals involved. Unfortunately, it can also perpetuate genetic defects in their offspring.

Nevertheless, the successful widespread breeding practice to produce "purebred" horses, cattle, dogs, and other animals as well as food crops, is a testimony to the potential upside of in-breeding. It resulted in reliably duplicating the positive qualities that were sought by the owners. However, there's no question that the likelihood of serious health/disease issues also arise more consistently in such animals; their undesirable regressive genes are often randomly united. Now days, crossbreeding of dogs, for example, seems more popular with the general public and will avoid the potential health issues associated the purebreds.

The predisposition to reproduce early and often is deeply entrenched in our instinctive makeup. The matter of reproducing before succumbing to life-ending events is a crucial survival mechanism common to all species. Humans owe their existence largely to the highly prolific nature of our ancestors during the Age of Dinosaurs… despite being ravaged by predators, these small mammals were experts in rapid reproduction!

Of course, the reproductive urge wasn't a consciously thought-out survival objective by the participants. More plausible is the instinctual behavior to mate for the pleasure of it, whether inbreeding or crossbreeding. The urge to merge with a different species arises when animals of similar genetic families happen to share geographical habitats. This tendency to engage in hybridization appears to be a rather common trait as noted earlier for hominins, and it's generally healthy for the collective gene pools.

Since their first appearance in southern Africa somewhere around 250,000 years ago, earliest versions of what eventually became Homo sapiens apparently began exchanging genes with the other earlier evolved hominin tribes scattered around the lower continent. It appears that after roughly 100,000 years of crossbreeding with these other species, this hybridization eventually settled into the gene pool and species we know as “Homo sapiens”. They had finally produced the latest “model” of which we are direct descendants.

Despite our ancestor’s peripatetic behavior as evidenced in the exploration and settling of the entire world over the course of nearly one hundred millennia, our gene pool seems to have remained relatively pure even though our early explorers were in contact with human-like “counterparts” in many locales. Most of the diversity in our modern genetic makeup and physical/mental characteristics is attributed to so-called *racial* differences. Apart from the possible Neanderthal and Denisovan DNA contributions note above, if other subsequent hybridization took place, there’s scant genetic evidence of it in our genes.

Whether it was hunting parties looking for meat or foraging parties looking for veggies, acquiring a hunter/gatherer’s “grocery list” constituted a risky and arduous lifestyle. Homo sapiens adopted a new approach to this chore following their settling in and around the world. About 10,000 -12,000 years ago, they began to corral livestock and raise crops. In effect, it heralded the beginning of an agrarian/ranching way of life and largely put their wandering ways to bed. There were still risks involved with crop failure or wild animals raiding the corrals, but these farmer/ranchers’ new lifestyle measurably lowered their daily stress levels and improved their overall comfort to a great extent.

Along with this more sedate agricultural lifestyle was the opportunity for a larger, more stable social order. Individual family homes could be built that undergirded a lasting, orderly, and growing community. The size of these communities and the security it offered extended well beyond that of previous tribal enclaves. More time was available for the increased variety of community activities and social life which was likely coordinated through a stable and mature hierarchy. The less frenetic pace also allowed time for more socialization, recreation, introspection, and probably philosophical thinking. It became a luxurious lifestyle when compared to prior millennia of hunting and gathering, which was often an incessant battle just to survive!

While this new agricultural development managed to rapidly improve everyone's living standards, the new social order was still comprised of individuals with differences in their inherent strengths and weaknesses. Humans possess a wide range of intelligence, temperament, and character, not unlike other animal species. This leads us to establish a "pecking order" within societal groups driven by: a) the group's inbred need for leadership, and b) an individual's inbred inclination to dominate others in order to get his or her way.

Even in a harmonious community, the social order seldom remains fixed for very long. The mix of personalities, interests, and talents are generally in a constant state of social flux, with transitions ranging from amicable transfers to violent coup d'états. We're apparently locked into this predictably wide range of social behavior wherever you find people in groups of two or more. Given its universality, and how strongly engrained and enduring it seems to be, this trait may have a net benefit for our species' survival. Or, we may have simply endured in spite of it!

Scientifically labeled *dominance hierarchy*, this social behavior is ingrained not only in humans, but in virtually all the members of the advanced animal kingdom. Unless Mother Nature or a common enemy presents us with an existential threat that diverts our attention, we often spend much of our time and energy jockeying for our rightful position in our local social structures. The roots of this behavior lie deep within our entrenched survival instincts while the carrying out of successful social activities rests more with our intellectually newer brain.

In fact, most of our human behavior is first initiated by our limbic systems responsibility to look after our best interests. This often conflicts with our newer brains penchant to think before acting in order to capitalize on previous positive experience. The more considered response usually turns out better for all parties involved. Since these two brain functions are so exquisitely intertwined with a very complex neural network, not only between themselves but with virtually all other parts of our brain, we have ongoing “battles” at microsecond speeds within ourselves as to how to finally behave. As we’ll discuss next, not all the battles turn out well either for us or for others.

The Root of All Goodness and Evil

This one complex organ, the brain, makes us
all that we are and will be, for better or for worse.

Chapter 10– The End Game?

Ever have someone derisively ask you "Didn't your Mama teach you anything?!" As humans, we make our share of stupid mistakes from time to time. Unfortunately, sometimes it's even a repeat performance which implies that we hadn't learned from the first time around. Those missteps are usually attributable to someone having simply warned us not to do this or that dumb or dangerous thing, but we disregarded or eventually forgot the instruction. Our "mammalian brain" would not have let us forget so easily if we had physically or emotionally suffered as a result of our stupidity.

Over the course of human progress, our collective mistakes in judgement and actions have caused <u>ever-increasing</u> duress not only to our fellow man, but to virtually all life on Earth. Part of this is the result of our massive physical presence on this planet. Over 8 billion of us are living here at last count, the most of any single advanced animal species alive. Although the global growth <u>rate</u> peaked back in the 1960's from 2% per year to now less than 1%, world population is clearly continuing to grow, expanding mostly in the lowest income areas of world such as sub-Saharan Africa. Obviously, this intensifies the competition for the finite available resources needed by ourselves as well as other life forms.

The other aspect of our "progress" is the incredible damage we can now inflict upon ourselves at the press of a button. If the finger on the button winds up on the hand of someone who's Mama didn't teach them anything, we, along with the entire planet, could be in for some unprecedented grief.

Since both our positive technical advancements and our potential for self-destruction have accelerated through the ages, one can only speculate where this will ultimately take us. We strive to be fundamentally rational in thought and action, but our outbursts and misdeeds often indicate otherwise. Maybe this underpins a subliminal suspicion that mankind needs to “spread out” and seek new beginnings elsewhere in our universe in order to survive.

We’ve made great strides in recent decades developing the means to do just that. Included in this rapidly expanding technological field is a growing class of machines called *robots*. Our earlier robotic machines improved the speed and accuracy of manufacturing, construction, assembly, and inspection jobs in many fields of endeavor. They also ridded us of many dangerous or tedious jobs.

The emerging sophistication of some robots reinforced the idea that ever brainy versions could eventually fill in for a real person. Pushing the technology even further, many believed this automatically meant the machine equipped with Artificial Intelligence (AI) also needed to somewhat look and respond like a real human. The degree of realism depended on the job, particularly with regard to the amount and type of interaction it would have with other real people.

Combined with advanced AI technology, some viewed the advanced robotics as a precursor to developing a near-perfect super-human. Besides AI’s capability of permanently retaining almost every known fact available in the world, they could be also be taught all the social lessons your Mama instilled and then some, and never forget them. Eventually, the circuitry to do this would have to be miniaturized down to a size that achieved or exceeded all the cognitive capability found within in a human-sized cranium. While likely to be absent of emotions and a few other exclusively human traits, these qualities would probably not be missed given the overwhelming amount of other information the super robot could provide.

On the negative side, there are concerns that these AI humanoids could outsmart us and essentially take control of our destiny (some might cynically suggest that this is all the more justification to continue their development). Although the prospects of this happening aren't very likely given the extensive surveillance under which they will likely develop, not to mention their astronomical individual cost. Still, it may be a little naïve at this point to ask "what could possibly go wrong?"

Currently, the fear of creating an electronic Frankenstein Monster is particularly hard-wired into Western society mentality, whereas Eastern societies, like Japan and South Korea, are more likely to accept these creations as a boon to their economy and lifestyle. The more immediate concerns regarding AI robots' existence should probably be directed toward their impressive job stealing potential.

Many manufacturing jobs have already been willingly given to robots because they were mindlessly repetitious (boring) or hazardous to human health and welfare. Over the course of those takeovers, robots' reputation for productivity gave them even more of a perceived commercial advantage over humans in that they worked very efficiently 24 hours a day without a break and without a complaint. Furthermore, their precision and consistently high-quality output far exceeds that any human worker could hope to duplicate. As the sophistication of robots increase, so will their ability to displace humans in many other areas of fabrication, quality control, and even sales.

Many of us will be working in a world full of very smart machines that will continually take over tasks we used to do simply because of the unassailable facts of economic life. Loss of jobs and income to the less expensive, yet unquestionably more proficient and productive robots will present real problem to the increasing number of folks so displaced. Humans occupying jobs that are in line for robotic takeover obviously need to learn new skills fast to stay gainfully employed.

Mechanical things like robots need to be maintained regularly and that job will largely be done by human “caretakers”. It makes perfect sense that some of those folks whose jobs were taken over by robots can become their caretakers, being familiar as they are with that specific industry. So, besides the human skills needed to design, manufacture, and install these robots, their maintenance requirements will require a trained cadre of people to keep this new generation of “workers” humming along at peak performance.

Despite the fact that such advanced creations are a long way from being deemed alive, ethical issues regarding the “rights” of the more advanced humanoid robots are, interestingly, already being debated. Very sophisticated versions of Artificial Intelligence are seen by some as equivalent to Artificial Life, which then begs for ascribing them moral rights. However, it seems to be the height of folly to ascribe moral rights to a machine no matter how human-looking it is. This also underscores our typical arrogance in believing we could duplicate our Creator’s accomplishment with a soul-less, emotion-less counterpart.

One requirement for being classed as alive is, as noted earlier, the ability to reproduce a copy of oneself. And naturally this, too, is being investigated as a possibility for robots. Enabling robots to reproduce themselves also contributes to (unfounded) fears of robotic takeover.

In regard to such reproduction, the first thing that comes to mind is a rather complex but mundane production line. Here, various kinds of other robots would be seen putting together pieces of plastic, metal, batteries, electrical wiring, and circuit boards, winding up with a completely programmed, working specimen at the end of the line.

This robotic creation by other robots is a far cry from self-replication. Still, what isn't usually appreciated is the logistics of gathering together all the necessary materials for an AI robot…this is an enormously complex physical and intellectual undertaking in itself. Acquiring, inspecting, and physically emplacing parts, then checking out the resulting creation will require robots that have a substantially higher price tag than comparable human laborers, so it really wouldn't make economic sense to do so. And the process certainly bears little resemblance to creation as we know it…beginning with the little one-cell zygote that adds and organizes billions of specialized cells over nine months in Mom's womb, followed by the creation of trillions more cells over two decades or so to become a fully mature human being.

Further complicating the robot reproduction is the reality that seldom does anything go 100% as planned. The anomalies that invariably pop up during any production process will require detection, removal and trashing of the errant parts, replacement with new parts, and checkout of the repair. Of course, the inspection and discarding of nonconforming items are even now routinely handled by robots. But, repairing a sophisticated robot to save it from the junk heap smacks of a human job since it will require lots of physical mobility and dexterity along with inventive thinking to access and install correct spare parts. A human is much more likely to be the more economic choice for this job than an incredibly sophisticated and extremely high-priced robotic counterpart (which, in turn, will need its own maintenance crew).

Less well-advertised are attempts at devising <u>living</u> or "soft" robots. Scientific labs in the US have nurtured live robots, each consisting of about 3000 skin cells of an African frog species, *Xenopus laevis,* in a Petri dish. These cells were not genetically changed, but instead simply “smushed” together and manipulated to form a very small shape that best fits the functions the scientists want the living robot to perform. How these stuck-together cells ultimately communicate with one another to form a specifically-molded multicellular entity for such purposes is unknown (while on a much smaller scale, it’s akin to the same perplexing multi-cellular coordination magic yet to be deciphered in our own bodies).

So far, the impressive capabilities of these microscopic living robots include a means of gathering together other stem cells and then producing clones of themselves in an unprecedented type of reproduction process! Aptly known as *Xenobots,* these are expected to initially become drug dispensers aimed at inserting drugs to specific areas within the human body via the bloodstream. After performing their delivery service, they will die out in about a week and our natural trashmen (*phagocytes*) will dispose of them like they would any dead cells. With this ongoing, rapid advancement of *nanotechnology*, we’ll soon find these microscopic-sized robots (*nanobots*) performing currently impossible medical diagnostic and remedial operations within our bodies.

Efforts are also now afoot to construct robots that replicate the human countenance to an extent previously unimagined. Still in very rudimentary stages of development, the incentive for devising such robots is currently more related to indulging our curiosity and showcasing our engineering creativity. This apparently stems from an innate urge to build credible-looking “humanoids” that will ultimately possess mental proficiency and physical attributes even superior to real humans, leaving out the “frailties” of human emotional behavior. Supposedly, we will have then created both the consummate conversationalist and a fountain of information as the ultimate companion.

On the other hand, movies often stoke fears of AI-imbedded androids becoming the ultimate threat to the human race. It seems unlikely that we would expend very much time and money trying to construct an army of these extremely expensive creations in the first place. Most of our efforts will be much more productively aimed at improving the large, ground-based machines in warehouse-sized facilities. We'll get significantly more germane output per dollar from these amazingly productive un-miniaturized non-human-looking machines. Trying to make robots mobile and as human-like as possible will require an extravagant amount of funding, and unlikely to draw many stakeholders. That said, a few versions will probably be built for exclusive use by the ultra-rich, to provide them with a literal "conversation piece".

Humans have always tended to anthropomorphize animals, pets, or certain play things (i.e., fantasize them as having human-like reactions and emotions). We'll more than likely wind up doing so with humanoid robots. Of course, the more sophisticated these humanoids get in terms of human likeness, the less imagination we'll need to perceptively "humanize" them. It's been found, however, that we evaluate and emotionally react differently to what we perceive as "objects" than when we respond to real live humans…we pick up on and evaluate the visual cues they elicit much differently.

The preferred gender of androids is also an interesting study in human emotional response. The usual movie versions of androids that depict evil intent are usually portrayed as male. Females, on the other hand, were found in studies by commercial interests to be less off-putting and inherently more approachable by human "customers". This same reaction applied regardless whether the human customers were men or women. One hotel in Japan is already experimenting with a partial staff of advanced androids made up entirely in the image of young Japanese women who are fluently multi-lingual; they are being lauded as one of the most congenial group of employees ever!

Depending on the accuracy of facial features and physique, our immediate impression of a full-bodied android could cause our human response antenna to rise like it would for the real thing. But a subsequent major emotional turnaround could follow when, upon closer examination, subtle inconsistencies or lack of normal feedback were detected in the machine's facade or responses. Unless we were alerted to it being a counterfeit person in advance, our limbic system would be jolted into the sudden realization that we were duped, giving immediate rise to fear, embarrassment, or anger. However, moments later, a more measured response could also motivate laughter and the incident would become food for humorous conversation over many years to come.

The more closely that idealized human anatomy and exemplary good behavior is reproduced in these androids, it might come to pass that we could see these creations as superior companions to real people. On the other hand, studies show that we are intrigued with credible human-like appearance up to a point, after which the similarities become "creepy". The artificial moles, scars, wrinkles, and other skin imperfections will still appear too "perfect". We apparently rebel against serious attempts to fool us into mistaking a machine for a real human being.

Despite the best intentions to create androids of seemingly friendly, faultless character, the deep protective emotional makeup inherent in our limbic system may forever remain a stumbling block to socially accepting them as one of us, no matter how smart or attractive they are. They will still seem "contrived". We could likely find them fascinating, even awe-inspiring works of art. If they are a permanent part of your world, you may come to love them like a pet or favorite toy, but not as an equal human being.

Like other machines, most super-intelligent AI robots will be created to assist us, not compete with us. The more cost-effective ones may not necessarily be formed to look precisely like us. Most will probably be designed to provide answers to deep problems or provide conversational company. Since we strive to obtain the most logical and correct results without the emotional baggage carried by humans, it's contradictory and thus unlikely that a subroutine with human emotions would be intentionally programmed into a robotic version of ourselves.

Besides, it'll be enormously challenging and expensive to duplicate human emotional responses. Emotions are one of our earliest forms of communication, and are driven by an incredibly complex interplay of memory, hormones, verbal stimuli, body language, physical interactions and a subtle ability to "read" other people's minds. It's possible that, despite efforts to the contrary, emotions and perhaps a few other complex qualities of the mind will likely forever remain the exclusive domain of real humans.

Besides a lack of emotion, AI will always lack imagination…it can certainly offer a huge array of programmed or even self-learned suggestions to solving the problem at hand, but a human's unique style of inspirational creativity, or thinking out-of-the-box, is another feature that can't be replicated. Of course, for all practical purposes, being inherently adept at storing huge amounts of data, then retrieving and processing it with astounding speed, the wide variety of very quick responses AI provides will probably still offer plenty of practical alternatives. So, lack of creative imagination may not be a huge hindrance in most applications, even though it might limit variety and innovation in certain fields of endeavor - for instance, the arts or even creative architectural engineering.

Regardless of the highly-regarded, non-emotional examination of data and factual evidence to get an unbiased answer, advanced AI may still not necessarily get the “right” answer for the particular social circumstances in play at the time. Political expediency may still govern the final decisions and therefore override the AI’s informed answers. It wouldn’t be the first instance politics overrode good judgement.

As noted earlier, AI super-robots will be very expensive to create, especially those androids with their “brains” and “bones” all dressed up in the sophisticated accoutrements needed to make them as human-like as possible. In attempting to ensure universal appeal, most androids will have a cheerful, intelligent, yet unobtrusive persona with impeccable multi-lingual capability. Much effort will be given to equip them with programmed body language responses, voice inflections, facial gestures, and eye movements that appear appropriate and sincere for the situation.

They’ll also be programmed to engage in respectful conversation, giving polite responses even to hostile questions or suggestions…this will give them an aura of dignity and steadfast self-control along with a seemingly unflappable moral compass. Of course, if equipped with all these admirable physical, mental, and moral traits, they may appear a bit too sophisticated for engaging in the inconsequential chatter and colorful language consistent with the community’s social groups. On the other hand, there is possibly a lucrative entertainment market aimed at eliciting androids’ unique perspectives while they sit in on a ladies’ lunch or commiserate with local sports fans at their favorite bar.

But, beyond these mundane commercial possibilities, the primary purpose of advanced AI is to provide us with unmatched insight and problem-solving capability. One important priority will be finding the cause and cure of diseases and genetic disabilities. And, without a doubt, national security issues and improved weaponry will be high on the agenda as well. There is already a sort of international AI "arms race" regarding the gathering of strategic intelligence by subverting national cybersecurity systems.

Probably the more popular AI applications for the rank-and-file citizenry will be the much less intelligent and much cheaper versions applied to household gadgets and personal aides. Offered by the usual line of commercial vendors, these later generation devices will completely outclass the current popular ones like the iRobot Roomba floor cleaners or the Alexis internet command center. No doubt many other personal conveniences not even in current demand will eventually arrive on the scene.

Given the rational arguments that a robot more closely resembling a human would <u>not</u> necessarily be better equipped to do the job than just a run-of-the-mill machine, why would someone want to pay hundreds of times more for the same capability? The obvious answer is that some people can afford the luxury, and like a rare automobile, these unique robots would not only be way more prestigious, they would be more pleasing to the eye as well…sort of a piece of art.

The same sort of answer can be made for the often-suggested use of androids as close friends, confidants, or even sexual partners. In the latter application, sex with an android not only comes with an exorbitant price tag but also carries the risks of mechanical breakdown, possible grievous injury to oneself, and outrageously high repair costs.

Even in a liberal society, it could also easily emerge that a romantic relationship with androids, whether platonic or not, will generally be seen as perverse behavior. Such a relationship seems fundamentally not normal behavior, although compassionate “bleeding hearts” might argue that certain unfortunate individuals could not otherwise experience true love or sustained happiness with a real human being. Unfortunately, this is symptomatic of one abnormal behavioral pattern being swapped for another.

Since these highly sophisticated anthropomorphic machines have to be manufactured by seriously committed entrepreneurs at great expense, the industry thus created will probably have to contend with government approvals and restrictions, with obligatory safety regulations and warnings imposed. Manufacturers will also be burdened with “tweaking” each sale of their standard product with refinements to the basic model. For instance, exterior appearance and AI brain so that the android better conforms to the prospective owner’s specific emotional or physical needs.

Manufacturers will most likely include some formal education to a new owner of an android regarding the “care and feeding” of such a complex device. The specs and techniques for routine hygienic care plus the ability to perform certain simpler types of repair work on the artificial skin and other areas will be outlined in a video or hard copy of the Operator Instruction Manual. But, given all the technical complexity and required skills to maintain such an intricate machine, a manufacturer’s service contract covering much of this involved maintenance/repair will no doubt be a popular add on.

The whole kit will also have to come with a warranty, such as “Satisfaction Guaranteed or Your Money Back”. If the machine would ultimately be returned to the manufacturer in a warranty issue, then his responsibility would be to refurbish the “slightly used” android to give someone else a fresh try at guaranteed companionship.

This human/android romance angle has, unsurprisingly, spawned wildly imaginative speculation mainly because of the provocative subject matter. The physical and intellectual uniqueness of these android machines leads some folks to jump to the conclusion that they are a game changer in terms of emotional attachment. But, it’s sort of naïve to believe that close examination wouldn’t reveal obvious flaws in the android’s façade, and for people to become “grossed out” rather than enamored with a mechanized imposter. One can develop special feelings to many things, ranging from inanimate objects (I love my car) to pets (I love my cat) to another human (I love my wife). But even with something looking akin to a human, deep down it will be perceived as a very cleverly designed, but still inanimate object.

This dispassionate view of androids is somewhat at odds with concerns seriously expressed by some psychologists. It pertains to the possibility of acquiring a scornful emotional response to real people because of our comparison to the near perfect (and potentially far less contentious) androids. In other words, social relationships with androids will lead to a permanently diminished attitude toward real humans. The problem is similar to an addiction, in that we’d seek out the company of androids in lieu of real people because they are more ego-satisfying and consistently more attractive in manner and action.

Psychologists also see that our conversations with androids are presumably more relaxed, in that we will expend less emotional energy avoiding faux pas that may otherwise lead to contentious reactions with real people. Not only that, but there is higher possibility that their responses to whatever we offer in conversation can be both more enlightening and entertaining. And if we really wish to deceive ourselves, we can believe that all the politeness and personal accolades the androids may dispense are actually their own genuine feelings. Of course, there would need to be regular, ongoing access to these pricey friends in order for such emotional attachments to really flourish. This could get expensive, like many other addictions.

Given their extraordinary monetary value, some form of theft protection for androids will likely need to be implemented. The idea of successfully kidnapping an android sounds a little over the top, as there would be numerous ways of tracking its whereabouts and equal number of ways to disable the unit to make it functionally worthless to the illicit new owner. But again, using the automobile analogy, organized crime manages to thwart many built-in safeguards against vehicle theft…they probably could also do so for a kidnapped android, as well as find ways to lucratively dispose of illicit "body parts".

The ultimate future of this technological leap to create machines in our own image is hard to forecast. There are imaginative scenarios way out in the future of space exploration where perhaps the need for displaying a realistic "human presence" has some relevance. But most near-future exploratory aims would not seem to require that extra expense, meaning that an android explorer intentionally configured like a human makes little sense. Rather, we will probably obtain most if not all exploratory information from advanced AI devices that are configured specifically for the job, rather than using either real humans or android copycats.

Incidentally, the argument some make for needing <u>real</u> human explorers on upcoming Mars expeditions is that androids can't think "out-of-the-box". It will be an incumbrance, they submit, if explorers encounter an unplanned or unusual circumstance. But, in fact, whether a real human or an android is commander, the first course of action will be to relay details this encounter back to human analysts on Earth for their analysis and recommendations before proceeding further.

The transit time for radio signals between Earth and Mars is 5 to 20 minutes depending where the two are in orbit from each other, but that is very incidental compared to total mission time of two years and the need to get the right response to unplanned incident. If the unplanned incident turns out to be fast and fatal, then it would be better to have an android expire than a human…it would probably prevent delaying, or even scrubbing, of follow-on missions.

It also makes little sense to have human missions equipped with four-wheeled Mars rovers when, instead, wheels could be built into an android explorer itself. It's far more expedient to navigate most terrains on wheels rather than legs unless one is intending to inspect mountainous terrain. But in those cases, an android explorer equipped with a helicopter rotor may be much simpler, quicker, and less rigorous than an exhausting climb by a human in a stiff space suit. As in all cases, protecting a human explorer from cosmic, solar, and local environmental effects imparts a huge cost penalty for the mission. The most bang for the exploring buck will derive from purposefully-designed androids that probably won't physically resemble a human being in the least bit. Yet, equipped with the most reliable and appropriately configured AI for the job, and requiring no sleep, they'll get more done than could ever possible with human counterparts.

Up to this point, we have hypothesized on future matters over which we humans have considerable involvement and control. To finish off, here are a couple of looming significant events over which we have no control whatsoever. The good news is that they may not be life-ending events for us or the world, but the bad news is that they will definitely impact our lifestyles and we'll need to make some uncomfortable adaptations.

Number one is the changing character of the Earth's magnetic field. These changes have periodically occurred throughout this planet's long history, and seem to be the result of the slow, massive churning effects of the semi-solid circulating mantle beneath our Earth's solid crust. It is first characterized by a weakening and breaking up of the normally strong North/South magnetic lines into a large number of local, weak, and poorly defined N/S pockets spread around the world. Altogether, it's a very chaotic event that can last 2,000 to 6,000 years to complete. These N/S pockets eventually recombine back into a strong, but completely reversed, magnetic N/S pole configuration.

Known in scientific circles as a *geomagnetic reversal*, humans were not around the last time this occurred, about 750,000 years ago. So, there will be a lot of learning and adapting when this once more materializes. According to all the paleomagnetic clues found in rocks around the world, the average time between reversals works out to be about 500,000 years. This would imply we are overdue for a reversal, but the rocks also tell us that intervals of up to 10 million years have been interspersed in the record. So, it's anyone's guess when we'll be in for this development.

There has been some erratic behavior measured in the magnetic field in recent years, which have initiated some experts to predict we are now being set up for a flip. One of the more blatant magnetic irregularities is a large area in the southern Atlantic Ocean that exhibits a particularly weak field. It has even been given a name - South Atlantic Anomaly (SAA). Because the SAA's locally weak magnetic field lets in increased solar and cosmic radiation, it causes some mischief for satellites and space stations when they fly over it, mostly related to burning out their electronics. The effect is similar to those relatively rare occasions when solar flare-ups or cosmic events bombard and more deeply penetrate our magnetosphere. The resulting ionizing particles wreck some of our ground-level electronics as well as those aboard orbiting satellites.

The prospect of a weakened magnetosphere has also stirred concern over the implied health issues. However, more recently acquired data indicates that the resulting increase in radiation may not be as serious as originally believed, or at least nothing we can't deal with. Still, there will probably be added cost and inconvenience for increased skin and eye protection as well as shielding devices to keep navigation systems, electrical power grids, and our ubiquitous electronic gadgets performing unscathed.

Number two of our short list relates to the current Quaternary Ice Age…few of us realize we are currently in the midst of one of Earth's deep glacial periods but are saved of this enormous "inconvenience" by also being temporarily immersed in one of its periodic <u>interglacial</u> periods. The only obvious remnants of the preceding cold spell are the remaining ice caps at the North and South poles. The time will come when things will start getting really cold again and those ice caps will expand to their more <u>normal</u> state. For within the ice ages, the cold glacial periods consume about 90% of the time, with the interspersed warm interglacial periods contributing only the remaining 10%.

So, we are super lucky to be living at this unusually balmy period in Earth's history, but current estimates as to when the climate will begin reverting back to its normally colder conditions range anywhere from tomorrow to a couple decades, to 50,000 years and even out to 100,000 years from now. (You have my endorsement if your confidence in climate projections is next to nil.) When the frigid climate does arrive, any people around still decrying our carbon emissions will probably have a change of mind.

A challenging problem as the ice age intervenes will be keeping the far northern cities from being buried under mile-deep snow and glacial ice. If we have mastered nuclear fusion energy by then, perhaps we will have the energy source necessary to actually heat our environment within the local city boundaries and transportation routes to keep things livable. This, in turn, may avoid or at least diminish the need for unprecedented and very unsettling mass migrations to the warmer equatorial regions of the planet.

Another big challenge will be the food shortage resulting from reductions in acreage of agricultural fields and livestock ranges by the encroaching icesheets. The specter of starvation can potentially destroy society in different ways…facing death from famine invites lawlessness and a general breakdown of civil behavior in the quest for food. An extended food shortage will of course rapidly cull down the population through increased death rates from violence and starvation, and in the longer run from the reduced interest in raising families. Another hit to the population will materialize by way of our higher susceptibility to fatal cold-weather diseases and accidents.

The Neanderthals, among other hominins, successfully endured the “inconveniences” that past ice ages posed, so it may seem logical that our even more advanced modern humans can fare even better. The problem is that we are acclimatized toward warmer, milder conditions, so plummeting from a comfy life style into harsh ice age conditions will be both a psychological letdown as well as a challenge to the health and survival of millions. It will underscore the sound judgement of those who had previously elected to become citizens of the extraordinary space cities we may have put into orbit by then.

There will no doubt be other surprises and challenges to our existence, from Mother Nature's climatic antics here on Earth, to life-threatening engagements with extraterrestrial incursions, to space stations' emergencies, and to various unprecedented behaviors of our solar system, galaxy, and universe. But, our ability to overcome such threats will also improve as time goes by, which includes development of advanced surveillance systems and defensive measures. We may also have the last resort - our "escape" from the bonds of Earth itself if that's what it takes to survive.

Of course, there's much more to living a productive life than simply surviving…we strive for a <u>fulfilling</u> lifetime. This doesn't mean we should expect our existence being entirely devoid of stress, pain, or heartbreak.

Living a fruitful, rewarding life can be summed up beginning with a real sense of <u>Accomplishment,</u> which in large part overrides life's discomforts that we endured to provide benefits for ourselves, our family and friends, and maybe even the greater world.

Secondly, <u>Acknowledgement</u> that your body and mind constitute a miracle of creation that deserves all the respect and care that you can give it.

Lastly, <u>Appreciation</u> for being given the privilege of participating in our Creator's Grand Plan.

This book unveils the journey of human evolution from single cell life to the trillion cell masterpieces we now are. It also examines the conscious and subliminal makeup of our behavior, and how this influenced our existence.

Heirs of the Big Bang

By William T. Beran