Remaking Eden

Cloning and Beyond in a Brave New World

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Epilogue: The Destiny of Humankind?

"I am Alpha and Omega, the beginning and the end, the first and the last."

Revelation 22:13

Dateline Washington, D.C.: May 15, 2350

`The commission of leading academics – established by Dr. Albert Varship six months earlier – had come to Washington, in secrecy, to present their final report. One representative from each of the relevant fields – the reprogeneticist, the evolutionary biologist, the demographer, the sociologist, and the psychologist – sat around the table in the conference room at the Department of Health and Human Services. One by one, they took turns presenting a portion of the report to the HHS Secretary.

Their findings were grim; their predictions were surreal. Yet, Dr. Varship could find no flaw in their logic, no reason to challenge the central conclusion in their final joint summary statement: "If the accumulation of genetic knowledge and advances in genetic enhancement technology continue at the present rate, then by the end of the third millennium, the *GenRich* class and the *Natural* class will become the *GenRich*-humans and the *Natural*-humans – entirely separate species with no ability to cross-breed, and with as much romantic interest in each other as a current human would have for a chimpanzee."

The presentation took just over two hours. Throughout, Dr. Varship sat in silence. It was too horrific to comprehend. Unbelievable, and yet, entirely predictable. Indeed, predicted long, long ago.

Dr. Varship's mind wandered back to his teenage years, when he had been an avid reader of science fiction, including stories written by one of the fathers of the field –H. G. Wells – at the end of the nineteenth century. So much of what Wells had prophesied – television, intercontinental air travel, space stations, motion pictures, air conditioned cities, and much more – had become real early on. And now this as well – "the splitting of the human species."[1] Wells had written that, "the gradual widening of the present merely temporary and social difference

between the Capitalist and the Laborer was the key to the whole position," in the antiquated political language of that era. Now it was all coming true.

The only thing that Wells got wrong was how long it would take. Space travel to other worlds was one thing, but the notion that humans might someday be able to manipulate their own genes was clearly too ludicrious to consider during the first half of the twentieth century, even by visionaries like Wells, Verne, Huxley, and Asimov. And yet here we were on the cusp of an incredible evolutionary event. Not in the way Wells had imagined – as the result of natural evolution, 800,000 years hence – but in less than a millenium as a result of self-evolution.

It had been 300 years since genetic enhancement began in earnest. During that time, twelve generations of *GenRich* individuals had lived and reproduced. With each generation, it became possible to start with an already-enhanced genome that could be enhanced even further. And with each generation, an increase in biomedical understanding and genetic technology allowed reprogeneticists to make ever more complex enhancements, with hundreds, sometimes thousands, of added genes.

Although the initial focus was on physical and mental health, it shifted quickly to personality traits and talents in the cognitive, athletic, and artistic realms. In these areas, different enhancements were chosen for different *GenRich* children. But these differences sat on top of an ever-expanding genetically enhanced framework that was shared by all members of the *GenRich* class.

Varship was frightened by what he heard, and searched for the right response. Genetic enhancement clinics – GE centers, as they were popularly known – were spread across North America. They were all run as private enterprises without any government assistance. Indeed, long-existing laws prohibited the use of Federal funds for what was euphemistically called "research" on human embryos. Elected officials and GE executives both found this prohibition convenient for political cover, and it provided the basis for the "hands-off" approach that the government had consistently taken toward GE. It was for this reason that Varship had formed his commission in secrecy. But now that their final report was in his hands, what could he do with it?

The problem was that GE represented a multi-billion dollar industry that served not only American citizens, but many foreigners as well. Indeed, the American GE industry benefited enormously from restrictive laws that limited its practice in many other countries, and as a consequence, this single industry had a major impact on reducing the balance of trade on the side favorable to the American economy. Not surprisingly, politicians and their supporters from the business community were loathe to go anywhere near it. Of course, over the years, common citizens had occasionally expressed their concern about the longterm societal impact of GE. Rights to privacy; individual liberties; the folly of governmental intrusion into the free market – these were the talking points that politicians focused on in response to such concerns.

Varship and all of the presenters in the room with him that morning were themselves *GenRich*. If they had been born otherwise, they would never have attained the positions they held. All members of Congress, all entrepreneurs, all other professionals, all atheletes, all artists, and all entertainers were members of the *GenRich* class. There was no longer any way that even the most talented *Natural* could advance into any of these realms.

What could be done? What was possible? Put a stop to the whole thing, there and then? Outlaw the practice of Genetic Enhancement? There would be an outcry from all the *GenRich*. A Congress filled with *GenRich* legislators would never allow it to happen. And even if it did come to pass, in the end, it would make no difference. Sure, it might slow things down in the short term – perhaps a few months – but GE centers would simply move to off-shore islands, and to under-developed countries eager for added tax revenue. The prospective *GenRich* parents would all follow them abroad.

If legal restrictions erected in one country or another were useless, was there another way to stop the practice of GE? Varship considered the moral argument. Perhaps he could convince the President – who underneath his tough political skin showed twinges of humanity – to bring his enormous influence to bear on the problem and preach the sins of GE. Perhaps a campaign could be undertaken to explain to all *GenRich* people the frightening moral consequences of GE for humanity as a whole.

Unconciously, Varship shook his head as he realized the elimination of GE was hopeless. All prospective parents wanted to provide their children with the greatest possible advantages in life. It had been that way for hundreds of thousands of years. How could you convince parents to forsake this instinctive personal desire for the good of society. Each individual parent would say, "the genetic enhancement of just my child has no impact on society at all. Why is it immoral for me to want the best for my children? I'm not harming anyone else by my actions."

So much had changed, and so much would have to change again to get back to the way things once were (if ever they really were so). The gap between the *GenRich* and *Naturals* lay not just in genes, but in every other aspect of their lives and communities and, most important, in their monetary resources. Stopping the practice of GE cold, at this point in history, would not bring the classes back together again.

If there was no way that GE could be halted, was there a way to stop it from breaking humankind into two? Varship imagined a utopian society in which GE was freely available to all, and where all *Naturals* were raised to the level of the *GenRich*. It brought a moment's smile to his face, but just a moment and not more. Santa Claus existed only in the minds of children, and there was no way a society could afford to provide this expensive service to all of its citizens, even if it wanted to.

Where had we gone wrong? Was there any time in the past when a different course might have been pursued? Varship was well-versed in the early history of GE. The original practitioners drew a moral line between preventing disease and enhancing characteristics. How could anyone argue against preventing childhood disease? But it soon became clear that the moral line was an imaginary one. It was all genetic enhancement. It was all done to provide a child with an advantage of one kind or another that she would not have had otherwise. And what was wrong with that? What was wrong with helping children to live better lives?

The history books made it clear that early 21st century scientists had failed to see the cumulative impact of GE. Even as scientific understanding and technology continued to explode exponentially around them, they continued to assume that the future would be the same as the present, and that complex physical and cognitive traits would always be beyond reach. With a

shock that opened his eyes wide, Varship realized that most present-day scientists had the same mental block as their predecessors.

It was late, by Varship's reckoning. Too late to do anything at all, he concluded helplessly. We were on a journey into a rapidly evolving future that no man, no woman, could stop. And where it might lead, no one could tell.

Dateline The Milky Way: June 1, 2997

Just as Dr. Varship had suspected 647 years earlier, his scientific colleagues had been woefully conservative in their predictions of where GE would lead humankind. It was all because they had failed to appreciate the power of exponential advancement – not just in technology but in the essence of the human species itself.

Even simple cumulative processes had a way of taking early scientists by surprise. By the twentieth century, evolutionary biologists knew that their species could trace its ancestry back along a direct line to an ape-like mother who had lived 5 million years earlier, and whose children had gone on to generate both human beings and chimpanzees. Nowhere along those lines of a million generations did any child appear to be very different from its parents. And yet at the beginning there was an ape; at the end of one line, there was a human being.

Spectacular changes occured even more rapidly when early humans consciously intervened in the cumulative process. Within a hundred generations, they took individuals from a single species of gray wolves and bred them down different pathways into French Poodles and St. Bernards, into hounds and sheep herders, and into so many other breeds that look and behave so differently it's hard to believe they are all distant cousins of each other.

All of this was known by the end of the 20th century. Futhermore, significant progress had already been made, at that time, in the major scientific areas that together formed the basis for GE. Scientists were well on their way toward an understanding of how each gene in the human genome functioned. Genetic engineering had already been accomplished with other mammalian species. A prototype of the artificial human chromosome had already been invented. Surely, those who watched these advances take place must have realized where it would all lead. How

could the biologists themselves be so blind as to not understand that changes in their own species –predetemined at every step – would occur even more rapidly than the random changes imposed on domesticated animals and plants by earlier people.

But instead, conservative naysaying scientists ruled the day. Yes, the biologists admitted, we will soon identify every human gene. But, we'll *never* truly understand how all these genes interact with each other during the development of a human life. Although the human genome provides a blueprint, the blueprint is indirect and impossible to read in any context other than the developing human embryo and fetus. This is because each one of the billions of cells in the fetus acts as its own little computer in interpreting the genetic instructions present in its DNA in the context of its own little micro-environment. As a consequence, the biologists said, it would be *impossible* for even the most powerful computer to simulate the development of a human being starting with just the information present in a one-cell embryo. And because of this, they went on, big changes to the human genome would never be attempted since reprogeneticists would have no way of knowing *ahead of time* how these changes would really affect the child that was born with them.

But these late 20th century scientists made the same mistake as so many of their predecessors. Understanding the true nature of the gene is "beyond the capabilities of mortal man," they said in 1935; it is *impossible* to determine the sequence of the complete human genome, they said in 1974; it is *impossible* to alter specific genes within the embryo, they said in 1984; it is *impossible* to read the genetic information present in single embryonic cells, they said in 1985; it is *impossible* to clone people from adult cells, they said in 1996. And all of these impossibilities not only became possible but were accomplished while the early naysayers were still alive.

It is hard to believe they couldn't see that not only would all genetic interactions be uncovered, but that computers *would* become powerful enough to simulate the effects of any imagined genetic alteration or addition to the genome. (Now, of course, no GE engineer would ever dream of adding a new gene-pack to an embryo without first testing its effects by computer simulation.)

In the 24th century, Dr. Varship's commission predicted that humans would diverge into just two species – the *GenRich* and the *Naturals*. *Naturals* had the standard set of 46 chromosomes that long defined the human species, while the *GenRich* alive at that time had an extra pair specially designed to receive additional gene-packs at each new generation. With 48 chromosomes and thousands of additional genes, the *GenRich* were, indeed, on their way to diverging apart from the *Naturals*.

But what 24th century reprogeneticists failed to see was the looming consolidation and competition within the GE industry, and the impact of the earth's population explosion. Until the end of the 24th century, reprogeneticists had agreed to use the same special chromosome as the platform for all their enhancements. But in the 25th century, everything changed. Independent GE centers around the world were bought up by one of the three giants – Microgene, Unigene, and Macingene. Soon thereafter, in the heat of intense competition, each corporation began to modify the chromosomes offered to their clients in different, incompatible ways. As a result, *GenRich* families enhanced at Microgene-owned clinics began to diverge from those enhanced at Macingene-owned clinics, and both began to diverge from those enhanced at Unigene-owned clinics. By the 26th century, the original species of *homo sapiens* had already evolved into four separate species, not two. And that was just the beginning.

In the 26th century, overcrowding on earth had reduced the quality of life so much that many *GenRich* parents decided to give their children special genetic gifts to help them survive on worlds that were inhospitable to the unenhanced. The development of these new gene-packs was based partially on genetic information obtained from various creatures living under extreme conditions on earth – including giant clams, tube-worms and microscopic bacteria that thrive in scalding hot sulfurous water around volcanic vents on the ocean floor, far removed from light and free oxygen; and other creatures that use a biological form of anti-freeze to thrive around Antarctica. In addition, GE engineers had achieved human symbiosis with plants through the successful incorporation of photosynthetic units into embryos.[2] Not only could symbiotic humans receive energy directly from the sun, but they were now able to self-produce some of their own oxygen from water and carbon dioxide, just like plants.

The new era of exploration began with a settlement at the edge of the ice-covered polar cap of Mars. The lung-modified thick-skinned dark green human descendants that began their lives on the fourth planet from the sun barely resembled the primitive *Naturals* still roaming the planet earth. Of course, these green people had made sure to arrive with a variety of specially engineered animal-plant creatures that were also uniquely adapted to their new world. Some were used for food, others as pets, and others still were designed to extract large quantities of oxygen from water (using sunlight as an energy source) for the maintenance of optimal living conditions within enormous bubble-enclosed biospheres.

As the earth's population continued to expand, other types of enhanced *GenRich* groups moved to other planets, moons, and asteroids in the original solar system, where they used GE to further enhance the ability of their own children to survive on their chosen worlds. As the first artificial chromosome pair reached capacity, additional chromsome pairs of different types were added into subsequent generations. By the middle of the 27th century, there were at least a dozen different species of human descendants having chromosome numbers that varied from 46 in *Naturals* to 54 in the most enhanced *GenRich* individuals.

It was a long-sought-after genetic enhancement – finally perfected in the 27th century – that made it possible to even *think* about traveling to other solar systems. This was the gene-pack –designed by Macingene – that slowed the aging process down to a crawl. Children born with the AGEBUSTER gene-pack would live for hundreds of years, perhaps longer, with minds and bodies intact. Like young explorers throughout all the centuries of human existence before the 20th, they said good bye to their families knowing they would never see them again, and boarded enormous city-like nuclear-powered spaceships to travel to inviting planets discovered by astronomers in nearby solar systems.

And now here we sit in the year 2997 and ponder the future. Ongoing enhancements in the AGEBUSTER gene-pack and the technology of space travel are certain to expand the reach of human life across our galaxy, and perhaps beyond. With this expansion, far-flung communities will begin to lose contact with each other.[3] Indeed, many will lose cultural memory of their species origin on the third planet in a nondescript solar system lost among the billions in the Milky Way. Eventually, the descendants of humankind will travel through

millions of centuries, explore millions of worlds, and diverge into millions of different species with little resemblance to the humans of the 20th century . . . as they recapitulate the many paths followed by that very first cell – the mother of *all* living things – on the planet earth, so long ago.

Dateline The Universe: ????

The most incredible thing about the original human genome was that it provided human beings with a human consciousness able to imagine all of the things described in this book. The journey from three billion bases of genetic information to human consciousness was long and contorted, but no scientist from the time of Watson and Crick onward could sincerely doubt that the journey was indeed made –during the development of each human being.

The second most incredible thing about the human genome was how readily it revealed its secrets to humankind. The biggest secret, of course, was the precise genetic pathway that led to consciousness and intelligence. There were those who thought that "intelligence genes" would be found by looking for differences in the genomes of so-called smart and dumb people, but this approach was hindered by strong interference from environmental influences. Others thought that answers would come only from a deep understanding of how the brain was wired. But 21st century neuroscientists had neither the tools, nor the mental abilities, to map out or comprehend the trillions and trillions of connections that existed between neurons. In the end, the breakthrough came from an entirely different direction –through a look at our own evolution.

To appreciate the evolutionary approach, it is useful to consider the way in which geneticists generally discovered the root causes of things. The genetic basis for sickle cell anemia was not determined by looking at diseased people alone, it was uncovered by searching for the difference between a diseased person and a healthy one. And in the same way, the genetic basis for human consciousness and intelligence was not discovered by comparing humans to each other, but by comparing the shared human genome to that of their nearest living relative – the chimpanzee.

Incredibly, to the scientists who first took a look, the genome of the chimpanzee was virtually identical to the genome of a human being. In retrospect, this shouldn't have been surprising since the two species were only five million years apart. Yet the human genome gave

rise to human consiousness, while the chimp genome gave rise to a primitive form of subhuman consciousness. Clearly, the genetic basis for the greatly enhanced consiousness and intelligence of human beings had to be found among the small number of significant differences that existed between the two genomes.

By the end of the 22nd century, all of the genetic enhancements that were required (in theory) to provide a chimp with a human mind had been identified, even though it took longer to really understand what a human mind was all about. In the view of some, it was God's gene-pack that had been uncovered. But to reprogeneticists, it was just a marvelous tool. For if a chimp's brain could be converted into a human's "on paper," then further enhancements of *those very same genes* could convert a human brain into something that was that much more advanced.

It was a critical turning point in the evolution of life in the universe. For when the first generation of cognition-enhanced *GenRich* matured, they produced among themselves scientists who greatly outshone geniuses from all previous epochs. And these scientists made huge advances in further understanding the human mind, and they created more sophisticated reprogenetic technologies which they then used to enhance cognition even further in the *GenRich* of the next generation. In each generation hence, there were quantum leaps of this kind. Throughout it all, there were those who said we couldn't go any further, that there were limits to mental capacity and technological advances. But those prophesied limits were swept aside, one after another, as intelligence, knowledge, and technological power continued to rise.

A special point has now been reached in the distant future. And in this era, there exists a special group of mental beings. Although these beings can trace their ancestory back directly to *homo sapiens*, they are as different from humans as humans are from the primitive worms with tiny brains that first crawled along the earth's surface. It took 600 million years for those worms to evolve into human beings. It has taken far less time for humans to self-evolve into the mental beings that now exist.

It is difficult to find the words to describe the enhanced attributes of these special people. "Intelligence" does not do justice to their cognitive abilities. "Knowledge" does not explain the depth of their understanding of both the universe and their own consciousness. "Power" is not

strong enough to describe the control they have over technologies that can be used to shape the universe in which they live.

These beings have dedicated their long lives to answering three deceptively simple questions that have been asked in every self-conscious generation of the past.

"Where did the universe come from?"

"Why is there something rather than nothing?"

"What is the meaning of conscious existence?"

Now, as the answers are upon them, they find themselves coming face-to-face with their creator. What do they see? Is it something that 20th century humans can't possibly fathom in their wildest imaginations? Or is it simply their *own* image in the mirror, as they reflect themselves back to the beginning of time . . . ?

1. p.335 "the gradual widening of the present merely temporary and social difference": Original reference is H. G. Wells (1895) *The Time Machine*. {Quote can be found on p.301 of *Three Prophetic Science Fiction Novels of H.G. Wells* (New York: Dover, 1960).}

2. p.344 the successful incorporation of photosynthetic units into embryos: The photosynthetic units of plant cells are contained within little organelles called chloroplasts that float in the cytoplasm. All chloroplasts can trace their ancestory back to an single-cell photosynthetic creature that was gulped into a larger non-photosynthetic cell. But instead of the smaller cell being eaten by the larger cell, the two set up a symbiotic relationship with each other that was so successful, it served as the starting point for the entire plant kingdom. Remarkably, as a lasting remnent of their independent origin, chloroplasts still retain their very own little genomes.

3. p.345 far-flung communities will begin to lose contact with each other: Freeman Dyson explains why: "Even messages traveling at the speed of light take fifty thousand years to creep across the galaxy. Whole historical epochs will pass, cultures will rise and fall, between a telephone call and the reply. Each little piece of the galaxy will be a world of its own, isolated from other pieces by the immensity of space and the quickness of time. We shall enjoy abundant communication with our neighbors in the past, but of our neighbors in the present we can know nothing." {*Imgagined Worlds* (1996) p.163.}