Now I Am Become Life

In his brilliant essay "The Modesty of History," the acclaimed Argentine writer Jorge Luis Borges argued that profoundly consequential events do not always receive due credit in the annals of history. "I have suspected," Borges wrote, "that history, real history, is more modest and that its essential dates may be, for a long time, secret. A Chinese prose writer has observed that the unicorn, because of its own anomaly, will pass unnoticed. Our eyes see what they are accustomed to seeing. Tacitus did not perceive the Crucifixion, although his book recorded it."[1]

May 2010 may well turn out to be one of those "essential dates" to which Borges was referring. Likely as not, anyone following international news reports that month concluded that the events of note were the violent clash on board the Gaza "peace" flotilla; the riots in Thailand; the growing tension between North and South Korea; the disastrous oil spill in the Gulf of Mexico; or even the final episode of Lost. In the long run, however, we may come to see that one of the most pivotal moments in our day went largely unheeded.

On May 20, the prestigious academic journal *Science* announced, in its typically dry style, the "Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome."[2] For those who ventured past the title, however, pure and unadulterated drama lay ahead: A team of American biologists, led by Craig Venter and Hamilton O. Smith from the J. Craig Venter Institute in Rockville, Maryland, declared that they had succeeded in creating something very similar to artificial life in the laboratory.

To be precise, only the genetic material of the synthetic, unicellular organism was man-made; the biological encasement into which the synthesized DNA sequence was transplanted belonged to a bacterium that had been painstakingly purged of its original chromosomes. Nevertheless, the significance of Venter and Smith's scientific breakthrough cannot be overstated. Fifteen years of rigorous research and nearly $40 million had come to fruition: For the first time in history, man had created a being with no ancestor. *The Economist*, one of the few leading media outlets to cover the story at length, proudly proclaimed, "Creating life is no longer the prerogative of gods."[3]

Popular imagination, of course, has long foreseen this achievement. One cannot but recall the cursed figure of Frankenstein, the protagonist of Mary Shelley's classic 1818 novel, who suffers a tragic fate for his megalomaniac efforts to bring inanimate matter to life. *Faust*, Johann Wolfgang von Goethe's famous play, published in 1832, adopts a less austere approach to the matter: Early in the play's second part, Faust's student, Wagner, creates in his laboratory a homunculus, an artificial human-like being. He then erupts into a poetic monologue reminiscent of countless scenes from Hollywood B-movies:

> The stuff evolves! More clearly moving—
> Conviction stronger, stronger proving:
> The mystery that in nature earned one's praise
> *We* dare essay by rational incubation,
> And what *she* managed in organic ways
> *We* bring about by crystallization….
> It rises, flashes, will concrete—
> A moment and the work's complete.
> A great resolve seems crazy at the start
> But chance will give us cause for laughter later:
> A brain that can think perfectly will also
> Later have a thinker for creator.[4]

Wagner rants and raves like a caricature of a mad scientist, seized by delusions of grandeur. Indeed, Goethe paints the entire scene in a farcical light (the homunculus casually addresses his creator, "Well, Dad! How are you?"[5]). But Faust, Wagner's source of inspiration, is a serious man. He is learned and assiduous in his pursuit of knowledge—and unwavering in his desire to unlock the mysteries of creation. He yearns to free himself from his vulnerable, mortal condition, and to become a being of almost divine stature. Not for nothing did the German philosopher Oswald Spengler see Faust as an embodiment of modern technological civilization, which aspires to lay bare nature's secrets, the better to subdue it. In his momentous work *The Decline of the West*, published in two parts between 1918 and 1922, Spengler explains, "The Faustian inventor and discoverer is a unique type. The primitive force of his will, the brilliance of his visions, the steely energy of his practical ponderings must appear queer and incomprehensible to anyone at the standpoint of another culture, but for us they are in the blood. Our whole culture has a discoverer's soul. To *dis*-cover that which is not seen, to draw it into the light-world of the inner eye so as to master it—that was its stubborn passion from the first days on."[6]

With their groundbreaking achievement, Venter, Smith, et al. have granted Faustian civilization (which has by now spread far beyond the geographical borders of the Western world) a splendid victory. No doubt, the debate between those eager to forge through the uncharted territory and those who seek to check—or at the very least slow—the swift charge ahead will accompany every step along the path to discovery and conquest. Although the dazzling pace of scientific and technological progress may, at times, create the impression that such debate is futile, it is in truth a moral imperative. For how we use the knowledge we have just gained will, in the final equation, determine whether science will bestow upon mankind infinite abundance, or, alternatively, lead it to utter ruin.

Impressive as it may be, the successful creation of a bacteria with an artificial genome is in truth only the latest stage of a biotechnological revolution that has been taking place for some time now. Already in 1952, University of Chicago biologists Stanley Miller and Harold Urey performed a small miracle when they demonstrated how amino acids, the building blocks of living matter, are spontaneously formed in a prebiotic mixture of water, ammonia, methane, and hydrogen. Yet it was only with the advance of science into the inner sanctum of life—its penetration of the veil surrounding genetic material—that human beings came close enough to smell the opportunity to transform themselves from beings *endowed* with creativity into "semi-creators" themselves. In fact, since the completion of the Human Genome Project in 2003, the genetic codes of countless other organisms have been sequenced, generating a growing pool of data that makes advancement in biological engineering possible. This puts scientists in a unique position to realize the old Faustian dream of bringing new and original life forms into the world.

To be sure, this kind of science can offer considerable practical benefit. To take just one example: Jay Keasling, a biochemist from the University of California, Berkeley, engineered E. coli bacteria to produce artemisinin, a drug effective in treating malaria. And Keasling's success is merely the tip of the iceberg. As Ronald Bailey, the science editor of *Reason* magazine and author of *Liberation Biology* (2005), put it, "The goal is to produce novel organisms that excrete biofuels, clean up toxic spills, strip clogged arteries of cholesterol, rapidly produce vaccines, grow more photosynthetically efficient crops, and manufacture eco-friendly plastics."[7] But why stop there? In an article published this past June in *Scientific American*, David Biello offers a glimpse of the marvelous future that synthetic biology holds in store for us:

> Imagine a world where bamboo is programmed to grow into a chair, rather than roughly woven into that shape through mechanical or human industry, or where self-assembling solar panels (otherwise known as leaves) feed

> electricity to houses. Or trees that exude diesel fuel from their stems. Or biological systems that are reengineered to remove pollution or to thrive in a changing climate. Reprogrammed bacteria might even be able to invade our bodies to heal, acting as an army of living doctors inside us.[8]

A brave new world indeed. Yet such unfettered optimism is a luxury we can no longer afford. The repercussions of exercising nature's primordial powers irresponsibly are clear even to those who have nothing but admiration for the immense contribution science has made to our lives. Just as the ability to create artificial life will no doubt elevate the stature of mankind, it may also wreak havoc. States, terrorists, and greedy corporations will not hesitate to employ these new technologies in the development of biological weaponry with apocalyptic powers of destruction. Nor can we ignore the catastrophic possibility that an accident will release into the world monstrous life forms created in the safety of the lab—creatures that should hardly have been permitted to exist in the first place. Indeed, who can predict with any confidence the long-term effects of introducing engineered organisms into the environment? True, strict regulation and enforcement standards at both the state and international levels could ward off some of these dangers. But they can never prevent them entirely.

Reservations about the grandiose pretensions of biotechnology are never based solely on practical considerations, however. At root lie grave moral concerns. For example, we ought to reflect upon the kinds of restrictions we wish imposed on the creation of beings whose main, if not only, purpose is to serve mankind. Should the human species treat the new organisms it brings into the world simply as a means for achieving its own ends? Do these organisms really lack meaning in and of themselves? There are those who believe that the living deserve a certain basic respect as such; Albert Schweitzer was one of the more outspoken proponents of this position. For the moment, such questions exist comfortably in the realm of the theoretical. But once man's creations gain the ability to feel pain, experience emotions, or perhaps even develop some level of consciousness, this

dilemma will become acute. Genetic engineering already enables scientists to design laboratory mice with the propensity to develop cancer. Although medical research surely derives valuable information from experiments on these unfortunate animals, one cannot but feel somewhat uncomfortable with the whole affair. True, humans have fed upon, utilized, and enslaved other animals since the beginning of time, but a line has been crossed now that biologists can imprint this exploitation on the genum. There have always been creatures born into a life of suffering; now, such a life may be intentionally designed.

These fears, however, are not the only unique dilemmas born out of the age of synthetic biology. With the proliferation of artificial life forms, there will undoubtedly be some who desire to patent them. From a legal point of view, such attempts would not be unreasonable—these creatures are, after all, the fruits of human labor and ingenuity. Yet the very idea that a person or organization should have exclusive rights over a living being, if only for a limited period of time, seems, on the face of it, absurd. In the words of Leon Kass, one of America's leading bioethicists, "It is one thing to own a mule; it is another to own *mule*."[9] Indeed, any attempt to enforce such copyright protections would likely be met with numerous, possibly insurmountable obstacles. More important, this kind of claim to ownership is morally problematic. Is there any way in which patenting a new species would *not* involve a fundamental assault on the value of life, rendering it, in the end, equal to energy-efficient light bulbs or stain-removing detergents?

The fear of desecrating life or disrupting the natural order of things will undoubtedly continue to play a central role in the public's quest to curb biotechnological innovation. While not always framed in religious terms, this sentiment expresses a deep-seated concern about any human achievement that can be perceived as a metaphysical transgression. *Frankenstein*'s subtitle—*The Modern Prometheus*—is a case in point. The Titan who granted mortals forbidden knowledge, stolen from the gods, is a recurring archetype in the debate on mankind's dominion over nature. In his book *Biological Time Bomb*, British journalist Gordon Rattray Taylor employed

the same imagery to alert us to the destructive hubris that threatens to engulf those who wish to unlock the secrets of life:

> Man now possesses power which is so extreme as to be, at most, godlike. Prometheus dared to bring down fire from the abode of the gods and give this technique to men, for which he was severely punished. Fire, for all its benefits, was a dangerous acquisition. The myth embodies (as is the function of myths) a lesson: great power constitutes a danger unless used with great wisdom and is therefore reserved to those who know all things and can foresee the consequences of using it. Today mankind is in a Promethean situation. It is precisely because we cannot see, in detail, the consequences of using the new biological powers that they constitute dangers. The fact that they *might* be used for benign purposes or so as to benefit man is not the point, for history shows us that man is far more likely to use power wrongly than rightly.[10]

These cautionary words, written in 1968, have lost none of their relevance. On the contrary, the passage of time has only reaffirmed their validity. They reflect a strong conviction that the creation of artificial life, as exhilarating as it may be, does not conform to some basic responsibility felt by humankind with respect to itself and to nature as a whole. In his megalomaniac efforts to become like God, man sows the seeds of his own downfall. "I trod heaven in my thoughts, now exulting in my powers, now burning with the idea of their effects," admits Dr. Frankenstein to his companion Walton. "From my infancy I was imbued with high hopes and a lofty ambition; but now am I sunk! Oh!"[11]

The principled debate over the pros and cons of synthetic biology is generally split between two, more or less opposite, camps. On the one hand, there are the optimistic visionaries, who defend bioengineering with the claim that man has the *right* to exercise his potential as a rational and creative being; on the other hand, there are the pessimists and skeptics,

who point to man's tendency to do evil, and who consequently underscore his *obligation* to avoid taking actions that may promote this tendency and magnify its destructive effects. Both positions are well reasoned, and neither should be dismissed out of hand. Yet when all the arguments are accounted for, there remains yet another consideration; namely, that in the current state of affairs, the creation and cultivation of artificial life is more than a mere prerogative. It may, in fact, be a moral imperative.

One need not take either side in the debate to acknowledge humanity's grisly past deeds and the utter devastation we have collectively wrought. The pessimists, who warn against the accumulation of godlike power in man's untrustworthy hands, have seemingly resigned themselves to the fact that he already possesses such abilities—at least since he discovered how to split the atom, and to consequently initiate devastation on a massive scale. Humanity still struggles to create artificial life, and yet, in all that pertains to the art of killing, it can teach even the most terrible deities a thing or two. When the American nuclear scientist Robert Oppenheimer observed the first atomic explosion of the Trinity Experiment, held in New Mexico on July 16, 1945, he was reminded of a line uttered by Krishna, the avatar of Shiva, in the *Bhagavad Gita*: "Now I am become Death, the destroyer of worlds." Indeed, the nuclear arsenal at the superpowers' disposal holds enough destructive power to turn the entire planet into a radioactive wasteland.

Of course, humanity does not need weapons of mass destruction to ravage itself or its environment. The brutal conduct of modern technological civilization leaves gaping wounds everywhere; its impact on our planet is so enormous that Paul Crutzen, a world-renowned scientist and Nobel laureate in chemistry, has suggested identifying the present geological era as the "Anthropocene epoch." According to Crutzen, since the industrial revolution of the late eighteenth century the human race has been systematically plundering the earth's resources, causing extensive changes to the environment. These changes, which include, among other things, the emission of greenhouse gases into the atmosphere and massive deforestation, have far-reaching implications for our world. If mankind does not meet its end in

some unforeseen disaster, Crutzen predicts, it "will remain a major geological force for many millennia, maybe millions of years, to come."[12] Other scholars believe that human activity has played a significant role in the sixth mass extinction in the history of the planet—a biological catastrophe that is still taking place. And in *The Future of Life* (2002), Edward Wilson, one of the most distinguished naturalists of our generation, estimates that if humanity continues to rampage through the biosphere, approximately half the earth's species will disappear by 2100.[13]

Considering the awesome powers the human species possesses, as well as the implications of its actions on the future of life on earth, it seem reasonable to argue that man must bear responsibility not only for his own destiny, but also for the fate of all beings living within the boundaries of his ever-expanding empire. The German Jewish philosopher Hans Jonas, one of the founding figures of environmental ethics, presents just such an argument in his influential treatise *The Imperative of Responsibility*, published in 1979. Jonas sought to formulate a philosophic defense of life, which he considered "the explicit confrontation of being with not-being."[14] Man, he writes, is obligated to say "yes" to being as such; this imperative is a necessity born of his supreme position in creation:

> Power conjoined with reason carries responsibility with it. This was always self-understood in regard to the intrahuman sphere. What is not yet fully understood is the novel expansion of responsibility to the condition of the biosphere and the future survival of mankind, which follows simply from the extension of power over these things—and from its being eminently a power of destruction. Power and peril reveal a duty which, through the commanding solidarity with the rest of the animate world, extends from our being to that of the whole, regardless of our consent.[15]

Jonas' imperative of responsibility was intended to place limits on the technological civilization's unbridled quest for power. Yet the same power, it must be noted, may very well serve this imperative. That is to say, if it is man's duty to act as the planet's caretaker—if it is, in other words, his task to

do everything within his power to prevent the extinction of the species that exist alongside him—can not biotechnology, and more importantly, synthetic biology, provide him with the necessary tools to fulfill his mission?

The possibilities excite the imagination. It is certainly possible that Sometime in the future mankind will command both the knowledge and skills necessary to reintroduce long-vanished creatures into our world. Who knows? Perhaps the dodo bird will one day roam our nature reserves again, or our children see mammoths with their own eyes (although we would do well to heed the warning of *Jurassic Park* and leave the Tyrannosaurus rex in nature's graveyard). Furthermore, science may gain the ability to grant new and regenerated life forms qualities required for survival under extreme conditions. Hopelessly polluted habitats may be revived, and areas previously considered too hostile for life may become home to new species. In the right hands, biological engineering may yet succeed in repainting this planet green.

Perhaps this vision is overly optimistic. Still, we have no choice but to regard it as a source of inspiration and purpose. In the age of modernity, man has become an agent of wholesale carnage. This, in turn, has placed him under a moral imperative to try and balance the scales. Put simply, he must act as a steward of life. The book of Genesis tells us that the Lord placed Adam in the Garden of Eden "to work it and to guard it." The epitome of God's creation will fulfill these expectations if he can lead the world into a new golden age of fervent biological productivity. He will, of course, need to exercise caution and avoid arrogant excess. This will prove no easy task, to say the least. But in the final analysis, is any mission more worthy?

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Notes

1. Jorge Luis Borges, *Other Inquisitions: 1937-1952*, trans. Ruth L.C. Simms (Austin: University of Texas, 2000), p. 167.

2. Daniel G. Gibson et al., "Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome," *Science* Express, May 20, 2010, www.sciencemag.org/cgi/rapidpdf/science.1190719v1.pdf.

3. "And Man Made Life," *The Economist*, May 22-28, 2010, p. 11.

4. Johann Wolfgang von Goethe, *Faust*, trans. Louis MacNeice (New York: Continuum, 1994), p. 188.

5. Goethe, *Faust*, p. 189.

6. Oswald Spengler, *The Decline of the West*, trans. Charles Francis Atkinson (New York: Knopf, 1934), p. 501.

7. Ronald Bailey, "Who's Afraid of Synthetic Biology?" *Reason*, May 25, 2010, http://reason.com/archives/2010/05/25/whos-afraid-of-synthetic-biolo.

8. David Biello, "Creation of Life," *Scientific American*, June 2010, p. 26.

9. Leon Kass, *Toward a More Natural Science: Biology and Human Affairs* (New York: Free Press, 1985), p. 151.

10. Gordon Rattray Taylor, *The Biological Time Bomb* (New York: World Publishing, 1968), pp. 222-223.

11. Mary Shelley, *Frankenstein: or, The Modern Prometheus*, ed. James Rieger, (Chicago: University of Chicago, 1982), p. 209.

12. Paul J. Crutzen and Eugene F. Stoermer, "The 'Anthropocene,'" *Global Change Newsletter* 41 (2000), pp. 17-18, www.mpch-mainz.mpg.de/~air/anthropocene/.

13. Edward O. Wilson, *The Future of Life* (New York: Knopf, 2002).

14. Hans Jonas, *The Imperative of Responsibility: In Search of an Ethics for the Technological Age*, trans. Hans Jonas and David Herr (Chicago: University of Chicago, 1984), p. 81.

15. Jonas, *Imperative of Responsibility*, pp. 138-139.