**Challenges of Life Science and Technology to an Ecological Worldview**

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**Post-Humanism Based on Postmodern Ecology**

 Our worldview determines our ways of thinking and methods for scientific inquiry, whether or not we are conscious of it. The scientific revolution of the 16th century, as well as the human-centered modern worldview that overcame the theocentric medieval perspective, provided the basis for a rational and mechanistic approach to separating nature and man, and to explaining nature as an object through the laws of matter and motion. This mechanistic approach to nature has provided a very useful means for scientific exploration of objects including life organisms, the philosophical background for the development of modern natural sciences. Further, it developed the reductionist approach to understanding the central properties of objects, which continuously reduces objects into smaller units. Needless to say, science and technology, which have developed rapidly on the basis of this worldview, have improved the material quality of our lives and freed human beings from the harsh conditions of nature. However, this is nothing more than a “falling upward”[[1]](#footnote-1) process for humanity, resulting in the overgrowth of human power leading to energy depletion, environmental destruction, global warming, and a worldwide crisis of ecosystem. Through the study of world history, we learned of the rise and fall of various civilizations, such as the Egyptians and Mayans. Although we strive to find political and social causes for the decline of civilizations, such as war, the most important cause was environmental change.[[2]](#footnote-2) At present, human beings face extreme environmental changes and risks, including population explosion due to the development of life science and medical technology; depletion of energy resources and climate change due to greenhouse gases created by fossil fuel abuse. We are also experiencing frequent natural disasters including viral epidemics and contamination of water due to the reduction of primeval forests. Because previous civilizations in history were territorial, their rise and fall could not threaten the whole of humanity; on the contrary, decline of the globalized modern civilization is expected to pose a serious threat to humanity as a species. Thus, to survive the present environmental crisis, human beings as a species must overcome various problems derived from their modern, human-centered worldview, moving toward a new, ecological worldview based on postmodern post-humanism. This new civilization based on the ecological worldview has been suggested as different names but the same context: the Gaia hypothesis[[3]](#footnote-3) that considers the Earth as a living organism in which organisms and non-organisms evolve and develop by close interactions; the Ecozoic Era[[4]](#footnote-4) concept of Thomas Berry and Brian Swimme; and the ecological model[[5]](#footnote-5)of Charles Birch and John B. Cobb. On the other hand, the rapid development of life science and technology brought another post-humanism with enhanced human capability based on technologies in the 21st century.

**Rapid Development of Life Science and Technology**

 In the 20th century, the rapid development of molecular biology based on the mechanistic reductionist methodology has confirmed Darwin’s theory of evolution and revealed that all organisms on Earth are maintained in the same fashion from the same genetic information in DNA. In the 21st century, the genome era has already been realized and the genome, the complete genetic information of any living organism including a human, can be quickly, easily, and cheaply determined. Living organisms are recognized as information. We rush toward an era in which humans design and produce living things, including themselves, and expand into machines.

 Although the general public has not yet overcome its fears about genetically modified organisms, or GMOs, life science has been opening the field of “synthetic biology”, since the end of the Human Genome Project in 2003. Synthetic biology refers to the creation of whole organisms, living systems of cell organelles, and proteins through design and synthesis at the molecular level using the basic building blocks of life.[[6]](#footnote-6) In this respect, a new era has begun in which human beings intellectually design living organisms. This synthesis began with bacterial systems, and gradually expanded to complex living organisms. Recent efforts have been made to regenerate extinct species or to investigate how life works by synthesizing human genomes. Synthetic biology is a refined expansion of the mechanistic theory of life by Jacques Monod, who said, “the secret of life is revealed at the level of chemical composition. If we can describe the chemical order as well as the laws of assembly, the secret of life will be publicly declared and the event will end the controversy of life.”[[7]](#footnote-7) Synthetic biology ultimately seeks to understand the laws of assembly of life as matter. Furthermore, synthetic biology aims to create new organisms or biosystems capable of necessary tasks by redesigning and applying concepts of engineering to current organisms or biosystems incapable of such tasks.[[8]](#footnote-8)

 Simultaneously, genome editing technology using the “CRISPR-Cas9”, which can correct or edit specific genetic information in a genome, has spread rapidly and been successfully applied or tested in most living organisms as of 2013. CRISPR-Cas9 is an excellent molecular scissor tool to cut and modify the genome with great precision and low cost. In the fields of life sciences and biotechnology, gene scissors inhabit a critical methodological position, making it easy to introduce a desired external gene into a genome, to edit the genome of an organism, or to transform genes to create living organisms with new genetic traits and altered genetic information. CRISPR-Cas9 has been applied to various fields beyond molecular biology, and has been used for a variety of purposes in numerous organisms such as bacteria, insects, plants, animals, and humans. CRISPR-Cas9 genome editing tool can easily correct, design, and transform living organisms, encouraging and facilitating the trend towards synthetic biology. This technology has ranked first among the top 10 most innovative science and technology developments every year since 2013. In July 2017, a study was published in which the CRISPR-Cas9 technology was successfully applied to fertilized human eggs; criteria for gene correction or editing in fertilized eggs is now the most important issue in the scientific community worldwide. Developments in life science bring us ever closer to realizing the world imagined in the science fiction novel *Brave New World*, written by Aldous Huxley in 1932, or the science fiction film *Gattaca*, released in 1997.

 Developments in psychology and cognitive science have accelerated studies intending to understand reductively how the brain works. These studies revealed what once described in terms of human spirit or mind, as the operation of substances such as hormones and neurotransmitters. Current research on living organisms is rapidly evolving into the investigation of the brain, beyond the genome. The Brain-Mapping Project aiming to understand the network of 100 billion nerve cells in the human brain, began in 2013 and expects to reach completion in 15 to 20 years.

 Additionally, brain-computer interface (BCI) devices, which connect swiftly advancing artificial intelligence (AI) to human brain functions, are developing at a rapid pace. BCI devices facilitate direct communication between a brain and computer. Thus, BCI devices enable human beings to communicate with computers without input devices such as a mouse or a keyboard; brain activity is input into the computer directly. BCI devices allow the brain to control the computer and its peripheral devices through brain signals alone, without moving muscles via motor nerves; the computer and its peripheral devices thus operate according to human intent. This technology will be very useful for patients with motor neuron dysfunction. Once commercialized, the technology could change life significantly, as seen in science fiction films. For example, remote devices could be controlled by brain functions of the people during consciousness, learning, and thinking. Our reality moves towards a world in which machines react to stimuli recognized by life forms, rather than one in which life forms respond to stimuli.[[9]](#footnote-9)

 The development of life sciences technology continues to prolong the average life expectancy of human beings. In today’s globalized, post-capitalist world, life science technologies uncontrollably accelerate the human desire to exceed the limits of existence as a living organism. We now live in a society in which aging is not a natural phenomenon but a pathology[[10]](#footnote-10) to be overcome. A remarkable example of this phenomenon is Project Gilgamesh, run by Calico (“California Life Company”), a biotech company founded by Google that dreams of human immortality. The desire to prolong human life is further reinforced by the development of artificial organs and body parts called prostheses, which can replace and assume the functions of damaged or missing parts of the human body.

 The rapid development of life science and medical technologies including synthetic biology, genome editing, brain science, BCI devices, and artificial prostheses, as mentioned in this article, poses questions about the definition of life and the identity of humans as a species: what is life, what is a human, and how should the relationship between human and machine tools be established? It is impossible to halt development of these technologies in our globalized, post-capitalist system. Therefore, we are urgently required to define what kind of worldview should accommodate these technologies.

**How Should Ecology-Based Post-Humanism Embrace Post-Humanism through Life Science and Technology?**

The development of life science and technology suggests that, in the near future, technology will infinitely extend humans’ fundamental abilities and overcome the limits of mortality and disease, enabling mankind to exceed present human capacity. This new type of human race is called the post-human[[11]](#footnote-11), and the tendency is called post-humanism. We also used the term trans-humanism to distinguish it from the post-humanism that refers to a new worldview to escape the human-centered modernity mentioned previously. Max More, an advocate of trans-humanism, describes it as “a set of life philosophies that continue and accelerate the evolution of intellectual life by using scientific and technological means to go beyond the present human form and limitations under guidance by the principles and values of life-promoting principles.” Nick Bostrom, who sparked the debate over post-humans, says, “What matters is not what the present human species or human beings are, but what kind of being humanity can become in the future.”[[12]](#footnote-12) In contrast, Francis Fukuyama argues that the remarkable development of biotechnology threatens the essence of human beings with its enormous influence, which can change the very nature of human beings. Fukuyama warns the dangers of a new history of post-humans, human descendants who are no longer human.[[13]](#footnote-13)

In this presentation, I would like to open a discussion of how we can answer the questions of defining life and human identity as species, posed by recent developments in life science and technology, in the perspective of the worldview of ecological post-humanism, which emphasizes the relationships required for survival of the human species on Earth. I also invite an open debate on how post-humans accelerated by life science and technology can be embraced by ecological post-humanism.

1. Charles Birch and John B. Cobb, *The Liberation of Life* (1990), pp 194-202 [↑](#footnote-ref-1)
2. Jared Diamond, *Collapse* (2005), pp. 486-525. [↑](#footnote-ref-2)
3. James Lovelock, *<Gaia: A new look at life on Earth>* 1979, pp 241-272 [↑](#footnote-ref-3)
4. Brian Swimme and Thomas Berry, *The Universe Story* (1994), pp. 375-495. [↑](#footnote-ref-4)
5. Charles Birch and John B. Cobb, *The Liberation of Life* (1990), pp. 119-164. [↑](#footnote-ref-5)
6. Kiwon Song et al., *Life Sciences, Challenged God* (2017), pp. 16-46. [↑](#footnote-ref-6)
7. Jacques Monod, *Chance and Necessity* (1974). [↑](#footnote-ref-7)
8. Drew Endy (2005), “Foundations for engineering biology,” *Nature* 438: pp. 449-453. [↑](#footnote-ref-8)
9. Kiwon Song, (2014), pp. 237-258. [↑](#footnote-ref-9)
10. Aubrey de Grey, *Ending Aging* (2007). [↑](#footnote-ref-10)
11. Nick Bostrom. [↑](#footnote-ref-11)
12. Nick Bostrom, *Superintelligence* (2009). [↑](#footnote-ref-12)
13. Francis Fukuyama, *Our Posthuman Future: Consequence of the Biotechnology Revolution* (2003). [↑](#footnote-ref-13)