

## The century of biology: three views

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**Abstract** The claim that the twenty-first century will be the century of biology could turn out to be true in three very different ways. One view is that developments in biotechnology will help to treat diseases and improve life. Another view is that changes in the biosphere will lead to extreme scarcity and endanger billions of humans. A third view is that biotechnology and climate change will further bifurcate the world into people with good health prospects and people with poor health prospects. I describe these views and show how they involve different accounts of the ethical issues that we will face and the ethical virtues that we will need to cultivate.

**Keywords** Biotechnology · Century of biology · Climate change · Ethics

The twenty-first century will be the century of biology. Or so people say. They may be right, but their claim could turn out to be true in three very different ways. And each way involves a different view of the ethical issues we will face and the ethical virtues we will need to cultivate.

When people speculate about the importance of biology in this century, they usually have in mind discoveries in molecular biology, reproductive biology, and genetics. Based on developments in these sciences, people imagine biotechnologies that will improve human health and life. The physicist Freeman Dyson takes this view (Dyson

2007). In an article titled “Our Biotech Future,” he predicts “that the domestication of biotechnology will dominate our lives during the next 50 years at least as much as the domestication of computers has dominated our lives during the previous 50 years” (Dyson 2007, p. 4).

Dyson emphasizes the great potential for biotechnologies, especially horizontal gene transfer, to treat diseases, address urgent problems, and improve life on Earth. We can already use our understanding of genetics to “modify plants so as to give them improved yield, improved nutritive value, and improved resistance to pests and diseases” (Dyson 2007, p. 6). In the future, we may be able to use our understanding of genetics to address the problems of energy production and climate change. Dyson (2007, p. 6) writes that

When we have mastered the art of genetically engineering plants, we may breed new crop plants that have leaves made of silicon, converting sunlight into chemical energy with ten times the efficiency of natural plants. These artificial crop plants would reduce the area of land needed for biomass production by a factor of ten. They would allow solar energy to be used on a massive scale without taking up too much land. They would look like natural plants except that their leaves would be black, the color of silicon, instead of green, the color of chlorophyll.

Of course, if we engineer plants in this way, we will also need to engineer microbes to eat all the silicon leaves that pile up in the fall.

Dyson’s view involves a particular attitude toward nature and a particular view of the key ethical issues. In his view, we should treat the natural world as material to be manipulated for the benefit of human beings. We should use our knowledge of biology to do, in a better and faster

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way, what humans have always done: shape the natural environment to meet human needs. Dyson acknowledges the need to establish appropriate limits in order to guard against dangers and unintended consequences. But, for Dyson, the big ethical issue is about the need to develop and diffuse technologies so as to benefit people all over the world. Since sunshine is more abundant and diffuse than oil, it could be combined with open-source biotechnologies to help alleviate rural poverty (Dyson 2007, pp. 6–8). Given this view of the ethical issues, the vices that we should avoid are the timidity that blocks new developments and the greed that tries to privatize biological knowledge. The virtues that we should cultivate are boldness, creativity, and a more expansive concern for all humans.

But the claim about biology and the twenty-first century may turn out to be true in a very different way than Dyson imagines. Climate change, ecosystem damage, and resource limits may turn out to be the key determinants of population health in this century. And the key sciences may be climate science, ecology, Darwinian biology, and Malthusian economics. This century may be dominated not by developments in biotechnology, but by developments in the biosphere.

James Lovelock (2006) takes this view. By emitting greenhouse gases, we are altering the temperature-regulating systems on Earth. When the concentration of carbon dioxide reaches 500 parts per million, Lovelock believes that ocean algae will begin to die and rain forests will turn to scrub, contributing even more to global warming (Lovelock 2006, pp. 60–65). Within the century, average temperatures could rise by 6–8°C. Although some humans will survive in the new climate, by settling in the habitable regions of what we now call the Arctic and Antarctic, billions will die off. Unless we act quickly, the ethical issues in this century won't be about biotechnologies. They'll be about lifeboat ethics.

Lovelock believes that we could further our understanding of what's happening, and our response to it, by

thinking of the whole planet as a single organism. He looks “on the Earth through Gaia theory as if, metaphorically, it were alive at least in the sense that it regulates climate and composition of the Earth's surface so as to always be fit for whatever forms of life inhabit it” (Lovelock 2006, p. xiii). We need to view nature as a living, self-regulating system, and to act quickly “with the health of the Earth, not the health of people, in mind” (Lovelock 2006, p. 7).

Given this view, the virtues we need are respect and love for Nature, Earth, or Gaia. We need a much better sense of our home on Earth and our place in the larger system. And we need enough humility and modesty to make a “sustainable retreat” from our misguided practices and assumptions (Lovelock 2006, p. 7,149). The vices that got us into this predicament are hubris, narrow concerns, and ignorance—about science, our home on Earth, and who we really are.

But both Lovelock and Dyson might be wrong. The claim about biology and the twenty-first century may turn out to be true in a third way. I think we are headed for a bifurcated world. At least over the mid-term, and at least if temperature increases are kept below 2°C, wealthier societies and people may be able to adapt to climate change. And they will probably benefit from new developments in biotechnology. But poorer societies and people will suffer more. Although they contribute very little to global warming, the poor are likely to bear the brunt of the problems associated with changes in the climate and environment. And they are unlikely to benefit from new developments in biotechnology. Indeed, many are still waiting to benefit from vaccines that were developed 50 years ago.

A bifurcated world is most likely because that's the kind of world we already have. Without a conscious and concerted effort to change habits and institutions, old patterns are likely to continue. These habits and institutions, along with the vested interests that are enmeshed in them, will exacerbate the environmental problems, distort the potential of the new biotechnologies, and widen the gap between

**Table 1** The century of biology: three views

Century of biology	Century of biotechnology	Century of the biosphere	Century of (further) bifurcation
Example	Dyson (2007)	Lovelock (2006)	Dwyer (2005)
Anticipated conditions	Relative abundance	Extreme scarcity	Increasing scarcity
Key ethical issues	Creating and diffusing new biotechnologies	Protecting the health of the Earth as a system	Sharing the capacity of the atmosphere and biosphere
Vices to avoid	Timidity Greed Privatization of knowledge	Hubris Ignorance Narrow concerns	Injustice Indifference Corruption of vested interests
Virtues to cultivate	Boldness Creativity Concern for all humans	Humility Modesty Respect and love for nature	Justice Modesty of demands Concern for the most vulnerable

rich and poor. Biotechnology alone will not solve our problems. To mitigate the problem of climate change and increase adaptive capacity, we will need to change social and international arrangements.

My view of the future has influenced my ethical outlook and focused my attention on certain issues (Dwyer 2005). Dyson sees a world of relative abundance, if we can develop and diffuse the appropriate technologies. Lovelock sees a world of extreme scarcity, and focuses on the health of the whole system. They both push the ethical discussion, in different directions, almost beyond the circumstances of justice—the “conditions under which human cooperation is both possible and necessary” (Rawls 1971). I see a world of increasing but manageable scarcity, and so I focus on the need to develop norms and institutions that will help us to share fairly the biosphere’s capacity to sustain life. Given my view, the virtues that we need are social justice, international justice, a concern for the most vulnerable, modesty of demands, and the creativity to fashion healthy and good lives with limited natural resources. The vices that we need to avoid are ignorance of our situation, the corruption of vested interests, the injustice of taking more than our share, and indifference to the plight of others.

Table 1 summarizes the three views that I have discussed.

A major ethical challenge in this century is to ensure healthy living conditions for all human populations. At present, life expectancy is about 40 years in Angola and Zimbabwe, while it is greater than 80 in Japan and Sweden. Another ethical challenge is to live in an environmentally sustainable way. Our current greenhouse gas emissions, ecological footprints, population growth, and forms of economic growth are unsustainable. A third ethical challenge is to preserve the life of other species. The current rate of extinction is about 100 times higher than it would be without human impact. Our feeble responses to these challenges may turn out to be the most characteristic feature of the twenty-first century.

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