The New York Review of Books

‘Our Biotech Future’: An Exchange

Wendell Berry, James P. Herman, and Christopher B. Michael, reply by Freeman Dyson
September 27, 2007 issue

In response to:

Our Biotech Future from the July 19, 2007 issue

To the Editors:

Science is valuable and admirable for its ability to establish a certain kind of truth beyond a reasonable doubt, for its precise methodologies and its respect for evidence. And so it is disconcerting to see an eminent scientist such as Freeman Dyson using his own prestige and that of science as a pulpit from which to foretell the advent of yet another technological cure-all.

In his essay “Our Biotech Future” [*NYR*, July 19], Mr. Dyson sees high technology as “marching from triumph to triumph with the advent of personal computers and GPS receivers and digital cameras,” and he foretells the coming of a “domesticated” biotechnology that will become the plaything and art form of “housewives and children,” that “will give us an explosion of diversity of new living creatures, rather than the monoculture crops that the big corporations prefer,” and will solve “the problem of rural poverty.”

This of course is only another item in a long wish list of techno-scientific panaceas that includes the “labor-saving” industrialization of virtually everything, eugenics (the ghost and possibility that haunts genetic engineering), chemistry (for “better living”), the “peaceful atom,” the Green Revolution, television, the space program, and computers. All those have been boosted, by prophets like Mr. Dyson, as benefits essentially without costs, assets without debits, in spite of their drawdown of necessary material and cultural resources. Such prophecies are in fact only sales talk—and sales talk, moreover, by sellers under no pressure to guarantee their products.

Mr. Dyson has the candor to admit that biotechnological games for children may be dangerous: “The dangers of biotechnology are real and serious.” And he lists a number of questions—serious ones, sure enough—that “need to be answered.” But perhaps the most irresponsible thing in his essay is his willingness to shirk his own questions: “I do not attempt to answer these questions here. I leave it to our children and grandchildren to supply the answers.” This is fully in keeping with our bequest to our children of huge accumulations of nuclear and chemical poisons. And isn’t it rather shockingly unscientific? If there is anything at all to genetics, how can we assume

that our children and grandchildren will be smart enough to answer questions that we are too dull or lazy to answer? And after our long experience of problems caused by industrial solutions, might not a little skepticism be in order? Might not, in fact, some actual cost accounting be in order?

As for rural poverty, Mr. Dyson's thinking is all too familiar to any rural American: "What the world needs is a technology that directly attacks the problem of rural poverty by creating wealth and jobs in the villages." This is called "bringing in industry," a practice dear to state politicians. To bring in industry, the state offers "economic incentives" (or "corporate welfare") and cheap labor to presumed benefactors, who often leave very soon for greater incentives and cheaper labor elsewhere.

Industrial technology, as brought-in industry and as applied by agribusiness, has been the cleverest means so far of siphoning the wealth of the countryside—not to the cities, as Mr. Dyson appears to think, for urban poverty is inextricably related to rural poverty—but to the corporations. Industries that are "brought in" convey the local wealth *out*; otherwise they would not come. And what makes it likely that "green technology" would be an exception? How can Mr. Dyson suppose that the rural poor will control the power of biotechnology so as to use it for their own advantage? Has he not heard of the patenting of varieties and genes? Has he not heard of the infamous lawsuit of Monsanto against the Canadian farmer Percy Schmeiser? I suppose that if, as Mr. Dyson predicts, biotechnology becomes available—cheaply, I guess—even to children, then it would be available to poor country people. But what would be the economic advantage of this? How, in short, would this *work* to relieve poverty? Mr. Dyson does not say.

His only example of a beneficent rural biotechnology is the cloning of Dolly the sheep. But he does not say how this feat has benefited sheep production, let alone the rural poor.

Wendell Berry
Port Royal, Kentucky

To the Editors:

In his excellent article titled "Our Biotech Future," Dr. Freeman Dyson makes a number of stimulating points about the nature of life, evolution, and most importantly about the uses of so-called "green" and "gray" technologies. I fully believe that in order to achieve sustainable economies, the world will have to embrace green technology fully. However, as Dr. Dyson continues, popular acceptance of widespread or complete use of green technology is far from a foregone conclusion, and for whatever reason, I think that a piece of the puzzle has been left out of this treatise on technological conversion. The connecting concept I speak of is the in-between realm that is the integration of green and graytechnologies.

To a certain extent, such combinations already exist. For instance, our current abilities to work with DNA—to transfer bits of genetic code around at will, to silence or amplify the effects of specific genes, to read off the code—clearly relies heavily both on industrial manufacturing processes (to make the tools used) and on basic uses of physics and chemistry (electrophoresis, mass spectroscopy, etc.) to achieve their ends.

Beyond these implicit syntheses of the technological types described by Dr. Dyson, two examples come to mind. First, in my own field of neuroscience, it has long been troubling that there is so much difficulty in directly controlling neural circuits. There is only so much that can be learned from observation of neural systems and thus direct manipulation becomes necessary. By harvesting the DNA that instructs algae how to make photosensitive ion channels (the membrane proteins which individual cells use to control their electrical states) and putting that code into animals such as the oft-studied nematode *C. elegans*, it becomes possible to blend that green technology with our existing gray abilities to manipulate light and measure the responses of the nervous system in ways that are sure to advance our understanding of brains.[1]

The second example is perhaps even more relevant to a point raised by Dr. Dyson. He points out that plants are only about 1 percent efficient in harvesting light energy. However, this is not true of the initial stages of photosynthesis, specifically in the transfer of light energy through excited electrons to the reaction centers of the two photosystems found in the membranes of the substructures of chloroplasts where energy extraction occurs. In these early stages, the plants are 95 percent or more efficient, a figure we can only hope to someday achieve with our silicon-based photoelectric cells. This feat is accomplished by the fact that evolution has discovered how to overlap the quantum states of pigment molecules such that the transfer of excited electrons is coherent, that is to say achieved not by thermal bumping of molecules into one another like the heating of a pot of water, but by a nearly lossless, smooth transfer of excitation.[2] If we were able to figure out how to harvest and incorporate such green technology with existing gray, perhaps we could improve our abilities to use sunlight, a key element in Dr. Dyson's vision of narrowing economic gaps between rich and poor countries.

Once again, I must say that I strongly believe that we must fully become a species of green technology users, as we were and animals are, in order to sustain ourselves in the long term. There is much territory to be explored, however, before we reach that point. The amalgamation of green and gray technologies offers us a path to move in that direction which will allow the public to become comfortable with the ubiquitous use of such means and facilitate understanding and discovery of phenomena which have as of yet remained out of reach.

James P. Herman
Graduate Student
Department of Neuroscience
City College of New York
New York City

To the Editors:

The fascinating speculations for the growth of technology in the twenty-first century in Freeman Dyson's "Our Biotech Future" apply directly to medicine. If one considers the biggest achievements of the twentieth century in medicine, they are all largely "gray technologies": artificial heart valves, hemodialysis, arterial stents, organ transplantation, internal cardiac defibrillators, heart-lung machines, deep brain stimulators, internal screw-fixation of bone, radiosurgery, etc.

Up until now relatively few medications have successfully altered genes or caused organs and tissues to regenerate. The promises of biotechnology are just barely starting to challenge the "nuts and bolts" of twentieth-century medicine. The primary reason the achievements in cardiac care in the twentieth century have outpaced other areas is that the heart (a pump) is uniquely suited to technology based on physics. On the other hand, the nanoscale of the central nervous system cannot be so easily manipulated by "gray technology." Therefore, limited progress has been made in reversing neurological diseases such as Parkinson's or Alzheimer's disease or even other common ailments like arthritis.

The biggest question is how medicine will achieve its paradigm shift to the new biotechnology in a research environment largely controlled by drug and device manufacturers with billions of dollars already at stake in "gray technology."

Christopher B. Michael, MD
Department of Neurosurgery
Baylor University Medical Center
Dallas, Texas

Freeman Dyson replies:

My thanks to Wendell Berry, James Herman, and Christopher Michael for their illuminating comments. As usual, I learn more from critics than from flatterers. I value Berry's criticism especially because it comes from Kentucky, a state that I know only superficially from a visit to Center College in Danville, where I was a guest of the local chapter of Phi Beta Kappa students. In Danville I saw three things that agree with my vision of the future: a world-class performance of the Verdi Requiem by a local choir, a bookstore where the owners know and love what they are selling, and a roomful of bright students arguing about science and technology in the midst of a rural society.

I am aware that Danville is not all of Kentucky, and that large parts of Kentucky do not enjoy the blessings of gentrification. But I still see Danville as a good model for the future of rural society, when people are liberated from the burdens of subsistence farming. I am not foretelling any "technological cure-all." I am only saying that science will soon give us a new set of tools, which

may bring wealth and freedom to the countryside when they become cheap and widely available. Whether we greet these new tools with enthusiasm or with abhorrence is a matter of taste. It would be unjust and unwise for those who dislike the new tools today to impose their tastes on our grandchildren tomorrow.

I agree with James Herman that gray technology will continue to provide essential tools for exploring the mysteries of biology. In his own field of neurology, recent dramatic progress resulted from the use of magnetic resonance imaging to observe transitory changes in local brain activity associated with specific perceptions and movements. In the future, it is likely that the gray technology of electrical and optical sensors will allow us to study neural activities with far greater precision. But the green technology of genetic engineering will still be crucial to our understanding of the development and architecture of brains. Gray technology observes brains and neurons from the outside, green technology from the inside.

Dr. Michael raises an important question that will soon be answered. Large investments have already been made in companies that advertise themselves as providing "personalized medicine." Their business plan is to extract information from the genome of a patient and to tailor the therapy to suit the patient's genetic constitution. It remains to be seen whether "personalized medicine" will be successful, either medically or financially. This application of "green technology" has nothing to do with the domesticated biotechnology that I described in my article. I am not suggesting that oncologists and neurologists should be replaced by do-it-yourself gene-therapy kits.

1. Feng Zhang et al., "Multimodal Fast Optical Interrogation of Neural Circuitry," *Nature*, Vol. 446, pp. 633–639. ↩

2. Gregory S. Engel et al., "Evidence for Wavelike Energy Transfer through Quantum Coherence in Photosynthetic Systems," *Nature*, Vol. 446, pp. 782–786. ↩