A Posthuman Future?

"How to Regulate Science" by Francis Fukuyama, in *The Public Interest* (Winter 2002), 1112 16th St., N.W., Ste. 530, Washington, D.C. 20036.

"Regulation brings with it many inefficiencies and even pathologies," writes Fukuyama, a noted conservative thinker and author of *The End of History and the Last Man* (1992) and other books. "But in the end, there are certain types of social problems that can only be addressed through formal government control, and biotechnology is one of them."

Though it could produce incomparable benefits, such as a cure for cystic fibrosis or diabetes, biotechnology also presents immense dangers—in human cloning for reproductive purposes, in eugenically selected "designer babies," and, ultimately, in the possible loss of any distinctive meaning to being "human."

A complete ban on human cloning for reproductive purposes (as recently urged by a National Academy of Sciences panel) is justified, in Fukuyama's view, because such cloning would result in "highly unnatural" parent-child relationships and would be the entering wedge leading to "designer babies." Such a ban would also demonstrate that political control of biotechnologies can be achieved.

The point must be made even though U.S. and international efforts to curb the spread of nuclear weapons, as well as restrictions put on neuropharmacological drugs and other dangerous products of science, already give the lie to "the widespread belief that technological advance cannot be restrained."

But human cloning for reproductive purposes is an exception among the coming biotechnologies, says Fukuyama. Most others will demand "a more nuanced regulatory approach" than an outright ban. Take, for example, the diagnosis and screening of embryos for birth defects and other traits before they are implanted in the womb. "In the future," he asks, "do we want to permit parents to screen and selectively implant embryos on the basis of sex and intelligence, of hair, eye, or skin color, or sexual orientation, once these characteristics can be identified genetically?"

It will be necessary, he says, to draw lines between legitimate and illegitimate uses of the technology—between, for instance, therapy and human enhancement. "The original purpose of medicine is, after all, to heal the sick, not to turn healthy people into gods."

Existing federal agencies such as the Food and Drug Administration won't be up to the job, in Fukuyama's view. Their mandates are too narrow, and much biotech research is now privately funded. He envisions a new agency to regulate biotechnology, with "statutory authority over all research and development, and not just research that is federally funded."

If nothing is done, Fukuyama warns, science may lead humanity into "a posthuman future in which we have the capacity, slowly but surely, to alter the essence of human nature"—while losing any "clear idea of what a human being is."

Curious Science

"Fighting Chance" by Siddhartha Mukherjee, in *The New Republic* (Jan. 21, 2002), 1220 19th St., N.W., Washington, D.C. 20036.

Last fall, in the wake of the anthrax attacks on several news organizations and Capitol Hill offices, Harvard University biologist John Collier suddenly found himself thrust into the national spotlight. Just a few months before, Collier and his colleagues had discovered a means of blocking the toxic effects of anthrax, pointing the way toward an eventual antidote. The Pentagon and the Department of Health and Human Services set aside nearly $2 billion for antiterror research, and Senator Max Cleland (D-Ga.)

called for a Manhattan Project-style assault on weapons of bioterror. Mukherjee, a doctor at Massachusetts General Hospital who teaches at Harvard Medical School, believes such targeted research will likely waste money and yield few results. "Scientific discoveries often happen when they are least expected," he points out.

Collier's case is instructive. He began studying anthrax in 1987, intrigued by the manner in which the bacterium attacks human cells. He did not set out to find an antidote but rather to delve "deeper and deeper into the basic biology of anthrax toxin." (U.S. Army researchers at Fort Detrick, Md., began working on anthrax in the 1960s but made no comparable contribution.) Collier's approach unlocked a critical method in the microbe's attack, leading to the discovery of the drugs that could interrupt the process.

Almost the opposite approach was tried with HIV research. In the early 1990s, AIDS activists put tremendous pressure on scientists at the National Institutes of Health (NIH) to produce results. And they got them. Adopting a "mission-oriented" approach, the researchers were able to develop effective antiviral therapies, "even before much of the basic biology of the virus was fully understood." The cost, however, was enormous. A 1999 study by NIH found that the federal government had spent proportionately more money (in dollars per year of life saved) on AIDS than on any other disease. Collier explained to Mukherjee that declaring war on a disease invites "bad science—a lot of junk aimed at getting some of that pork-barrel money."

Ironically, NIH and the National Science Foundation were established to provide federal backing for exactly the kind of "curiosity-driven" basic science that Collier represents. Important discoveries more often come about by synthesizing results from seemingly disparate fields than emerge as the end product of goal-oriented research. The protease inhibitors that have been the most effective weapon against AIDS were only found because of earlier work by scientists studying kidney disease.

"Examples of such serendipitous breakthroughs abound in the folklore of science," says Mukherjee. But "the more narrowly you define a scientific goal—hoping to focus and streamline discovery—the more you potentially logjam the discovery process itself."

Baby, It's Busy Up There!

"The Gas between the Stars" by Ronald J. Reynolds, in *Scientific American* (Jan. 2002), 415 Madison Ave., New York, N.Y. 10017–1111.

A new and startling picture of the vast interstellar regions of the Milky Way has emerged over the past several decades. Astronomers long conceived of the "interstellar medium" as a static reservoir of very thin gases, little more than a nuisance that got in the way of their efforts to observe the stars. The medium was thought to be much like the atmosphere of the moon, which is to say no atmosphere at all—a medium that conducted neither sound nor heat.

"Now we recognize the medium as a tempestuous mixture with an extreme diversity of density, temperature, and ionization," reports Reynolds, an astronomer at the University of Wisconsin, Madison. (The medium is about 90 percent hydrogen in various forms and 10 percent helium, with trace amounts of other elements.) "Supernova explosions blow giant bubbles"; there are "fountains," "chimneys," and "clouds." Conceptually, the interstellar medium increasingly looks like Earth's atmosphere, binding together the galaxy and ensuring that an event in one place will have an impact in another. This new view is revolutionizing the way scientists comprehend the galaxy.

For example, it now appears that supernovas (exploding stars) create vast "hot bubbles," along with cosmic rays that "raise the pressure of the interstellar medium; higher pressures, in turn, compress the dense molecular clouds and increase the chance they will collapse [and form] stars." Oversized bubbles may extend all the way to the halo of the galaxy, each forming a kind of cosmic chimney that transports hot gases