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OUR POSTHUMAN FUTURE: CONSEQUENCES OF THE BIOTECHNOLOGY REVOLUTION. By *Francis Fukuyama*. New York: Farrar, Straus, and Giroux. 2002. Pp. xiii, 256. $25.

With *The End of History and the Last Man*,[1] Francis Fukuyama[2] established himself as the prophet of liberal democracy and free markets, heralding their triumph as the only form of governance capable of commanding legitimacy. Asked to reflect on his predictions a decade later, Fukuyama concluded that the greatest threat to liberalism comes from biotechnology because it alone has the potential to remake the human nature that liberal democracy was designed to serve. Fukuyama makes a compelling case that biotechnology may produce developments that should concern us; he is ironically less persuasive in articulating a liberal-democratic framework for governing the developments he fears.

Our Posthuman Future: Consequences of the Biotechnology Revolution is provocative. It establishes the breadth of the threat Fukuyama perceives by linking four areas of biotechnology rarely discussed together: neuroscience and the ability to determine the genetic basis of traits like homosexuality or intelligence, pharmacology and the transformation of human psyches made possible by drugs such as Ritalin or Prozac,[3] the potential to unlock the secrets of aging that could usher in revolutionary changes in demographics, and genetic

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1. FRANCIS FUKUYAMA, THE END OF HISTORY AND THE LAST MAN (1992) [hereinafter FUKUYAMA, END OF HISTORY].

2. Dean of Faculty and Bernard L. Schwartz Professor of International Political Economy, Paul H. Nitze School of Advanced International Studies, John Hopkins University.

3. Fukuyama links Ritalin, one of a number of drugs used to treat attention deficit-hyperactivity disorder, to "overt . . . social control," p. 46, and describes the antidepressant Prozac as affecting "that most central of political emotions, the feeling of self-worth, or self-esteem," p. 44.

engineering with its prospect of designer babies. Examined individually, each of these developments has the potential to relieve human suffering. Considered collectively, Fukuyama argues, they threaten to alter fundamentally human nature.

Given the breadth of the challenge, Fukuyama maintains that it is essential to consider not just the propriety of individual applications, but the governance of biotechnology more generally. His clarion call, to weigh the implications of the decentralized, globalized, free markets in which decisions on such technologies might otherwise be made, is in many ways prescient. Such decisions produced the revolution in information technology and information technology in turn accelerated the decentralization of power associated with it. Public discussion of the implications of the new technology is occurring only now that the information-technology revolution is largely complete.

Biotechnology, in contrast, touches more directly on people's hopes and fears than the computing power of the next generation of silicon chips. Biotechnology, after all, involves food, drugs, and medicines. It is no accident that one of the first of the alphabet agencies that became the hallmark of the regulatory state was the Food and Drug Administration ("FDA"). Authorized in 1906, the FDA appeared a generation earlier than the New Deal institutions associated with government growth. It is similarly no accident that stem-cell research, though still in an embryonic stage, touched off a firestorm of controversy unlike anything in the computer world. In contrast, Napster, though fully developed, implemented, and dismantled, never commanded the attention of popes or presidents. Biotechnology is and will continue to be governed differently as it takes place within a heavily regulated marketplace far more dependent on government funding and approval and the vagaries of public support or condemnation.

If Fukuyama is therefore right that biotechnology presents a different type of challenge than information technology and prescient in his call for an examination of its governance, his book nonetheless disappoints in its examination of the framework for resolution. Fukuyama's project is incomplete, and it is understandable that he reserved a more detailed blueprint for other work. Less forgivable, however, is his failure to confront the problem central to governance: it may be necessary to destroy liberal democracy in order to save it or, more prosaically, it may be necessary to curtail scientific exploration and the application of lifesaving treatments to preserve human nature as Fukuyama defines it.

The dilemma of stopping the threats to human nature without derailing the scientific freedom and curiosity central to it arises from two sources, one following from the way Fukuyama defines the threat and the other from the intrinsic nature of biotechnology. Fukuyama is concerned about anything that would undermine the human essence,

which he describes as the sum of human unity and continuity (pp. 130, 172). He takes great pains to explain how an "ought" — thou shalt not alter human nature — can be derived from an "is" — our existing human nature establishes the values on which human institutions and judgments are based (pp. 114-17). He never quite says, however, what it is about human nature as it presently exists that is so valuable. In failing to do so, his reasoning becomes circular: we should not change human nature because doing so will necessarily change the values it produces. And changing those values appears to be wrong even if it makes us smarter, happier, and wiser — and inclined to value the improvements.

Because Fukuyama's definition of the human essence is so elusive, it can be used to oppose anything that changes us or our societies. Modern sanitation or the transformation in women's roles have arguably altered human society as much as Prozac or a revolution in the treatment of aging. To prevent such broad-based changes, to forestall effects that result from the culmination of thousands of otherwise innocuous decisions, indeed, to return women to the kitchen or prevent parents from seeking Ritalin for their hyperactive children, requires a response as draconian as Marx's response to capitalism. If human values reflect the human condition, then only preserving human conditions in all their misery will preserve those values. In his zeal to defend the essence of what it means to be human, Fukuyama must necessarily be dogmatic in opposing scientific advances, however seemingly benign, that threaten it. Fukuyama has thus become a fundamentalist in his defense of secular humanism.[4]

The dilemma for governance remains even if we relax Fukuyama's definition of the problem. Biotechnological innovations — the discovery of the human genome, new drug treatments for AIDS, gene therapies — typically involve large initial investments in risky enterprises whose ultimate products may be hard to predict. Once the basic science has been developed, however, individual applications may be

4. "Secular humanism" is a philosophy that "centers upon human concerns and employs rational and scientific methods to address [a] wide range of issues" and values. Fritz Stevens et al., *What Is Secular Humanism?*, Council for Secular Humanism, *at* http://www.secularhumanism.org/intro/what.html (last updated Feb. 27, 2003). Fundamentalism, in contrast, is often associated with religious fundamentalism, and it has been defined as "do[ing] battle for fundamentals." Curtis Lee Law, WATCHMAN-EXAMINER (New York), July 1, 1920, at 9, *cited in* KARL KEATING, CATHOLICISM AND FUNDAMENTALISM: THE ATTACK ON "ROMANISM" BY "BIBLE CHRISTIANS" 17 (1988). The fundamentalists associated with a particular religion insist on adherence to what they view as the essential elements of that religion, and tend to be rigid and dogmatic in their interpretation of what the religion commands. *Id.* Fukuyama is a secular humanist, first, in that he relies on secular rather than religious grounds for his conclusion, though he acknowledges that religious convictions can produce the same results. P. 91. Second, his arguments are clearly grounded within a rationalist tradition identified with the nature of what it means to be human. *See infra* Part II *passim*. He is nonetheless a "fundamentalist" in that he seeks to identify and preserve the fundamental or essential aspects of what it means to be human. Pp. 149-50.

relatively easy and inexpensive. AIDS drugs that cost a billion dollars to develop may be duplicated for pennies. Promising scientific developments may therefore be relatively easy to derail while their more questionable applications may be impossible to stop.

Although Fukuyama's prescriptions are mild ones — preventing, for example, preimplantation-embryo selection to favor world-class sprinters — his call to action is most likely to empower those who oppose broad categories of scientific research (p. 211). Consider the potential of stem-cell research. If the secrets of embryonic development will facilitate the existence of athletes with greater endurance, Fukuyama will oppose the development. But where would he draw the line: At prohibition of the basic research that might also lead to new techniques to fight heart disease? At public funding of animal trials? At implementation in humans? And more fundamentally, who is to decide? Fukuyama's greatest failing in *Our Posthuman Future* is that he does not convincingly address the question of whether governance of biotechnology on the terms he advances is possible at all.

The obstacle to Fukuyama's project comes from human nature itself. We are messy, stubborn, contentious beings, with authoritarian tendencies that require constant vigilance — or so Fukuyama argues in his other work.[5] In a monograph that he wrote for the Rand Corporation in 1999 that summarized the results of his early research for this book, Fukuyama argued that information technology had produced a rapidly changing, globalized, decentralized, privatized world that had outflanked the possibility of government control.[6] Yet, Fukuyama's project — to prevent the overuse of Prozac, the prolongation of life expectancy, the preimplantation selection of healthier embryos — requires a degree of government regulation at odds with the developments Fukuyama describes in his other work. And while he personally favors nuanced determinations that distinguish creation of bioengineered mathematicians from treatments for dyslexia, it is not so clear either that those sitting next to him on government-created bioethics panels will share the same views, or that he can really stop the developments he opposes without derailing the basic research that makes them possible.[7] In a book that celebrates

5. *See* FUKUYAMA, END OF HISTORY, *supra* note 1, *passim*. Fukuyama characterizes human nature as violent, pp. 154, 329, locked in a struggle for recognition that includes the assertion of superiority and a desire for tyranny as well as self-respect, p. 184, and concludes that only liberal democracy can keep these forces in balance, p. 338.

6. FRANCIS FUKUYAMA & CAROLINE S. WAGNER, INFORMATION AND BIOLOGICAL REVOLUTIONS: GLOBAL GOVERNANCE CHALLENGES — SUMMARY OF A STUDY GROUP ix-x (1999).

7. Pp. 208-11. For example, Fukuyama, who rails against the use of Ritalin to treat behavior within a normal range, nonetheless acknowledges that there are children at the end of the distribution who are so hyperactive that "normal functioning is impossible," and "it is hard to object to treating them with Ritalin." P. 210. He emphasizes the need to draw the line between enhancement and therapy even when ambiguous. P. 210.

and tries to preserve human nature, Fukuyama does not seriously consider how that nature will inevitably influence the shape and success of his efforts.

This Review considers the implications of Fukuyama's work for the future regulation of biotechnology. First, the Review maintains that Fukuyama is almost certainly right that biological innovations span a continuum of developments that range from vitamins enhancing infant cognition to research unlocking the secrets of cellular aging.

Second, the Review argues that the value of Fukuyama's analysis cannot lie in the precision of his prescriptions, which are in any event vague. Instead, discussion of human nature can contribute to a reexamination of how technology can serve human institutions. Biotechnology has potentially dangerous implications precisely because it may transform us and because we are likely to make decisions about its implementation on the basis of our most primal emotions — hope, fear, love, grief, and the desire for immortality. The insight into human nature most critical for biotechnology's future is the one that explains how individually unobjectionable decisions may produce collective calamities.

Finally, the Review considers the prospects for a different approach to biotechnology's governance. Many of the most controversial developments Fukuyama describes — use of the nuclear-cell transfer technology associated with cloning, selection of embryos with desirable traits — have already been done in readily moveable fertility clinics with a small amount of private funding from a determined clientele. The potential applications with the greatest promise, however — such as genetically modified plants that address the nutritional needs of the developing world, or breakthroughs in the use of stem cells to treat paralysis, cancer, or diabetes — require public funding and/or a large measure of international acceptance. Fukuyama correctly observes that we do not have the infrastructure necessary to either promote or control these developments (p. 215). Whatever our conclusions about the wisdom of the new technology, we are far behind in developing political oversight capable of even keeping track of the new developments' scientific, ethical, and social implications. Reconnecting political participation with scientific innovation will be biotechnology's greatest challenge.

I. WHAT IS BIOTECHNOLOGY? NATURE, SCIENCE, AND POLITICS

Fukuyama's concern about a "posthuman future" grows less from his understanding of science than his understanding of politics. He sprung to international fame with a book entitled *The End of History and the Last Man*, which argued that information technology had helped spur the collapse of communism and a convergence toward

liberal democracy and free markets around the globe.[8] In *Our Posthuman Future*, Fukuyama identifies biotechnology, and the potential transformation of human nature, as the single greatest threat to the triumph of liberal democracy. Fukuyama argues that:

> human nature exists, is a meaningful concept, and has provided a stable continuity to our experience as a species. It is, conjointly with religion, what defines our most basic values. Human nature shapes and constrains the possible kinds of political regimes, so a technology powerful enough to reshape what we are will have possibly malign consequences for liberal democracy and the nature of politics itself. (p. 7)

His definition is thus a political rather than a scientific or ethical one.

Fukuyama's political focus allows him to unite several seemingly disparate developments. Underlying all of them is an increasing understanding of how the human body works and how it can be changed to produce not only better health, but different behavior. Fukuyama picks four areas to illustrate the process. First, he considers the "sciences of the brain" (pp. 18-40). He examines our greater understanding of the link between genetics and behavior, and speculates about the coming ability to identify, for example, those with a "gay gene" and techniques designed to counter or eliminate its expression.[9] Magnetic resonance imaging ("MRI"), which allows scientists to serve the brain in operation, similarly offers the potential to identify individuals with the "wrong" sexual tendencies, and to measure the effectiveness of efforts to "reprogram" them.[10] Fukuyama emphasizes that the challenge is just as great if the decision to implement these technologies comes from parents choosing a particular future for children as it does when the decision comes from the state (p. 40).

Second, and perhaps most prominently, Fukuyama analyzes neuropharmacology. Prozac and Ritalin provide his most cited exhibits. Over 10% of Americans are already on Prozac, an antidepressant colloquially described as a "happiness pill" (p. 46), and 12% of Medicaid recipients between the ages of *two and four* were on stimu-

8. FUKUYAMA, END OF HISTORY, *supra* note 1, at xii-xiii.

9. Fukuyama refers, for example, to research on the importance of hormones in utero, and considers the possibility that introduction of testosterone at a critical point in male fetal development might counter the expression of a gene associated with same-sex sexual attraction. Pp. 39-40.

10. Fukuyama devotes greater attention to the links between heredity and IQ and gender and behavior than he does to neuroscience, perhaps because the latter field has only recently been garnering attention. Pp. 20-40 *passim*. Nonetheless, studies of brain imaging may contribute as much as studies of genetics to predicting human behavior. *See, e.g.*, Erica Goode, *Brain Imaging May Detect Schizophrenia in Early Stages*, N.Y. TIMES, Dec. 11, 2002, at A32 (stating that brain imaging may be used to predict who will develop schizophrenia and to determine the effectiveness of early treatment); Wendy Kaminer, *Gender Bender*, AM. PROSPECT, Sept. 9, 2002, at 9 (discussing gender differences in neurological functioning).

lants such as Ritalin in one midwestern study (p. 51). No science fiction, no new discoveries are necessary; we are already remaking our psyches.

Third, Fukuyama highlights the science of aging, and the demographic revolution underway on the basis of existing medical advances. Life expectancy in the United States rose over the course of the last century from 48.3 years for men and 46.3 for women in 1900 to 74.2 and 79.9 years for men and women, respectively, in the year 2000 (p. 57). Existing trends suggest that the median age in the U.S. will rise to 40 by the middle of this century, and to 54 in Germany, 56 in Japan, and 58 in Italy (p. 61). The race is on to find a genetic shortcut to prolonging life, and research has already provided important insights into the nature of cellular aging (pp. 58-60). If these investigations hit pay dirt, life expectancy could double or more. These increases in life expectancy and the decreases in fertility are already creating more rigid, more conservative, and more female societies.

Finally, Fukuyama addresses the implications of genetic engineering (pp. 72-83). Parents can now select which fertilized eggs to implant based on characteristics such as the absence of a disease-causing gene or the presence of a match for a sibling in need of a donor. With greater understanding of the relationship between genes and intelligence, violence, and sprinting speed, parents may be able to design the children of their choice (pp. 76-82).

Our Posthuman Future emphasizes that the result of these changes is cumulative (pp. 81-82). With better understanding of genetics, we can more effectively choose among possible offspring. With better ability to choose, we may accelerate demographic changes — increasing height? — happening anyway. With wholesale changes, involving, for example, the elimination or biochemical suppression of the "gay gene," the organic causes of depression, and the physiological sources of aging, we will have fundamentally changed what it means to be human — and we may do so in incremental steps that we barely notice.

II. WHAT IT MEANS TO BE POSTHUMAN: HUMAN NATURE AND NATURAL RIGHTS

Fukuyama asks "Why Should We Worry?" What's wrong, after all, with taller, smarter, saner, blonder humans? Parents and patients, not governments, will make the choices. They presumably will choose better futures for themselves and their offspring. The sum of suffering and disease will decline. The source of the cautionary note Fukuyama sounds in opposition is, in contrast to the potential benefits of biotechnological advances, maddeningly elusive.

It is also easy to lampoon. Cass Sunstein begins his review of Fukuyama by quoting John Stuart Mill: "Nearly all the things which

men are hanged or imprisoned for doing to one another, are nature's everyday performances."[11] Ralph Brave, writing in *The Nation*, is less polite. Fukuyama defines "human nature" as "the sum of the behavior and characteristics that are typical of the human species, arising from genetic rather than environmental factors" (p. 130). He then argues that what we want to protect is "the full range of our complex, evolved natures against attempts at self-modification. We do not want to disrupt either the unity or the continuity of human nature, and thereby the rights that are based on it" (p. 172). Brave is disdainful:

> Human nature is defined by . . . human nature! To the extent that it is capable of being located in our material bodies, it is all that arises from our genetics. Any attempt at greater precision is a violation of our unity or continuity — and threatens to expose the author's empty hand. Through such sophistry, Fukuyama wishes to assert mastery over any biotechnological innovation that he considers threatening, since he can now arbitrarily choose when it is disruptive of the unity or continuity of the human nature arising from our genetics. Even a heritable cancer could qualify for protection under Fukuyama's rubric for that which is to be defended from biotechnical intervention.[12]

Fukuyama, however, does not mindlessly glorify the natural. He does not even oppose all use of Ritalin. Instead, the content in his message comes from the latter half of the sentence Brave quotes; the harm Fukuyama identifies is that which will come if we "disrupt either the unity or the continuity of human nature, and *thereby [disrupt] the rights that are based on it*" (p. 172; emphasis added). The key to his argument lies in the connection between human nature and human rights, and that connection rests on two component arguments.

First, Fukuyama argues that "in the political realm we are required to respect people equally on the basis of their possession of Factor X" (p. 150). Aside from saying that Factor X is the essence of what it means to be human, Fukuyama does not provide much of a definition of human. Moreover, he acknowledges that we do not necessarily treat existing humans equally, as we assign different rights to children than to adults, to the mentally incompetent, etc. At the same time, he insists such differential treatment does not indicate lack of a human essence (pp. 173-74). Nonetheless, he clearly identifies that which he fears. A "brave new world" of genetically bred Alphas, Betas, Epsilons, and Gammas threatens the unity of human nature. Even Lee Silver, who advances libertarian arguments in favor of most prospective biotechnological innovations, is wary of the creation of a class of "GenRich" humans so genetically distinct — and superior — that they

11. Cass R. Sunstein, *Keeping Up With the Cloneses*, NEW REPUBLIC, May 6, 2002, at 32 (reviewing *Our Posthuman Future*).

12. Ralph Brave, *The Body Shop*, NATION, Apr. 22, 2002, at 25, 27 (reviewing *Our Posthuman Future*).

become a separate species.[13] At the point where not just individuals but groups are bred to be different, the premise on which equal respect — and therefore equal rights — rests disappears.[14]

Second, Fukuyama argues that our insistence on and willingness to recognize rights depends on human emotions. He maintains that "it is the distinctive gamut of emotions that produces human purposes, goals, objectives, wants, needs, desires, fears, aversions, and the like and hence the source of human values" (p. 169). For Fukuyama, these emotions bridge the gap between the "is" and the "ought." He observes:

> [T]here is scarcely a judgment of "good" or "bad" that has been pronounced by a human being that has not been accompanied by a strong emotion, whether of desire, longing, aversion, disgust, anger, guilt or joy. . . . When we unearth the tortured body of a political prisoner in an authoritarian dictatorship, we pronounce the words *bad* and *monstrous* because we are driven by a complex gamut of emotions: horror at the decomposed body, sympathy for the victim's sufferings and those of family and friends, and anger at the injustice of the killing. We may temper these judgments by rational consideration of mitigating circumstances . . . . But the process of value derivation is not fundamentally a rational one, because its sources are the "is" of the emotions. (p. 117)

Human nature is a source of rights because human nature produces the emotions that define our objectives and motivate our reactions. When we respond with horror to the tortured prisoner, our emotions produce an identification with the victim, and a determination to avenge the death or prevent the occurrence of similar wrongs. Fukuyama argues that human nature, through these emotions, prompts the moral opprobrium we attach to murder, and leads to the creation of rights to be free from torture, arbitrary imprisonment, and wrongful death. Change human nature, administer a tranquilizer that allows torture to be viewed with equanimity, interfere with the identification with the victim as an equal, and you will undermine the rights and values that follow from the strength of the emotional response. Prozac is as much a threat to human nature as genetic engineering because it alters the emotions that define and shape our values (p. 46).

Our Posthuman Future resonates with Leon Kass's *The Wisdom of Repugnance*.[15] In that article, Kass, now the chair of President Bush's

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13. *See* LEE M. SILVER, REMAKING EDEN: CLONING AND BEYOND IN A BRAVE NEW WORLD 4-8 (1997).

14. Fukuyama observes, for example, that "for believers in liberal equality, Factor X etches a bright red line around the whole of the human race and requires equality of respect for all of those on the inside, but attributes a lower level of dignity to those outside the boundary." P. 151. While he resists the efforts of other theorists to ascribe Factor X to God (i.e., to the creation of human beings in God's image and likeness), to Kant's emphasis on the capacity for moral choice, or to any other single factor, he emphasizes the importance of human dignity and equal respect as "the dominant passion of modernity." P. 149.

15. Leon R. Kass, *The Wisdom of Repugnance*, NEW REPUBLIC, June 2, 1997, at 17.

bioethics council, argued against the morality of cloning partially on the basis of our instinctive repulsion at the prospect of human-genetic copies. Fukuyama's argument, however, is considerably more complex. He does not maintain that any particular emotion provides a determinate moral guide. Instead, he insists that it is the balance among competing interests that explains the evolution of human institutions. Fukuyama can argue that we have come to the "end of history" because "there is a logic to human history that is ultimately driven by the priorities that exist among natural human desires, propensities, and behaviors" (p. 126). Murder is "natural," but so are the gallows. Human nature balances a desire for dominance with an appreciation of the security of property rights. Even globalization — defined as "a world order in which mankind's largest in-groups no longer violently compete with one another for dominance but trade peaceably" (pp. 126-27) — can be seen as the logical product of a natural preference for positive-sum competition. Fukuyama's most fundamental book may not be so much *The End of History and the Last Man*, but *Trust: The Social Virtues and the Creation of Prosperity*.[16] Trust — and prosperity — rest on the creation of institutions designed to encourage untrustworthy beings to interact with each other. Make them more trustworthy, and you will eventually remake the institutions that protect them from each other.

III. WHAT SHOULD WE DO? THE GOVERNANCE OF BIOTECHNOLOGY

Fukuyama's argument is clever, distinctive, and very thin. If the problem with changing human nature is that it may change our values, why are those values special? Why do the values associated with this state of existence matter more than those associated with another state we may voluntarily choose? Without identification of the values that matter most, on the basis of something other than the conclusion that they are the product of our existing nature, Fukuyama's argument becomes circular. Although Fukuyama himself offers carefully measured proposals, the logic of his argument supports those who would limit promising biotechnology research now because of any future *change* they can envision. If, for example, daily aspirin contributes to longevity or vaccinations limit infant mortality, they too may have political effects that justify their restriction. Indeed, as conservative commentators insistently point out, a changing economy has transformed women's roles — and corresponding family values — at

16. FRANCIS FUKUYAMA, TRUST: SOCIAL VIRTUES AND THE CREATION OF POSTERITY (1995).

least as fundamentally as Prozac, Ritalin, or the genetic engineering on the immediate horizon.[17]

The fog at the core of Fukuyama's argument is particularly pernicious because he fails to develop the connection between any particular avenue of research and the harm he envisions. Genetic engineering, for example, is probably the potential development with the broadest consensus against its implementation. Science-fiction writers as long ago as H.G. Wells could envision the breeding of human strains so distinct they become different species.[18] Fukuyama fears discoveries that may identify a genetic basis for intelligence or criminality almost as much. The existing genetic lottery creates a real-life form of Rawls's original position.[19] Even if, as a matter of statistical probability, the offspring of elite parents are more likely to share their elite characteristics than are the general population, the parents cannot be sure their genetic gifts will be passed on, and they cannot be certain that advantageous results are the product of inheritance as opposed to environment. If parents could guarantee offspring with the right gene combinations, or if they could determine in advance that it is futile to train a child who lacks the gene for world-class-sprinting speed, existing societal divisions might be exacerbated. The research thought likely to contribute to such a result, however, might also produce the opposite effect.

Consider the rapidly growing body of information about the genetic basis of disease. Scientists trace families with hereditary forms of illness such as breast cancer. By comparing relatives with the disease to those without, they attempt to isolate the relevant genes or chromosomes. Sometimes, identification of the genetic culprit leads to abortion-based genetic screening or preventive measures such as mastectomies for the healthy. In other cases, however, identifying a particular disease-causing chromosome may lead to the discovery of the underlying mechanism causing the illness. If, for example, the relevant gene produces (or fails to produce) a particular protein, identification of that protein may be critical in fighting the disease, and

17. *Compare* JUNE CARBONE, FROM PARTNERS TO PARENTS: THE SECOND REVOLUTION IN FAMILY LAW (2000), *with* FRANCIS FUKUYAMA, THE GREAT DISRUPTION: HUMAN NATURE AND THE RECONSTITUTION OF SOCIAL ORDER (1999). Fukuyama, although perceptive in his discussion of the importance of norm formation to human nature, concluded with a mechanistic call for a return to traditional-family values without systematic recognition of the effect of changing women's roles on how those values are reached. *Id.* at x.

18. H.G. WELLS, THE TIME MACHINE (1895); *see also* ALDOUS HUXLEY, BRAVE NEW WORLD (1946).

19. JOHN RAWLS, A THEORY OF JUSTICE (1971) (describing original position as an imagined state in which people bargain without knowing their individual characteristics such as race, wealth, or gender).

it may lead to more effective treatments for both the genetic and nongenetic forms of the cancer.[20]

The same thing may ultimately be true for more complex traits such as intelligence. Scientists may discover that a particular gene combination is associated with superior mathematical reasoning because of its contribution to the biochemical development of the brain. This could lead to the deliberate breeding of the mathematicians of the twenty-third century. It might also lead to early childhood interventions that enhance the mathematical functioning of the average child. Identification of the genetic sources of intelligence is the development that most causes thoughtful observers to be wary. Yet, the result of such discoveries in the long run could conceivably increase equality in a manner similar to vaccinations (which compensate for the unequal genetic distribution of disease resistance), universal public education (which in some cases mitigates and in other cases exacerbates natural differences in ability), or the rapidly increasing understanding of the physiology of dyslexia (facilitating more accurate identification of dyslexics *and* new teaching strategies that increase dyslexics' success in learning to read).

All biological advances have potentially differential effects for society. Discoveries about the links between nutrition, sanitation, and human flourishing, for example, first brought advantages to the elites, and continue to be a major source of inequality between the developed and the developing world. Few would argue, however, that the response ought to be to restrict sanitation in London as opposed to mounting a public-health campaign in Calcutta. If the most critical human-political value is equal dignity and respect, and if selective breeding is the potential scientific advance that most threatens it, there may still be no necessary connection between any particular line of research and the feared outcome.

Fukuyama concentrates his energies in *Our Posthuman Future* on identification of the evils he fears, and construction of a revitalized natural-law justification for opposing them. He then encourages us to "think about the design of institutions that can make and enforce regulations on, for example, the use of preimplantation diagnosis and screening for therapeutic rather than enhancement purposes, and how those institutions can be extended internationally" (p. 211). Curiously, though, he does not develop the critique of human motivation and decisionmaking that has been the hallmark of his earlier work. And it is how biotechnological decisions are likely to be implemented, rather

20. For a recent example of this, see Lara Jakes Jordan, *Brain Defect Study Finds Mutation*, ASSOCIATED PRESS, Oct. 1, 2002, LEXIS, Academic Universe, N.Y. Times Library (stating that a newly discovered fatal-gene mutation, found only in Amish newborns, could be a major first step toward helping scientists prevent brain defects in babies worldwide).

than identification of the slippery slope of possible calamities, that offers the greatest hope of designing appropriate structures for governance.

Let us take, for example, use of the technology associated with genetic transfer. Scientists cloned Dolly the sheep by taking an egg from the womb of a sheep, destroying its nucleus, and replacing the egg nucleus with one from an adult sheep cell.[21] The new egg was transplanted into the womb of a sheep who gave birth to an animal with the same nuclear DNA as the adult. Now compare two other forms of genetic transfer:

— In the first, scientists extract the nucleus from the egg of a fertility patient, insert it into a donor egg whose nucleus has been removed, and add sperm from the patient's partner. The result is a fertilized egg, implanted in the patient's womb that produces a child genetically related to three parents: it has nuclear DNA from the intended mother and father, and mitochondrial DNA (mtDNA)[22] from the woman who donated the egg.[23] This procedure permits a fertility patient with deteriorating cytoplasm or defective mtDNA to bear a healthy child.[24] It also involves a germline-genetic alteration.[25] The child will pass on mitochondrial DNA from the donor to her offspring.

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21. *See* SILVER, *supra* note 13, at 107-10.

22. DNA occurs in two places: the cell nucleus, and the cytoplasm surrounding the nucleus. The nuclear DNA creates a person's inheritable traits. The cytoplasm contains mitochondrial DNA (mtDNA), which, according to evolutionary theory, originated from a mitochondrian, a foreign cell capable of energy production that invaded the one-celled organism from which we descended. Subsequently, the two cells formed a symbiotic relationship because the mitochondrian provided energy and the host cell became a home for the mitochondrian cell. Since then, all of our cells have contained mtDNA, and rely on mitochondria to produce energy. *See* John Jain, *The Future of Assisted Reproductive Technologies*, 21 WHITTIER L. REV. 435, 435-36 (1999).

23. In the first efforts to address cytoplasmic defects, scientists sucked 5% of the cytoplasm from the donor egg and inserted it into the cytoplasm of the patient's egg, where presumably the donor mtDNA and the patient's mtDNA combined. Subsequent tests confirmed that the baby "inherited" the donor's DNA in at least some of the cases where the technique was tried. John Mangels, *Geneticists Jump Across Ethical Frontier*, CLEVELAND PLAIN DEALER, May 21, 2001, at 1A. Fertility specialists in New York then tried the technique described in the text, and inserted the patient's cell nucleus into a donor egg, whose nucleus had been destroyed. This technique, which involves the more classic form of nuclear transfer often banned by anticloning legislation, should have produced a child with mtDNA only from the donor. Erik Parens, *Degrees of Engineering: Have Fertility Techniques Overtaken Ethical Concerns?*, WASH. POST, Oct. 18, 1998, at C5.

24. One reason many older women have trouble conceiving is that the cytoplasm in their eggs deteriorates with age. Other women have mitochondrial diseases that do not affect their nuclear DNA. *See* Jain, *supra* note 22, at 438-40.

25. Most people think of germline alterations as manipulating genes in the nucleus of an embryo because mtDNA contains relatively little genetic material. Yet, switching mitochondria would make a permanent and inheritable change in future descendants. Jain, *supra* note 22, at 440.

— In the second, scientists take a cell from a diabetic child. They obtain an egg from a fertility-clinic donor. They destroy the egg nucleus, and insert the child's cell nucleus.[26] The scientists then permit the egg, which contains the child's DNA, to develop in a petri dish long enough to harvest stem cells that can be coaxed into becoming pancreatic cells that the child needs to regulate his production of insulin. The stem cells, a genetic match, cure the child's diabetes without the risk of rejection. They do not, however, alter the DNA he will transfer to his offspring.

The first example involves genetic alteration of a kind Fukuyama — along with many ethicists and legislators — strongly oppose. The second involves a less controversial technique, contentious more because of its destruction of the developing egg from which the stem cells are taken than because of its effect on the patient. Yet, the first has already been done in humans while the second has not.

It is tempting to conclude that differences in regulation provide the primary part of the explanation. Fertility clinics are at the frontier of the medical profession, with virtually no federal funding — or oversight — and relatively little insurance coverage — or oversight. Universities, in contrast, rely on federal funding with all kinds of strings attached, and pharmaceutical companies need to convince the shareholders and venture capitalists who fund them that they can produce a marketable product worth the investment. Marketability, in turn, requires FDA approval or a measure of public acceptance that would be jeopardized by insensitivity to research protocols.

The regulatory framework, however, is itself a product of the structure and financing of the underlying industry. How expensive is the basic research? Who does it? How far removed is implementation in humans from the initial discoveries? How willing are doctors and patients to try untested techniques? Stem-cell researchers working on diabetes could also escape existing regulatory scrutiny if they were willing to operate in decentralized, privately funded clinics. They do not because of the different financing and motivation at play in the two examples. The first scenario — involving mtDNA donation — depended on the development of nuclear-transfer techniques financed by large-scale agricultural interests, and then implemented in humans by small clinics with a determined clientele. The British government, for example, through its Ministry of Agriculture, provided 65% of the funding that made Dolly, the first cloned mammal, possible. PPL

26. For a description of this process, see Nicholas Wade, *New Stanford Institute Is to Study Stem Cells*, N.Y. TIMES, Dec. 12, 2002, at A37, which documents a research agenda for nuclear-transfer process. *See also Status of the Implementation of the Fed. Stem Cell Research Policy: Hearing Before a Subcomm. of the S. Comm. on Appropriations,* 107th Cong. 10-13 (2002) (Statement of Roger Pederson, Ph.D., Dep't of Surgery, Cambridge Univ.) (describing promising diabetes research in mice using embryonic-stem cells to produce insulin).

Therapeutics, a Scottish biotechnology company, provided the rest.[27] The goal was not to clone humans, or even to cure disease. Instead, the institute involved in the research hoped to create precisely copied animals carrying proteins valuable in drugmaking or replicating high-quality beef.[28] Other companies, for example, have engineered goats to give milk containing human antibodies that can serve as medicines, and analysts speculate that a "single herd of goats may soon replace a $150 million drug factory."[29] With governments supplying the funds for basic research, agricultural applications that increase farm productivity or facilitate the production of new drugs are big business.

Once the basic science has been developed, however, its application to human patients may be a relatively straightforward and inexpensive process. Little scientific innovation was involved in the fertility treatments treating the mitochondrial defects. Implementation required only willing doctors and consenting patients. The patients often have an intense relationship with fertility specialists, with both committed to one overriding goal — the production of a child. Maureen Ott, the first woman to bear a child using a donor's cytoplasm, told reporters: "When we were told by doctors that it was unlikely we would ever have children, we were not ready to believe that . . . . We wanted a baby so badly that we felt it was important to pursue every option available."[30] After four failed efforts at in vitro fertilization, the Otts may well have felt that use of the experimental technique was their last chance to have a child to whom they would be genetically related. In such circumstances, it is easy to discount the risks. Mrs. Ott, when interviewed after her child's birth, insisted that: "I was never concerned about the risk of abnormality, based on what we were told. To me it seemed that the risk was no greater than it would have been in any birth for someone of my age."[31] The doctors, however, may be less sanguine. Dr. Jamie Grifo, the New York fertility specialist who has used nuclear-transfer techniques, was asked why he had not done safety testing first in monkeys. "Animal colonies cost a fortune to maintain," he said. And because there is a ban on federal-research money being spent on embryo research, "we have no

27. Edith M. Lederer, *Poll: Americans Oppose Human and Animal Cloning*, ASSOCIATED PRESS, Mar. 4, 1997 (announcing that a $411,000 government grant would be cut in half), *available at* http://www.gene.ch/gentech/1997/8.96-5.97/msg00187.html.

28. *Id.*

29. Juan Enriquez & Ray A. Goldberg, *Transforming Life, Transforming Business: The Life-Science Revolution*, HARV. BUS. REV., Mar.-Apr. 2000, at 96, 99.

30. *Healthy Baby Born After World's First Successful Cytoplasmic Transfer*, BUS. WIRE, July 18, 1997, WL, Business Wire Plus Database.

31. Lois Rogers, *Fertility Doctors Create Babies with Two Mothers*, SUNDAY TIMES (London), May 16, 1999, at 28.

research dollars."[32] In the four years since the birth of the first child using these techniques, at least one has developed a serious developmental disorder, and some researchers speculate that the conflict between the donor and the patient mtDNA might have caused the problem.[33] There may be no way to know without carefully controlled trials that the clinics lack the money to fund.

In contrast, stem-cell research involves high-caliber university researchers, using proven clinical techniques, including animal experimentation and human trials. The basic research, like that performed to clone Dolly, can be enormously expensive, and lack an immediate commercial application. Dr. Elias Zerhouni, Director of the National Institutes of Health, testified before Congress that:

> We are at a very early stage of embryonic stem cell research, and have a great deal of basic research to conduct before we can unlock the potential of these cells and fulfill their promise. . . . As is the case at the beginning of any new field of discovery, there is a shortage of researchers with expertise in stem cell research. This dearth is currently a rate-limiting step in advancing the progress of embryonic stem cell research. Simply growing embryonic stem cells to the state where they can be used for experimentation requires substantial knowledge, training and experience. NIH will strive to make stem cell research as attractive as possible to our most talented research scientists, whose creativity in developing investigator-initiated research will move the research agenda forward.[34]

In addition, Dr. Zerhouni emphasized that there are many steps required to develop stem cells from when they are first removed from an embryo to the point where they become part of a well-characterized cell line ready for distribution to the research community. As a "first step" in that process, NIH has awarded $4.3 million in grants to fund the expansion, testing, quality assurance, and distribution of cells.[35] Once the basic research is completed, preclinical studies, including animal experimentation, will need to be done, and only then will human trials on small, carefully selected populations be attempted. Under ideal circumstances, it could easily take decades and millions of dollars to realize the beneficial results of such research. And without demonstrated evidence of the safety and efficacy of such

32. Nigel Hawkes, *Baby Race That May Be Too Fast for Safety*, TIMES (London), Oct. 10, 1998, at 4.

33. Shannon Brownlee, *Designer Babies: Human Cloning Is a Long Way Off, but Bioengineered Kids Are Already Here*, WASH. MONTHLY, Mar. 1, 2002, at 25. Nor is there any way to know at this stage whether the risk is limited to cytoplasm transfer that mixes mtDNA from two different mothers, or extends as well to nuclear transfer.

34. *Status of the Implementation of the Fed. Stem Cell Research Policy: Hearing Before a Subcomm. of the S. Comm. on Appropriations*, 107th Cong. 5, 7 (2002) (prepared statement of Elias Zerhouni, M.D., Director, National Institute of Health, U.S. Dep't of Health and Human Services).

35. *Id.*

treatments, it would be difficult to justify experimentation on diabetic children. The Otts may have been willing to try an untested technique as their only way to produce a genetically related child; they should be far less willing to try such a technique to cure that child of a chronic, but not life threatening, ailment.

The contrast between these two examples illustrates the challenges facing any system designed to govern the future of biotechnology. A particular line of research, at a critical preliminary stage, may be relatively easy to derail or simply to starve from lack of funding. The results of that research, however, are unknowable. The research may unlock secrets of the cell that hold the key to curing diabetes or paralysis, or it may facilitate genetic engineering of athletes with faster metabolisms.

Once the research is developed, however, controlling its use, limiting, for example, "preimplantation diagnosis and screening for therapeutic rather than enhancement purposes" (p. 211) becomes a far more difficult matter. Egg, sperm, and embryo selection, genetic therapy, and drug use (steroids, Ritalin) can be done in a friendly jurisdiction or in carefully concealed labs.[36] In an example of "fertility tourism," for example, Swedes now routinely travel to Denmark for artificial insemination with donor sperm in order to circumvent a Swedish law that requires identification of the donors.[37] If the life of a dying child or the ability to conceive were at stake, prospective patients and their families would be willing to go to even greater lengths to secure treatment. And if an underground practice developed with respect, for example, to enhancing athletic performance or permitting gay and lesbian couples to bear offspring genetically related to two, same-sex parents, a whole community might arise committed to funding, promoting, and concealing such activities. Fukuyama acknowledges these difficulties, but he does not examine the motivation necessary to make a new regulatory regime work.

Doing so will require consideration of two processes that go well beyond Fukuyama's book and the existing discourse about biotechnology. The first is the creation of consensus. Most existing technological developments occurred without serious consideration of the wisdom of their adoption. We have begun to wonder about the implications of the revolution in information technology only now that

36. *See, e.g.*, Tom Cohen, *Canada Regulates Meth Chemicals*, ASSOCIATED PRESS, Oct. 17, 2002, LEXIS, Academic Universe, N.Y. Times Library ("Often called the 'poor man's cocaine,' methamphetamine can be made in bathtubs, on kitchen stoves and in car trunks from commercially available chemicals. It normally contains ephedrine and pseudoephedrine, found in over-the-counter cold medications.").

37. Matthew Hill, *Sperm Donors "Want to Keep Anonymity,"* BBC NEWS: WORLD EDITION, Oct. 15, 2002 ("Across Denmark last year 336 Swedish women were given donor insemination, which resulted in 81 pregnancies — 30 pregnancies more than in Sweden."), *available at* http://news.bbc.co.uk'/L/hi/'health/2329675.stm.

it is fully upon us. Biotechnology, on the other hand, as Fukuyama's book illustrates, touches on deep-seated human hopes and fears. Ill-considered legislation might derail promising research at the same time that more questionable activities may flourish by going underground or abroad. The Swedes, unable to command respect for their policy of sperm-donor identification, cannot prevent their citizens from going to Denmark. The scientific community, which has been appalled by religiously motivated proposals for prohibitions on stem-cell research, is likely to have few compunctions about moving such research to friendlier climates. Genuinely policing biotechnology requires not just passing laws, but forging understandings capable of winning widespread adherence.

Second, implementing moral and ethical understandings, if consensus can be forged, requires the alignment of incentives and the desired behavior. Fukuyama observes that through the early nineties virtually all biomedical research in the United States was federally funded (p. 214). That meant that the best researchers only undertook federally approved projects, overseen by professional boards that developed standards for acceptable practices. The biotech industry has since doubled in size, with private funding upstaging federal efforts such as the Human Genome Project, and more decentralized programs, like fertility clinics, flourishing in areas too politically hot to fund with public money. Infusion of large amounts of federal or foundation grants to underwrite the research is likely to produce greater public participation in the decisions about implementation. Care should also be given to the development of private consortiums capable of developing industry standards and seals of approval. But in some areas, there will be no substitute for nurturing moral understandings at the individual level. Creating internalized codes that not only bar, but condemn, steroid-enhanced-athletic performance needs to go hand-in-glove with the line-drawing between acceptable and unacceptable use of genetic knowledge to produce those likely to be the athletes of tomorrow.

CONCLUSION

Whatever the failings of *Our Posthuman Future*, Fukuyama has written a compelling book that rests on a provocative thesis. His most important insight is that human beings are messy. We strive for recognition — and dominance. We can be violent — and compassionate. We seek autonomy — and community. We are not intrinsically trustworthy, but we seek to provide the circumstances in which we can trust others. Politics, the state, the sources of restraint on state power, rights, and the celebration of freedom and community all come from our need to restrain our worst impulses, while encouraging the flourishing of others. We wish to extol genius, even when accompanied by

madness, restrain violence without eliminating the capacity for self-defense, celebrate creativity even while acknowledging that it may interfere with community, and permit ourselves to live together in close proximity with a minimum of coercion. The institutions that we design to achieve these results depend on the nature of human interactions, and thus their shape fundamentally depends on human nature. If we no longer seek recognition or dominance, if we eliminate our tendencies toward violence and creativity, if we do not value individuality or autonomy, we do not need the institutions we have, and we neither need nor warrant rights designed to promote the welfare of a species that has left those values behind.

What Fukuyama most seeks to prevent is *Brave New World*.[38] He fears that Prozac may be a precursor to "soma," the drug in Aldous Huxley's world that kept workers contented with their lot (p. 46). Genetic engineering could produce Alphas and Betas, football players and pianists who become different species. Brain scans may identify the sexually deviant and justify their internment or exile. In the process, we will have lost our need and demand for democracy. We will not be equals, and we will have lost our willingness to demand or recognize equal rights.

Fukuyama has undertaken yeoman work in articulating the connection between human tendencies and human institutions that has formed the core of his earlier work. What *Our Posthuman Future* curiously fails to do is to develop the political economy of the biotech industry in which these decisions will be made. If human nature is what has created our current institutions, then Fukuyama must engage with human nature in designing new institutions capable of advancing his objectives. Once he acknowledges human nature in all its complexity, he will face an insolvable dilemma: among the most basic human tendencies will be the desire to circumvent anything he devises. If the U.S. bans stem-cell research, Sweden or China may endorse it.[39] If the world unites in opposition to cloning, the Raelians may finance Caribbean clinics for grieving parents who wish to clone their lost children. And athletes will try anything that promises to enhance their performance. Our posthuman future may not be inevitable, but it may well be beyond the ability of any individual or group to direct.

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38. HUXLEY, *supra* note 18.

39. Indeed, Dr. Grifo, the New York University fertility specialist who helped pioneer the use of nuclear transfer techniques to assist patients with mitochondrial defects, moved his research to China after the FDA attempted to regulate such activities. *See* Antonio Regalado & Karby Leggett, *Fertility Breakthrough Raises Questions About Link to Cloning*, WALL ST. J., Oct. 13, 2003, at 1A (reporting that a team of Chinese and American doctors were expected to announce that they had created the first human pregnancy using a DNA-swapping technology similar to that which created Dolly the sheep).