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A TALE OF TWO DYSTOPIAS

The threat to man does not come in the first instance from the potentially lethal machines and apparatus of technology. The actual threat has always afflicted man in his essence. The rule of enframing (*Gestell*) threatens man with the possibility that it could be denied to him to enter into a more original revealing and hence to experience the call of a more primal truth.

Martin Heidegger, *The Question Concerning Technology*[1]

I was born in 1952, right in the middle of the American baby boom. For any person growing up as I did in the middle decades of the twentieth century, the future and its terrifying possibilities were defined by two books, George Orwell's *1984* (first published in 1949) and Aldous Huxley's *Brave New World* (published in 1932).

The two books were far more prescient than anyone realized at the time, because they were centered on two different technologies that would in fact emerge and shape the world over the next two generations. The novel *1984* was about what we now call information technology: central to the success of the vast, totalitarian empire that had been set up over Oceania was a device called the telescreen, a wall-sized flat-panel display that could simultaneously send and receive images from each individual household to a hovering Big Brother. The telescreen was what permitted the vast centralization of social life under the Ministry of Truth and the Ministry of Love, for it allowed the government to banish privacy by monitoring every word and deed over a massive network of wires.

Brave New World, by contrast, was about the other big technological revolution about to take place, that of biotechnology. Bokanovskification, the hatching of people not in wombs but, as we now say, in vitro; the drug soma, which gave people instant happiness; the Feelies, in which sensation was simulated by implanted electrodes; and the modification of behavior through constant subliminal repetition and, when that didn't work, through the administration of various artificial hormones were what gave this book its particularly creepy ambiance.

With at least a half century separating us from the publication of these books, we can see that while the technological predictions they made were startlingly accurate, the political predictions of the first book, *1984*, were entirely wrong. The year 1984 came and went, with the United States still locked in a Cold War struggle with the Soviet Union. That year saw the introduction of a new model of the IBM personal computer and the beginning of what became the PC revolution. As Peter Huber has argued, the personal computer, linked to the Internet, was in fact the realization of Orwell's telescreen.[2] But instead of becoming an instrument of centralization and tyranny, it led to just the opposite: the democratization of access to information and the decentralization of politics. Instead of Big Brother watching everyone, people could use the PC and Internet to watch Big Brother, as governments everywhere were driven to publish more information on their own activities.

Just five years after 1984, in a series of dramatic events that would earlier have seemed like political science fiction, the Soviet Union and its empire collapsed, and the totalitarian threat that Orwell had so vividly evoked vanished. People were again quick to point out that these two events—the collapse of totalitarian empires and the emergence of the personal computer, as well as other forms of inexpensive information technology, from TVs and radios to faxes and e-mail—were not unrelated. Totalitarian rule depended on a regime's ability to maintain a monopoly over information, and once modern information technology made that impossible, the regime's power was undermined.

The political prescience of the other great dystopia, *Brave New World*, remains to be seen. Many of the technologies that Huxley envisioned, like in vitro fertilization, surrogate motherhood, psychotropic drugs, and genetic engineering for the manufacture of children, are already here or just over the horizon. But this revolution has only just begun; the daily avalanche of announcements of new breakthroughs in biomedical technology and achievements such as the completion of the Human Genome Project in the year 2000 portend much more serious changes to come.

Of the nightmares evoked by these two books, *Brave New World*'s always struck me as more subtle and more challenging. It is easy to see what's wrong with the world of *1984*: the protagonist, Winston Smith, is known to hate rats above all things, so Big Brother devises a cage in which rats can bite at Smith's face in order to get him to betray his lover. This is the world of classical tyranny, technologically empowered but not so different from what we have tragically seen and known in human history.

In *Brave New World*, by contrast, the evil is not so obvious because no one is hurt; indeed, this is a world in which everyone gets what they want. As one of the characters notes, "The Controllers realized that force was no good," and that people would have to be seduced rather than compelled to live in an orderly society. In this world, disease and social conflict have been abolished, there is no depression, madness, loneliness, or emotional distress, sex is good and readily available. There is even a government ministry to ensure that the length of time between the appearance of a desire and its satisfaction is kept to a minimum. No one takes religion seriously any longer, no one is introspective or has unrequited longings, the biological family has been abolished, no one reads Shakespeare. But no one (save John the Savage, the book's protagonist) misses these things, either, since they are happy and healthy.

Since the novel's publication, there have probably been several million high school essays written in answer to the question, "What's wrong with this picture?" The answer given (on papers that get A's, at any rate) usually runs something like this: the people in *Brave New World* may be healthy and happy, but they have ceased to be ***human beings***. They no longer struggle, aspire, love, feel pain, make difficult moral choices, have families, or do any of the things that we traditionally associate with being human. They no longer have the characteristics that give us human dignity. Indeed, there is no such thing as the human race any longer, since they have been bred by the Controllers into separate castes of Alphas, Betas, Epsilons, and Gammas who are as distant from each other as humans are from animals. Their world has become unnatural in the most profound sense imaginable, because ***human nature*** has been altered. In the words of bioethicist Leon Kass, "Unlike the man reduced by disease or slavery, the people dehumanized à la *Brave New World* are not miserable, don't know that they are dehumanized, and, what is worse, would not care if they knew. They are, indeed, happy slaves with a slavish happiness."[3]

But while this kind of answer is usually adequate to satisfy the typical high school English teacher, it does not (as Kass goes on to note) probe nearly deeply enough. For one can then ask, What is so important about being a human being in the traditional way that Huxley defines it? After all, what the human race is today is the product of an evolutionary process that has been going on for millions of years, one that with any luck will continue well into the future. There are no fixed human characteristics, except for a general capability to choose what we want to be, to modify ourselves in accordance with our desires. So who is to tell us that being human and having dignity means sticking with a set of emotional responses that are the accidental byproduct of our evolutionary history? There is no such thing as a biological family, no such thing as human nature or a "normal" human being, and even if there were, why should that be a guide for what is right and just? Huxley is telling us, in effect, that we should continue to feel pain, be depressed or lonely, or suffer from debilitating disease, all because that is what human beings have done for most of their existence as a species. Certainly, no one ever got elected to Congress on such a platform. Instead of taking these characteristics and saying that they are the basis for "human dignity," why don't we simply accept our destiny as creatures who modify themselves?

Huxley suggests that one source for a definition of what it means to be a human being is religion. In *Brave New World*, religion has been abolished and Christianity is a distant memory. The Christian tradition maintains that man is created in God's image, which is the source of human dignity. To use biotechnology to engage in what another Christian writer, C. S. Lewis, called the "abolition of man" is thus a violation of God's will. But I don't think that a careful reading of Huxley or Lewis leads to the conclusion that either writer believed religion to be the *only* grounds on which one could understand the meaning of being human. Both writers suggest that nature itself, and in particular human nature, has a special role in defining for us what is right and wrong, just and unjust, important and unimportant. So our final judgment on "what's wrong" with Huxley's brave new world stands or falls with our view of how important human nature is as a source of values.

The aim of this book is to argue that Huxley was right, that the most significant threat posed by contemporary biotechnology is the possibility that it will alter human nature and thereby move us into a "posthuman" stage of history. This is important, I will argue, because 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.

It may be that, as in the case of *1984*, we will eventually find biotechnology's consequences are completely and surprisingly benign, and that we were wrong to lose sleep over it. It may be that the technology will in the end prove much less powerful than it seems today, or that people will be moderate and careful in their application of it. But one of the reasons I am not quite so sanguine is that biotechnology, in contrast to many other scientific advances, mixes obvious benefits with subtle harms in one seamless package.

Nuclear weapons and nuclear energy were perceived as dangerous from the start, and therefore were subject to strict regulation from the moment the Manhattan Project created the first atomic bomb in 1945. Observers like Bill Joy have worried about nanotechnology—that is, molecular-scale self-replicating machines capable of reproducing out of control and destroying their creators.[4] But such threats are actually the easiest to deal with because they are so obvious. If you are likely to be killed by a machine you've created, you take measures to protect yourself. And so far we've had a reasonable record in keeping our machines under control.

There may be products of biotechnology that will be similarly obvious in the dangers they pose to mankind—for example, superbugs, new viruses, or genetically modified foods that produce toxic reactions. Like nuclear weapons or nanotechnology, these are in a way the easiest to deal with because once we have identified them as dangerous, we can treat them as a straightforward threat. The more typical threats raised by biotechnology, on the other hand, are those captured so well by Huxley, and are summed up in the title of an article by novelist Tom Wolfe, "Sorry, but Your Soul Just Died."[5] Medical technology offers us in many cases a devil's bargain: longer life, but with reduced mental capacity; freedom from depression, together with freedom from creativity or spirit; therapies that blur the line between what we achieve on our own and what we achieve because of the levels of various chemicals in our brains.

Consider the following three scenarios, all of which are distinct possibilities that may unfold over the next generation or two.

The first has to do with new drugs. As a result of advances in neuropharmacology, psychologists discover that human personality is much more plastic than formerly believed. It is already the case that psychotropic drugs such as Prozac and Ritalin can affect traits like self-esteem and the ability to concentrate, but they tend to produce a host of unwanted side effects and hence are shunned except in cases of clear therapeutic need. But in the future, knowledge of genomics permits pharmaceutical companies to tailor drugs very specifically to the genetic profiles of individual patients and greatly minimize unintended side effects. Stolid people can become vivacious; introspective ones extroverted; you can adopt one personality on Wednesday and another for the weekend. There is no longer any excuse for anyone to be depressed or unhappy; even "normally" happy people can make themselves happier without worries of addiction, hangovers, or long-term brain damage.

In the second scenario, advances in stem cell research allow scientists to regenerate virtually any tissue in the body, such that life expectancies are pushed well above 100 years. If you need a new heart or liver, you just grow one inside the chest cavity of a pig or cow; brain damage from Alzheimer's and stroke can be reversed. The only problem is that there are many subtle and some not-so-subtle aspects of human aging that the biotech industry hasn't quite figured out how to fix: people grow mentally rigid and increasingly fixed in their views as they age, and try as they might, they can't make themselves sexually attractive to each other and continue to long for partners of reproductive age. Worst of all, they just refuse to get out of the way, not just of their children, but their grandchildren and great-grandchildren. On the other hand, so few people have children or any connection with traditional reproduction that it scarcely seems to matter.

In a third scenario, the wealthy routinely screen embryos before implantation so as to optimize the kind of children they have. You can increasingly tell the social background of a young person by his or her looks and intelligence; if someone doesn't live up to social expectations, he tends to blame bad genetic choices by his parents rather than himself. Human genes have been transferred to animals and even to plants, for research purposes and to produce new medical products; and animal genes have been added to certain embryos to increase their physical endurance or resistance to disease. Scientists have not dared to produce a full-scale chimera, half human and half ape, though they could; but young people begin to suspect that classmates who do much less well than they do are in fact genetically not fully human. Because, in fact, they aren't.

Sorry, but your soul just died . . .

Toward the very end of his life, Thomas Jefferson wrote, "The general spread of the light of science has already laid open to every view the palpable truth, that the mass of mankind has not been born with saddles on their backs, nor a favored few booted and spurred, ready to ride them legitimately, by the grace of God."[6] The political equality enshrined in the Declaration of Independence rests on the empirical fact of natural human equality. We vary greatly as individuals and by culture, but we share a common humanity that allows every human being to potentially communicate with and enter into a moral relationship with every other human being on the planet. The ultimate question raised by biotechnology is, What will happen to political rights once we are able to, in effect, breed some people with saddles on their backs, and others with boots and spurs?

A STRAIGHTFORWARD SOLUTION

What should we do in response to biotechnology that in the future will mix great potential benefits with threats that are either physical and overt or spiritual and subtle? The answer is obvious: *We should use the power of the state to regulate it.* And if this proves to be beyond the power of any individual nation-state to regulate, it needs to be regulated on an international basis. We need to start thinking concretely now about how to build institutions that can discriminate between good and bad uses of biotechnology, and effectively enforce these rules both nationally and internationally.

This obvious answer is not obvious to many of the participants in the current biotechnology debate. The discussion remains mired at a relatively abstract level about the ethics of procedures like cloning or stem cell research, and divided into one camp that would like to permit everything and another camp that would like to ban wide areas of research and practice. The broader debate is of course an important one, but events are moving so rapidly that we will soon need more practical guidance on how we can direct future developments so that the technology remains man's servant rather than his master. Since it seems very unlikely that we will either permit everything or ban research that is highly promising, we need to find a middle ground.

The creation of new regulatory institutions is not something that should be undertaken lightly, given the inefficiencies that surround all efforts at regulation. For the past three decades, there has been a commendable worldwide movement to deregulate large sectors of every nation's economy, from airlines to telecommunications, and more broadly to reduce the size and scope of government. The global economy that has emerged as a result is a far more efficient generator of wealth and technological innovation. Excessive regulation in the past has led many to become instinctively hostile to state intervention in any form, and it is this knee-jerk aversion to regulation that will be

one of the chief obstacles to getting human biotechnology under political control.

But it is important to discriminate: what works for one sector of the economy will not work for another. Information technology, for example, produces many social benefits and relatively few harms and therefore has appropriately gotten by with a fairly minimal degree of government regulation. Nuclear materials and toxic waste, on the other hand, are subject to strict national and international controls because unregulated trade in them would clearly be dangerous.

One of the biggest problems in making the case for regulating human biotechnology is the common view that even if it were desirable to stop technological advance, it is impossible to do so. If the United States or any other single country tries to ban human cloning or germline genetic engineering or any other procedure, people who wanted to do these things would simply move to a more favorable jurisdiction where they were permitted. Globalization and international competition in biomedical research ensure that countries that hobble themselves by putting ethical constraints on their scientific communities or biotechnology industries will be punished.

The idea that it is impossible to stop or control the advance of technology is simply wrong, for reasons that will be laid out more fully in Chapter 10 of this book. We in fact control all sorts of technologies and many types of scientific research: people are no more free to experiment in the development of new biological warfare agents than they are to experiment on human subjects without the latter's informed consent. The fact that there are some individuals or organizations that violate these rules, or that there are countries where the rules are either nonexistent or poorly enforced, is no excuse for not making the rules in the first place. People get away with robbery and murder, after all, which is not a reason to legalize theft and homicide.

We need at all costs to avoid a defeatist attitude with regard to technology that says that since we can't do anything to stop or shape developments we don't like, we shouldn't bother trying in the first place. Putting in place a regulatory system that would permit societies to control human biotechnology will not be easy: it will require legislators in countries around the world to step up to the plate and make difficult decisions on complex scientific issues. The shape and form of the institutions designed to implement new rules is a wide-open question; designing them to be minimally obstructive of positive developments while giving them effective enforcement capabilities is a significant challenge. Even more challenging will be the creation of common rules at an international level, the forging of a consensus among countries with different cultures and views on the underlying ethical questions. But political tasks of comparable complexity have been successfully undertaken in the past.

BIOTECHNOLOGY AND THE RECOMMENCEMENT OF HISTORY

Many of the current debates over biotechnology, on issues like cloning, stem cell research, and germ-line engineering, are polarized between the scientific community and those with religious commitments. I believe that this polarization is unfortunate because it leads many to believe that the *only* reason one might object to certain advances in biotechnology is out of religious belief. Particularly in the United States, biotechnology has been drawn into the debate over abortion; many researchers feel that valuable progress is being checked out of deference to a small number of antiabortion fanatics.

I believe that it is important to be wary of certain innovations in biotechnology for reasons that have nothing to do with religion. The case that I will lay out here might be called Aristotelian, not because I am appealing to Aristotle's authority as a philosopher, but because I take his mode of rational philosophical argument about politics and nature as a model for what I hope to accomplish.

Aristotle argued, in effect, that human notions of right and wrong—what we today call human rights—were ultimately based on human nature. That is, without understanding how natural desires, purposes, traits, and behaviors fit together into a human whole, we cannot understand human ends or make judgments about right and wrong, good and bad, just and unjust. Like many more recent utilitarian philosophers, Aristotle believed that the good was defined by what people desired; but while utilitarians seek to reduce human ends to a simple common denominator like the relief of suffering or the maximization of pleasure, Aristotle retained a complex and nuanced view of the diversity and greatness of natural human ends. The purpose of his philosophy was to try to differentiate the natural from the conventional, and to rationally order human goods.

Aristotle, together with his immediate predecessors Socrates and Plato, initiated a dialogue about the nature of human nature that continued in the Western philosophical tradition right up to the early modern period, when liberal democracy was born. While there were significant disputes over what human nature was, no one contested its importance as a basis for rights and justice. Among the believers in natural right were the American Founding Fathers, who based their revolution against the British crown on it. Nonetheless, the concept has been out of favor for the past century or two among academic philosophers and intellectuals.

As we will see in Part II of this book, I believe this is a mistake, and that any meaningful definition of rights must be based on substantive judgments about human nature. Modern biology is finally giving some meaningful empirical content to the concept of human nature, just as the biotech revolution threatens to take the punch bowl away.

Whatever academic philosophers and social scientists may think of the concept of human nature, the fact that there has been a stable human nature throughout human history has had very great political consequences. As Aristotle and every serious theorist of human nature has understood, human beings are by nature cultural animals, which means that they can learn from experience and pass on that learning to their descendants through nongenetic means. Hence human nature is not narrowly determinative of human behavior but leads to a huge variance in the way people raise children, govern themselves, provide resources, and the like. Mankind's constant efforts at cultural self-modification are what lead to human history and to the progressive growth in the complexity and sophistication of human institutions over time.

The fact of progress and cultural evolution led many modern thinkers to believe that human beings were almost infinitely plastic—that is, that they could be shaped by their social environment to behave in open-ended ways. It is here that the contemporary prejudice against the concept of human nature starts. Many of those who believed in the social construction of human behavior had strong ulterior motives: they hoped to use social engineering to create societies that were just or fair according to some abstract ideological principle. Beginning with the French Revolution, the world has been convulsed with a series of utopian political movements that sought to create an earthly heaven by radically rearranging the most basic institutions of society, from the family to private property to the state. These movements crested in the twentieth century, with the socialist revolutions that took place in Russia, China, Cuba, Cambodia, and elsewhere.

By the end of the century, virtually every one of these experiments had failed, and in their place came efforts to create or restore equally modern but less politically radical liberal democracies. One important reason for this worldwide convergence on liberal democracy had to do with the tenacity of human nature. For while human behavior is plastic and variable, it is not infinitely so; at a certain point deeply rooted natural instincts and patterns of behavior reassert themselves to undermine the social engineer's best-laid plans. Many socialist regimes abolished private property, weakened the family, and demanded that people be altruistic to mankind in general rather than to a narrower circle of friends and family. But evolution did not shape human beings in this fashion. Individuals in socialist societies resisted the new institutions at every turn, and when socialism collapsed after the fall of the Berlin Wall in 1989, older, more familiar patterns of behavior reasserted themselves everywhere.

Political institutions cannot abolish either nature or nurture altogether and succeed. The history of the twentieth century was defined by two opposite horrors, the Nazi regime, which said biology was everything, and communism, which maintained that it counted for next to nothing. Liberal democracy has emerged as the only viable and legitimate political system for modern societies because it avoids either extreme, shaping politics according to historically created norms of justice while not interfering excessively with natural patterns of behavior.

There were many other factors affecting the trajectory of history, which I discussed in my book *The End of History and the Last Man.*[7] One of the basic drivers of the human historical process has been the

development of science and technology, which is what determines the horizon of economic production possibilities and therefore a great deal of a society's structural characteristics. The development of technology in the late twentieth century was particularly conducive to liberal democracy. This is not because technology promotes political freedom and equality per se—it does not—but because late-twentieth-century technologies (particularly those related to information) are what political scientist Ithiel de Sola Pool has labeled technologies of freedom.[8]

There is no guarantee, however, that technology will always produce such positive political results. Many technological advances of the past reduced human freedom.[9] The development of agriculture, for example, led to the emergence of large hierarchical societies and made slavery more feasible than it had been in hunter-gatherer times. Closer to our own time, Eli Whitney's invention of the cotton gin made cotton a significant cash crop in the American South at the beginning of the nineteenth century and led to the revitalization of the institution of slavery there.

As the more perceptive critics of the concept of the "end of history" have pointed out, there can be no end of history without an end of modern natural science and technology.[10] Not only are we not at an end of science and technology; we appear to be poised at the cusp of one of the most momentous periods of technological advance in history. Biotechnology and a greater scientific understanding of the human brain promise to have extremely significant political ramifications. Together, they reopen possibilities for social engineering on which societies, with their twentieth-century technologies, had given up.

If we look back at the tools of the past century's social engineers and utopian planners, they seem unbelievably crude and unscientific. Agitprop, labor camps, reeducation, Freudianism, early childhood conditioning, behavioralism—all of these were techniques for pounding the square peg of human nature into the round hole of social planning. None of them were based on knowledge of the neurological structure or biochemical basis of the brain; none understood the genetic sources of behavior, or if they did, none could do anything to affect them.

All of this may change in the next generation or two. We do not have to posit a return of state-sponsored eugenics or widespread genetic engineering to see how this could happen. Neuropharmacology has already produced not just Prozac for depression but Ritalin to control the unruly behavior of young children. As we discover not just correlations but actual molecular pathways between genes and traits like intelligence, aggression, sexual identity, criminality, alcoholism, and the like, it will inevitably occur to people that they can make use of this knowledge for particular social ends. This will play itself out as a series of ethical questions facing individual parents, and also as a political issue that may someday come to dominate politics. If wealthy parents suddenly have open to them the opportunity to increase the intelligence of their children as well as that of all their subsequent descendants, then we have the makings not just of a moral dilemma but of a full-scale class war.

This book is divided into three parts. The first lays out some plausible pathways to the future and draws some first-order consequences, from those that are near-term and very likely through those that are more distant and uncertain. The four stages outlined here are:

- increasing knowledge about the brain and the biological sources of human behavior;
- neuropharmacology and the manipulation of emotions and behavior;
- the prolongation of life;
- and finally, genetic engineering.

Part II deals with the philosophical issues raised by an ability to manipulate human nature. It argues for the centrality of human nature to our understanding of right and wrong—that is, human rights—and how we can develop a concept of human dignity that does not depend on religious assumptions about the origins of man. Those not inclined to more theoretical discussions of politics may choose to skip over some of the chapters here.

The final part is more practical: it argues that if we are worried about some of the long-term consequences of biotechnology, we can

do something about it by establishing a regulatory framework to separate legitimate and illegitimate uses. This part of the book may seem to have the opposite vice from Part II, getting into the details of specific agencies and laws in the United States and other countries, but there is a reason for this. The advance of technology is so rapid that we need to move quickly to much more concrete analysis of what kinds of institutions will be required to deal with it.

There are many near-term practical and policy-related issues that have been raised by advances in biotechnology such as the completion of the Human Genome Project, including genetic discrimination and the privacy of genetic information. This book will not focus on any of these questions, partly because they have been dealt with extensively by others, and partly because the biggest challenges opened up by biotechnology are not those immediately on the horizon but the ones that may be a decade to a generation or more away. What is important to recognize is that this challenge is not merely an ethical one but a political one as well. For it will be the political decisions that we make in the next few years concerning our relationship to this technology that determine whether or not we enter into a posthuman future and the potential moral chasm that such a future opens before us.

5

GENETIC ENGINEERING

"All beings so far have created something beyond themselves; and do you want to be the ebb of this great flood and even go back to the beasts rather than overcome man? What is the ape to man? A laughingstock or a painful embarrassment. And man shall be just that for the overman: a laughingstock or a painful embarrassment. You have made your way from worm to man, and much in you is still worm. Once you were apes, and even now, too, man is more ape than any ape."

Friedrich Nietzsche, *Thus Spoke Zarathustra* I.3

All of the consequences described in the preceding three chapters may come to pass without any further progress in the most revolutionary biotechnology of all, genetic engineering. Today, genetic engineering is used commonly in agricultural biotechnology to produce genetically modified organisms such as Bt corn (which produces its own insecticide) or Roundup Ready soybeans (which are resistant to certain weed-control herbicides), products that have been the focus of controversy and protest around the world. The next line of advance is obviously to apply this technology to human beings. Human genetic engineering raises most directly the prospect of a new kind of eugenics, with all the moral implications with which that word is fraught, and ultimately the ability to change human nature.

Yet despite completion of the Human Genome Project, contemporary biotechnology is today very far from being able to modify human DNA in the way that it can modify the DNA of corn or beef cattle. Some people would argue that we will never in fact achieve this kind of capability and that the ultimate prospects for genetic technology have been grossly overhyped both by ambitious scientists and by biotechnology companies out for quick profits. Changing human nature is neither possible, according to some, nor remotely on the agenda of contemporary biotechnology. We need, then, a balanced assessment of what this technology can be expected to achieve, and a sense of the constraints that it may eventually face.

The Human Genome Project was a massive effort, funded by the United States and other governments, to decode the entire DNA sequence of a human being, just as the DNA sequences of lesser creatures, like nematodes and yeast, had been decoded.[1] DNA molecules are the famous twisted, double-stranded sequences of four bases that make up each of the forty-six chromosomes contained in the nucleus of every cell in the body. These sequences constitute a digital code that is used to synthesize amino acids, which are then combined to produce the proteins that are the building blocks of all organisms. The human genome consists of some 3 billion pairs of bases, a large percentage of which consists of noncoding, "silent" DNA. The remainder constitutes genes that contain the actual blueprints for human life.*

The complete sequencing of the human genome was completed way ahead of schedule, in June 2000, in part because of competition between the official government-sponsored Human Genome Project and a similar effort by a private biotech company, Celera Genomics. The publicity surrounding this event sometimes suggested that scientists had decoded the genetic basis of life, but all the sequencing did was present the transcript of a book written in a language that is only partially understood. There is great uncertainty on such basic issues as how many genes are contained in human DNA. A few months af-

*Those who are interested in seeing exactly what the raw code looks like, and how each chromosome is divided into genes and noncoding areas, can simply look at the Web site of the National Institutes of Health's National Center for Biotechnology Information at http://www.ncbi.nlm.nih.gov/Genbank/GenbankOverview.html.

ter completion of the sequencing, Celera and the International Human Genome Sequencing Consortium released a study indicating that the number was 30,000 to 40,000 instead of the more than 100,000 previously estimated. Beyond genomics lies the burgeoning field of proteomics, which seeks to understand how genes code for proteins and how the proteins themselves fold into the exquisitely complex shapes required by cells.[2] And beyond proteomics there lies the unbelievably complex task of understanding how these molecules develop into tissues, organs, and complete human beings.

The Human Genome Project would not have been possible without parallel advances in the information technology required to record, catalog, search, and analyze the billions of bases making up human DNA. The merger of biology and information technology has led to the emergence of a new field, known as bioinformatics.[3] What will be possible in the future will depend heavily on the ability of computers to interpret the mind-boggling amounts of data generated by genomics and proteomics and to build reliable models of phenomena such as protein folding.

The simple identification of genes in the genome does not mean that anyone knows what it is they do. A great deal of progress has been made in the past two decades in finding the genes connected to cystic fibrosis, sickle-cell anemia, Huntington's chorea, Tay-Sachs disease, and the like. But these have all tended to be relatively simple disorders, in which the pathology can be traced to a wrong allele, or coding sequence, in a single gene. Other diseases are caused by multiple genes that interact in complex ways: some genes control the expression (that is, the activation) of other genes, some interact with the environment in complex ways, some produce two or more effects, and some produce effects that will not be visible until late in the organism's life cycle.

When it comes to higher-order conditions and behaviors, such as intelligence, aggression, sexuality, and the like, we know nothing more today than that there is some degree of genetic causation, from studies in behavior genetics. We have no idea what genes are ultimately responsible, but suspect that the causal relationships are extraordinarily complex. In the words of Stuart Kauffman, founder and chief scientific officer of BiosGroup, these genes are "some kind of

parallel-processing chemical computer in which genes are continuously turning one another on and off in some vastly complex network of interaction. Cell-signaling pathways are linked to genetic regulatory pathways in ways we're just beginning to unscramble."[4]

The first step toward giving parents greater control over the genetic makeup of their children will come not from genetic engineering but with preimplantation genetic diagnosis and screening. In the future it should be routinely possible for parents to have their embryos automatically screened for a wide variety of disorders, and those with the "right" genes implanted in the mother's womb. Present-day medical technology, such as amniocentesis and sonograms, gives parents a certain degree of choice already, as when a fetus diagnosed with Down's syndrome is aborted, or when girl fetuses are aborted in Asia. Embryos have already been successfully screened for birth defects like cystic fibrosis.[5] Geneticist Lee Silver paints a future scenario in which a woman produces a hundred or so embryos, has them automatically analyzed for a "genetic profile," and then with a few clicks of the mouse selects the one that not only lacks alleles for single-gene disorders like cystic fibrosis, but also has enhanced characteristics, such as height, hair color, and intelligence.[6] The technologies to bring this about do not exist now but are on the way: a company called Affymetrix, for example, has developed a so-called DNA chip that automatically screens a DNA sample for various markers of cancer and other disorders.[7] Preimplantation diagnosis and screening does not require any ability to manipulate the embryo's DNA, but limits parental choice to the kind of variation that normally occurs through sexual reproduction.

The other technology that is likely to mature well before human genetic engineering is human cloning. Ian Wilmut's success in creating the cloned sheep Dolly in 1997 provoked a huge amount of controversy and speculation about the possibility of cloning a human being from adult cells.[8] President Clinton's request to the National Bioethics Advisory Commission for advice on this subject led to a study that recommended a ban on federal funding for human cloning research, a moratorium on such activities by private companies and concerns, and consideration by Congress of a legislative ban.[9] In lieu of a congressional ban, however, the attempt to clone a human being by a non–federally funded organization remains legal. There are reports that a sect called the Raelians is trying to do just that,[10] as well as a well-publicized effort by Severino Antinori and Panos Zavos. The technical obstacles to human cloning are substantially smaller than in the case of either preimplantation diagnosis or genetic engineering, and have mostly to do with the safety and ethicality of experimenting with human beings.

THE ROAD TO DESIGNER BABIES

The ultimate prize of modern genetic technology will be the "designer baby."[11] That is, geneticists will identify the "gene for" a characteristic like intelligence, height, hair color, aggression, or self-esteem and use this knowledge to create a "better" version of the child. The gene in question may not even have to come from a human being. This is, after all, what happens in agricultural biotechnology. Bt corn, first developed by Ciba Seeds (now Novartis Seeds) and Mycogen Seeds in 1996, has an exotic gene inserted into its DNA that allows it to produce a protein from the *Bacillus thuringiensis* bacterium (hence the Bt designation) that is toxic to insect pests such as the European corn borer. The resulting plant is thus genetically modified to produce its own pesticide, and it hands down this characteristic to its offspring.

Doing the same thing to human beings is, of all of the technologies discussed in this chapter, the most remote. There are two ways by which genetic engineering can be accomplished: somatic gene therapy and germ-line engineering. The first attempts to change the DNA within a large number of target cells, usually by delivering the new, modified genetic material by means of a virus or "vector." A number of somatic gene therapy trials have been conducted in recent years, with relatively little success. The problem with this approach is that the body is made up of trillions of cells; for the therapy to be effective, the genetic material of what amounts to millions of cells has to be altered. The somatic cells in question die with the individual being treated, if not before; the therapy has no lingering generational effects.

Germ-line engineering, by contrast, is what is done routinely in

agricultural biotechnology and has been successfully carried out in a wide variety of animals. Modification of the germ line requires, at least in theory, changing only one set of DNA molecules, those in the fertilized egg, which will eventually undergo division and ramify into a complete human being. While somatic gene therapy changes only the DNA of somatic cells, and therefore affects only the individual who receives the treatment, germ-line changes are passed down to the individual's offspring. This has obvious attractions for the treatment of inherited diseases, such as diabetes.[12]

Among other new technologies currently under study are artificial chromosomes that would add an extra chromosome to the forty-six natural ones; the chromosone could be turned on only when the recipient was old enough to give his or her informed consent and would not be inherited by descendants.[13] This technique would avoid the need to alter or replace genes in existing chromosomes. Artificial chromosomes might thus constitute a bridge between preimplantation screening and permanent modification of the germ line.

Before human beings can be genetically modified in this manner, however, a number of steep obstacles need to be overcome. The first has to do with the sheer complexity of the problem, which suggests to some that any meaningful kind of genetic engineering for higher-order behaviors will simply be impossible. We noted earlier that many diseases are caused by the interaction of multiple genes; it is also the case that a single gene has multiple effects. It was believed at one time that each gene produced one messenger RNA, which in turn produced one protein. But if the human genome in fact contains closer to 30,000 than 100,000 genes, then this model cannot hold up, since there are far more than 30,000 proteins making up the human body. This suggests that single genes play a role in producing many proteins and therefore have multiple functions. The allele responsible for sickle-cell anemia, for example, also confers resistance to malaria, which is why it is common among blacks, who trace their ancestry to Africa, where malaria was a major disease. Repairing the gene for sickle-cell anemia might therefore increase susceptibility to malaria, something that may not matter much for people in North America but would harm carriers of the new gene in Africa. Genes have been compared to an ecosystem, where each part influences every other part: in the words of Edward O. Wilson, "in heredity as in the environment, you cannot do just one thing. When a gene is changed by mutation or replaced by another gene, unexpected and possibly unpleasant side effects are likely to follow."[14]

The second major obstacle to human genetic engineering has to do with the ethics of human experimentation. The National Bioethics Advisory Commission raised the danger of human experimentation as the chief reason for seeking a short-term ban on human cloning. It took nearly 270 failed attempts before Dolly was successfully cloned.[15] While many of these failures came at the implantation stage, nearly 30 percent of all animals that have been cloned since then have been born with serious abnormalities. As noted earlier, Dolly was born with shortened telomeres and will probably not live as long as a sheep born normally. One would presumably not want to create a human baby until one had a much higher chance of success, and even then the cloning process might produce defects that wouldn't show up for years.

The dangers that exist for cloning would be greatly magnified in the case of genetic engineering, given the multiple causal pathways between genes and their ultimate expression in the phenotype.[16] The Law of Unintended Consequences would apply here in spades: a gene affecting one particular disease susceptibility might have secondary or tertiary consequences that are unrecognized at the time that the gene is reengineered, only to show up years or even a generation later.

The final constraint on any future ability to modify human nature has to do with populations. Even if human genetic engineering overcomes these first two obstacles (that is, complex causality and the dangers of human experimentation) and produces a successful designer baby, "human nature" will not be altered unless such changes occur in a statistically significant way for the population as a whole. The Council of Europe has recommended the banning of germ-line engineering on the grounds that it would affect the "genetic patrimony of mankind." This particular concern, as a number of critics have pointed out, is a bit silly: the "genetic patrimony of mankind" is a very large gene pool containing many different alleles. Modifying, eliminating, or adding to those alleles on a small scale will change an

individual's patrimony but not the human race's. A handful of rich people genetically modifying their children for greater height or intelligence would have no effect on species-typical height or IQ. Fred Iklé argues that any future attempt to eugenically improve the human race would be quickly overwhelmed by natural population growth.[17]

Do these constraints on genetic engineering, then, mean that any meaningful alteration of human nature is off the table for the foreseeable future? There are several reasons to be cautious in coming to such a judgment prematurely.

The first has to do with the remarkable and largely unanticipated speed of scientific and technological developments in the life sciences. In the late 1980s there was a firm consensus among geneticists that it was impossible to clone a mammal from adult somatic cells, a view that came to an end with Dolly in 1997.[18] As recently as the mid-1990s, geneticists were predicting that the Human Genome Project would be completed sometime between 2010 and 2020; the actual date by which the new, highly automated sequencing machines completed the work was July 2000. There is no way of predicting what kinds of shortcuts may appear in future years to reduce the complexity of the task ahead. For example, the brain is the archetype of a so-called complex adaptive system—that is, a system made up of numerous agents (in this case, neurons and other brain cells) following relatively simple rules that produce highly complex emergent behavior at a system level. Any attempt to model a brain using brute-force computation methods—one which tries to duplicate all of the billions of neuronal connections—is almost certainly bound to fail. A complex adaptive model, on the other hand, that seeks to model system-level complexity as an emergent property might have a much greater chance of succeeding. The same may be true for the interaction of genes.

That the multiple functions of genes and gene interactions are highly complex does not mean that all human genetic engineering will be on hold until we fully understand them. No technology ever develops in this fashion. New drugs are invented, tested, and approved for use all the time without the manufacturers knowing exactly how they produce their effects. It is often the case in pharmacology that side effects go unrecognized, sometimes for years, or that a drug will interact with other drugs or conditions in ways that were totally unanticipated when it was first introduced. Genetic engineers will tackle simple problems first, and then work their way up the ladder of complexity. While it is likely that higher-order behaviors are the result of the complex interactions of many genes, we don't know that this is invariably the case. We may stumble on relatively simple genetic interventions that produce dramatic changes in behavior.

The issue of human experimentation is a serious obstacle to rapid development of genetic engineering but by no means an insuperable one. As in drug testing, animals will bear most of the burden of risk at first. The kinds of risks acceptable in human trials will depend on projected benefits: a disease like Huntington's chorea, which produces a one-in-two chance of dementia and death in individuals and their offspring who carry the wrong allele, will be treated differently from an enhancement of muscle tone or breast size. The mere fact that there may be unanticipated or long-term side effects will not deter people from pursuing genetic remedies, any more than it has in earlier phases of medical development.

The question of whether the eugenic or dysgenic effects of genetic engineering could ever become sufficiently widespread to affect human nature itself is similarly an open one. Obviously, any form of genetic engineering that could have significant effects on populations would have to be shown to be desirable, safe, and relatively cheap. Designer babies will be expensive at first and an option only for the well-to-do. Whether having a designer baby will ever become cheap and relatively popular will depend on how rapidly technologies like preimplantation diagnosis come down the cost curve.

There are precedents, however, for new medical technologies having population-level effects as a result of millions of individual choices. One has to look no further than contemporary Asia, where a combination of cheap sonograms and easy access to abortion has led to a dramatic shifting of sex ratios. In Korea, for example, 122 boys were born in the early 1990s for every 100 girls, compared with a normal ratio of 105 to 100. The ratio in the People's Republic of China is only somewhat lower, at 117 boys for every 100 girls, and there are parts of northern India where ratios are even more skewed.[19] This has led to a deficit of girls in Asia that the economist Amartya Sen at one point estimated to be 100 million.[20] In all of these societies, abortion for the purpose of sex selection is illegal; but despite government pressure, the desire of individual parents for a male heir has produced grossly lopsided sex ratios.

Highly skewed sex ratios can produce important social consequences. By the second decade of the twenty-first century, China will face a situation in which up to one fifth of its marriage-age male population will not be able to find brides. It is hard to imagine a better formula for trouble, given the propensity of unattached young males to be involved in activities like risk-taking, rebellion, and crime.[21] There will be compensating benefits as well: the deficit of women will allow females to control the mating process more effectively, leading to more stable family life for those who can get married.*

Nobody knows whether genetic engineering will one day become as cheap and accessible as sonograms and abortion. Much depends on what its benefits are assumed to be. The most common fear expressed by present-day bioethicists is that only the wealthy will have access to this kind of genetic technology. But if a biotechnology of the future produces, for example, a safe and effective way to genetically engineer more intelligent children, then the stakes would immediately be raised. Under this scenario it is entirely plausible that an advanced, democratic welfare state would reenter the eugenics game, intervening this time not to prevent low-IQ people from breeding, but to help genetically disadvantaged people raise their IQs and the IQs of their offspring.[22] It would be the state, under these circumstances, that would make sure that the technology became cheap and accessible to all. And at that point, a population-level effect would very likely emerge.

That human genetic engineering will lead to unintended consequences and that it may never produce the kinds of effects some people hope for are not arguments that it will never be attempted. The

*Marcia Guttentag and Paul Secord have suggested that the sexual revolution and the breakdown of the traditional family in the United States was produced in part by sex ratios favoring men in the 1960s and 1970s. See Marcia Guttentag and Paul F. Secord, *Too Many Women? The Sex Ratio Question* (Newbury Park, Calif.: Sage Publications, 1983).

history of technological development is littered with new technologies that produced long-term consequences that led to their modification or even abandonment. For instance, no large hydroelectric projects have been undertaken anywhere in the developed world for the past couple of generations, despite periodic energy crises and rapidly growing demand for power.* The reason is that since the burst of dam building that produced the Hetch Hetchy Dam in 1923 and the Tennessee Valley Authority in the 1930s, an environmental consciousness has arisen that began to weigh the long-term environmental costs of hydroelectric power. When viewed today, the quasi-Stalinist movies that were made celebrating the heroic construction of Hoover Dam seem quaint in their glorification of the human conquest of nature and their blithe disregard of ecological consequences.

Human genetic engineering is only the fourth pathway to the future, and the most far-off stage in the development of biotechnology. We do not today have the ability to modify human nature in any significant way, and it may turn out that the human race will never achieve this ability. But two points need to be made.

First, even if genetic engineering never materializes, the first three stages of development in biotechnology—greater knowledge about genetic causation, neuropharmacology, and the prolongation of life—will all have important consequences for the politics of the twenty-first century. These developments will be hugely controversial because they will challenge dearly held notions of human equality and the capacity for moral choice; they will give societies new techniques for controlling the behavior of their citizens; they will change our understanding of human personality and identity; they will upend existing social hierarchies and affect the rate of intellectual, material, and political progress; and they will affect the nature of global politics.

The second point is that even if genetic engineering on a species level remains twenty-five, fifty, or one hundred years away, it is by far

*There have been major new hydroelectric projects, such as the Three Gorges Dam in China and the Ilisu Dam in Turkey, both of which have produced strong opposition from developed countries for their likely effects on the environment and on the populations in the floodplain, and, in the case of the Turkish dam, for the antiquities that will be covered by the floodwaters.

the most consequential of all future developments in biotechnology. The reason for this is that human nature is fundamental to our notions of justice, morality, and the good life, and all of these will undergo change if this technology becomes widespread. Why this is so will be taken up in Part II.

6

WHY WE SHOULD WORRY

"Take Ectogenesis. Pfitzner and Kawaguchi had got the whole technique worked out. But would the Governments look at it? No. There was something called Christianity. Women were forced to go on being viviparous."

Aldous Huxley, *Brave New World*

In light of the possible pathways to the future laid out in the previous chapters, we need to ask the question: Why should we worry about biotechnology? Some critics, like the activist Jeremy Rifkin[1] and many European environmentalists, have been opposed to innovation in biotechnology virtually across the board. Given the very real medical benefits that will result from projected advances in human biotechnology, as well as the greater productivity and reduced use of pesticides coming from agricultural biotech, such categorical opposition is very difficult to justify. Biotechnology presents us with a special moral dilemma, because any reservations we may have about progress need to be tempered with a recognition of its undisputed promise.

Hanging over the entire field of genetics has been the specter of eugenics—that is, the deliberate breeding of people for certain selected heritable traits. The term *eugenics* was coined by Charles Darwin's cousin Francis Galton. In the late nineteenth and early twentieth centuries, state-sponsored eugenics programs attracted surprisingly broad support, not just from right-wing racists and social Darwinists, but from such progressives as the Fabian socialists Beatrice and Sidney Webb and George Bernard Shaw, the communists J.B.S. Haldane and J. D. Bernal, and the feminist and birth-control proponent Margaret Sanger.[2] The United States and other Western countries passed eugenics laws permitting the state to involuntarily sterilize people deemed "imbeciles," while encouraging people with desirable characteristics to have as many children as possible. In the words of Justice Oliver Wendell Holmes, "We want people who are healthy, good-natured, emotionally stable, sympathetic, and smart. We do not want idiots, imbeciles, paupers, and criminals."[3]

The eugenics movement in the United States was effectively terminated with revelations about the Nazis' eugenics policies, which involved the extermination of entire categories of people[4] and medical experimentation on people regarded as genetically inferior.[5] Since then, continental Europe has been effectively inoculated against any revival of eugenics and has, in fact, become inhospitable terrain for many forms of genetic research. The reaction against eugenics has not been universal: in progressive, social democratic Scandinavia, eugenics laws remained in effect until the 1960s.[6] Despite the fact that the Japanese conducted medical "experiments" on unwilling subjects during the Pacific War (through the activities of the infamous Unit 731), there has been a much smaller backlash against eugenics there and in most other Asian societies. China has pursued eugenics actively through its one-child population control policy and through a crude eugenics law, passed in 1995 and reminiscent of Western ones from the early twentieth century, that seeks to limit the right of low-IQ people to reproduce.[7]

There were two important objections to those earlier eugenics policies that would most likely not apply to any eugenics of the future, at least in the West.[8] The first was that eugenics programs could not achieve the ends they sought given the technology available at the time. Many of the defects and abnormalities against which the eugenicists thought they were selecting through forced sterilizations were the product of recessive genes—that is, genes that had to be inherited from both parents before they could be expressed. Many seemingly normal people would remain carriers of these genes and propagate those characteristics in the gene pool unless they could somehow be identified and sterilized as well. Many other "defects" were either not defects at all (for example, certain forms of low intelligence) or else were the result of nongenetic factors that could be remedied through better public health. For instance, certain villages in China have large populations of low-IQ children as a result not of bad heredity but of low levels of iodine in the children's diets.[9]

The second major objection to historical forms of eugenics is that they were state-sponsored and coercive. The Nazis, of course, carried this to horrifying extremes by killing or experimenting on "less desirable" people. But even in the United States it was possible for a court to decide that a particular individual was an imbecile or a moron (terms that were defined, as many mental conditions tend to be, very loosely) and to order that he or she be involuntarily sterilized. Given the view at the time that a wide variety of behaviors, such as alcoholism and criminality, were heritable, this gave the state potential dominion over the reproductive choices of a large part of its population. For observers like science writer Matt Ridley, state sponsorship is *the* primary problem with past eugenics laws; eugenics freely pursued by individuals has no similar stigma.[10]

Genetic engineering puts eugenics squarely back on the table, but it is clear that any future approach to eugenics will be very different from the historical varieties, at least in the developed West. The reason is that neither of these two objections is likely to apply, leading to the possibility of a kinder, gentler eugenics that will rob the word of some of the horror traditionally associated with it.

The first objection, that eugenics is not technically feasible, applies only to the kinds of technologies available in the early twentieth century, like forced sterilization. Advances in genetic screening currently allow doctors to identify carriers of recessive traits before they decide to have children, and in the future might allow them to identify embryos that carry a high risk of abnormality because they have

inherited two recessive genes. Information of this sort is already available, for example, to individuals from a population such as Ashkenazi Jews, who have higher than normal probabilities of carrying the recessive Tay-Sachs gene; two such carriers may decide not to marry or to have children. In the future, germ-line engineering offers the possibility that such recessive genes could be eliminated from all subsequent descendants of a particular carrier. If the treatment were to become cheap and easy enough, it is possible to conceive of a particular gene being largely eliminated from entire populations.

The second objection to eugenics, that it was state-sponsored, is not likely to carry much weight in the future, because few modern societies are likely to want to get back into the eugenics game. Virtually all Western countries have moved sharply in the direction of stronger protection of individual rights since World War II, and the right to autonomy in reproductive decisions ranks high among those rights. The idea that states should legitimately worry about collective goods like the health of their national gene pools is no longer taken seriously but rather associated with outdated racist and elitist attitudes.

The kinder, gentler eugenics that is just over the horizon will then be a matter of individual choice on the part of parents, and not something that a coercive state forces on its citizens. In the words of one commentator, "The old eugenics would have required a continual selection for breeding of the fit, and a culling of the unfit. The new eugenics would permit in principle the conversion of all the unfit to the highest genetic level."[11]

Parents already make these kinds of choices when they discover through amniocentesis that their child has a high probability of Down's syndrome and decide to have an abortion. In the immediate future, the new eugenics is likely to lead to more abortions and discarded embryos, which is why those opposed to abortion will resist the technology strongly. But it will not involve coercion against adults, or restrictions on their reproductive rights. On the contrary, their range of reproductive choices will dramatically expand, as they cease to worry about infertility, birth defects, and a host of other problems. It is, moreover, possible to anticipate a time when reproductive technology will be so safe and effective that no embryos need be discarded or harmed.

My own preference is to drop the use of the loaded term *eugenics* when referring to future genetic engineering and substitute the word *breeding*—in German, *Züchtung*, the word originally used to translate Darwin's term *selection*. In the future, we will likely be able to breed human beings much as we breed animals, only far more scientifically and effectively, by selecting which genes we pass on to our children. *Breeding* has no necessary connotations of state sponsorship, but it is appropriately suggestive of genetic engineering's dehumanizing potential.

Any case to be made against human genetic engineering should therefore not get hung up on the red herring of state sponsorship or the prospect of government coercion. The old-fashioned eugenics remains a problem in authoritarian countries like China and may constitute a foreign policy problem for Western countries dealing with China.[12] But opponents of breeding new humans will have to explain what harms will be produced by the free decisions of individual parents over the genetic makeup of their children.

There are basically three categories of possible objections: (1) those based on religion; (2) those based on utilitarian considerations; and (3) those based on, for lack of a better term, philosophical principles. The remainder of this chapter will consider the first two categories of reservations, while Part II will deal with the philosophical issues.

RELIGIOUS CONSIDERATIONS

Religion provides the clearest grounds for objecting to the genetic engineering of human beings, so it is not surprising that much of the opposition to a variety of new reproductive technologies has come from people with religious convictions.

In a tradition shared by Jews, Christians, and Muslims, man is created in God's image. For Christians in particular, this has important implications for human dignity. There is a sharp distinction between human and nonhuman creation: only human beings have a capacity for moral choice, free will, and faith, a capacity that gives them a higher moral status than the rest of animal creation. God acts

through nature to produce these outcomes, and hence a violation of natural norms like having children through sex and the family is also a violation of God's will. While historical Christian institutions have not always acted on this principle, Christian doctrine emphatically asserts that all human beings possess an equal dignity, regardless of their outward social status, and are therefore entitled to an equality of respect.

Given these premises, it's not surprising that the Catholic Church and conservative Protestant groups have taken strong stands against a whole range of biomedical technologies, including birth control, in vitro fertilization, abortion, stem cell research, cloning, and prospective forms of genetic engineering. These reproductive technologies, even if freely embraced by parents out of love for their children, are wrong from this perspective because they put human beings in the place of God in creating human life (or destroying it, in the case of abortion). They allow reproduction to take place outside the context of the natural processes of sex and the family. Genetic engineering, moreover, sees a human being not as a miraculous act of divine creation, but rather as the sum of a series of material causes that can be understood and manipulated by human beings. All of this fails to respect human dignity, and thus violates God's will.

Given the fact that conservative Christian groups constitute the most visible and impassioned lobby opposed to many forms of reproductive technology, it is often assumed that religion constitutes the *only* basis on which one can be opposed to biotechnology and that the central issue is the question of abortion. While some scientists, like Francis Collins, the distinguished molecular biologist who since 1993 has headed the Human Genome Project, are observant Christians, the majority are not, and among this latter group there is a widespread view that religious conviction is tantamount to a kind of irrational prejudice that stands in the way of scientific progress. Some think that religious belief and scientific inquiry are incompatible, while others hope that greater education and scientific literacy will eventually lead to a withering away of religiously based opposition to biomedical research.

These latter views are problematic for a number of reasons. In the first place, there are many grounds to be skeptical about both the practical and ethical benefits of biotechnology that have nothing to do with religion, as Part II of this book will seek to demonstrate. Religion provides only the most straightforward motive for opposing certain new technologies.

Second, religion often intuits moral truths that are shared by nonreligious people, who fail to understand that their own secular views on ethical issues are as much a matter of faith as those of religious believers. Many hardheaded natural scientists, for example, have a rational materialist understanding of the world, and yet in their political and ethical views are firmly committed to a version of liberal equality that is not all that different from the Christian view of the universal dignity of humankind. As will be seen below, it is not clear that the equality of respect for all human beings demanded by liberal egalitarianism flows logically from a scientific understanding of the world as opposed to being an article of faith.

Third, the view that religion will necessarily give ground to scientific rationalism with the progress of education and modernization more generally is itself extraordinarily naive and detached from empirical reality. It was the case that many social scientists a couple of generations ago believed that modernization necessarily implied secularization. But this pattern has been followed only in Western Europe; North America and Asia have seen no inevitable decline in religiosity with higher levels of education or scientific awareness. In some cases, belief in traditional religion has been replaced by belief in secular ideologies like "scientific" socialism that are no more rational than religion; in others, there has been a strong revival of traditional religion itself. The ability of modern societies to "free" themselves of authoritative accounts of who they are and where they are going is much more difficult than many scientists assume. Nor is it clear that these societies would necessarily be better off without such accounts. Given the fact that people with strong religious views are not likely to disappear from the political scene anytime soon in modern democracies, it behooves nonreligious people to accept the dictates of democratic pluralism and show greater tolerance for religious views.

On the other hand, many religious conservatives damage their own cause by allowing the abortion issue to trump all other considerations in biomedical research. Restrictions on federal funding for embryonic stem cell research were put in place by abortion opponents in Congress in 1995 to prevent harm to embryos. But embryos are routinely harmed by in vitro fertilization clinics when they are discarded, a practice that abortion opponents have been willing to let stand up to now. The National Institutes for Health had developed guidelines for conducting research in this extremely promising area without risk of raising the number of abortions performed in the United States. The guidelines mandated that embryonic stem cells should be derived not from aborted fetuses or those created specifically for research purposes, but from extra embryos produced as a by-product of in vitro fertilization, ones that would have been discarded or stored indefinitely were they not used in this fashion.[13] President George W. Bush modified these guidelines in 2001 by limiting federal funding to only those sixty or so stem cell "lines" (that is, cells that had been isolated and that could replicate indefinitely) that had already been produced. As Charles Krauthammer has pointed out, religious conservatives have focused on the wrong issue with regard to stem cells. They should not be worried about the sources of these cells but about their ultimate destiny: "What really ought to give us pause about research that harnesses the fantastic powers of primitive cells to develop into entire organs and even organisms is what monsters we will soon be capable of creating."[14]

While religion provides the most clear-cut grounds for opposing certain types of biotechnology, religious arguments will not be persuasive to many who do not accept religion's starting premises. We thus need to examine other, more secular, types of arguments.

UTILITARIAN CONCERNS

By *utilitarian*, I mean primarily economic considerations—that is, that future advances in biotechnology may lead to unanticipated costs or long-term negative consequences that may outweigh the presumed benefits. The "harms" inflicted by biotechnology from a religious perspective are often intangible (for example, the threat to human dignity implied by genetic manipulation). By contrast, utilitarian harms are generally more broadly recognized, having to do either with economic costs or with clearly identifiable costs to physical well-being.

Modern economics provides us with a straightforward framework for analyzing whether a new technology will be good or bad from a utilitarian viewpoint. We assume that all individuals in a market economy pursue their individual interests in a rational fashion, based on sets of individual preferences that economists do not presume to judge. Individuals are free to do this as long as the pursuit of these preferences does not prevent other individuals from pursuing theirs; government exists to reconcile these individual interests through a series of evenhanded procedures embodied in law. We can further presume that parents will not seek to deliberately harm their children, but rather will try to maximize their happiness. In the words of the libertarian writer Virginia Postrel, "People want genetic technology to develop because they expect to use it *for themselves*, to help themselves and their children, to work and to keep their own humanity . . . In a dynamic, decentralized system of individual choice and responsibility, people do not have to trust any authority but their own."[15]

Assuming that the use of new biotechnologies, including technologies like genetic engineering, comes about as a matter of individual choice on the part of parents rather than being coercively mandated by the state, is it possible that harms can nonetheless result for the individual or for society as a whole?

The most obvious class of harms are the ones quite familiar to us from the world of conventional medicine: side effects or other long-term negative consequences to the individual undergoing treatment. The reason the Food and Drug Administration and other regulatory bodies exist is to prevent these kinds of harms, through the extensive testing of drugs and medical procedures before they are released on the market.

There is some reason to think that future genetic therapies, and particularly those affecting the germ line, will pose regulatory challenges significantly more difficult than those that have been experienced heretofore with conventional pharmaceuticals. The reason is that once we move beyond relatively simple single-gene disorders to behavior affected by multiple genes, gene interaction becomes very complex and difficult to predict (see Chapter 5, pp. 74–75). Recall the mouse whose intelligence was genetically boosted by neurobiologist Joe Tsien but which seems also to have felt greater pain as a result.

Given that many genes express themselves at different stages in life, it will take years before the full consequences of a particular genetic manipulation become clear.

According to economic theory, social harms can come about in the aggregate only if individual choices lead to what are termed negative externalities—that is, costs that are borne by third parties who don't take part in the transaction. For example, a company may benefit itself by dumping toxic waste in a local river but will harm other members of the community. A case like this has been made about Bt corn: it produces a toxin that kills the European corn borer, a pest, but it may also kill monarch butterflies. (This charge, it would appear, is not true.[16]) The issue is, Are there circumstances in which individual choices regarding biotechnology may entail negative externalities and thus lead to society as a whole being worse off?[17]

Children who are the subjects of genetic modification, obviously without consent, are the most clear class of potentially injured third parties. Contemporary family law assumes a community of interest between parents and children and therefore gives parents considerable leeway in the raising and educating of their offspring. Libertarians argue that since the vast majority of parents would want only what is best for their children, there is a kind of implied consent on the part of the children who are the beneficiaries of greater intelligence, good looks, or other desirable genetic characteristics. It is possible, however, to think of any number of instances in which certain reproductive choices would appear advantageous to parents but would inflict harm on their children.

Politically Correct

Many kinds of characteristics that a parent might want to give a child have to do with the subtler elements of personality whose benefits are not as clear-cut as looks or intelligence. Parents may be under the sway of a contemporary fad or cultural bias or simple political correctness: one generation may prefer ultrathin girls, or pliable boys, or children with red hair—preferences that can easily fall out of favor in the next generation. One could argue that parents are already free to make such mistakes on behalf of their children and do so all the time by miseducating them or imposing their own quirky values on them.

But a child who is brought up in a certain way by a parent can rebel later. Genetic modification is more like giving your child a tattoo that she can never subsequently remove and will have to hand down not just to her own children but to all subsequent descendants.*

As noted in Chapter 3, we are already using psychotropic drugs to androgynize our children, giving Prozac to depressed girls and Ritalin to hyperactive boys. The next generation may for whatever reason prefer supermasculine boys and hyperfeminine girls. But you can always stop giving drugs to children if you don't like their effects. Genetic engineering, on the other hand, will embed one generation's social preferences in the next.

Parents can easily make wrong decisions concerning the best interests of their children because they rely on advice from scientists and doctors with their own agendas. The impulse to master human nature out of simple ambition or on the basis of ideological assumptions about the way people ought to be is all too common.

In his book *As Nature Made Him*, the journalist John Colapinto describes the heartbreaking story of a boy named David Reimer, who had the double misfortune of having his penis accidentally cauterized as a baby during a botched circumcision and falling under the supervision of a noted sex specialist at Johns Hopkins University, John Money. The latter stood at one extreme of the nature-nurture controversy, arguing throughout his career that gender identities are not natural but constructed after birth. David Reimer provided Money with an opportunity to test his theory, since he happened to be one of a pair of monozygotic twins and thus could be compared with his genetically identical twin brother. After the circumcision accident, Money had the boy castrated and oversaw the raising of David as a girl named Brenda.

Brenda's life became a private hell because she knew that, despite what her parents and Money told her, she was a boy and not a girl.

*It has been suggested that we will be able to sidestep the problem of consent in genetic engineering through the use of artificial chromosomes, which can be added to a child's normal genetic inheritance but switched on only after the child is old enough to be able to give his or her consent. See Gregory Stock and John Campbell, eds., *Engineering the Human Germline* (New York: Oxford University Press, 2000), p. 11.

From an early age she insisted on urinating standing up rather than sitting down. Later,

> Enrolled in Girl Scouts, Brenda was miserable. "I remember making daisy chains and thinking, If this is the most exciting thing in Girl Scouts, forget it," David says. "I kept thinking of the fun stuff my brother was doing in Cubs." Given dolls at Christmas and birthdays, Brenda simply refused to play with them. "What can you do with a doll?" David says today, his voice charged with remembered frustration. "You look at it. You dress it. You undress it. Comb its hair. It's boring! With a car, you can drive it somewhere, go places. I wanted cars."[18]

The effort to create a new gender identity wreaked so much emotional havoc that by the time Brenda reached puberty, she broke free of Money and had her sex change reversed through penis reconstruction; today David Reimer is reportedly a happily married man.

Nowadays it is much better understood that sexual differentiation begins well before birth, and that the brains of human males (as well as other animals) undergo a process of "masculinization" in utero when they receive a bath of prenatal testosterone. What is noteworthy about this story, however, is that Money could assert for almost fifteen years in scientific papers that he had succeeded in changing Brenda's sexual identity to that of a girl, when exactly the opposite was the case. Money was widely celebrated for his research. His fraudulent results were hailed by feminist Kate Millet in her book *Sexual Politics*, by *Time* magazine, and by *The New York Times* and were incorporated into numerous textbooks, including one in which they were cited as proving that "children can easily be raised as a member of the opposite sex" and that what few inborn sex differences might exist in humans "are not clear-cut and can be overridden by cultural learning."[19]

David Reimer's case stands as a useful warning about the uses to which biotechnology may be put in the future. His parents were driven by love for their child and desperation at the misfortune he had suffered, and they assented to a horrific treatment for which they felt profoundly guilty in later years. John Money was driven by a combination of scientific vanity, ambition, and the desire to make an ideological point, characteristics that led him to overlook contrary evidence and work directly against the interests of his patient.

Cultural norms may also lead parents to make choices that harm their children. One example was alluded to earlier, the use in Asia of sonograms and abortion to select the sex of offspring. In many Asian cultures, having a son confers clear-cut advantages to the parents in terms of social prestige and security for old age. But it clearly harms the girls who then fail to be born. Lopsided sex ratios also harm males as a group by making it harder for them to find appropriate mates and decreasing their bargaining position vis-à-vis females in marriage markets. If unattached males produce higher levels of violence and crime, then the society as a whole will suffer.

If we move from reproductive technologies to other aspects of biomedicine, there are additional types of negative externalities that can arise from rational individual decisions. One concerns aging and future prospects for life extension. Faced with a choice between dying and prolonging their lives through therapeutic intervention, most individuals will choose the latter, even if their enjoyment of life will be impaired to varying degrees as a result of the treatment. If large numbers of people make the choice to, for example, extend their lives for another ten years at the cost of, say, a 30 percent decrease in functionality, then society as a whole will have to pick up the tab for keeping them alive. This is, in effect, what has already begun to happen in countries that, like Japan, Italy, and Germany, have rapidly aging populations. One can imagine much more dire scenarios in which dependency ratios become even more extreme, leading to substantial declines in average standards of living.

The discussion of life extension in Chapter 4 suggests negative externalities that go beyond simple economic ones. The failure of older people to get out of the way will harm younger people seeking to move up the ladder in age-graded hierarchies. While any individual will want to postpone death as long as possible, people in the aggregate may not enjoy living in a society whose median age is 80 or 90, where sex and reproduction become activities engaged in by a small minority of the population, or where the natural cycle of birth, growth, maturity, and death has been interrupted. In one extreme scenario, the indefinite postponement of death will force societies to put

severe constraints on the number of births allowed. Care for elderly parents has already begun to displace child care as a major preoccupation for people alive today. In the future, they may feel enslaved to the two, three, or more generations of ancestors dependent on them.

Another important type of negative externality is related to the competitive, zero-sum nature of many human activities and characteristics. Height confers many advantages on individuals who are above average, in terms of sexual attractiveness, social status, athletic opportunities, and the like. But these advantages are only relative: if many parents seek to have children tall enough to play in the NBA, it will lead to an arms race and no net advantage to those who participate in it.

This will even be true of a characteristic like intelligence, which is often cited as one of the first and most obvious targets of future genetic enhancement. A society with higher average intelligence may be wealthier, insofar as productivity correlates with intelligence. But the gains many parents seek for their children may prove illusory in other respects, because the advantages of higher intelligence are relative and not absolute.[20] People want smarter kids so that they will get into Harvard, for example, but competition for places at Harvard is zero-sum: if my kid becomes smarter because of gene therapy and gets in, he or she simply displaces your kid. My decision to have a designer baby imposes a cost on you (or rather, your child), and in the aggregate it is not clear that anyone is better off. This kind of genetic arms race will impose special burdens on people who for religious or other reasons do not want their children genetically altered; if everyone around them is doing it, it will be much harder to abstain, for fear of holding their own children back.

Deference to Nature

There are good prudential reasons to defer to the natural order of things and not to think that human beings can easily improve on it through casual intervention. This has proven true with regard to the environment: ecosystems are interconnected wholes whose complexity we frequently don't understand; building a dam or introducing a plant monoculture into an area disrupts unseen relationships and destroys the system's balance in totally unanticipated ways.

So too with human nature. There are many aspects of human nature that we think we understand all too well or would want to change if we had the opportunity. But doing nature one better isn't always that easy; evolution may be blind process, but it follows a ruthless adaptive logic that makes organisms fit for their environments.

It is today politically correct, for example, to deplore human proclivities for violence and aggression, and to denounce the bloodlust that in earlier periods led to conquest, dueling, and similar activities. But there are some good evolutionary reasons such propensities exist. Understanding the good and bad in human nature is far more complex than one would think, because they are so intertwined. In evolutionary history, human beings learned, in biologist Richard Alexander's phrase, to cooperate in order to compete.[21] That is, the vast panoply of human cognitive and emotional characteristics that enable such an elaborate degree of social organization was created not by the struggle against the natural environment but rather by the fact that human groups had to struggle against one another. This led over evolutionary time to an arms-race situation, in which increasing social cooperation on the part of one group forced other groups to cooperate in similar ways in a never-ending struggle. Human competitiveness and cooperativeness remain balanced in a symbiotic relationship not just over evolutionary time, but in actual human societies and in individuals. We certainly hope that human beings will learn to live peacefully in many circumstances where they don't do so today, but if the balance shifts too far away from aggressive and violent behavior, the selective pressures in favor of cooperation will also weaken. Societies that face no competition or aggression stagnate and fail to innovate; individuals who are too trusting and cooperative make themselves vulnerable to others who are more bloody-minded.

So too with the family. Since Plato's time, it has been widely understood among philosophers that the family stands as the major obstacle to the achievement of social justice. People, as kin selection theory suggests, tend to love their families and relatives out of proportion to their objective worth. When there is a conflict between fulfilling an obligation to a family member and fulfilling an obligation to an impersonal public authority, family comes first. This is why Socrates argues in Book V of *The Republic* that a perfectly just city requires the

communism of women and children, so that parents will not know who their biological offspring are and therefore will not be in a position to favor them.[22] This is also why all modern rule-of-law societies must enforce myriad regulations forbidding nepotism and favoritism in public service.

And yet the natural propensity to love one's own offspring to the point of irrationality has a powerful adaptive logic: if a mother does not love her children in this way, who else will devote the resources, both material and emotional, that are required to raise a child into mature adulthood? Other institutional arrangements, like communes and welfare agencies, work a good deal less well because they are not based on natural emotions. There is, moreover, a profound justice to the natural process, for it guarantees that even children who are unlovely or untalented will have a parent to love them in spite of their disadvantages.

Some have argued that even if we had the technological capability to change human personality in fundamental ways, we would never *want* to do so because human nature in some sense guarantees its own continuity. This argument, I believe, greatly underestimates human ambition and fails to appreciate the radical ways in which people in the past have sought to overcome their own natures. Precisely because of the irrationality of family life, all real-world communist regimes targeted the family as a potential enemy of the state. The Soviet Union celebrated a little monster named Pavel Morozov, who turned in his parents to Stalin's police in the 1930s, precisely to try to break the hold the family naturally has on people's loyalties. Maoist China engaged in a prolonged struggle against Confucianism, with its emphasis on filial piety, and turned children against parents during the Cultural Revolution in the 1960s.

It is impossible at this juncture to say how decisive any of these utilitarian arguments against certain developments in biotechnology will be. Much will depend on precisely how these technologies play out: whether we have life extension, for example, that does not simultaneously maintain a high quality of life, or develop genetic therapies that unexpectedly produce horrific effects that emerge only twenty years after first being administered.

The important point is this: we should be skeptical of libertarian arguments that say that as long as eugenic choices are being made by individuals rather than by states, we needn't worry about possible bad consequences. Free markets work well much of the time, but there are also market failures that require government intervention to correct. Negative externalities do not simply take care of themselves. We do not know at this point whether these externalities will be large or small, but we should not assume them away out of a rigid commitment to markets and individual choice.

The Limitations of Utilitarianism

While it is convenient to argue for or against something on utilitarian grounds, all utilitarian arguments ultimately have a major limitation that often proves a decisive flaw. The goods and bads that utilitarians tote up in their cost-benefit ledgers are all relatively tangible and straightforward, usually reducible to money or to some easily identifiable physical harm to the body. Utilitarians seldom take into account more subtle benefits and harms that cannot be easily measured, or which accrue to the soul rather than to the body. It is easy to make a case against a drug like nicotine, which has clearly identifiable long-term health consequences, such as cancer or emphysema; it is harder to argue against a Prozac or a Ritalin, which may affect one's personality or character.

A utilitarian framework has particular difficulty encompassing moral imperatives, which tend to be regarded as just another type of preference. The University of Chicago economist Gary Becker, for example, argues that crime is the result of a rational utilitarian calculation: when the benefits of committing a crime outweigh the costs, a person will do so.[23] While this calculus is obviously what motivates many criminals, it implies at one extreme that people would be willing to, say, kill their own children if the price was right and they were assured of getting away with the crime. The fact that the vast majority of people would not ever think of entertaining such a proposition suggests that they in effect put an infinite value on their children, or that the obligation they feel to do right by them is not really commensurable with other types of economic values. There are, in other words, things that people believe to be morally wrong regardless of the utilitarian benefits that might flow from them.

So it is with biotechnology. While it is legitimate to worry about unintended consequences and unforeseen costs, the deepest fear that people express about technology is not a utilitarian one at all. It is rather a fear that, in the end, biotechnology will cause us in some way to lose our humanity—that is, some essential quality that has always underpinned our sense of who we are and where we are going, despite all of the evident changes that have taken place in the human condition through the course of history. Worse yet, we might make this change without recognizing that we had lost something of great value. We might thus emerge on the other side of a great divide between human and posthuman history and not even see that the watershed had been breached because we lost sight of what that essence was.

And what is that human essence that we might be in danger of losing? For a religious person, it might have to do with the divine gift or spark that all human beings are born with. From a secular perspective, it would have to do with human nature: the species-typical characteristics shared by all human beings qua human beings. That is ultimately what is at stake in the biotech revolution.

There is an intimate connection between human nature and human notions of rights, justice, and morality. This was the view held by, among others, the signers of the Declaration of Independence. They believed in the existence of natural rights, rights, that is, that were conferred on us by our human natures.

The connection between human rights and human nature is not clear-cut, however, and has been vigorously denied by many modern philosophers who assert that human nature does not exist, and that even if it did, rules of right and wrong have nothing whatever to do with it. Since the signing of the Declaration of Independence, the term *natural rights* has fallen out of favor and has been replaced with the more generic *human rights*, whose provenance does not depend on a theory of nature.

It is my view that this turn away from notions of rights based on human nature is profoundly mistaken, both on philosophical grounds and as a matter of everyday moral reasoning. Human nature is what gives us a moral sense, provides us with the social skills to live in society, and serves as a ground for more sophisticated philosophical dis-

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cussions of rights, justice, and morality. What is ultimately at stake with biotechnology is not just some utilitarian cost-benefit calculus concerning future medical technologies, but the very grounding of the human moral sense, which has been a constant ever since there were human beings. It may be the case that, as Nietzsche predicted, we are fated to move beyond this moral sense. But if so, we need to accept the consequences of the abandonment of natural standards for right and wrong forthrightly and recognize, as Nietzsche did, that this may lead us into territory that many of us don't want to visit.

To survey this terra incognita, however, we need to understand modern theories of rights and what role human nature plays in our political order.

PART II

BEING HUMAN