Human Genetic Engineering

An Interview with Richard Hayes

Casey Walker: Will you describe how you came to realize the significance of developments in human genetic manipulation and why you consider public involvement a matter of urgency?

Richard Hayes: As part of my dissertation studies at Berkeley I wanted to learn about the new human genetic technologies and their social implications. I did course work in genetics and began attending conferences. I was stunned by what I discovered. We are very close to crossing technological thresholds that would change forever what it means to be a human being. The most consequential of these involve the modification of the genes that get passed to our children. In addition, there's human cloning, artificial human chromosomes, bovine/human embryos, "reconstructed" embryos using genes from three adults, and more. It sounds like science fiction, but it isn't.

These technologies are being developed right now in university and corporate labs, and neither policy makers nor the general public have any idea of what's going on. These technologies are being promoted by an influential network of scientists and others who truly believe that they are about to usher in a new, techno-eugenic epoch for human life on earth. They look forward to a world in which parents design their children quite literally by selecting genes from a catalog. This would change everything we understand about what it means to be a parent, a child, a family, or a member of the human community. We'd come to see people as artifacts, collections of parts assembled to achieve a particular result determined by someone else. Once we start genetically engineering our children, how would anything less than the "best" be considered acceptable? Once we start, where do we stop?

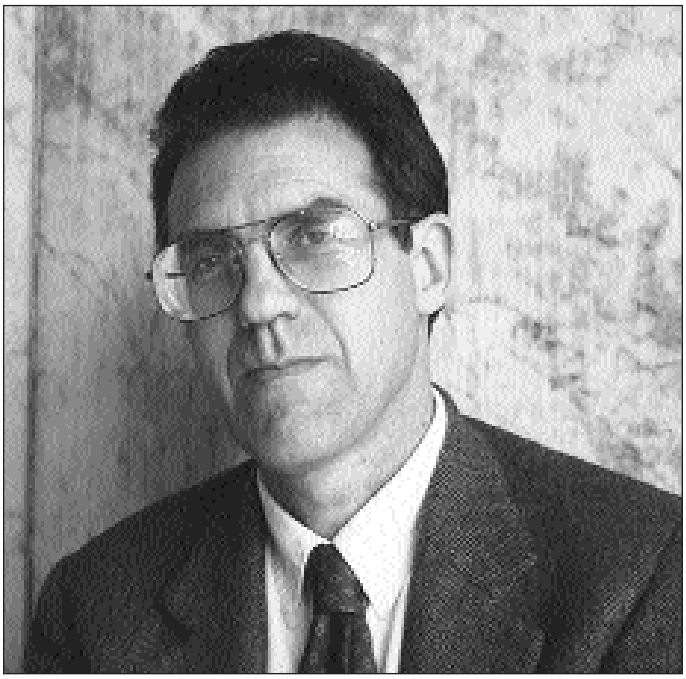
Until recently these sorts of questions could be dismissed as speculative and far-fetched, but no longer. Last year a major conference was held at UCLA to promote the idea of how wonderful it's going to be when we can manipulate our children's genes and finally "seize control of human evolution." One thousand people attended and press coverage was extensive. Just a few months later, one of the noted scientists at the conference submitted the first proposal to begin experiments involving the modification of heritable genes. Things are moving very fast.

Mind you, some of these technologies hold great promise to relieve suffering and prevent disease. But we can draw bright lines to separate benign applications from those that are likely to set the world on a slippery slope to a horrific future.

Will you describe current genetic engineering technologies and those lines you believe can be drawn?

Sure. First, what's a gene? A gene is a string of chemicals that codes for and enables production of a particular protein, and proteins are the building blocks of our entire bodies. Genetic engineering is the process of adding, deleting, or modifying specific genes in a living cell. If your lung cells, for example, are missing a gene that produces an essential protein, you can use genetic engineering to try to acquire that gene. To do this you attach copies of the needed gene to harmless viruses, and let the viruses penetrate the cell walls and nuclear membranes of your lung cells. The needed genes are released into cell nuclei, incorporated into chromosomes–which are just long strings of genes–and, hopefully, begin producing the needed protein. That's genetic engineering.

However, an important distinction must be made between "therapy," which refers to gene modifications intended to address a medical condition, and "enhance-



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ment," which refers to modifications intended to improve some aspect of normal appearance or performance. Treating or preventing sickle cell anemia or cystic fibrosis would be therapy. Attempting to modify stature, agility, cognition, personality, or life span of a healthy person would be "enhancement."

A second important distinction must be made between gene modifications that have an impact solely on a single person and those that have an impact on a person's children and subsequent descendants. This is the distinction between "somatic" and "germline" genetic manipulation. Somatic manipulation seeks to change the genetic makeup of particular body (somatic) cells that comprise our organs–lungs, brain, bone, and so forth. Changes in somatic cells are not passed on to one's children. Germline genetic manipulation changes the sex cells–that is, the sperm and egg, or "germ" cells–whose sole function is to pass a set of genes to the next generation.

The critical question–perhaps the most critical ever posed in human history–is, where do we draw the line? Somatic gene therapy for individuals in medical need is already being tested, and few find it ethically objectionable. Somatic gene enhancement of people without medical conditions raises more concerns. Some somatic enhancements may be no more controversial than rhinoplasty, while others may be profoundly dangerous or otherwise unacceptable. But the effects of somatic enhancements are limited to a single person, so the risk to future generations is nil.

By far the most important issues concern germline engineering. Advocates of germline engineering invariably appeal to our compassionate desire to prevent the suffering often associated with heritable disease, but they're not putting all their cards on the table. Couples who believe they are at risk of transmitting a serious disease can already employ the far simpler technique of pre-implantation screening to ensure that their children are free of the condition. In this procedure, a number of fertilized eggs are created *in vitro*–that is, in a petrie dish–and are tested to see which ones are free of the disease causing gene. Only these are implanted. Any child subsequently born will be free of the disease, as will all of that child's descendants. The current aggressive push for germline therapy makes no sense, unless the real intent is to pave the way for germline enhancement, designer babies, and the technological reconfiguration of human biology.

We are very close to crossing technological thresholds that would change forever what it means to be a human being. The most consequential of these involve the modification of genes that get passed to our children.

Along the same lines, will you address human cloning and other technologies?

Cloning is the asexual creation of a human being by taking the nucleus from a cell of an adult or child and transplanting it into a woman's egg from which the nucleus has been removed. The resulting embryo would produce a baby that would be the genetic duplicate of the nucleus donor, similar to a twin. If someone cloned themselves, it's not clear whether the resulting infant should be regarded as the "sibling" or the "child" of the nucleus donor. In fact, it's neither; it's a new category of human relational identity: a clone.

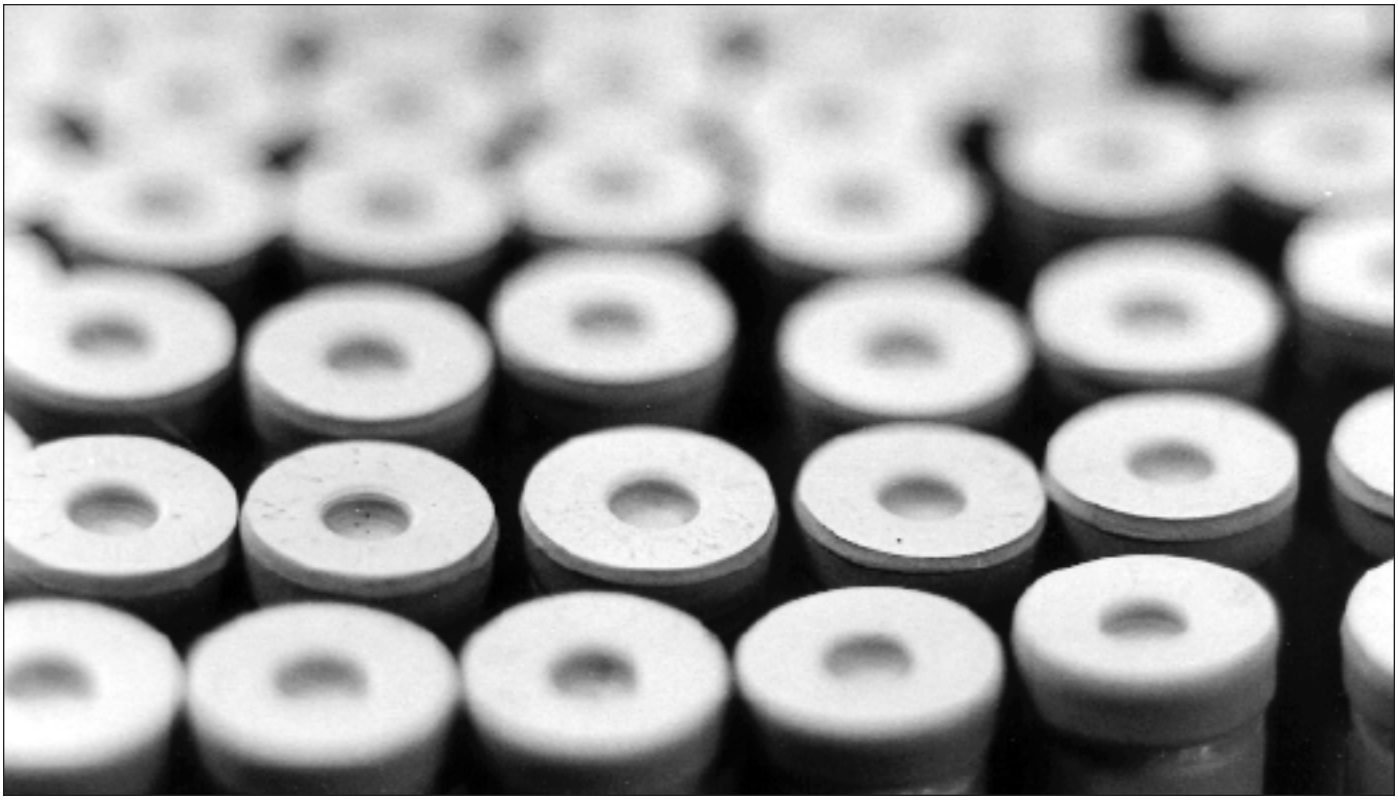
Over the past century few issues have garnered such immediate and resolute consensus as has the issue of human cloning. Over 90 percent of Americans oppose human cloning. The great majority of industrial democracies, with the U.S. being the glaring exception, have already made human cloning illegal. Human cloning is condemned by every major religious denomination in the world. The United Nations, the G-7, the World Health Organization, and other international bodies have all called for a ban on human cloning.

Despite this, some scientists declare that they're going to do it anyway. Others say that although they are against replicative cloning–the cloning of fully-formed human beings–they support the cloning of human embryos, which can be manipulated at very early stages to produce tissues for treating degenerative diseases. However, success in cloning embryos would make replicative cloning almost trivially easy. Further, the techniques of embryo cloning are precisely those necessary to make germline manipulation commercially practicable. This hasn't been mentioned in any of the media coverage of cloning. It's very difficult to get a desired new gene into a fertilized egg on a single try. To use germline engineering as a routine procedure you'd start by creating a large culture of embryonic cells derived from a fertilized egg, douse these with viruses carrying the desired new gene, and transplant cell nuclei that have been successfully modified into new, enucleated eggs. These clonal embryos are then implanted in a uterus. Without embryo cloning, no commercial designer babies.

Currently at least half a dozen approaches to producing therapeutic replacement tissues, none of which require embryo cloning, are under investigation. There's no overriding reason to develop human embryo cloning techniques, unless the intent is to produce fully formed human clones or to make germline genetic engineering commercially practicable.

What is the significance of artificial chromosomes?

Germline engineering in which the only goal is to change a single gene is technically feasible today. But to engineer a child for more refined enhancements, many genes would need changing and current techniques are too



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crude. One solution is to build an artificial chromosome that contains all the necessary genes, organized in just the right way. Artificial chromosomes have been successfully tested in mice and in cultured human cells. The cells divide and the chromosomes are replicated intact. Now, human beings have 23 pairs of chromosomes and an extra, artificial chromosome pair would create 24. If you wanted to have the benefits of the artificial chromosomes passed to your children, you could only mate with someone who carried the same artificial, 24th chromosome pair. One of the key characteristics of a species is that members of the same species can only breed with each other. So you see where this is going. In effect, we're talking about the possibility of creating a new human species, perhaps within one or two decades. Few people outside the science and biotech community are aware of this.

If the current pace of research and development continues, there will be an explosion of genetic knowledge and capability over the next several years. We will be able to transform the biology of plants, animals, and people with the same detail and flexibility as today's digital technologies and the microchip enable us to transform information. The challenge before us is to summon the wisdom, maturity, and discipline to use these powers in ways that contribute to a fulfilling, just, sustainable world, and to forgo those uses that are degrading, destabilizing and–quite literally–dehumanizing. Advocates of a full-out techno-eugenic future believe we're not up to that challenge. When push comes to shove, they believe, people won't be able to resist using a new genetic application if it looks like it might allow their children some advantage over other people's children. And they believe that once we allow even a little bit of germline engineering, the rest of the techno-eugenic agenda follows inexorably. I disagree with the first belief–I think we can be wiser than that. But I agree that if the germline threshold is crossed, further control becomes far more difficult.

The infamous slippery slope. Will you elaborate?

Suppose it became permissible to use germline engineering to avoid passing on simple genetic diseases like cystic fibrosis, even though pre-implantation screening could accomplish the same result. What would the argument be against using germline engineering to avoid passing on predispositions to more complex conditions like diabetes, asthma, hypertension, and Alzheimer's–assuming the procedures were judged to be safe and effective? It's not obvious. After that, some scientists might offer gene packages that would endow healthy children with increased resistance to infectious diseases. Is this therapy or enhancement? It's a gray area. Similarly, what if genes that would predispose a child towards being very short could be engineered to predispose the child towards average height? How would you argue that such a genetic intervention be prohibited, assuming it was safe? Once it's accepted that parents have a right to use germline intervention to change a predisposition to shortness into a predisposition to average height, could you argue that they didn't have a right to predispose their child towards above-average height? Or towards above-average performance levels for a variety of simple and measurable cognitive skills? And after that, what about novel abilities that humans have never possessed before? Even if you banned such practices, advocates of germline manipulation say they'll just set up clinics

in the Cayman Islands.

Scenarios like this one persuade some people that resistance to the techno-eugenic vision is futile and that we should just accept that it's going to happen. But think of the full implications. If a couple believes that it's desirable and acceptable to engineer their kids to be taller, wouldn't they typically also find it desirable to have a kid that's, say, less disposed to being overweight? Or disposed to being smarter, however they define that? Or more cheerful and outgoing? Or likely to live longer? Once you say "yes" to one enhancement, what rationale do you have for ever saying "no" to any other? If you accept that it's okay to engineer your kid, then doesn't *not* engineering your kid become something of a dereliction of parental responsibility? Especially when everybody else who can afford it is doing so? There are over 80,000 human genes. How many modified genes do you want to put into your child? Ten? Fifty? Five hundred? Five thousand? Where does it stop?

If the current pace of research and development continues, there will be an explosion of genetic knowledge and capability over the next several years. We will be able to transform the biology of plants, animals, and people with the same detail and flexibility as today's digital technologies and the microchip enable us to transform information.

Imagine explaining to your fourteen-year-old that you engineered her with a set of fifty or five hundred or five thousand carefully chosen genes. Now imagine your child trying to understand who or what she is, and what's expected of her. Imagine her trying to figure out what about her is really *her*. Imagine her thinking about the children she would like to have someday and of the different ways in which she might like to engineer *them*.

Let's take it one step further. Suppose you've been genetically engineered by your parents to have what they consider enhanced reasoning ability and other cognitive skills. How could you evaluate whether or not what was done to you was a good thing? How could you think about what it would be like *not* to have genetically engineered thoughts?

I think the entire scenario of genetic "improvement" is quite literally insane. The fact that so many educated, accomplished people seem untroubled by it is truly frightening. It's the materialist-reductionist-determinist worldview run amok. It's what happens when people become disconnected from themselves, others, and nature. I've been at conferences where participants use phrases like "when we start engineering our children" as if it's a forgone conclusion, with no indication that they appreciate the enormity of what they're saying.

In my opinion, there are clear lines that we can and should draw: no human germline engineering and no human cloning, ever. This is a moderate position, because it doesn't necessarily rule out many forms of somatic engineering, genetic testing and screening. We're going to have our hands full just deciding which non-germline applications to allow; but whatever we decide, we're not putting the future of humanity at risk, we're not eroding the basis of human individuality, self-regard, and autonomy, and we're not undermining the integrity of civil society and a democratic political ethos. But germline engineering and cloning, I believe, would set us on a path that leads in those directions.

I know some people argue that we don't need to be overly concerned about germline manipulation, because, they say, it relies upon the discredited model of genetic reductionism and thus will quickly be found to be ineffective. It's true, obviously, that the great majority of human traits involve complex interactions of genes, epigenetic biochemistry, environment, society, and free will. My guess is that over the next decade we'll find the full spectrum of possible relations between traits and genes: some traits will be strongly influenced by genes, others will have little relation to genes at all, others will be influenced by genes in some environments but not in others, and so on. But in the absence of a ban, researchers will have no problem finding couples willing to run high degrees of risk in order to have a "superior" child. Some procedures will work and others won't. On balance, the techno-eugenic agenda would move forward. If we don't want to go down that road, we need to take stronger steps than, in effect, trusting the market.

Will you describe the world imagined by those advocating a techno-eugenic future?

The key text is Lee Silver's book, *Remaking Eden: How Cloning and Beyond Will Change the Human Family*. It's one of the most pernicious books I've ever read. Silver envisions a world in which the new genetic and reproductive technologies are freely and fully used by everyone who can afford them, in order to give their children a competitive edge over other people's children. He acknowledges that this will lead to deeper class inequities, and then to a system of genetic castes, and eventually to separate human species, which he calls the GenRich and the Naturals. To those who want laws passed to ban the technologies leading to such a world, Silver sort of smirks and says, just try to stop us. He says that today's affluent professionals will develop and use these technologies no matter what the majority of people may decide.

It's difficult to overstate how grotesque a vision of the human future this is. It casually dismisses commitments to equality and democracy and common decency that men and women have struggled for centuries to achieve. It denigrates values of community and compassion as anachronisms ill-suited for the new techno-eugenic era. It celebrates nothing less than the end of our common humanity. Silver and his colleagues are quite aware of all this, but they really don't seem to care; they just want to enable

people like themselves–smart, accomplished, aggressive, cynical–to get on with the business of segregating their "high-quality" genetic lines from those of the rest of humanity.

It's astonishing that few leaders in the scientific and biotechnology community have publicly denounced Silver's vision. I've spoken with many, and asked them to tell me how they believe his scenario can be avoided, once we begin germline manipulation of any sort. A third of them avoid the question by making a joke. Another third say, "I don't know." And the final third say, "It's going to happen whether you like it or not."

Some people think scenarios like Silver's are so outlandish that they don't need to be taken seriously. I wish I could agree. It's important to remember that in Germany in the 1920s many people dismissed the Nazis as buffoons. Thresholds can be crossed that change realities of power and consciousness–we should know this by now. I'm not saying that techno-eugenicists are Nazis–in most ways they're quite the opposite, they're radical libertarians. Yet both are obsessed by the idea of the planned creation of biologically superior human beings. This obsession leads in only one direction. What would happen if the elites began engineering their children into a separate human species? There'd be protest, to say the least. Eventually the emerging GenRich would become impatient and start looking for a Final Solution. This is where the techno-eugenic vision leads. It's obscene and needs to be challenged.

Will you speak to the repeated claim that the techno-eugenic future is "inevitable"?

I think it's pretty apparent that claims of inevitability are rhetorical moves to rally supporters and demoralize opponents. Nothing in human affairs is inevitable. Most Americans are surprised to find that in the great majority of industrial democracies–all of Europe, Canada, Australia, and Japan, for example–both germline genetic engineering and human cloning have already been banned. The U.S. is the rogue country on these issues. The claim that people are incapable of agreeing to fore go individual, competitive striving in order to realize a larger social good is simply wrong. Of course, the fact that citizenship values are increasingly and profoundly being eroded by consumer values–in the United States and worldwide–presents a challenge. We're in a classic danger/opportunity situation: if we can't invoke and mobilize a sense of shared human citizenship, it will be difficult to constrain dangerous genetic technologies; on the other hand, the stark danger of these technologies might be just what's needed for the importance of a shared human citizenship to be widely understood and affirmed.

Some say that an authoritarian police state would be needed to enforce a ban on techno-eugenics, because people will do it anyway on the black market. That's hardly reason to accept and encourage it. Rather, we need to say with conviction that germline manipulation and cloning are unacceptable acts of power and domination by some persons over others, and we need to make clear that these technologies are not about curing disease–they're about turning people into artifacts. Strong moral suasion and effective laws can minimize and even eliminate black market abuses.

Techno-eugenic advocates believe they will prevail if they can convince people that bans on germline manipulation and cloning constitute infringements upon reproductive rights. We need to be clear that there's an enormous difference between seeking to terminate an unwanted pregnancy and seeking to manipulate the genetic makeup of a child and all subsequent generations. The great majority of people I work with on these issues support both access to legal abortion and bans on human cloning and germline manipulation. There's no inconsistency in holding both positions.

Will you give a brief chronology of the scientific developments that have led us to where we are today?

Watson and Crick figured out the structure of DNA in 1953, and by the late 1960s the genetic code for all the proteins had been deciphered. The ability to put genes into bacteria was developed in 1973, and transgenic mice were created in 1978. By the 1980s proposals for genetic engineering of humans were being put forth, amid great controversy. A large coalition of religious leaders declared that germline engineering represented "a fundamental threat to the preservation of the human species as we know it," and should be opposed "with the same courage and conviction as we now oppose the threat of nuclear extinction." Germline engineering supporters decided to lay low and work instead to ensure approval of somatic therapy. In 1985 the federal government gave somatic therapy the go-ahead, and banned germline engineering "at this time." The ensuing race among researchers to be the first to "do somatic" was won in 1991 by W. French Anderson, who inserted genes into a young girl to treat an enzyme deficiency disease.

By the mid-1990s, articles began appearing with titles such as "Germline Therapy: The Time Is Near." In March 1998 the UCLA conference, "Engineering the Human Germline," was organized by a vocal techno-eugenic advocate, Gregory Stock. The event signaled the kick-off of a national campaign to, in Stock's words, "make it [germline engineering] acceptable" to the American people. The *New York Times*, *The Washington Post* and other papers gave the event front page coverage. A repeated theme was that germline engineering was all but inevitable. Stock said, "The question is not whether, but when."

After the event, Stock released a set of policy recommendations which called on the United States to "resist any effort by UNESCO or other international bodies to block the exploration of human germline engineering," and for the federal government to rescind its 1985 germline engineering ban. Three months later, the federal committee that oversees human genetic research, the Recombinant DNA Advisory Committee (RAC), discussed Stock's petition and agreed to review its policy on germline engineering. Simultaneously, the RAC received a proposal from W.

French Anderson, the somatic therapy pioneer and a lead figure at the UCLA symposium, to begin a form of somatic therapy with a high probability of "inadvertently" modifying the human germline. It was an open secret that this proposal was a ploy. Anderson himself was quoted in the press saying that his proposal was designed to "force the debate" about germline engineering. If the RAC approves Anderson's proposal, it will establish for the first time that some forms of germline modification are permissible. As of today, Anderson hopes to be ready for human trials by 2002.

Will you speak to the challenges these issues pose for the environmental movement?

It's difficult to see how a world that accepts the germline manipulation and cloning of human beings will long be able to maintain, much less deepen, any sense of respect, reverence, and humility regarding the rest of the natural world. The techno-triumphalist vision calls for the wholesale transformation of literally everything living– plants, animals, humans, and ecosystems. It's not just a matter of putting a single pesticide gene into a corn plant or manipulating a single enzyme gene in a human zygote. What's underway is a reconfiguration of the deep structures of life. The new genetic technologies demand that the environmental movement deepen its critique if it doesn't want to be rapidly co-opted by an eco-utilitarian, technological worldview.

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Have you heard of the new, transgenic EnviroPig? It's been engineered by Canadian scientists to contain both mouse genes and bacterial genes and produces manure with 20-50 percent less phosphorus than non-engineered pigs. It was developed to allow pork producers to raise more pigs per hectare and still comply with Canadian water quality regulations. Should environmentalists feel good or bad about EnviroPig? Should we oppose EnviroPig but accept EnviroHuman? Or is it the other way around? Do we accept neither? Or both?

Here's another: Michael Rose at UC Irvine has patented human genes that some scientists suspect might be able to increase our life spans up to 150 years. Should environmentalists oppose this, support this, or isn't this an environmental issue? Students at UC Berkeley protested research on genetically enhanced life spans, claiming that it could lead to massive overpopulation and resource degradation. But if EnviroPig can alleviate water degradation, maybe we can engineer EnviroCattle and EnviroTree to alleviate other types of resource degradation. And after that, why not EnviroPlanet: a clean, green, non-toxic, non-polluting, completely genetically engineered global ecosystem lovingly managed by genetically transformed EnviroHumans. This is exactly where we're going. Presently, environmentalists don't have a compelling way to say that this vision should be rejected. We really need to get to work.

Many are aware that the San Francisco Bay Area is now called the Biotech Capital of the world. Will you comment?

Genetic engineering proper started in San Francisco in 1973, when Herb Boyer at UCSF and Stanley Cohen at Stanford figured out how to combine the genes of two different species. Three years later Boyer co-founded the first commercial genetic engineering firm, Genentech. Today the Bay Area has the single greatest concentration of biotech firms in the country. Besides Genentech there's Chiron, Shaman, Anergen, Clontech, SciClone and many more. UC Berkeley just concluded a $25 million deal that gives the drug firm Novartis an unprecedented role in deciding UC's research priorities. In San Francisco, Mission Bay is being developed as a 120-acre biotech theme park. Of course, much of the research going on here is beneficial and deserves support. The problem is that the biotech industry is incapable, on its own, of drawing lines between what's acceptable and what isn't, and its increasing clout is enabling it to fend off attempts at regulation.

A critical case is that of Geron corporation, based in Menlo Park. Geron is potentially the ground-zero site for human cloning and germline manipulation, worldwide. Geron recently announced that it had acquired Roslin Bio-Med, the firm that held the patents to the technology that produced the cloned sheep in Scotland. Geron has announced its opposition to replicative human cloning, and they're probably sincere, because there's very little money in it. What they really want is the freedom to clone human embryos and use them to produce replacement tissues for a mass market. Geron claims that it wants to find a way to produce replacement tissues without having to use human

embryos. That would be a good thing; I support that. But get this: last year Geron established an in-house ethical advisory committee of local bioethicists sympathetic to human genetic manipulation and asked their advice concerning human embryo cloning. The committee concluded that embryo cloning would be acceptable so long as the embryos were "treated with respect," which Geron promptly pledged to do. So Geron appears to be hedging its bets.

Have you heard that California has established an Advisory Committee on Human Cloning? It's dominated by the biomedical and biotech community and, incredibly, seems disposed to recommend that human cloning be allowed in California as an acceptable form of reproduction. This could be explosive.

What developments with implications for human genetic engineering can we expect in mainstream media over the next year or so?

Significant developments are going to appear in the press on an almost weekly basis. This fall the sequencing of the fruit fly genome will be announced. Texas A&M hopes to announce the cloning of a pet dog, Missy, at a cost of $2.3 million dollars donated by a controversial Arizona multi-millionaire. Dr. James Grifo of New York University hopes to announce the birth of the first baby with genes from three parents, created as part of an effort to increase fertility among older women. Richard Plomin in the UK is expected to announce the discovery of multiple genes associated with IQ scores. The big event will be the completion of the rough draft of the sequence of the human genome next spring, with the final version due 18 months later. All these developments will be interpreted by the press almost exclusively through the framework of mainstream genetic triumphalism. At this time there are few effective voices offering an alternative, critical interpretation. As a result, the scientists and the biotech industry are controlling the development of public perceptions and public policy.

What is to be done?

We can take a deep breath and remind ourselves of the beauty and mystery of human life, and of all creation besides. Then we have to get to work. Germline genetic engineering is the single most portentous technological threshold in history, and we'll need a new social movement of commensurate scope and scale to prevent ourselves from slipping, or being pushed, over it. We'll need to alert, educate, and engage the general public, policy makers, and the press about what's at stake, and we'll need advocacy and political organizing as well. Substantively we'll need permanent global bans on germline engineering and replicative cloning, at least a moratorium on embryo cloning, and an effective system of oversight for somatic genetic applications. We need to start talking about these things with everyone we know.

Educate yourself on the issues and figure out how organizations and networks with which you're affiliated can bring their influence to bear. The great majority of people recoil at the idea of humanity divided into GenRich and Naturals. We need to make it clear that the genetic transformation of human beings is something we neither need nor want to do. If we can accomplish that, we'll have established a new foundation for using our tremendous scientific and technological gifts in the service of a truly inclusive future for life on earth.

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