Redesigning Humans: Is It Inevitable?

Is genetic technology just the next step in human discovery about ourselves, or does it mean the end of humanity as we know it? Could we literally redesign humanity out of existence? On the other hand, there are those who maintain that we are headed down a disastrous technological and ethical road.

 *This article is also available in Spanish.*

The People Are Restless

There is a general unease in the wind. People are a little squeamish concerning the coming revolution in biotechnology. There is a sort of stand-offish fascination where we wonder at the possibilities for curing genetic diseases and even for making ourselves smarter, prettier, or stronger. Yet we shrink from the potential horror of the world we might create for ourselves with no hope of turning back.



We have faced such forks in the road before. Every new technology has presented fantastic benefits and uncertain costs. Gunpowder, electricity, the combustion engine, atomic energy, etc., have all offered tantalizing either/or tensions. Some of these tensions we still live with, such as the threat of nuclear weapons and encroaching pollution from combustion engines.

But for the most part we have been able to develop a stable coexistence between the potential for good and the potential for evil. Weapons have become more precise, minimizing unnecessary collateral casualties, the combustion engine has become cleaner and more efficient, and atomic weapons so far

have been remarkably harnessed.

But what about genetic technology? Is this just the next step in human discovery about ourselves, or does it mean the end of humanity as we know it? Could we literally redesign humanity out of existence? There are voices in our culture today that will tell us that indeed we can and we will and it is inevitable and "you'd just better get used to it."

On the other hand there are those who maintain that we are headed down a disastrous road, and that we have a small opportunity to harness the benefits of the new technologies while minimizing and corralling the hazards.

I recently spent several days at the United World College in New Mexico developed by the late Armand Hammer, one of several upper high schools around the world for the best and brightest. The occasion was a student-led conference organized for discussing the ethics of human genetic engineering and cloning. Three other invited guest speakers and I spent two days with the 200 students from around the world and the UWC faculty and staff.

About fifty of the students were from a variety of backgrounds from here in the U.S., and the other 150 were from almost ninety countries. Their knowledge and perspectives on human genetic engineering ran from those who saw few problems and were perplexed by those with reservations to those who held all such technologies at arm's length and couldn't understand why anyone would want to do such things.

Who's right? Beyond that, What have we done already? And is there any opportunity for science and society to meet together to figure this out? In this program we will hear from several voices and see if we can navigate the coming genetic mine fields.

Is There a Posthuman Future?

One of participants at the UWC conference designated himself a "transhumanist." Transhumanists are among those who welcome with open arms the possibilities of genetic engineering to alter who and what we are. They scoff at the reluctance of others to step into this coming Brave New World. They relish the possibilities of double and triple average life-expectancy, designer babies, and the elimination of genetic disease. They aren't troubled by the necessity of costly mistakes and failures. That's just the price of research and progress. We accept risk all the time, they say. Why should genetic research be any different? They apply rather consistently a naturalistic worldview which sees human beings as just another species. We certainly aren't made in the image of God, they say, so why is our current genetic structure sacred?

Gregory Stock opened his 2002 book, *Redesigning Humans: Our Inevitable Genetic Future*, this way: "We know that *homo sapiens* is not the final word in primate evolution, but few have grasped that we are on the cusp of profound biological change, poised to transcend our current form and character to destinations of new imagination."{1}

Stock rightly points out that we have already started down the road of genetic manipulation of our species. Several fertility clinics in the U.S. already offer preimplantation genetic diagnosis or PGD. This procedure screens newly created embryos by in vitro fertilization for a few genetic diseases such as Tay Sachs, cystic fibrosis, and hemophilia. You can also have the embryos screened for sex selection. Some clinics even offer sex selection as the sole purpose of your visit to the clinic.

One couple from Wyoming had fourteen embryos created by in vitro. Seven were male, seven were female. They chose three females to be implanted to ensure their fourth child was a

girl after three boys. The technique is virtually 100% effective. Less efficient sperm selection techniques are only 91% effective for girls and only 76% effective for boys.{2} But should we be selecting the sex of our children?

Over one million IVF babies have been born worldwide, around 28,000 in the U.S.—roughly 1% of newborns. This may soon become the "natural" way once more procedures become available to design our own babies. We may recoil today at the thought of designer babies, but we also recoiled twenty-five years ago against the thought of test-tube babies.

Stock closes his book by saying, "We are beginning an extraordinary adventure that we cannot avoid, because, judging from our past, whether we like it or not this *is* the human destiny."{3} But is it?

What's So Wrong With Tinkering With Our DNA?

Couples are already being given the power to choose the sex of their child, even at the cost of simply rejecting the embryos that are the wrong sex. But our technology is advancing rapidly to allow a far broader array of genetic choices.

Gene therapy, the ability to transfer a normal human gene into the affected tissues of a person affected by a single gene disease, has been pursued for over ten years. So far results have been disappointing. That is partly the reason why many are looking for improved ways to add genes to the earliest one cell stage embryo so the gene can be spread to all tissues at once. This process is also rather inefficient in animals, successful only about 1% of the time.

But this does not deter some because they already view the embryo, before fourteen days after conception, as little more than reproductive cells and not yet worthy of being declared human. If this definition holds, embryos can be wasted as long

as a supply of human eggs is readily available. In addition to preimplantation genetic diagnosis (PGD) for sex selection and selection of embryos that are free of cystic fibrosis, Tay Sachs, hemophilia, and other genetic diseases, other genetic technologies are on the near horizon.

Researchers have already devised artificial chromosomes. These chromosomes pass on stably over several generations in mice. They have been tested successfully in human tissue culture, and have remained stable over dozens of cell divisions. No one has added foreign genes to these chromosomes, but that is the plan: to provide a safe and effective means of adding genes to embryos and have them distributed to all tissues and to succeeding generations.

Genetic futurist Gregory Stock summed it up when he said, "Breakthroughs in the matrixlike arrays called DNA chips, which may soon read thirty thousand genes at a pop; in artificial chromosomes, which now divide as stably as their naturally occurring cousins; and in bioinformatics, the use of computer- driven methodologies to decipher our genomes—all are paving the way to human genetic engineering and the beginnings of human biological design."{4}

Some may scoff at these projections, but people seem quite willing around the world to consider taking advantage of technologies that can genetically enhance themselves or their offspring. "In a 1993 international poll, Daryl Mercer, director of the Eubois Ethics Institute in Japan, found that a substantial segment of the population of every country polled said they would use genetic engineering both to prevent disease and to improve the physical and mental capacities inherited by their children. The numbers ranged from 22 percent in Israel and 43 percent in the United States to 63 percent in India and 83 percent in Thailand."{5} So what's the problem?

What’s Our Next Step?

I believe that being able to genetically redesign human beings is far closer than most people realize. Not only is the technology developing at an ever-increasing rate, but people are also far more willing to consider using such technologies than most would want to think.

I hope my tone in this article has indicated that I have deep reservations about this seemingly inevitable future. But why do I say this is inevitable? And why would I have reservations about taking this next step?

I believe that at least trying to alter ourselves genetically is inevitable because the technology is developing rapidly using animal models. And whatever we have done in animals, we eventually do in humans. The naturalistic worldview says quite strongly that we are just another animal species. If our understanding of our own genetics continues to increase and we gain the technology to correct our defects and faults, the naturalist says, Why not?!

Society and governments have put few barriers in the way of scientists and researchers from simply taking the next logical step. So far, we have been unwilling to say that there are some experiments we will not do. Even though most will say they are against human cloning—even scientists—that figure is changing, and we have few reasons for our objections besides the fact that it is not yet safe. If it does become safer, the public will have little room to say no. We’ve painted ourselves into a bit of a corner.

In regard to genetic engineering, we are easily swayed by appeals to eliminate genetic diseases without considering how difficult it is to delineate between curing genetic disease and producing genetic enhancements. James Watson, co-discoverer of the structure of DNA and Nobel Laureate, exposes our difficulty with two penetrating statements. Concerning

curing genetic disease he said, “What the public wants is not to be sick and if we help them not to be sick, they’ll be on our side.”{6}In another context Watson would have left most people dead in their tracks when he said, “No one really has the guts to say it, but if we could make better human beings by knowing how to add genes, why shouldn’t we?”{7}

Leon Kass, chairman of President Bush’s Council on Bioethics, put it quite succinctly when he said, “The first thing needful is a correction and deepening of our thinking.”{8} When I speak to young people in particular, I almost plead with them to pay attention in biology class. These genetic choices will probably begin to be available to today’s high school students as they marry and begin their families. They and we need to be better prepared.

How Will the Church Be Challenged?

There are just a few voices warning of the coming challenges and opportunities of the developing crisis over human dignity as the diesel engine of human genetic technology gains momentum and steam. Some fear it may already be beyond the point of no return and believe we’d better figure out how we are going to cope with our inevitable future of redesigned humans.

Leon Kass’s book, *Life, Liberty, and the Defense of Dignity,* is a good place to start. Though not a Christian, Kass dances around the edges of a Christian or theistic worldview that at least acknowledges that there is a human design in place that we need to be mindful of before we head out at breakneck speed to change who and what we are.

Kass sees that our efforts to redesign humans challenge our very dignity and identity as human beings. If parents have constructed the best child for them using the best available technology they can afford, are they still parents, or creators and owners with additional rights and privileges? A

child becomes a commodity to be designed, manufactured, and even sold. Love and nurture will turn to management and stimulation.

Gregory Stock is the director of the Program on Medicine, Technology and Society at the UCLA School of Medicine. His book, *Redesigning Humans: Our Inevitable Genetic Future*, will sober you up quite quickly. Stock is a naturalist and has little patience with those who would hold back our genetic future. He is knowledgeable and unflinching about the possibilities. One commentator wrote; “This is the most important book ever written about what we could do to make better people. I could not put this book down because it challenged everything I knew about human nature.” I would agree.

In my travels I have found the church to be largely unaware of how close we are to Stock’s vision of redesigning humans. Within a few short decades our children will be pressured to alter their children genetically to keep up with society. Scientific research may well make use of human embryos as matter of fact research subjects. This may likely extend to developing fetuses, and it will all in the name of furthering health and eliminating disease.

How will we react? The Barna Research Group tells us over and over again that the Christian community does not think or act in an appreciatively different manner than society at large. That means these genetic technologies will find their way into the church. There will be a new source of discrimination to deal with. No longer will churches be segregated by economic status and race but by genetic pedigree as well.

Do we really think we can improve on or maybe at least recover the original design? There may be a new Tower of Babel on our horizon. We must take seriously this threat to our future, both of humanity and the church.

Notes

1. Gregory Stock, *Redesigning Humans: Our Inevitable Genetic Future* (New York: Houghton Mifflin, 2002).
2. Claudia Kalb, "Brave New Babies," *Newsweek,* 26 January, 2004, 45-53.
3. Stock, 197.
4. Ibid., 13.
5. Ibid., 58.
6. Quoted in Leon Kass, *Life, Liberty, and the Defense of Dignity: The Challenge of Bioethics* (San Francisco: Encounter Books, 2002), 7.
7. Quoted in Stock, 12.
8. Kass, 8.

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"I'm a Girl Because That's What Mommy Wanted!" – The Ethics of Screening for Gender Using IVF

The brave new world of the future is not so far away anymore. Fertility clinics, originally created to assist infertile couples have children, can now screen for numerous genetic traits. Are we ready for the responsibility and future ethical questions? My experience says we are woefully unprepared. In our consumer oriented society of the 21st century, we want what we want, when we want it. If a couple has the financial resources and says they are willing to take the medical risks, who can say what they can and can't do?



Watch Dr. Bohlin on WFAA-TV video

In July 2015 an article appeared on Yahoo Parenting{1} about a couple in Frisco, Texas, north of Dallas. Rosa (36) and Vincent (37) Costa spent $100,000, enduring seven rounds of In Vitro Fertilization (IVF), including one miscarriage, just to ensure their third child would be a girl. Numerous fertility clinics allow infertile couples to genetically screen their embryos for nearly 400 genetic disorders. One additional benefit is that the embryos can also be screened for gender. Gender is a fairly simple assessment. Males will contain an X chromosome and a Y chromosome. Females are XX. These chromosomes are easily identified and distinguished.

This service is becoming more commonplace for couples since a round of IVF can cost around $12,000. If for an additional $6,000, screening can focus on healthy embryos, why not? Identifying the sex of the embryos is an added bonus. But in the last few years, couples like the Costas have mushroomed. Some clinics report a rise of 250%. As one who has addressed the issue of genetic engineering for over twenty years, I have regularly discussed the possibility of choosing the sex of your next child. The primary method used by fertility clinics is to assess gender before implantation. If you desire a girl, then only female embryos are implanted. Embryos of the “wrong” sex can be discarded, frozen for later use, made available for adoption or donated to “science” for stem cell research. Most frozen embryos end up in limbo. They do not stay viable forever. Some frozen embryos have been successfully revived after 5 years in storage. But many are simply discarded. Embryos donated for stem cell research are also ultimately killed. In order to retrieve the valuable embryonic stem cells, the embryo is destroyed.

Consequently, this IVF procedure to guarantee the sex of your child ultimately results in the death of numerous perfectly healthy embryos. So you have perfectly healthy parents sacrificing healthy embryos just to get the male or female child they desire. This cost is far more consequential than the dollar amount. I'm opposed to even discarding genetically challenged embryos for healthy embryos. Now we have crossed the line to create human life in the laboratory with the full intention of sacrificing embryos of the wrong sex. In another article{2}, fertility specialist, Dr. Jeffrey Steinberg, acknowledges he has had the technology to screen for eye-color since 2009. He delayed making it available then due to an outcry from the public. Saying he has a waiting list of 70-80 people, he's getting ready to make it available again.

But despite the clear loss of innocent human life in our search for a "balanced family" or even worse, children of the preferred eye color, we run into the specter of facing up to responsibilities too few have considered. The Costas, for instance, want a little girl. There is nothing wrong with that necessarily. But what are they really expecting? After all, they've spent $100,000 in the effort. The article mentions they will be decorating the new nursery in pink. But what if Olivia, their chosen name, ends up not liking pink? What if she's a tomboy who doesn't even like dresses? Or even more extreme, what if she decides as a little girl, she's really a boy! What do you do then? Even when selecting a child's gender, you likely have some concept in your mind of what a boy or girl will be like-otherwise, why choose gender at all?

It seems we are unwilling to ask the hard questions. Fertility experts will likely cater to what their clients want. There is competition, after all. One fertility specialist even believes that withholding these technologies puts him in the role of "playing god." He won't withhold something a client wants when the technology is available. That equates the consumer as a "god." The American Idol is not just a performer looking to

win a contest to land a lucrative recording contract. The American Idol is personal choice. As I said earlier, if someone says they understand the risks, has the money and wants to pursue a medical technology, whose is going to say no? Should we say no? We have known for some time that absolute power corrupts absolutely. Do we just stand by and allow people to make choices that show an utter disregard for innocent human lives in the pursuit of personal preferences? Life becomes cheap across the board. Everyone is suddenly at risk. Where do we draw the line?

My great concern is that public demand, not reasonable ethical considerations, will guide medical decisions. Do we really not have the collective will to say there are some medical procedures or even experiments we will not do?

Notes

1. Why One Mom Spent 100K to Guarantee Baby No. 3 Is a Girl Accessed July 14 2015.

2. Couple Spends 50K to Choose Baby's Sex, Shining Light on Trend Accessed July 14, 2015.

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Into the Void: The Coming Transhuman Transformation

In the TV show *The Six Million Dollar Man*, Lee Majors played Steven Austin, a crippled astronaut who was rehabilitated through bionic technology that gave him superhuman strength and powers. The show, like so much science fiction, presents us with the dream that technology will enhance all our

facilities from sight to memory, hearing to strength, and lengthen our life span to boot. The bionic man represents a fictional forerunner of the transhuman transformation. The Transhumanist school believes that technology will not only enhance the human condition, but eventually conquer death and grant us immortality. Human enhancement technology performs wonders in allowing the lame to walk, the blind to see, the deaf to hear and the sick to be well, but even immortality is out of the reach of technology. In striving to enhance our physical existence we may lose our souls in the process.

In his famous book, *The Abolition of Man* published in the 1940s, C. S. Lewis wrote that modern society is one step away from "the void"{1}—"post-humanity,"{2} a state of existence from which there will be no return. Lewis argues that when we step outside of what he calls the Tao{3}, we lose all sense of value for human life that has always governed civilization. What Lewis calls the Tao, we might call Natural Law or Traditional Morality—that internal moral understanding of right and wrong which God has written on the hearts of all people (Romans 2), the *Logos* by which all things were created (John 1, see especially verse 4).{4}

In leaving traditional spiritual values behind, Lewis argues, modern technological civilization has reduced human value to only what is natural, and we have lost our spiritual quality. Modern society has striven to conquer nature and largely succeeded, but at a great cost—with each new conquest, more losses in human dignity, more of the human spark extinguished. Lewis offers the example of eugenics from his time in the 1930's and 40's.{5} Eugenics is now a debunked science of racial manipulation and something we know was practiced with particular ferocity in Nazi Germany.{6} But the driving philosophy of manipulating nature and humanity into something new and final remains prominent. Lewis underestimated the truth of his own prophecy. He thought that maybe in 10,000 years the final leap will be taken when mankind will solidify

itself into some kind of inert power structure dominated by science and technology.{7}

However, the 21st century may prove to be the era of posthumanity that Lewis foresaw in his time. The current movement of transhumanism, or human enhancement, asserts that humanity will eventually achieve a new form as a species through its adaption to modern computer technology and genetic engineering in order to reach a higher evolutionary condition. Our present state is not final. Transhumanism derives from Darwinian doctrine regarding the evolution of our species. Evolutionary forces demand that a species adapt to its environment or become extinct. On this view, many species experience a pseudo–extinction in which their adaptation gives way to another kind of species leaving its old form behind. Many evolutionists believe this happened to the dinosaurs on their way to becoming modern birds and that humanity faces the same transformation on its way up a higher evolutionary path.{8} Primates evolved into humans so humans will eventually evolve into something higher (posthuman).

Metaman

Our present condition will give way to the cyborg (which is short for cybernetic organism) as we join our bodies and minds to technological progress. Transhumanists believe that because Artificial Intelligence (computing power) advances at such a rapid pace, it will eventually exceed human intelligence and humanity will need to employ genetic engineering to modify our bodies to keep pace or become extinct. Therefore, the cyborg condition represents humanity’s inevitable destiny.

The two predominant pillars in transhumanism revolve around Artificial Intelligence (AI) and genetic engineering. One represents a biological change through manipulating genes. The other presents the merging of human intelligence with AI. The biological position (through use of genetic engineering) claims that through transference of genes between species, we

eradicate the differences and create a global superorganism that encompasses both kinds of life—the natural and the artificial. Biophysicist Gregory Stock states that once humanity begins to tamper with its genetic code, and the codes of all other plants and animal species, that "the definition of 'human' begins to drift."{9} Through genetic engineering we will transform the human condition by merging humanity with the rest of nature, thereby creating a planetary superorganism. A superorganism operates like a bee hive or an anthill as a collection of individual organisms united as a living creature. Stock calls this Metaman, the joining of all biological creatures with machines, making one giant planetary life form. This superorganism encompasses the entire globe.

Transhumanism presupposes that no distinction exists between humanity, nature or machines. Metaman includes humanity, all it creates, and also the natural world. It acknowledges humanity's key role in the creation of farms and cities, but includes all natural elements, such as forests, jungles and weather. Metaman includes humanity and goes beyond it.{10} Stock envisions a greater role for genetic engineering in redefining biological life as different species are crossed. Humanity may now control the direction of its evolution and that of the entire planet.

Stock states that through "conscious design" humanity has replaced the evolutionary process.{11} This leads us to Post–Darwinism where people have supplanted the natural order with their own technological modification of humanity and the entire ecological system. "Life, having evolved a being that internalizes the process of natural selection, has finally transcended that process."{12} Humanity may now, through the agency of technological progress, seize direction of its development and guide it to wherever it wants itself to go. No other species has ever controlled its own destiny as we do.

The Singularity

A second transhumanist belief argues for the arrival of an eventual technological threshold that will be reached through the advancement of Artificial Intelligence. The argument goes like this: because AI develops at a rapid pace it will achieve equality with the human brain and eventually surpass it. Estimates as to when this will happen range from the 2020's to 2045. The evolutionary process will reach a crescendo sometime in the 21st century in an event transhumanists call "the Singularity."{13} There will be a sudden transformation of consciousness and loss of all distinction, or Singularity, between humanity and its creations, or the absence of boundaries between the natural and artificial world. Singularity watchers expect that this event will mark the ultimate merging of humans and machines. Renowned inventor and AI prophet Ray Kurzweil states, "The Singularity will allow us to transcend these limitations of our biological bodies and brains. . . . There will be no distinction, post–Singularity, between human and machine. . . ."{14}As the fictional CEO and mastermind behind a cutting edge AI company in the year 2088 crowed, "My goal is for us to end death as we know it on earth within 50 years—for the essence of every person to live perpetually in an uploaded state. . . . The transhuman age has dawned."{15}

Both of these positions, one emanating from genetic engineering that seeks to enhance the body, the other from Artificial Intelligence that seeks to supersede and even supplant the need for bodies, argue for the eventual replacement of humanity with biological–machine hybrids. Metaman and Singularity systems are direct heirs of the modern idea of progress. They present the dawning of a technological Millennium, but they also share a long history dating back into medieval Christendom. In the early Church, technology, or the "mechanical arts," was never considered as a means to salvation or Edenic restoration. Historian David Noble argues

that from Charlemagne to the early Early Modern period technology became associated with transcendence as the means of restoring the lost divine image or *imago dei*.{16}

Theologian Ernst Benz argues similarly that the Modern technological project was founded on a theological notion in which humanity believed itself to be the fellow worker with God in establishing His kingdom on earth through reversing the effects of the Fall.{17} We are fellow workers with God; however, this position overemphasized humanity's role in restoration to the point of becoming a works–based salvation of creation.

Despite the apparent secularity of the super science behind all the technological wonders of our time, the notions of modern progress and transhumanism remain grounded in an aberrant form of Christian theology. Noble summarizes this well when he states, "For modern technology and modern faith are neither complements nor opposites, nor do they represent succeeding stages of human development. They are merged, and always have been, the technological enterprise being, at the same time, an essentially religious endeavor."{18} The theology behind Modern technological progress remains rooted in Medieval and Early Modern notions of earthly redemption when the "useful arts,"{19} which ranged anywhere from improved agricultural methods to windmills, were invested with redemptive qualities and humanity began to assume an elevated status over nature. "In theological terms, this exalted stance vis-à-vis nature represented a forceful reassertion of an early core Christian belief in the possibility of mankind's recovery of its original God–likeness, the 'image–likeness of man to God' from Genesis (1:26), which had been impaired by sin and forfeited with the Fall."{20} Technology becomes the means of restoring the original divine image. Technological development was expected to reverse the effects of the Fall and restore original perfection. This theology also serves as the impetus behind Millennial thought which believes

technology helps humanity recover from the Fall and leads to an earthly paradise. Transhumanism extends this Millennial belief into the twenty–first century.

Redeeming Technology

We are faced with the problem of how to redeem all the advances of technology such as human enhancement without losing ourselves in the process. Idolatry preoccupies our central concern with technology. Biblically speaking, idolatry exalts the work of humanity, including individual human beings, over God; we commit idolatry when we serve the creature rather than the Creator. "Professing to be wise, [we] became fools, and exchanged the glory of the incorruptible God for an image in the form of corruptible man and of birds and four–footed animals and crawling creatures" (Rom. 1:22-23). Theologian Paul Tillich offers a keen and insightful definition of idolatry when he states, "Idolatry is the elevation of a preliminary concern to ultimacy. Something essentially partial is boosted into universality, and something essentially finite is given infinite existence."{21} Transhumanism presents us with a spiritualization of technology believed to grant us immortality through shedding our bodies and adopting machine ones or through genetic engineering that will prolong bodily life indefinitely. Our Modern age defines technology as a source of material redemption by placing finite technical means into a divine position, thus committing idolatry.

In seeking to reconcile technology with a biblical theology we have three possible approaches. *Technophobia* represents the first position. This view contends that we should fear technological innovation and attempt to destroy it. The Unabomber Manifesto offers the most radical, pessimistic and violent expression of this position, arguing for a violent attack against the elites of technological civilization such as computer scientists in an effort to return society to

primitive and natural conditions in hopes of escaping the kind of future transhumanists expect.{22} However, the entire tenor of our times moves in the opposite direction, that of *technophilism*, or the inordinate love for technology. Transhumanism optimistically believes that through technological innovation we will restore our God–like image. A third position asserts a mediating role between over–zealous optimism and radical morose pessimism. {23}

Technocriticism

Technocriticism offers the only viable theological position. By understanding technology as a modern form of idolatry we are able to place it in a proper perspective. Technocriticism does not accept the advances of innovation and all the benefits new technology offers without critical dialogue and reflection. Technocriticism warns us that with every new invention a price must be paid. Progress is not free. With the invention of the automobile came air pollution, traffic and accidents. Computers make data more accessible, but we also suffer from information overload and a free–flow of harmful material. Cell phones enhance communication, but also operate as an electric leash, making inaccessibility virtually impossible. Examples of the negative effects of any technology can be multiplied if we cared enough to think through all the implications of progress. Technocriticism does not allow us the luxury of remaining blissfully unaware of the possible negative consequences and limitations of new inventions. This approach is essential because it demonstrates the fallibility of all technological progress and removes its divine status.

Technocriticism humanizes technology. We assert nothing more than the idea that technology expresses human nature. Technology is us! Technology suffers the same faults and failures that plague human nature. Technology is not a means of restoring our lost divine image or reasserting our rightful place over nature. This amounts to a works–based salvation and

leads to dangerous utopian and millennial delusions that amount to one group imposing its grandiose vision of the perfect society on the rest. Such ideologies include Marxism, Technological Utopianism and now Transhumanism. We are restored to the divine "image of His Son" by grace through faith alone (Rom. 8:29). Technology, serving as an extension of ourselves, means that what we create will bear our likeness, both as the image-bearers of God and in sinful human identity. It contains both positive and negative consequences that only patient wisdom can sort through.

Through criticism we limit the hold technology has on our minds and free ourselves from its demands. We use technology but do not ascribe salvific powers of redemption to it. A critical approach becomes even more crucial the further we advance in the fields of genetic engineering and AI. We do not know where these fields will lead and an uncritical approach that accepts them simply because it is possible to do so appears dangerous. We live under the delusion that technology frees us, but as Lewis warns, "At the moment, then, of Man's victory over Nature, we find the whole human race subjected to some individual men, and those individuals subjected to that in themselves which is purely 'natural'—to their irrational impulses."{24} The famous science–fiction writer Frank Herbert echoes Lewis's sentiments in his epic novel *Dune*: "Once men turned their thinking over to machines in the hope that this would set them free. But that only permitted other men with machines to enslave them."{25} Genetic engineering or merging humanity with AI only exchanges one condition for another. We will not reach the glorified condition transhumanists anticipate. A responsible critical approach will ask, Into whose image are we transforming?

Notes

1. C. S. Lewis, *The Abolition of Man* (New York: Macmillan, 1947), 77.
2. Ibid., 86.

3. Lewis, of course, did not originate this ancient Chinese concept but rather applied it to universally accessible principles.
4. Ibid., 56.
5. Ibid., 72
6. See *Darwin's Racists: Yesterday, Today and Tomorrow* by Sharon Sebastian and Raymond G. Bohlin, Ph.D. Though the German Nazis acted out this hideous ideology to an extreme, eugenics was actually first promulgated in the United States, Germany and Scandinavia around the turn of the 20th Century.
7. Lewis, *The Abolition of Man*, 71.
8. See Dr. Ray Bohlin's article PBS Evolution Series, especially the section entitled "'Great Transformations' and 'Extinction'."
9. Gregory Stock, *Metaman: The Merging of Humans and Machines into a Global Superorganism* (New York: Simon and Schuster, 1993), 165.
10. Ibid., 20.
11. Ibid., 228.
12. Ibid., 231.
13. Ray Kurzweil, *The Singularity is Near* (New York: Penguin, 2005).
14. Ibid., 9.
15. David Gregory, *The Last Christian*, (Colorado Springs: Waterbrook Press, 2010), 102.
16. David F. Noble, *The Religion of Technology* (New York: Knopf, 1997), 9.
17. Ernst Benz, *Evolution and Christian Hope: Man's Concept of the Future from Early Fathers to Teilhard de Chardin* trans., Heinz G. Frank (New York: Doubleday, 1966), 124-125.
18. Noble, *The Religion of Technology*, 4, 5.
19. Ibid.,14.
20. Ibid.
21. Paul Tillich, *Systematic Theology: Reason and Revelation Being and God*, Vol. 1 (Chicago: University of Chicago Press, 1951), 13.
22. FC, *The Unabomber Manifesto: Industrial Society and Its*

Future (Berkeley, CA: Jolly Roger Press, 1995).
23. See Neil Postman, *Technopoly: The Surrender of Culture to Technology* (New York: Knopf, 1992), 5.
24. Lewis, *The Abolition of Man*, 79, 80.
25. Frank Herbert, *Dune* (New York: Ace, 1965), 11.

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"At What Stage of Pregnancy is a Fetus Able to Be Genetically Engineered?"

I am a high school student wondering about the process [of] genetic screening. I would like to know at what stage of pregnancy a fetus is able to be genetically engineered, or if the process must begin before a child is conceived. I would also like to know whether or not a normal gene has to be cloned from a donor in order to replace a problem gene in another. Any help would be greatly appreciated!

Just to make sure we are on the same page, *genetic engineering* and *genetic screening* are two different, but related things. *Genetic screening* involves testing a person for certain genetic diseases. This test can occur before the embryo is implanted into the womb as in the case of in vitro fertilization (IVF), it can occur during the pregnancy through a procedure call amniocentesis, and it can occur after a baby is born including into adulthood. Often with IVF, embryos are screened and the "best" ones are selected for implantation. Embryos need not just be screened for diseases, they can also be screened for gender and certain genetic markers. In some states pregnant women over 40 may be required to get genetic

testing to determine if their baby has Down's syndrome since the chances of Down's syndrome increases when the mother is over 40. Most babies after they are born are tested for certain diseases such as phenlyketouria because, if they test positive, the parents need to keep them on a strict diet. Lastly, some couples might want to be genetically screened before they decide to get married. This was practiced in a particular group of American-Jewish people who had a high incidence of Tay-Sachs disease. If both people were carriers, then they may decide not to get married because they would likely have a child that would die from Tay Sachs (they usually die at about age 5).

Genetic modification and *genetic engineering* are slightly different. *Modification* is done with plants and with some farm animals (although usually they use hormonal and breeding techniques for reasons outlined below). *Genetic engineering* in humans is still more theoretical than actual. The reason for this has to do with our lack of knowledge regarding the genome.

The theory goes like this: in the lab, we can replace segments of DNA with other segments of DNA in organisms like bacteria. So, what if we do this with human beings: replace unwanted DNA that codes for unwanted traits with DNA that codes for wanted traits. Sounds simple enough. Unfortunately—or fortunately, depending on your point of view—our genome is *not* that simple. There isn't just one strand of DNA that codes for eye color and another that codes for hair color. Our genes (genes are composed of lots of DNA) are very complex and the functions they code for are interwoven, often coding for multiple things at a time. Also, scientists are finding that DNA doesn't simply code for traits in a letter–to–letter fashion. Rather, there is apparently some interaction between two genes spatially in the genome.

As far as whether a normal gene has to be cloned from another, theoretically one can make segments of DNA in the lab. And

scientists have been able to insert these segments into bacterial cells. However, replacement and insertion of a DNA segment in mammalian cells is a very different story, and has not been successful in laboratory settings to the extent of being able to conduct genetic engineering. I suppose if you wanted to genetically engineer traits into a human being, it would have to be at an early embryonic stage when there are only 6-8 cells to deal with. But even then, it is unclear whether we could use synthesized DNA or if we must receive large segments from a donor. This is very problematic because there is still the issue of expressing (i.e., flipping the "on switch") of the DNA in the organism.

Thanks for writing. Hope this is helpful.

Heather Zeiger

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Animal/Human Hybrids

Editor's Note: The bulk of Heather Zeiger's study in bioethics has focused on the major issues addressed in American media, politics and science, such as stem cells, cloning and euthanasia, which is why she so anticipated this year's theme for the Center for Bioethics and Human Dignity Conference: Global Bioethics. The global context brought a broader perspective on the issues surrounding bioethics: India's medical tourism and black market organ donations, treating AIDS/HIV in Africa with limited resources, and euthanasia laws in Australia. One country that has been at the forefront of bioethics news is Great Britain because of their lenient legislation on issues concerning human dignity and "human exceptionalism" *(the idea that humans have a higher moral*

status than any other species). This is the first article emerging from her studies and experience at the Global Bioethics conference.

Dr. Calum MacKellar of the Scottish Council on Human Bioethics, who has represented Scotland at the Council of Europe and UNESCO, discussed human/animal hybrids, which can be legally created for research purposes in Great Britain. This article reports the major points of Dr. MacKellar's lecture and unless otherwise noted, all facts and statistics are drawn from his extended report on the Scottish Council on Human Bioethics Web site (www.schb.org.uk).

What Are Hybrids? What Are the Possibilities?

True Hybrids are embryos formed when the gametes (egg and sperm) are from different species. For example a human/chimp hybrid would be formed from the combining of a human egg with a chimpanzee sperm, or vice versa. These true hybrids create a new entity or species. One familiar example brought about by breeding is a mule, which is produced from horse and donkey gametes. In nature animal/animal hybrids tend to be less fit than their parents. Experiments to combine human and animal gametes have not been successful.

Cybrids are formed when the nucleus of an egg from one species is removed and filled with the nuclear material of another species. This mimics the technology of cloning, except one is using nuclear material from one species and a cell from a different species. The term *cybrid* comes from the combination of "cytoplasmic hybrid" because the genetic material in this new embryo is 99.9% of the nuclear species and 0.01% of the species that donated the egg [Michael Cook, "Soft Cell: How Scientists Are Easing away Opposition to Animal-Human Hybrids" *Salvo,* Issue 4, Winter 2009]. Most genetic material is found in the nucleus, but a little bit is left in the cytoplasm of

the egg. Scientists have been able to insert human genetics (a nucleus) into a cow's egg (an enucleated egg). The resulting embryo survived for twelve days. Other experiments have involved inserting human genetic material into a frog's egg and into a rabbit's egg. Neither of these survived beyond a week and never reached the blastocyst stage.

Chimeras (kī-'mir-uhz) are formed when the cells of one species are added to the embryo of another species. This results in an animal that has distinct parts from one species or the other. Think of the centaur in fantasy fiction. Fictional centaurs exhibit distinct parts that are human and distinct parts that are horse. This has actually been done in the lab with a goat and sheep. The resulting animal did survive and had distinctive goat legs and a distinctive sheep head.

Transgenic embryos are created by adding a few genes from one species into the embryo of another species. However, only a few genes can be added before the embryo collapses, providing self-limitations for this technique. Scientists have inserted human genes into pigs to create human insulin for diabetes patients. Scientists have also attempted to replace damaged human heart valves with animal heart valves. This is using animal parts in a mechanistic sense, and is known as *xenotransplantation*.

Although the media and legislation discuss human/animal hybrids, they are really talking about human/animal cybrids. While there are examples of hybrids in nature, thus far all experiments with human/animal hybrids have proven unsuccessful, even using *in vitro* fertilization technology.

Is This Legal?

Very few countries have passed specific legislation pertaining to any kind of combination of human and non-human material. Most laws either single out humans or animals. However,

several recent initiatives have been discussed:

• **Council of Europe:** ***Embryonic, Foetal and Post-natal Animal-Human Mixtures, Doc. 10716*** (October 11, 2005)—This document encourages the participating states to consider the ethical ramifications of creating human/animal hybrids, and also encourages the formation of a steering committee within the Council of Europe to address these ethical issues.

• **Canada:** ***Assisted Human Reproduction Act 2004*** —This act prohibits the creation of a chimera or a hybrid and prohibits the transfer of a chimera or hybrid into a human being or a non-human life form.

• **USA:** ***Draft Human Chimera Prohibition Act of 2005 (S.1373)*** —This draft, introduced by Senator Sam Brownback, would prohibit "any person to knowingly, in or otherwise affecting interstate commerce: (1) create or attempt to create a human chimera; (2) transfer or attempt to transfer a human embryo into a non-human womb; (3) transfer or attempt to transfer a non-human embryo into a human womb; or (4) transport or receive for any purpose a human chimera." In this case, some hybrids would fall under the category of chimera.

• **United Kingdom:** ***Human Fertilisation and Embryology Act (1990)***—This legislation states that the creation of human/animal entities would exist in a "legal vacuum" and hybrids could be formed if a proper license is obtained. The importance of this act is the fact that it makes it unclear whether the human/animal entities fall under human or animal legislation.

What Are the Consequences of Using This Technology?

Legal Consequences

There are several legal issues to consider, but probably the

most troubling is whether the entity produced should fall under human or animal legislation. Several questions follow this, such as “What percentage of the being needs to be human to fall under human legislation? What if the human/animal entity began as 30% human and 70% animal, but the human cells grew faster and the entity ended up being 70% human and 30% animal?” Dr. MacKellar preferred erring on the side of caution and giving the entity the protection and dignity entitled to a human being, however this is only a protective declaration and does not solve the myriad legal issues surrounding the creation of this new entity.

Societal Consequences

The formation of an entity that is both animal and human raises questions of personhood and challenges our definition of humanness. These beings will inevitably be met with challenges that go beyond identification with a minority group. Would protections such as the Fourteenth Amendment apply to these creatures, and how human would they have to be for them to possess rights and privileges? Would society want to grant them rights and privileges? Would the military want to create a human/ape hybrid soldier in hopes that they would be bigger, stronger, and easier to feed? Given human history, the temptation to relegate these beings to a lower class would be inevitable.

There are risks associated with diseases that may cross the species barrier. As Dr. MacKellar pointed out, we have several examples of diseases crossing the species barrier including HIV, swine flu and bird flu. We also know that these diseases can sometimes be more harmful or even fatal to one species than they were to another. If an entity is part human and part animal, and a disease is very contagious among either type of animal it shares characteristics with, it will likely infect the hybrid. At this point, the disease may adapt to human DNA, posing a great health threat to all humans, not just hybrids.

Do Hybrids and Cybrids Have Souls?

I believe, from a biblical perspective, the creation of hybrids, cybrids, and chimeras is unethical. However, some instances of transgenic technology, namely *xenotransplantation*, may be ethical, especially since there are built-in biological limitations regarding how many genes can be inserted into another species.

Do these procedures violate the sanctity of human life? Several thoughts:

• Humans are created in God's image (Gen 1:26);

• We were created separately (Gen 1:25, 26). We were created differently than the animals ("Let the earth bring forth living creatures…" Gen 1:24; "then the Lord God formed the man of dust from the ground and breathed into his nostrils the breath of life, and the man became a living creature" Gen 2:7);

• We humans were given dominion over the animals (Gen 1:29, 30). Therefore, these procedures do seem to violate the sanctity of human life as revealed in Scripture.

Are scientists attempting to bridge the gap in created kinds?

God directly created animals according to their kind, and it is implied in the flood account that He intended for them to reproduce according to their kind (Gen. 1:21; Gen. 8:17).

The Bible indicates that man has dignity and worth. If we try to create a being that might be less-than-human by combining it with animal cells or gametes, this would diminish such God-given qualities. It is from a naturalistic perspective that people believe animals are better than man because they seem to be stronger, faster, or heartier. This is not the Biblical perspective.

Do these procedures have something in common with bestiality?

One could argue that the creation of human/animal hybrids may constitute an instance of bestiality. Biblically, bestiality is a type of fornication with animals; it is a type of intimacy that perverts the real intimacy that God designed between a husband and wife. I find bestiality to be a particularly distasteful subject, and perhaps we get an indication of God's distaste for this since it is a sin that was punishable by death (Ex. 22:19; Lev. 18:23; Lev. 20:15, 16; Deut. 27:21). Procreation and consummation are not distinctly separate in the Bible. It is only through modern technology that procreation can occur in the laboratory apart from consummation. I think an argument could be made that procreation with human and animal gametes is a connection with animals that man was not meant to experience.

But what about…?

This article is a short report on hybrids and variations on combining human and non-human species, but we have not even discussed the multiple questions that arise from this type of experiment, such as:

• Why are scientists doing this?

• What are the implications for common descent if human and animals can breed?

• How does this affect the definition of species?

Also, I did not really deal with whether hybrids have souls or not because we just don't know. Personally, I think it will be biologically impossible to create a true human/animal hybrid, but cybrids may be a possibility. I think that, much like clones, a cybrid that grows beyond the embryonic stage would be very unstable and unhealthy as well as incredibly expensive and inefficient to make. And much like clones, I can't answer if they would have a soul.

I am thankful for groups like the Scottish Council on Human Bioethics for addressing this topic in secular language within the public square, but with an underlying Biblical perspective. It is groups like this that enable us to interact in a well-informed way in our places of influence. Whether it is voting for legislation or simply talking with our friends at Starbucks, you don't have to work for the Council of Europe to champion the Biblical perspective within the public square.

You can find Dr. MacKeller's full report on the Scottish Council of Human Bioethics Web site: www.schb.org.uk.

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"Cloning Could Help So Many People"

I am intrigued by the possibilities of cloning. Is human cloning possible? Could we use it on nearly extinct animals? What would be the risks of cloning, and if it were a success what might be the outcome?

I am interested in this because I think that cloning should be allowed to go ahead because it could one day help a lot of people. I would like to know as much information as you have on genetic cloning, so that I can gain an understanding of it and how it works. We would also have the ability to feed the starving children in Africa and other third world countries.

> *I am intrigued by the possibilities of cloning. Is human cloning possible? Could we use it on nearly extinct animals?*

Human cloning is not possible at this time. Cloning to

preserve endangered species is counter-productive since cloning produces genetically identical organisms. Endangered species usually suffer from a lack of genetic diversity. Cloning only makes the problem worse.

> *What would be the risks of cloning, and if it were a success what might be the outcome?*

Cloning produces a nearly identical genetic copy of the original by taking the nucleus of a cell from an organism and placing inside an egg cell of the same species. The egg needs to "reprogram" the original cell's DNA to perform embryonic functions. The risks currently are that this process is not always complete and the organism dies at various stages of development, or it is born deficient in some way. Some scientists believe that all clones are genetically handicapped in some way but some are able to survive, but marginally.

> *I am interested in this because I think that cloning should be allowed to go ahead because it could one day help a lot of people.*

We don't really know yet what cloning could do for anybody. At the moment there are only hopes and wild dreams.

> *I would like to know as much information as you have on genetic cloning, so that I can gain an understanding of it and how it works.*

I have several articles on our website. Check there first: http://www.probe.org/faith-and-science/bioethics/

> *If we were to be able to clone cows it would mean that we would not have a loss of meat production.*

Cloning cows is more expensive than normal reproduction. Currently only bulls are cloned to make more copies of good

genetic stock for normal animal husbandry purposes.

> *We would also have the ability to feed the starving children in Africa and other third world countries.*

Unfortunately, cloning will not answer this problem.

I hope you find this helpful.

Respectfully,

Ray Bohlin, Ph.D.

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Amniotic Stem Cells

On January 8, 2007, the Associated Press reported that scientists from Wake Forest University and Harvard University discovered a new type of stem cell found in the amniotic fluid within the wombs of pregnant women. Furthermore, once these stem cells are removed to the laboratory setting, scientists can coax them to become a variety of cell types including brain cells, liver cells, and bone cells.



Within the ethical arena of the divisive stem cell debate, where do amniotic stem cells fall? The crux of the stem cell debate is whether it is ethical to extract stem cells from a blastocyst (an embryo in its earliest stage of development) at the cost of destroying the embryo, or whether

this embryo should be respected and protected as an individual with research only to be conducted on alternative stem cell sources. The debate is exacerbated by emotional appeals and political agendas that are coupled with the media's sometimes uninformed or misconstrued reporting and the scientific community's vying for funds.

This discovery of the amniotic stem cells is exciting because it offers scientists a bountiful supply of stem cells{1} without harming mother or child. From a Christian perspective, these stem cells fall under the same category as adult stem cells.{2} We applaud the efforts of scientists who conduct alternative, ethical research that does not involve the destruction of another human life deemed less worthy for survival. Scientists have discussed the possibility of setting up a stem cell bank with amniotic stem cells from willing donors, but it will be several years before these stem cells are ready for human trial use. Dr. Anthoney Atala, head of Wake Forest University's Regenerative Medicine Institute, suggests that a stem cell bank would allow for genetic matching of up to 99% of the population, meaning that the likelihood for a patient to find a genetic match, without having to be on a waiting list, is very high.

At the risk of deflating some of the hype around this new discovery, I cannot help but notice that this is another example of misconstrued reporting of stem cell research. The reports would have the reader believe that this is some kind of breakthrough that may be the solution to all of our stem cell differences, but stem cells have been discovered in fetal tissue before. Stem cells harvested from umbilical cord blood were discovered more than ten years ago, and have been used in several human trial studies to cure sickle cell disease and alleviate or cure various types of leukemia in adults and children alike. Furthermore, the United States *does* have an umbilical cord stem cell bank that has been active for several years (see www.cordblood.com—the Web site for the National

Cord Blood Registry). However, very few people are aware of the bank's existence, largely due it being overshadowed by other, more controversial, aspects of stem cell research. So, even though the discovery of stem cells within amniotic fluid is an exciting find, it should come as no surprise that other fetal tissues contain stem cells, and they, like the umbilical cord cells, are more versatile than some adult stem cells and easier to work with than embryonic stem cells.

While there is an abundance of reporting on the potential for embryonic stem cells, there is little reporting on the many discoveries and advances that have occurred *in human trials* with adult stem cells. Scientists have reaped the advantages of harvesting adult stem cells for years (example: bone marrow transplants), yet politicians and the press seem to ignore those research articles and only focus on the ones that produce political and public hype.

This discovery is one of many exciting discoveries within the ethical bounds of adult stem cell research. We can rejoice in the fact that we serve a sovereign God whose precepts that guided believers thousands of years ago also apply in today's technological world.

For more information see Dr. Ray Bohlin's article The Continuing Controversy Over Stem Cells www.probe.org/the-continuing-controversy-over-stem-cells/. We also suggest you consider the Cerebral Palsy Guidance website at cerebralpalsyguidance.com.

Notes

1. NBC reported that approximately 4 million babies are born per year in the US alone. See www.msnbc.com.
2. Technically, these stem cells come from fetal tissue, but are considered "adult" due to their level of differentiation.

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“Do You Have More Information on Human Cloning?”

I am looking to inform my class on the steps to cloning a human and also the most recent experiments done in this field of work. I have read your articles, but is there any additional information you could provide me?

Below is the recent announcement by the first group to publicly say they are actively going to seek to clone a human. There is no published results from any laboratory anywhere in the world. The potato is just a little too hot yet. The story from the BBC may also provide some additional links for you.

The article confirms some of the scientific and ethical problems I have mentioned elsewhere.

Respectfully,

Ray Bohlin
Probe Ministries

Tuesday, 30 January, 2001, 17:08 GMT
Cloned human planned ‘by 2003’

http://news.bbc.co.uk/hi/english/sci/tech/newsid_1144000/1144694.stm

By BBC News Online’s Alex Kirby

A private consortium of scientists plans to clone a human being within the next two years.

The group says it will use the technique only for helping infertile couples with no other opportunity to become parents.

It says the technology will resemble that used to clone animals, and will be made widely available.

One member said the group hoped to produce the world's first baby clone within 12 to 24 months.

It was founded by an Italian physician, Dr Severino Antinori, whose work includes trying to help post-menopausal women to become pregnant.

A spokesman for the group is Panos Zavos, professor of reproductive physiology at the University of Kentucky, US.

No alternative

He said it would "develop guidelines with which the technology cannot be indiscriminately applied for anybody who wants to clone themselves."

As with animal cloning, he said, the technology would involve injecting genetic material from the father into the mother's egg, which would then be implanted in her womb.

"The effort will be to assist couples that have no other alternatives to reproduce and want to have their own biological child, not somebody else's eggs or sperm," Professor Zavos said.

He said he believed human cloning was achievable. It could at first cost $50,000 or more, but he hoped that could come down to around the cost of in vitro fertilisation, about $10,000 to $20,000.

Professor Zavos said he was well aware of the ethical dimensions of the project.

"The world has to come to grips [with the fact] that the cloning technology is almost here," he said. "The irony about it is that there are so many people that are attempting to do it, and they could be doing it even as we

speak in their garages.

“It is time for us to develop the package in a responsible manner, and make the package available to the world. I think I have faith in the world that they will handle it properly.”

‘Irresponsible’ plan

But the plans of Professor Zavos and his colleagues received an unenthusiastic response in the UK.

Dr Harry Griffin is assistant director of the Roslin Institute, Scotland, which successfully cloned Dolly the sheep.

He told BBC News Online: “It would be wholly irresponsible to try to clone a human being, given the present state of the technology.

“The success rate with animal cloning is about one to two per cent in the published results, and I think lower than that on average. I don’t know anyone working in this area who thinks the rate will easily be improved.

“There are many cases where the cloned animal dies late in pregnancy or soon after birth.

“The chances of success are so low it would be irresponsible to encourage people to think there’s a real prospect. The risks are too great for the woman, and of course for the child.

“I remain opposed to the idea of cloning human beings. Even if it were possible and safe—which it’s not—it wouldn’t be in the interest of the child to be a copy of its parent.”

Tom Horwood, of the Catholic Media Office in London, told BBC News Online: “A lot of our objections come down to questions of technique.

‘Morally abhorrent’

“But beyond that, cloning human beings is inconsistent with their dignity, and involves seeing them as a means, not an end.

“The scientists involved in the project are planning a conference in Rome to explain their plans.

“I don’t think you’ll start getting lots of papal pronouncements just because they’re meeting in Rome.

“The reaction in the Vatican will be the same as everywhere else—that the project is morally abhorrent and ethically very dubious.”

The Controversy Over Stem Cell Research

What Are Stem Cells and Why Are They Important?

President Bush recently decided to allow the use of federal funds to research the therapeutic properties of privately produced human embryonic stem cells (ES). President Bush clearly maintained the prohibited use of federal monies to produce human ES cells, since the procedure requires the destruction of the embryo to obtain them, which is currently prohibited by federal law. To fully understand the ramifications of this decision, I will discuss the nature of stem cells and their potential to treat disease.

Most of the more than one trillion cells that form the tissues

of our bodies possess a limited potential to reproduce. If you remove some live human skin cells, they may divide in culture (laboratory conditions) five or six times and then die. Special cells in the underlying skin layers are what produce new skin cells. These cells' sole function is to churn out replacement cells. These are known as stem cells. Most tissues of our bodies possess stem cells that can reproduce the different cells required in that tissue. Bone marrow stem cells can produce the many different cells of the blood. They are called stem cells, since they are seen as the stem of a plant that produces all the "branches and leaves" of that tissue.

What I've described is referred to as adult stem cells. There is no controversy revolving around the use of human adult stem cells in research, since they can be retrieved from the individual requiring the therapy. The promise of adult stem cells has increased dramatically in recent years. Stem cells have even been found in tissues previously thought to be devoid of them, such as neural tissue. It has recently been shown that certain types of stem cells are not limited to producing cells for the tissue in which they reside. For instance, bone marrow stem cells can produce skeletal muscle, neural, cardiac muscle, and liver cells. Bone marrow stem cells can even migrate to these tissues via the circulatory system in response to tissue damage and begin producing cells of the appropriate tissue type.{1}

In addition to the advantages of previously unknown adult stem cells and their unexpected ability to produce numerous types of cells, adult stem cells carry the added potential of not causing any immune complications. Conceivably adult stem cells could be harvested from the individual needing the therapy, grown in culture to increase their number, and then be reinserted back into the same individual. This means the treatment could be carried out with the patient's own cells, virtually eliminating any rejection problems. Adult stem cells

may also be easier to control since they already possess the ability to produce the needed cells simply by being placed in the vicinity of the damaged tissue.

Human Embryonic Stem Cells

The advances in adult stem cell research has only come about in the last three years. Traditionally it was thought that ES cells carried the greatest potential to treat wide-ranging degenerative diseases such as diabetes, Parkinson's, multiple sclerosis, spinal chord injuries, and Alzheimer's. Since ES cells derive from the inner cell mass of the early embryo (5-7 day old blastocyst), they are capable of forming all the tissues of the body. Therefore, researchers have long felt that human ES cells hold the greatest potential for treatment of degenerative diseases.

While the potential has always existed, the problem has been that in order to obtain these human ES cells, the embryo is destroyed during the harvesting procedure. In addition, while ES cells had been obtained and grown successfully in culture from several mammals, including mice, efforts at producing ES cells from other mammals had failed. Nobody was sure human ES cells could even be successfully produced until November 1998 when James Thomson from the University of Wisconsin announced the establishment of five independent human ES cell lines.{2} (A cell line is a population of cells grown from a single cell that has been manipulated to continue growing indefinitely in culture, while maintaining its cellular integrity.) Geron Corporation funded Thomson's work, so it did not violate the federal ban on government funds being used for such purposes. But his announcement immediately opened up a desire by federally funded researchers to use his already established human ES cells.

But there are potential problems and uncertainties in both adult and ES cells. While the ethical difficulties are non-existent for adult stem cells, they may not prove as helpful

as ES cells. ES cells have the potential for universal application, but this may not be realized. As stated earlier, establishing ES cell lines requires destruction of human embryos. An ethical quagmire is unavoidable.

Whereas adult stem cells can be coaxed into producing the needed cells by proximity to the right tissue, the cues needed to get ES cells to produce the desired cells is not known yet. Some in the biotech industry estimate that we may be twenty years away from developing commercially available treatments using ES cells.{3} Clinical trials using adult stem cells in humans are already under way.

In August of 2000, NIH announced new guidelines allowing federally funded researchers access to human ES cell lines produced through private funding. The Clinton administration hailed the new guidelines, but Congressional pro-life advocates vowed a legal confrontation claiming the new guidelines were illegal.

The Options for President Bush

This was the situation facing President Bush when he took office. The pressure to open up federally funded human ES cell research mounted from patient advocacy groups for diabetes, spinal chord injuries, Parkinson's disease, and Alzheimer's. Additional pressure to reject federal funding of human ES cell research came from traditional pro-life groups including National Right to Life and the Catholic Church, with personal lobbying from Pope John Paul II.

One option open to the President and advocated by the scientific community was to free up all research avenues to fully explore all possibilities from ES cells regardless of their source. This would include federal funding for ES cells derived from embryos specifically created for this purpose. Few openly advocated this, but the oldest fertility clinic in the U. S. (in Virginia) announced recently that they were

doing just that. Few within the government or research communities offered much protest.

Another option on the opposite end of the spectrum would have been to not only prohibit all federal funding on the creation and use of ES cells, but to also propose a law which would effectively ban all such research in the U. S., regardless of the funding source. Because of my view of the sanctity of human life from the moment of conception, this would be the ideal solution. However, this is not practical, since Roe v. Wade still is the rule of law in the U. S. This means that by law, a mother can choose to do with her embryo whatever she wants. If she wishes to end its life by abortion or by donation for research as a source of ES cells, she is free to do so.

A third option open to the President, and the one advocated by most in the research community, was to open up federal funding for the use and creation of ES cells derived from leftover embryos destined for destruction at fertility clinics. Some have estimated that there are over 100,000 such embryos in frozen storage in the U. S. alone. The intent is to find some use or ascribe some value to these leftover embryos. It is common practice in fertility clinics to fertilize 8-9 eggs at a time to hedge your bet against failure and to minimize expenses. As many as half of these embryos are left over after a successful pregnancy is achieved. These embryos are either left in frozen storage or destroyed at the request of the parents. So why not use them for research?

Other Options Available to President Bush

Advocates for ES cell research argue that if the embryos left over from infertility clinics are going to be wasted anyway, why not put them to some use and allow their lives to be spent helping to save someone else? The first mistake was to generate extra embryos without a clear intent to use all of them or give them up for adoption. Second, these tiny embryos

are already of infinite value to God. We're not going to redeem them by killing them for research. Each embryo is a unique human being with the full potential to develop into an adult. Each of us is a former embryo. We are not former sperm cells or egg cells.

Third, this is essentially using the dangerous ethical maxim that "the end justifies the means." A noble end or purpose does not justify the crime. Just because a bank robber wants to donate all the money to charity doesn't make the bank heist right. Nazi researchers gained valuable information through their many life- threatening experiments on Jews and other "undesirables" in the concentration camps of WWII. But most would not dignify these experiments by examining and using their findings.

A fourth option that I prefer is to close off all federal funding for human ES cell research. This would allow private dollars to fund human ES cell research, and federal dollars can be used to vigorously pursue the ethically preferable alternative offered by adult stem cells, which have shown great promise of late.

This would undoubtedly slow the progress on human ES cells and some researchers. Because of their dependence on federal research grants, they would not be able to pursue this line of research. But nowhere is it written that scientists have a right to pursue whatever research goals they conceive as long as they see a benefit to it. For years the U. S. Congress passed the Hyde Amendment that prohibited the use of federal funds for abortions, even though abortions were legal. The creation of human ES cells may be legal in the U. S. but that doesn't mean researchers have a right to government monies to do so.

The President did decide to allow the use of federal funds only for research involving the 60 already existing human ES cell lines. The President expressly prohibited the use of

government dollars to create new ES cell lines, even from leftover embryos. Researchers and patient advocates are unhappy, because this will limit the available research if these already existing ES cell lines don’t work out. Pro-life groups are unhappy, because the decision implicitly approves of the destruction of the embryos used to create these ES cell lines.

Stem Cells in the News Since the President’s Decision

When the President decided to open up federal funding for research on already existing human embryonic stem cell lines, just about everybody was unhappy. Researchers and patient advocates were unhappy, because this will limit the available research if these already existing cell lines don’t work out. The supply just might not meet the research demand. Pro-life groups were unhappy, including myself, because the decision implicitly approves of the destruction of the embryos used to create these ES cell lines. They will cost researchers at least $5,000 per cell line. Therefore, to purchase them for research indirectly supports their creation. Since both sides are unhappy, it was probably a good political decision even if it was not the right decision.

We certainly haven’t heard the end of this debate. Members of Congress are already positioning to strengthen or weaken the ban by law. Either way, the policy of the United States has clearly stated that innocent human life can be sacrificed without its consent, if the common good is deemed significant enough to warrant its destruction. I fully believe that this is a dangerous precedent that we will come to regret, if not now, then decades into the future. The long predicted ethical slippery slope from the abortion decision continues to threaten and gobble up the weak, the voiceless, and the defenseless of our society.

What has alarmed me the most since the President's decision is the full assault in the media by scientists to gain even greater access to more human embryonic stem cells, regardless of how they are produced. The ethical question virtually dropped from the radar screen as scientists debated whether the existing cell lines would be enough.

This attitude is reflected in the increasing attention given to potential benefits, while downplaying the setbacks and problems. The scientists speaking through the media emphasize the new therapies as if they are only a few years down the road. The more likely scenario is that they are decades away. Your grandmother isn't likely to be helped by this research.

Virtually nobody knows about the failure of human fetal cells to reverse the effects of Parkinson's disease in adults. About 15 percent of patients from a recent trial were left with uncontrollable writhing and jerking movements that appear irreversible. The others in the study weren't helped at all.{4} Chinese scientists implanted human embryonic stem cells into a suffering Parkinson's patient's brain only to have them transform into a powerful tumor that eventually killed him.{5}

Research with mouse embryonic stem cells has not faired much better. Scientists from the University of Wisconsin recently announced success in tricking human embryonic stem cells into forming blood cell-producing stem cells. Enthusiastic claims of future therapies overshadowed the reality that the same procedure has been successful in mice, except that when these cells are transplanted into mice, nothing happens. They don't start producing blood cells and nobody knows why.{6}

This debate will continue. Stay tuned.

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Human Genome Project

Dr. Ray Bohlin takes a brief look at the accomplishment, purpose and consequence of the Human Genome Project.

 *This article is also available in Spanish.*

What's All the Fuss About the Human

Genome Project?

In February of 2001, virtually every media outlet, whether TV news, newspapers, radio, Internet news services, or news magazines, was all worked up about the announcement of the completion of the Human Genome Project. In this article we will explore this monumental achievement and what it means for the future of medicine and our understanding of ourselves.

To appreciate this important accomplishment, we need to review a little basic genetics. It may actually astonish most adults just how much genetics the National Institutes of Health assumes we know about our genetic heritage. The educational video from the HGP includes a three-minute review of basic genetic processes like DNA packaging, transcription of DNA into message RNA, and the translation of message RNA into protein. It’s no exaggeration to say that when I played this short piece during a lecture for high school students and their parents, mom and dad were left in the dust.

Honestly, I did that intentionally; because we are only in the beginning stages of a genetic revolution that will transform the way we diagnose and treat disease and how we may even alter our genetic structure. These new technologies bring with them numerous ethical and moral dilemmas we have only begun to address and for which there may not be simple answers. If we don’t take the time to familiarize ourselves with genetic research and its implications, we risk responding out of fear and ignorance and potentially throwing away crucial medical advances.

I have contended for a long time that we can no longer afford to remain ignorant of genetic technologies. They simply harbor far too great a power for both tremendous good and tremendous evil. We must work hard to take every thought captive to Christ and see what there is of benefit and what avenues of research and application we need to avoid to preserve human freedom and dignity.

Well let’s talk about our genome, the sum total of all our genes. In most of the 100 trillion cells of our body are 46 chromosomes. These chromosomes are tightly coiled and packed strings of a remarkable molecule called DNA (Deoxyribonucleic Acid). DNA is a polymer, a repetitive sequence of four molecules, which I will only refer to by their one-letter abbreviations, A, G, C, and T. The human genome sequence is simply the sequence of these four molecules in DNA from all our chromosomes. If you laid out the DNA from all our chromosomes in each of our cells end to end, it would stretch six feet long.

A gene is a segment of DNA that contains the precise coding sequence for a protein. And proteins do all the real work in our cells. By looking at our completed sequence, it is predicted that our genome consists of 30,000 to 45,000 genes in each of our cells. So, now that we have the sequence, what does it mean? We’ll begin answering that question in the next section.

What Does the Human Genome Project Hope to Accomplish?

The National Institutes of Health in cooperation with several international research organizations began the HGP in 1990 in the U.S. There were four primary objectives among the many goals of the HGP{1}.

The first and primary goal of the HGP was to map and sequence the entire human genome. There is a critical and significant difference between a map and the sequence. There are over three billion letters, or base pairs, in the human genome, spread out over 23 pairs of chromosomes. Trying to locate a sequence of say 1,000 letters, the code for a large protein, is a one in a million task. Therefore, researchers needed a refined roadmap to the genome. The map entails particular sequences that can be used like signs on a road map. If the

trait a scientist is studying always seems to be present with this marker, the gene involved is probably nearby. In 1995, a detailed map was published with over 15,000 markers, one for every 200,000 base pairs. This will aid greatly in associating genes with particular diseases. And now with the sequence nearly complete, with over 99% accuracy, determining the precise effect of this gene on disease will be even easier.

A second critical goal was to map and sequence the genomes of several important model organisms: specifically, the bacterium E. coli, yeast, the roundworm, fruit fly, and mouse. This information is helpful, because each of these organisms have been used for laboratory studies for decades. Being able to coordinate knowledge of their genomes with cellular and biological processes will certainly inform our study of the human genome and its various functions.

The third important objective of the HGP was to systemize and distribute the information it gathered. Any sequence over 2,000 base pairs is released within 24 hours. The sequence and map data is contained in publicly accessible databases on the Internet. The HGP has also been creating software and other tools for large-scale DNA analysis.

The fourth and final primary goal of the HGP was to study the ethical, legal, and social implications of genetic research. A full 5% of all funds appropriated for the HGP have been earmarked for these kinds of considerations. There are many concerns revolving around the use of genetic sequence data. Not the least of which are worries about ownership, patenting, access to personal sequence data by insurance companies, potential for job discrimination based on personal sequence data, and the prospects for genetic screening, therapy, and engineering. In the next section we'll begin investigating how the HGP thinks this information can be used.

What are the Long Term Hopes for the HGP?

The completion of the sequence was announced jointly in February 2001 in the journals *Nature*{2} and *Science*{3}. Both *Science* and *Nature* have made these landmark issues available, without subscription, on their websites.

The importance of recognizing the sequence of a particular gene has three important ramifications.{4} The first is diagnosis. Over the last few years, single genes have been found leading to deafness and epilepsy. Numerous genes, however, will influence most diseases in complex ways. Recently, genetic influences have been found in many forms of hypertension, diabetes, obesity, heart disease, and arteriosclerosis{5}. Genetic analysis of cancer tumors may someday help determine the most effective drug therapy with the fewest side effects. Genetic diagnosis has the potential to more precisely prescribe treatments for many medical conditions.

Second, diagnosing ailments with more precision with genetics will also lead to more reliable predictions about the course of a disease. Genetic information about an individual's cholesterol chemistry will aid in predicting the course of potential heart disease. Obtaining a genetic fingerprint of a cancerous tumor will provide information concerning its degree of malignancy. Third, more precise genetic information will also lead to the development of better strategies for prevention of disease.

Many more ailments in newborns can eventually be screened more specifically to avoid disorders later in life. Currently, babies in the U.S. and other countries are routinely screened for PKU, a metabolic disorder that prevents the breakdown of a specific amino acid found in proteins. This condition becomes toxic to the nervous system, but can be prevented and managed with appropriate diet. Without dietary changes, affected babies face extreme mental retardation. Hopefully, the number

of conditions this type of screening applies to can be expanded.

Screening can also be done for adults, to see if they may be carriers of potential genetic conditions. Certain Jewish and Canadian populations regularly obtain voluntary screening for Tay-Sachs disease, a known child-killer. This information has been used to help make decisions about future marriage partners.

Perhaps the greatest benefit will come from what is called gene-based therapy. Understanding the molecular workings of genes and the proteins they encode will lead to more precise drug treatments. The more precise the drug treatment, the fewer and milder will be the side effects.

Actual gene therapy, replacing a defective gene with its normal counterpart, is still very experimental. There are still many hurdles to overcome involving how to deliver the gene to the proper cells, controlling where that gene is inserted into a chromosome, and how it is activated.

Not surprisingly, some have seen the human genome sequence as a vindication of Darwin. We'll examine that contention next.

Did the Human Genome Sequence Vindicate Darwin?

Amid the controversy and exultation over the release of the near complete human genome sequence has been a not so quiet triumphal howling from evolutionary biologists. The similarity of many genes across boundaries of species, the seemingly messy patchwork nature of the genome, and the presence of numerous apparently useless repetitive and copied sequences all have been laid out for us as clear validations of evolution. Really!

If Darwin were alive today, he would be astounded and humbled

by what we now understand about the human genome and the genomes of other organisms.

Let's take a closer look at the claims of one bioethicist, Arthur Caplan{6}, who thought the major news story was missed. So let's just pick a few of the more glaring statements to help us understand that little in his comments should be trusted.

First, Caplan says, "Eric Lander of the Whitehead Institute in Cambridge, Mass., said that if you look at our genome it is clear that evolution must make new genes from old parts."

While it may be true that we can see some examples of shared sequences between genes, it is by no means true that we see wholesale evidence of gene duplication throughout the genome. According to one group of researchers,{7} less than 4,000 genes share even 30% of their sequences with other genes.

Over 25,000 genes, as much as 62% of the human genes mapped by the Human Genome Project, were unique, i.e., not likely the result of copying.

Second, Caplan says, "The core recipe of humanity carries clumps of genes that show we are descended from bacteria. There is no other way to explain the jerry-rigged nature of the genes that control key aspects of our development."

Not everyone agrees. The complexity of the genome does not mean, necessarily, that it has been jerry-rigged by evolution. There is still so much we do not know. Caplan is speaking more out of ignorance and assumption than data. Listen to this comment from Gene Meyers, one of the principal geneticists from Celera Genomics, from a story in the *San Francisco Chronicle*:

> *'What really astounds me is the architecture of life,' he said. 'The system is extremely complex. It's like it was designed.'*

> *My ears perked up. 'Designed? Doesn't that imply a designer, an intelligence, something more than the fortuitous bumping together of chemicals in the primordial slime?'*
>
> *Myers thought before he replied. 'There's a huge intelligence there. I don't see that as being unscientific. Others may, but not me.'{8}*

Jerry-rigged? Hardly! Confusing at the moment? Certainly! But more likely to reveal hidden levels of complexity, rather than messy jerry-rigging.

It will take more than bluster to convince me that our genome is solely the result of evolution. The earmarks of design are clear, that is, if you have eyes to see.

What are the Challenges of the Human Genome Project?

In closing, I would like to address what are many people's concerns about the potential for abuse of this information. While there is great potential for numerous positive uses of the human genome, many fear unintended consequences for human freedom and dignity.

Some are justifiably worried about the rush to patent human genes. The public consortium, through the National Institutes of Health, has made all its information freely available and intends to patent nothing. However, there are several patent requests pending on human genes from the time before the HGP was completed.

It is important to realize that these patents are not necessarily for the genes themselves. What the patent does protect is the holder's right to priority to any products derived from using the sequence in research. With the full sequence fully published, this difficult question becomes even more muddled. No one is anxious for the courts to try its hand

at settling the issue. Somehow companies will need some level of protection to provide new therapies based on genetic information without hindering the public confidence and health.

Another concern is the availability of information about individual genetic conditions. There are legitimate worries about employers using genetic information to discriminate over whom they will hire or when current employees will be laid off or forced into retirement. Upwards of 80-90% of Americans believe their genetic information should be private and obtained or accessed only with their permission. The same fears arise as to the legality of insurance companies using private genetic information to assess coverage and rates. A recent bill (June 29,2000) before Congress to address these very concerns was amended to the Health and Human Services appropriations bill, but was removed in committee. The bill will be reintroduced this session.{9} I would be very surprised if some level of privacy protection is not firmly in place by 2002.

Moreover, many are apprehensive about the general speed of discovery and the very real possibilities of genetic engineering creating a new class, the genetically enhanced. Certainly, there is cause for vigilance and a watchful eye. I have said many times that we can no longer afford to be ignorant of genetic technologies. And while I agree that the pace of progress could afford to slow down a little, let's be careful not to throw the baby out with the bathwater.

After a series of lectures on genetic engineering and human cloning at a Christian high school, one student wrote me to say:

> *I am a senior, in an AP Biology class, and I find genetics absolutely fascinating. It's both fascinating and scary at the same time. . . . [You have inspired me] to not be afraid of the world and science in particular, but to take on its*

challenge and trust God.

Amen to that!

Notes

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