

Choosing Hope: The Reality of Germline Engineering

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O supreme generosity of God the Father, O highest and most marvelous felicity of man!

To him it is granted to have whatever he chooses, to be whatever he wills.

Pico della Mirandola, *Oration on the Dignity of Man*

Introduction

The year 2003 marked the fiftieth anniversary of Watson and Crick's discovery of the structure of DNA. In those fifty years, completion of the Human Genome Project made possible man's ability to "read from the book that is the [human] genome" (Ridley 22). It is the Human Genome Project that serves as a "launch pad" (*Engineering*) for the subject I will address in this essay, germline engineering. After reading this essay, one should be informed of the different categories and applications of human genetic modification. Primarily, I will present arguments against germline engineering, followed by explanations for why those arguments are invalid. I urge you not to dismiss my advice, as millions of people tormented by genetic disease are relying on the public discourse of this issue. Whether or not we are in agreement at the end of this essay, remember that the United States of America is a democracy, and it is the citizens who have the power.

Fundamentals of Human Genetic Modification

Two categories of human genetic modification exist: somatic gene therapy and germline engineering. Somatic gene therapy is used to treat all cell types, with the exception of sex cells, and serves as a method for "re-engineering" individual humans. Conversely, germline engineering refers to the treatment of sex cells (spermatozooids and oocytes) and is not manifest in an individual, but in the offspring of that individual.

Several applications of human genetic modification are now offered via somatic gene therapy. The most common of these applications is the addition of a functional gene in a non-specific locus to alleviate the effects of a nonfunctional gene. This method is often performed with the aid of a vector, a vehicle for transporting genetic material to target cells. Because viruses are quite efficient at infecting human cells, many genetic engineers have made viruses their vector of choice. Though deliberately infecting humans with viruses may sound absurd, it is important to realize that the disease-causing genes of the virus are replaced by therapeutic genes that, ideally, restore functionality to the target cells without harm to the patient.

Alternatives to viral vector-mediated gene therapy are available, however. One such approach to gene therapy is direct introduction of therapeutic DNA to target cells. Unfortunately, this approach is rarely taken because few cell types accept the DNA. Another approach to gene therapy takes advantage of a target cell's plasma membrane, which is primarily composed of lipids. By this method, a structure called a liposome transfers therapeutic DNA by penetrating the target cell. Probably the least viable option for gene therapy involves the binding of therapeutic DNA to membrane receptors on the

target cell's surface. This DNA may then be phagocytized by the plasma membrane and sent to the nucleus for incorporation into the patient's DNA.

Conceivably, the most practical approach to gene therapy will not entail the assimilation of therapeutic DNA into the patient's chromosomes at all. Genetic engineers are now considering the manufacture of human artificial chromosomes for delivery into target cells. Presumably, these HAC vectors would not trigger an immune response (unlike viral vectors) and would work in conjunction with chromosomes already present in the target cells (*Gene*).

Regardless of which of these applications is most preferred, human genetic modification is a practice that will only become more feasible with time. It should be noted that these applications are undoubtedly more challenging to perform in sex cells than they are in somatic cells. Nevertheless, germline engineering is banned in much of the free world (Lowenstein 19 – 21).

What's So Bad About Germline Engineering?

Germline engineering is one of the most controversial issues raised by the Human Genome Project. Despite the potential of germline engineering for therapeutic purposes, most stand in opposition to its use. Ted Peters, a renowned theologian and bioethicist, declares, "Every ethical interpreter I have reviewed agrees that somatic [gene] therapy is morally desirable" (145). Matt Ridley, U.S. editor for *The Economist* and author of *Genome*, views somatic gene therapy as "just another form of therapy." No witness to the effects of cancer treatments like chemotherapy "would begrudge them [cancer patients] the comparatively painless possibility of [somatic] gene therapy instead" (250). On the contrary, this desirability is not often shared in regard to germline engineering.

The purpose of germline engineering is an honorable one – elimination of genetic disease. The elimination of genetic disease, however, almost seems impossible due to the present lack of technology. Earlier I used the word "ideally" in my description of viral vector-mediated gene therapy. Alas, not everything in science occurs ideally. In reality, viral vectors are "unguided missiles," erratically delivering therapeutic DNA to myriad positions of the genome. The imprecision of this technique may cause some genes to become nonfunctional due to alterations of chromosome structure. This gene addition has not been shown to yield nonfunctional somatic cells because one "good" gene copy is sufficient and has "worked fine" in treating, for example, severe combined immune deficiency; however, the effect of gene addition in human sex cells is unknown. According to LeRoy Walters, Georgetown University philosophy professor and NIH committee chairperson, passing on both functional and nonfunctional genes resulting from gene addition is simply "not appropriate" at this time (222). Ensuing damage from germline engineering might foster the emergence of new diseases or disabilities, despite good intentions (Warren 151). Furthermore, negative effects from germline engineering may not be evident until after recipients have their own children, consequently prolonging the damage (Walters 229). The World Council of Churches advises humanity to "wait and see" until more scientific data is available (Peters 146).

Perhaps science does overcome the technical difficulties exemplified by germline engineering. Could society then anticipate triumph over all genetic disease? Maybe so, but another problem might eventually surface. What constitutes a disease is determined by society, not by "facts of nature" (Annas 135). An editorial from *The New York Times*

recognizes “there is no discernible line to be drawn between making inheritable repair of genetic defects and improving the species” (qtd. in Rifkin 140). Uncertainties about what truly makes a gene “defective” clearly exhibit the risk of shaping germline therapy into germline enhancement, gene transfer for the purposeful modification of heritable, nonpathological human traits.

One dispute against germline enhancement is that it could engender “a possible loss of human dignity” by widening socioeconomic divisions (Peters 151). Supporters of this argument propose that only wealthier individuals would be able to afford such “enhancement.” Undoubtedly, those individuals might continue to “improve,” increasing the division between themselves and the rest of society. Some speculate these actions may well generate reciprocally “infertile” human species (Warren 151)!

Even if financial status were not an issue, Jeremy Rifkin, president of The Foundation on Economic Trends, fears human aspiration to become “perfect beings.” Rifkin asks “against what ideal of perfection are we to be measured?” Additionally, Rifkin wonders if “perfect” humans will be able to tolerate others seen as “errors in the code” (147). Rifkin believes this “algeny” is representative of “excessive human pride” and advocates a laissez-faire approach to germline engineering (qtd. in Peters 13). The Bible does say “pride goes before destruction” (qtd. in Peters 12).

Further resistance to germline engineering stems from anxiety that genetic enhancement may lead to domination either by a small faction or by a tyrant. Those having sovereignty (likely from supreme knowledge of gene transfer) could pursue a dystopian society much like that in Aldous Huxley’s *Brave New World* or create a “master race” to do their bidding (Walters 229). The Council for Responsible Genetics’ (CRG) Human Genetics Committee even associated germline engineering with Nazi eugenicists who sought “racial hygiene,” most notably through the extermination of Jews (Peters 150).

Some anxious people worry most about man’s attempt to “play God” by intervening in human evolution (Walters 230). Germline engineering could place the fate of *Homo sapiens* in jeopardy if genes now deemed “bad” become advantageous in the future. For example, a particular single nucleotide polymorphism (SNP) in one copy of the gene coding for β -hemoglobin results in sickle-cell trait. Sickle-cell trait can actually be an advantage, unlike sickle-cell anemia produced from two “defective” copies of β -hemoglobin, because carriers are practically immune to malaria (Reilly 250). Suppose the abolishment of “defective” copies of β -hemoglobin becomes reality, only to be followed by a global outbreak of malaria. Would the human race survive, and if so, would this particular “improvement” have been worth the risk? Many in society could very well be aware of the threat of germline engineering to human evolution. According to a *Time/CNN* poll, fifty-eight percent of the participants said germline engineering is “against the will of God,” assuming the “will of God” is to avoid driving the human race to extinction. Pope John Paul II supposes germline engineering is sinful because it “places our destiny in our own hands” (qtd. in Peters 11). Maybe the fate of our species should indeed be left up to God.

In Defense of Germline Engineering

Opponents of germline engineering have offered some valid arguments, but I will now attempt to inform you of their faults. The talk of “unguided missiles” (Walters 222)

in human genetic modification is unquestionably legitimate for now, but one need not resort to pessimism. One alternative to gene addition may come from Mario Capecchi's discovery of homologous recombination in mice. Capecchi found that mouse embryonic stem cells have the ability to replace existing genes with their corresponding alleles (Ridley 254). Capecchi notes homologous recombination would be a "Herculean challenge" for somatic gene therapy, due to its low efficiency, but would be "much more easily" applied in germline engineering. Lee Silver, molecular biology professor at Princeton University, says the low efficiency of homologous recombination is negligible for germline engineering, because all that is needed is one cell. James Watson questions why we would "wait until the sun burns out" for somatic gene therapy. In addition, Watson stresses "we might as well do what we finally can" (qtd. in *Engineering*). Homologous recombination could just be the "major technological breakthrough" (Walters 222) for which humanity has been waiting. Maybe the word has not reached everyone, though, because scores of children are still being born with genetic diseases.

I do not intend to criticize others for being worried that manipulation of the germline may facilitate prejudices against those unable to benefit from the technology. Those individuals have a right to be apprehensive and are likely displaying sincere concern for the welfare of others, but germline engineering may not be perpetually achievable by the wealthy alone. Technological advancements have sufficiently lowered the costs of everything from books to food. One should not presume the costs of germline engineering will be adamant (Cohen 15). Likewise, the notion that germline engineering will lead to unattainable ideals "fails on the grounds of triviality." Countless ideals are already beyond the reach of most in our society (Peters 152). No matter the case, germline engineering will not cause discrimination, something that has probably existed since the dawn of man.

Power-wielding genetic engineers should not be feared if held accountable for their actions by their governments and fellow citizens. In fact, genetic engineers have thus far permitted their work to be overtly scrutinized before enrolling human subjects in somatic gene therapy trials. Certainly, germline engineering trials would demand nothing less (Walters 230). Furthermore, the CRG's association of germline engineering with Nazi eugenics is an erroneous belief. Eugenics may indeed have been "a weapon in the service of injustice" for Hitler and the Third Reich, but that does not mean eugenics is the cause of injustice. The CRG's attempt at using the word "Nazi" is merely to "paint their opponents in such a repulsive color that no one will open-mindedly view the matter" (Peters 150).

In response to the final argument, the goal of germline engineering is not necessarily to "play God" by intentionally altering the course of human evolution. Even if proponents of germline engineering wish to "play God," they would not be the first to make the effort. The truth is that medical technologies have already taken charge of human evolution (Walters 230). Still, should we as humans be frightened that germline engineering will endanger our species? Not according to Phillip Reilly, president of the American Society of Law, Medicine, and Ethics and author of *Abraham Lincoln's DNA and Other Adventures in Genetics*. Reilly states "[germline engineering] alters in a miniscule way the future of the human gene pool" (258). If germline engineering did have an effect on the future of the human gene pool, then it would expectedly be "beneficial" (Walters 228).

All this concern over going “against the will of God” (Peters 11) should not deter humanity from pursuing germline engineering. Not all humans believe as the Pope does. Some do not believe in God at all. I propose that if the religious wish to abstain from germline engineering, then they are welcome to do so, as anyone else should be. Yet, the choice should be left to individuals. No religious body speaks for everyone.

A recurrent theme in all these arguments is something Bonnie Steinbock, Chair of the Department of Philosophy at the State University of New York at Albany, calls “the fallacy of genetic determinism.” The idea that germline engineering will be used to customize babies by selecting, for example, intelligence level, artistic ability, or sexual orientation is oversimplified. The environment has just as much influence on human traits and conditions as genes, with a few notable exceptions. Moreover, polygenic inheritance is not only implicated in these traits and others, but also in many genetic diseases (183-84). Pico della Mirandola was not entirely correct by declaring man “can be whatever he wills.” Most of one’s traits and conditions cannot simply be chosen through any method. Thus, society will probably never see germline engineering used to predetermine a child’s behavior or appearance, or at least all of it (Steinbock 184). Dean Hamer, Chief of Gene Structure and Regulation in the Laboratory of Biochemistry at the National Cancer Institute puts it best: “You are born with a pen and paper in hand, but you have to write your own story” (314). Regrettably, these same concepts mean it will take a very long time to eliminate multifactorial diseases, such as epilepsy and asthma, through germline engineering (Steinbock 184). Nonetheless, there is still hope, even for now. Germline engineering gives us the power to eliminate monogenic disorders such as cystic fibrosis and Huntington’s disease. Why the delay? Uncertainty is apparent in most plans for the future and “should not deter research and experimentation guided by a vision of a healthier humanity” (Peters 149).

It is irrational to dread an age when genetic status would cause divergence in the human species, when “perfect” soldiers are engineered to fight in the names of scientists, or when humans bring about their own extinction by “playing God.” Those events could hardly become reality by altering a few genes in the human germline. Instead, one should anticipate an age where human suffering from genetic disease is no more. Walters believes, “all future generations will be grateful to both the researchers and the subjects who pioneered in the use of this promising technique [germline engineering]” (231). Sometimes people have to take risks, and one of those is germline engineering. Yet, germline engineering is by no means the greatest risk to humanity. “The greatest risk,” says Hamer, “has always been ignorance” (313-14).

Conclusion

It has now been revealed that one of the most controversial issues arising from the Human Genome Project, germline engineering, is not as frightening as many have led the public to believe. If you are not convinced, at least now you should have a general understanding of germline engineering and the controversy surrounding its use. Opposition to germline engineering is a choice one is allowed to make; however, it is not my choice. I refuse to let such ignorance vanquish the hope of millions affected by genetic disease. Despite how one may view germline engineering, it is essential that this issue is addressed as soon as possible. Express to friends and family how you feel on this

issue. Moreover, if you really want to make a difference, contact your government officials and tell them how you feel. It is time for resolution, and you have the power.

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