THE ETHICS OF GENETIC ENGINEERING

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> "Recombinant DNA technology [genetic engineering] faces our society with problems unprecedented not only in the history of science, but of life on the Earth. It places in human hands the capacity to redesign living organisms, the products of some three billion years of evolution… It presents probably the largest ethical problem that science has ever had to face."
>
> **George Wald (1976)**
> Nobel Prize winning biologist and Harvard professor

ABSTRACT

This paper seeks to examine the ethical questions surrounding the intentional manipulation of genes to achieve phenotypic modifications in humans. It is not concerned with distributive justice or the ethics of research, but rather with the debate over whether the technology of genetic engineering itself, once it is to a reasonable level proven both safe and effective, is ethical to use. The study begins by motivating the discussion and introducing some key concepts related to the technology. After establishing the scope and structure of the analysis, the paper proceeds by reviewing the most commonly presented arguments against genetic engineering and demonstrating that all fail to establish a legitimate ethical basis upon which such a criticism could stand. Finally, the paper concludes with a short discussion outlining possible areas for further study and discourse.

INTRODUCTION: MOTIVATING THE DEBATE

Though its origins can be traced back to the humble pea pods of a 19th century Augustinian priest, genetic engineering remains a fairly recent technological development. Since the confirmation of DNA's role in heredity in 1952 and the discovery of the double helix structure of DNA just one year later, research in the field of genetics has advanced at an ever-increasing rate, finally reaching the incredible level at which its application can legitimately be termed the engineering of genes. Recent studies have confirmed the ability to directly and purposefully manipulate genes, the material responsible for myriad human characteristics ranging from the mundane (like eye, hair, or skin color) to the ultimately life-changing (such as genetic diseases and predispositions to other illnesses).[1] Though the technology to do so safely and effectively has not yet been developed, the realization of true genetic engineering may not be too distant in the future.

These scientific discoveries could not have been made at a more fortunate time. Never in its history has mankind been more aware of the need for effective therapy for genetic diseases. Though in many developed countries the amount of suffering due to infectious diseases and nutritional deficiencies has decreased, the incidence of genetic diseases, which are not as easily prevented or treated by traditional means, remains high. One figure places inherited disorders as a major factor in up to 50 per cent of childhood deaths worldwide[2]. Furthermore, 15% of congenital disorders can be traced to the errors of single genes. The World Health Organization estimates that two single-gene defects that result in sickle cell disease and thalassemia account for more than 200,000 deaths per year and 100 million carriers of the diseases[3]. To those suffering under the burden of such disorders, genetic engineering may provide salvation.

It is highly debated issue, however, whether genetic engineering *should* be the answer to these ills. The fact remains that while genetic engineering has many entirely altruistic ends, it could

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[1] Wright.
[2] West (1988).
[3] Fletcher (1983),

potentially be used to modify virtually any aspect of any living creature, a fact that causes some to reject its use on ethical grounds. Erwin Chargaff, a biochemist whose two eponymous rules helped lead to the discovery of the double helix DNA structure[4], warns, "The technology of genetic engineering poses a greater threat to the world than the advent of nuclear technology." The fact that the use of genetic engineering is such a contentious issue means that the ethics of its application must be discussed now while time remains to establish any safeguards or regulations deemed necessary for its safe and ethical use.

SCOPE: SETTING BOUNDARIES

This study is concerned specifically with the ethical arguments in support of or against the intentional manipulation of genes to achieve phenotypic modifications in humans. To ground the analysis it attempts to separate rationally based concerns from irrational fears caused by the novelty and unknowns of genetic engineering. This requires two things. First, the paper will assume that the technology exists in a reasonably safe and effective form, and second, it will disregard questions of distributive justice.[5] The first assumption is formed in an attempt to avoid dystopian arguments based solely on hypothetical worst-case scenarios, which prophesize the destruction of humanity at the hands of genetic engineering. While it is true these speculative situations paint a bleak portrait of a future that could conceivably (albeit improbably) come to pass, the development and application of this technology will be incredibly gradual, enough so that if humankind observes itself heading such a direction, there will still be a reasonable amount of time in which to switch courses for the better. The second point is made in order to avoid drifting into the similar, yet completely separate debate over how to best ensure equal access to genetic engineering technology. To focus on issues of distributive justice would be to

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[4] Chargaff's rules state that the DNA of any living cell should have a 1:1 ratio of purine and pyrimidine base pairs– that is, adenine and thymine should be equal in number and the same is also true of guanine and cytosine.

[5] One additional type of argument against genetic engineering that is not included in this analysis is that which follows from a set of theistic principles, as these points rely on specific views of God that are not necessarily universally shared and certainly not based in fact.

neglect the fundamental question of whether its application should be aspired to in the first place.[6] By sufficiently condensing the scope of its ethical investigation, this paper has laid the groundwork to probe more deeply into the remaining relevant issues from which it can derive conclusions.

FRAMEWORK: STRUCTURING THE ANALYSIS

Prior to continuing the investigation, one relevant distinction between two different forms of genetic engineering will be useful to make, largely because the ethical discourse surrounding genetic engineering tends to be divided along this line. Two different methods exist by which scientists can alter genetic material – somatic genetic engineering and germline genetic engineering. Somatic cells, or regular body cells such as muscle cells and brain cells, contain 23 chromosomal pairs and their genetic material is not passed onto children. On the other hand, germline cells, or the reproductive egg and sperm cells, contain 23 unpaired chromosomes with DNA that are passed onto all future generations. The ethically relevant difference lies in the perpetual inheritance by successive generations of genetic changes to germline cells.

In an attempt to most efficiently prove the ethical statuses of both these methods, this paper builds its analysis upon two important postulates. First, it maintains that the burden of proof rests upon critics of genetic engineering. This follows quite reasonably from the fact that opponents of this technology rest their cases upon the ontologically positive claim of the social ills that may ensue from its use, whereas the proponents of genetic engineering cite the direct application of the technology[7] as their

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[6] In an attempt to address these concerns, however, this paper presents a couple plausible distribution schemas. Utilizing a Rawlsian perspective, the upper class with greater access to genetic engineering technology could be limited in their pursuit of enhancement insofar as they are able to improve the situation of the least well-off class. Other distribution schemas could involve lotteries for genetic modifications or requiring that the wealthy seeking enhancements subsidize treatment for the poor. Perhaps such regulation would not even be necessary. Channeling Adam Smith's theory of the invisible hand, Simon Young argues, "Economic growth in a market economy increases the prosperity of the poor, as well as the rich. As the techno-industrialized nations become ever more wealthy, so the poorest members of society will enjoy ever-increasing accessibility to the benefits of biodesign" (Young 62). Society tolerates many inequalities today (those of wealth, intellect, etc.), and it does not follow that genetic engineering would result in inequalities of a different nature. Furthermore, an increase in unjust inequalities due to technology is not adequate to discourage the development of genetic engineering. Though the wealthy were likely the first to benefit from the invention of the computer, this does not present a valid reason for not building the computer.

support. In other words, genetic technology will necessarily and directly reduce human suffering due to genetic disorders, while any negative external consequences that result from its application appear only in hypothetical scenarios. Second, the paper argues that somatic genetic engineering is strictly less ethically contentious than germline genetic engineering – that is, for any situation in which it is ethically acceptable to use germline genetic engineering, it is also ethically reasonable to use somatic genetic engineering. To illustrate this point, consider an example with two people, Jack and Jill, who each wish to alter their genetic material via somatic and germline genetic engineering, respectively. The nature of the alterations they seek is irrelevant, but for the sake of comparison, let their desired changes be similar. Now, in order to facilitate the ethical comparison, imagine that all of Jack's descendants also opted to undergo the same somatic genetic modifications. In this example, both somatic and germline genetic engineering produce identical consequences, and the only difference between the two cases rests in the fact that each of Jack's descendants were given the choice to opt into the treatment while Jill's descendants were not. Regardless whether the genetic manipulations are made to cure a disease or enhance a trait, it cannot be ethically justified that giving people some sort of choice is worse than not giving them a choice. Therefore, somatic genetic engineering is at least as ethical as germline engineering.

Upon the foundation of the two conjectures established above, by proving unjustifiable all currently existing arguments against germline genetic engineering[8], this investigation will be able conclude that *both* germline and somatic germline engineering are ethically permissible within the current set of presented facts and arguments.

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[7] The direct application of genetic engineering is to modify the genetic material in humans in a *beneficial* way. Note that concerns about its risks are not ethically relevant, as this paper concerns itself only with a safe and effective version of the technology. Challenges to the ethics of genetic engineering must instead call upon external ramifications not directly related to its application.

[8] Admittedly, not *every* argument against genetic engineering will be refuted here, as such a task would fall outside the scope of this paper. A significant and relevant subset of the arguments, however, will be addressed.

DEBATE: TO WHAT DEGREE IS GENETIC ENGINEERING ETHICAL?

This section seeks to develop and refute many commonly held arguments against germline engineering, including those that are also used to argue against somatic engineering. Critics of germline genetic engineering typically focus on social and moral problems that could arise from its application. Though such arguments generally rely upon the construction of hypothetical, albeit theoretically plausible circumstances, some of the concerns they raise do seem to have an ethical basis, and for that reason they need to be addressed.

One of the most well-known arguments involves the issue of consent. This position holds that changing the genetic material that is transmitted to one's offspring violates the basic ethical principle that an individual must provide consent in order to permit change in or experimentation with his or her person.[9] While the principle of informed concern is a standard, widely accepted criterion upon which to base ethical conclusions, its relevance to the argument at hand seems dubious at best. The unfortunate truth is that children, regardless of whether their parents engage in genetic engineering, never truly reserve the right to consent to their genetic composition. Sandel agrees that this argument "wrongly implies that absent a designing parent, children are free to choose their characteristics for themselves."[10] Furthermore, parents are generally very paternalistic in other ways that do not often incite ethical inquiry, controlling significant factors of development like a child's education and environment without their consent. In response, one could explain this apparent discrepancy by attempting to draw a distinction between the aspects of life that a child can assume control over when he or she matures and the aspects of life that a child can never change. The idea is that manipulating the former group of aspects without consent would be acceptable while doing so with the latter would not be. This binary, however, also fails in that genetic engineering could still reasonably fit in the acceptable category shared by the examples of determining a child's environment or education. As genetic technology continues to

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[9] Sandel, (2004).
[10] *Ibid.*

become safer, more effective, and more accessible, it is very likely that a child, upon reaching adulthood and finding herself unhappy with her genes, could choose to modify her own genetic composition. In fact, upon further scrutiny the principle of consent fails altogether as a binary in the context of determining the genetic composition of a child. Parents inherently exert power over their children's genes in choosing only certain mates for reproduction. Though this too, in essence, is genetic manipulation without consent, one would be hard pressed to find anyone who would object to reproductive freedom on such ethical grounds. Given that the principle of consent fails to establish an adequate distinction between what is ethically acceptable and what is ethically deplorable, it would make sense to discard this doctrine for another more appropriate principle upon which to support an ethical argument against genetic engineering.

Departing from the principle of consent, perhaps the real factor influencing the intuitions of opponents of genetic engineering is specificity. A rule of specificity might propose that there is an ethical difference between selecting a mate with traits that one might want to pass down to future generations and selecting which specific traits a child should possess. This raises two common arguments against genetic engineering – the killing of parental love and the issue of inviolability.

The first argument raised by specificity posits that manipulating genes with the aim of influencing specific traits will destroy the institution of unconditional love between parents and children.[11] While the tradition of parental love is certainly an important ethical objective – just imagine a world in which parents simply abandoned all unruly children – it is not realistic to believe that the application of genetic engineering to alter a child's traits will undermine this powerful natural instinct. Nick Bostrom writes, "What relevant evidence we have, for instance regarding the treatment of children who have been conceived through the use of in vitro fertilization or embryo screening, suggests that the pessimistic prognosis is alarmist. Parents will in fact love and respect their children even when artificial

[11] Sandel (2004).

means and conscious choice play a part in procreation."[12] Rather than destroying parental love, it is completely plausible that the advent of being able to choose the traits of one's children will usher in a new era of parents who feel complete love and adoration for their children. Certainly, one can easily envision parents finding it easier to love a child who fulfills their every desire.[13] Perhaps it is not the destruction of parental love that bothers the intuition most, but rather the possible evolution of parental love – that it may become motivated by different underlying reasons. If, however, the feeling of love for a child remains strong enough to maintain the social dynamics it currently supports, principally the caring relationship that a parent and child share, then is its evolution even ethically relevant? From a consequentialist viewpoint, it is not. For a non-consequentialist approach, consider an example involving two families, the Browns and the Smiths, who are of similar socio-economic statuses. The Browns have just given birth to a child who is incredibly gifted and who will grow up to become an incredibly successful, self-sustaining adult, while the Smiths have just given birth to a child who, as a result of his genes, possesses a disadvantage that will cause him to be a burden upon the family for the rest of his life. Now suppose that each family loves and cares for their child to the utmost of their abilities, which are for the sake of argument similar in degree. It does not follow intuitively that the fact that the Brown family child places less of a burden on his parents should cause their love for him to be of any less worth or of any greater ethical questionability in comparison to that of the Smiths. Given the arguments presented above, this paper concludes that genetic engineering does not threaten the ethically relevant aspects of parental love.

The rule of specificity also raises one of the least clearly defined and yet sometimes one of the most inherently intuitive arguments against genetic engineering – that genetic engineering desecrates the principle of inviolability. The concept of inviolability stems from the belief in certain natural institutions or basic underlying principles of existence that humans do not have the authority to alter. This paper will

[12] Bostrom (2003).
[13] Furthermore, given that the technology is safe and effective, as established earlier, there is no reason all parents would not be completely satisfied with their children.

consider the inviolability of human genome[14] and also the inviolability of the human dignity[15], two of the most frequently cited interpretations of inviolability used to attack genetic engineering.

In response to the argument citing the inviolability of the human genome, this analysis attempts to discredit the claim that the human genome holds this hallowed status. To establish inviolability of the genome, it must be demonstrated that either the process that produced the current human genome has some special moral significance such that humans lack the authority to change it, or that the product of this process, the genome itself, holds some sacrosanct standing. Though both criteria could be accepted on a theological basis, this investigation excludes any framework that relies on beliefs not necessarily universally shared, and so it must then turn to secular reasoning. In a secular context, the first criterion fails to be satisfied. Emanuel Agius et. al. write, "The human genome as we have it is the outcome of past mutations, selective pressures, genetic drift, random catastrophes, and the various constraints of natural forces and laws."[16] These apparently random influential factors in the evolution of the human genome hardly evoke any notion of a process of special moral significance, indeed their influence seems rather arbitrary and without purpose. The second criterion similarly falls flat when placed against the background of human history. As implied in the quote above, the human genome has evolved a great deal over the years, and to argue that it is inviolable is to contend that the factors that influenced its evolution – like mutation, genetic drift, random catastrophes – were and continue to be unethical. An argument that necessarily deems unethical factors that operate outside the realm of human control cannot be reasonable, and so the inviolability of the human genome cannot be established. Without this supporting principle, critics of genetic engineering may instead turn to the argument that future generations have a right to inherit an unaltered genome. What if genetic engineering allowed humans to free future generations from debilitating and deadly genetic diseases? On what grounds could these descendants be denied these benefits? It is possible that the crux of this argument lies upon the concern

[14] Nordgren (2001), p. 191.
[15] Article 24 of UNESCO's Universal Declaration on the Human Genome and Human Rights.
[16] Agius (1998), p. 53.

for future generations to be protected from the risks of genetic engineering, but a review of this point is outside of the scope of this paper, suffice to say that clearly, a cost-benefit analysis must be undertaken to deem genetic engineering acceptable. In any case, it has been shown that arguments against genetic engineering that question the ethics of altering the human genome are not substantial.

Regarding the second interpretation of inviolability, the preservation of human dignity is a principle that accords well with human intuition, and many texts have already argued for its status as an inviolable right, so this paper seeks instead to prove that this right is not violated by genetic engineering. For the sake of discussion, the analysis takes a Kantian interpretation of human dignity, which dictates that humans are never to be treated solely as means to an end. Clearly, somatic genetic engineering, which affects only the individual to whom it is applied, does not violate this definition of human dignity. The case of germline genetic engineering differs slightly, though in no ways that change the resulting conclusion. The fact that these modifications are inherited by future generations could possibly cause an individual to be treated as a means if the beneficiary of interest is that individual's descendant who received this benefit by means of inheritance from that individual. It can be argued, however, that should a descendant benefit from a genetic alteration, nothing fundamentally different exists about the ancestor that would cause the ancestor to not also benefit from said genetic alteration.[17] Thus, both ancestors and descendants are treated as ends, and human dignity is not violated by somatic or germline genetic engineering.

Another significant point often advanced against the development and application of genetic engineering is the fear of society undergoing a eugenic extermination reminiscent of those conducted by the Japanese and Nazi regimes in the 20th century. Though such examples of genocide were without a doubt ethically deplorable, the concept of eugenics does not necessarily entail such indecencies.

[17] One possible exception to this argument could involve an ancestor who makes some genetic modification that is deleterious to himself and yet advantageous to his descendants because of some factor that changes in the intermittent time period. For example, consider a man who changes his own genetics to stunt his growth in a time period when height is held in high esteem. Now imagine that over time the societal preferences change such that men of shorter height are more respected. The descendant of that man will benefit in this time period while the ancestor will have been treated as a means to that end.

Eugenics is rather simply defined as "the study and practice of selective breeding applied to humans with the aim of improving the species."[18] By this definition, mankind already practices a form of eugenics by freely selecting suitable mates for reproduction. Additionally, it can be argued that a society with access to genetic engineering is no more likely to experience this depraved form of eugenics than a similar society without the technology. Michael Sandel asserts, "To remove coercion is to remove the very thing that makes eugenic policies repugnant."[19] In a non-totalitarian state in which the people are free to choose whether they wish to be genetically modified and in what ways they wish to do so, the practice of eugenics appears to be ethically permissible. Moreover, such a form of eugenics may even be ethically obligatory. Rawls writes, "The parties to the social contract want to insure for their descendants the best genetic endowment (assuming their own to be fixed)."[20] To insure the best genetic endowment for its descendants, a society must practice some measure of eugenics to both preserve a reasonable level of natural abilities and prevent the diffusion of genetic defects. Thus, there exists no increased threat of an ethically repugnant eugenics movement occurring in a society with access to genetic engineering, and furthermore, the morally acceptable eugenic trends that may arise in such a society are in fact ethically obligatory.

Other ethical arguments against genetic engineering exist, but they contribute little, if anything, significant to the debate. These are discussed here in brief. First, germline genetic engineering is sometimes specifically argued against on the grounds that it is irreversible.[21] The sole virtue of being irreversible, however, does not give reason to oppose the technology. If humans were made irreversibly resistant to cancer, this would be cause for celebration rather than criticism. In any case, the modifications made by germline genetic engineering could just as easily be undone through further genetic engineering, so this is a moot point. Second, it is argued that genetic engineering will disrupt society by increasing the average human lifespan. If humans suddenly gain a significant number of

[18] http://en.wikipedia.org/wiki/Eugenics
[19] Sandel (2004).
[20] *Ibid.*
[21] Bostrom (2003).

healthy years, what would that mean for pension-plans or overpopulation? Allhoff et. al. write, "Unless it will be clearly and seriously harmful, social disruption by itself does not seem enough to count as a strong reason against regulating enhancement technologies."[22] Indeed, the ethical imperative to improve the human condition, which supports such applications of technology, would need to face fairly significant and more clearly defined social ills to render genetic engineering unethical – a mere appeal to possible scenarios will not suffice. Third, some wonder whether genetic engineering used to enhance human capabilities would serve to belittle human accomplishments[23], but history indicates otherwise. Despite their greater capacities for sport, contemporary athletes do not discount the incredible feats of ancient Greek Olympians. In fact, athletes in general are already genetically predisposed to have greater abilities, yet they are celebrated in spite of and because of their genetic superiority.[24] A final ethical argument against genetic engineering cites increased social stigmatization and discrimination of those with genetic diseases as a result of the technology. As Nick Bostrom explains, though, that the opposite is entirely plausible as well, "The practice of germ-line enhancement might lead to better treatment of people with disabilities, because a general demystification of the genetic contributions to human traits to make it clearer that people with disabilities are not to blame for their disabilities."[25] Furthermore, with fewer people living with genetic diseases, more resources could be devoted to each of them to reduce the burdens associated with their conditions. Though each of these points raises reasonable concerns, none establish a sufficiently robust ethical basis upon which to substantially threaten the ethical standing of genetic engineering.

CONCLUSION: A FEW PARTING COMMENTS AND CONCERNS

It follows from the evidence presented above that the arguments currently offered against genetic engineering fail to stand up to ethical scrutiny. In refuting each of the claims, this paper makes a

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[22] Allhoff, "Ethics".
[23] Allhoff (2008), "Germ-line Genetic Enhancement".
[24] One might argue that a difference exists between advantages that are natural and those that are specifically created, but this distinction is not robust because most abilities are developed through interventions. For example, education and exercise are interventions though they are deemed ethically obligatory rather than deplorable.
[25] Bostrom (2003).

challenge to critics of genetic engineering to either develop new justifications for their view or accept that the burden of proof has not been met. Though it has not attempted to prove that genetic engineering is ethically obligatory, this analysis has demonstrated that both somatic and germline genetic engineering are at the very least ethically permissible within the scope of the current discourse.

Upon reaching this conclusion, further discussion would likely shift to discuss possible frameworks one could use to determine which specific uses of genetic technology are ethical and which are not. Unfortunately, doing so falls outside of the scope of this paper, though such an investigation would likely proceed by attempting to establish binaries that can adequately encapsulate most ethical intuitions. Potential binaries could include frameworks that distinguish genetic therapies from enhancements, positional goods from non-positional goods, or external effects from internal effects. Another relevant area of further discussion involves who should ultimately be given the authority to decide in what cases genetic engineering should be used. Such a study would likely debate the potential virtues and failings of different degrees of libertarian and paternalistic policies.

Finally, this paper would like to address one last matter of concern regarding the development of genetic engineering. As the technology advances to the point at which it is both safe and effective to use, humankind must be particularly careful not to make changes from which it cannot return. Though this issue may seem similar to the argument of irreversibility refuted above, it actually involves an entirely different matter altogether. It is possible that certain alterations to the genetic code may modify the drives and motivations of human generations in such a way that humans simply stop caring about their own survival or advancement and get trapped in a state of apathy or worse. Still, this is not sufficient reason to not pursue the development of genetic engineering, but rather reason to remain reasonably cautious about its future.

> "The advance of genetic engineering makes it quite conceivable that we will begin to design our own evolutionary progress."
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> **Isaac Asimov**
> American author and Boston University professor of Biochemistry

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