Our Near Future: Human Genetic Modification

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As technology advances, the ethical implications of manipulating the human genome become more pressing. While genetic modification has the potential to address many diseases and improve diagnosis and treatment, there are significant concerns about unforeseen effects, equality and justice, and unresolved existential dilemmas. The prevalence of genetic diseases is a global issue, with around 65% of people suffering from a condition related to genetic mutations. The solution for many diseases appears to be on the horizon, however, the dangers of getting there create an irreparable predicament. The possible risks of using genome editing technology to alter DNA and physical characteristics outweigh the benefits, creating a difficult ethical dilemma. The benefits we may gain from genetic modification are outweighed by the potential for negative consequences on both the individual and society, as well as the morally unjust violation of basic human rights and the inherent value of life.

Human genetic modification, also known as human germline engineering, refers to the practice of altering the genetic makeup of an individual's reproductive cells, such as eggs or sperm, in order to produce offspring with specific traits or to prevent the transmission of genetic diseases. This technology has the potential to revolutionize medicine and improve human health, but it also raises a number of ethical and moral concerns, particularly from the perspective of Catholic theology.

In the Catholic tradition, human life is considered to be sacred and valuable from the moment of conception. Pope John Paul II explicitly states this in his letter "Evangelium Vitae", saying, "The biblical text is concerned to emphasize how the sacredness of life has its foundation in God and in his creative activity: "For God made man in his own image." (John Paul II, 1995). The Church teaches that human beings are created in the image and likeness of God, and

therefore have inherent dignity and value. This belief is reflected in the Church's opposition to abortion and other practices that involve the deliberate destruction of human life. Given this belief in the intrinsic value of human life, the Catholic Church has historically been cautious about the use of genetic modification and other technologies that involve manipulating the human genome. In particular, the Church has expressed concern about the potential for such technologies to be used for eugenic purposes, or to select certain traits in an effort to create a "superior" human race.

On the other hand, the Church also recognizes the value of science and technology in advancing human health and well-being. In this regard, the Church has acknowledged that genetic modification may be acceptable in certain circumstances, such as when it is used to treat or prevent serious genetic diseases. Ultimately, the Catholic Church's position on human genetic modification is one of caution and concern. While the Church recognizes the potential benefits of this technology, it also believes that it must be used responsibly and ethically, and that it should not be used to undermine the grandeur of human life.

The Process of Human Genetic Engineering

The genome is the complete set of DNA found in an organism. In humans, the genome is made up of around 3 billion DNA base pairs that can be found in almost every cell of the body. It is now becoming increasingly clear that certain regions of the human genome have important functions. While it is not a new concept that gene mutations can play a role in human diseases, more and more diseases are being identified as being genetically based as more information about the human genome becomes available (Mandip et al., 2019).

Human genetic modification, a process by which specific changes are made to an individual's genetic makeup, can be done through various methods. CRISPR/Cas9 is a method

that uses an enzyme called Cas9 to cut a specific location in the DNA sequence. The cut can then be repaired, either by inserting a new piece of DNA or by allowing the DNA to repair itself. Zinc Finger Nucleases are another type of enzyme that recognize and cut specific sequences of DNA. They can also be customized to target specific genes, making them useful for gene editing. Transcription activator-like effector nucleases (TALENs) are a third type of enzyme that splice specific strings of DNA. A different form of genetic treatment is gene therapy, which is a method that involves introducing a gene that is not present in the individual's DNA or replacing a faulty gene with a functional one. This is done through a vector, such as a virus, which carries the gene into the cells (Gupta, 2014).

The process of human genetic modification begins with identifying the specific gene or genes that are to be modified. Once these genes have been identified, the appropriate gene editing method is chosen and changes are made to the individual's DNA. The modified cells are then grown in a culture and are tested to ensure that the changes were successful. If the changes are successful, the modified cells are then introduced back into the individual's body (Gupta, 2014).

In the future, medical professionals hope to treat gene disorders such as Huntington's disease, muscular dystrophy, and cystic fibrosis using cutting-edge genetic technology. However, there are many ethical questions surrounding genome editing. Professor Acker-Palmer asks, "What impact do alterations have on gene interaction? And how can we prevent unintended "off-target" effects, like modifying genes that were not intended to be edited and potentially causing cancer?" (Acker-Palmer, 2021). While these single anomalies raise important questions, many argue that the entire practice of genome editing itself is unethical, regardless of the specific situations.

The Catholic Church has a longstanding tradition of supporting the use of technology and science for the betterment of humanity, however, it also emphasizes the need to respect the worth and importance of every individual life. (Développement et Paix., 2020). In the case of genetic modification, the Church believes that any intervention into the genetic makeup of an individual should be carefully considered, and should only be pursued if it respects the human person (USCCB, 2019).

The Negative Effects of Human Genetic Engineering

The greatest negative of such breakthrough technology is the fact that we must be ready for unforeseen and unintended consequences. When genes are altered, it can lead to unanticipated changes in the body. For example, if a gene is modified to cure a particular disease, it could possibly lead to other health problems or unexpected side effects. There is also a risk of "off-target" effects, where the gene editing process unintentionally modifies other genes, leading to unexpected consequences.

Another negative of human genetic engineering is the social and ethical issues that follow alongside the scientific perspective. There is a fear that gene editing could be used to create "designer babies," where parents can choose specific traits for their children, leading to a society in which certain qualities are seen as more desirable than others. This could create a divide between those who can afford gene editing and those who cannot, leading to social and economic inequalities. While The Pope has in the past spoken on the possible benefits of this technology if used right, he also warns of its dangers if used unethically, stating their abuse as, “insidious forms of violation of the rights to live in a worthy way as a human being” (The New York Times, 1982). Additionally, the ethical concerns surrounding the possibility of creating “superhumans,”

those with enhanced mental or physical abilities, could lead to discrimination and mistreatment of those who do not possess such traits.

A specific example lies within the case of Dr. He Jiankui. Dr. Jiankui is a Chinese scientist who claimed to have used the CRISPR gene editing technology to genetically engineer twin girls who were born in November of 2018. He claimed that he had used CRISPR to disable a gene called CCR5, which is believed to play a role in HIV infection. However, this claim was met with widespread condemnation from the scientific community and the general public (Davies, 2019). One major concern is that Dr. Jiankui's actions were unethical as he did not follow the proper protocols for conducting human genetic experiments. He also did not seek proper ethical approval before conducting the procedure, and did not inform the parents of the potential risks and side effects of the CRISPR treatment.

Another concern of his actions is that the long-term effects of CRISPR gene editing are unknown, and there is a risk of unintended consequences for the twin girls, as well as any future offspring that they may have. Additionally, Dr. Jiankui's actions have raised concerns about the potential for the abuse of gene editing technologies for eugenic purposes (Darnovsky, 2019). Altogether, Dr. Jiankui’s actions have been met with international condemnation because they violated ethical guidelines and raised significant concerns about the safety and ethical implications of gene editing.

Other serious ethical and technical concerns surrounding the use of CRISPR gene editing include the risk of unexpected genomic mutation, otherwise known as mosaicism. Despite some of the apparent precautions taken by Dr. Jiankui, the decision to implant manipulated embryos was reckless and could have had disastrous consequences if not stopped immediately (Carroll, 2017). The use of this technology has sparked debate between those who support heritable

genome editing and those who fear it will lead to inequality and eugenics. There are also concerns that modifying DNA in the human germline could result in alterations that are passed down to future generations, which leads to further unpredictable consequences.

In order to protect human, animal, and environmental safety, as well as to address social concerns, the United States has put lots of time and money into regulating research and the development of technical products. There are various measures in place to achieve this regulation, such as performance requirements, tradable allowances, government-industry discussions, and pre-market safety and effectiveness studies (Kuzma, 2021). However, despite the potential benefits of gene editing, such as the diagnosis and treatment of diseases, the issue of safety and the potential for errors remains a significant concern for scientists and government agencies responsible for funding research. While it is impossible to completely eliminate risk in experimental research, the question is not whether something is completely safe, but rather whether it is safe enough to pursue (Kuzma, 2021).

Regarding ethics and safety, John Paul II when discussing the danger of human genetic modification, states,

> "Whatever genetic modifications are effected on the germ cells of a person will be transmitted to any potential offspring. Because the risks connected to any genetic manipulation are considerable and as yet not fully controllable, *in the present state of research, it is not morally permissible to act in a way that may cause possible harm to the resulting progeny.* In the hypothesis of gene therapy on the embryo, it needs to be added that this only takes place in the context of *in vitro* fertilization and thus runs up against all the ethical objections to such procedures. For these reasons, therefore, it must be stated

> that, in its current state, germ line cell therapy in all its forms is morally illicit." (John Paul II, 1998).

As stated by John Paul II, genetic modification of germ cells should not be allowed because it carries significant risks and is not yet fully controllable. Germ line cell therapy in all its forms is morally illicit and not morally acceptable at this time due to the potential harm it could cause to future generations and the societal issues surrounding its use.

The Church also emphasizes the need to avoid playing God and interfering with the natural order of things. The Catechism of the Catholic Church (CCC) states,

> "The natural law is written and engraved in the soul of each and every man, because it is human reason ordaining him to do good and forbidding him to sin . . . But this command of human reason would not have the force of law if it were not the voice and interpreter of a higher reason to which our spirit and our freedom must be submitted" (CCC, 2022, para. 1954).

Natural law is a concept that believes that there is a universal moral code that is inherent in all humans, regardless of their culture or society. It is believed to be written in the soul of each individual, and it directs them towards good actions and away from sin. As such, it is important to consider the potential ethical implications of genetic modification and to ensure that any interventions are done in a responsible and ethical manner.

The Violation of Human Dignity

The incorporation of an article in the Swiss Constitution in 1992, which required the federal government to issue regulations on the use of genetic material that consider the dignity of nonhuman organisms, raises philosophical questions about how we should define "the dignity of nonhuman animals," as well as what moral demands arise from recognizing this dignity in

relation to genetic engineering (Balzer, 2018). To understand what is meant by this, it is important to differentiate between human and nonhuman dignity. Some ideas about human dignity should be discarded in favor of a fourth: the right not to be degraded (Balzer, 2018).

According to the Catechism of the Catholic Church (CCC),

> "God has given man stewardship over the earth and its creatures. Man must therefore use his scientific knowledge responsibly, respecting the integrity and preservation of the natural world" (CCC, 2022, para. 2415).

This suggests the use of scientific knowledge and technology as a responsibility that must be exercised with care and respect for the natural world. This right means that those who possess it have the cognitive abilities necessary for self-respect. Respecting the dignity of nonhuman beings, who do not have this ability, requires acknowledging their inherent value, which is linked to their ability to pursue their own interests.

Furthermore, the use of such advanced science, which directly changes the genetic code that defines one's life, can be argued to cause a divide between values. Pope Benedict XVI expands upon this in his address to the Pontifical Academy of Sciences, stating that,

> "Science, however, while giving generously, gives only what it is meant to give. Man cannot place in science and technology so radical and unconditional a trust as to believe that scientific and technological progress can explain everything and completely fulfill all his existential and spiritual needs" (Benedict XVI, 2006).

Science is a tool, and while it is meant to help, it is not meant to change the very nature of the one who uses it. Ultimately, the controversy and ethical concerns surrounding human genetic modification outweigh its current potential advantages, and it is best to focus on research that

does not pose a potential threat to the code of our life, which can just as easily pass on to future generations.

The Benefits of Genetic Modification

Despite the major disadvantages in the long-term effects and moral values of genetic engineering, there are many positive perspectives in which this process has piqued scientific interest.

Genetic engineering could be used to correct genetic defects that cause diseases or disorders, such as cystic fibrosis or sickle cell anemia. This would significantly improve the health and quality of life of individuals with these conditions. Furthermore, some proponents of genetic engineering argue that it could be used to enhance certain physical or mental abilities, such as intelligence or athletic performance (Acker-Palmer, 2021).

The Catholic theology perspective of stewardship provides us with a view on why genetic modification should be used. As Catholics, we believe that God has given us the gift of life and the responsibility to care for it, including the responsibility to use science and technology for the betterment of humanity. Genetic modification can be used to alleviate suffering and disease, improve overall health and longevity, and even enhance human capabilities, all of which align with the principle of stewardship. Additionally, as long as genetic modification is used ethically and with respect for the dignity of human life, it can be seen as a way to fulfill our God-given duty to use our talents and resources to improve the world around us.

With the direct effect on humans aside, looking at the use of genetic modification in plant GMOs brings up other benefits of this process. While in humans the technology has a plethora of regulations and safety measures, genetic modification in plants is a much easier process to carry out, and is in heavy use today in many of our crops. The U.S. Food and Drug Administration

states, “GMO crops are tolerant to herbicides and help farmers control weeds without damaging the crops. When farmers use these herbicide-tolerant crops, they do not need to till the soil” (FDA, 2022). Furthermore, they also state, “GMO crops were developed specifically to benefit consumers. For example, a GMO soybean that is used to create a healthier oil is commercially grown and available” (FDA, 2022). The use of genetic modification in crops has shown a positive economic and environmental impact, and it has also allowed us to create products that can directly fit our nutritional needs. Also, theoretical studies are being carried out in which vaccines are delivered through our consumption of genetically modified organisms. In conclusion, the current successful use of genetic modification in plants that we consume acts as a vision for how human genetic modification can be successful, while regarding heavy safety regulations.

Altogether, it is still important to approach the topic of human genetic modification with caution, and to carefully consider both potential benefits and risks before moving forward with any interventions. Assessing risk can include actions such as engaging in open and transparent discussions about the ethical implications of genetic modification and involving a diverse range of perspectives from various fields.

The Future of this Process

Human genetic manipulation has the potential to be transformative, but also raises concerns about the unintended consequences of modifying DNA in the human germline, which could be passed down to future generations. Pope John Paul II acknowledges this safety concern in the letter “Evangelium Vitae,” opposing embryology, “It must nonetheless be stated that the use of human embryos or fetuses as an object of experimentation constitutes a crime against their

dignity as human beings who have a right to the same respect owed to a child once born, just as to every person" (John Paul II, 1995).

While there is no denying that human genetic modification has the potential to do good, it is important to consider the ethical implications of this technology and to ensure that it is used responsibly. Some critics argue that techniques like preimplantation genetic diagnosis (PGD), which is used during in vitro fertilization to identify genetic abnormalities in embryos, can already help to prevent the transmission of certain genetic disorders, however the debate over the need for more advanced techniques like embryo editing is ongoing. It is crucial to have these ethical debates before these techniques become widely available, as it will be harder to address concerns and establish guidelines once they are in widespread use.

To delve further into the safety concerns of genetic modification, experiments that don't directly involve humans have also been in heavy use. The XenoMouse experiment involved the creation of mice that had human genes inserted into their genome. This was done in order to study the function of specific human genes and how they influence development and disease. One example of this type of experiment was the creation of a XenoMouse that had a human gene for Alzheimer's disease inserted into its genome. Scientists were able to observe how this gene affected the development and behavior of the mice, providing insights into the mechanisms of the disease and potential therapeutic approaches.

This type of experiment is related to human genetic modification because it allows scientists to study the effects of specific human genes in an animal model. This can provide valuable information about how these genes function and how they may be used to treat or prevent certain diseases in humans. However, it is important to note that the XenoMouse

experiment is not a direct form of genetic modification in humans, as the genes are only studied in mice and not directly altered in human DNA (Green, 2017).

Instead of pursuing the uncertain and potentially harmful field of human genetic modification, it is more advisable to conduct research that does not pose risks to humans and future generations. Pope John Paul II strongly agrees with these dangers again in "Evangelium Vitae", stating that, "The various techniques of artificial reproduction, which would seem to be at the service of life and which are frequently used with this intention, actually open the door to new threats against life" (John Paul II, 1995). While human genetic engineering may hold potential benefits, its ethical concerns and controversies make it questionable. To address these ethical debates and ensure the safety of the human genome, it is crucial for future research to adopt an interdisciplinary approach that incorporates perspectives from various fields such as philosophy, history, and economics.

As the future of genetic engineering has the power to fundamentally alter human life, all ethical and moral considerations must be taken into account. The future of human genetic modification could be beneficial, though its controversy and questionable ethics outweigh its apparent advantages. The benefits we may gain from genetic modification are outweighed by the potential for negative consequences on both the individual and society, as well as the morally unjust violation of basic human rights and the inherent value of life.

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