The Ethical Dilemma Involved in Genetic Engineering and Gene Therapy

Amber Schrag

A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2023

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial
fulfillment of the requirements for graduation from the
Honors Program of Liberty University.

_____

Jeremiah Winter, Ph.D.
Thesis Chair

_____

Gary Isaacs, Ph.D.
Committee Member

_____

Emily C. Knowles, D.B.A.
Assistant Honors Director

_____

Date

Abstract

Genetic engineering and gene therapy are greatly disputed in our time. With the advancement of technology, one has the power to manipulate genes in the body, which raises the questions: What is our role in this? Is there a limit to this power, or should there be? This paper reviews the uses of this technology and evaluates the ethics from a scientific and Biblical point of view. It is concluded that using gene therapy to help cure diseases is very beneficial in both the scientific and Biblical realm as it is restoring individuals back to health and wholeness.

Where Do We Draw the Line? The Ethical Dilemma Involved in Genetic Engineering and Gene Therapy

When considering the topics of genetic engineering and gene therapy, especially from a Christian perspective, it is easy to want to run and hide before the discussion even begins. This paper is focused on these topics to support certain viewpoints and worldviews, without avoiding the fundamental issues. Christians must have great influence and boldness in determining what happens in this realm, as they know the Lord and hear His voice through His Word and His Spirit. This grants them greater discernment to handle these situations.

Genetic engineering and gene therapy are very easily confused, as the language is similar, but the definitions are very different. Genetic engineering is basically altering genetic or hereditary material of an organism to get rid of traits or introduce new ones (Patra, 2015). Genetic engineering, in its most technical definition, is simply the manipulation of genes in the body, whether for therapy or enhancement. Within this paper, genetic engineering will be referenced by its most common definition, which is that of genetic engineering being used for enhancement that is not medically necessary. Gene therapy, on the other hand, is a form of genetic engineering applied only to cases of therapy in which there is a medical need caused by a genetic problem (Curators of the University of Missouri).

What is the need for discussing this topic? It may seem unnecessary to some, but this technology is already being abused, and if nothing is done about it there could be terrible consequences. In this paper we will discuss some of the negative implications of genetic engineering and some of the failed experiments that produced tragic and unnecessary results. We will also discuss some of the practical ways that gene therapy has been helpful to provide life and cures for diseases that seemed fatal at first glance. It is important to review past triumphs and

mistakes to provide a guideline for the future. In addition to this, some aspects of genetic engineering may need to be completely changed based on a Biblical basis for life, ethics, and morals. The Biblical backing for this will be explored throughout this paper, as this is needed to truly talk about ethics and guidelines for life. The ethical standards used to make decisions in genetic engineering and therapy will be examined, specifically considering the Christian worldview.

This paper will be exploring the ethics behind genetic engineering and gene therapy by looking at current applications, questions of technology misuse versus therapy, the actual ethical basis for gene therapy and genetic engineering, and ultimately what the role and responsibility is for Christians.

Current Applications of Genetic Engineering and Gene Therapy

Benefits of Genetic Engineering

We will begin by discussing the overall benefits of genetic engineering. Genetic engineering has helped produce readily available insulin, growth hormone, and vaccines (Britannica, 2021). A major advance in diabetic care came through insulin production through genetic engineering. Indeed, almost all the insulin made today for diabetics is created through genetic engineering (Cerier, 2018). In this case, *E. coli* is transformed with a plasmid containing the code for human insulin. This is then used to allow diabetics to have greater access to insulin, as the bacteria grow easily, producing a sustainable and easily accessed source of human insulin. Not only this, but genetic engineering has also been used to increase food production. This paper will not go into detail on that, as it is also a very controversial topic, but so many foods are genetically modified either to increase production, shelf-life, or other aspects. Also, technically many lab experiments that are done in genetics research, cell biology research, and other areas

use a form of genetic engineering when testing specific hypotheses, similar to how the information for insulin is expressed in bacterial cells, as mentioned above. Genetic engineering is sometimes done by just changing the DNA sequence and analyzing the outcome in the gene or protein product. In this sense, genetic engineering is neither good nor evil, but merely a pragmatic way to understand biological systems. The morality of each specific experiment will be determined based on the nature of it (Bohlin, 2000). It is hard to argue ethics on topics such as insulin production in bacteria, as this is a very beneficial part of technology that remediates the effects of a harmful disease. In reference to experiments, most would agree upon the value of gene manipulation, because it has taught us more than we knew before about how our bodies work. In this regard, genetic engineering seems to be helping humanity by providing products and foods that were not available naturally. It is important, though, to weigh these advantages against the disadvantages to get an accurate representation of how people are using this technology today.

Downfalls of Genetic Engineering

Genetic engineering has been used in beneficial ways, but in other ways it has failed. One prime example is an experiment done in China on two human embryos. A Chinese biophysicist tried to modify these embryos to make them HIV resistant, as their father was HIV positive. He was modifying the CCR5 gene which allows the HIV virus to infect the cells of our body. Instead of inducing the Δ32 mutation that would allow these cells to be HIV resistant, they tried to modify the gene close to the specific mutation rather than the actual CCR5 Δ32 mutation. They knew they were doing this, lied about it in the article and ended up generating other mutations that had unknown consequences. They also created a mosaic effect of edited and unedited cells but continued to implant these embryos without testing any of these potential

adverse consequences. This was also unnecessary due to the technology already available in "sperm washing", that these scientists claimed to have already done (Perrin & Burgio, 2022). Sperm washing takes the sperm that have tested negative for HIV and separates them from the others in order to use only those specific sperm for reproduction (Zafer, et al., 2017). It is experiments such as these that demonstrate the risks and detrimental effects of genetic engineering, especially when handled with improper care by the wrong people. Many other experiments done in this way with ill intentions could have even worse, detrimental outcomes. There clearly needs to be more testing before these methods should be implemented, and even then, the ethics need to be evaluated.

Another point to be mentioned is the potential for terrorists to use this technology for biological weaponry. They could create a weapon that is treatment resistant or targeted to infect specific people. It could even be engineered to work quickly over large populations, creating an extremely destructive situation. It is something that seems to only be possible in the movies, but in the hands of the wrong people, this technology could be very destructive. Some people believe this could have even been the case with COVID. It was thought to have escaped from a lab, but before this, could it have possibly been a bioweapon? This seems outlandish, but even if this is not the case, imagine if someone had created something so dangerous and deadly to where the entire world had to respond. This technology contains this potential and can be harmful if handled poorly. Bohlin writes that it is a terribly evil deed to manipulate genes into a pathogen with the agenda of releasing it as a weapon to hurt and kill people (Bohlin, 2000). This is something that the average person would never think of but is a very real potential when considering this technology.

Another issue is that athletes are now using this technology in a practice referred to as "gene doping," which is when the performance of an athlete is enhanced through altering their genetic make-up (Simmons, 2008). Because testing for steroid use has become a widespread practice and is easy to detect, athletes are coming up with ways around the system. This includes tactics such as using genes to increase protein production and increase their performance. This could have drastic effects that no one is even considering, as they could increase the production of certain proteins that have adverse consequences. It also could put others at a disadvantage because these athletes will have an unnatural increased performance that cannot be detected. If they can use this as a form of enhancement, there are no limits to the strength people could discover.

Some believe one of the biggest issues involved in genetic engineering is the topic of "designer babies". If children have no say in the matter, should parents be allowed to select specific traits for them before they are born? (Simmons, 2008). From just a scientific point of view it seems like an unnecessary use of technology which does not provide true health benefits. In a case like this, it seems like technology is being used to satisfy the wants and desires of an individual rather than medical use for actual health services. It also raises additional concerns as children will not think they are original or perhaps even wanted unless they have specific traits. Say a child was chosen to be musical, what happens to their relationship with their parents if they grow up and do not like music? (Simmons, 2008). Once this begins, it seems likely that only those with enough money or power would be able to choose these traits for their children, due to the likely expense of the procedure. This could then create a race of superiority leading to far greater issues than can even be discussed in this paper (Simmons, 2008). The issues with this technology are too important to be ignored. Whether physically or psychologically, this

technology should be researched further to determine if it is being used in an ethically responsible way. If the answer to this question is no, then the use of this technology may need to be restricted.

Gene Therapy

In light of the potential risks discussed, it may be desirable to run from the topic altogether, and to ban the use of gene manipulation. However, while there are examples of misuse, there are also benefits which has led to gene therapy being revolutionary in medicine. Gene therapy focuses on correcting mutations through inserting normal genes, adding a normal gene in place of an abnormal one, repairing the abnormal one, or altering gene regulation (Hunt, 2008). As this demonstrates, gene therapy is focused on taking current issues and finding actual cures and methods to resolve the problem. In this way, gene therapy can become another tool for the medical doctor in meeting basic healthcare needs.

A major step forward for gene therapy came in the discovery of CRISPR technology. The Jackson Library discusses CRISPR saying it is repetitive DNA sequences with "spacer" DNA that match the viral DNA and transcribes this during viral infection into the RNA (The Jackson Laboratory). It is easy to use CRISPR/Cas to disrupt genes and potentially insert new sequences into specific places (The Jackson Laboratory). This technology has allowed researchers to cut DNA at very specific places and either replace DNA with a corrected form, delete the specific gene, or just add a specific piece into the existing DNA. This is a very important breakthrough that now allows for research to be done on replacement of mutations with corrected forms of the gene.

Specific ways this is already being developed and implemented are in diseases such as cystic fibrosis, Duchenne muscular dystrophy, and other inherited diseases. In cases such as

cystic fibrosis, it is theoretically possible to insert DNA to correct the known mutation to cure the disease (The Jackson Laboratory). This is a very promising study currently, as the gene that must be targeted is already known, so the potential to replace it is very real. Research has already been done on other diseases as well. The FDA approved the first form of gene therapy for an inherited disease in December 2017. It was for a rare condition causing blindness that starts in childhood (Cerier, 2018). Another disease that is being treated is severe combined immunodeficiency, or "bubble boy" disease (Patra, 2015). Research has also been done in Duchenne muscular dystrophy, which is an x-linked muscular disease that is incurable. They tested the gene therapy effects of inserting a gene on a viral vector into dogs with muscular dystrophy and found it to restore their original function, demonstrating a safe and effective use of gene therapy in an animal model. This gives hopes for clinical trials for patients with muscular dystrophy in the future (Le Guiner, et al., 2017). There are so many examples of research being done in these areas, including many success stories of gene therapy in correcting mutations. Some of them have proved their efficacy and have been approved for human use, while others are still in the trial phase.

In addition to what has been mentioned, research is currently being done in cancer treatment, hoping to use this same technology of gene replacement through a viral vector to correct these life-threatening mutations. In 2017 the first genetically engineered treatment for leukemia was recommended. The FDA recommended the approval of this treatment that alters cells to essentially fight the cancer themselves, becoming a "living drug" (Cerier, 2018). Just think of the way medicine would be revolutionized if gene therapy became the standard method of treatment for cancer patients. As can be clearly seen from these examples, avoiding this topic would rob people of important potential cures for diseases which previously looked hopeless.

All this to say, the current breakthrough in technology that allows for gene manipulation should not be cause for complete alarm and distrust. It is not only being used for good but has proven to go far beyond what people once thought possible. However, it does have downsides, both from a scientific and Biblical ethical standpoint, which will be addressed next.

Ethical Dilemma

Enhancement, Prevention, & Therapy

In the ethical dilemma that genetic engineering presents, a key delineation comes from the difference between enhancement and therapy. Enhancement is aiming to supposedly fix something that technically is not a problem. It is just an act of improvement from the current state, rather than restoration from a faulty state. Should this act of supposed improvement be required by medical professionals? Some people argue enhancing humans to promote wellbeing is something we are morally obligated to do (Small, 2012), but is this truly a priority for medical professionals? What if the DNA of human embryos could be changed to resist the common cold and flu when they were born? (Lagay, 2001). This would not fall under the category of treatment, because there was never an initial problem that needed to be fixed. Rather, it would fall under the area of prevention rather than remediation (Lagay, 2001). Prevention can be seen as medical intervention because it helps to maintain health and alleviate the need for treatment later. While true, preventing specific genotypes from coming to be is not actually prevention (Lagay, 2001). What if a child was tested before birth and found to have a lower cognitive ability or aggressive behavior? (Lagay, 2001). In this case would it be prevention to use medicine to fix these traits that were found? It would not be therapy, as there was no initial medical illness or disease that needed to be fixed. This raises the question: Is prevention truly necessary? Although it is medical, it is not fixing a current issue that somebody has; furthermore, the “cure” of

prevention may be worse than the perceived problem. But others say if fixing diseases is found to be safe, then the enhancements coming alongside these should be acceptable as well (Hardin, 2019). But is it truly ethical to require a doctor to do something that is not what they technically signed up to do when they took the oath to become a doctor?

Another point that gets brought up in this argument is the fact that plastic surgeons also fall into this gray area (Lagay, 2001). This is a prime example of the same technology having the potential to be used for both therapy and enhancement. In this case, plastic surgery can be used to help burn victims heal from a devastating loss but can also be used to enhance a person to look younger than normal. This once again can fall into the category of those with more money and power being the ones that can afford to have enhancements that others will not have. It seems more probable in the future for those who cannot pay out of pocket to still be able to access this technology in terms of therapy, prevention, and remediation (Lagay, 2001). Those who want enhancements already have the luxury of getting them in other areas if they have the means to do so. In a traditional medical sense, the services required of doctors should be those that are in their realm of medical treatment for disease. In the end, there will always be debates over where this specific line should be drawn, but from solely a scientific and medical perspective, treatment and remediation are the only things that should be required of physicians. However, some believe it is the duty of society to provide treatment for medical needs which depart from normal function (Lagay, 2001). Prevention falls into a medical category but does not seem to be as necessary as therapy. It does not seem ethical to require enhancement from medical professionals, although they can do what they believe to be best for their specific patient. As opposed to plastic surgery, which focuses on appearance, genetic engineering technology has the potential to give people skills and abilities through other routes rather than natural inheritance or practice. Are we

cheating the system when we go through alternate routes of learning or discipline in sports and music? (Lagay, 2001). If enhancement is done to get rid of the normal course of life to choose characteristics and help performance beyond the normal, then this suggests that it should not be allowed. If this were a common technique that was offered, there would be no limit on power and control and certain people would excel in areas that others got to through hard work or natural inheritance.

Risks

Related to the discussion of ethics is the question of how much risk is involved with these procedures. Who gets to decide how much risk is taken in this genetic realm? It should be agreed upon that all therapy, whether in the traditional medical realm, or in gene therapy, should be allowed. Particularly as it is restoring biological function back to the original state as all doctors are required to do. Some argue that for desirable traits to be selected in genetic engineering the risks must be balanced against the benefits before treatment begins (Häyry & Lehto). Many times, advances have been made before the ethical basis of them can be discussed and decided upon (Hunt, 2008). Therefore, it is even more important now that the ethical debate be resolved in this area before the use of this technology is widespread. A genetically engineered species could have unpredictable effects on the environment (Patra, 2015). With this in mind, it seems like a risk to use this type of technology that could potentially bring unknown harm to the environment. Some believe this decision of risk should be left to those who will be affected by the decision (Häyry & Lehto). It would make sense that those who could experience the harmful outcomes from these decisions be the ones to decide if treatment occurs. This could be true, but then there will be people without expert knowledge choosing for the large community, when most likely they will be deciding out of fear rather than real knowledge. If those who are not

experts in the specific topic are allowed to choose these things, many good outcomes could be prevented simply because they do not understand the technology (Häyry & Lehto). In cases where there are large amounts of risk such as this, there must be checkpoints put into place. It seems safest to analyze the morality of new inventions first, and if there are any doubts about it, then the implementation of them should be prevented (Häyry & Lehto).

Not only do ethics matter to Christians, which will be discussed further in the next section, but even non-Christians who are not consciously living under the same convictions are still skeptical of certain things "crossing a line". Even from the beginning when genetic engineering was first discovered, there was a meeting called to discuss the ethics behind it (History of Genetic Engineering). This raises a fundamental question – namely, what is the source of ethical standards? It seems like people intrinsically know that something could be wrong without having logical reasoning behind their decision. Some are skeptical of this technology because they believe only God or nature can create life. When humans try to do this, they believe it is disrespectful from a moral perspective (Small, 2012). Another issue arises when one manipulates genes belonging to different species of life. If crossing animals and humans, there could be confusion over what type of species results (Small, 2012). Not only this, but when it comes to ethics it seems that many agree that the person operating the technology creates a greater risk than the technology itself. These are both topics that could be discussed at great lengths, but this paper focuses on the technology itself and the ethics behind how it is used.

Genetic Testing

Regarding genetic testing, it is important to understand that it is commonly used for preimplantation genetic diagnosis of offspring. This is typically done as an act of precaution to test children for genetic disorders. *In vitro* technology has been advanced to where people can

choose embryos that do not have genetic illness and only implant those into the uterus of the woman (Simmons, 2008). How can it be justified that people are allowed to see what type of disorder their unborn child may have and then decide if they want to bring that life into the world or not? Not only this, but genetic testing at any age can have harmful outcomes. What about the social, psychological, and financial outcomes (Committee on Bioethics, 2001)? Many of these conditions that are revealed through testing are untreatable or very difficult to treat, making this information less valuable for their actual medical care (Committee on Bioethics, 2001). How can it be beneficial to tell a young child they have the chance to get an untreatable illness? However, as with almost any technology this can be used for good. There are cases such as cystic fibrosis, which was discussed earlier, in which early testing means earlier treatment (Mayo Foundation, 2021). If this is the case, then genetic testing could be an important tool for gene therapy to detect diseases and treat with this therapy early on.

Ethical Dilemma from A Christian Perspective

Dominion

In discussing the Biblical worldview for this topic, it is important to first start with the very beginning of the Bible. It says in Genesis 1:28, “God blessed them and said to them, “Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish in the sea and the birds in the sky and over every living creature that moves on the ground” (New International Version, 2015). From the very beginning of time, the Lord gave dominion to man over everything in the earth. Humans are made in the image of God and meant to carry out His purposes on earth (Hardin, 2019). From this, it is our responsibility to obey the commands of God. It must be considered: what is the proper way to rule over creation? As it pertains to genetic engineering, we should view this technology as something that cannot be used in a way to where

it would control mankind. We are to rule over it, which can mean using it for good and healing purposes. If everything in creation is complex, what right do we have to alter it when more problems may arise due to a misunderstanding of the biological system being manipulated (Hardin, 2019)? Having dominion also brings a responsibility to steward well what we have been given. We were meant to care for creation as its stewards (Hardin, 2019). Due to this, research must be completed, thoroughly tested, and found safe enough before being used on human subjects. Animal trials have proven to be of great use in testing how outcomes will affect a living being. This is an important step before human trials, as putting humans directly in harm's way without testing first is not using our authority and dominion as God intended it. Dominion also carries responsibility, and that extends to this technology that has great power.

Fear

While mankind is called to exercise dominion, it is common to be hindered by fear. Genetic engineering is a term that many people hear and immediately run from due to that fear. Because the topic is controversial, many decide to avoid it altogether since they are unsure what to think. In John 14:27, Jesus says, “Peace I leave with you; my peace I give you. I do not give to you as the world gives. Do not let your hearts be troubled and do not be afraid” (New International Version, 2015). As He directly forbids His people to be afraid, it is clearly seen how the passage applies to this matter in that topics that induce fear should not be cause for running away. When Jesus left, He gave peace, but He also gave the Holy Spirit and the power that comes with that. We are new creations (2 Corinthians 5:17) and now we have “the mind of Christ” (1 Corinthians 2:16), which is not driven by fear (New International Version, 2015). Who better to decide important decisions about technology that is life altering than those who have the mind of Christ and are actual temples of the Holy Spirit (1 Corinthians 2:16, 1

Corinthians 6:19, New International Version, 2015)? We must not keep this power to ourselves, but rather use the gifts that God gives to make wise decisions, as the world is in desperate need of the influence of the Lord.

Original Design

To properly comprehend the ethics of genetic engineering it is crucial to examine it in the context of original design. Human beings have been made in the image of God as it says in Genesis 1:27, "So God created mankind in his own image, in the image of God he created them; male and female he created them." (New International Version, 2015). There can be no sin in the image of God because God is sinless and perfect. Because of the fall, sin entered the world, as seen in Genesis 3, but that was not how God first intended it to be. In the work of the gospel, Jesus' goal was to restore humanity back to original design and bring man back to union with God. In 2 Corinthians 5:17 it says, "Therefore, if anyone is in Christ, the new creation has come: The old has gone, the new is here!" (New International Version, 2015). As Christians grow in their faith, they begin to realize that He purifies them and makes them righteous, to where they are no longer the old man they once were. Not only this, but why would Christ go through the process of beating and bruising and torture to only let us believe we deserve partial freedom in our lives? In John 8:36 it says, "So if the Son sets you free, you will be free indeed" (New International Version, 2015). There are many different beliefs surrounding the Biblical basis for healing, and the theology of it could be covered through many essays; however, through our current knowledge, we must recognize that the Lord desires healing, and His priority is that of redemption. Throughout scripture it mentions how our bodies are united with Christ, how we are now one with Him (Galatians 3:26-28). Our bodies are important to Him, as He is full of compassion, and wants to bring us to fullness. We must realize this state of original design we

were formed in, so then we see a piece of the Biblical basis for healing and restoration in our bodies back to what mankind used to be. We will continue this by looking at Jesus and His ministry of healing, as He lived out this life of compassion and redemption that we are ultimately meant to follow.

Jesus's Healing Ministry

During His earthly ministry Jesus healed many people. In light of this alone, it is logical to assume that He desired to restore them to fullness and health. It says in Luke 4:40, "At sunset, the people brought to Jesus all who had various kinds of sickness, and laying his hands on each one, he healed them" (New International Version, 2015). He was a walking representation of love and redemption, first to their physical bodies, but ultimately in the hopes that they would turn to Him as He brought restoration of their souls through the cross. In James we see an extension of that to even now, as we are told to pray for one another for healing. James 5:16 says, "Therefore, confess your sins to one another and pray for one another, that you may be healed. The prayer of a righteous person has great power as it is working" (New International Version, 2015). If it is the desire of God that we pray for healing, we believe for healing, and that we were brought to redemption of body, soul and spirit, then it follows that gene therapy that brings restoration of body must be a Biblical concept. Jesus fulfilled many prophecies through his miracles, but also relieved suffering. Genetic engineering does have the potential to be used for evil, but also can relieve suffering and potentially bring cures for genetic diseases (Bohlin, 2000).

Is Gene Therapy Biblical?

As Christians, if we are obedient to what is said in James and believe in His healing power being at work in us today, then we must not only rely on medicine for our healing. God

heals in different ways, as He may heal directly and supernaturally, but He also often uses means such as medical intervention. However, it would be foolish to put our faith in the surgical instrument rather than the one who is using it. God gives His children wisdom, and that wisdom extends to how to responsibly use existing genetic technology. In Galatians 2:20 it says, "I have been crucified with Christ and I no longer live, but Christ lives in me. The life I now live in the body, I live by faith in the Son of God, who loved me and gave himself for me" (New International Version, 2015). This is even more justification that now we have been given the nature of Christ, and the help of the Holy Spirit (John 14:26). We are meant to walk in the compassion and love He had for people, and through this we must do what we can for them to be healed. We must pray but also use the gifts we have been given to bring wisdom in medical intervention. The debate over where to pray vs. use medicine is not for this paper, although scripture calls on us to pray without ceasing, as even medicine works only according to the sovereign will of God. The main point is that there is a Biblical backing for using what we have been given to help restore individuals back to health and wholeness. This extends to genetic engineering and gene therapy, as these are methods that can be used to bring healing through medicine and relieve suffering. God has worked through some of the most gifted doctors to bring people health. This is ultimately that they may find Him and his healing of their soul, and that He would be glorified through it all. When asked to heal a man once, Jesus responded with, "Your sins are forgiven" (Matthew 9:5) and the man got up and walked. He clearly showed physical healing as a model of His ultimate plan of redemption of Spirit. Our responsibility is to now mirror this redemption of Spirit He has given to us, and to tell others about Him, but also use what He has given us to help bring them to healing both physically and Spiritually.

It does not seem like those who are using this technology without regard to Him, are walking out what He desired. Separating the God of healing from healing itself was never how God intended it. He never wanted us to take matters into our own hands, because ultimately as humans we will end up using it for ourselves rather than for Him. He created it all and is in all, and to walk out in areas of healing and restoration without regards to the Healer would be a tragic waste of time.

In addition to this, what rationale do those that are not living under a Christian worldview truly have for healing? If coming at it from the angle of "survival of the fittest", then those that are not healthy should not live. The act of simply having compassion is a characteristic of the Christian worldview and our intrinsic knowledge that we were originally made in the image of God. In this sense, gene therapy for healing from disease must be a Biblical concept as the very essence of healing itself must be considered from the standpoint of Christian morals and worldviews.

Post-Fall Effects of Sin

It is the desire of God to bring each one of us to redemption and restoration. This is why the work of a doctor is not only important, but Biblical. Medical doctors seek to restore people that are hurt and broken back to a healthy state. The world is not as the Lord intended, as Romans 8:18-22 says that all creation is subject to groans and sufferings, waiting for the sons of God to be revealed to set them free from corruption (Bohlin, 2000). Scripture teaches that in the beginning man was created pure, and then sin entered the world and corrupted the original design. Gene therapy can be viewed as a way to fix genetic disorders and disease, which is the central purpose for any physician. It is not just by some random chance that we have disease, illness, and mutations in our world today, but it is a direct result of sin being brought into the

world through the Fall (Bohlin, 2000). Dominion over creation includes dealing with the effects of sin in the world (Jhawley, 2022). Due to this, when Jesus came to remediate the effects of the fall, primarily through salvation on the cross, this can also apply to the sin and death and effects of this on the earth, such as sickness disease and illness. We see this, as mentioned before, in Jesus' healing ministry. There are many clear examples of the love of Jesus being poured out to heal the sick. His nature is then what He ultimately gave to us as Believers. He gave this nature to His believers as a part of the new covenant, as an extension of the love of Christ which can be seen in healing of the body even today.

It is clearly seen that not everyone that is prayed over gets healed, but that does not mean that we are not meant to pray for it. The Bible clearly states in John 14:12, "Very truly I tell you, whoever believes in me will do the works I have been doing, and they will do even greater things than these, because I am going to the Father" (New International Version, 2015). We must believe as Christians we have been given this nature and now have power to pray and believe for healing, but also to use the knowledge we have been given to bring treatment and hopefully healing through gene therapy. It seems that healing is a Biblical concept, as it is the essence of compassion, and helps to combat certain aspects of the Fall that were never meant to be there in the beginning. Because healing is Biblical, gene therapy can also be considered Biblical, as it is just an extension of this medicine that aims to heal.

Precautions

Having established a Biblical rationale for implementing gene therapy, the technology of genetic engineering as a whole must be executed with great caution. It is clear when examining the issue regarding unborn children. The scientific basis for this has already been discussed, as it can cause children psychological harm and can create a dominant race. In the Biblical realm

there are also severe risks. Are children becoming more a commodity than a gift if their genomes are being altered based on the desire of their parents (Hardin, 2019)? Psalm 127:3 says, "Children are a heritage from the Lord, offspring a reward from him" (New International Version, 2015). If parents are choosing how they wish their child to turn out, or what intrinsic traits they desire them to have, they are not treating them as a gift, but rather a possession to do with what they choose. I do not believe this is the way God intended for it to be. Some may argue that children are already being altered when their parents choose for them to have ear piercings or braces at a young age. There is a far different standard for this as parents can take discretionary action on outward appearances, that are ultimately reversible, once their child is born rather than manipulating genes that are intrinsic to who a child is. In Jeremiah 1:5 it says, "Before I formed you in the womb I knew you, before you were born I set you apart; I appointed you as a prophet to the nations" (Jeremiah 1:5). What would have happened if Jeremiah's parents would have had the technology to modify him to something else? We likely would have never had the prophet Jeremiah and the words he wrote in the Bible. It comes down to changing the intent of who the person is rather than the outward traits about them. Who are we to decide certain traits are "bad" when they are not by medical terms outside of "normal"?

In the end, it is clear Christians are first called to love, which is why this technology should be used to prevent disease, but they should be cautious as well, as it has the potential to violate Christian morals (Hardin, 2019). One must always remember to have compassion and humility when exercising our role as stewards over this earth. This technology should be used to help restore the body and combat aspects of the Fall, including remediating the effects of genetic disease. It does not seem ethical from a Biblical standpoint to use enhancements that some think are "better" than how God first created it. This very idea shows the hubris of man that they are

wise enough to alter what God originally called good. Indeed, since God first looked at creation and called it good, then who are we to take humanity into a state that is altered from original design (Genesis 1:31, New International Version, 2015). It only seems ethical to use the wisdom the Lord has given us to help bring individuals back to original design as God created them, rather than enhancement beyond the natural to a place we were never meant to get to.

Future

Everything discussed thus far begs the question - What are we doing with this technology? What are the next steps that must be taken to implement these ethical changes and use the technology for good? If this were a perfect world full of perfect people, these goals for the future could be more realistic rather than theoretical. This paper aims to present the facts and the most beneficial outcome, although it may not be probable right now. Ideally, it should be used for therapy and doing research to cure diseases. Gene therapy and genetic engineering are very promising in their potential to cure cystic fibrosis, hemophilia, muscular dystrophy, and many other deadly hereditary diseases (Small, 2012). In a case such as cystic fibrosis, where there is currently no cure, treatment to improve quality of life is invaluable (Mayo Foundation, 2021). In the case of genetic testing, this is one instance where testing sooner would prove beneficial to the future of the child. The only thing they can currently do is to ease pain and try to increase quality and length of life through drugs and therapy. With the new methods of gene therapy, they are currently working on targeting the CFTR gene in an effort to cure the disease. Gene therapy treatments are getting closer to clinical trials as the field gains momentum due to innovation in delivery of genetic sequences. This could change the lives of thousands of people who have dealt with this disease for years. They have already approved gene therapy for a form of inherited blindness as well (Khamsi, 2020).

It is clear to see that this field has already proved beneficial. It is important that these studies are continued so these people have hope that we are using our knowledge for good. If there is potential for further breakthroughs, to research and find cures for such things that seemed hopeless, it would be irresponsible not to do so. Research must continue as the medical community seeks to better understand how to treat these diseases. In a perfect world, this research could be conducted without worry that it would be abused in other areas. Unfortunately, this is not the case, as gene therapy cannot fully be separated from genetic engineering, and if the technology is available, people will continue to seek to use it for their own benefit and enhancement. To think that scientific technology will only be used for good would be very ignorant. In the end, advances in technology are going to be made and will always contain the potential to be abused. We can pray and hope for those in power to have greater influence for good, but in the end the world is not perfect. Therefore, we are here to provide a godly influence and hope that this power is put in the hands of the right people.

Conclusion

In examining the ethics of genetic engineering and gene therapy, this paper first looked at the current state of technology, then the actual ethical basis for this technology, and ultimately what the role and responsibility is for Christians.

To summarize, this technology is currently being used in multiple ways. It is used for the production of human insulin, genetic engineering research, and gene therapy, which all could be considered beneficial. It is also being used for research in cloning and “designer babies”, weapons of warfare, and has the potential to create power struggles and new mutations. From a scientific standpoint, there are many factors to be considered when approaching this issue ethically. First, what could happen to our race if these changes were put into place? Would a new

race be formed, or power be given to those with more money and influence? It was discussed how enhancing individuals should not be the requirement of a medical doctor. People that do not even have a Biblical backing for their reasoning also believe there are risks and ethics involved in this decision. Should parents really be allowed to choose traits for their children, or choose not to implant their embryos if they find a tendency towards a certain trait or disease?

From a Christian standpoint, there are also many points to consider regarding genetically altering children. First, children are a gift, and their intrinsic, irreversible traits and giftings should not be chosen for them. From the beginning of time, God gave dominion to man over all things, which came with a responsibility to steward what we were given. In this stewardship it is important to use for good, yet never to change beyond what God originally designed and called "good" in the garden. In Christ's work of redemption on the cross, His goal was to bring all creation to wholeness, and to bring them back to Himself. His entire ministry was and is bringing us back into original design. It seems like this applies not only to our souls but gives backing to why healing is Biblical for our bodies as well. As the ministry of Christ was full of healing, His goal was never to set His people partially free or to leave their bodies in turmoil and despair. In the medical community if we have this potential in gene therapy to bring individuals back to original design and combat aspects of the Fall, then it would be a disservice not to pursue it. Christians are meant to walk in compassion and love, and healing is a direct representation of compassion to the world. We must use what we have been given and walk in humility and compassion with the technology set before us. In saying this, it is also vital to see the precautions from a Biblical standpoint in that we were never meant to have more power than God, to create what was never meant to be created, to choose what was never meant to be chosen. After bringing up all these points, where do we go from here?

In a perfect world, it would be right to say this technology should be used for therapy rather than enhancement, that from a Biblical and scientific standpoint this is the only correct way and the only thing that can be required of medical professionals. If it were possible to have this technology and use it for therapy rather than enhancement, then the risks involved of power, designer babies, weapons of warfare, and other harmful consequences would not need to be discussed. The power in the hands of the wrong people is clearly a topic for another paper, but for now we will conclude that optimal use of this technology is not realistic, but that it contains within itself the potential for good and evil. It is a tedious task to draw this line, especially in a world where everyone has different ideas of morals and ethics from their worldview. If coming at this from purely a Christian worldview, the correct conclusion would be that enhancement of intrinsic traits that affect who you are is not Biblical, but therapy is. We are meant to walk in the power of the Holy Spirit, to influence the world for good and bring the Lord glory. It seems as though He is glorified when we are redeemed, body, soul, and spirit. If we have the technology to help people in this world through the knowledge He has given us, it only seems right to help.

References

Bohlin, D. R. (2000, May 27). Genetic engineering – A Christian scientist's perspective. *Probe*. Retrieved March 29, 2022, from https://probe.org/genetic-engineering-2/

Britannica, T. Editors of Encyclopaedia (2021, December 20). genetic engineering. Encyclopedia Britannica. https://www.britannica.com/science/genetic-engineering

Cerier, S. (2018, March 15). Genetic engineering leads to Medicine Revolution. *Agri-View*. Retrieved March 29, 2022, from https://www.agupdate.com/agriview/news/business/genetic-engineering-leads-to-medicine-revolution/article_96365ea3-9488-5e20-802c-3c01ed37bbdc.html

Committee on Bioethics. (2001). Ethical issues with genetic testing in Pediatrics. *Pediatrics*, 107(6), 1451–1455. https://doi.org/10.1542/peds.107.6.1451

Curators of the University of Missouri. (n.d.). Gene Therapy and Genetic Engineering. MU School of Medicine. Retrieved March 29, 2022, from https://medicine.missouri.edu/centers-institutes-labs/health-ethics/faq/gene-therapy

Hardin, J. (2019, February 13). Genome editing and the Christian. *BioLogos.* Retrieved March 29, 2022, from https://biologos.org/articles/genome-editing-and-the-christian

Häyry, M., & Lehto, T. (n.d.). Genetic Engineering and the Risk of Harm. BU. Retrieved March 28, 2022, from https://www.bu.edu/wcp/Papers/Bioe/BioeHay2.htm

History of Genetic Engineering and the Rise of Genome Editing Tools. Synthego. (n.d.). Retrieved March 28, 2022, from https://www.synthego.com/learn/genome-engineering-history

Holy Bible, New International Version. (2015). BibleGateway. https://www.biblegateway.com (Original work published 1996)

Hunt, S. (2008) Controversies in treatment approaches: Gene therapy, IVF, stem cells, and pharmacogenomics. *Nature Education* 1(1):222. Retrieved January 10, 2023, https://www.nature.com/scitable/topicpage/controversies-in-treatment-approaches-gene-therapy-ivf-792/

Jhawley. (2022, June 23). Does the Bible provide guidance on genetic engineering? Apologetics. Retrieved January 13, 2023, from https://www.namb.net/apologetics/resource/does-the-bible-provide-guidance-on-genetic-engineering/

Jones J. (1999, May 8). Cloning may cause health defects. *BMJ*.;318(7193):1230. PMCID: PMC1115633.

Khamsi, R. (2020, July 29). Gene therapy could offer an inclusive cure for cystic fibrosis. *Nature News*. Retrieved February 3, 2023, from https://www.nature.com/articles/d41586-020-02111-z

Lagay, F. (2001). Gene therapy or genetic enhancement: Does it make a difference? *Virtual Mentor*, 3(2), 37–39. https://doi.org/10.1001/virtualmentor.2001.3.2.gnth1-0102

Le Guiner, C., Servais, L., Montus, M., et al. (2017). Long-term microdystrophin gene therapy is effective in a canine model of Duchenne muscular dystrophy. *Nature Communications,* 8(16105). https://doi.org/10.1038/ncomms16105

Mayo Foundation for Medical Education and Research. (2021, November 23). Cystic fibrosis. Mayo Clinic. Retrieved February 3, 2023, from https://www.mayoclinic.org/diseases-conditions/cystic-fibrosis/diagnosis-treatment/drc-20353706

Patra, S. (2015). Human, social, and environmental impacts of human genetic engineering. *Journal of Biomedical Sciences*, 04(02). https://doi.org/10.4172/2254-609x.100014

Perrin, D., & Burgio , G. (2022, November 17). China's failed gene-edited baby experiment proves we're not ready for human embryo modification. *The Conversation*. Retrieved January 25, 2023, from https://theconversation.com/chinas-failed-gene-edited-baby-experiment-proves-were-not-ready-for-human-embryo-modification-128454

Simmons, D. (2008) Genetic inequality: Human genetic engineering. *Nature Education* 1(1), 173 Retrieved January 5, 2023, from https://www.nature.com/scitable/topicpage/genetic-inequality-human-genetic-engineering-768/

Small, B. (2012). Genetic engineering and moral responsibility. Genetic Engineering - Basics, New Applications and Responsibilities. https://doi.org/10.5772/31866

The Jackson Laboratory. (n.d.). What is CRISPR? The Jackson Laboratory. Retrieved March 29, 2022, from https://www.jax.org/personalized-medicine/precision-medicine-and-you/what-is-crispr Zafer, M., Horvath, H., Mmeje, O., van der Poel, S., Semprini, A. E., Rutherford, G., & Brown, J. (2016). Effectiveness of semen washing to prevent human immunodeficiency virus (HIV) transmission and assist pregnancy in HIV-discordant couples: A systematic review and meta-analysis. *Fertility and Sterility*, 105(3). https://doi.org/10.1016/j.fertnstert.2015.11.028