CRISPR-Cas9 and Genetic Modifications:
The Science, the Ethical Questions and Theological Reflection

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Abstract

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Genetic engineering has been a subject of interest to ethicists and theologians specifically with genetic modifications using CRISPR-Cas9. The way CRISPR functions is that it can cut a specific DNA sequence and then it can silence or insert and delete genes. This scientific method can help treat or prevent diseases by removing the DNA sequences that causes them. Furthermore, CRISPR could also be used to enhance genetic traits through this kind of gene editing. The ethics surrounding CRISPR has been a growing concern, specifically whether someone has the right to intervene in a person's DNA without their consent, such as *in utero.* In addition, there have also been concerns on how genetic modifications affect our autonomy, moral agency, actions and society as a whole. Theological reflection on genetic modifications asks deeper questions. We begin to see how genetic modification can affect the foundations of Christianity in healthcare. Moreover, theology explores the question of whether or not it is moral for a human to play God and what a future might be like with genetically modified individuals. This leads us to reflect on what it means to be human once our bodies are changed in this way. Genetic modifications provoke differing views among many people and this thesis will explore the different perspectives in order to come to a deeper understanding of what is at stake.

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Table of Contents

Introduction

The goal of this thesis is an exploration of the ethical and theological implications of genetic modifications and CRISPR-Cas9. The following is a brief overview of what each of the three chapters tackles. It will first start by introducing the science behind genetic modifications and CRISPR-Cas9 to understand what this technology is and how it functions. This will lead, in the second chapter, to the discussion of the ethical implications surrounding genetic modifications that raise questions about autonomy, moral agency, and parental intervention. The last chapter of the thesis will cover theological arguments regarding genetic modifications. Such arguments include the topics of Christian foundations, playing God, eschatology, and the question of human nature. These various topics will bring to light the very essence of what is involved in discussions around genetic modifications.

CRISPR-Cas9 is slowly making a name for itself in the world with new progress every day for treatment options. CRISPR stands for "clustered regularly-interspaced short palindromic repeats" which consists of short repetitions of DNA sequences followed by short non-coding DNA that arose from the discovery of a bacterial virus or plasmid.[1] In addition, the cas (CRISPR-associated) genes code for the cutting enzymes that cut or unwind DNA in an organism.[2] How this system works is that CRISPR stores and protects DNA sequences from invading viruses or plasmid, so when the same type invades again the system will recognize it using a copied RNA sequence that directs a cas cutting enzyme to cut the DNA.[3] What CRISPR does is that it targets a specific DNA sequence and modifies that DNA. Scientists have been doing extensive work since 2013 to ensure that it is used safely on human beings.[4] CRISPR-Cas9 can be engineered for different functions such as introducing DNA into the germline of any organism, modifying somatic genes by genome editing and modifying different DNA factors to target and activate or silence specific genes.[5] However, this gene editing tool can also cause unintended mutations. Unintended mutations in the genome can delay the use of CRISPR-Cas9, specifically with gene therapy.[6] In addition, CRISPR-Cas9 could cut unintended DNA sequences that could cause cells to die or

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[1] E. Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," *Journal of Clinical Research and Bioethics* 07, no. 02 (March 24, 2016): 1, https://doi.org/10.4172/2155-9627.1000266.

[2] Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," 1, paraphrased from Ruud. Jansen et al., "Identification of Genes That Are Associated with DNA Repeats in Prokaryotes," *Molecular Microbiology* 43, no. 6 (April 25, 2002): 1565-75, https://doi.org/10.1046/j.1365-2958.2002.02839.x.

[3] Rodriguez, 1.

[4] Rodriguez, 1, paraphrased from Alfred Chin, "CRISPR-Cas9 Therapeutics: A Technology Overview," Science Innovation Union, The Science Innovation Union, September 9, 2015, http://science-union.org/articlelist/2015/9/9/crispr-cas9-therapeutics-a-technology-overview.

[5] Rodriguez, 1; paraphrased from Matthew H. Larson, et al., "CRISPR Interference (CRISPRi) for Sequence-Specific Control of Gene Expression" *Nature Protocols* 8, no. 11 (October 17, 2013): 2180-96, https://doi.org/10.1038/nprot.2013.132.

[6] Puping Liang,et al. "CRISPR/Cas9-Mediated Gene Editing in Human Tripronuclear Zygotes," *Protein & Cell* 6, no. 5 (April 18, 2015): 364, https://doi.org/10.1007/s13238-015-0153-5, paraphrased from Patrick D. Hsu, Eric S. Lander, and Feng Zheng, "Development and Applications of CRISPR-Cas9 for Genome Engineering," *Cell* 157, no.6 (June 5, 2014): 1262-78, https://doi.org/10.1016/j.cell.2014.05.010 ; Prashant Mali, Kevin M. Esvelt, and George M. Church, "Cas9 as A Versatile Tool for Engineering Biology," *Nature Methods* 10, no. 10 (September 27, 2013): 957-63, https://doi.org/10.1038/nmeth.2649 ; Jeffry D. Sander and J. Keith Joung, "CRISPR-Cas Systems for Editing, Regulating, and Targeting Genomes," *Nature Biotechnology* 32, no. 4 (March 2, 2014): 347-55, https://doi.org/10.1038/nbt.2842.

transform into something that might cause problems to the person in question.[7] Scientists have been trying to reduce these kinds of off-target mutations, but more improvement through testing is needed. This is especially so for therapeutic interventions, which are very precise.[8]

It is important that people are made aware of the ethical implications that are associated with genetic modifications and CRISPR-Cas9. This area of genetic engineering is relatively new, and education about it is important. The general public may only know of it because of the mass media and so may only know of its name and have a surface understanding of what it is and can do. A deeper understanding is required and the general public should be informed about different ethical concepts relevant to genetic modification. These include autonomy, moral agency, parental intervention in a child's genetic makeup, and the effects of social classes. Some questions that arise are whether it is right for a parent to intervene in their child's genetic makeup or is someone still able to be autonomous after being genetically modified. There are also questions linked to the responsibility of actions after being modified. These discussions have been taken up by different thinkers such as Jürgen Habermas, John Harris, and Michael Sandel. Debate on the ethics surrounding gene editing can play a role in educating the public on its positive and negative aspects. This can be valuable for people especially if they want to partake in a discussion with this newfound knowledge and voice their opinion on the topic. This becomes especially needed for legislative and regulating purposes. Moreover, adding theology to the discussion becomes pertinent as well.

Theology becomes important for people who want to have a deeper understanding of themselves. When using the theological method of foundations, the individual can understand how genetic modifications can coincide with the foundations of Christianity in healthcare. One doctor in particular, Dr. Daniel Sulmasy, demonstrates the symbolism and the values that Christianity offers in the context of healthcare. This can especially be seen with relationships that are formed between doctors and patients. Theology also allows individuals to ask existential questions in relation to genetic modifications and CRISPR-Cas9. It can help go beyond the surface to understand why human beings might undertake this role of trying to "play God" along with its positive and negative aspects. Furthermore, this ability to reflect deeply on their own experience in asking these existential questions allows them to understand the essence of what it means to be human in our current society. This can also lead to comparisons from the past and what the possibilities may be in the future. With that being said, we see why ethics and theology in relation to genetic modifications becomes very important. Theological and ethical questions are important because they allow people to go beyond their horizons by learning something that is completely new and challenging.

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[7] Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," 2, paraphrased from Yanfang Fu et al., "High Frequency Off-Target Mutagenesis Induced by CRISPR-Cas Nucleases in Human Cells" *Nature Biotechnology* 31, no. 9 (June 23rd, 2013): 822-26, https://doi.org/10.1038/nbt.2623 ; Xiao-Hui Zhang et al., "Off-Target Effects in CRISPR/Cas9-Mediated Genome Engineering," *Molecular Therapy Nucleic Acids* 4, no. 11(January 1, 2015): e264, https://doi.org/10.1038/mtna.2015.37.

[8] Rodriguez, 2, paraphrased from L. Cong et al., "Multiplex Genome Engineering Using CRISPR/Cas Systems," *Science* 339, no. 6121 (January 3, 2013): 819-23, https://doi.org/10.1126/science.1231143 ; Yuanwu Ma, Lianfeng Zhang, and Xingxu Huang, "Genome Modification by CRISPR/Cas9," *FEBS Journal* 281, no. 23 (November 7, 2014): 5186-93, https://doi.org/10.1111/febs.13110 ; Patrick D Hsu et al., "DNA Targeting Specificity of RNA-Guided Cas9 Nucleases," *Nature Biotechnology* 31, no. 9 (September 21, 2013): 827-32, https://doi.org/10.1038/nbt.2647.

CRISPR-Cas9 and genetic modifications are a very recent topic in the world of genetic engineering. Due to this, there were some challenges in relation to the research that was done for this thesis. In terms of ethical research, there was quite a lot of literature on this topic since genetic engineering in general has been frequently discussed in the world of bioethics. Genetic modification has received much attention among ethicists in the last ten years. Ethical analyses allow us to weigh the benefit and risks of certain topics to see if it can benefit humanity.

In terms of theological research, this is where challenges can occur due to the lack of abundant resources. There are recent theological resources, for example, papal and church documents discussing gene editing and there are some but not many theologians who have recently written on this topic. Most literature found was between twelve to twenty years old. While this may seem recent, the technology advances every day. The values and message that this literature advocates is definitely still relevant today, but more theological analyses are needed since it has become a 'hot topic' in science in most recent years. The input of papal and church documents is valuable, but it would also be interesting to see other theological perspectives. Theological reflection on genetic modification is significant since it lets all of society relate to it and not just those who understand the science. When people read theological literature, it enlightens their capacity to go within themselves to find a deeper meaning of what genetic modification really means to them. Yet, with this scientific technology becoming more popular, there is no doubt that more theological literature will appear in the years to come.

As stated previously, not every individual is familiar with the CRISPR-Cas9 technology. The thesis aims to shed light on CRISPR-Cas9 and genetic modifications. It will engage in arguments that are both for and against genetic modifications in order to understand both sides. The aim of this is to explore the different ethical and theological perspectives of genetic modifications to enhance knowledge on this topic.

The ethical and theological aspects surrounding CRISPR-Cas9 and genetic modifications are intriguing and important to discuss. This new technology has the potential to eradicate a disease in a family line forever and it can also alter a person by enhancing a genetic trait. Ethical and theological questions/concerns emerge because of the power of the technology. This thesis will identify these questions and explain the concerns. Discussions around CRISPR and gene editing need to involve more than science. We need to consider the human being involved in this process, how it will affect them and what their beliefs are on it. It affects their identity as a person trying to grasp what this all means to them. The goal of the thesis is to begin to understand what CRISPR really means and how it will affect humanity.

Chapter 1: The Science of Genetic Modifications and CRISPR-Cas9

Introduction

Gene editing technology has been one of the most spoken about and controversial technologies in genetic engineering. Genetic engineering has been a growing field over the last two decades especially prenatally. These new and emerging technologies, such as CRISPR-Cas9 are presenting many challenges. CRISPR-Cas9 targets specific sections of genetic code and edits DNA at exact locations.[9] Scientists see CRISPR as a way to help prevent illnesses, so parents may have healthy babies and not have them suffer from an illness all their life. In order to understand what CRISPR-Cas9 does, before exploring the topics of ethics (Chapter two) and theology (Chapter three) concerning genome editing, one must understand its scientific background

The way CRISPR-Cas9 functions is that it can cut DNA and it can silence genes or even insert and delete genes. CRISPR-Cas9 is revolutionary because it could help treat diseases by removing the genetic sequence that could cause the disease. However, CRISPR-Cas9 could also affect off-target sites, which are genetic sequences that are not targeted by CRISPR-Cas9. This could lead to side effects or even mutations that may cause serious illnesses. More research is needed to improve the efficacy of CRISPR but as of recently there are some biological tools that scientists have produced in order to detect these off-target sites. Some of these methods are not as reliable because they are still in the development stage. There is also another technique to help eliminate diseases and those are mitochondrial replacement techniques which are somewhat safer than CRISPR-Cas9 since these changes in mitochondrial replacement techniques are passed down uniparentally and not from both parents. CRISPR-Cas9 should be understood scientifically first before one can tackle the concerns it raises.

The chapter is divided into five sections. First, CRISPR-Cas9 will be defined following by an explanation of its different functions. This leads to a third section that explores the problem of unwanted mutations in the genome and different methods of dealing with these problems. Following this will be a consideration of the overlap and differences between genetic enhancement and genetic therapy. The final section investigates an alternative to gene editing, that is, mitochondrial replacement techniques.

1) What is CRISPR-Cas9?

Genome editing is a technique used to effectively modify DNA within a cell at precise locations on the DNA strand.[10] Enzymes called 'nucleases' cut specific DNA sequences.[11] Enzymes are produced by the body to help speed up a biochemical reaction. Genome editing can add, remove or modify DNA in a gene and edit the DNA characteristics of a cell or an organism.[12] CRISPR stands for "clustered regularly-interspaced short palindromic repeats" which are short

[9] "Questions and Answers about CRISPR," Broad Institute, Broad Institute, accessed September 18th, 2019, https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/questions-and-answers-about-crispr.

[10] "What Is Genome Editing?," yourgenome, The Public Engagement team at the Wellcome Genome Campus, last modified August 23, 2017, https://www.yourgenome.org/facts/what-is-genome-editing.

[11] "What is Genome Editing?"

[12] "What is Genome Editing?"

repetitions of DNA sequences followed by short non-coding DNA that came from a bacterial virus or plasmid.[13]

In addition, there are proteins that are associated with CRISPR, which are the "cas" (CRISPR-associated) genes that code for nuclease enzymes that are linked to CRISPR since they function to cut the DNA.[14] There are three types of CRISPR mechanisms but type II is the most studied.[15] The type II mechanism is described as follows: invading DNA from viruses or small plasmids are cut into small pieces and are fused at a fixed position on the CRISPR chromosome.[16] The fused pieces at the fixed position on the CRISPR DNA are copied, and the copies are processed to make small RNA which are called cr-RNA (CRISPR-RNA).[17] The cr-RNA are then used to guide the nuclease enzymes, which target invading DNA based on DNA sequence complementarity/similarity.[18] Complementarity is when the RNA and DNA strands are aligned to show that they have similar base pairs in common. Moreover, only one Cas protein, Cas9, has been shown to be a key element in some CRISPR mechanisms such as type II.[19] Furthermore, type II is unique because it only requires Cas9 for gene silencing and for genome editing.[20]

This CRISPR process is not the mechanism used on humans, rather, a simpler process which is the RNA-programmable method is used to help with genome editing. It can be used for insertion or deletion of genes.[21] The type II mechanism states that Cas9 must be paired with crRNA and trans-activating crRNA(tracrRNA).[22] This will help disrupt a gene in the genome editing process so that a single-guide RNA (sgRNA) which is the combination of the crRNA and the tracrRNA directs Cas9 to a specific location on the genome.[23] Then, the sgRNA (crRNA + tracrRNA) interacts with the Cas9 protein so that it can cut the target DNA.[24] Next, this protein complex (sgRNA + Cas9) will cut the target-specific double-stranded DNA and the cutting site will be repaired by joining the two ends of the DNA strands. This can be an erroneous process because foreign DNA could be inserted or deleted which then disrupts the function of the gene.[25] In sum, there are different mechanisms on how CRISPR works but the main idea is that it uses an RNA that is paired to Cas9 to cut the target DNA and replace it at a specific location.

2) Functions of CRISPR

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[13] Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," 1.

[14] Rodriguez, 1, paraphrased from Jansen et al., "Identification of Genes That Are Associated with DNA Repeats in Prokaryotes," 1565-75.

[15] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology," New England Biolabs: Reagents for the Life Sciences Industry, New England Biolabs, accessed January 26, 2019, https://international.neb.com/tools-and-resources/feature-articles/crispr-cas9-and-targeted-genome-editing-a-new-era-in-molecular-biology.

[16] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology."

[17] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology."

[18] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology."

[19] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology."

[20] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology."

[21] "Introduction to the CRISPR/Cas9 System," Takara Bio-Home, Takara Bio USA, Inc., accessed January 29, 2019, https://www.takarabio.com/learning-centers/gene-function/gene-editing/gene-editing-tools-and-information/introduction-to-the-crispr/cas9-system.

[22] "CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology."

[23] "Introduction to the CRISPR/Cas9 system."

[24] "Introduction to the CRISPR/Cas9 system."

[25] "Introduction to the CRISPR/Cas9 system."

CRISPR-Cas9 can be engineered to do whatever genetic functions a person desires. It can introduce DNA in the germline, which are the heritable genes of any organism, and modify somatic genes, which are the non-heritable genes, by genome editing.[26] Therefore, CRISPR-Cas9 can genetically edit the non-heritable genes of living organisms such as humans and animals. In addition, CRISPR-Cas9 has been modified to adjust specific transcription factors, which are copies of DNA that can activate or silence specific genes.[27] With this, CRISPR-Cas9 can be used to target and activate the genes a person wants and silence the ones that are deemed unnecessary. Furthermore, CRISPR-Cas9 can be used to make animal models for research to imitate diseases or to study the disease's development by mutating or silencing genes associated to that disease.[28] There has already been testing on animals to see how CRISPR-Cas9 works when it comes to genetic diseases, but human trials will need to be regulated thoroughly because of the side effects CRISPR may cause due to off-target effects. For example, a mouse was used to test the harmful effects of mutations found in cancer by inputting the loss-of-function mutations in tumor suppressor genes or gaining-of-function in proto-oncogenes.[29] In this example, it seems that these scientists were exploring the functions that CRISPR-Cas9 can do. It could silence a gene that is used to help suppress tumors in order to observe the effects that could happen to the mouse. This could lead to promoting the function in proto-oncogenes, which can then lead to cancer.

Moreover, "genome editing has the potential to cure diseases by disrupting endogenous disease-causing genes, correcting disease causing mutations or inserting new genes with protective functions."[30] It can also correct gene mutations that caused the disease and insert new genes that can protect the body from harm. If this is inserted in the germline then future generations will not carry this disease. In addition, disrupting endogenous disease causing genes can benefit the biomedicine industry because it can help develop tissue-based treatments for cancer and other diseases.[31] For instance, CRISPR-Cas9 can target the HIV provirus.[32] A provirus can be integrated in the genetic material of a host cell where it then replicates the host and spreads from one cell generation to the next.[33] This will then help with the removal of the integrated HIV viral genome or prevent the entry of the virus cells.[34] Thus, CRISPR-Cas9 can prevent this disease from ever trying to form in the body so the human being wouldn't have to take any precautionary measures in their life. Furthermore, "modifying the immune system to attack HIV has been gaining attraction

[26] Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," 1.

[27] Rodriguez, 1, paraphrased from Larson et al., "CRISPR Interference (CRISPRi) for Sequence-Specific Control of Gene Expression," 2180-96.

[28] Rodriguez, 1.

[29] Rodriguez, 1-2, paraphrased from Alfred Chin, "CRISPR-Cas9 Therapeutics: A Technology Overview."

[30] Rodriguez, 2.

[31] Rodriguez, 2, paraphrased from Devashish Rath et al., "The CRISPR-Cas Immune System: Biology, Mechanisms and Applications," *Biochimie* 117 (October 2015): 119-28, https://doi.org/10.1016/j.biochi.2015.03.025.

[32] Rodriguez, 2, paraphrased from Sheena Saayman et al., "The Therapeutic Application of CRISPR/Cas9 Technologies for HIV," *Expert Opinion on Biological Therapy* 15, no. 6 (April 12, 2015): 819-30, https://doi.org/10.1517/14712598.2015.1036736.

[33] "Provirus," Merriam-Webster, Merriam-Webster, Incorporated, accessed May 11, 2020, https://www.merriam-webster.com/dictionary/provirus.

[34] Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," 2, paraphrased from Saayman et al., "The Therapeutic Application of CRISPR/Cas9 Technologies for HIV," 819-30.

as a promising therapeutic use of genome editing."[35] This means that this method could also have the potential to be used to treat other diseases once more positive outcomes are achieved.

According to scientific research, the outcomes of cell-based/gene therapies could be very advantageous since these therapies can remove, manipulate, expand and reintroduce these cells into the patient in order to enhance the therapeutic effect they want.[36] However, with "other diseases such as solid tumor cancers or those that effect tissues and organs, CRISPR-Cas9 is unlikely to be effective given the present state of the technology."[37] For instance, there is research being conducted where CRISPR-Cas9 is being used to edit the CFTR gene in cystic fibrosis and dystrophin in Duchenne muscular dystrophy.[38] However, there are still some hindrances because even though there were some technological advancements, the research is still just beginning and this gene editing technology runs into some challenges in relation to the delivery methods of the transfer of genes that were first seen in the 1990s.[39]

Even though CRISPR-Cas9 and other cell-based therapies have been shown to be effective, it does not work on every disease. More research must be done to determine if it will be effective on other diseases as well. Diseases that affect tissues and organs or cancers are still not suitable for CRISPR-Cas9 because as mentioned previously there could be off-target mutations carrying the possibility of health side effects for the human and offspring. In addition, since cancer remains very difficult to cure, there still needs to be extensive research done with CRISPR in order for it to work. Cancer divides abnormal cells uncontrollably, which is still difficult to cure, and the off-target effects could negatively impact the cancer patient by causing more pain and discomfort then they already have.

In addition, with CRISPR-Cas9 the modification of DNA can occur in human embryos. In 2015, a scientist from China published a paper in the journal, *Protein and Cell*, and stated that modifying DNA with abnormal human embryos rejects the use of in vitro fertilization.[40] He also found there to be "limited success in correcting a mutation that causes the disease of beta-thalassemia using CRISPR-Cas9 [since] [t]he experiments resulted in changing only some of the genes and, had off-target effects on other genes."[41] These off-target effects could severely impact the human being in question. CRISPR-Cas9 is not ready to be used for medical purposes especially

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[35] Adam P. Cribbs and Sumeth M W Perera, "Science and Bioethics of CRISPR-Cas9 Gene Editing: An Analysis Towards Separating Facts and Fiction," *Yale Journal of Biology and Medicine* 90, no.4 (December 19, 2017) 628, https://pubmed.ncbi.nlm.nih.gov/29259526/, quoted from Pablo Tebas et al., "Gene Editing ofCCR5in Autologous CD4 T Cells of Persons Infected with HIV," *New England Journal of Medicine* 370, no. 10 (March 6, 2014): 901-10, https://doi.org/10.1056/nejmoa1300662.

[36] Cribbs and Perera, "Science and Bioethics of CRISPR-Cas9 Gene Editing: An Analysis Towards Separating Facts and Fiction," 628.

[37] Cribbs and Perrera, 628.

[38] Cribbs and Perrera, 628, paraphrased from Gerald Schwank et al., "Functional Repair of CFTR by CRISPR/Cas9 in Intestinal Stem Cell Organoids of Cystic Fibrosis Patients," *Cell Stem Cell* 13, no. 6 (December 5, 2013): 653-58, https://doi.org/10.1016/j.stem.2013.11.002. ; Hongmei Lisa Li et al., "Precise Correction of the Dystrophin Gene in Duchenne Muscular Dystrophy Patient Induced Pluripotent Stem Cells by TALEN and CRISPR-Cas9," *Stem Cell Reports* 4, no. 1 (January 13, 2015): 143-54, https://doi.org/10.1016/j.stemcr.2014.10.013.

[39] Cribbs and Perrera, 628.

[40] Rodriguez, "Ethical Issues in Genome Editing using CRISPR/Cas9 System," 2.

[41] Rodriguez, 2; paraphrased from Puping Liang et al., "CRISPR/Cas9-Mediated Gene Editing in Human Tripronuclear Zygotes," *Protein & Cell* 6, no. 5 (April 18, 2015): 363-72, https://doi.org/10.1007/s13238-015-0153-5.

since it modifies all the cells in zygotes or early stage embryos, including the germline cells.[42]. Medical use on humans is not yet recommended since much improvement is required.

CRISPR-Cas9 is already used for plants and this is something with which society is already familiar. Genetically altered plants, fruits and vegetables are called GMO's or genetically modified organisms. Therefore, gene editing is not completely new to everyone today since we have all been exposed to GMOs for several years, but in the form of plants, vegetables and fruits. In brief, CRISPR has the potential to treat and prevent some illnesses but not all. Even with that potential, there is still the risk of side effects. Since this technology is constantly evolving, it is hopeful with scientific research that these side effects could be minimal in the future.

3) Mutations

After discussing the function and the applications of CRISPR-Cas9, it is important to mention the off-target mutations. Not only can these mutations affect the health of an individual person, if modifications are done on the human germline the effect can be passed on to future generations as well. CRISPR-Cas9 can also edit unintended DNA sequences when trying to make cuts to the target sequence. This can cause mutations in the genome and result in cell death or transformation.[43] These are what we refer to as off-target sites that were affected by CRISPR-Cas9. The cell death or transformation caused by these unintended mutations could impact the individual's health and physical condition as well. Scientists are trying to reduce off-target mutations, but further improvement is needed if CRISPR-Cas9 is expected to be used for treatment purposes.[44]

Moreover, therapeutic interventions in *somatic* cells are considered acceptable since it offers more benefits and there is informed consent.[45] However, therapeutic interventions done on the *germline* are still considered unacceptable since it can produce mutations and side effects, and these unpredictable changes could be passed down to future generations.[46]

In addition, there were more of off-target effects found in human cells compared to mice and zebrafish.[47] Therefore, it seems that these off-target effects are graver for humans. However, even though both mice and humans are mammals, the results will not be the same and the research findings are questionable as a result. Furthermore, "some of the potential side effects transmitted to future offspring may not be observed until several subsequent generations."[48] This can be a serious issue for future generations, it may not affect the person who got genetically modified but it could affect their offspring in the long run. These side effects could appear out of nowhere on

[42] Rodriguez, 2.

[43] Rodriguez, 2, paraphrased from Fu et al., "High-Frequency off-Target Mutagenesis Induced by CRISPR-Cas Nucleases in Human Cells," 822-26; Zhang et al., "Off-Target Effects in CRISPR/Cas9-Mediated Genome Engineering," e264.

[44] Rodriguez, 2, paraphrased from Cong et al., "Multiplex Genome Engineering Using CRISPR/Cas Systems," 819-23; Ma, Zhang, and Huang, "Genome Modification by CRISPR/Cas9," 5186-93; Hsu et al., "DNA Targeting Specificity of RNA-Guided Cas9 Nucleases," 827-32.

[45] Rodriguez, 3.

[46] Rodriguez, 3.

[47] Rodriguez, 2.

[48] Cribbs and Perera, "Science and Bioethics of CRISPR-Cas9 Gene Editing: An Analysis Towards Separating Facts and Fiction," 630.

future offspring and they would not even know because they never consented to these genetic modifications.

Moving on, CRISPR-Cas9 seems to be highly specific when it comes to targeting DNA, but the question is how are off-target sites affected? The crRNA and tracrRNA come together to form the sgRNA and this will be similar to the target DNA sequence and a sequence called the protospacer adjacent motif (PAM).[49] Even though Cas9's DNA targeting specificity is supposed to be pretty accurate because of the sgRNA and PAM, off-target activity could still happen on the DNA sequence.[50] A certain part of the DNA sequence on PAM influences the binding specificity between Cas9 and sgRNA, this sequence is called the seed sequence.[51] The seed sequence of PAM regulates the concentration of the Cas9-sgRNA complex which is important for Cas9 binding, sgRNA abundance and specificity.[52]

In a CRISPR-Cas9-mediated mutagenesis in fruit flies, Ren et al. "observed a positive correlation between the mutagenesis efficiency and the GC content of the most proximal region to the PAM sequence of the sgRNAs."[53] The GC content are the nucleotides guanine and cytosine, which form a part of the basic structural unit of DNA/RNA, which are located at the beginning of the PAM sequence of the sgRNAs. The results of this experiment showed that "sgRNAs with at least four GCs in the sequence of the six base pairs that are the [closest] to the PAM sequence have a heritable mutation" which was "generated by the effective concentration of sgRNA in the CRISPR-Cas9 system."[54] The mutation rate was at sixty percent, which could mean that sgRNAs can be chosen in regards to their GC content.[55] Since the seed sequence of PAM influences the Cas9-sgRNA binding and there is a heritable mutation in at least four GCs out of the six then this mutation can be passed down to future generations once the Cas9-sgRNA complex is brought to the target DNA. If the scientists examine the GC content carefully and conduct tests to see how their mutation rates vary, they could fix that in order to lower the mutations on the PAM sequence so Cas9 can bind to the invading DNA without any off-target mutations developing. By ruling out which guanines and cytosines in the sequence that cause mutations, Cas9 binding can be more efficient since there would be fewer mutations.

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[49] Xiao-Hui Zhang et al., "Off-target Effects in CRISPR/Cas9-mediated Genome Engineering," *Molecular Therapy—Nucleic Acids* 4, no.11 (November 17, 2015): 1, https://doi.org/10.1038/mtna.2015.37 , paraphrased from F. J. M. Mojica et al., "Short Motif Sequences Determine the Targets of the Prokaryotic CRISPR Defence System," *Microbiology* 155, no. 3 (March 1, 2009): 733-40, https://doi.org/10.1099/mic.0.023960-0 ; Samuel H. Sternberg et al., "DNA Interrogation by the CRISPR RNA-Guided Endonuclease Cas9," *Nature* 507, no. 7490 (January 29, 2014): 62-67, https://doi.org/10.1038/nature13011 ; Carolin Anders et al., "Structural Basis of PAM-Dependent Target DNA Recognition by the Cas9 Endonuclease," *Nature* 513, no. 7519 (July 27, 2014): 569-73, https://doi.org/10.1038/nature13579.

[50] Zhang et al., "Off-Target Effects in CRISPR/Cas9-Mediated Genome Engineering," 1.

[51] Zhang et al., 1-2.

[52] Zhang et al., 2, paraphrased from Xuebing Wu et al., "Genome-Wide Binding of the CRISPR Endonuclease Cas9 in Mammalian Cells," *Nature Biotechnology* 32, no. 7 (April 20, 2014): 670-76, https://doi.org/10.1038/nbt.2889 ; Tim Wang et al., "Genetic Screens in Human Cells Using the CRISPR-Cas9 System," *Science* 343, no. 6166 (January 3, 2014): 80-84, https://doi.org/10.1126/science.1246981.

[53] Zhang et al., 2, quoted from Xingjie Ren et al., "Enhanced Specificity and Efficiency of the CRISPR/Cas9 System with Optimized SgRNA Parameters in Drosophila," *Cell Reports* 9, no. 3 (November 6, 2014): 1151-62, https://doi.org/10.1016/j.celrep.2014.09.044.

[54] Zhang et al., 2 quoted in Ren et al., "Enhanced Specificity and Efficiency of the CRISPR/Cas9 System with Optimized SgRNA Parameters in Drosophila," 1151-62.

[55] Zhang et al., 2 paraphrased from Ren et al., 1151-62.

Moreover, "[d]irect delivery of [a] purified Cas9 protein and sgRNA into cells has [shown] to result in reduced off-target effects compared to the delivery of plasmid sequences [that] encod[e] Cas9 and sgRNA."[56] Plasmid sequences of Cas9 and sgRNA are the replicated sequence of the pure Cas9 and sgRNA. Hence, if a purified form of Cas9 and sgRNA are introduced in cells then the rate of off-target effects is reduced rather than using the plasmid sequence of it that contains a secondary version of Cas9's and sgRNA's sequence which are not considered to be pure. This is because pure Cas9-sgRNA complexes cut DNA nearly right after delivery and can disintegrate quickly in cells.[57] The plasmids do not degrade right away like the pure complexes which means that they are susceptible to having off-target effects occuring.

There are various types of scientific methods that are used to detect these off-target effects. These methods would be the T7 endonuclease assay I, web-based predictions and ChIP-based sequencing, GUIDE sequencing, HTGTS, IDLV Digenome sequencing, and FISH.[58] For the purpose of this thesis, I will only name these methods rather than explain them because of their complicated scientific explanations. Some of these methods are more accurate than others. Some of these methods could detect mutations at a lower frequency and others at higher frequencies.[59]

In summary, CRISPR-Cas9 is known to cause off-target effects in genes which can be an issue if one is trying to treat a disease. There are still improvements that need to be made regarding these off-target effects and scientists are using different methods to detect these effects in order to help reduce them.

4) How Gene Enhancement Coincides with Gene Therapy

The CRISPR-Cas9 technology can be used to for gene therapy, which is used to cure or treat illnesses, but it can also be used to enhance certain genetic traits. In addition, there could be different possibilities of how gene therapy and gene enhancement coincide and share some commonality.

It is possible that some gene-editing interventions that are made to treat patients with serious illnesses could also have enhancement effects when given to healthy individuals.[60] For example, a therapeutic genetic intervention for muscular dystrophy could also strengthen muscles in healthy a person.[61] Genetic interventions that treat health issues by enhancing genetic

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[56] Zhang et al., 3, quoted from S. Kim et al., "Highly Efficient RNA-Guided Genome Editing in Human Cells via Delivery of Purified Cas9 Ribonucleoproteins," *Genome Research* 24, no. 6 (April 2, 2014): 1012-19, https://doi.org/10.1101/gr.171322.113; S. Ramakrishna et al., "Gene Disruption by Cell-Penetrating Peptide-Mediated Delivery of Cas9 Protein and Guide RNA," *Genome Research* 24, no. 6 (April 2, 2014): 1020-27, https://doi.org/10.1101/gr.171264.113.

[57] Zhang et al., 3, paraphrased from Kim et al., "Highly Efficient RNA-guided Genome Editing in Human Cells via Delivery of Purified Cas9 Ribonucleoproteins," 1012-1019; Ramakrishna et al., "Gene Disruption by Cell-Penetrating Peptide-Mediated Delivery of Cas9 Protein and Guide RNA," 1020-27.

[58] Zhang et al., 4-5.

[59] Zhang et al., 4-5.

[60] Eric T. Juengst, "Crowdsourcing the Moral Limits of Human Gene Editing?" *Hastings Center Report* 47, no. 3 (May 2017): 19, https://doi.org/10.1002/hast.701.

[61] Eric T. Juengst, "Crowdsourcing the Moral Limits of Human Gene Editing?" 19, paraphrased from National Academies of Sciences, Engineering, and Medicine, *Human Genome Editing: Science, Ethics, and Governance* (Washington: National Academies Press, 2017): 116, https://doi.org/10.17226/24623.

components "that restore functionality or resist functional deterioration might be of interest to enhancement engineers."[62]

Another way a therapeutic intervention can also be seen as a genetic enhancement is through the modification of pathological traits.[63] These therapeutic interventions would be related to cognitive illnesses. Something like this "is also not implausible, as interest in early detection and prevention of late-onset diseases fosters the discovery of new clinical entities like 'mild cognitive impairment' as targets for medical intervention."[64] Therapeutic interventions could become very important in early detection of cognitive disorders in order to prevent it and also treat it as well. Furthermore, society in the future could have a different view on what the accepted normal range for certain traits are, and genetic improvements are able to give catch patients up to speed with the "new normal."[65] Therefore, when society decides what the normal traits of the average person are supposed to be then improvements using therapeutic interventions to help patients catch up will no longer be seen as genetic enhancements.[66]

5) The Science of Mitochondrial Replacement

One alternative to the gene editing technology CRISPR-Cas9 is another gene editing related technology called mitochondrial replacement. This technique is considered to be somewhat safer compared to CRISPR-Cas9 because it is only the mother's heritable traits that are passed down and not the father's. For CRISPR-Cas9, the offspring would obtain both their mother and father's heritable traits. Germline genome editing via CRISPR-Cas9 is more disconcerting than mitochondrial replacement techniques since mitochondrial DNA carries a lesser amount of genetic material than genomic DNA.[67] Therefore, mitochondrial replacement techniques could be considered safer than CRISPR-Cas9. In addition, mitochondria have a smaller amount of genes and these genes have their own specific roles to play in that organelle.[68] Hence, the chances of this technique going wrong are quite low and there is no nuclease-based engineering (CRISPR-Cas9) that is occurring, meaning no off-target or unintended mutations.[69] For CRISPR-Cas9, there are still some off-target mutations that occur when trying to do gene therapy to treat a disease. There have been improvements on this, but with CRISPR-Cas9 it is still likely that these off-target mutations could occur. Furthermore, the harmful effects that are transplanted in the mitochondria cannot be passed down through sexual reproduction like the nuclear genome because the mitochondria are inherited only through the mother.[70]

Moreover, a harmful genetic mutation that arises across all mitochondrial genomes in a body is called "homeoplasmy" or there is "heteroplasmy" which is when harmful genetic

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[62] Juengst, 19.

[63] Juengst, 19.

[64] Juengst, 19, paraphrased from Peter J. Whitehouse and Eric T. Juengst, "Antiaging Medicine and Mild Cognitive Impairment: Practice and Policy Issues for Geriatrics," *Journal of the American Geriatrics Society* 53, no. 8 (August 2005): 1417-22, https://doi.org/10.1111/j.1532-5415.2005.53411.x.

[65] Juengst, 20.

[66] Juengst, 20.

[67] Katrine S Bosley et al., "CRISPR Germline Engineering-the Community Speaks," *Nature Biotechnology* 33, no. 5 (May 2015): 485, https://doi.org/10.1038/nbt.3227.

[68] Bosley et al., "CRISPR Germline Engineering-the Community Speaks," 485.

[69] Bosley, et al., 485.

[70] Bosley et al., 485.

mutations arise in some mitochondria.[71] Mothers who are homeoplasmic will pass that mutation to their offspring and offspring from heteroplasmic mothers will inherit both mutated and healthy mitochondria.[72]

The first mitochondrial replacement technique is maternal spindle transfer (MST) which helps to get eggs from the mother and a donor.[73] The eggs from the mother have the mutant mitochondria while and the donor's eggs do not.[74] Next, the chromosomes which are in the spindle shaped group of both eggs are taken out and the mother's chromosomes are transferred to the donor egg who had its own nucleus removed.[75] The reconstructed egg now contains healthy mitochondria and can be used for *in vitro* fertilization.[76] Thus, the healthy mitochondria can now be passed down through the mother to future generations and there will be no risk of getting a mitochondrial disease.[77] Additionally, if the chromosomes that were transferred do not carry enough harmful mitochondria that cause heteroplasmy, then the future child will live a healthy life.[78]

The next mitochondrial replacement technique to be discussed is protonuclear transfer (PNT) which is when two zygotes are fabricated *in vitro*, where one of them is created with the parents' sperm and egg then another with a donor egg and the father's sperm.[79] In PNT, the father's sperm is used, whereas in MST it is only the female egg. During the first couple of hours, when the sperm has fertilized the egg, the germ cells of both parents/donors are bound to two different cell membranes that are called the male and female 'pronuclei'.[80] Both pronuclei are taken out

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[71] César Palacios-González, "Ethics of Mitochondrial Replacement Techniques: A Habermasian Perspective," *Bioethics* 31, no. 1 (December 14, 2016): 29, https://doi.org/10.1111/bioe.12307 ; paraphrased from Nuffield Council on Bioethics, *Novel Techniques for the Prevention of Mitochondrial DNA Disorders: an Ethical Review* (London: The Medical Research Council, the Nuffield Foundation, and the Wellcome Trust, 2012), vii, https://www.nuffieldbioethics.org/publications/mitochondrial-dna .

[72] Palacios-González, "Ethics of Mitochondrial Replacement Techniques: A Habermasian Perspective," 29, paraphrased from Nuffield Council on Bioethics, *Novel Techniques for the Prevention of Mitochondrial DNA Disorders: An Ethical Review*, vii.

[73] Palacios-González, 29, paraphrased from Nuffield Council on Bioethics, vii; Masahito Tachibana et al., "Mitochondrial Gene Replacement in Primate Offspring and Embryonic Stem Cells," *Nature* 461, no. 7262 (August 26, 2009): 367-72, https://doi.org/10.1038/nature08368 ; Louise A. Hyslop et al., "Towards Clinical Application of Pronuclear Transfer to Prevent Mitochondrial DNA Disease," *Nature* 534, no. 7607 (June 16, 2016): 383-86, https://doi.org/10.1038/nature18303 ; Mitsutoshi Yamada et al., "Genetic Drift Can Compromise Mitochondrial Replacement by Nuclear Transfer in Human Oocytes," *Cell Stem Cell* 18, no. 6 (June 2, 2016): 749-54, https://doi.org/10.1016/j.stem.2016.04.001.

[74] Palacios-González, 29-30, paraphrased from Nuffield Council on Bioethics, vii; Tachibana et al., "Mitochondrial Gene Replacement in Primate Offspring and Embryonic Stem Cells," 367–72; Hyslop et al.,, "Towards Clinical Application of Pronuclear Transfer to Prevent Mitochondrial DNA Disease," 383–86; Yamada et al., "Genetic Drift Can Compromise Mitochondrial Replacement by Nuclear Transfer in Human Oocytes," 749-54.

[75] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Tachibana et al., 367–72; Hyslop et al., 383–86; Yamada et al., 749-54

[76] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Tachibana et al., 367–72; Hyslop et al., 83–86; Yamada et al., 749-54.

[77] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Tachibana et al., 367–72; Hyslop et al., 383–86; Yamada et al., 749-54

[78] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Tachibana et al., 367–72; Hyslop et al., 383–86; Yamada et al., 749-54.

[79] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Lyndsey Craven et al., "Pronuclear Transfer in Human Embryos to Prevent Transmission of Mitochondrial DNA Disease," *Nature* 465, no. 7294 (April 14, 2010): 82-85, https://doi.org/10.1038/nature08958.

[80] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Craven et al., "Pronuclear Transfer in Human Embryos to Prevent Transmission of Mitochondrial DNA Disease," 82–85.

from both zygotes on the first day of their development before they fuse together.[81] Moving on, the parents' pronuclei are moved to the enucleated (no nucleus) zygote, which was made with the donor's egg and then the reconstructed cell is transferred into the uterus.[82] The other pronuclei and the enucleated zygote made with the mother's egg are thrown away.[83] If the chromosomes that were transferred do not carry harmful mitochondria that can cause a disease, the future child will live a healthy life.[84] Therefore, if the future child is heteroplasmic then this means the child will have a mix of healthy and mutant mitochondria.[85] To sum up, MST uses the egg whereas PNT uses the sperm. Both these methods try to remove disease causing mitochondria as best as possible to ensure that a healthy baby is born.

Conclusion

In summary, CRISPR contains two components: the cutting enzyme Cas9 and the guide RNA. We first need to identify which genetic sequence needs to be genetically edited.[86] Then, CRISPR-Cas9 functions to make a cut in the DNA at the precise location where you want to insert and replace the DNA.[87]

The science of CRISPR-Cas9 works in a variety of ways, whether it is to edit a gene to eliminate a disease or to enhance a genetic trait. Still, there needs to be extensive work done to decrease unintended mutations caused by the off-target effects. Once research starts improving, CRISPR could become a powerful tool in the world of medical science. Overall, the science of CRISPR-Cas9 can help a person better understand how this technology works and why it is becoming so popular in society today. By knowing the science behind it, it will help with ethical and theological perspectives in the chapters that follow. Since we now know about what goes on in our bodies with the CRISPR technology, it helps us think about the different ethical and theological stances and understand both sides of that spectrum.

[81] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Craven et al., 82–85.
[82] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Craven et al., 82–85.
[83] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Craven et al., 82–85.
[84] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Craven et al., 82–85.
[85] Palacios-González, 30, paraphrased from Nuffield Council on Bioethics, vii; Craven et al., 82–85.
[86] "CRISPR explained," Mayo Clinic, July 24, 2018, YouTube video, 1:38, https://www.youtube.com/watch?v=UKbrwPL3wXE.
[87] Rachel Haurwitz, "CRISPR: Editing our genetic instructions | Rachel Haurwitz | TEDxSanFrancisco," TEDx Talks, October 26, 2016, Youtube video, 15:41, https://www.youtube.com/watch?v=wktwXGAbP_Q.

Chapter 2: Ethics and Genetic Editing Technology

Introduction

For nearly thirty years, genetic engineering has been a subject of interest in relation to ethics, first starting with prenatal genetic testing, then the mapping of the human genome, and now more recently, gene editing with CRISPR-Cas9. There has been a growing concern about scientists meddling with human genes because of the rapid development in genetic sciences over the years. More specifically, ethical questions arise about making changes to a person's DNA, such as editing a person's DNA in order to prevent disease or even enhance a genetic trait.

A question can be raised concerning the moral agency of a person such as, is a person still in control of their autonomy if their genetic traits are chosen for them? Moreover, is one responsible for their actions once they become genetically modified? For instance, will a person feel that they are in control of their actions or would they feel that a third-party is in control since the changes were made by someone else? Some individuals say that the person in question is fully responsible for their actions because that person is able to *choose* whether or not they want to use the enhanced capacity that was given to them. A genetically modified person is autonomous and able to make their own choices when it comes to their bodies just like a non-enhanced person. Another concern is that gene editing could trigger a new difference in classes of people, such as a superior race and an inferior race. The superior race would be those who can afford to be genetically modified, whereas those who cannot would be considered inferior. As a result, this split could create social issues such as segregation. People tend to be more in favour of gene therapy when done on somatic genes, since it could help prevent diseases. Edited genes on the human germline are still a topic of discussion since these changes will be passed down from one generation to the next. This brings up the question of consent; how could people who are not born yet consent to this? Some say it would not be right to change the human germline considering that those future generations cannot approve it, but others say consent would not matter since this change will be for the greater good. Gene editing raises many ethical questions.

Jürgen Habermas is one of the best-known scholars to speak about this subject because of his book, *The Future of Human Nature*, where he specifically states that he is against genetic modifications. He believes parents should not intervene because the unborn child is not able to give consent.[88] Habermas also asserts that enhanced children are "made rather than grown," meaning that these children will be genetically modified for certain traits rather than achieving them naturally through their life experiences as they grow up.[89] In this chapter, I will explore these ethical questions by first discussing the argument Habermas makes regarding gene editing which will then pave the way for the second section, which is the intervention of parents in the genetic makeup of their children. In the third section, I will be drawing on Peter Herissone-Kelly's article "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," to elucidate John Harris and Michael Sandel's positions on how gene editing affects autonomy. In the fourth section, I will discuss moral agency and responsibility in relation to the actions of a genetically modified individual. Next, I will consider how prenatal genetic interventions could disrupt the natality of an unborn child and how environmental causes can also disrupt this. Natality is the very condition of being born where a person is still able to be

[88] Jürgen Habermas, *The Future of Human Nature* (Cambridge: Polity, 2003), 51.
[89] Habermas, *The Future of Human Nature,* 53.

autonomous despite societal influences. We will see how Habermas contradicts himself on this notion in regards to his exception on therapeutic interventions and how environmental factors can influence a baby *in utero.* In the sixth section, there is the question of psychology, that is, can a person be autonomously conscious after being genetically modified? Are they able to understand that they still have control over their autonomy? The seventh section will discuss how gene editing could cause an eradication of different animal species which could lead to extinction. The final section will touch upon how gene editing could cause social superiority since a select population could be able to access it.

1) Habermas' Argument

Jürgen Habermas has important insights in relation to genetic modifications. Ethicists and philosophers always mention his statements when it comes to explaining their own views on genetic interventions and generally either support or oppose them. Habermas' philosophical arguments on this topic come from his book, *The Future of Human Nature*.

Habermas believed "that genetic manipulation could change the self-understanding of [a] species in [a] [very] fundamental way[,] [where] the attack on modern conceptions of law and morality [could] affect the inalienable normative foundations of societal integration."[90] Thus, for Habermas, an individual's perspective of themselves is changed dramatically when using genetic interventions. These new perspectives that people may have of themselves could affect the law and morality of society by allowing for these enhancements to happen or to even give special treatment to those who are enhanced. This could cause a problematic division within society.

Moreover, Habermas discusses whether or not parental intervention in the genetic makeup of their child is the correct thing to do. He says that "the parents' choice of a genetic program for their child is associated with intentions [that] will later take on the form of expectations addressed to the child."[91] When it comes to parental intervention, it may seem that they do have good intentions for their future children and want the best for them, but these intentions turn into expectations once the child grows up. They expect their child to follow the life plan that they bestowed upon them by editing a certain trait in them. For instance, they enhanced the child's intelligence so that they could become a medical doctor. Thus, they expect the child to use their enhanced intelligence and strive for the goal that the parents wanted. In their decision making, parents were only looking at their own preferences, as if they were speaking about an object.[92]

When the children grow older, they will start seeing themselves differently because of these changes their parents made. For instance, when the adolescent learns about the plan that was drawn up by their parents for intervening in their genetic makeup in order to modify specific traits, the perception of being "grown" may be replaced.[93] Also, when questioning their self-perception, they could see themselves as something "made."[94] When a person is grown, they experience life naturally and with contingency learning through experience about their likes and dislikes. When a person is made, it means that someone chooses genetic qualities for them that they expect them to

[90] Habermas, 26.
[91] Habermas, 51.
[92] Habermas, 51.
[93] Habermas, 53.
[94] Habermas, 53.

use in the future. These qualities were made for them and did not grow from the self that was given to them at birth. They may no longer feel responsible for their actions because they feel they were a product of someone else's desires. The requirements for the moral self-understanding of autonomous actors are jeopardized.[95] The relationship between the person who intervened and the subject in question is formed in a way where the subject feels that the person who wanted them genetically enhanced is responsible for all their actions. The subject loses the natural human precondition, which is to understand themselves as autonomous actors and as their own decision makers.

It can be said that Habermas' view on genetic interventions is a negative one; he is completely opposed to it. He believes that individuals will lose their autonomy and contingency when genetically enhanced. Yet, he states that a parent or third party can only consent to the exception that the genetic intervention may prevent "extreme and highly generalized evils."[96] Still, what diseases would classify as extreme and evil since each disease is harmful in their own way?

2) The Intervention of Parents

Parents always want what is best for their children and sometimes that means intervening with their genetic makeup in order for them to live a healthy and overall good life. Furthermore, individuals "conduct [their] lives in ways that are valuable to [them] and that protect [their] descendants against the harmful vagaries of fate as [much] as possible, where responsibility is attached to those ventures."[97] For example, a deadly inherited disease. In addition, these individuals, who could also be parents, feel that it is in their responsibility to be protective from anything that could be bad.

Even if prenatal genetic interventions are not used, future descendants will not remain the kinds of beings they are now because evolutionary forces will cause change at some point in time.[98] In Timothy F. Murphy's article, "In Defense of Prenatal Interventions," he states that, "if we want [our] human descendants to stay human in the contemporary sense, we would have to intervene […] with [prenatal genetic interventions] to protect against these [evolutionary] changes, and make sure those interventions reach […] [future generations] that [could] drift into [different] beings."[99] These genetic changes would need to be inserted in the human germline, so that future generations do not go through any evolutionary changes. John Harris, a bioethicist, stated that "[w]hether or not nonhuman persons arise through technology or, in the course of further Darwinian evolution, in the future, the far future perhaps, there will be no more humans."[100] This means that even without the use of gene editing technologies, a nonhuman species could emerge naturally. Again, we do not know the agenda for human evanescence but in biogenetic terms , there is no escape from change.[101] Therefore, even though we do not know the timeframe for the change of the human

[95] Habermas, 63.

[96] Habermas, 63.

[97] Timothy F. Murphy, "In Defense of Prenatal Genetic Interventions," *Bioethics* 28, no. 7 (October 1, 2012): 337, https://doi.org/10.1111/j.1467-8519.2012.02009.x.

[98] Murphy, "In Defense of Prenatal Genetic Interventions,"338.

[99] Murphy, 338, quoted from Timothy F. Murphy, "The Ethics of Possible and Impossible Changes to Human Nature," *Bioethics* 26, no. 4 (December 7, 2010): 191-197, https://doi.org/10.1111/j.1467-8519.2010.01851.x.

[100] Murphy, 338, quoted from John Harris, "Taking the 'Human' out of Human Rights," Cambridge *Quarterly of Healthcare Ethics Committees* 20, no. 1 (February 19, 2010): 16, https://doi.org/10.1017/s0963180109990570.

[101] Murphy, 338.

species, there is no stopping it because nature is always evolving, even long before the invention of gene editing technologies. With this in mind, Murphy believes that if individuals attempt to hold on to the biogenetic species that we currently are, they would have to do genetic interventions that involve authorships of another person's life.[102]

One would need to analyze what 'an extremely and highly generalized evil' is in accordance to the problems human beings encounter every day.[103] For instance, for genetic reasons some people are immune to HIV infections while most are not.[104] Habermas' theory of morality is not violated according to these differential outcomes because it was by chance and all people need to be considered morally equal in order to author their lives in the right way.[105] Murphy states that "all the benefits that prenatal genetic interventions could confer in terms of resistance to disease […] [fail] to undermine Habermas' objection to parents' authorships of their children's lives, because on his analysis the benefit of protecting against HIV infection would not outweigh the importance of preserving the conditions of moral equality."[106] Habermas' objection will still stand even if a diseases can be prevented for future offspring. The natural lottery falls under his theory of morality where a life of chance will dominate because Habermas does not believe in a fixed life history that genetic interventions provide.

In order to treat matters consistently, the level of acceptability for prenatal genetic interventions seems to be any illness or disability that undercuts the prospect for the authorship of a life, not situations that introduce some kind of evil into human life.[107] Hence, it seems plausible to think that the greatest evils that happen to human beings are those of great pain and suffering, but it may not diminish the ability to author a life.[108] Yet, this questions Habermas' exception because not all pain can alter a person's autonomy. In fact, it can make a person contemplate their suffering so that they can figure out what they should do in that situation. For instance, a person could be involved in a bad accident leaving them paralyzed from the waist down, but still competent to make their own decisions about how they want to live their life since they were not left incompetent. Likewise, unless these types of individuals are greatly incapacitated by their pain, people can still maintain the ability to make decisions about how to live with it.[109]

When a person is incompetent mentally, they cannot make decisions about how to live through their mental illnesses. In addition, "some genetic disorders do undercut the prospect of self-authorship (without involving extreme physical pain and suffering) significantly since they disable the very conditions of choice and it is presumably for that reason that the use of [prenatal genetic interventions] would be morally acceptable […] because of the [indirect] pain and suffering that [being mentally incompetent may involve]."[110] The use of prenatal genetic interventions to aid in a child's brain development would be morally acceptable for the child because they could regain a sense of autonomy. When a child is born with a mental or cognitive

[102] Murphy, 338.
[103] Murphy, 339, Jürgen Habermas, *The Future of Human Nature* (Cambridge: Polity, 2003), p.63.
[104] Murphy, 339, paraphrased from Gérard Lucotte, "Distribution of the CCR5 Gene 32-Basepair Deletion in West Europe: A Hypothesis about the Possible Dispersion of the Mutation by the Vikings in Historical Times," *Human Immunology* 62, no. 9 (September 2001): 933-936, https://doi.org/10.1016/s0198-8859(01)00292-0.
[105] Murphy, 339.
[106] Murphy, 339.
[107] Murphy, 339.
[108] Murphy, 339.
[109] Murphy, 339.
[110] Murphy, 339.

defect, they are not able to make their own choices rather it is their caregiver who does that for them. Therefore, they might not be autonomous agents. The child with the defect may not be aware of the pain related to not being able to make their own choices but the people around them are. For this reason, prenatal genetic interventions could be morally acceptable since the child could have a chance at being cognizant and autonomous. This could help parents who have down-syndrome children, although they can still retain a certain amount of their mental capacity, therapeutic interventions may help them regain their full autonomy. Moreover, if therapeutic interventions are used, this could lower abortion rates for parents who use prenatal genetic testing to see if their child will have a severe mental illness since their likely to terminate the pregnancy because of those illnesses.

Furthermore, it seems fair to argue that parents should be allowed to intervene prenatally in their children's genetic traits to the point that foreseeable outcomes can interfere with the ability for a person to author a morally good life.[111] For instance, some cognitive disorders, although not that extreme, can interfere with the ability for individuals to implement choice in their lives.[112] Cognitive disorders are a great example of how one's autonomy is impaired since they do not have the capacity to even think thoroughly. Ultimately, they are not the authors of their own lives. In addition, to have that freedom taken away because of a disease can be extremely upsetting and if therapeutic interventions can help with this, then it may be beneficial for the future.

In Murphy's article "In Defense of Prenatal Genetic Interventions," he draws on John Rawls' veil-of-ignorance methodology to demonstrate how it is possible to reject Habermas' concern about the threats that genetic interventions may pose to the equality of human beings.[113] John Rawls suggests that individuals sit behind a veil-of-ignorance which keeps them from knowing their identity and identifying with their own personal situations in order to come to a judgement about what one ought to do.[114] When we are ignorant towards our own situation, we can objectively consider how societies function without any biases.[115] There are two principles that are included in Rawls' veil-of-ignorance method. The first one is the liberty principle, which confirms that every person enjoys the maximum liberty possible without interfering on anyone else's freedom.[116] The second one is the difference principle, which states that if there are any social or economic differences in a social setting, then one should help the less fortunate and any advantages should be available to all of society regardless of social class.[117] Essentially, a veil-of-ignorance allows one to put aside any personal circumstances in order to see if a specific objective could benefit a community.

The veil-of-ignorance method challenges Habermas' main objection about genetic interventions. It requires decision makers to identify certain standards that measure the morality of different social practices.[118] This means they put their own identities aside, contemplate how it

[111] Murphy, 339.
[112] Murphy, 339.
[113] Murphy, 340.
[114] "Veil of Ignorance," Ethics Unwrapped, Ethics Unwrapped - McCombs School of Business – The University of Texas at Austin, accessed May 28, 2019, https://ethicsunwrapped.utexas.edu/glossary/veil-of-ignorance.
[115] "Veil of Ignorance."
[116] "Veil of Ignorance."
[117] "Veil of Ignorance."
[118] Murphy, "In Defense of Prenatal Genetic Interventions," 340.

would affect all populations and what they ought to do.[119] This is a method decision makers will use to see if Habermas' objections can be dismissed. Therefore, if genetic interventions were evaluated through the lens of a veil-of-ignorance methodology, "the use of [genetic interventions] [might] not violate the conditions that Habermas says are [important] to moral equality because contingency is preserved relative to the fate of the decision makers."[120] This means that every person oversees their own life and contingency depends on our human choices because each person is the author of their own life whether they are genetically modified or not. In addition, since their decisions have to abide with protecting all possible selves, decision makers under a veil-of-ignorance make decisions for the sake of all humanity and how it would benefit all populations.[121]

Children whose parents have used prenatal genetic interventions will have a contingent life just like any other child who is not the product of prenatal genetic interventions. If a parent has the power to choose the sex of the child regardless if it is from sperm-sort mechanisms, dietary practices, folk practices, or prenatal genetic diagnosis, they do not interfere with the child's capacity to live as a being with a sex.[122] Therefore, the sex selection of a child will not interfere with the outcomes of this person's life since they will be able to make any choices regardless of what sex they are. Even though their sex was chosen for them, this does not mean that these children must live their lives a certain way or as a specific gender. Each child has the option to choose the life they want to live regardless of what gender they may be.

3) Harris, Sandel and Autonomy

John Harris, a prominent pro-enhancement bioethicist, states that Habermas' book, *The Future of Human Nature*, is "excruciatingly complex," "crushingly conservative," and he accuses Habermas of "mystical sermonizing."[123] For Harris, there are other parental factors that influence a person's life history besides genetic enhancement. He states that "[o]ur parents and teachers [who] shape our education, make choices about our diet, encourage the development of [certain] talents, bring us up with certain values, and so on."[124] These influences have an immeasurable effect on a person's life history where the choices that parents and teachers make are wise ones and are not seen as unethical.[125] Harris states that "if such influences are destructive [to] autonomy, then there has never existed any autonomy to destroy [since] there has never been a human being free of such influence."[126] People will always want to look up to someone that inspires them and want to improve themselves so that they can be like them.

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[119] Murphy, 340.
[120] Murphy, 340.
[121] Murphy, 340.
[122] Murphy, 341.
[123] Peter Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," *Cambridge Quarterly of Healthcare Ethics* 21, no. 2 (February 29, 2012): 201, https://doi.org/10.1017/S0963180111000703 , quoted from John Harris, *Enhancing Evolution: The Ethical Case for Making Better People* (Princeton, NJ: Princeton University Press, 2007), 137; John Harris, "No sex selection please, we're British," *Journal of Medical Ethics* 31, no. 5 (May 1, 2005): 286, https://doi.org/10.1136/jme.2004.008870.
[124] Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," 202.
[125] Herissone-Kelly, 202.
[126] Herissone-Kelly, 202, quoted from Harris, *Enhancing Evolution: The Ethical Case for Making Better People*, 140.

Michael Sandel opposes human genetic enhancement, yet rejects Habermas' claim about the impact of human agency and autonomy.[127] Like Harris, he believes, "our lives are already irreversibly and profoundly influenced by the decisions of others without any apparent diminution of autonomy."[128] Sandel concentrates on Habermas' claim that it is crucial for human beings to view themselves as "grown" rather than "made."[129] This part of Habermas' work is compatible with Sandel in two ways.[130] First, Sandel claims that one of the most important things in human life is the quality he calls "giftedness," which is significant because it will contain a reasonable amount of "openness to the unbidden" and "a correlative relinquishment of a drive toward mastery and domination."[131] Sandel's concept of giftedness relates to having contingency in human life and that a person should be exposed to things that are in a way, unplanned. Which goes hand in hand with the fact that some individuals will give up on certain skills that they wanted to master because this is how life works. We try to learn something and sometimes we fail so we move on to something else and see if it works for us. It is by chance that we learn something new to see if we pass or fail it. Second, since giftedness is important to any human life, then "it points beyond the limits of liberal, or 'postmetaphysical' considerations."[132] Habermas stated that if individuals want to be free, in a postmetaphysical age, to follow their own impression of the good, the only thing that stops them from doing so is human genetic enhancement since it will undermine their autonomy in this quest.[133] Since Sandel does not agree with Habermas' claim that autonomy is diminished with human genetic enhancement, he believes that this giftedness goes beyond these postmetaphysical conditions Habermas speaks of, because these people have their own autonomy and are able to pursue the good in their own respective ways. They are able to make their own decisions on how they want to live their life.

Let's imagine a person has an enhanced capacity that allows them to complete the *Times* crossword in five minutes, in that moment they may be responsible for that action of completing the crossword where they alone decide to use that capacity.[134] Peter Herissone-Kelly believes that "once the crossword is completed, there is another sense in which [that person] is not responsible for its having been finished so quickly […] [it could be] an alien capacity [that] is responsible."[135] Consequently, a person could have the capacity to finish this crossword quickly and is responsible for that action but once finished, there comes a realization that maybe they are not responsible for it being done that fast. This external capacity is alien to them because the capacity is made instead of grown.[136]

Since the enhanced capacity does not grow out of a given self which comes naturally, its presence will be viewed as discontinuous for the given self we are responsible for.[137] An enhanced

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[127] Herissone-Kelly, 203.
[128] Herissone-Kelly, 203.
[129] Herissone-Kelly, 203.
[130] Herissone-Kelly, 203, paraphrased from Michael J. Sandel, *The Case Against Perfection: Ethics in the Age of Genetic Engineering* (Cambridge: Belknap Press, 2007), 81.
[131] Herissone-Kelly, 203, quoted from Sandel, *The Case Against Perfection: Ethics in the Age of Genetic Engineering,* 81.
[132] Herissone-Kelly, 203, Sandel, 81.
[133] Herissone-Kelly, 203.
[134] Herissone-Kelly, 206.
[135] Herissone-Kelly, 206.
[136] Herissone-Kelly, 206.
[137] Herissone-Kelly, 207

capacity is not grown from birth, so it does not come from the given self. This means it is experienced as discontinuous because we are not responsible for it and it is not conceived naturally. Furthermore, taking responsibility for the given self, identifying that the given self and its capacities is how we are.[138] As a result, we cannot switch our loyalty to a characteristic whose foundation is foreign to the given self.[139] The self and its capacities are who we are, from the start of our lives as infants, and we grow to discover what capacities are for us that will then shape our identity. For this reason, to switch to a new capacity that is outside of our given selves is unacceptable.

Peter Herissone-Kelly asserts that the issue of autonomy is always questioned when it comes to genetic enhancement and feels that there is something undesirable about it and is not sure it could ever be justified.[140] This is because Habermas' claim about enhancement procedures having a negative impact on an enhanced person's autonomy is referenced more to cases about first-person, self-sanctioned gene editing.[141] Herissone-Kelly thinks that Habermas' claims on the negative aspects of genetic enhancement will work better on self-sanctioned enhancement rather than the third-party/parental enhancement scenarios he refers too in *The Future of Human Nature*.[142]

Herissone-Kelly goes on to say that Habermas' central message is that genetically enhanced humans would have a feeling of diminishment in regards to their autonomy because of being enhanced and being unable to feel responsible for the lives they would live.[143]

He wants to justify the claim on whether or not enhancement has an impact on human agency since Habermas only speaks of third-party/parental enhancement, meaning consent is assumed by a parent and not consent that the patient in question gave himself or herself.[144] For instance, enhancer A conducts genetic enhancements on an embryo that will become person B and A prevents B from being the author of their own life by making A that author.[145] Thus, the person conducting the enhancement procedure on the future person will be the author of that person, where that offspring will not be an autonomous agent. Herissone-Kelly feels this reasoning is not correct for two reasons.[146] First, it seems to rely on an inaccurate and weak genetic determinism that assumes that once a genotype is put in place there is a predestined life history.[147] An edit to one specific gene which then makes a person's life history predestined seems to be an unreasonable statement since that person is still able to do many other things in their life. Second, an enhanced person will be genetically enhanced for specific characteristics, not globally.[148] To be more specific, an embryo is genetically enhanced to be athletically gifted and this could have a great influence on their life.[149] However, it would not govern their whole life history, nor would it guide

[138] Herissone-Kelly, 207.
[139] Herissone-Kelly, 207.
[140] Herissone-Kelly, 201.
[141] Herissone-Kelly, 201.
[142] Herissone-Kelly, 201.
[143] Herissone-Kelly, 202.
[144] Herissone-Kelly, 202.
[145] Herissone-Kelly, 202.
[146] Herissone-Kelly, 202.
[147] Herissone-Kelly, 202.
[148] Herissone-Kelly, 202.
[149] Herissone-Kelly, 202

them to want to acquire those athletic abilities.[150] It is possible for an enhanced genetic trait to have a great impact on a person's life, but a person is still able to lead a life they want and make the choice on whether or not they want to develop that specific enhanced trait.

Peter Herissone-Kelly asks two questions in the case of self-sanctioned enhancement: one is "How is it that I can be responsible for actions that proceed from capacities that are simply given, capacities that I did not choose?"[151] He answers that we take responsibility for a given self which makes us responsible for our actions so why can we not take responsibility for the attributes of the enhanced self, enhanced capacities that we chose and actions that come from them?[152] Therefore, the choice of an unenhanced person to enhance themselves is a choice that must come from a given self for which they are responsible.[153] However, the enhanced capacity does not flourish from the given self because it is not something the given self has the capacity for, it is alien to it.[154]

Herissone-Kelly's second question states: "How is it that I can only be responsible for such actions?[155] Why would I not be responsible for actions that proceed from a capacity that I had wholly chosen?"[156] And yet, with this question, we can see that the person could have doubts about whether they are the only ones responsible for their actions. The appearance of an enhanced capacity could be viewed as discontinuous with the self for which we are responsible.[157] This means that an enhanced capacity would have an alien effect on the self, something that is not familiar. Even if it is something for which we take responsibility, it is still not something that was grown.

4) Moral Agency and the Responsibility for Actions

Genetic modifications can change a person genetically by either preventing disease or by enhancing traits, but could it really change the autonomy of a person? This introduces moral agency which is the condition of the possibility of responsibility for our actions and our ability to act in the world.[158] Is a person still responsible for their actions after being genetically modified? Peter Herissone-Kelly believes "[g]enetic modifications undercut that agency and therefore our responsibility for the resulting actions that, in a sense, happen to us rather than being the effects of choice."[159] Herissone-Kelly also states that "[one] can only look at that outcome as an event external to oneself: 'because [an] enhanced capacity does not grow out of [our] given self…its presence will be experienced as discontinuous with the self for which we have taken

[150] Herissone-Kelly, 202.
[151] Herissone-Kelly, 207.
[152] Herissone-Kelly, 207.
[153] Herissone-Kelly, 207
[154] Herissone-Kelly, 207.
[155] Herissone-Kelly, 207.
[156] Herissone-Kelly, 207.
[157] Herissone-Kelly, 207.
[158] Timothy F. Murphy, "Genetic Modifications for Personal Enhancement: A Defence," *Journal of Medical Ethics* 40, no. 4 (April 23, 2013): 242, https://doi.org/10.1136/medethics-2012-101026.
[159] Murphy, "Genetic Modifications for Personal Enhancement: A Defence," 242, quoted from Peter Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," *Cambridge Quarterly of Healthcare Ethics* 21, no. 2 (February 29, 2012): 206, https://doi.org/10.1017/S0963180111000703.

responsibility.' "[160] It is clear that Herissone-Kelly believes that a person loses moral agency once genetically modified and that it is external to the person's given self which is from birth.

Timothy F. Murphy objects to what Herissone-Kelly says about moral agency diminishing when genetic modifications are introduced. For instance, parents may want to introduce prenatal genetic modifications that enhance athletic abilities, but they are aware that these modifications would not determine the person's entire life history since the affected person might choose another life path.[161] Herissone-Kelly states "an example of making all the genetic modifications […] necessary to [give] 'the full range of capacities responsible for high quality philosophical work.'"[162] Even though this person would have thorough connections between genetic modifications and behaviour, the aspect of being able to do high quality philosophical work needs to be mastered by a certain amount of work and analytic skills, which are separate from genetic modifications.[163] Genetic modifications cannot coax anyone as philosophically inclined.[164] This means "that outcomes do not flow from capacities in any causally determinate way, certainly not without contextual influence [and] […] [t]here is plenty of room for the exercise of moral agency."[165] This goes back to the example John Harris had stated about teachers having an influence on an individual's life history by encouraging the development of certain talents.[166] This is what philosophy professors do in order for their students to become skilled philosophers. An edit in a gene does not make you a philosopher, rather it is about learning from people who have had experience in this field who can then influence you to be a great philosopher one day.

For the case of prenatal genetic interventions, Murphy mentions that Herissone-Kelly claims that parents might only see the effects of genetic interventions as an deterioration of a child's agency.[167] Since these genetic interventions are done before a baby is born, the child is not aware of what changes are made and just goes about their life, whereas, the parents know about the genetic modifications and think their child's moral agency is lost. Context can impact behaviour with methods that can defy genetic reductionism.[168] The contingency of the human person and the choices this human person makes during life preserves moral agency.[169] Not only does context influence behaviour that could be different from the genetic modifications that were given to that child but the possibility of experience and choices during their life preserves their moral agency. Therefore, "people who choose genetic modifications for themselves will have just as much contingency in their lives as would be the case as if they had no modifications."[170] For example, a person may want to enhance their musical abilities later on in life, but it is not for music competitions, but to be able to offer music lessons to children as a way to earn some money.[171] Here it can be seen that the person who chose to be genetically modified to have enhanced musical

[160] Murphy, 243 quoted from Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," 207.
[161] Murphy, 243.
[162] Murphy, 243, quoted from Herissone-Kelly, 205-06.
[163] Murphy, 243.
[164] Murphy, 243.
[165] Murphy, 243.
[166] Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," 201.
[167] Murphy, "Genetic Modifications for Personal Enhancement: A Defence," 243.
[168] Murphy, 243.
[169] Murphy, 243.
[170] Murphy, 243.
[171] Murphy, 244.

abilities followed a different path in order to help others and they were responsible for this choice. Their moral agency is preserved through the choices they make even though they are genetically modified. Murphy does not see how these results, as valuable as they are, can be understood as morally valueless because they were accomplished through genetic modification.[172] Outcomes from genetically modified individuals are still valuable and there is no reason why they should not be seen that way just because it was done with the help of gene editing.

Likewise, one could set their personal and social goals even higher for any enhanced capacity that was done by genetic modification,.[173] A person's personal or social goal can be widened thanks to the help of genetic modification because these interventions can expand on choices that a person can make. For instance, one can have the ability to learn a new language and not only will they grasp that language faster than the average person, but they may be able to set their goals higher, such as to learn Portuguese or Latin.[174] Hence, we have choices in relation to our individual capacities.[175] A person may have a genetic enhancement to learn a specific language but that would not limit them in wanting to learn another language because a person can make their own choices when it comes to their own capacities. At the same time, it is not that evident that genetically modified people are to interpret their achievements as external to their own identities.[176] A person's language capacity changes over time, they learn more and more each year that passes, and their skills evolve. When their skills evolve, they may want a new challenge such as learning another language.

Moreover, Murphy notes how Herissone-Kelly states "that the conferral of genetic immunity on oneself would mean that HIV protection would have been achieved as if it were an event external to oneself."[177] And yet, wouldn't some health protection be preferable? Murphy mentions how he would prefer to have permanent immunity against HIV or any other illness rather than having to be medically vigilant all his life.[178] A genetic intervention that could give a person immunity to HIV is still seen as an event external to the self of that person, but the majority would rather be immune to this disease than have to constantly be vigilant all their life so they would not contract this infection. If there comes a time where HIV can be eradicated for good using CRISPR, most probably the majority of individuals will choose this rather than having periodic medical exams.

5) How Natality is Affected by Gene Editing

A parent who chooses to do prenatal genetic interventions on their baby is arguably disrupting the child's natality. What Habermas means by natality is the very condition of being born, he draws on Hannah Arendt's concept of natality, which is our being born.[179] Natality allows

[172] Murphy, 244.
[173] Murphy, 244.
[174] Murphy, 244.
[175] Murphy, 244.
[176] Murphy, 244.
[177] Murphy, 244, quoted from Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," 207.
[178] Murphy, 244.
[179] Jonathan Pugh, "Autonomy, Natality and Freedom: A Liberal Re-Examination of Habermas in the Enhancement Debate," *Bioethics* 29, no. 3 (February 19, 2014): 146, https://doi.org/10.1111/bioe.12082.

one to find themselves prior to the determining influence of socialization.[180] Thus, autonomy is possible even with the forces of socialization.[181] According to Jonathan Pugh, Habermas says "that influencing a child prior to the point of natality will disrupt its sense of self-continuity, since it will be unable to conceive of itself as ever existing in [the concepts] from the forces of socialization, [i.e. life's experiences in a social setting]."[182] If the population of genetically modified babies increases, then this specific population will have their traits pre-selected for them. This means that there will be less individuals actually learning and experiencing what talents they possess within the concepts of socializations such as educational institutions, place of employment or influential people.

However, enhancement supporters are likely to point out that Habermas' notion on natality seems to be in tension with his views on the genetic treatment/enhancement distinction.[183] He claimed that therapeutic modifications are morally acceptable since a person has a right to consent in order to eliminate an extreme evil.[184] Yet, "the claim that therapeutic modifications are morally permissible seems to be in tension with his appeal to natality [because] carrying out therapeutic modifications threatens the [conviction] that natality marks a point of differentiation of one's social and natural fates just as much as enhancement modifications."[185] In both those cases, the contingencies of the child's genetic makeup, which is needed for the child's autonomy according to Habermas, is withdrawn.[186] Modifying the genes for therapeutic purposes still alters a person's genetic makeup like enhancement modifications. Therapeutic purposes go against Habermas' view because the child will automatically be immune to a certain disease or infection and that child will be different from the unmodified children who will have a possibility of developing a certain sickness. If a sense of self-continuity and autonomy are needed for the contingency of a person's genome, then this implies that a child who has received a therapeutic genetic intervention cannot have a genome that is contingent, meaning they do not have that sense of self-continuity that is essential for autonomy.[187]

Habermas should have stated that a child who is exposed to therapeutic interventions can also regard themselves in a way that can justify autonomy since their therapeutic modifications do not contain any values that could be required for the 'uncontaminated' prenatal self.[188] However, enhancement supporters could see this as problematic if they believe health itself is a value.[189] They might point out that health is a value that we mold according to the socializing influences that Habermas claims would threaten the future child's notion of themselves as an autonomous agent.[190] For example, parents would want to genetically modify a child to 'cure' the child's deafness, but in more recent cases it was suggested that deaf parents would not consider the

[180] Pugh, "Autonomy, Natality and Freedom: A Liberal Re-Examination of Habermas in the Enhancement Debate," 146.
[181] Pugh, 146-47.
[182] Pugh, 149.
[183] Pugh, 149.
[184] Pugh, 149.
[185] Pugh, 149.
[186] Pugh, 149.
[187] Pugh, 149.
[188] Pugh, 149.
[189] Pugh, 149.
[190] Pugh, 149.

eradication of a child's deafness as a treatment method since they do not regard it as an affliction.[191] They would simply want them to have a good life.[192] Non-deaf parents would not want their child to be deaf so that they could have a good life and be able to hear growing up and deaf parents do not see deafness as an issue because it can be an easy thing to live with. If the deaf parents were to genetically edit their child's deafness, it would be for efficiency reasons and not health reasons.

Genetic enhancement supporters might raise concerns about the argument from natality when considering Habermas' claim "that a child's ability to conceive of themselves as an [autonomous] agent is undermined if their parents seek to enhance them prenatally."[193] There is a problem with this because we are already exposed to environmental factors before natality, such as "our developmental well-being *in utero* which depends on our mother's diet and overall health."[194] Moreover, *in utero* fetuses can be stimulated by environmental factors like playing specific music that can benefit the child.[195] In addition, it is "not believed that these [environmental] interventions are [harmful] to the child's ability to conceive of themselves as the author of their own life."[196] If only a specific amount of traits are useful for an expansive range of life plans, then enhancing these traits would not mean a prenatal expectation of a life plan.[197] Genetic enhancement can be useful to a child because they are able to choose different life plans they like where they will not be limited to just one as Habermas stated. Genetic enhancements such as the environmental factors can promote child development. Consequently, presumed consent for the enhancement of general purposes does not mean an expectation of a specific life plan and are unlikely to lead to harsh cases that are useful to any life plan.[198]

6) Autonomously Conscious?

Daniel C. Henrich, an ethicist, explains Habermas' concept of 'human nature' as follows: "the term 'human nature' relates to those features of an individual they have developed entirely on their own and that have only been intervened upon under the condition of anticipated consent."[199] Despite the fact that genetic engineering implies a reification, why should our morality depend on such intervention?[200] Morality should not be dependent on an intervention because a person is their own being and can also make their own choices, modified or unmodified.

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[191] Pugh, 150, paraphrased from Julian Savulescu, "Deaf lesbians, 'Designer Disability,' and the Future of Medicine" *BMJ* 325, no. 7367 (October 5, 2002): 771-73, https://doi.org/10.1136/bmj.325.7367.771.

[192] Pugh, 150, paraphrased from Savulescu, "Deaf lesbians, 'designer disability,' and the future of medicine" 771-73.

[193] Pugh, 150.

[194] Pugh, 150, quoted from Lucilla Poston, Lucien F Harthoorn, and Eline M Van Der Beek, "Obesity in Pregnancy: Implications for the Mother and Lifelong Health of the Child. A Consensus Statement," *Pediatric Research* 69, no. 2 (February 2011): 175-80, https://doi.org/10.1203/pdr.0b013e3182055ede.

[195] Pugh, 150, paraphrased from Poston, Harthoorn, and Van Der Beek, "Obesity in Pregnancy: Implications for the Mother and Lifelong Health of the Child. A Consensus Statement," 175-80.

[196] Pugh, 150.

[197] Pugh, 150.

[198] Pugh, 150.

[199] Daniel C. Henrich, "Human Nature and Autonomy: Jurgen Habermas' Critique of Liberal Eugenics," *Ethical Perspectives* 18, no. 2 (2011): 256, https://doi.org/10.2143/EP.18.2.2116812.

[200] Henrich, "Human Nature and Autonomy: Jurgen Habermas' Critique of Liberal Eugenics," 257.

On account of genetic manipulation, the individual lacks "a mental precondition for coping with moral expectations to take the sole responsibility for his or her own life."[201] Moreover, Henrich states that human nature "can be understood as a precondition of our ethical self-understanding" and that "'our consciousness of autonomy' is a psychological condition for moral agency."[202] He also states that only some genetically modified individuals would feel unsure in regards to their moral accountability and that the ethical assessment of genetic engineering would vary from person to person depending on their psychological nature.[203] Some genetically modified individuals will not have the psychological strength to grasp the fact that they were genetically edited or responsible for their actions. These individuals could lack support from their loved ones either because they do not see them as autonomous agents who are responsible for themselves or because they are not there to talk to them about their issues. It is important for the genetically modified individual to have a support group for their mental health because they can be there to help and encourage the patient that they are their own person. The support group can be there to reassure the person that they are responsible for their actions and not a third-party. This can drastically help their mental health and help them live a good life.

Henrich mentions how John Dupré, a philosopher, states that the idea that human beings' concrete intentions and life plans could be seen as a 'genocentric fallacy' because saying that genes are responsible for specific traits is scientifically wrong.[204] According to John Dupré,

> It is still very common to hear references to 'genes for' this or that eye color, intelligence, height, homosexuality, and so on. However, it is vital to remember that though the production of particular proteins is necessary for the appearance of many traits, it is almost never close to sufficient.[205]

With this is in mind, it is not enough to say that a specific gene causes a specific trait.

Similarly, there are limits of these alien determinations that need to be mentioned. Alan Handyside, a genetic scientist states:

> The first is that the genetic elements that make up a trait [needs] to be present in one or both parents. The second is that since [IVF] results in only a handful of fertilized embryos for biopsy and testing, the chances of one embryo inheriting the right combination of genetic elements to [get] the desired [trait] may be too low to even make the procedure worth trying. Finally, although complex traits such as intelligence are known to have a strong genetic component, [while] many other variables would make it impossible to identify individual embryos with desired traits.[206]

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[201] Henrich, 257.
[202] Henrich, 257-59
[203] Henrich, 259.
[204] Henrich, 261.
[205] Henrich, 261, quoted from John Dupré, *Darwin's Legacy. What Evolution means Today*, (Oxford: Oxford University Press, 2003), 84.
[206] Henrich 261, quoted from Alan Handyside, "Let Parents Decide," *Nature* 464, no. 7291 (April 2010): 978, https://doi.org/10.1038/464978a.

Therefore, with Alan Handyside's three reasons we can see that the process of genetic modifications are not as easy as they are claimed by some to be and that there are limits, which many are unaware of.

7) Destroying a Species with Gene Drives

CRISPR-Cas9 is being used more frequently in labs across the world. CRISPR is currently being used to modify insects, animals, plants, and microorganisms and to make human therapeutics.[207] CRISPR has been used to edit the female mosquito so that it is unable to carry malaria and others aim to make male mosquitoes sterile to prevent reproduction or limit of their progeny's lifespan.[208] At the extreme, this could eradicate an entire species and could have many environmental consequences because of it.[209]

In addition to editing a gene, there is something called a gene drive: it is a tool that makes it more possible to pass down an edited trait to progeny through sexual reproduction.[210] The resulting progeny has a fifty percent chance of inheriting the edited trait, with a gene drive it can copy a mutation made by CRISPR on one chromosome to its partner chromosome.[211] Which ensures that all progeny and its future descendants will inherit the edited gene.[212] If this is done with the example of the mosquitoes then, it could in fact lower transmission rates of dengue fever or malaria.[213] Yet, it poses a lot of large environmental risks such as destroying an entire species, eliminating a food source for other kinds of species or promote an excessive amount of invasive pests.[214] Even though there are some benefits to gene drives, the risks outweigh them since it could make a species extinct.

The eradication of a species using gene drives demonstrates the negative effects that gene editing could have in our world. It can show how this tool can wipe out an entire species of mosquitoes and it is experiments like this where one needs to discuss ethics and regulations. It would not be right to conduct experiments like these if it means a species extinction, seeing as this tool should be used for species to not face extinction. Experiments like this will need to face an evaluation in order to see if these experiments are ethical and beneficial. It would not be right to use CRISPR on a species to render it sterile in order to benefit another species. This is ethically wrong because as stated previously, it would also eliminate a food source for other animals on the planet. There needs to be rules and regulations set in place in order to conduct just research.

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[207] Arthur L. Caplan et al., "No Time to Waste—the Ethical Challenges Created by CRISPR : CRISPR/Cas9, Being an Efficient, Simple, and Cheap Technology to Edit the Genome of Any Organism, Raises Many Ethical and Regulatory Issues beyond the Use to Manipulate Human Germ Line Cells," *EMBO Reports* 16, no.11 (November 8, 2015) : 1421, https://doi.org/10.15252/embr.201541337.

[208] Caplan et al, "No Time to Waste—the Ethical Challenges Created by CRISPR : CRISPR/Cas9, Being an Efficient, Simple, and Cheap Technology to Edit the Genome of Any Organism, Raises Many Ethical and Regulatory Issues beyond the Use to Manipulate Human Germ Line Cells," 1422.

[209] Caplan et al., 1422.

[210] Caplan et al., 1422.

[211] Caplan et al., 1422

[212] Caplan et al., 1422.

[213] Caplan et al., 1422.

[214] Caplan et al., 1422.

8) Social Superiority

When a new cutting-edge technology is introduced to the world, the majority of individuals will be curious as to what it is. Something such as CRISPR-Cas9 will definitely grasp the attention of a lot of individuals who will want to use it in order to edit genes to be immune to certain diseases. Specifically, gene therapies that affect the human germline because that will mean future offspring will be immune to certain diseases. Also, others may be interested in genetic enhancement in order to enhance some genetic traits. These desires always come at a price and not many individuals would be able to afford this.

There are at least three different concerns that are raised in relation to the negative impact on society with genetic interventions. The first concern is wealthy people having access to genetic technology in order to have an advantage over the poor, both within nations and on a global basis.[215] Could this create an increasing divide between social classes?[216] Could this divide also be applied to poor and rich nations?[217] The rich could have a higher advantage over the poor because they can afford these special treatments. This could cause a divide between social classes where the more affluent individuals will have access to this genetic technology to better themselves and as a result, possibly see themselves as more superior than unenhanced humans.

The second concern is that genetic enhancement could deteriorate the respect that people have for one another.[218] Could this lead to individuals seeing themselves as profoundly different from the poor?[219] As mentioned previously, enhanced beings could start seeing as themselves as better than the unenhanced person, and this could lead to a loss of respect toward a less fortunate person. Some individuals could start seeing themselves as fundamentally different from the poor and this may lead to poor treatment of these people who cannot afford these genetic interventions.

The third concern affects the poor because how can we explain "spending millions of dollars of private or federal research funds on high-tech genetics in a world where so many people lack access to basic medical care."[220] This will certainly have a negative impact on the poor because it questions how a less fortunate person could afford these genetic interventions when they cannot even get basic medical care in their own country. It could make the poor, poorer if this were to happen.

On the contrary, "gene enhancements, if properly handled, could narrow the gap between society's haves and have-nots, between developed and developing nations."[221] Thus, gene enhancements could offer nations things that they could have been missing in order to make their people healthier and stronger. Furthermore, genetic modification can challenge the superiority that supports class and social divisions and it can create new opportunities for the less fortunate.[222] It could increase instead of reducing parents' reproductive options and it could possibly avoid bad eugenics of the past.[223] Additionally, germline gene modifications "may actually *lower* health care

[215] Ronald M. Green, *Babies by Design: The Ethics of Genetic Choice* (New Haven: Yale University Press, 2007), 209.
[216] Green, *Babies by Design: The Ethics of Genetic Choice*, 209.
[217] Green, 209.
[218] Green, 209.
[219] Green, 209.
[220] Green, 209.
[221] Green, 210.
[222] Green, 210.
[223] Green, 210.

costs for [people] by replacing costly halfway medical technologies with dramatic new solutions to health care needs."[224] Individuals will not need to spend as much money on medical exams. Since CRISPR can target the eradication of diseases in the somatic and human germline, then they will not need to get regularly checked for a certain disease they have had for themselves or for their future offspring.

Conclusion

The ethical debate of CRISPR-Cas9 presents many opinions on whether or not it should be allowed. It raises many questions regarding the outcomes when it comes to third-party interventions.

Many believe that they should not be intervening because it should be up to the future child whether they want to be genetically enhanced. Habermas believes that when people intervene, the offspring will not be autonomous agents and will question their own self-understanding as they get older. Yet, sometimes it is acceptable for a parent to intervene because they only want what is best for their children and that is the case when it comes to therapeutic interventions, so the children and future generations can forever be immune to a specific disease. Correspondingly, when using John Rawls' veil-of-ignorance method, contingency relates to human choices and humans are the author of their own lives whether they are genetically modified or not. Thus, under a veil-of-ignorance, their decisions are to protect themselves from sickness which benefits all populations. It is also equally important to note that one may not be able to see themselves as the author of their own lives if their enhanced traits were chosen by someone else.

John Harris believes there are other external factors that can influence a person's life history, such as parents and teachers, and not just gene enhancements. No human has ever lived without some sort of external influence. On the other hand, Michael Sandel opposes enhancement not because of the lack of life history claim, where one has their life predetermined because of a specific trait that was chosen for them, but because people will not be exposed to chance to see what they are good at and not good at. Yet, a person could still be fully autonomous and responsible for their actions despite being genetically enhanced. An enhanced person still has the power to decide on whether or not they would want to use their enhanced capacity even though it was given to them by someone else. Their moral agency and autonomy will not be diminished, and they will have just as much contingency as the unenhanced person. Likewise, some say they would want their children to be immune to certain diseases instead of having them be cautious all their lives in order to avoid contracting them. With these reasons in mind, it is important to note the psychological effects of an enhanced person where sometimes that enhanced person cannot mentally grasp the fact that they are responsible for their own actions rather they think someone else is. This is why they would need a support group to reassure them that they are their own person. Like the unenhanced person, we all handle our situations differently.

Additionally, some say the role of gene editing could eradicate a species which could lead them to extinction. This can be seen with the example of mosquitoes where they are genetically edited to be sterile in order to not carry malaria and give it to humans. This shows the negative aspect of gene editing without any regulation. Then there is also the aspect of social superiority where genetically modified individuals will be superior over those who are not because they cannot

[224] Green, 210.

afford this kind of treatment. These less fortunate people will not be respected as equals anymore. On the other hand, gene editing could help the less fortunate by giving them more reproductive options and replace the medical care we have currently with more cutting-edge technology.

Ultimately, the ethics of gene editing allows for many questions to be asked and each situation needs to be assessed accordingly to determine if it is something that could be beneficial to future generations.

Chapter 3: Theology and Genetic Editing Technology

Introduction

With CRISPR-Cas9 emerging in the scientific world and all the contemporary ethical issues surrounding it, it is important to evaluate it in terms of a deeper meaning, specifically through a theological perspective.

In the science and medical world, it is important for physicians to treat their patients exceptionally well. The foundations of Christian faith provide an understanding of what this means. Daniel Sulmasy, a general internal medicine doctor and bioethicist, insists that when healing a patient, it should be done as an act of love. Sulmasy states that through the love a physician has for God, they should do everything they possibly can to save the patient, who is incarnate in God, until there are no other means left. In Christian faith, God created humanity in his image, thus God is incarnate in them. This means that doctors are to serve patients who want to be treated so that they can improve themselves in the image of God and doctors must do this with love to preserve God's work on Earth. In addition, he also states the importance of a physician-patient relationship by drawing on Franciscan compassion which means to go above and beyond for the patient in imagining new ways to help treat their illness. Sulmasy also emphasizes the importance of transcendent questions that a patient may have and how a doctor should go about addressing them.

Genetic modification also raises the issue of humans trying to play God. Papal and church documents from Popes John Paul II, Benedict XVI, and Francis have mentioned that the risks associated with germline gene editing are too grave to even attempt but somatic gene editing is acceptable. It is strongly suggested in these documents that there needs to be a discussion to regulate these genetic interventions.[225] Furthermore, according to the Jewish and Christian tradition, when God created humanity, humans were not equal to God and should not be second guessing God's will or doing anything to his creations when they are not ill, such as genetic interventions to enhance a trait. Genetic modification draws the attention of future-oriented theology, meaning we look forward to future offspring as being a part of our community and how

[225] International Theological Commission, *Communion and Stewardship: Human Persons Created in the Image of God,* accessed July 10th, 2019, http://www.vatican.va/roman_curia/congregations/cfaith/cti_documents/rc_con_cfaith_doc_20040723_communion-stewardship_en.html; Congregation for the Doctrine of the Faith, Instruction *Dignitas personae*, On Certain Bioethics Questions, accessed July 10th 2019, http://www.vatican.va/roman_curia/congregations/cfaith/documents/rc_con_cfaith_doc_20081208_dignitas-personae_en.html; John Paul II, *Dolentium hominum,* accessed July 10th, 2019, http://www.vatican.va/content/john-paul-ii/en/motu_proprio/documents/hf_jp-ii_motu-proprio_11021985_dolentium-hominum.html; Francis, *Laudato si',* accessed July 10th, 2019, http://www.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html.

the future people adapt to change. This theology envisions a future that God may have intended, where humanity will preach God's divine purpose for a life with reduced pain and suffering.

Genetic enhancement can be seen as a type of salvation because it helps escape human error, but this is not the true form of Christian transcendence. In terms of the Christian doctrine of eschatology, every human and non-human creature is on its way to its unity and glorification in Christ. However, some say that technology could tempt humanity to imagine a future made by human effort relying on something other than God's grace. Genetic modification raises the question of what it means to be human. Humans can be changed by genetic modifications but according to some, that does not mean God will see them as any different from non-modified humans. Some say it is a way to improve what God has made. The answer to what it means to be human brings different viewpoints where scholars may not be in agreement with each other.

From a Jewish perspective,[226] it is important for a doctor to heal a patient because they are God's agent and genetic modification can be seen as a health care option to heal all. God created the world in a way for humanity to constantly improve in order to preserve God's creation and this is what genetic modification can do.

This chapter discusses the importance of Christian faith in healthcare (in the section titled "Foundations") and how the role of "playing God" in humans can be a problem concerning gene editing in relation to church documents and creation theology (the section titled "Playing God"). Next, in the section titled "The Jewish Tradition and Genetic Modification," the Jewish perspective will be discussed exploring the Jewish view on genetic modification. Then in the section titled "Future–Oriented Theology," I will discuss theology in terms of how future generations will adapt in our community due to the changes offered by gene editing and how it pushes individuals to build a life free from pain and suffering. Following this, eschatology and genetic modifications will be explained in order to explore how genetically modified individuals might find salvation in Christ. Finally, raising the question of what it means to be human will be discussed to show what happens when our bodies are genetically modified.

1) Foundations

The theological method of foundations is concerned with the origins, the genesis, the present state, the possible developments and adaptations of the categories in which Christians understand themselves, communicate with one another, and preach the gospel to all nations.[227] It plays a very important role in the area of healthcare. The foundation of Christian faith is important in healthcare because it radically changes how the physician works. Thus, from this perspective, to be able to serve God is to be able to form deeper connections through spirituality, to be able to comfort the patient and tend to their needs through the inspiration of God's love.

[226] The article I draw on for the Jewish perspective is by Elliot N. Dorff and is titled, "Judaism and Germline Modification," from *Design and Destiny: Jewish and Christian Perspectives on Human Germline Modification*, ed. Ronald Cole-Turner (Cambridge: MIT Press, 2008). Dorff draws on many different Judaic traditions to propose a common Jewish perspective.

[227] Bernard J.F. Lonergan, *Collected Works of Bernard Lonergan: Method in Theology,* ed. Robert M. Doran and John D. Dadosky (Toronto: University of Toronto Press, Scholarly Publishing Division, 2017), 274.

Love is the central ethic in Christian faith and physicians draw on love to do their work. Sulmasy states:

> Gospel-centered health care begins where the gospel begins, in an encounter with a Person. We meet that person in each patient that a physician serves, one at a time. Gospel faith tells us that God is love. Love is ultimately an act of surrender, surrender to our heart's deepest desire, which is both of God and For God. The Gospel impels us to serve our patients with love, full of faith that the infinite God is, incarnate in our world, especially in the sick.[228]

Thus, for Sulmasy, the Gospel begins with an encounter with a Person (God) and it introduces the global aspect of what God is, which is love. The Gospel sheds light on how doctors can serve patients with love because God is incarnate in our world, specifically in people who are ill. To rephrase Sulmasy's words, love is the ultimate surrender to our heart's deepest desire which is both of God and for God. We should serve each patient as if we were serving God, which will make the physician provide the best care they possibly can.

What light might this shed on the physician/patient relationship in genetic modification? For many, in the Christian faith God created humans in his image which means God is incarnate in them. This suggests that doctors serve these patients who want to improve themselves in the image of God with the utmost love to preserve God's work on Earth. In a secular society, can Christian values be altered to some degree where individuals see love as something to satisfy their own desires?[229] They can disregard *agape*, the other-regarding love, which Christian faith considers to be the highest form of love and which is also God's love for humanity.[230] Some doctors who focus on the advances of science rather than the well being of their patients, can demonstrate a selfish love instead of a love they have for God. Since CRISPR is a relatively new technology, the physicians who have had breakthroughs with CRISPR might see it as a sense of accomplishment, which could symbolize a self-satisfying love, rather than the love that they have for their patient.

Sulmasy also mentions that transcendence plays an important role when wanting to incorporate the foundation of Christian faith in healthcare. Physicians are to heal whole persons; not only to understand injury to the body but what disease and injury can do to them as an embodied spiritual person dealing with transcendent questions.[231] Here it can be seen that physicians need to be able to heal people by understanding that the illness affects the body and spirit because this person could have numerous deep questions about their illness. Moreover, if physicians "are to heal patients as whole persons, they themselves must seriously engage in transcendent questions that only persons can ask" and if they are "true healers, they must rediscover what it means for health care to be a spiritual practice."[232] They can rediscover the meaning of spirituality in

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[228] Daniel P. Sulmasy, "Without Love, We Perish: Gospel-Centered Health Care is a Radical Approach in Today's Secular World," *Health Progress* 90, no. 4 (July 2009): 35, https://www.chausa.org/publications/health-progress/article/july-august-2009/without-love-we-perish.

[229] Daniel P. Sulmasy, "Without Love, We Perish: Gospel-Centered Health Care is a Radical Approach in Today's Secular World," 33.

[230] Sulmasy, 33.

[231] Daniel P. Sulmasy, "Strong Medicine: Health Care Practice as a Spiritual Discipline," *Human Development* 30, no. 1 (Spring 2009): 9, http://0-search.ebscohost.com.mercury.concordia.ca/login.aspx?direct=true&db=rfh&AN=CPLI0000477980&site=eds-live .

[232] Sulmasy, "Strong Medicine: Health Care Practice as a Spiritual Discipline," 9.

healthcare by engaging in the patients' questions and a bond can be formed. Furthermore, illness raises troubling questions of a transcendent nature, about meaning and value. How physicians address these questions for themselves will affect the way they help their patients struggling with them.[233]

Transcendent questions of meaning that can arise from patients are: "what is the meaning of my illness?" "…my suffering?" "…my death?"[234] When it comes to disease, patients wonder what illness means and what the meaning of suffering is, which will then lead to questions concerning their death. The physician might help the patient reflect on what it means, if there is something one might hope for even if that patient is not cured, or if there is any spiritual significance to the word 'hope'.[235] This could imply that hope could be religiously related or it could signify a prayer that needs to be expressed.

Transcendent questions about value are questions patients have concerning how value relates to their appearance, to their productivity or their independence.[236] In addition, these questions ask if there is anything about that patient that is valuable when their appearance, productivity or independence are threatened.[237] These questions also ask if there is anything valuable about the patient that will persist after death.[238] Physicians may also have questions regarding value such as if the patient is able to hold on to a sense of their own dignity and purpose.[239] Do the people close to the patient care about them as a person?[240] Are there any spiritual or religious resources upon which the patient can draw to help see them through this?[241]

The transcendent healing process of the divine is not only found in dying patients but in all moments of the hospital experience since they are always communicating meaning and value to patients.[242] Physicians are always communicating transcendence to all patients because they care about their patients' well being and want to be able to help their patients spiritually. Sometimes a physician-patient relationship can be shattered, for instance, when a physician uses a drug incompetently and they violate the trust the patient has placed in them.[243] A good healthcare professional will address the patient's questions as to why this drug was used incompetently in order to try and rebuild the patient's trust once more. It is a trust that transcends the relationship between the patient and physician and transcends the pharmaceutical drug.[244] To betray that trust is to deny the spirit.[245]

We have argued that transcendent questions that a patient asks a doctor are very important in a physician-patient relationship. Sulmasy's insights can also be used in relationships scientists can have with patients in terms of gene editing. These patients will also have questions regarding

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[233] Sulmasy, 10.

[234] Daniel P. Sulmasy, "Spiritual Issues in the Care of Dying Patients: ". . . It's Okay Between Me and God"," *JAMA* 296, no.11 (September 20, 2006): 1387, https://doi.org/10.1001/jama.296.11.1385.

[235] Sulmasy, "Spiritual Issues in the Care of Dying Patients: ". . . It's Okay Between Me and God"," 1387.

[236] Sulmasy, 1387.

[237] Sulmasy, 1387.

[238] Sulmasy, 1387.

[239] Sulmasy, 1387.

[240] Sulmasy, 1387

[241] Sulmasy, 1387.

[242] Sulmasy, "Strong Medicine: Health Care Practice as a Spiritual Discipline," 10.

[243] Sulmasy, 10.

[244] Sulamsy, 10

[245] Sulmasy, 10.

meaning and value in relation to what happens after the gene editing process is completed. When a doctor is using gene therapy on a patient, they need to understand that the disease not only affects the body but also the spirit. Before going through with these gene therapies, physicians will need to engage in transcendent questions in order to understand their patients. This will then indicate that they are forming deeper connections with their patients rather then just a quick fix using genetic interventions.

Gene therapies play a part in the process of transcendent questions of meaning. The patient will want more information in regards to the disease they have and how the cure could fix it. They want to know why there is so much suffering from the disease they have and about the possibility of death. The doctor then explains to them more about their specific disease and the chances of them being cured after taking part in these genetic interventions. In regards to the death aspect, the doctor can mention the possibility that they will be able to live a long and healthy life after receiving this treatment. Therefore, the doctor gives the patient hope and could also refer them to a spiritual coordinator if they wish to receive help beyond the medical world.

Transcendent questions about value also play an important role in the world of genetic modifications. This is where the patient could be struggling the most yet also receive a sense of purpose again. With the aid of genetic therapy, a person's value can become positive since the disease can be treated and they may start feeling better physically. They may then be able to live a productive life and act independently and make their own decisions. With the help of gene therapy, patients may begin to see themselves as valuable because they may be able to contribute to society. It might be possible when death approaches them in old age, that they can look back and see that they did live a valuable life that their loved ones will remember. A spiritual coordinator could speak with a patient to see if they are able to understand their own dignity and purpose after being genetically edited. Spiritual coordinators can do this by asking questions such as "are you concerned you will not be the same person?" or "do you feel you are not responsible for your own actions anymore?" Some people may not be able to grasp the fact that their genetic makeup has been edited. Specifically, if it was a choice done by a parent and the child only finds out later in life. This might cause that person to feel that they are not responsible for their own health but rather someone else is. The physician also needs to make sure that the people close to a genetically modified patient still sees them as a person and not someone who is alien to them. The physician should consult with the family and see if they have any questions regarding the genetic modification process. The physician could address their questions and reassure them that the patient is still the same person they knew prior to the procedure. If the family still has further questions that the physician is not equipped to address, they can refer the family to a therapist who can better aid them in speaking about their feelings with this. Furthermore, if the patient is struggling to grasp this new change then the physician may recommend a spiritual/religious or psychological resource in order to help them gain a sense of themselves.

For individuals that have a terminal illness and cannot be cured by gene therapies, traditional Christian theology still considers their lives as valuable. These patients may have lived with this illness through the course of their life and were dependent on others, but it does not mean that their lives were not worthwhile. They were valuable in the sense that they belonged to a family or had people that they loved. Terminally ill or not, Christian ethics sees human lives as valuable.

Since Sulmasy was a Franciscan friar, he explains the importance of compassion in Franciscan spirituality when incorporating it in the foundation of Christian faith in healthcare in

three different forms. Sulmasy explains the difference between generic compassion and Franciscan compassion.[246] Franciscan compassion is mediated along the following three dimensions; personal, incarnational and imaginative.[247] In terms of genetic modification, only incarnational and imaginative will be considered because personal has already been mentioned above.

The second dimension of Franciscan compassion is incarnate compassion. Incarnate compassion means compassionate action.[248] For instance, it means emptying bedpans, using morphine judiciously to relieve the pain of the dying patient, binding wounds with reverence and love, and taking the time to listen.[249] Consequently, physicians who live and practise a Franciscan spiritual life will be present in the flesh.[250] These listed examples demonstrate that compassionate action is about being attentive to the patient's needs and giving them the best possible care. It is about being there for them. In addition, it means to go the extra mile to fight for the needs of patients when they are denied essential care such as health insurance by societies that transform healthcare into a business exchange.[251] In other words, it is a physician's job to provide health care to all patients. In a story with Saint Francis and Saint Clare, they showed concern for their sick brothers and sisters by feeding them grapes, providing feather pillows and blankets to help with their discomfort[252] Saint Francis and Saint Clare first demonstrated this compassionate action in a simple way by feeding and providing comfort to the sick which then sets an excellent example for physicians acting in today's secular world.

The third dimension of Franciscan compassion is imaginative compassion. Physicians with Franciscan imagination will see in the suffering of patients and in the suffering of the physician, the suffering of Christ the Lord.[253] Physicians who practise Franciscan spirituality should have imaginative compassion in order to imagine Jesus' suffering in themselves and in the patients they treat. Moreover, physicians put their hands in bloody wounds every day and need to have religious imagination to find God there because God is in the suffering and in the compassionate hand that reaches out to heal.[254] Physicians are to treat the wounds of the patients as if they were treating the wounds of God.

Furthermore, Franciscan imagination encourages scientific research for the sake of the sick.[255] God's gifts of reason and imagination seek new ways to ameliorate the symptoms of suffering.[256] Franciscan imagination will also challenge physicians to create new healthcare structures because healthcare today increasingly dulls the imagination, turning patient care into an

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[246] Daniel P. Sulmasy, "A Franciscan Spirituality of Healthcare," *New Theology Review* 14, no. 4 (November 2001): 45, https://search-ebscohost-com.lib-ezproxy.concordia.ca/login.aspx?direct=true&db=rfh&AN=CPLI0000283546&site=ehost-live&scope=site.

[247] Daniel P. Sulmasy, "A Franciscan Spirituality of Healthcare," 45.

[248] Sulmasy, 47.

[249] Sulmasy, 47.

[250] Sulmasy, 47.

[251] Sulmasy, 47.

[252] Daniel P. Sulmasy, *A Balm for Gilead: Meditations on Spirituality and the Healing Arts* (Washington, D.C.: Georgetown University Press, 2006), 100-01.

[253] Daniel P. Sulmasy, "A Franciscan Spirituality of Healthcare," 47

[254] Sulmasy, 48.

[255] Sulmasy, 48.

[256] Sulmasy, 48.

assembly line.[257] The Franciscan approach personalizes the healthcare system, creating doctor-patient relationships based on love rather than a business model.

This is an important factor for scientists to consider with their patients who want to use genetic interventions and want to form a virtuous relationship to them. To have a doctor who listens to you and tends to your needs when you are ill is essential because a trusted bond is formed between the physician and patient. These doctors/scientists know that gene therapies can be costly and not everyone can afford it. For this reason, it should be up to doctors to stand up for patients when the government and insurance companies deny this essential care to patients who need this treatment. This would not be fair because every person has the right to essential health care. As stated in the previous chapter, gene editing technologies could replace our present mediocre technologies in order to give society the proper health treatments they need.

The third dimension of Franciscan compassion also plays an important role in terms of genetic modification. It gives the scientists/doctors a mental visual as to what the patient is going through and what their suffering must feel like with the illness that they have. The symbolism used to imagine Jesus' suffering in patients can drive scientific research for the sick, for instance, the use of genetic interventions with CRISPR. This type of motivation will only have an impact on scientists/doctors who are believers in Christ. Through God's gifts of reason and imagination, scientists will conduct more research to see how CRISPR can target the infected DNA. This will prompt scientists to conduct research on animals to test its accuracy and see what off-target effects could occur. Through these continuous tests, improvements can be made to reduce the off-target mutations. Once that has been done, scientists and doctors can move on to conduct human clinical trials in order to see its effect on humans and if the disease is treated permanently.

Physician-Patient relationships that draw on Christian spirituality could provide important insights for scientist-patient relationship in gene editing. The insights of Christian spirituality exemplified in Franciscan compassion can be used for genetic modifications in order to help scientists/doctors have a deeper understanding of their patients and see them as more than test subjects in a lab-based experiment.

2) Playing God

Genetic modifications can give people the power to manipulate genes in order to improve themselves by either eradicating a disease or enhancing a specific trait. This kind of power can be seen as a God-like power to the human person. Individuals are able to change a human being's genetic makeup prenatally either to be immune to a certain disease or even enhance a certain trait according to the parents' desires. Some Christians would not agree with this because they feel that they are violating God's creation since God made everyone in his image.

Public opinion polls at the beginning of the era of genetic engineering in the early 1980s showed that two-thirds of Americans believed that altering human genes is against God's will.[258] In addition, in a nationwide telephone survey that was commissioned by *Harper's Magazine* in 1997, people were asked to choose from a list about who should have the power to control the

[257] Sulmasy, *A Balm for Gilead: Meditations on Spirituality and the Healing Arts,* 102.
[258] Green, *Babies by Design: The Ethics of Genetic Choice*, 265.

genetically linked characteristics of a child before birth.[259] Less than one percent of respondents chose "the doctor"; eleven percent chose "the parents"; sixteen percent chose "no one" and seventy percent chose "God". [260] At that time, the average American was known to be quite religious and many felt as though only God had the power to control genetically linked characteristics. In January 2016, a poll was conducted by STAT and the Harvard T.H. Chan School of Public Health in the United States asking who should make decisions on whether or not to allow changing genes before birth.[261] Fifty-three percent said it should be left up to scientists, physicians and similar experts.[262] Nine percent said it should be left up to government officials and policy makers.[263] It is clear from the 2016 poll Americans have become more secular and believe that scientists/physicians should be responsible for changes made on genes. Nineteen years ago, it was less than one percent who said it should be up to the doctor, indicating that many Americans today have more faith in science than in God, indicating that Americans may have come to trust science more but this does not necessarily mean that they have lost faith in God.

Despite a climate of increasing secularism, the Church provides contributions to the global decision-making process in rapidly advancing technologies.[264] The distinctive reasoning and values of the Catholic church offers one possible framework for achieving the goods of human genome editing while avoiding its harms.[265]

In 2003, Cardinal Joseph Ratzinger[266] openly approved germline genetic engineering that involves genetic modifications in a man's sperm-producing cells, i.e. a man's germline cells.[267] Other Christian commentators urged a special caution to it because it involves germline interventions.[268] Yet, Ratzinger and the other commentators both agreed that interventions designed to prevent or cure disease, including those that can safely eliminate a genetic disorder from a family line, are consistent with the traditional permission for human medical care.[269] The church document, *Communion and Stewardship: Human Persons Created in the Image of God* also stated that:

> Germ line genetic engineering with a therapeutic goal in man would in itself be acceptable were it not for the fact that is it is hard to imagine how this could be achieved without disproportionate risks especially in the first experimental stage, such as the huge loss of embryos and the incidence of mishaps, and without the use of reproductive techniques. A possible alternative would be the use of gene therapy

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[259] Green, 265.

[260] Green, 265.

[261] Sharon Begley, "Harvard Poll: Americans Say No to 'Designer Babies'," STAT, STAT, February 16, 2016, https://www.statnews.com/2016/02/11/stat-harvard-poll-gene-editing/.

[262] Begley, "STAT-Harvard Poll: Americans Say No to 'Designer Babies'."

[263] Begley, "STAT-Harvard Poll: Americans Say No to 'Designer Babies'."

[264] Kevin FitzGerald, "Human Genome Editing: A Catholic Perspective," *The National Catholic Bioethics Quarterly* 17, no. 1 (2017): 108, https://doi.org/10.5840/ncbq20171719.

[265] FitzGerald, "Human Genome Editing: A Catholic Perspective," 108.

[266] Now Pope Benedict XVI.

[267] Green, *Babies by Design: The Ethics of Genetic Choice,* 267, paraphrased from International Theological Commission, *Communion and Stewardship: Human Persons Created in the Image of God,* nn.90.

[268] Green, 267, paraphrased from International Theological Commission, nn.90.

[269] Green, 267, paraphrased from International Theological Commission, nn.90.

> in the stem cells that produce a man's sperm, whereby he can beget healthy offspring with his own seed by means of the conjugal act.[270]

This statement clarifies Ratzinger's early statement about approving germline gene editing in a man's sperm. If gene therapy is used to alter the genetic makeup on a man's stem cells to produce a man's sperm, then they can conceive babies naturally rather than genetically modifying an embryo which poses too many risks.

In 2008 Benedict XVI[271] who was part of a congregation that wrote the church document, *Dignitas personae*, which directly addresses gene therapy and states that "*procedures used on somatic cells for strictly therapeutic purposes are in principle morally licit* since such actions *seek to restore the normal genetic configuration of the patient or to counter damage caused by genetic anomalies or those related to other pathologies*" (Italics are mine).[272] As for germline therapy, since the risks connected to any genetic manipulation are not yet 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*…the questions of using genetic engineering *for purposes other than medical treatment also calls for consideration*" (Italics are mine).[273] Germline gene editing is still something that could pose a danger to future generations even if it is to cure a disease and enhancement procedures still need to be spoken about among the general population to see if it should be allowed.

The commonality between the two texts show that Benedict XVI and his congregation agree that germline genetic engineering is not safe enough to use because of all the risks that were associated with it. More research needs to be done in order for it to be effective. The only plausible option would be somatic gene therapy since it is the safer option or gene therapy on a man's sperm using stem cells. Anything that involves changes to future generations should not be considered just yet.

John Paul II stated that "a curative intervention, whether genetic or otherwise, generally 'falls within the logic of the Christian moral tradition.'"[274] Furthermore, in John Paul II's apostolic letter *Dolentium hominum*, he states "that medicine and therapeutic cures be directed not only to the good and the health of the body, but to the person as such who, in his body, is stricken by evil."[275] Healing the person does not only mean healing the wound, it includes the healing of the spirit as well. When a person is healed spiritually, their positivity and will for life come back. Evil is not only the disease, but also how the disease affects the person spiritually. For instance, the disease could lead the patient into a depression. Thus, when a doctor restores the patient back to health, they are removing this depression as well and the patient's morale improves. The concern about playing God seems to focus on the idea of genetic enhancement. John Paul II articulated his

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[270] International Theological Commission, *Communion and Stewardship: Human Persons Created in the Image of God,* nn.90.

[271] Formerly Cardinal Joseph Ratzinger.

[272] FitzGerald, "Human Genome Editing: A Catholic Perspective," 112, quoted from Congregation for the Doctrine of the Faith, Instruction *Dignitas personae*, On Certain Bioethics Questions, nn.26-27.

[273] FitzGerald, 113, quoted from Congregation for the Doctrine of the Faith, nn.26-27.

[274] Green, *Babies by Design: The Ethics of Genetic Choice,* 267; quoted from Pope John Paul II, "Ethics of Genetic Manipulation," *Origins* 13, no. 23 (November 17, 1983): 388.

[275] FitzGerald, "Human Genome Editing: A Catholic Perspective," 111; quoted from John Paul II, *Dolentium hominum,* nn. 1-2.

opinion by stating that he approved of medical genetic interventions but "he urged the avoidance of 'manipulations tending to modify the [human] genetic store.' "[276]

In Francis' encyclical letter *Laudato si'*, he states on the topic of genetic enhancement that "discussions are needed in which all those directly or indirectly effected (farmers, consumers, civil authorities, scientists, seed producers, people living near fumigated fields, and others) can make known their problems and concerns, and have access to adequate and reliable information in order to make decisions for the common good, present and future."[277] With gene editing, there needs to be a discussion, not just with scientists, but everyone because this is something that will affect all of humanity. While Francis is referring to genetically modified food, his comment can be applied to examples related to therapeutic interventions. There needs to be a discussion on what illnesses should be considered for its use. This would involve scientists, doctors, patients, patients' families and government. By going through different case studies, government and medical professionals would need to come together to decide what diseases qualify for genetic therapy. Yet, every illness is harmful and severe in its own way and government officials need to take this into consideration. Patients and their families need to be involved in the discussion to advocate their views that they should be allowed to use gene therapies regardless of what illness it is. The government needs to listen to what they have to say and make decisions around that as well. This is why discussion is important; it allows all the voices to be heard and understood. There needs to be discussion and regulation in order to make decisions that will benefit us presently and for the future.

The use of genetic modification for purposes other than medicine also needs to be discussed. For instance, in *Dignitas personae* it states that:

> Some have imagined the possibility of using techniques of genetic engineering to introduce alterations with the presumed aim [to] [improve] and [strengthen] the gene pool, [but] these proposals exhibit a certain dissatisfaction with or even rejection of the value of the human being as a finite creature and person. Apart from technical difficulties and the real and the potential risks involved, such manipulation would promote a eugenic mentality and would lead to social stigma with regard to [certain] people who lack certain qualities, while privileging qualities that happen to be appreciated by a certain culture or society.[278]

Therapeutic modifications to the germline might not be completely ruled out if safe procedures and outcomes can be achieved.[279] Clinical trials are still required in order for therapeutic modification to be approved completely. The risk of off-target effects are too hazardous to even attempt on the human germ line since subsequent generations could be affected. Moreover, to purposely create people who are considered better and more valuable than others raises a

[276] Green, *Babies by Design: The Ethics of Genetic Choice,* 268; quoted from quoted from Pope John Paul II, "Ethics of Genetic Manipulation," 388.

[277] FitzGerald, "Human Genome Editing: A Catholic Perspective," 120; quoted from Francis, *Laudato si',* n.135.

[278] FitzGerald, 113, quoted from Congregation for the Doctrine of the Faith, Instruction *Dignitas personae*, On Certain Bioethics Questions, nn. 26-27.

[279] FitzGerald, 113.

disagreement in the assessment of different human beings which violates the Christian vision of primacy of the equality of all human lives.[280]

In the book of Genesis, God repeatedly states that creation, including the creation of human beings, to be "good" or "very good" (Genesis 1:4, 10, 12, 18, 25, 31).[281] In a world created by God as "good", do we have the authority to make changes or improvements?[282] The world came into existence with divine blessing, and to change it, other than to repair the damage that humans brought, can be seen as a rejection of God's sovereignty and trying to play God.[283] Some Christians hold the view that a human person should not be God-like and change the world God made. This view applies to genetic enhancements because the human genome comes into being at God's behest.[284] Granted, the correction of disorders do fit in with the general permission to diminish the ravages of sin, gene enhancement exemplifies to second-guess God's will for a child and putting ourselves in God's place by attempting this technology.[285]

Habermas draws on theology to explore the idea of the distinction between Creator and creature. He draws on Christian Theology by saying that human beings are made in the image of God: they are creatures and cannot be equal to God.[286] Furthermore, humans were created free but if they were emanations from God, their being would be equivalent to God and remain determined by God's being.[287] However, Robert Song, an ethicist, states that since humans are created by God's will, there can be a definite difference between creator and creature, and God's determination of humanity can also be a determination that they are free.[288] Humans are given the Bible to understand God's guidelines, but it is their choice to understand what is right and wrong. God gave humanity the gift of free will and choice. Guided by an interpretive community, human beings can choose what they want to do with the information in the Bible. Accordingly, it is a person's choice then, whether or not they choose to apply genetic interventions on an embryo or be genetically modified themselves. It is their decision on whether it is right to play God in that sense.

The fact that humans are created, there are three implications that are relevant to the question of genetic enhancement.[289] First, according to Christian theology, the goodness of creation which includes our bodies makes a clear assumption against intervening.[290] In addition, the Western tradition of medicine states that if the body is healthy, the first thing a doctor should do is to not perform any action that would harm the body.[291] Since genetic enhancement procedures are invasive and with the potential of off-target effects then it would not be recommended. Still,

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[280] FitzGerald, 113.
[281] Green, *Babies by Design: The Ethics of Genetic Choice,* 269.
[282] Green, 270.
[283] Green, 270.
[284] Green, 270.
[285] Green, 270.
[286] Robert Song, "Knowing There Is No God, Still We Should Not Play God? Habermas on the Future of Human Nature," *Ecotheology* 11, no. 2 (June 2006): 205, https://doi.org/10.1558/ecot.2006.11.2.191.
[287] Song, "Knowing There Is No God, Still We Should Not Play God? Habermas on the Future of Human Nature," 205.
[288] Song, 205.
[289] Song, 207.
[290] Song, 207.
[291] Song, 207.

therapeutic interventions may be allowed but more research is needed to reduce effects that can harm the body. If the body is healthy, then the doctor will research to see if this intervention will cause more harm than good considering its side effects. The doctor should not be playing God if they do not need to; if the body is healthy then doctors should not do anything to it. They should not enhance the body that God made if there is nothing wrong with it, especially since off-target effects could occur, potentially causing ailments to the body.

Secondly, even a favourable decision to intervene in an individual case has limits with regard to human responsibility for the future.[292] The future is not something we can mould as a whole.[293] Still, parents feel that it is their duty to make plans for the future because therapeutic interventions can prevent unnecessary illness. They want to guarantee that their child is born healthy and free of a disease that would disrupt their quality of life. On the other hand, people performing genetic enhancement could control the future in regards to creating a human person tethered to their specific needs. The future needs to occur naturally and not be known to present people unless it is to prevent a disease. The only time it seems plausible for a human to play God and mould the future is to prevent or eradicate a disease with genetic modification. This ensures a healthy life for the future human being.

Thirdly, the resurrection as the confirmation of the created order also opens a discussion for making distinctions between therapy and enhancement, between healing what is wounded and enhancing what is given.[294] Medicine, from a theological perspective is understood in terms of healing, which in the New Testament symbolizes a witness to salvation in Christ.[295] Humans are not trying to play God in this perspective, rather the patient they are healing with therapeutic interventions symbolizes God, therefore it is as if they are healing God as Sulmasy mentioned in the previous section. He also stated that the person being healed by the physician symbolizes the salvific Christ who rose from the dead and it is the physician's purpose to do everything they can to heal that person.[296] If the patient is healed, it symbolizes the Christ who rose from the dead.[297] This is not always the case for the terminally ill, but it is the physician's job to provide them with the best possible care they can. The danger of genetic enhancements is that it suggests the body is raw material to be improved by technology, where salvation can be seen as part of the gnostic struggle to escape from human frailty.[298] In terms of genetic enhancement, CRISPR can be used on the body to edit the genes the person desires because humans feel the need to fix themselves since they feel they are defective or imperfect, i.e. wanting to escape from human frailty. In the case of genetic enhancements, humans are considered to be playing God in a sense because they are enhancing themselves to escape the body that God gave them. They see genetic enhancement as a salvation because of the improvements it does to the body instead of trusting what God has for them.

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[292] Song, 207.

[293] Song, 207, paraphrased from Oliver O'Donovan, *Begotten or Made?* (Oxford: Clarendon Press, 1984), 13.

[294] Song, 207.

[295] Song, 207.

[296] Sulmasy, "Without Love, We Perish: Gospel-Centered Health Care Is a Radical Approach in Today's Secular World," 35.

[297] Sulmasy, 35.

[298] Song, "Knowing There Is No God, Still We Should Not Play God? Habermas on the Future of Human Nature," 207-208.

3) The Jewish Tradition and Genetic Modification

While the focus above has been on Christian perspectives in exploring ethical and theological thinking around genetic modifications, there is also literature providing Jewish perspectives that are important to consider. Rabbi Joseph Karo, author of the *Shulchan Arukh*, which is an authoritative code of Jewish law states that a physician who does not attempt to heal a person when he can is considered a murderer and this concept can be applied to gene editing.[299] God controls illness and health, but the physician is God's agent and partner in the ongoing act of healing: "Just as if one does not weed, fertilize, and plow, the trees will not produce fruit, and if fruit is produced but is not watered or fertilized, it will not live but die, so with regard to the body. Drugs and medicaments are the fertilizer, and the physician is the tiller of the soil."[300] This symbolism indicates that physicians are to look after the sick and do everything they can to treat them in order to preserve God's creation on earth until it is their time to pass.

With this view of medicine and Judaism's sense of community, there is an important implication for health care, generally and with germline modification.[301] The community as a whole has a duty to provide obligatory health care to all, including the support of research to overcome illness and disability.[302] This duty is based on two biblical passages; "Do not stand idly by the blood of your brother" (Leviticus 19:16) and "Love your neighbor as yourself" (Leviticus 19:18).[303] The Talmud states that the former verse is a positive duty to come to the help of others: "On what basis did we know that if a man sees his fellow drowning, mauled by beasts, or attacked by robbers, he is bound to save him? From the verse, 'Do not stand idly by the blood of your neighbor.' "[304] Furthermore, Elliot N. Dorff explains that:

> the Talmud and Rabbi Moses ben Nahman (Nahmanide, 1194-1270) argue that 'Love your neighbor as yourself' gives an express warrant to try and to bring cure even when that involves the infliction of wounds through surgery or other risks to the patient, for everyone would (or should) prefer such risks to certain death. They also argue that the same verse also requires us to spend money to heal others if we lack the expertise.[305]

In Jewish scripture, "love your neighbor as yourself" involves, not just the caring for others, but also the specific behaviours that express that attitude, where health care is one of them.[306]

Correspondingly, research involving CRISPR to cure diseases in the human germline is strongly encouraged. This kind of research can provide or restore health to the extent that its cures

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[299] Elliot N. Dorff, "Judaism and Germline Modification," in *Design and Destiny: Jewish and Christian Perspectives on Human Germline Modification*, ed. Ronald Cole-Turner (Cambridge: MIT Press, 2008), 35, paraphrased from Joseph Karo, *Shulhan Arukh, Yoreh De'ah* (1563), 336:1, later glosses by Moses Isserles.

[300] Dorff, "Judaism and Germline Modification," 35; quoted from *Midrash Temurrah* as cited in *Otzar Midrashim*, ed. J.D. Eisenstein (New York: 1915) II: 580-581; B. *Avodah Zarah,* 40b.

[301] Dorff, 35.

[302] Dorff, 35.

[303] Dorff, 35, Bible translation not known.

[304] Dorff, 35-36, quoted from B. *Sanhedrin,*73a.

[305] Dorff, 35-36, quoted from B. *Sanhedrin,* 84b (on the permission to inflict pain in order to heal), 73a (on the requirement to spend money to heal when we lack expertise); Nahmanides, *Torat Ha-Adam, Sh'ar Sakkanah,* quoted by Joseph Karo, *Bet Yosef, Yoreh De'ah,* 336.

[306] Dorff, 36, paraphrased from B. *Gitten,* 61a.

can be made readily available to everyone who needs them.[307] In addition, funds and energy should be assigned to this form of research by considering the likelihood of achieving such results in contrast to other treatment therapies.[308] Hence, if genetic interventions show positive progress, it is definitely something that the Jewish tradition encourages.

Does Judaism also encourage genetic enhancement? As with the Christian community, genetic enhancement is not as widely accepted as therapeutic interventions. The Jewish concept of healing as an obligation includes the greater obligation to work toward fulfilling the Jewish mission of *tikkun olam* which means fixing the world.[309] This could imply the use of genetic enhancement in order to improve the world we live in.

Could fixing the world include genetics? It depends on Judaism's understanding of technology.[310] Adam and Eve are told in the Garden of Eden "to work it and preserve it" (Genesis 2:15).[311] God wants humanity to continuously preserve the earth. We must always be preserving the earth for God. The rabbis stated:

> Observe the work of God, for who can repair what he has ruined? At the time that the Holy One, blessed be He, created the first man, he took around and showed him all its trees of the Garden of Eden. He said to him: 'Observe my creations, how beautiful and praiseworthy they are. Everything I created, I created for you. Take care not to ruin or destroy my world, for if you ruin it, there is nobody to fix it after you'.[312]

In terms of genetic enhancement, it is clear that enhancing genes could help preserve the world that God made.

God intended that humans are to steward the world that he made during their life and act as God's agents to improve it.[313] This was stated in a rabbinic comment about circumcision.[314] The comment states that "if God wanted all Jewish boys circumcised, the rabbis ask, why did He not create them that way?"[315] The rabbis' response was that "God deliberately created the world in need of fixing so that humanity would have a divinely coordinated task in life, which gives the human life purpose and meaning." [316] Furthermore, humanity is not just allowed, but mandated to find ways to bend God's world to God's purposes and ours as well.[317] However, we must preserve the world God made in the process.[318] Consequently, it is a human's divine purpose to fix what God has made because there is always room for improvement in our world. If the world was made perfect, then there would be nothing for humanity to do. Genetic enhancements can help with these improvements.

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[307] Dorff, 36.
[308] Dorff, 36.
[309] Dorff, 36.
[310] Dorff, 36.
[311] Dorff, 36.
[312] Dorff, 37; quoted from *Ecclesiates [Kohelet] Rabbah* 7:19; *Midrash Zutah, Ecclesiastes [Kohelet],* 7:11.
[313] Dorff, 37.
[314] Dorff, 37, *Genesis Rabbah,* 11:6; *Pesikta Rabbati,* 22:4.
[315] Dorff, 37, *Genesis Rabbah,* 11:6; *Pesikta Rabbati,* 22:4.
[316] Dorff, 37, *Genesis Rabbah,* 11:6; *Pesikta Rabbati,* 22:4.
[317] Dorff, 37.
[318] Dorff, 37.

The Jewish tradition allows that technology can be both good and bad depending on how we use it.[319] If it is used to aid in the forming the world to achieve morally good ends while we preserve the world, then this use of technology is theologically approved and morally good.[320] Yet, if humans neglect their duty to preserve the world through the use of technological tools, then they are involved in a theologically and morally bad act.[321] Genetic intervention technologies are encouraged to be used for the greater good to preserve the world God made.

4) Future-Oriented Theology

Future-oriented theology of creation and its understanding of the human being as God's created cocreator can be explained in three ways. First, a future-oriented theology of creation is not impeded by giving priority of existing persons over future generations.[322] The theology of the continuing of creation looks forward to the new, for instance, individuals who do not yet exist.[323] They will exist in the moral community that humans belong to, which constantly encourages to improve living conditions.[324] One of these improvements could be CRISPR. Through genetic modification, a healthy society can be achieved as well as traits improved. Moreover, abundant food is able to be made without it getting spoiled.

Second, future-oriented theology is realistic in taking into account that through the course of time, things are subject to change.[325] What individuals do affects and is affected by the future with their different possibilities.[326] Individuals need to be creative in terms of what could be good and bad for the future.[327] For instance, doctors and scientists are conducting more research on gene editing. This will follow with more clinical trials to see if the genome editing process is working on humans. This can specifically be done with gene therapies but done mostly on somatic genes. If we introduce gene editing in the human germline to cure a disease, future offspring will not be affected by that disease. This is something that could definitely benefit society in the future. The creative process behind genome editing offers good aspects and bad aspects depending on a person's opinion of it. Gene therapies offer something good by eliminating disease, but gene enhancement is still something controversial.

Thirdly, humanity's task is to determine as best they can the direction of divine purpose and use that as an ethical guide.[328] What is the future that God intends? When interpreting the apocalyptic symbol of the New Jerusalem where "crying and pain will be no more" (Revelation 21:4), we can be inspired and guided toward decisions today that will affect future generations tomorrow.[329] We are driven to make a good life where our future descendants are happy and not suffering. One approach could be that therapeutic interventions used on the human germ line to

[319] Dorff, 37.
[320] Dorff, 37.
[321] Dorff, 37.
[322] Ted Peters, *Playing God?: Genetic Determinism and Human Freedom,* 2nd ed. (New York, London: Routledge, 2003), 157.
[323] Peters, *Playing God?: Genetic Determinism and Human Freedom,* 2nd ed., 157
[324] Peters, 157.
[325] Peters, 157.
[326] Peters, 157.
[327] Peters, 157.
[328] Peters, 157.
[329] Peters, 157.

ensure that disease is eliminated forever. A future-oriented theology could view gene editing as a way to promote the greatest good through the development of a healthy society.

5) Eschatology and Genetic Enhancement

To define eschatology, it is the study of end times, the return of Christ, when the rapture occurs, the nature of the millennium, and much more.[330] The rapture is when both living and dead believers of Christ will ascend into heaven in order to meet Jesus Christ at the Second Coming.[331] The nature of the millennium, which is explained in the book of Revelation is that Christ will invoke a one thousand-year reign of the saints on Earth before the Last Judgement.[332] In addition, it is a concept of time were there will be supernatural peace and abundance on Earth.[333] Thus, eschatology deals with humanity's fate when it is time for the final events of the world to occur. When eschatology and technology are part of a discussion, the majority of the time it is not something positive that is being spoken about. Some Christians will use the "heresy card" to claim that technology tempts us to imagine a future built by human effort, as if it were some modern technological Pelagianism intended to lure humanity into relying on something other than grace.[334] This is considered a form of Pelagianism because the human will is capable of choosing between good and evil without divine aid. Ultimately, most negative replies all come down to the same conclusion which is to be afraid of the consequences related to gene editing technologies.[335]

Technology is constantly advancing and evolving leading to human transformation. According to Karl Rahner, human transformation "is not concerned with this or that man but with *man*, with mankind;" humanity is seen as an engineering project and its goal is "coolly to sketch, design and calculate a new, different man and then to produce him technologically in accordance with this plan."[336] This agrees with gene editing technology since it can change all humankind when it is done on the human germline. In addition, genetic enhancement can be categorized as wanting to design and produce a human. Rahner states that technology has made human beings "operable" and he does not seem bothered by this.[337] Rahner also says that "according to Christian anthropology man really is the being who manipulates himself."[338] Thus, humankind is always changing whether it is naturally or technologically. Moreover, Rahner states that:

> What is new in this issue is therefore not that man is *faber sui ipsius* [i.e. maker of himself], but that this fundamental constitution of man is manifested historically today in a totally new way. Today for the first time

[330] "Eschatology," CARM: Christian Apologetics & Research Ministry, CARM, accessed August 21, 2019, https://carm.org/eschatology.

[331] Matt Stefon, "The Rapture," Encyclopædia Britannica, Encyclopædia Britannica, inc., last modified October 26, 2018, https://www.britannica.com/topic/Rapture-the.

[332] Richard Landes, "Millennialism," Encyclopædia Britannica (Encyclopædia Britannica, inc.), last modified January 5, 2018, https://www.britannica.com/topic/millennialism.

[333] Landes, "Millennialism."

[334] Ronald Cole-Turner, "Eschatology and the Technologies of Human Enhancement," *Interpretation* 70, no. 1 (December 18, 2015): 26, https://doi.org/10.1177/0020964315603683.

[335] Cole-Turner, "Eschatology and the Technologies of Human Enhancement," 26.

[336] Cole-Turner, 30; quoted from Karl Rahner, "The Experiment with Man," in *Theological Investigations*, vol. 9 (New York: Herder & Herder, 1972), 207-208.

[337] Cole-Turner, 31, paraphrased from Rahner, "The Experiment with Man," 210.

[338] Cole-Turner, 31; quoted from Rahner, 212.

> man's possibility of transcendental self-manipulation irreversibly takes on a clear and historically categorical form.[339]

Consequently, Rahner states that theology today is challenged with something different which is the question of man's essence.[340]

Genetic modification can create a new category of human that did not exist in the past. Technology can aid in making a new species. It was said that all humans are made in the image of God but with the introduction of genetic manipulations we are able to improve ourselves, either by preventing illness or enhancing traits. Hence, it seems that humans may want to be the creator rather than created. This questions how humans will perceive themselves. What will this new historical category of humanity mean? Will this new human transformation be accepted? Or will they perceive themselves as something non-human?

According to Ronald Cole-Turner, eschatology sees that each creature, humans included, as on its way to being unified with Christ.[341] Christian Theology "has no utopian plan or technological program."[342] There is no utopian plan for a perfect eschatology, we must trust the mystery of God. As for technology, it cannot replace God. Christian Eschatological faith accepts the invitation to see all creations as open to a transformation rooted in their future in God.[343] Cole-Turner states that eschatology is open to transformations, even genetic ones as long as creation still relies on God's grace. All creatures are open to smaller transformations and Christian eschatological faith is open to the prospect of the technological modification of the natural world, including human individuals and human species.[344] According to Cole-Turner, Christian faith and hope that are open to the ultimate future as the final consummation should be open to the near future as an essential change as well.[345] In addition, to visualize each thing as already on its way to its consummation is to view it as presently open to change.[346] This is because each thing is moving toward its consummation since humanity is constantly evolving in different aspects, specifically technologically or biologically.

Moreover, it is without a doubt that humans today are different from the people of the time of Jesus, "we believe that we are [all] included in the scope of the incarnation."[347] Even though the future forms of humanity may be different, they are not excluded from being in unity with Christ.[348] We do not envision a "partial Christ who stops redeeming when technology starts modifying[,] God's plan is to gather up all things in Christ."[349] A human being is still a human being even if they are modified, everything around us is constantly evolving and that is a fact of life. God gave us the power to improve ourselves and therefore we are preserving the image of

[339] Cole-Turner, 31; quoted from Rahner, 213.
[340] Cole-Turner, 31.
[341] Cole-Turner, 29
[342] Cole-Turner, 29.
[343] Cole-Turner, 32.
[344] Cole-Turner, 32.
[345] Cole-Turner, 32.
[346] Cole-Turner, 32.
[347] Cole-Turner, 32.
[348] Cole-Turner, 32.
[349] Cole-Turner, 32.

God in all of humanity. Genetic modification is preserving this image by eliminating disease and improving the human person.

In every age, Christians believe that "neither death, nor life, nor angels, nor rulers, nor things present, nor things to come…will be able to separate us from the love of God in Christ Jesus our Lord" (Rom 8:38-39).[350] The things we cannot predict will not stop God from loving humanity in Jesus. Based on previous statements, humans must embrace the unknown as if God had intended it to be like that. Cole-Turner states that when humanity has confidence in God, they can truly be hopeful about the future.[351]

6) What it Means to Be Human

There will always be an underlying question as to what happens to the human being after being genetically modified. People will wonder if that person is still the same or if they are something different. Paul Ramsey, a Christian ethicist, appears to take on a negative attitude towards this, he mentions something called "species suicide" meaning that making changes to the human flesh is a violation of what is human, such as violating human will or freedom.[352] Ramsey is against modifications and believes that human beings should not be treated as science experiments. Ramsey believes that genetically modifying a person is basically identical to eliminating a species because a person is killing their former self. Moreover, "the human body is not a tool for a given human being, Human beings are bodies."[353] With this, it would be proper to look at the different ideas of what it means to be human.

Some ethicists have a more open outlook regarding the human person and what makes them human. James C. Peterson, a professor and ethicist, states that "God's people will still be the same individuals, but in a strikingly new form."[354] This should be the case as long as they continue to have faith in God. In addition, "according to the Christian tradition, our current physical form is not required for us to be human."[355] That being said, when humans ascend into heaven their physical bodies are technically left behind and it is their spiritual bodies that ascend. In addition, current bodies are not always required to who each of us is as a person.[356] Hence, because of the soul's ability to go beyond the physical world, physical bodies do not define the human person. In order to be with God, human beings were given the ability to reach transcendence through the love they have for God.

Is "human" a static concept that has already been attained or does it comprise of qualities that can be developed positively?[357] This appears to be a continuous debate that is part of the bigger question of what it means to be human. Some aspects of this continuous debate are: if physical

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[350] Cole-Turner, 32.

[351] Cole-Turner, 33.

[352] James C. Peterson, *Genetic Turning Points: The Ethics of Human Genetic Intervention* (Grand Rapids: William B. Eerdmans Publishing Company, 2001), 280, paraphrased from Paul Ramsey, *Fabricated Man: The Ethics of Genetic Control* (New Haven: Yale University Press, 1970), n.p.

[353] Peterson, *Genetic Turning Points: The Ethics of Human Genetic Intervention*, 280, quoted from Ramsey, *Fabricated Man: The Ethics of Genetic Control,* n.p.

[354] Peterson, 280.

[355] Peterson, 280.

[356] Peterson, 280.

[357] Peterson, 281.

bodies are to remain unchanged or if physical bodies can be subjected to improvement. Human beings are physical beings but that does not mean that their physical nature is to remain unchanged.[358] It is a fact that we are physical beings, but like everything else, we change over time. For instance, our physical nature changes since our skin wrinkles and we age. Change is inevitable. Moreover, future descendants will be physically different from our current state and could be more human in what we value as human.[359] Darwinian evolution is a fact and subsequent generations may look different than the current human being. Future "humans" could have a different genetic makeup as well. Future people might have a different definition of what a human is. Everything in life changes and if we decide to input our current moral values in the future, there is a chance that the outcome could be negative. Future people may think these values are outdated since it does not fit with their current world views. Naturally, things around us are subject to change. Our bodies can change through evolution, so what makes editing genes any different?

In an opposing view, Ramsey states that "to intervene in human genetics is to make [ourselves] Lord and creator [of] future generations. Human beings are to serve human life, not change it."[360] Human life is not to be changed and only God has the power to make changes. Humanity does not have the position to improve God's creation, "only God has the authority and ability to form and change [humanity]."[361]

Peterson states that for James Gustafson, a theological ethicist, "human beings are not yet what [they] should be[,] and [they] do indeed find [their] purpose in development."[362] Therefore, if there is a final form, human beings have yet to reach it. Part of a human's purpose then is to constantly find ways to improve themselves and their quality of life. Gene editing is a form of improvement on human life because it will help eradicate disease. Additionally, genetic enhancement will help a person make improvements in the areas where enhanced traits are needed. Similarly, when considering the responsibility we have to future generations, the current physical state of humans is not definite.[363] The human person is always changing whether it is naturally or scientifically through genome editing. It is in our nature to want to constantly improve and develop ourselves. There is a place for change because we gain a sense of what values to preserve, which helps us "enhance the qualities of life that give[s] [everyone] a sense of fulfillment."[364] Thus, there is always a place for change when it comes to being human whether it is physically or spiritually. These changes help people preserve what they think could be valuable to the future and/or also be rid of other things that might hold no value in order to enhance the quality of lives for future generations. The fulfilment that is received when a patient's quality of life is improved comes from achieving a purpose to surpass present accomplishments. Partly, this is what being human is about: seeking to have a good life and letting go of what has already served us in order to reach new goals. This applies to gene editing since scientists are continuously researching to improve CRISPR in order to reduce off-target effects. Then clinical trials are conducted to see if these improvements are working on humans.

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[358] Peterson, 281.
[359] Peterson, 281.
[360] Peterson, 282, quoted from Ramsey, *Fabricated Man: The Ethics of Genetic Control*, 88.
[361] Peterson, 282.
[362] Peterson, 283.
[363] Peterson, 283.
[364] Peterson, 283, quoted from James M. Gustafson, "Basic Ethical Issues in the Bio-Medical Fields," *Soundings: An Interdisciplinary Journal* 53, no. 2 (Summer 1970): 178, www.jstor.org/stable/41177779.

The individuals who argue that genetic intervention is a part of God's mandate for humanity to share in creation, redemption, and transformation of creation would see a risk not in an attitude of pride but of sluggishness.[365] Not fulfilling the duty to turn genetic modifications into a service would show a strong and destructive attitude of laziness.[366] For this reason, if genetic interventions are to be part of God's mandate on Earth then humans cannot be sluggish about it since it is shared in creation, redemption and transformation of creation. It plays a part in creation since foetuses can be genetically modified prenatally and all genetically modified individuals can be redeemed in Christ. The argument is that through evolution God's people change over time so there is no difference when humans make changes to themselves. This is seen as a transformation of creation because as stated previously, human beings will always be subjected to change whether it is evolutionary or with genetic interventions. Genetic interventions can transform creation into healthier beings and with enhanced traits to help society prosper. If we can do surgery on various parts of the body, we can do surgery on someone's genes.[367] Therefore, for Peterson, performing surgery on a human body is just as much a change as genetic interventions. Both intend to make changes to the human person in order to improve their quality of life.

Conclusion

The theology of gene editing technologies is still relatively new, and research is ongoing but what has been done presently is attracting attention. In order to better introduce CRISPR, it is best to see how it can be examined under the foundations of Christianity. Sulmasy believes that the foundation of Christian faith is important in healthcare because it changes how the physician works. When a physician serves God, it means that deep connections are to be formed with patients through spirituality. Although gene editing is lab-based there are still patients that are involved in the process. Thus, it is important for these patients to be treated with the same love a physician has for God. Transcendence is also important because you are not just healing the physical person but also the spiritual person. In addition, physicians would help patients with any transcendent questions that they could have in relation to their illness and their value as a person. Moreover, Sulmasy states the importance of Franciscan compassion in healthcare for physicians. Doctors with Franciscan compassion are to go above and beyond for their patients to acquire gene therapy. These doctors must also be conducting constant research on gene editing to reduce off-target effects.

Furthermore, playing God becomes a vital topic in the discussion of genetic modification. Benedict XVI approves of somatic therapeutic interventions since it is consistent with the traditional permission of medical care, John Paul II agrees as well. Francis believes that there needs to be discussion on this topic before it can be fully accepted. Their papal and church letters state that therapeutic interventions are good because not only do they heal, they may also remove the disease permanently. Somatic therapeutic interventions are approved but germline therapeutic interventions still need more testing. In the case of genetic enhancement, some Christian commentators do not approve it and feel that it is not acceptable to be making changes to God's creation. There is a difference between creator and creature because God did not make humans the same being as God is. God made humans to be equal and intervening genetically could disrupt this

[365] Peterson, 286.
[366] Peterson, 286.
[367] Peterson, 286.

equality. In terms of creation, if a body is healthy, it is not right to intervene. Likewise, the future should not be moulded as a whole: we cannot control creation. Enhancement on God's creation cannot be seen as Christian because it is as if humans want to escape human troubles instead of embracing the body God gave us.

The Jewish tradition takes on a different perspective: in terms of therapeutic interventions, a physician must provide health care to everyone. Accordingly, genetic therapeutic interventions need to be accessible to everyone. Enhancement helps to preserve and improve God's work.

There are three ways in which genetic modifications describe a future-oriented theology. The first is that a current society always looks forward to future generations to see how they will blend in our current society, specifically genetically modified individuals. Second, nature is dynamic and always changing; it allows people to be creative in order to adapt to new changes. Third, since nature is always changing it is our duty to establish an ethical direction in this dynamic world on how to live a life with minimal pain and suffering.

Christian Eschatological faith accepts the invitation to see all creations open to a transformation rooted in their future with God. God's people are constantly changing, whether naturally or by human aid. Christ does not stop redeeming when technology starts modifying. God's plan is to gather up all creation in Christ, no matter how different. People often wonder if the understanding of the human being changes because of these modifications. Ramsey believes once a person is genetically modified, it is identical to species suicide, the end of the human race as we speak. On the other hand, Peterson and Gustafson state that God's people will remain his people but in a new form. The physical form is not required for us to be human, specifically when we unite with God. If genetic modifications are to be part of God's mandate, humans cannot be sluggish about it because we are obliged to continuously preserve his work.

Overall, the discussion between genetic modifications and theology raises a lot of important questions on a deeper level specifically on what happens to the human person and their body in the eyes of God. The subject of genetic modification is being widely discussed in the Judaeo-Christian world to see how this technology can affect our current society. That being said, can genetic modification be a future God intends for us in order to evolve as a species?

Conclusion

In this thesis, we explored the science, ethics and theology surrounding CRISPR-Cas9 and genetic modification. The science chapter explained the technicalities of CRISPR-Cas9. It explained how CRISPR-Cas9 targets the invading DNA at the spot where you would need to add or remove DNA sequences. It is the nuclease enzyme Cas9 which acts as the molecular scissors to make that cut on a specific spot on the DNA strand. Sometimes these cuts can cause off-target effects where unintended mutations can occur leading to some health side effects. Scientists are still researching and finding ways to reduce these off-target effects.

Chapter two explained different perspectives concerning the ethics of genetic modification from various individuals including John Harris, Michael Sandel and Jürgen Habermas. Habermas was the most studied for this thesis since most ethicists draw on him primarily because of his strong arguments against genetic modifications. It also examined whether individuals were still autonomous after genetic modification. If not, who would be responsible for their actions, the person or their "enhancer"? Many believe that individuals are still able to make their own choices regarding their enhanced trait.

Chapter three dealt with deeper theological questions regarding the proper use of gene editing technologies, specifically the use of it on the human germline. These issues were brought up in different papal and church documents. In addition, the status of the human person after genetic modification was also discussed. Specifically, how some believe that God's work is to be preserved on Earth with the use of CRISPR-Cas9, while others believe we should not be changing God's creation with this scientific tool. Likewise, through a Christian eschatological perspective, some Christians believe that these modified people cannot be in union with God, while others say that God accepts all creatures who have faith in him. CRISPR and genetic modifications raise a lot of challenging questions and it is something that needs to be thoroughly regulated.

We explored many themes and topics in this thesis in regards to genetic modifications being done on human beings. The two themes that seem to be the most important on this topic is the self and society. These two themes become important in trying to understand genetic modifications, in a personal aspect and also in a more global aspect.

When we think of the first theme: the self, we think of our own person and what happens to us if we were to be genetically modified. Autonomy is a central concept when speaking about genetic modifications. While some may wonder if a person is still able to be autonomous if their parents intervene in their genetic makeup, the genetically modified person is still able to be autonomous and make their own life choices. There is also the possibility of moral agency which becomes important to the self. Genetically modified individuals are still able to be responsible for their actions, regardless of these modifications. While autonomy and moral agency are present, the modified person still struggles psychologically with these possibilities. There is also the question of self-sanctioned enhancement that Peter Herissone-Kelly speaks about and whether or not they are responsible for their actions after the genetic enhancements.[368] If they chose to be enhanced, then wouldn't they still have responsibility over their actions? [369] Yet, this enhanced capacity is not something that came from the self at birth.[370] The self can be a conflicting theme because the

[368] Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," 207.

[369] Herissone-Kelly, 207.

[370] Herissone-Kelly, 207.

person is still a person after being genetically modified but they need to find it within themselves to understand that they are still autonomous agents who are responsible for their actions and can make their own decisions.

The second theme, society, is important to consider because people interact with others on a daily basis and build relationships with them. A society allows voices to be heard on certain topics that need to be spoken about. In addition, it also plays a part in how a genetically modified individual will integrate in society. We previously spoke about parents who intervene genetically because they have a life plan for their child, however, parental influences were always there. John Harris mentioned how parents and teachers shape children's education, encourage the development of certain talents and bring children up with different values.[371] Furthermore, there is the notion of natality which is our being born and the person we are before being influenced by society.[372] For Habermas, genetic modifications would disrupt this notion.[373] Still, parents can influence their baby *in utero* with music to help with its development or through a diet to keep the baby healthy.[374] We see that society offers an external influence on people every day regardless of them being genetically modified. Furthermore, genetic modifications could also cause a divide among society if this new technology is not distributed justly. This technology should not be accessible just to the rich but to everyone to avoid a division among social classes. This technology is to help all of society and not a select few.

Ethics contributes significantly to the discussion on CRISPR and genetic modifications. Genetic engineering in general has been spoken about frequently in the area of bioethics. Ethics in terms of genetic modifications raises questions about autonomy, regulations, consent, and much more. In addition, the contribution of ethics allows a person to understand what both sides (for and against) of genetic modifications have to say. Ethics helps a person understand the reasoning of both sides and weigh the strength of the arguments. They may not choose a side at all; they could remain neutral or in the middle. Ethics helps us understand why some parts may be negative and why others may be positive. It shows us how the negative implications of gene editing could cause a lot of harm. For instance, this was seen with the risk of unintended mutations causing health side effects of gene editing procedures. More improvement needs to be done before it can be used for medicine or enhancement procedures. Moreover, the ethics of gene editing needs to be communicated to people since they may not be aware of it. The majority of people only know of the simple facts related to gene editing or its basic science. Ethics contributes by giving people insight into how gene editing affects a person, the people around them and society as a whole. It can also expand a person's knowledge on this topic, which can help them develop an opinion on it. This opinion can add input to the government policies on how it could be regulated. Therefore, it can help build policies and rules for it so that it may be accessible one day.

The value of an ethical analysis in relation to genetic modifications and CRISPR can be seen in many different ways. It demonstrates the rights and freedoms that a person has regardless of being modified or not. Following this, it shows that genetically modified individuals can still be autonomous agents of their own lives. The value of an ethical analysis also shows that certain areas

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[371] Herissone-Kelly, "Habermas, Human Agency, and Human Genetic Enhancement: The Grown, the Made, and Responsibility for Actions," 202.

[372] Pugh, "Autonomy, Natality and Freedom: A Liberal Re-Examination of Habermas in the Enhancement Debate," 146.

[373] Pugh, 146.

[374] Pugh, 150.

of gene editing requires government regulations, specifically with how it will be distributed, ongoing improvement to reduce off-target mutations and what people use it for. In addition, we see the value of how far parents go to make sure their child grows up healthy by using therapeutic interventions. This brings up the question of consent, where one side says it is fine for a parent to consent for the unborn child if it means it will eradicate a disease and the other believes that a child should always consent regardless of it being for therapeutic purposes or enhancement purposes. If this technology is used wisely then it can help improve humanity. There is also value in comprehending both the pro and con arguments in terms of gene editing. We get to see how both views share valid points on whether or not it should be done. An ethical analysis lets us see that there is good in this new technology, but it can only be achieved if we decrease the risks associated with it in order for it to truly help humanity.

The contribution of theology towards genetic modifications is recent and current literature on it is quite limited. Theology allows one to go beneath the surface of ethical concepts to ask deeper questions against backdrop of a faith tradition. It allows us to make observations that an ethical analysis does not. One specific observation that we can explore with theology is the question of what it means to be human. Reflecting on this helps us probe the question of genetic modification in a multitude of ways. It allows us to wonder if the human body can be changed and what will happen to humans if the body is changed. We begin to think of what happens to our physical bodies when we are united with Christ. Do our bodies really define what it means to be human or is it something more? This question lets us think about the human soul a lot more. In *Genetic Turning Points: The Ethics of Human Genetic Intervention*, James Peterson points out that Gustafson believed human beings find their purpose in development and that our current physical state is not definite. Do these genetic changes really make a big difference to our bodies? Are we still considered to be human after these modifications? Or are we considered something else? It is questions like these that help us probe the very essence of what it means to be human.

A second observation that theology explores is the question of what it means to be made in the image of God. This helps us probe the question of genetic modification in terms of whether it is right to make changes to the creation God made. Is it right for one to play God on Earth? It could be acceptable if it is a therapeutic intervention that could save a person's life or eradicate a disease from a family line. Will giving the power of God to a human being cause a rift in our world? It is questions like this that make us wonder whether it is right for humans to toy with the human genetic store, even though this could be a breakthrough in the science and medical world. Still, God gave humanity the gift of free will, so it is up to us to decide where to draw the line of playing God in certain aspects, specifically between therapy and enhancement. Therapeutic interventions are slightly more accepted than enhancements, if done on somatic cells. The human germline still poses too much risk, so we can see where a line can be drawn. However, we see in "Judaism and Germline Modification," where Dorff states that some Jewish traditions do believe in therapeutic interventions on both somatic and germline cells because medical professionals need to do anything they can to heal a person. Dorff also states that enhancement is accepted as well because it helps preserve God's work on Earth. We can see here that drawing the line on genetic modifications can vary from religion to religion or even person to person. This is where societies must come together and find common ground on where one should draw the line.

CRISPR-Cas9 and genetic modifications have been one of the most recent controversial topics to surface. There are many contrasting views on it and opinions on how it should be used. This thesis explored the opposing sides of genetic modification to come to an understanding that

this technology, as with every technology, will have positive and negative aspects. If this is something that will be used in the future then improvement is still needed to make sure it is safe for use. If used correctly, CRISPR-Cas9 can be a great benefit to the world.

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