GENETIC EDITING: ETHICAL AND SOCIAL ISSUES

OVERVIEW

This module will explore various ethical and conceptual issues surrounding gene editing. Genetic editing is a process that permits scientists to alter the DNA of different organisms, including plants, bacteria, animals, and humans. Manipulating DNA can cause changes to different genetic dispositions, including physical traits, diseases, and more. Through different technologies, scientists have been able to accomplish this feat of science. These technologies serve as genetic scissors which remove specific strands of DNA at certain spots. Then scientists can remove, add, or replace the DNA where it was cut. The first genetic editing technologies were created at the end of the 21st century. However, around a decade ago, CRISPR was discovered. CRISPR has made it much more feasible to edit DNA than with previous methods. It serves as a simpler, more efficient, cheaper, and more accurate alternative to previous technologies. As a result, most scientists currently use CRISPR. Displaying the huge impact that CRISPR and genetic editing has had, the famed scientific journal Science determined CRISPR to be the “Breakthrough of the Year” in 2015. The goal of the module is to encourage informed, open dialogue regarding genetic editing.

1. INTRODUCTION TO TOPIC

Before discussing ethical issues surrounding genetic editing, it is important to get all students on the same page about terminology pertinent to the debate.

A designer baby is a baby whose genetic makeup has been selected in order to eradicate a particular defect, or to ensure that a particular gene is present. With designer babies, there are several possible traits that can be altered or have the potential to be altered in the future:

- Gender
- Appearance
- Intelligence
- Disease
- Personality

A photospacer adjacent motif is a 2-6 base pair DNA sequence. This sequence is used as a location for Cas9 to latch on to.

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LEARNING OUTCOMES

1. Define terms pertinent to the debate of genetic editing and use them correctly.
2. Learn the background of genetic editing and its implications in the future world.
3. Consider and analyze the several areas of ethics that this debate is involved in.
4. Come to a conclusion about the debate.

PROCEDURES AND ACTIVITIES

This unit uses a student-centered and interactive approach to teaching. Activities are designed to allow for student participation and are marked as an individual, partner or group activity.
An endonuclease is an enzyme that cuts a DNA sequence by separating bases other than the ones at the ends.

**Eugenics** is the scientific process of refining a community or population by controlled reproduction to eliminate undesirable traits.

The **gene pool** is the collection of all human genes. A species that has a larger genetic pool is considered to be more genetically diverse. This composition of genes can change over time as evolution occurs, as well as through the targeted manipulation of it, through eugenics for example.

**RNA**, which stands for ribonucleic acid, is a complex compound of great importance that serves in the process of cellular protein synthesis and carries certain genetic information. The compound contains ribose nucleotides (nitrogenous bases affixed to a ribose sugar) attached by different bonds. The nitrogenous bases that RNA has are adenine, guanine, cytosine, and uracil.

**DNA**, which stands for deoxyribonucleic acid, is an organic compound of extremely high importance that is found in all prokaryotic, eukaryotic cells, as well as in most viruses. DNA codes genetic information for the transfer of genetic traits. Its nitrogenous bases include adenine, guanine, cytosine, and thymine.

A **hereditary mutation** is a gene change that happens in a reproductive cell (an egg or a sperm) and is then included into every cell in the developing body of the organism. These mutations play a major role in several genetic diseases, such as cancer. Hereditary mutations are also known as a germline mutation.

Now that students have a better understanding of the terms relevant to this issue, survey attitudes surrounding the following questions regarding genetic editing:

1. What effect has CRISPR-Cas9 had on the world of genetic editing?
2. What financial implications can genetic editing have on society in the future?
3. How will the government regulate future genetic editing?
4. In your opinion, would future genetic editing be assuming the role of a “god”?
5. Can genetic editing remove genetic diseases from the gene pool in the future?

These, and other questions, will be discussed as well as analyzed in this module.

2. THE ROLE OF CRISPR-CAS9 IN GENETIC EDITING

CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) is a new technology that allows geneticists and other researchers in medical fields to change different genes by altering, adding, or deleting entire genes. This biological technology is acquired and adapted from bacteria. CRISPR is a genome existent in a bacterium’s immune system that cuts off pieces of DNA from invading virus, creating CRISPR arrays. These arrays are then used by the bacteria to detect the virus or other specimens with similar DNA.

A. **How the system is used in labs**

There are several components that make up the CRISPR-Cas9 system as it is used in labs. Cas9 is an enzyme (biological molecules that are typically proteins which aid in the processes and reactions intrinsic to life) that serves as “molecular scissors.” This splicer locates and cuts strands of DNA at very specific locations. In addition to Cas9, gRNA makes up the system. gRNA is a pre-created RNA sequence (20 bases long)
situated inside a much larger RNA frame. This frame then has the ability to bind to the target DNA. The shorter, specifically designed sequence guides the Cas9 enzyme to the specific area of focus on the genome.

In the lab, scientists begin by creating a small snippet of gRNA. This RNA is used to identify a specific location on a DNA sequence. It is able to do so because its base pairs are complementary to the target DNA. Because of this, this process is very targeted, for the RNA will target only the specific DNA sequence because of its unique nitrogenous base composition. There are five different types of nitrogenous bases (the building blocks of DNA and RNA). DNA contains two purines (adenine and guanine) and two pyrimidines (thymine and cytosine). RNA contains the same building blocks except instead of containing thymine, it contains the nitrogenous base known as uracil. In these molecular building blocks, adenine binds to thymine (DNA) or uracil (with RNA). In addition, guanine binds to cytosine. The following is an example of complementary base pairs of RNA and DNA.

\[
\text{AGU:TCA} \\
\text{(RNA):(DNA)}
\]

The Cas9 enzyme, which is secreted by CRISPR, binds to this area and then removes the unwanted location which was identified by the RNA. This removal turns off the gene that is being targeted.

B. Other genetic editing technology

While CRISPR-Cas9 is currently the most used technology for genetic editing, there are others that are used more rarely. The biggest of the other technology involves the use of chemicals and radiation. These substances create beneficial mutations which are used to fix genes. However,
C. Why CRISPR over other gene editing tools?

There are several reasons as to why CRISPR-Cas9 is considered to be superior to other gene editing tools. First, it is much cheaper, more efficient, and more customizable because of the specificity of its target DNA. Additionally, CRISPRs do not need to be paired with different, artificially made enzymes to cut off the piece of DNA because it secretes its own (Cas9). Speaking to its effectiveness, CRISPRs easily match with the guide RNA (gRNA). This is possible because the gRNA is readily available - tens of thousands of sequences are introduced. As a result, the gRNA is also able to target multiple genes and DNA sequences at the same time.

D. Applications and implications of the technology

Genetic editing through the use of CRISPR-Cas9 has several applications and implications as well, including the potential to edit the genomes of both somatic and germ cells. This allows for the ability to not only cure genetic diseases, but to edit the characteristics of future offspring. Somatic cells are all the body cells except for reproductive ones. There is some controversy surrounding the genetic editing of somatic cells. This type of genetic manipulation has already been used to treat various human diseases, including in both life-threatening and non-life-threatening cases. On the other hand, germ cells are the male and female reproductive cells (sperm and egg). These cells contain the genetic material that is passed onto offspring. The main controversy of genetic editing has resulted over the manipulation of these germ cells because they have the power to dictate the traits of the offspring.

E. Future

In the future, the main goal for scientists is to further improve the targeting of CRISPR while keeping the efficiency high. Currently, in many cases in which CRISPR is used, not all 20 base pairs are needed to target the specific area of DNA. However, sometimes similar DNA sequences are found in other parts of the human genome. For example, the first 18 bases of the gRNA may be complementary to two completely different genes. As a result, the Cas9 could target and remove the wrong part of the genome. This could have a benign effect, but it could also have the potential to create life altering effects if it is a gene of particular importance. Scientists have already conjectured different potential solutions to the problem.

Scientists have hypothesized that they could use a Cas9 enzyme that only cuts one strand of the DNA rather than both. This would require two sequences of gRNA and two enzymes to bind to the proper DNA sequence. As a result, it would double the chances that the CRISPR-Cas9 sequence binds to the actual sequence of interest. In order to create this version of Cas9, scientists would have to deactivate one of its two nuclease domains. The two nuclease domains that they contain are the RuvC domain, which cuts the non-target DNA sequence, and the HNH domain, which cuts the target DNA sequence. If the RuvC domain were to be deactivated, the process of gene editing would require a secondary Cas9 enzyme with only the HNH domain activated to supplement the other one.

In addition to cutting off one of the Cas9 domains, scientists can use different versions of gRNAs. The single-guide, off-target RNAs (sgRNAs) have the potential to add much more efficacy to CRISPR technology. Currently, a growing number of new RNA-guided endonuclease with a different spacers adjacent motif (PAM) have been discovered, suggesting the necessity to develop a versatile tool for designing sgRNA to meet the requirement of different RNA-guided DNA endonuclease.

Lastly, scientists are creating “CRISPR-OFFender.” This is a program that allows for user-defined PAM and sgRNA lengths, allowing for an increased target range and specificity.

Even with all of these future solutions, it will likely be many years until CRISPR-Cas9 is used regularly for humans.
3. ETHICS OF GENETIC EDITING: THE PROS

A. Rectifying specific genetic diseases

Today, there are over 10,000 diseases created from mutations in a single gene (monogenic diseases) according to the World Health Organization (WHO). There are even more polygenic diseases, or diseases caused by mutations in multiple genes. Because there are so many diseases, and so many deaths as a result, there is clearly a huge need to fix these most prevalent diseases. With the help of CRISPR, which can turn off genes responsible for some of these diseases, our world could have a near disease free future. Currently, most of the research involving genetic editing and the fixing genetic diseases is on monogenic ones. Of these many monogenic diseases, fourteen are being researched to find a solution through gene manipulation.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Mutated Gene</th>
<th>Description</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-1 antitrypsin deficiency (AATD)</td>
<td>SERPINA1</td>
<td>Causes lung disease and damage to the liver</td>
<td>1 in every 2,500 (especially of European decent)</td>
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<tr>
<td>Amyloid transthyretin (ATTR) amyloidosis</td>
<td>TTR</td>
<td>Damages the nerves which connect the nervous system to muscles; leads to various major health issues with time</td>
<td>3.5% of African Americans</td>
</tr>
<tr>
<td>Beta-thalassemia</td>
<td>HBB</td>
<td>Decreased production of hemoglobin; leads to anemia and a much higher risk of blood clots</td>
<td>1 in every 10,000</td>
</tr>
<tr>
<td>Disease</td>
<td>Gene</td>
<td>Description</td>
<td>Prevalence</td>
</tr>
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<td>----------------------------------------</td>
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<tr>
<td>Cystic fibrosis</td>
<td>CFTR</td>
<td>Damages channels that allow the flow of chlorine and water across cell membranes; leads to respiratory and digestive problems</td>
<td>1 in every 2,500 (Caucasian); not as prevalent in other ethnic groups</td>
</tr>
<tr>
<td>Duchenne muscular dystrophy (DMD)</td>
<td>DMD</td>
<td>Damages the production of dystrophin protein; leads to muscle deficiency</td>
<td>1 in every 3,300 men</td>
</tr>
<tr>
<td>Glycogen storage disease Ia (GSD Ia)</td>
<td>G6PC</td>
<td>Causes extra amounts of glycogen and fat; leads to liver, kidney, and intestinal problems</td>
<td>1 in every 125,000</td>
</tr>
<tr>
<td>Hemophilia A and B</td>
<td>F8 (Type A) and F9 (Type B)</td>
<td>Causes blood clotting deficiencies</td>
<td>A: 1 in every 4,500 men</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B: 1 in every 20,000 men</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Very rare amongst women</td>
</tr>
<tr>
<td>Huntington’s disease</td>
<td>HTT</td>
<td>Causes deficiencies in Huntington proteins; leads to the deterioration of the nervous system ultimately causing death</td>
<td>1 in every 20,000 people of European decent</td>
</tr>
<tr>
<td>Leber congenital amaurosis 10 (LCA10)</td>
<td>CEP290</td>
<td>Most prominent disease that causes blindness in children</td>
<td>1 in every 40,000</td>
</tr>
<tr>
<td>Mucopolysaccharidosis (MPS) I and II</td>
<td>IDUA (Type 1) and IDS (Type 2)</td>
<td>Prevents the breakdown of glycosaminoglycans (GAGs) which are major sugar molecules; leads to the enlargement of tissues and organs</td>
<td>Severe form: 1 in every 100,000</td>
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<td></td>
<td></td>
<td></td>
<td>Less severe form: 1 in every 500,000</td>
</tr>
<tr>
<td>Disease</td>
<td>Gene</td>
<td>Description</td>
<td>Prevalence</td>
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<tr>
<td>Primary hyperoxaluria (PH) type 1</td>
<td>AGXT</td>
<td>Results in the buildup of glyoxylate; leads to the repeated formation of kidney and bladder stones which can cause kidney failure</td>
<td>1 in every 72,500</td>
</tr>
<tr>
<td>Severe combined immunodeficiency (SCID)</td>
<td>IL2RG or</td>
<td>Prevents the immune system from fighting off viruses, bacteria, and infections</td>
<td>1 in every 50,000</td>
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<tr>
<td></td>
<td>JAK3 or</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>ZAP70</td>
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<tr>
<td>Sickle cell anemia</td>
<td>HBB</td>
<td>Shapes red blood cells like sickles causing the cells to die early; leads to pain and infections</td>
<td>1 in 500 African Americans</td>
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<td></td>
<td></td>
<td></td>
<td>1 in every 1,200 Hispanic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Americans</td>
</tr>
<tr>
<td>Usher syndrome 2A</td>
<td>USH2A</td>
<td>Results in hearing loss sprouting from the beginning of one’s life as well as vision loss during teenage years</td>
<td>1 in every 20,000</td>
</tr>
</tbody>
</table>

Four of these monogenic diseases are closest to being able to be genetically edited. These include amyloid transthyretin (ATTR) amyloidosis, beta-thalassemia, hemophilia type B, and leber congenital amaurosis 10 (LCA10).

With amyloid transthyretin (ATTR) amyloidosis, CRISPR-Cas9 is used to do a gene knockout of the TTR gene. This gene knockout simply involves the deactivation or deletion of a sequence in a gene.

Next, beta-thalassemia, CRISPR-Cas9 is being used to change DNA sequences in the HBB gene to diminish the effects of the mutations. In this process, cells are removed, the HBB gene in the cell is edited, and then the changed cells are put back into body.

With hemophilia type B, ZFN editing (different from CRISPR-Cas9) is being used to replace the damaged F9 gene with a proper one in liver cells. The new gene then creates specific coagulation factor proteins that allow the blood to clot.

Lastly, with leber congenital amaurosis 10 (LCA10), CRISPR-Cas9 is supposed to remove the genetic mutation in the CEP290 gene. An injection below the retina delivers the gene-editing therapy to the photoreceptor cells in the eye.

When it comes to helping a future baby, genetic editing helps families who are plagued with a long history of genetic diseases that keep getting passed down from generation to generation. In the future, gene editing may have the ability to fix other diseases that affect the world on a far larger scale, ones that affect millions of
people every year. This includes, but is not limited to, obesity, diabetes, cancer, mental illness, and Alzheimer’s. In addition to the baby at hand, genetic editing can help future generations. This occurs because once a gene is deleted from the genome of the baby, the baby’s future offspring will be less likely to have the offspring. Eventually, this process could delete entire genetic diseases from the gene pool.

4. ETHICS OF GENETIC EDITING: THE CONS

Despite the various benefits to genetic editing, the other side to the debate must be considered as well.

Partner Activity

What could the statement that genetic editing can lead to “social inequality written into DNA” imply? Ask students to explore the various meanings that this statement could hold, and how these implications can impact society as a whole.

A. Inequality based on wealth

The economic disparity between the rich and the poor will inevitably increase as a result of genetic editing. This first emerges from the sheer cost to gene edit. Obviously, the cost of various procedures will differ greatly, however, all forms of genetic editing will require a great sum of money. For example, using CRISPR-Cas9 to fix a single point mutation costs $15,000 at Yale, and that’s before the cost of genotyping, which can cost up to $2,000. At Harvard, the rate for the same procedure exceeds $19,000. A point mutation is a very small mutation involving only a few nucleotides, yet it costs this great sum of money to alter.

Additionally, it costs from $15,000 to $25,000 for in vitro fertilization (IVF) with gender selection for a future baby. Most people cannot afford these procedures, considering the average income is $58,000 in the U.S. and that these procedures are not typically covered by insurance. An additional problem is that not all procedures are successful. For example, Rosa and Vincent Costa, a couple from New York, spent over $100,000 on seven attempts to guarantee that their child would be a girl. Dr. David King, a former molecular biologist and founder of Human Genetics Alert, stated, “Once you start creating a society in which rich people’s children get biological advantages over other children, basic notions of human equality go out the window.” He further added that “what you get is social inequality written into DNA.” King predicts that there will be inevitable market-based inequality based on past precedents. This includes the large cost of ova donated by “tall, beautiful Ivy League students.” Additionally, the demand for the international surrogacy market among the people who are able to travel for the baby is yet another precedent pointing to the economic inequality of genetic editing. CRISPR would inevitably become an expensive commodity available exclusively to the wealthy. This would give this demographic an unfair advantage in the economic competition against the other classes. A time in which people are able to make themselves more entrepreneurial, smarter, more socially adept or more charismatic than others only because of money could lead to an even further lack of economic mobility, a problem that is already plaguing society. Eventually it could form an extreme class system seen in dystopian books where the wealthy are able to buy advantages that will inevitably lead to more wealth.

In addition to the cost of genetic editing itself, it could also cause the baby to make more money in the future, furthering the already large disparity based on wealth in this nation. Improvements to a baby’s genome involving physical characteristics, which are inevitable to arrive in the future, would likely affect that baby’s success in the future. Time after time, physical characteristics have been seen to affect success and productivity. For example, people with greater height tend to be more economically successful in life. One study done by the American Psychological Association showed that over a 30-year career, a six-foot person on average makes $166,000 more than a five-foot five person. Additionally, nearly all Fortune 500 CEOs are over six-foot two-inches tall, even though people over six-foot-two make up only 3.9% of the world’s population. Moreover, physical beauty according to culture, in addition to height, correlates to greater income. Daniel Hamermesh, a labor economist from the University of Texas, conducted a study to determine the correlation between beauty and income. When considering twelve other categories, such as education, age, and race, he
found that men who are considered to be less physically attractive earned on average 17% less than their
good-looking counterparts. In addition, he found that women earn 12% less.

Group Activity

Have students propose a plan or policy to protect the nation from further social inequality from genetic editing.
This could be made in the form of a law or general advisement.

B. Potential for eugenics?

The study of genetics has always had a strong connection to eugenics. There have been several significant
eugenic movements in recent history, including in Nazi Germany, as well as in the United States. Eugenics,
however, first emerged hundreds of years ago with farm animals. By the end of the 19th century, people known
as “social Darwinists” applied Darwin’s theory of natural selection to human populations, pushing for the
artificial selection of groups of humans, often racially. It is important to understand these past movements to
draw the connection between the movements and the future of genetic editing.

The most widely known example of eugenics in recent history was with the Nazis. In his Mein Kampf, Hitler
stated that any non-Aryan race, including the Jews, gypsies, and more, were inferior to the German Aryans.
The Holocaust was meant to eliminate these groups of people from the gene pool. Eventually, the Law for the
Prevention of Hereditarily Diseased Offspring was passed. This led to the large-scale sterilization of individuals
with physical or mental disorders that were considered genetic, including schizophrenia, manic depression
(bipolar disorder), epilepsy, blindness, deafness, and alcoholism. In 1940, Hitler turned to euthanasia to kill off
the disabled instead of sterilization. Euthanasia, which is theoretically the painless killing of someone suffering
from an incurable disease or disorder, became greatly twisted as a result of the Nazis’ use of it. Their methods
of euthanasia included gas or lethal injection and involved the murdering of hundreds of thousands of innocent
citizens.

Even though our nation likes to think that we have never been anything like the Nazis, the United States has
had its fair share of eugenics programs - and it isn't as if there is no possibility for eugenics programs to
emerge in the U.S. in the future. Eugenics was very prominent in America during the late 19th century, as well
as in the 20th century. At the end of the 1800s, Francis Galton, cousin to Charles Darwin, wanted to improve
mankind through the propagation of the elite in Britain. Although this plan was never truly implemented in
England, it was more readily accepted in America. In America, eugenics first took the form of marriage laws; in
1896, Connecticut made it illegal for those with epilepsy or who were considered to be unintelligent to marry.
The movement was more widely accepted in 1903, when the American Breeder’s Association was established
to promote eugenics. Additionally, John Kellogg, founder of Kellogg cereal, created the Race Betterment
Foundation in 1911 and implemented a “pedigree registry.” This organization held national conferences on
eugenics in 1914, 1915 and 1928. As eugenics became more widely accepted, America’s elite, scientists, and
socialists promoted the cause and eventually established the Eugenics Record Office. This office tracked
families and their genetic traits and determined that a majority of the inferior groups were immigrants,
minorities, and poor. Additionally, the record office determined that bad family traits resulted because of bad
genesis, rather than racism, economics, and societal standards of the time.

After the initial movements that promoted eugenics, forced sterilizations eventually emerged in the U.S. From
1909 to 1979, around 20,000 sterilizations occurred in California mental asylums under the disguise of the
shielding society from the children of the mentally disabled. In addition to the mentally disabled, many
sterilizations were thrust upon minorities. Eventually, 33 states allowed forced sterilization on whomever
they determined to be unworthy for reproduction. In the 1930s, Menendez Ramos, the governor of Puerto Rico
at the time, created widespread sterilization programs for Puerto Rican women. These programs were meant
to fight widespread poverty, although he was considered to have a possible secondary motive - the protection
of the so called “Aryan gene pool” from being “contaminated” by the Latin bloodline during Hitler’s rise to
power. In addition to these instances, 25%-50% of Native Americans were sterilized from 1970 to 1976. During
most of these cases, the sterilizations were performed during other surgical procedures such as appendectomies.

Now that the past examples of eugenics have been established, one must consider the connection between eugenics of the past and genetic editing today. The very possibility of eugenics on a smaller scale through genetic editing could make the use of larger scale, more dangerous eugenics accepted in society. As the inevitable drive for the “perfect” child progresses if genetic editing becomes common, this designer baby will meet the societal standards of perfection. Society’s social values could lead these parents to choose traits for the child that meet these standards. Based on the demographic that has the most social privileges, these children could likely model a white, straight, handsome, tall man. This demonstrates how unregulated genetic editing combined with cultural values has the potential to move our society towards an “perfect” race, paralleling the Aryan race which the Germans idealized, whether or not society is aware of it. By giving people the ability to select traits that go against genetic and physical differences, people could inevitably be allowing the intolerance of the disparities.

Despite the seeming connection, one must consider the following: is gene editing truly like other examples of eugenics? Joshua Lederberg, a Nobel Prize-winning biologist, believes that changing human genetics can possibly lead to eugenics, but at the same time he still thinks that it is very different from the genocidal eugenics performed by the Nazis. No person would be removed from the gene pool, as the negative connotation of eugenics often implies. J.B.S. Haldane, another evolutionary biologist, described genetic editing as being “positive eugenics.”

C. Possible confusion over the government’s role

Another area of possible controversy is the government’s role in the regulation of the technology. Should the government have the right to dictate how parents deal with their children’s DNA? Arguing against government intervention, as long as gene editing is shown to be safe, the government should not logically be able to regulate them any more than the government controls the ability of wealthier people to pay for expensive trainers to improve their fitness or expensive tutors to help their children get admitted into top tier schools.

Group Activity

Have the students become lawmakers! Form several groups for your students. In each group, have the students create a governmental policy that finds the balance between the pros of genetic editing, as well as the cons. Make sure the students consider inequality, the ability to improve making in the bigger picture, eugenics, and more.

5. LOOKING AT GENETIC EDITING THROUGH A RELIGIOUS LENS

Due to the current large role that religion plays in many lives, different religious view points must be considered when debating the ethics of genetic editing. The following religions were chosen simply due to the fact that these three are the most widely practiced in the United States. Although the subsequent analyses take stances, the explanations and stances are not meant to be exclusive; the explanations simply offer the most widespread viewpoints in each religion.

A. Christianity

According to the Bible, the creation of humanity was affected by our sin and anticipates being fixed from sin’s effects. As a result, as caretakers of creation, humans have an obligation to mend the effects of the curse, using any means possible. Therefore, any scientific or technological advance should be used for the improvement of humanity. Despite this, there are still specific concerns regarding the use of genetic editing to cure the curse of disease.
For example, there is the view that genetic engineering would parallel the role of God. The Bible declares that all creations were created by God. Too much alteration of the genetics could be messing with God’s plan. The creation was affected by the events of Genesis 3, which involved humankind’s rebellion against God’s plan. For example, death entered into the scope of humanity, and man’s genetic make-up took a dark turn. According to the Bible, God provides a solution to this - redemption through Jesus - the backbone of Christianity. As a result, genetic editing would be like cheating God.

Additionally, there is the concern that genetic engineering may mess with the procedure of life according to God. For example, the Bible outlines the importance of the relationship between the baby and the mother in the womb. Would the use of genetic editing of germ cells to create life outside of the body interfere with the development of the soul?

Genetic editing can also potentially viewed as being an effort of resistance against God. Genesis 11:1-9 displays the effects of humanity’s defiance against God. The people in this chapter were not obedient to God. As a result, God stopped their progress by creating several dangers along their journey. The problem is that genetic manipulation could be seen as having similar motives, which would inevitably create paralleled results.

B. Judaism

Assuming the surgery of the genetic editing of a germ cell can be successfully performed, gene surgery would probably be accepted in Judaism. A major doctrine of Judaism is that a human life has infinite value. As a result, there is a moral obligation to help heal the sick and prevent disease. It's so important that in Jewish oral law, the Mishnah, it states that “He who saves one life, it is as if he saved the whole world.” Because this is so significant, Rabbis consider it to override other rules of Judaism.

It may seem obvious that since genetic engineering is able to avert disease, it should be used. However, should genetic editing be allowed to alter characteristics that don’t pertain to your health, such as eye color, height, personality, intelligence and facial features? Conservative Judaism does not permit several body modifications such as tattoos and piercings. Jews believe that the human body is God’s creation, and therefore by altering your body for non-health purposes would be an insult to God’s work. According to Judaism, Jews must believe that God, the greatest craftsman of all, formed them in a perfect way. If mankind truly believes that God’s plan is perfect, then there is no need to make “improvements” to genetic makeup.

Another argument for the allowance of genetic engineering is the fact that a germ cell or even the fertilized zygote is not considered to be a person when outside the womb. As a result, gene manipulation would not be seen as interfering with an existing or future human being.

Additionally, Jews view each human as being a “partner of God” in the betterment of the world. As a result, the thought that genetic editing would assume the position of God is less pertinent to the debate in Judaism.

C. Islam

Islam has different viewpoints on genetic editing due to conflicting tenets. The different factors considered include the idea of technological advancement, discrimination, interference with God’s plan, and more.

Islam has no problem with scientific advancements as long as no lives are terminated in the process, parental identity is maintained, and the parents of the offspring are married. Along the line of technological advancements, many Muslims argue that God has given humanity the knowledge and skills, and therefore the ability, to develop solutions for harms to our health.

However, at the same time, the use of this technology to select gender and other traits could inevitably lead to disparities in societies, discrimination, and deviations from the world that God created mankind in. With this,
some Muslims could see genetic manipulation as aiming to ‘improve’ on God’s creation. This might be considered to be inherently assuming the role of God, which would be seen as a despicable.

Additionally, Islamic law describes life as being a test including suffering. The Qur’an states, “Believers, fortify yourselves with patience and prayer. God is with those that are patient.” This refers to the fact that humans must wait to overcome suffering rather than fighting it - God’s plan will resolve the suffering.

Lastly, any manipulation that has the potential to result in the loss of life of the embryo would be going against God. Muslims believe that the embryo already has a soul and the termination of the soul is strictly against Islam.

6. CONCLUSION

Teachers should invite students to return to the questions outlined in the beginning of this module. An optional reflection may be written, so that students can compare their thoughts on the issue before and after the lesson. Make sure the student explains his or her reasoning behind their answers.

Group Activity

Form groups for the students. Have half of the groups create a PSA, either in the form of a video or poster, to warn the public about the negatives of genetic editing. Have the other half of the groups create a PSA on the benefits of genetic editing.

7. REFERENCES AND ADDITIONAL RESOURCES


disease/


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