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Research and Writing

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Is Crispr worth the risk?

Imagine a future where we can genetically modify a baby before it is delivered. This is not far from reality with Crispr technology. Crispr (Clustered Regularly Interspaced Short Palindromic Repeat) is a fascinating but frightening technology, because of the many things that it is capable of. It can potentially be used to treat Cancer, improve drug research, improve agriculture, and repair genetic disorders in unborn babies. This technology has the capability to make a lot of improvements in society, but it also has the ability to create mass destruction. Despite ethical concerns, I believe that we should proceed with the use of Crispr to improve humanity as long as we establish more regulations.

To better understand the pros and cons of Crispr, one must first understand what it is and where it came from. Crispr-Cas9 is a technology that allows researchers to alter DNA sequences and modify gene function. It can be used to alter genes in plants, bacteria, animals, and even humans. It is faster, easier, and cheaper to use than former gene-editing tools because it uses a natural function of bacteria. It was first discovered to be a tool in 2012 by Jennifer Doudna and Emmanuelle Charpentier. Although there were many other scientists that contributed to Crispr's discovery behind the scenes, these women receive the most credit for the discovery. These two scientists won the 2020 Nobel Prize in Chemistry (Ledford and Calloway). Their discovery has opened up an opportunity to completely change the world as we know it.

One of the ways that Crispr can positively impact the world is its ability to be used in cancer research and treatment. In his article about using Crispr in cancer research, Ratan explained, “The CRISPR-Cas9 system is cutting-edge gene-editing technology with wide potential that stands alone among other cytogenetic techniques of gene editing in cancer-related diseases” (Ratan). Crispr has the potential to remove genes that would interfere with cells that can kill cancer. It can also be used to pinpoint where cancer cells spread. Crispr has the ability to make cuts when a cell spreads, which can then allow researchers to track the cell changes. This is a huge advancement in cancer research because these changes in cells were almost impossible to notice before. Changes in the DNA are what cause cancer, so a DNA-manipulating tool such as Crispr has the potential to be life-changing for cancer patients. In 2019, the University of Pennsylvania conducted a study to test a Crisper-made cancer therapy. The technology was used to genetically modify the cancer patient’s immune cells to better kill the cancer. The test resulted in the tumors of two patients to stop growing for a while. The test also proved that Crispr treatment was safe. Reacting to the test results, Dr. Stadtmauer expressed, “It's exciting that the treatment initially worked for the sarcoma patient because solid tumors have been a much more difficult nut to crack with cellular therapy. Perhaps Crispr techniques will enhance our ability to treat solid tumors with cell therapies” (NCI). As more studies are conducted, there is confidence that more groundbreaking discoveries will be made in the use of Crispr treating cancer.

Another benefit of Crispr is that it can improve our agriculture. This technology has the ability to create climate-resistant and disease-resistant plants. There have been growing concerns over food security, especially in today’s times, so modifying a crop to be more resistant to climate change would be very useful. A genome biology article explained the concept of engineering a disease resistant plant, saying that “In the context of disease resistance, this

technology has been used to engineer resistance by disrupting a plant susceptibility (*S*) gene, which alters the plant-pathogen interaction, leading to reduced pathogen fitness on the host plant" (Zaidi). The plant susceptibility gene is what the plant uses to fight off diseases, and Crispr is the only known technology that can add such a gene to a plant. Going even further, Crispr can be used to put more desirable traits in crops which would make our food healthier and of better quality. For example, this tool could be used to alter a gene related to pest resistance in a food, and enhance it so that the food becomes more resistant to pests. It can even be used to make our food last longer, by eliminating genes that make food go bad. This could reduce food waste and eliminate the fear that a foregin DNA is in the food that we eat everyday.

The third way that Crispr can have a positive impact is through the editing of a baby's genes. Gene-editing can help babies avoid inheritable diseases by cutting and replacing DNA sequences that contain faulty genes in the human embryo. Some of the diseases that can be prevented in a baby include Huntington's disease and Down Syndrome. The guarantee that every baby can be born completely healthy would be a huge advancement in the human race. This can go even further in the sense that a parent could have the ability to choose certain characteristics in their child. In his article about the debate of embryo editing, Morrison disclosed:

> Fertility services, which allow evaluation and selection of embryos bearing certain characteristics, including pre-implantation genetic diagnosis and in some countries sex selection, are already provided through an array of largely private clinics in countries around the world and some scientists (including He) have already indicated interest in opening IVF clinics specialising in embryo editing. (Morrison)

Although these clinics are located in other countries outside of America, it shows just how much this technology is able to do, and that people are willing to use it for such things as choosing the

characteristics of their baby. Vesikansa touched on Crispr's effect in the central nervous system diseases, voicing that "In combination with recent breakthroughs in stem cell and 3-dimensional (3D) culture technologies, CRISPR facilitates the studying of mechanisms underlying CNS diseases in human-derived in vitro model systems" (Vesikansa). He believes that scientists will be able to unravel the mechanisms of diseases in the central nervous system, which could potentially help prevent these diseases. The final goal of using this technology is to be able to cure any disease with a genetic origin, but the technology is still far too new.

A final way that Crispr can have a positive impact is improving drug research and speeding up the drug discovery process. As of now, drug development is super time consuming and costly. These high costs make it hard for pharmaceutical companies to develop new drugs which can stop us from ever discovering drugs that could potentially be effective. Furthermore, many of these drugs that are developed don't even make it to the market. Brittany L. Enzmann explained the concept that "High costs make the development of new drugs a risky endeavor for pharmaceutical companies and consequently may hinder the exploration of new therapeutics. Removing these barriers using new technologies like CRISPR is key to expanding drug discovery" (Enzmann). Crispr is a fast and cheap tool which could make the drug discovery much faster and cheaper, resulting in the discovery of more useful drugs. Crispr advances each step in drug discovery which includes target identification, compound screening, hit validation, lead identification, and clinical trials. Enzmann expressed her excitement about the use of Crispr and proclaimed that "Because CRISPR makes gene editing more tractable and precise, drug targets can be identified faster, and disease models can be generated that are more realistic" (Enzmann). Many drug makers have already started using Crispr in their drug research, so we could soon see a huge advancement in the next generation of drugs.

Although Crispr seems to be leaving a positive impact on our world, the technology has posed many potential threats. There is one big question being asked by every concerned onlooker: Is it ethical? Editing DNA sequences could lead to mutations and bring unwanted changes. It could even cause cells to lose entire chromosomes. Ball raised his concern, stating, "It can and does lead to off-target modifications, the health consequences of which are unknown and unpredictable" (Ball). If we aren't certain about all of the possible consequences of using Crispr, then I don't think that we should be using it on people, especially human embryos. Dr. Greg Licholai voiced what he believes is the biggest fear of Crispr:

> Humans manipulating the genetic code, and those manipulations get passed on generation to generation to generation. We think we know what we're doing, we think we're measuring exactly what changes we're doing to the genes, but there's always the possibility that either we miss something or our technology can't pick up on other changes that have been made that haven't been directed by us. And the fear then is that those changes lead to antibiotic resistance or other mutations that go out into the population and would be very difficult to control. (Licholai)

These accidental mutations could potentially create incurable diseases. The question is whether the attempt to cure disorders is worth the risk of creating them.

One case of Crispr edited babies that shocked the world was the case of He Jiankui. Jiankui is a Chinese scientist who illegally edited the genes of two twin babies before they were delivered for the first time in history. He was sentenced to three years in prison for violating national regulations on biomedical research and medical ethics. According to Normile, "A court in Shenzhen found that He and two collaborators forged ethical review documents and misled doctors into unknowingly implanting gene-edited embryos into two women, according to

Xinhua, China's state-run press agency" (Normile). Ever since this case there have been many questions raised as to why and how this was carried out. The case has been kept mostly in secret, including the whereabouts of He Jiankui and the health of the twin babies. Although the Chinese government tightened regulations on gene editing after this case, there is a strong possibility that something like this could happen again. Everything about the case was very secretive and mysterious, which is alarming to a lot of people. If something like this could happen so easily, who knows how many people could be using Crispr illegally or with bad intentions. Regulations must be put on Crispr, especially in America, before things get out of hand.

Another problem with Crispr technology is that it's still very new. Therefore, many people believe that there should be more restrictions placed on the use of a technology so dangerous. There have already been cases in other countries where Crispr has been used without regulation, such as the He Jiankui case. This case caused the Chinese legislative body to undertake regulatory reform. Explaining the actions taken after the incident, Song described:

> In response to He Jiankui's case and broader bioethical issues, the Chinese government introduced a series of regulatory reforms that are discussed in the following sections: the first section discusses laws approved by the National People's Congress and its Standing Committee; the second section touches on department regulations; the third section introduces the conceptual plan of constituting a National Medical Ethics Committee and the fourth section explores questions of legal liability raised by The Jiankui's case going beyond the court's decision. (Song)

These reforms cover the entire research process including the possession and utilization of genetic resources such as Crispr. Although this was a big step in China towards more regulation surrounding the use of Crispr, there are still many labs around the world where genome editing is

being done in an unsafe manner. If the wrong people get their hands on this technology, things could end up very badly. This technology has the ability to end the human race if it is not governed with caution.

Another factor that should be considered when using Crispr is how far we should go. Should we stop at curing diseases or should we allow Crispr to make genetic enhancements? Speaking on the public anxiety after the He Jiankui case, Shwartz explained, "Although the experimental embryos were not viable, some worried that fertility clinics would start using CRISPR to genetically engineer children with traits parents might want, like making them stronger, taller or smarter" (Shwartz). Although this might sound extreme, many parents would jump at the chance to design their babies and give them the genetics that they desire. On the other hand, many people believe that this would be unethical and unfair. For example, Balch expressed how "Some worried that, if someday it is possible to enhance certain traits that are perceived as beneficial, it might further increase inequities between the "super" elites and people not afforded such enhancements" (Balch). It would be unfair for the wealthy to give their kids special enhancements which would give them an advantage in life, while people who couldn't afford it would have kids born with an automatic disadvantage.

Another very frightening possibility is the use of Crispr to create bioweapons. We have already seen warfare shift from the use of conventional weapons to the use of technology. Crispr has the potential to replace existing genes with harmful genes, and this process can be used to create bioweapons. For example, terrorists can use Crispr to genetically modify a virus that can wipe out a large amount of humans. The worst part about this is that Crispr is so accessible and cheap, that anyone could get their hands on it. This means our enemies, who have internet access, can simply search up the science surrounding Crispr. With enough determination, they

can successfully use it to create whatever they want, especially with the little to no regulation. Although creating a genetic virus that can wipe out a population sounds insanely difficult, it's actually not as hard as one would believe. Nicholas Cropper, an intern for the American Security Project, explains how simple it can be:

> Making existing bacteria more dangerous and altering organisms to produce different biochemicals are common lab practices around the world today. Recreating known viruses sounds difficult, but in 2002 scientists successfully recreated the Polio virus from only the publicly available genome and mail-order biomolecules. That experiment was conducted before the discovery of CRISPR-Cas9 and the method has only become easier in the intervening years. (Cropper)

This is why we need more regulations on the use of Crispr, and we also need to make sure this technology doesn't fall into the wrong hands.

Crispr is a very complex and fascinating technology. It does things that we never could have imagined were possible just a few years ago. It can advance Cancer research, improve our agriculture, eliminate inheritable diseases in human embryos, and improve drug research. However, Crispr is also a very dangerous technology if not used with regulation and responsibility. There isn't enough regulation surrounding the use of Crispr, and we have seen the outcomes of this in the He Jiankui case. Crispr is capable of doing many harmful things such as being used to create bioweapons or causing unwanted mutations in a gene. These unwanted mutations could even lead to an outbreak of incurable diseases farther down the line. Furthermore, many people are concerned about whether or not this technology is ethical. Designer babies seem like an incredible advancement, but this is something I don't think we

should be using our technology for. Despite all of these concerns, Crispr is a groundbreaking discovery which has the potential to completely change the world as we know it.

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