FORUM:	Commission on Science and Technology for Development
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Introduction

Gene editing, also called gene modification, is a relatively new biotechnological innovation that involves the modification of an organism's DNA for pharmaceutical, agricultural, and technological use. Basically, gene transfer undergoes the following steps. First, plasmid, a small circular DNA strand in the cytoplasm, is removed from the bacterial cell by using the restriction enzyme. mRNA is extracted and it is converted into DNA by restriction transcriptase. Then, the gene of interest is cut by using a restriction enzyme. DNA from plasmid and interest gene are attached together with ligase. As a result, bacteria will reproduce carrying the transferred gene. Such modification and transfer of the gene is complicated to perform but the benefits outweigh the complication.

Well-known uses of gene editing include the medical treatment of genetic disorders like cystic fibrosis and sickle cell anemia and the development of crops with enhanced nutrient content, longer shelf life, and increased resistance to pesticides and diseases. Likewise, gene modification has actively been used in our daily lives, settled as one of the most fundamental biotechnology. On the other hand, it is important to heed the ethical, safety, and regulatory challenges of the technology, especially its vulnerability to genetic inheritance. Because there's no guarantee that the target gene is proactively removed without causing any genetic mutations to genes nearby during the modification procedures, gene editing is always accompanied by uncontrolled variables. Still, given that such biotechnology has granted immense advantages which has quickly assimilated into our daily lives, to recommence and establish chronicles, experts and the CSTD should come up with solutions to tackle the addressed solutions to recraft the technology more ethically, and safely under adequate regulatory frameworks.

Figure 1. Gene Editing

Background

CRISPR – Cas9 is a well-known gene editing method that adopts a naturally occurring genome editing system that bacteria use as an immune defense. Bacteria capture viral DNA and insert it into their DNA, creating CRISPR arrays. When infected, they recognize and attach RNA segments to target regions, using Cas9 or a similar enzyme to cut the DNA apart. Researchers have adapted this system to edit DNA by creating a guide RNA that binds to a specific target sequence in a cell's DNA. The Cas9 enzyme cuts the DNA at the targeted location, mirroring the process in bacteria. Researchers can use other enzymes, such as Cpf1, to add or delete genetic material or modify the DNA.

Yet, adversaries point out that there exist ethical concerns about technologies like CRISPR – Cas9, which artificially alters the human genome to change traits of interest. This artificial change in somatic cells and germline cells could result in permanent changes that are passed on to future generations, producing what are called "designer babies". In fact, CRISPR – Cas9 was found to have been used to genetically modify human embryos not for clinical use in China. Editing an unborn child's genome in parents' interests raises disputable discussions.

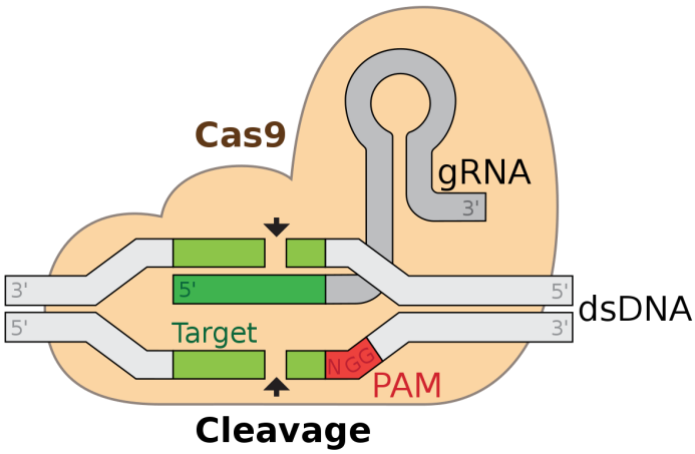

Figure 2. CRISPR - Cas9

A lack of effective and humane gene editing research should be accounted for by the absence of integrated guidelines. Without an elucidated guide, there are simply too many vulnerabilities in this specific field of genetics and biotechnology to effectively use the blessing of scientific innovation.

Problems Raised

Ethical concerns upon the world's first designer babies

In November 2018, resentment erupted over the announcement of He Jiankui of the birth of gene-edited twins called Lula and Nana. He Jiankui described his experiments as "successful and needed technology for the families, and willing to take the criticism". After Xinhua News agency confirmed that there was an unexpected third baby born during the process, the public blasted immediate lawful measures, accusing He of crossing the bottom line of ethics in scientific research in the pursuit of personal fame and gain. Upon a series of thorough police investigations regarding his research, He was convicted of violating the government ban by carrying out his own experiments in human embryos without legalized approval and sentenced to three years in jail. Although a proper decision has been made

for the scientist, repercussions of the experiments remain. It is found that He failed to create the HIV resistant mutation in babies as he intended, which might incur threatening health issues in three babies later.

Experts point out that the gene experiments taken by He Jiankui should be explicitly shared with the Western counterparts of the gene editing related research agencies for academic review, accusing China's lack of supervision on research on gene editing in the first place.

Impact on biodiversity

Unlike human genome editing that affects the patient themselves and their bloodline, agricultural genome editing might result in unintended consequences for ecosystems and biodiversity as these mutated crops hold greater survival advantages over others. Once targeted cells were successfully modified in a crop's genome, the crop could be resistant to certain traits as well as acquire strong inhibition of other living organisms with which previously had a mutualistic relationship. Acknowledging that regulations and restrictions on gene edited crops and normal crops have not been established and that awareness of scientist-farmers is low, gene edited crops' impact on biodiversity should be heeded carefully along the necessary guidelines.

International Actions

Global Gene Editing Regulation Tracker

Global Gene Editing Regulation Tracker was built to track down human and agriculture gene editing history and regulations. On their website, they illustrate the gene editing index, which represents the current status of gene editing regulations of countries, not limited to human gene editing but also the agriculture bit. The tracker has yielded a great benefit for individuals interested in gene editing to understand guidelines and regulations in their associated affiliations (countries) of all kinds as well as the existing foundation of fellow nations'.

WHO's Human genome editing: recommendations

WHO has recently released a representative report that condenses global consultations on different gene therapy measures to represent a leap forward for this area of rapidly emerging science. Noting that WHO seeks the world to make an effective advance in such a potential field for the benefit of all people, the recommendations in the report include the necessity of a centralized governance of human gene editing in nine discrete areas. Moreover, WHO will keep on digging further into establishing global

frameworks by convening a small expert committee on its own with the support of UN agencies across the world.

Key Players

United Nations Educational, Scientific and Cultural Organization (UNESCO)

UNESCO adopted its first declaration on the human genome and human rights in November 1997 at their annual 29th general conference. The declaration was endorsed by the United Nations General Assembly the following year, which still holds today. The declaration proclaims the principles of 7 distinct areas, which include their position on human gene editing research and conditions for the exercise of scientific activity and more. Clause C of their declaration, in specific, outlines that "no research or research applications concerning the human genome should prevail over respect for the human rights, fundamental freedoms and human dignity of individuals or, where applicable, of groups of people". Upon the declaration, the international bioethics committee of UNESCO disseminated the principles and examined the issue of their applications, organizing appropriate consultations with parties.

Figure 3. Human genome

United States

The US National Academy of Sciences and the US National Academy of Medicine, with the participation of academies of sciences and medicine from around the world, convened an International Commission on the Clinical Use of Human Germline Genome Editing in 2019. The commission did not only engage with external expertise in a public call for evidence but also gave webinar presentations to inform the state of research of genome editing at the hands of the US. As shown, the United States, as a leading nation in innovations in genome editing, has spurred the development of a translational pathway for genome editing upon articulated criteria in guidance documents. Further, they seek to create generalized guidance for research on gene editing to prevent the world from extra misuse and failure of the technology.

Possible Solutions

Public Consultation

It is important that delegates be aware of the importance of public inclusion in the decision making process for the gene editing field. To resolve the problems that past guidelines exposed, active public consultations rise as an essential medium for two reasons. First, public consultations in both offline and online platforms can lead to more inclusive and acceptable guidelines that are favorable for both the affiliation, which is often the country, and the beneficiary. Without full attention to public awareness of the risk of misusing Crispr-CAS 9 gene editing, the guideline is figureless and ineffective. Also, in terms of agricultural gene editing in which farmers are actively involved, a decent understanding of the crop they cultivate is necessary to prevent the misguided farming process.

Figure 4. Monitoring the regulatory bodies

Monitoring and reporting

As accentuated in WHO and UNESCO's declaration on human genome and the human rights, ongoing governance is the key to all research on gene editing. Science and medicine communities in the world could identify and address any safety or ethical concerns promptly upon ongoing monitoring and reporting of the progress of gene editing research. This could include the establishment of regulatory bodies that oversee the gene editing experiments, ensuring their compliance with established guidelines and the declaration of the United Nations.

Glossary

Ligase

Enzyme that can catalyze the ligation of two molecules by forming a new chemical bond

mRNA

messenger RNA, a single stranded RNA made from a DNA template during the transcription

Restriction Transcriptase

Enzyme produced by some viruses reverses the normal process of transcription

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