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Ethical Research on Human Gene Editing

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Abstract. The development of biotechnology will inevitably increase its application in medical and health care. Since the experiment of Huang Jun and his team in 2015, there have been a number of biomedical laboratories trying to apply gene editing technology to human therapy. This has aroused great controversy in international academic circles. Many people believe that the misuse of gene editing will not only destroy the existing ethical construction of society, but also affect the ability of human beings to adapt to the future environment. However, this paper believes that gene editing technology can be gradually applied to human body after the government first makes relevant policy preparations and technological breakthroughs are achieved in epigenetic editing. It is hoped that this paper can dispel the excessive concerns of those who oppose human gene editing and provide constructive suggestions on the development of this technology's humanbody application.

Keywords: Human gene editing, crisper-cas9, Social ethics, gene pool

1. Introduction

As human beings continue to explore the origin of biology, as well as the continuous improvement of physiological health requirements, there are voices calling for the introduction of gene editing technology into the field of health care. In fact, the technologies of gene editing are already widely used in agriculture to modify the genes of crops to produce the species that have better features and larger productivity. For example, by improving the genes of soybean, the environment resistance and disease resistance of soybean can be improved, making it more suitable for production in tropical and subtropical regions. Gene editing is now also being used in animal husbandry. The IGF2 gene of the pigs are targeted and modified in order to improve the rates of the lean meat.

Gene editing is defined as the technique that use nucleases to produce precisely targeted double strand breaks (DSB) and then use the exogenous DNA to repair DSB to produce the desired edits, which can be targeted at any location in the genome, resulting in no excess genetic material in the genome. Currently, the mainly used gene editing techniques are ZFN, Talen and CAS9. The ZFN system consists of zinc finger proteins that can specifically recognize and bond to DNA and Fok I endonuclease that cleaves specific DNA sequences and causes DNA double-strand breaks. DSB will activate the cell's DNA repair mechanism, which makes targeted modifications to the genome. The disadvantage of ZFN technology is that not only it is complicated and expensive, but also it cannot recognize every wanted target. TALEN system is composed of a series of TAL proteins and Fok I endonuclease. Long target fragments can be recognized by assembling multiple TAL proteins together since each TAL protein recognize and bind to one base at a time. This technique can achieve arbitrary knockout to the genome and has high success rate, high efficiency and low miss rate. The only problem

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is that its operation is quite complicated. The CRISPR/Cas9 system contains crRNA, tracrRNA and Cas9 proteins. In actual operation, one end of crRNA is complementary to double stranded nucleotide, and the other end is complementary to tracrRNA to form guide RNA. After the formation, Cas9 protein is combined with guide RNA to make site-specific cleavage of DNA. The building of the CRISPR/Cas9 system is quite easy and has low cost and high efficiency.

Among ZFN, Talen, CAS9 and other technologies, CRISper-Cas9 technology has been widely used due to its characteristics of simple operation and low access threshold. In 2015, Associate Professor Huang Jun of Sun Yat-sen University and his team used CRISper/Cas9 technology to edit HBB gene in human embryos to completely cure the genetic disease beta Thalassemia [1]. Then in 2018, He Jiankui, an associate professor at Southern University of Science and Technology, edited the CCR5 gene in the fetus, resulting in the birth of "HIV-immune gene-edited babies" Lulu and Nana [2]. These research experiments have attracted extensive attention in the international community.

Based on related ethical debates, this paper analyzes the ethical problems existing in the current stage of gene editing technology, puts forward suggestions to solve such problems, and discusses the development prospects of gene editing technology in the future, so as to provide some references for future researches.

2. Analysis of ethical problems of gene editing

Aside from technical shortcomings such as the off-target effect of gene editing technology, the current society is not fully prepared to welcome gene editing humans. Haphazard use of this technology may lead to many social problems.

First of all, the "perfect gene" may amplify existing inequalities in society. Embryo gene editing is expensive. Currently, a single fDA-approved gene therapy drug for pediatric spinal muscular atrophy costs $2.1 million. It is conceivable that once the relevant gene editing technology is allowed to be used in humans, only those with high social status or a lot of wealth will be able to afford the relevant gene editing at first, which will inevitably lead to their offspring being superior to the general population. Their advantages can in turn help them win the competition with the masses and snowball more wealth. The advantages directly determined by genes cannot be easily changed and surpassed, which means these gaps are difficult to be filled by efforts and become insurmountable gaps, and eventually even evolve into so-called "genetic civilians" and "genetic aristocrats" [3]. Therefore, the class gap that still exists in our society will be widened and solidified after the introduction of gene editing, making the distribution of social resources more unequal.

Besides, the abnormal modification and replenishment of the human gene pool may have a huge impact on human evolution and the future of the race. The current gene pool of each species has undergone a long process of natural selection and co-evolution with other species and environments [4]. The insects' broken wing genes may be a disadvantage under normal circumstances, but they can keep insects from being blown out to sea on small islands that are prone to hurricanes. Therefore, the "bad" genes that are cut and edited now may actually be "life-saving" genes in the future when the environment changes. Moreover, genetic modification of one single human body is bound to infuse and affect the entire human gene pool after the birth of offspring. So after several generations of accumulation of the deletion or the modification to the present favorable gene direction, the natural adaptive ability of human beings may become worse, which even can change the natural evolution trajectory of human beings [5].

Gene editing could create a race of humans that does not exist today, challenging the current definition of race and potentially triggering even more contentious issues for people's livelihoods. Although biomedical experiments are currently limited to using gene-editing techniques to cut and optimize existing genes, there is no denying that, once human gene-editing is approved, more will be used to modify the human body, such as introducing relevant genes from animals into human embryo cells. However, can the beings that has the properties of animals be called "human" in the traditional sense? Are they able to achieve equal respect and spiritual respect from ordinary people? Can their mental health be guaranteed?

Last but not least, the law on gene editing is still incomplete, and there is a lot of ambiguity, controversial places about the right to life, the right to genes and so on. First, does the embryo have the

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subject state as humankind? Does the parents infringe on their gene-tic rights if they edit the embryo's gene based on their self-willingness? To make and design a baby is to define the embryo as a commoditized "object" [6]. In China, the definition of an embryo as a right object is the consensus of the civil law, which is an organization of its mother. However, the current law has not concerned the recent embryonic stem cell researches and has its own limitations, which means it still needs to be revised [7]. Second, if gene editing is popular, how can it be ensured that people's personal genetic information is not easily disclosed to research institutions, recruitment agencies? Although gene editing is still in the research stage, related cases have cropped up frequently. Around 1996, Harvard University illegally organized "physical examinations" in China's Dabie Mountains and secretly collected genetic samples for genetic diseases. In 2009, civil servant recruiters in Foshan, Guangdong province, secretly tested candidates' genes. What rights do these particular individuals have over their own genes? How to regulate this right in law [8]?

3. Governance of genetic ethical issues

However, even if gene-editing technology being applied to humans may have undesirable consequences for social ethics, the future advances in biotechnology and society can contain the drawbacks and bring great benefits by improving the technology and revising the law to prepare the society for the application.

From the technical point of view, with the development of epigenetic editing technology, the problem of abnormal permanent changes in gene pool caused by gene editing can be solved in the future. Epigenetics refers to the ability to change the function of a gene without changing its DNA sequence, and such changes can be transmitted stably in development and cell proliferation and even with heritability [9]. By regulating gene expression in the form of epigenetic editing, it is not only possible to achieve the regulation and modification of the gene "switch", but it is more important that it does not change the structure and sequence of the genome, which means it is reversible. Once in the future the "good" gene is no longer adapted, the original gene can be "activated" or return to the human genome.

From the social perspective, society is always in a progressive process. Unfair and national rights can be solved by communication and revolution, but cannot be solved by the fear of problems. Although the present society still faces a huge racial contradiction, it has made a great leap in the protection of the interests of the black community. Although the social class gap still exists, the allocation of social resources is fairer under the control of the government. Gene editing should be a real problem to social ethics. But it is a positive trigger to think about the solution, rather than the excuse to crack down on the development of gene editing medicine. Actually, many of the current pessimism views come from social or legal scholars who have little knowledge of science and technology. Their understanding of gene editing is involved in a certain scientific fantasy, so it is easy for them to overstate the bad consequences [10]. But the human genome editing is not a Pandora's box and it's more like the scientists' tools to bring life to the health care industry.

Therefore, in view of the challenges that gene editing may bring to social laws and social racial fairness, the government should discuss the status of embryos and limit the relationship between embryos and their mother before allowing the embryo gene editing. In addition, by taking into account the existing race protection act, and changing flexibly according to the characteristics and results of different types of gene editing, the government should introduce a law that covers the benefits of the vast majority of people who have undergone gene editing. At the same time, relevant courses should be started in primary schools and other educational and scientific publicity means such as public lectures, welfare activities and so on should be carried out to subtly eliminate the discrimination, targeting on the adults and children respectively. Approving gene editing when the technology is better and easier to implement would lower the market price of gene editing and make it affordable to ordinary people, thus avoiding class solidification from its source. The application of epigenetic modification, such as gene methylation and histone modification of chromatin, can avoid direct modification of gene pool while achieving gene silencing and functional changes of genes.

4. Conclusion

In conclusion, even though the human genome editing may lead to problems, such as making society more unequal, changing the direction of human evolution, and challenging the social order in terms of

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law and human rights, the author still thinks that with the development of bioepigenetic editing technology, some inherent shortcomings of gene editing, such as destroying the natural gene pool of human beings, can be solved. In the near future, it is hoped to establish a policy on maintaining social fairness in the future before introducing the gene editing technology to the health care career. The introduction should start with the basic modification after the techniques are entirely mature and use the other genetic editing methods after a long-period observation. Related educational and legal means should not be neglected to guarantee the equal treat and right of all humans that undergo the gene editing with a variety of unique feature. With all this preparation, it is possible to tame what has been called a modern Pandora's box into a useful tool in the hands of doctors.

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