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# WHAT IS GENE EDITING?

According to the NIH National Human Genome Research Institute, gene (or genome) editing is "a method that lets scientists change the DNA of many organisms, including plants, bacteria, and animals. Editing DNA can lead to changes in physical traits, like eye color, and disease risk. Scientists use different technologies to do this."

# HOW DOES IT WORK?

A common, recently-developed tool for genetic modifications is CRISPR, or Clustered Regularly Interspaced Short Palindromic Repeats. The Broad Institute explains that "CRISPR 'spacer' sequences are transcribed into short RNA sequences ('CRISPR RNAs' or 'crRNAs') capable of guiding the system to matching sequences of DNA. When the target DNA is found, Cas9 - one of the enzymes produced by the CRISPR system - binds to the DNA and cuts it, shutting the targeted gene off." CRISPR can also be used to replace sequences of DNA, effectively altering the gene of interest.

# BIOETHICAL CONSIDERATIONS

## Autonomy

Genetic modification can present challenges of maintaining autonomy of any of the individuals involved. The decision to undergo somatic editing through gene therapies may be influenced by societal standards, therefore removing any real autonomy on behalf of the individual. A similar problem presents itself to parents deciding to undergo germline editing. Who really decides what should be edited? In this case, the embryo will eventually grow up forced to live with a decision made without their consent.

## Beneficence

A distinction in the field is made between gene therapy and genetic enhancement, despite both being for the benefit of the individual. The Principle of Procreative Beneficence, formed in response to IVF, states that parents have a moral responsibility to selecting the embryo that will live the "best" life. What determines the parents' definition of a "good" or "bad" trait? If a parent wanted to alter an embryo carrying the GJB2 mutation to prevent deafness, would that be to the child's benefit? What if a deaf family wanted to include the GJB2 mutation? Is that considered harmful or is it just another human experience?

## Justice

Research in the US has a history of mistreating or underrepresenting minority groups. As a result, equal representation in gene modification studies has been difficult to achieve. Furthermore, socioeconomic status is tied to race, which in turn influences access to healthcare and health technologies, such as gene therapy or assistive reproductive technologies that may soon utilize germline embryo modification. Is it equitable to move forward with developing these technologies without consideration of access and the potential of socioeconomic gaps widening?

## Nonmaleficence

Because gene-editing is such a new technology and germ-line editing is widely prohibited for use in reproduction, it is difficult to predict the downstream effects years after the birth of genetically modified embryos. Thus, there is no way to demonstrate that gene-editing would cause as little harm as possible to the child, parents, and society.

## WHO?

HE JIANKUI IS A SCIENTIST AND ASSOCIATE PROFESSOR AT SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY THAT STUDIED AT BOTH RICE AND STANFORD UNIVERSITIES.

## WHAT?

HE JIANKUI GENETICALLY MODIFIED THE GERMLINE OF A SET OF TWINS, - LULU AND NANA - TO BE RESISTANT TO CONTRACTING HIV. IT HAS SINCE BEEN CONFIRMED THAT A THIRD GENETICALLY EDITED CHILD HAD BEEN BORN AS WELL.

## HOW?

USING CRISPR-CAS9, HE JIANKUI EDITED THE CCR5 GENE IN THE EMBRYOS IN ORDER TO PREVENT HIV FROM BEING ABLE TO ENTER AND SUBSEQUENTLY INFECT CELLS.

THE CASE OF

*HE*

*JIANKUI*

If the experiment were to prove successful in conferring HIV resistance in the twins, then it would be beneficial both to the twins and to society. However, the altered gene appears to not express ubiquitously in either subject, rendering it likely ineffective. This calls into question the undue risk each child underwent for this apparent lack of a benefit.

## **Beneficence**

The most obvious violation of autonomy in this experiment is the possibility of a lack of informed consent given to the parents from which the embryos were formed. The parents were recruited under the guise of an "AIDS Vaccine development project" and were, thus, potentially unaware that they were instead signing up for a gene-editing human trial.

## **Autonomy**

## **Justice**

In couples in which the sperm contributor has HIV, the risk of transmission to the child can be minimized via IVF, which is costly. Because the information given to the parents by He Jiankui in terms of informed consent were unclear, it is possible that this experiment could have targeted socioeconomically disadvantaged parents looking to have a child free from HIV based on the way in which this trial was explained to them.

# **BIOETHICS**

## **Of He Jiankui's Experiments**

## **Nonmaleficence**

Arguably the greatest bioethical violation here, the experiments were done without prior testing on mammalian model organisms, such as mice, with no evidence to predict the downstream effects of the genetic modification. While the mutation didn't seem to have a positive effect, it is possible that the gene-editing could actually have negative consequences later on in the twins' lives.

# WHAT HAPPENED TO HE JIANKUI?

Following the announcement of his experiment, the scientific community erupted with overwhelming disapproval, including from the co-creator of the technology used, Dr. Jennifer Doudna. Since then, He Jiankui has been sentenced to serve 3 year in prison and charged a fine of \$430,000 by a court in China. Additionally, his co-conspirators were charged with lesser sentences.

# WHERE ARE THE TWINS NOW?

The twins, named Nana and Lulu for anonymity, were born around 2018, having been supposedly genetically modified through the deactivation of their CCR5 gene. While there doesn't seem to be complete expression of this modification in both children, it has been reported that they could potentially have enhanced cognitive function as well as reduced recovery time following stroke, as new research suggests. It likely be years, however, before observable changes due to the genetic editing are expressed.

TAKE THE QUIZ!

# Gray Area

**➤ SHOULD GENETIC MODIFICATION OF ANY KIND BE ALLOWED SO LONG AS THE PARENTS ARE WELL-INFORMED AND THE CHANGES DON'T CAUSE PHYSICAL HARM?**

**A) YES**

**B) NO**

**C) IT DEPENDS**

**➤ SHOULD PARENTS BE ALLOWED TO ALTER DEGENERATIVE MONOGENIC DISEASES, SUCH AS HUNTINGTON'S DISEASE?**

**A) YES**

**B) NO**

**C) IT DEPENDS**

**➤ SHOULD PARENTS BE ALLOWED TO ALTER NONFATAL MONOGENIC TRAITS?**

**A) YES**

**B) NO**

**C) IT DEPENDS**

**➤ SHOULD PARENTS BE ALLOWED TO ALTER THE GJB2 GENE TO PREVENT DEAFNESS?**

**A) YES**

**B) NO**

**C) IT DEPENDS**

**➤ SHOULD PARENTS BE ALLOWED TO ALTER THE GJB2 GENE, OR REFUSE TO ALTER THE MUTATED GENE, TO INDUCE DEAFNESS?**

**A) YES**

**B) NO**

**C) IT DEPENDS**

# If you answered...

## Mostly A's

You likely agree with the Proactive trend! Classified by Macpherson et al., the Proactive trend "rejects any intellectual barrier to research and claims to investigate freely, expanding knowledge and eliminating alarmism."

You might agree with the goals of the Preventative trend. Macpherson et al. describes this as "currents of thought whose common element is the attempt to preserve the human nature from the initiatives of germinal line modification."

## Mostly B's

## Mostly C's

You fall in between the Proactive and Preventative trends, in a trend termed the Regulatory trend by Macpherson et al. This trend is described as having "great sensitivity for the consequences, positive and negative, that may accompany genetic enhancement and try to solve it by proposing the need for clear legislation as a result of a public, open, and reflective debate."

# A FINAL WORD

Gene-editing has the potential to develop into a eugenic practice without proper regulation that anticipates the consequences of the technology. This is because it is a rapidly developing technology that necessitates frequent discussion and debate of the social and ethical implications it may have, in order to create legislation that can maintain the pace of its advancement. The bioethical framework is a useful starting point for these conversations through its inclusion of multiple aspects of ethics that are relevant to the individual and society as a whole. The actions of He Jiankui do not seem to have done immediate harm to the children that he modified as embryos; however, because these changes are heritable and potentially harmful as their effects are unknown, He Jiankui may have altered the gene pool of future generations, making developing proper legislation a transnational responsibility.

THANK YOU FOR READING!

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