

What We Know So Far About 'Designer Babies' And Human Gene Editing

The once futuristic idea of designer babies remains a subject of speculation and intense ethical debate.

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A Chinese scientist may have changed the course of human history, for better or for worse. In November 2018, He Jiankui of Shenzhen announced that he had altered the DNA of embryos for seven couples as part of their in vitro fertilization (IVF) treatments. So far, one set of twins has been born and the babies are reportedly healthy. They represent the world's first gene-edited humans. The scientist faced widespread criticism following his presentation and has allegedly gone into hiding.

When genetic manipulation is performed on sperm, eggs or embryos it is referred to as *germ-line* editing. In contrast to *somatic gene* editing (e.g. altering the pancreatic cells of one person) germ-line cells are passed down to future generations. In other words, germ-line editing can permanently change the DNA of an entire lineage of people.

Human gene editing is possible using a relatively new technology called CRISPR-Cas9 (which is short for clustered regularly interspaced short palindromic repeats). The system was adopted from a process naturally found in bacteria. It can be used to search through DNA, cut out a defective gene, and then replace it with a new one if necessary.



CHINA NEWS SERVICE VIA GETTY IMAGES

Biological researcher He Jiankui speaks at a summit on human genome editing at the University of Hong Kong on Nov. 28, 2018 in Hong Kong, China.

To ensure that the 'healthy' gene is present in *all* of a person's cells, the gene editing treatment must occur very early in the reproductive process. Research on gene editing technologies has attempted to 'fix' disease-causing genes in sperm and eggs *before* in vitro fertilization, or in zygote embryos as early as one day after fertilization.

CRISPR-Cas9 has been recognized for its incredible potential to remove debilitating diseases caused by a single faulty gene. More than 10,000 such disorders are known to exist. They include potentially fatal childhood illnesses such as hemophilia and cystic fibrosis as well as serious later-onset conditions such as inherited breast cancer and hypertrophic cardiomyopathy.

While promising, the implementation protocols for CRISPR-Cas9 have not yet been perfected. Studies in monkeys showed that the process could inadvertently disrupt normal genes, leading to abnormalities later in life. Another potential problem, termed *mosaicism*, has been studied in mice. This occurs when some cells get corrected and others do not, resulting in a mixture of 'good' and 'bad' genes in the same person.

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In Jiankui's patients, gene editing was performed to manipulate a segment of DNA with the intention of conferring immunity to the HIV virus. His work is considered by many to be premature and ethically irresponsible. The creation of gene-edited humans is banned in most countries pending further long-term safety research and ethical discussion.

As a fertility doctor I understand that every parent's wish is for a healthy baby. With IVF, it is currently possible to test embryos for hundreds of genetic conditions such as Down syndrome and Huntington's disease. An IVF cycle aims to create many embryos, with the intention to select one that is genetically normal. In Canada, it is illegal to select an embryo purely based on sex.

The once futuristic idea of designer babies, now possible with human gene editing, remains a subject of speculation and intense ethical debate. Despite the backlash faced by Jiankui, only time will reveal when the next gene-edited humans will enter the world. When it comes to CRISPR-Cas9, this is only the tip of the iceberg.