Issue Overview: Gene editing

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TOP: DNA strand BOTTOM: Graphics courtesy of Bloomberg.

DEFINITIONS

germline cells
The cells that pass genes from parents to children

gene
A unit of information passed down from parent to child that determines some of the child's traits, or qualities

hereditary
Traits, or qualities, that are determined by genes and are passed down from parent to child

Humans have been manipulating genetics since early civilizations realized that certain traits of crops, animals and humans themselves were hereditary. The modern-day mapping of all human genes raised the prospects

of learning precisely which genes control which traits and then directly altering their DNA codes. For years, those tasks proved both challenging and hit-and-miss. But a new technology on every geneticist's tongue is changing that.

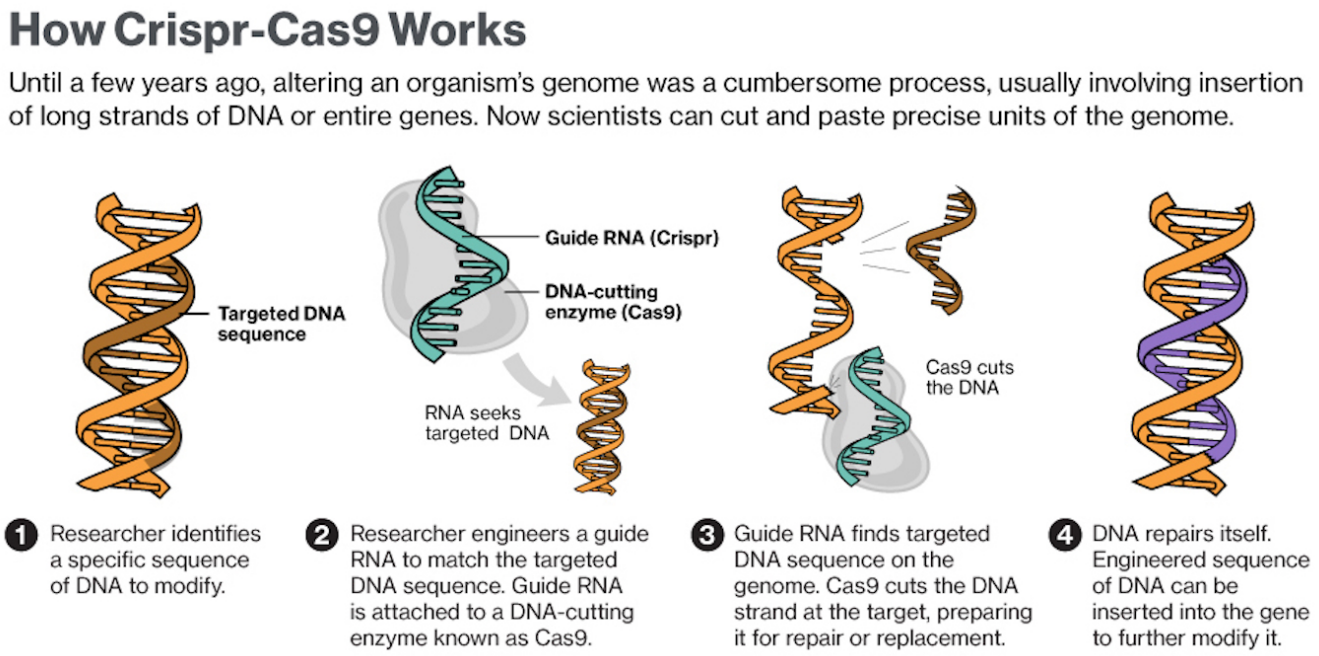
Crispr-Cas9, more commonly called Crispr, is a gene-editing system so simple, cheap and effective that it promises to change mankind's relationship with genetics. Its champions foresee using Crispr to control pests, increase food production and eliminate human diseases. Others worry that it could be used to create designer babies, dangerous mutants and biological weapons.

The Situation

Labs and companies in at least 83 countries are experimenting with Crispr. Their ambitions include killing off malaria-carrying mosquitoes, making wheat invulnerable to mildew and producing eggs suitable for people allergic to them. A group of scientists at Harvard is even trying to bring a woolly mammoth back from extinction.

The most attention-grabbing applications relate to human disease. In experiments with human cells, researchers have used Crispr to repair a mutation that causes blindness, remove HIV from immune cells and correct the defect responsible for cystic fibrosis. In late 2015, researchers published results on the first successful use of the technique to treat mature animals. They repaired a defective gene in mice with muscular dystrophy and watched as muscles throughout the animals' bodies strengthened. These experiments suggest that similar gene-editing cures could eventually be used to treat humans.

Controversially, a handful of labs are using Crispr to experiment with human germ-line cells. These are cells such as sperm, eggs and zygotes, which pass genetic material to children. A group of Chinese researchers created an outcry in early 2015 when they published results of a Crispr experiment on human embryos, even though they said the embryos were nonviable. In 2017, after a year of studying the issue, a U.S. science and medicine research group decided to support the use of technologies like Crispr for the prevention of serious diseases and disabilities.



The Background

Crispr-Cas9 is a simple immune system that Japanese scientists first noticed in bacteria nearly 30 years ago. Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) are sequences of genetic code broken up by remnants of genes from past invaders. These gene remnants help bacteria identify them when they appear again. This allows the Cas9 enzyme to slice through them.

Scientists' understanding of how the system can chop through and then replace sequences of DNA grew slowly until 2012. That year, researchers at the University of California, Berkeley published a paper on making molecular "guides" that allow Crispr to skim along DNA, targeting exactly the right spot to make a slice. Soon afterward, scientists at the Broad Institute said they'd adapted Crispr for use in human cells. That led to an ongoing patent dispute, with implications for anticipated scientific prizes.

A researcher with basic skills and a few thousand dollars' worth of equipment can employ Crispr, creating enormous space for both scientific breakthroughs and abuse. The gene-editing system isn't perfect, at least not yet. It makes unintended cuts in DNA as often as 60 percent of the time in some applications, with effects unknown.

The Argument

Decisions about whether to use Crispr to treat people who are already sick could be made through traditional consideration of risks and benefits, once they are better understood. The issues arising from germ-line editing, however, are philosophical as well as medical. The potential to do good is enormous: eliminating a genetic disease from a family forever. But if something goes wrong, the consequences are potentially eternal, too, affecting future generations who could not give prior consent.

Some scientists worry that germ-line editing would invite enhancements of babies for nonmedical reasons. At the same time, philosopher Nick Bostrom and author Carl Shulman argued in a 2013 paper that this might be a good thing. They say that cognitively enhanced individuals could produce ideas and inventions that improve life for everyone.

Quiz

1 Which of the following sentences from the article BEST develops a central idea?

(A) Humans have been manipulating genetics since early civilizations realized that certain traits of crops, animals and humans themselves were hereditary.

(B) Crispr-Cas9, more commonly called Crispr, is a gene-editing system so simple, cheap and effective that it promises to change mankind's relationship with genetics.

(C) Their ambitions include killing off malaria-carrying mosquitoes, making wheat invulnerable to mildew and producing eggs suitable for people allergic to them.

(D) It makes unintended cuts in DNA as often as 60 percent of the time in some applications, with effects unknown.

2 *Some people worry that using Crispr on humans could be a problem.*

Which sentence from the article BEST supports the main idea above?

(A) Controversially, a handful of labs are using Crispr to experiment with human germ-line cells.

(B) A group of Chinese researchers created an outcry in early 2015 when they published results of a Crispr experiment on human embryos, even though they said the embryos were nonviable.

(C) But if something goes wrong, the consequences are potentially eternal, too, affecting future generations who could not give prior consent.

(D) At the same time, philosopher Nick Bostrom and author Carl Shulman argued in a 2013 paper that this might be a good thing.

3 How does the graphic help the reader to understand how Crispr-Cas9 works?

(A) by showing how it can solve many biological problems

(B) by detailing how Crispr-Cas9 helps to repair parts of DNA

(C) by explaining the relationship between the enzyme Cas9 and guide RNA

(D) by highlighting the importance of enzymes in the formation of healthy DNA

4 Which of the following statements BEST represents the position of people who support using Crispr to alter human genes?

(A) Using Crispr could help scientists learn more about human embryos.

(B) Using Crispr could eliminate diseases such as malaria.

(C) Using Crispr could bring back the woolly mammoth and other extinct animals.

(D) Using Crispr could help to cure blindness or cystic fibrosis.