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The Ethics of Editing Human Embryos

Imagine if genetic diseases could be removed from the very biological code of our species — a future in which the likes of hemophilia, cystic fibrosis or dozens of other afflictions are simply edited out of human embryos.

In April online in the journal *Protein and Cell*, a team of Chinese scientists reported the first documented experiment to do just that.

The researchers attempted to quash an inherited, potentially fatal blood disorder by injecting 86 non-viable human embryos with the gene-editing system CRISPR/Cas9. In recent years, CRISPR has emerged as a game-changing tool in biology, allowing researchers to tweak an organism's DNA with unprecedented ease. Based on a defense mechanism in the immune system of bacteria that hunts and destroys invading viruses, CRISPR can locate and replace specific genes.

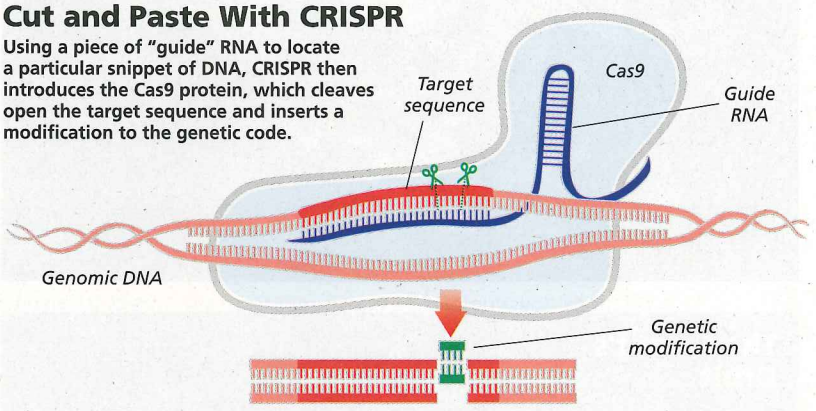
In the human embryo experiment, the researchers used it to delete a faulty gene and replace it with one that produces normal blood cells. But the editing worked for only four of the embryos and created numerous unintentional mutations.

Those accidental mutations illustrate the concerns some scientists have about using the tool in humans. Earlier in the year, when the Chinese team's experiment was still a rumor, 18 researchers co-authored a letter in *Science* that called for the community to address the ethical questions and potential hazards of using CRISPR in humans. Until we can wield CRISPR more precisely and understand the implications of its use more fully, said the scientists, it should not be used on humans.

Despite the concerns, in September researchers at the Francis Crick Institute in London applied to the United Kingdom's governing authority on fertility research for permission to use CRISPR on human embryos. The need for clear guidelines has spurred the organization of an international summit on human gene editing. As of this writing, it was scheduled for early December in Washington, D.C. —SHANNON PALUS

Cut and Paste With CRISPR

Using a piece of "guide" RNA to locate a particular snippet of DNA, CRISPR then introduces the Cas9 protein, which cleaves open the target sequence and inserts a modification to the genetic code.



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Splice of Life

The door to creating designer species blew open in March when scientists announced the first successful demonstration of genetically altered animals passing their tweaked DNA automatically to their progeny.

Normally, any mutation has a 50-50 chance of being passed on because half the genes come from mom, the other half from dad. But biologists at the University of California, San Diego, found a way to ensure a fruit fly offspring inherited a genetic splice from a parent 95 percent of the time, according to the paper in *Science*.

The team used the CRISPR genetic engineering technique to ensure that a mutation they inserted into one copy of the fly's chromosome spread automatically to the other copy, according to Valentino Gantz, a co-author of the study. It's a process he calls mutagenic chain reaction, or MCR.

MCR could transform entire populations of sexually reproducing species within months, making it a powerful new tool for research. The technique could also be used to tinker with plant pests or mosquitoes so they don't spread lethal diseases, such as malaria. —LINDA MARSA

Researchers introduced a mutation — lighter coloration on the flies' left side — to test a new way of altering DNA.

TOP: ALISON MACKEY/DISCOVER. BOTTOM: VALENTINO GANTZ/UC SAN DIEGO