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Assessments

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New Gene-Editing Techniques Are Reshaping the Ethics of Biotechnology

Highlights

- *The European Union's rigorous definition of genetic editing will limit the benefits that the Continent sees from the application of the technology to agriculture.*
- *In the United States, strict rules on embryonic research will cause it to fall behind other countries when it comes to applying the techniques to genetic medical disorders.*
- *China will continue to push against Western ethical norms on multiple international fronts, and the use of biotechnology will be no different.*

Emerging gene-editing technology is raising questions around the world about the ethics of altering the structure of life: DNA. From Europe to the United States to China, cultural and societal influences shape how each country sees this biotechnology and how it should be regulated. These differences hinder international consensus, as well as the enforcement of any restrictions, especially when the long-term implications of a rapidly advancing technology are unclear. Gene-editing techniques, especially CRISPR, have improved immensely in a relatively short time, and CRISPR's ease of

use and relatively low cost make its application to agriculture and medicine inevitable. In the end, the debate about its use may be shaped as much by economics as by ethics.

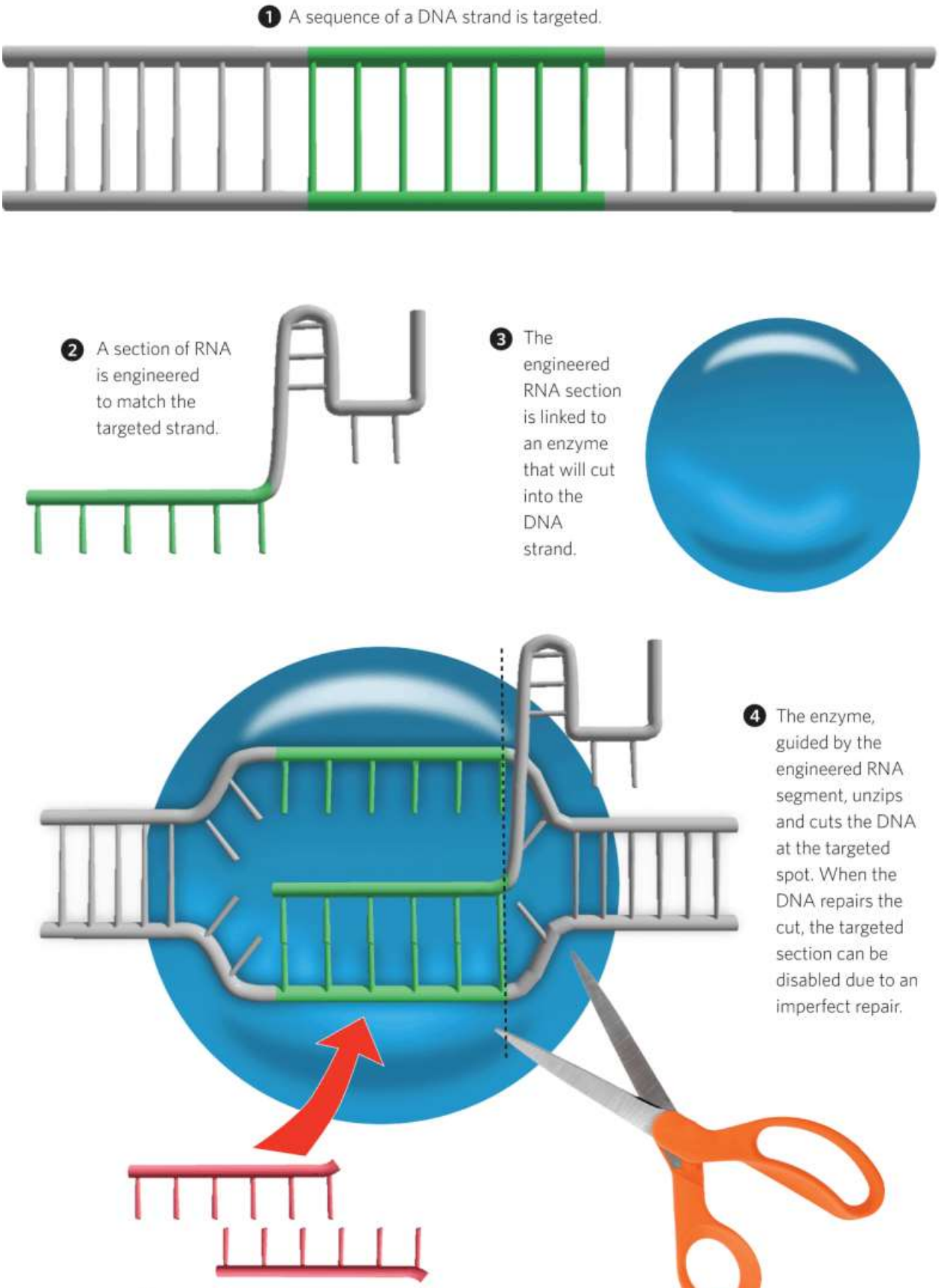
Drawing the Line Down on the Farm

Even before the advent of new gene-editing techniques, the use of genetic modifications had divided the global agricultural community for several decades. European nations, especially France, have strict regulations on which genetically modified crops can be grown and imported. The European Union has found that the potential rewards (higher crop yields and lower use of fertilizers and herbicides) do not outweigh the potential risks, especially the threat to biodiversity and to human health, which remains a subject of intense debate. In July, the European Court of Justice ruled that genetically edited plants (and animals) fall under the broader definition of genetically modified organisms and are covered by EU regulations. The court's decision to put genetic-editing techniques like CRISPR in the GMO bucket has the potential to hinder future trade negotiations. The United States draws a distinction between the two techniques (gene editing and gene modification), and the European Union's recently established regulations on them could be viewed as a non-tariff trade barrier.

Additionally, the ruling and the stringent regulations halted field trials in the United Kingdom, Belgium, Sweden and Finland. This move could put European farmers at a disadvantage and make the EU agricultural sector less competitive. The United States, on the other hand, has taken the opposite approach, announcing in April that genetically edited crops would not be regulated. Canada, similarly, treats gene editing in the same vein as traditional breeding. Australia is on the path to go one step further and deregulate the use of genetic-editing techniques in animals. South American agricultural exporters Brazil and Argentina have tiered regulation, but genetic editing that does not insert a new gene isn't strictly regulated.

In the long run, these technologies could help to shore up food security around the globe. And as countries are forced to deal with increased severe weather, higher temperatures and less rainfall, they are likely to turn to genetic engineering, which has the potential to help plants and animals adapt more quickly to climatic changes.

Altering Genes



Source: Nature 503: 14–15

Ecology, Humans and Consequences

The most difficult ethical questions and moral dilemmas will arise when the technology is applied to human health problems. For example, should gene editing be used to prevent malaria? The obvious answer would seem to be yes. CRISPR has been used to edit the genomes of mosquitoes in research labs, now making the elimination of some populations that carry the malaria parasite a possibility. Through gene drives, an edited or inserted gene can be spread throughout a natural population, and additional field trials are likely in the near future.

However, should these insects be eradicated — even if the reward is greater than the risk? What will be the impact on the rest of the ecosystem? Questions remain about how the genetic alterations would proliferate, and scientists are still exploring the possible outcomes. The benefits of eliminating malaria must be weighed against the unknown consequences. But in South America, eliminating invasive species — which certain kinds of mosquitoes are — is less controversial. And this South American reality helps illustrate an ecological-ethical tug of war. The inherent caution of the developed nations that primarily control the technology will have to contend with the needs of the developing world, where the diseases the techniques could potentially cure have the greatest economic and social impacts.

Taking gene editing even further — experimenting with the human body — involves even greater ethical questions: When does life begin and how moral is it to alter the DNA of Homo sapiens? The debate will also be colored by arguments about risk vs. reward and right vs. wrong. And the discussion is likely to be shaped more by religion than science and raise question about whether humans should "play God."

On the practical side, these techniques have the ability to treat diseases in adults and even genetic disorders before birth. Japan and parts of the European Union have approved the use of CRISPR on human embryos. However, it is China that has been racking up a number of firsts in medical treatments and trials using this technique. Chinese scientists were the first to successfully use CRISPR on nonviable and — as of August — viable human embryos. More than 100 people have been involved in CRISPR trials for various diseases, including cancer. However, in the United States, the highly partisan debate over abortion rights, in a highly partisan time, has led to far greater restrictions on research. Though embryonic research using CRISPR is being conducted in the United States, any application in the future will likely face significant regulatory hurdles. China, which is seeking to become a global leader in biotechnology, has a bit of an advantage in advancing and using the technology because the ethical standards of its culture are less restrictive on this front.

Biotechnology has entered a new era that will be defined by gene-editing technology. It remains unlikely that any effective global regulations or regulatory body will be implemented because national economic, political and social interests differ greatly around the globe. From ethics to restrictions, the biotechnology sector will be shaped, much like its emerging tech siblings, by global standards that grow out of the shifting global order.

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