What is gene editing and how could it shape our future?

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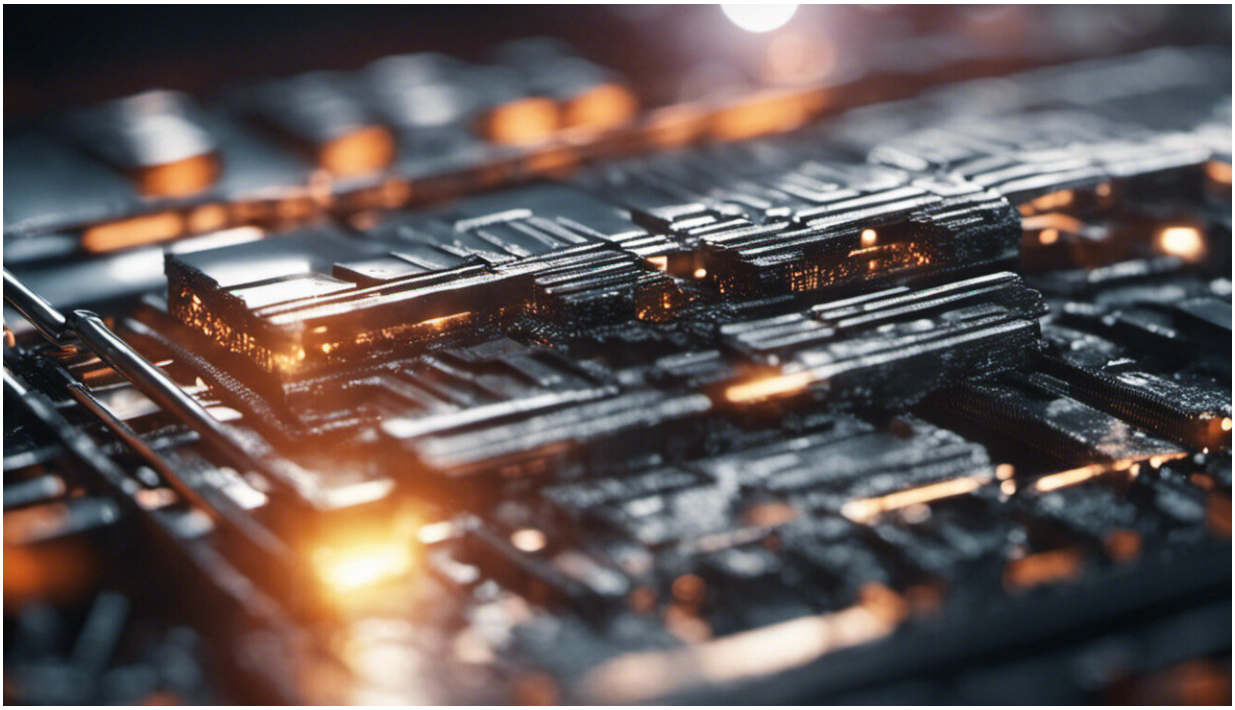

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It is the most exciting time in genetics since the discovery of DNA in 1953. This is mainly due to scientific breakthroughs including the ability to change DNA through a process called gene editing.

The potential for this technology is astonishing—from treating genetic

diseases, modifying food crops to withstanding pesticides or changes in our climate, or even to bring the dodo "back to life", as one company claims it hopes to do.

We will only be hearing more about gene editing in the future. So if you want to make sure you understand new updates, you first need to get to grips with what gene editing actually is.

Our DNA is made of four key molecules called bases (A, T, C and G). Sequences of these four bases are grouped into genes. These genes act as the "code" for key substances the body should make, such as proteins. Proteins are important molecules, vital for maintaining a healthy and functional human being.

Genes can be short, typically made of less than a hundred bases. A good example includes ribosomal genes, which code for different ribosomes, molecules which help create new proteins.

Long genes are made up of millions of bases. For example, the DMD gene codes for a protein called dystrophin, which supports the structure and strength of muscle cells. DMD has over 2.2 million bases.

How does gene editing work?

Gene editing is a technology that can change DNA sequences at one or more points in the strand. Scientists can remove or change a single base or insert a new gene altogether. Gene editing can literally rewrite DNA.

There are different ways to edit genes, but the most popular technique uses a technology called CRISPR-Cas9, first documented in a pioneering paper published in 2012. Cas9 is an enzyme that acts like a pair of scissors that can cut DNA.

It is assisted by a strand of RNA (a molecule similar to DNA, in this case created by the scientist), which guides the Cas9 enzyme to the part of the DNA that the scientist wants to change and binds it to the target gene.

Depending upon what the scientist wants to achieve, they can just remove a segment of the DNA, introduce a single base change (for example changing an A to a G), or insert a larger sequence (such as a new gene). Once the scientist is finished, the natural DNA repair processes take over and glue the cuts back together.

What could gene editing do?

The benefits of gene editing to humanity could be significant. For example, making a single base change in people's DNA could be a future treatment for sickle cell disease, a genetic blood disease. People with this disease have just one base that has mutated (from A to T). This makes the gene easier to edit compared with more complex genetic conditions such as heart disease or schizophrenia.

Scientists are also developing new techniques to insert larger segments of bases into the DNA of crops in the hope they can create drought resilient crops and help us adapt to climate change.

Why is gene editing controversial?

Gene editing is a controversial topic. Unless governments work together with scientists to regulate its use, it could become another technology that benefits only the wealthiest people.

And it comes with risk.

The first case of illegal implantation of a genetically edited embryo was reported in 2019 in China, and led to the imprisonment of three

scientists. The scientists had attempted to protect twin fetuses from HIV being passed on by their father.

But when other scientists read passages from an unpublished paper written by the DNA experiment lead about the twins, they feared that instead of introducing immunity, the researchers probably created mutations whose consequences are still unknown.

The risks of developing designer babies are so high it is unlikely that it will become legal anytime soon. A tiny mistake could destroy the health of a baby or lead to other diseases throughout their lifetime, such as increased risk of cancer.

Laws and regulations surrounding this technology are strict. Most countries prohibit the implantation of a human embryo that has been genetically altered in any way. However, as the 2019 example shows, laws can be broken.

Gene editing has its advantages. It holds the potential to cure genetic disease and create crops resistant to drought. But scientists need to work closely with law and policy makers to ensure the technology can be used for the benefit of mankind while minimizing the risks.

The fact a private company recently announced plans to try to bring back the dodo shows how important it is that international gene-editing laws keep up with the ambitions of corporations.

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