

**“It’s really amazing
how quickly
research into
CRISPR-Cas9
and its possible
applications
has developed in
recent years.”**



PHOTO: DEREK HENTHORN FOR MPG; ILLUSTRATION: HENNING BRUER



NOBEL PRIZE IN CHEMISTRY

EMMANUELLE
CHARPENTIER



CRISPR-Cas9 contains two molecules of RNA that can be combined into a single molecule. A recognition sequence matching a specific sequence on the DNA strand directs the enzyme Cas9 to the location where it should cut the strand.

With some discoveries, it seems like it will only be a matter of time before they are honored with the Nobel Prize, and the CRISPR-Cas9 gene-editing scissors were one such discovery. In early October, the time had finally come: the Royal Swedish Academy of Sciences awarded the Nobel Prize in Chemistry 2020 to Emmanuelle Charpentier for her work on CRISPR-Cas9. She shares the prize with Jennifer Doudna, a molecular biologist at the University of California, Berkeley. Charpentier is the Director of the Max Planck Unit for the Science of Pathogens in Berlin and is considered one of the world's leading experts on the infectivity and immunity of pathogenic bacteria. In the 2000s, researchers identified

CRISPR-Cas9 as an adaptive immune system that bacteria and archaea use to defend themselves from attacks by viruses. In 2011, Emmanuelle Charpentier and her research groups, who were conducting joint research at Umeå University and the University of Vienna at the time, described tracrRNA – an RNA molecule that activates the CRISPR-Cas9 system. A year later, Charpentier and Doudna published their findings describing exactly how CRISPR-Cas9 homes in on the correct location in the DNA strand and how the system can be used as a tool for modifying genetic material.

The key discoveries that paved the way for the award are therefore just nine years old. This unusually short time frame for the awarding of a Nobel Prize serves as a testament to the colossal importance of the research conducted by Emmanuelle Charpentier and Jennifer Doudna. In the ensuing period, researchers have refined CRISPR-Cas9 into a precise genetic tool that can correct defective DNA as easily as if it were a document in a word-processing program. This technique is therefore also referred to as genome editing and can be used to study a whole host of scientific questions. As the method is

also relatively straightforward in terms of its operation, it's hard to imagine laboratory work without it nowadays. However, CRISPR-Cas9 has not only revolutionized basic research, but has also become an indispensable tool in medicine, biotechnology, and agriculture. Indeed, physicians around the world are working flat out to convert the CRISPR-Cas9 technology into therapies for as-yet-untreatable diseases. Microorganisms with modified genetic material are intended to improve the efficiency of food and medicine production. And agricultural crops whose genetic material has been modified using CRISPR-Cas9 promise higher yields and greater resistance to diseases and environmental impacts.

But as with any new technology, the gene-editing scissors also involve some risks. So far, there has been barely any research into the environmental impacts of the release of genome-edited plants and animals. Moreover, the genetic modification of cells in the human germline (e.g. to create “designer babies”) is highly controversial from an ethical perspective. It is up to society and political leaders to weigh up the pros and cons of genome editing and to establish a legal framework for its use.