

Speaker's manuscript – Chemistry Prize 2020

Genetic scissors: a tool for rewriting the code of life

The Nobel Prize in Chemistry

- The Nobel Prize in Chemistry is one of the five prizes founded by Alfred Nobel and awarded on 10 December every year.
- Before Alfred Nobel died on 10 December 1896, he wrote in his will that the largest part of his fortune should be placed in a fund. The yearly interest on this fund would pay for a prize given to "those who, during the preceding year, shall have conferred the greatest benefit to humankind."
- The interest would be divided into five equal parts, with one part awarded "to the person who shall have made the most important chemical discovery or improvement".



Who is rewarded with the Chemistry Prize?

- The Nobel Prize in Chemistry is thus awarded to people who have made discoveries or improvements that have given us knowledge about the structure of various substances and how they are created and changed – how and why they react with each other, and even how we can create new molecules.
- This is Ada Yonath, who was awarded the 2009 Nobel Prize in Chemistry for her pioneering contributions to studies of the ribosome.



Chemistry Prize 2020

- The 2020 Nobel Prize in Chemistry is awarded for the discovery of one of gene technology's sharpest tools: the CRISPR/Cas9 genetic scissors.
- Researchers can use these scissors to change the DNA of living organisms, which has been a great benefit to basic research about how genes work.
- The technology can also be used in the development of food crops, for example, and can lead to innovative medical treatments.



The 2020 Chemistry Laureates

- The 2020 Chemistry Prize will be shared by microbiologist Emmanuelle Charpentier and biochemist Jennifer A. Doudna. They conducted research separately for several years before meeting for the first time in a café in Puerto Rico during a research conference. That was the start of what became a close collaboration.
- Just one year later, in 2012, they made the discovery for which the Nobel Prize is awarded and which would soon revolutionise research on how life works.



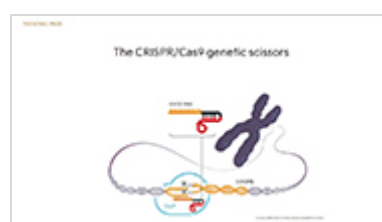
Bacteria have an ancient immune system

- Emmanuelle Charpentier and Jennifer A. Doudna started exploring the immune system of Streptococcus bacteria. They thought they might be able to develop a new form of antibiotic.
- Instead, they discovered that the bacteria have a clever way of fighting viruses. Just like people, bacteria can be infected by viruses, so they need a way to defend themselves.
- With the help of small RNA molecules and a special protein called Cas9, the bacteria can recognise a virus DNA and cut it apart, making the virus harmless. Together, the RNA molecules and the protein are called CRISPR/Cas9, or the genetic scissors.



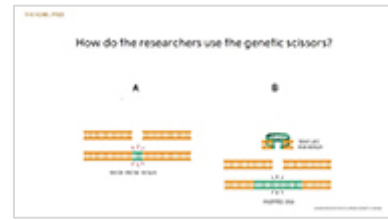
The CRISPR/Cas9 genetic scissors

- The two researchers realised that the bacteria's clever genetic scissors could be used to make changes to the genetic code - that is, the genome - of other living organisms besides bacteria.
- In order to get the scissors to cut the DNA strand in the right place, the researchers constructed artificial so-called "guide RNA" that matches the DNA code at the place where the cut is to be made. The guide RNA then links up with the Cas9 protein to form a genetic scissors. Now the genetic scissors can find the right location on the DNA strand and make its cut.



How do the researchers use the genetic scissors?

- When the cut is made in the DNA strand, there are two ways to go:
 - A. The cell can repair the cut in the DNA strand itself. In some cases, that leads to the gene's function being turned off.
 - B. The researchers can construct a specially designed template to insert new pieces of DNA where the cut was made. The cell will use the template when it repairs the cut in the gene, resulting in a change in the genome.



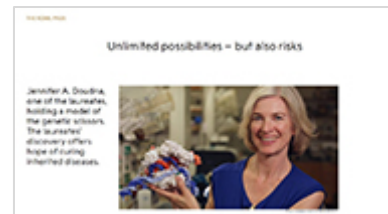
New technology that affects us all

- Because the genetic scissors is so easy to use, it is now widespread in basic research. It is used to change the DNA of cells and laboratory animals for the purpose of understanding how different genes function.
- The genetic scissors have also become a standard tool in applied research. One example is plant breeding, where researchers have developed rice that does not absorb poisonous heavy metals from the soil. They have used the genetic scissors to turn off the genes that would otherwise cause the rice to absorb cadmium and arsenic. The result is a healthier kind of rice.



Unlimited possibilities – but also risks

- Thanks to the genetic scissors, medical researchers are on the way to making a dream come true: curing serious or life-threatening diseases. The only limit to how the genetic scissors can be used is our imagination. But there are also risks that the technology could be misused. We need to have ethical discussions and rules to govern their use.
- For many years now there have been laws and regulations that determine how gene technology may be used, such as forbidding changes to the human genome that can be inherited by following generations.



“We had a sense that we were onto something big – I think we had no idea how big.”

- In an interview given in conjunction with the announcement of the 2020 Nobel Prize in Chemistry, one of the laureates, Jennifer A. Doudna, talks about her collaboration with Emmanuelle Charpentier.

