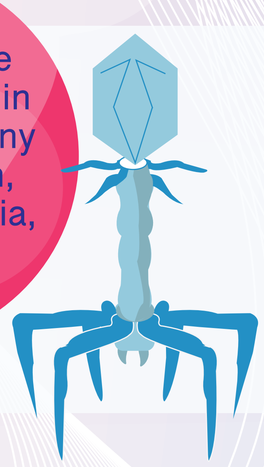
CRISPR-CAS9

A POWERFUL GENE-EDITING TOOL

There are more bacteriophages in the world than any other organism, including bacteria, combined!



Viruses that attack bacteria are called **bacteriophages** (or phages.) They latch on and insert pieces of their own DNA, where it replicates and takes over the cell. Bacteria have their own **immune defense system** to protect them against these viruses. In the cases where the bacteria survives a phage attack, a copy of the attacker's DNA is stored in its own DNA, allowing it to recognize it if it attacks again **--and slice it up!** This natural process of slicing DNA uses two main components.

The first are short snippets of repetitive DNA sequences called **CRISPR:**

Clustered -- **means they are found together on the genome.**

Regularly -- **refers to the fact that between these repeats are unique pieces of DNA, called spacers. This is where the viral DNA is stored!**

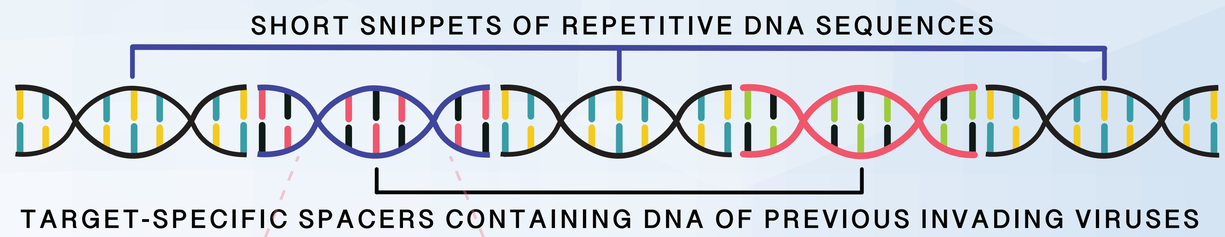
Interspaced

Short ---- **means the sequence is just 20 or 40 base pairs long.**

Palindromic -- **means the sequence can be read the same forward or backward.**

Repeats -- **means this palidromic sequence is repeated over and over.**

The second component are Cas proteins, short for **CRISPR-associated proteins**. The Cas genes are located near the CRISPR on the genome. The repeated patterns help the protein to find the invaders' DNA. There are different types of Cas complexes, but **Cas9** was the first adapted for use for human purposes. When a bacterial cell senses bacteriophage invasion, the Cas proteins take a transcript (known as **guide RNA**) of the unique DNA sequences stored in the CRISPR array from previous attacks, and scan the invader's DNA for a matching sequence. If recognized as invading phage, the Cas9 (with the helicase part of the protein) **unwind** and (with the nuclease part of the protein) **chop up** the viral DNA like molecular scissors, destroying it and therefore halting the phage infection.



Scientists discovered they could apply the **find and cut mechanism** of the CRISPR-Cas system to other organisms including **plants, animals, and humans** by adapting different guide RNAs for the use with Cas9. This **guide RNA (gRNA)** helps Cas9 to find the place in the DNA where it is supposed to cut. After it is cut, the DNA then repairs itself. It would then be unreadable. Alternatively, **scientists can add a DNA template in addition to Cas9** that will then be inserted into the cutting site during the DNA repair process. This allows novel genes to be introduced at a specific site of interest in the genome, therefore **enabling researchers to create new features in different organisms.** This technique can be used for many purposes in bio-technology and medicine. Of course, ethical concerns need to be taken into consideration.

CURRENT AND FUTURE USES OF CRISPR:

CRISPR is currently used in many aspects of **food production:** from specialized crops to cell-based meat, to modified yoghurt cultures. In **biomedicine,** it has been used to cure sickle-cell disease and beta-thalessemia, and in treating retinal diseases.

Some **current developments** include treating certain genetic diseases, and helping with improved transplant methods and smarter T-cells. It is being developed to engineer crops that can withstand extreme weather conditions and get rid of pests without harmful chemicals, to create enhanced biofuels, aid in environmental conservation, and much more!

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BERLIN, GERMANY
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