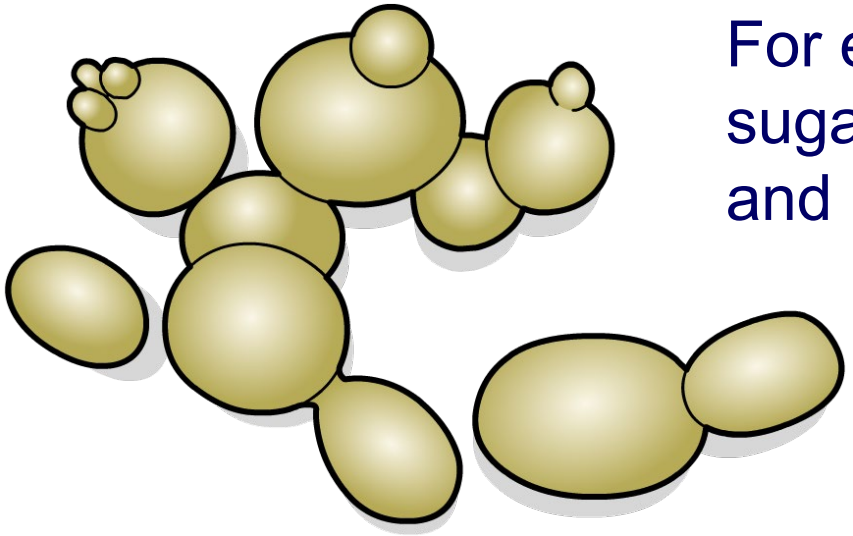
Genetic Engineering

What is genetic engineering?

Living things naturally create useful products.

Genetic engineering can be used to make living things produce other, more valuable, products.



For example, yeast naturally converts sugar into carbon dioxide and alcohol, and is used in baking and brewing.

Yeast can also be genetically engineered to produce vaccines for human diseases.

Genetic engineering is about changing the DNA of a living thing to change its characteristics.

How does genetic engineering work?

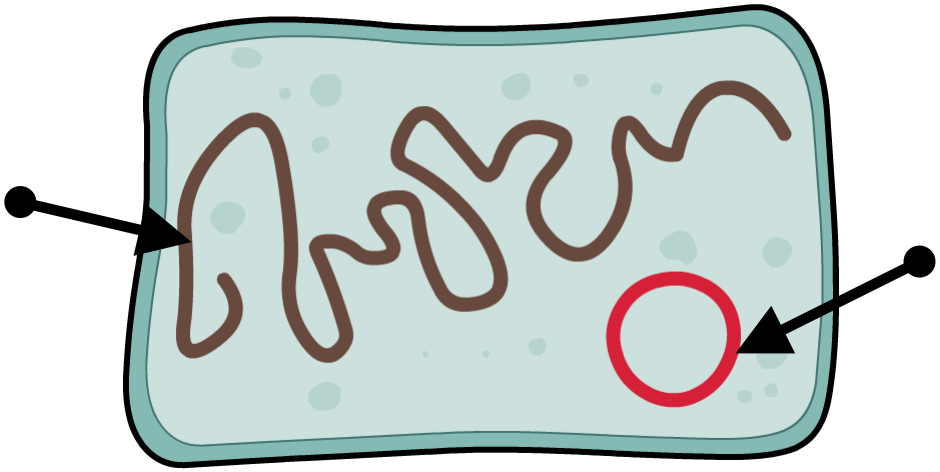
Genetic engineering involves four main stages.

Stage	Example
1. Select the product or characteristic needed	antigen for hepatitis B
2. Isolate genes from specialist cells	hepatitis B virus
3. Insert the genes into target cells	yeast
4. Replicate the new organism	yeast culture in fermenters

What is the product in this example? Hepatitis B vaccine.

Changing the genetic code

Bacteria are often genetically engineered to produce useful chemicals because their DNA is loose in the cytoplasm, making it easy to modify. They also grow and replicate quickly.



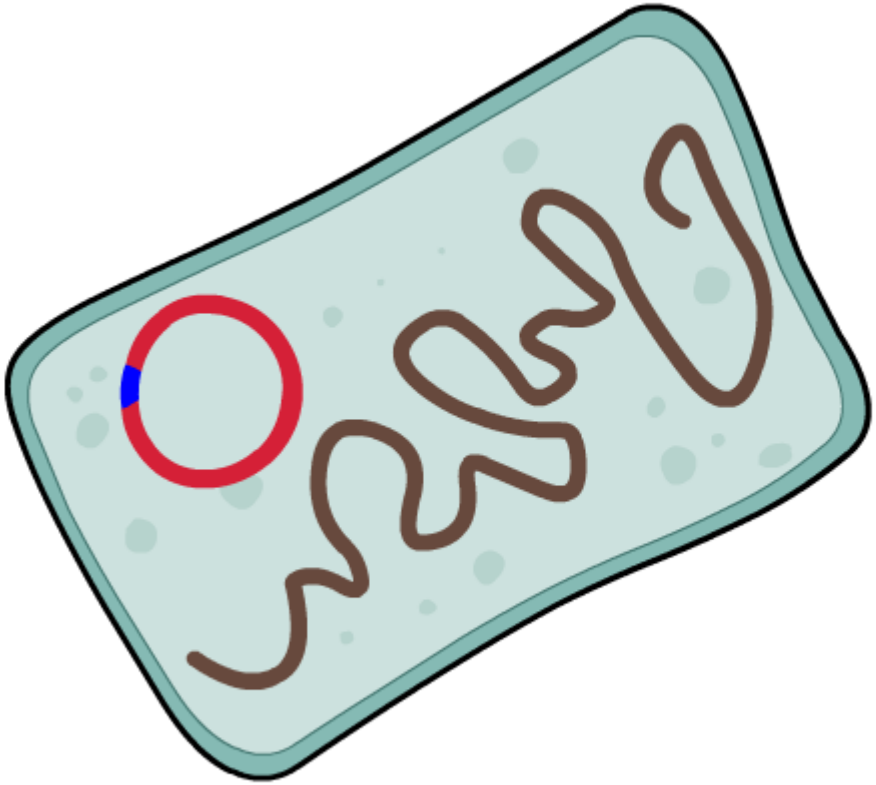
A new gene can be inserted into the **plasmid** and the bacteria then produce the protein for which the gene codes.

Using enzymes in genetic engineering

Which enzymes are used in genetic engineering?

Biological products like insulin are made using genetically engineered bacteria. Several different enzymes are used in this process.

Click "**start**" to find out how they are used.



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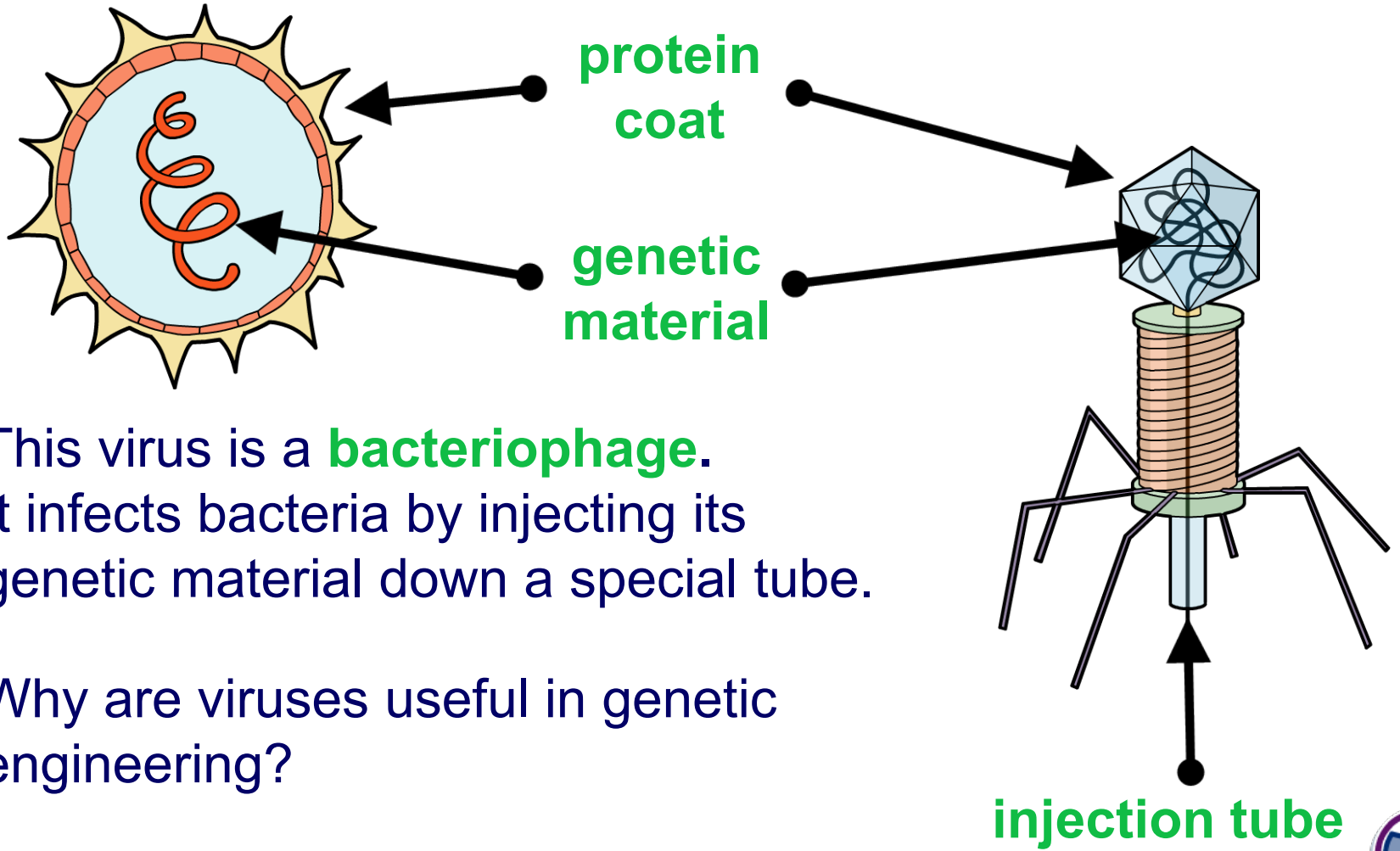
Using viruses

A virus cannot read its own genes, but it can make a host cell copy them and make the proteins.



This virus is a **bacteriophage**.
It infects bacteria by injecting its genetic material down a special tube.

Why are viruses useful in genetic engineering?

Replicating microbes

Genetically-engineered microbes, such as bacteria and yeast, can easily be replicated on a large scale.

Tanks called **fermenters** or **bioreactors** are used. These enable the microbes to be grown, or ‘cultured’, at optimum pH, temperature and nutrient levels.

The product can be continuously removed and purified.

Alternatives to bacteria

Genetically-engineered bacteria are unable to make proteins that are identical to those found naturally in humans, despite having human DNA.

This is because the *way* in which bacteria make proteins is different to the way that mammals make proteins.

A better way is to use genetically-engineered **mammalian cells** grown in industrial bioreactors. These produce proteins that are identical to the ones found in humans.