Lec3\ Biotechnology and nanotechnology

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What is biotechnology?

Biotechnology is the industrial use of biological processes to make products.

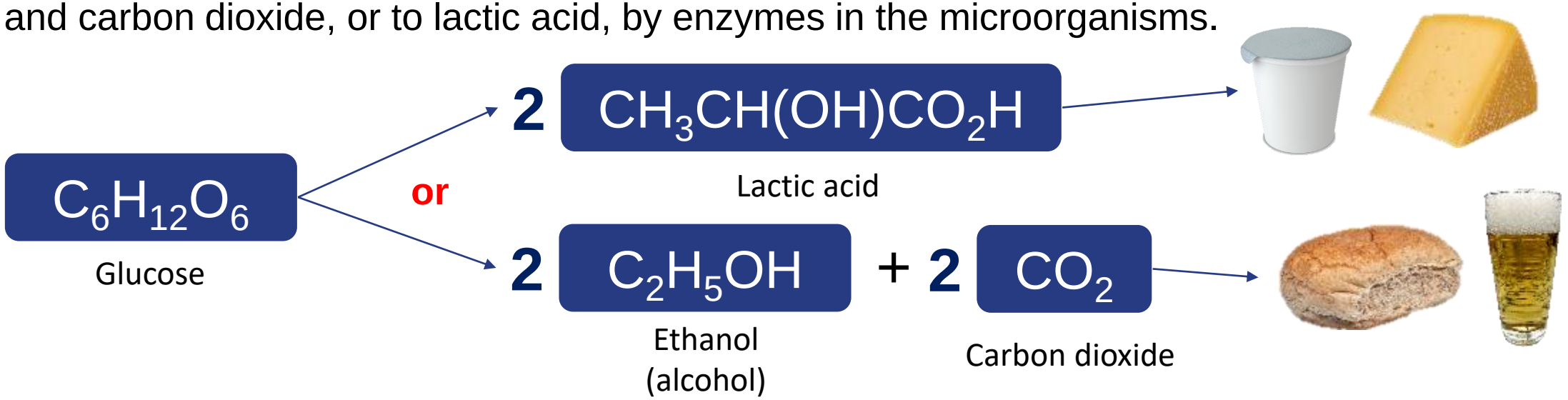
In food, its **major uses are in production and preservation**.

Biotechnology is not new

التكنولوجيا الحيوية ليست حديثه

For many centuries the process of fermentation has used microorganisms (yeasts and bacteria) to make beer, bread, yogurt and cheese. Bread making, beer brewing and pickling all use naturally occurring microorganisms in the production of food and drink.

The basis of the fermentation process is the conversion of glucose (sugar) to alcohol and carbon dioxide, or to lactic acid, by enzymes in the microorganisms.



Increases in biotechnology

Increases in the use of biotechnology by the food industry are due to:

- **competition** between food companies for an increased market share التنافس بين الشركات المنتجه
- attempts to **increase efficiency and reduce** the **environmental** impact of production;انتاج منتجات مناسبة واقل ضرر للبيئة
- consumer demand for convenient, high quality **products at a less cost.**انتاج منتجات اقل كلفه

Traditional biotechnology غير مطلوب

Traditional biotechnology mainly involves the production of foods such as cheese, bread, yogurt and wine.

The fermentation process:

- offers a method of preservation, e.g. by producing acid which lowers the pH (converting a perishable food into one that has a longer shelf-life);
- can be used to change the nutritional value of food products, e.g. converting milk to cheese;
- can create or improve sensory characteristics of foods (flavour, aroma and texture).

Food production

Cheese – rennet (containing the enzyme renin) is used to coagulate milk, forming curds and whey. The curds are then used to make the cheese. Lactic acid bacteria also contribute to this process. During ripening, other bacteria or moulds may also alter the cheese.

Alcoholic beverages – maltose is broken down into glucose within yeast cells, which then use enzymes to ferment the glucose into alcohol and carbon dioxide.

Bread – enzymes within the flour break down starch, eventually producing glucose. This is fermented by enzymes present in yeast producing alcohol and carbon dioxide. The carbon dioxide trapped in the dough causes it to rise when baked.

Modern biotechnology

The emphasis of modern biotechnology is on the production of raw materials and food ingredients.

Work is based on changing the characteristics of plants, animals and microorganisms, including fungi. So far, the majority of this work has been performed in plants.

Genetics and selective breeding

Every cell in plants and animals contains genes.

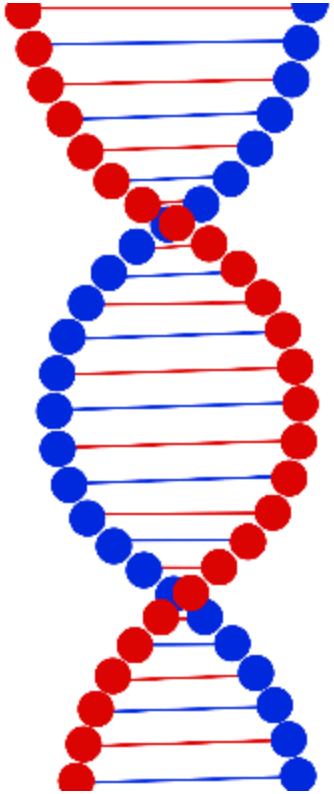
They are inherited from each parent and passed on to future generations. They carry information about physical characteristics and ‘qualities’.

Historically, plants or animals with a desirable characteristic were bred together, to try and enhance these genetic qualities. This is known as ‘selective breeding’.

This process is slow, and so plant and animal breeders have had to work through many generations, waiting for years for noticeable changes (e.g. cross-breeding pigs to produce pork with more muscle and less fat).

Modern bananas have been bred to be much sweeter and have smaller seeds.

Deoxyribonucleic acid (DNA)



Today, scientists are able to identify genes which control particular characteristics. These discoveries offer a quicker and more exact way to improve crops and livestock.

Understanding the nature of deoxyribonucleic acid (DNA) has paved the way for genetic modification.

This is the process by which biotechnologists can alter DNA sequences, to produce a crop, for example, with additional or improved characteristics.

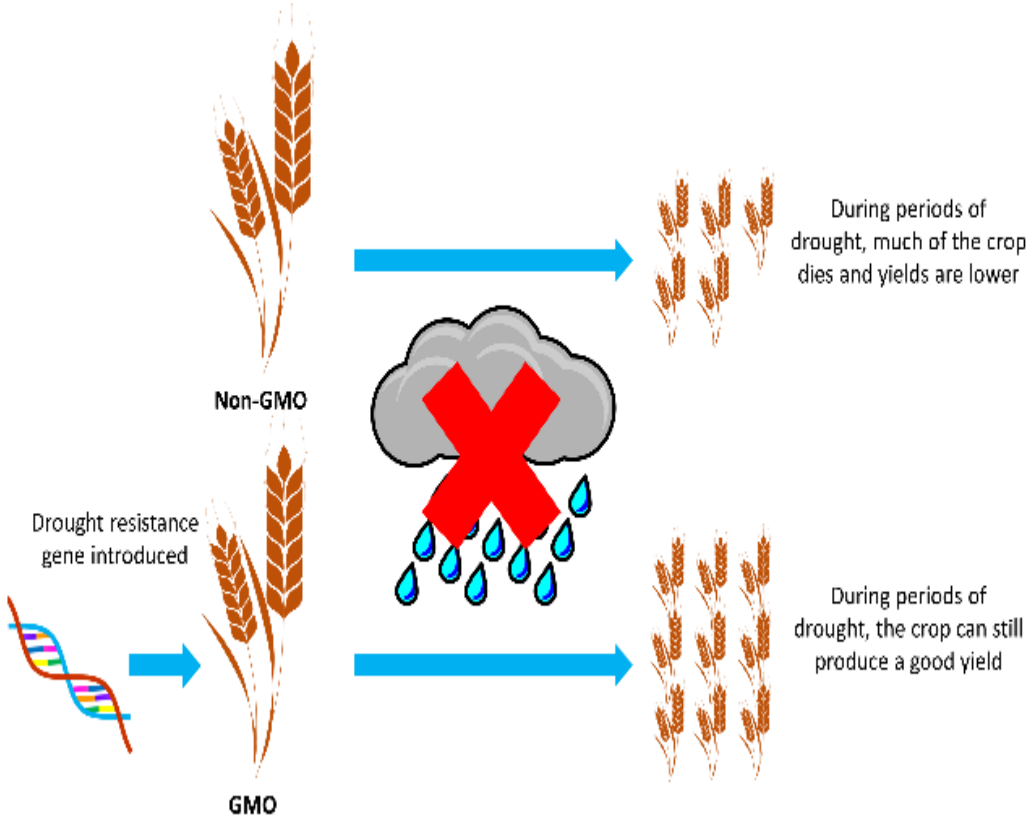
For example, ‘Golden Rice’ is a genetically modified rice crop that contains vitamin A, in order to combat deficiencies that can be a serious problem in some countries.

Improving crops and livestock

Improving varieties of crops or livestock by introducing or modifying specific genes is faster and more accurate than traditional breeding.

If the gene can be identified and modified, the following changes may be possible:

- plant crops may have a longer shelf-life, be more resistant to pests, disease or drought, be more nutritious, have a better taste or give a higher yield;
- animals may be made more resistant to disease, produce less fatty meat, grow faster or be more fertile.



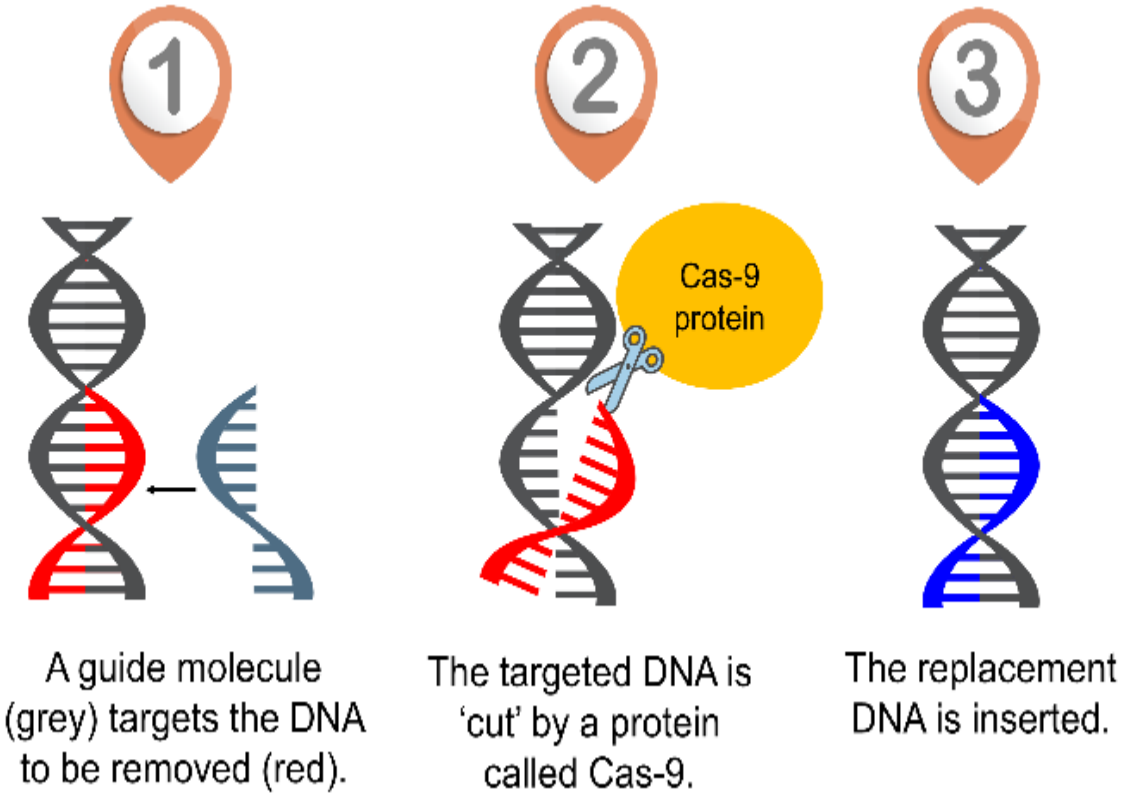
Recent advances غير مطلوب

Recent advances in science now allow for a new way to modify genes.

This technology is known as gene editing.

Gene editing allows for specific and targeted changes to an organism's DNA.

Gene editing is very similar to the 'cut and paste' function on a computer.
A specialised protein is used to cut the DNA, and the desired replacement piece of DNA can be inserted into the cut.



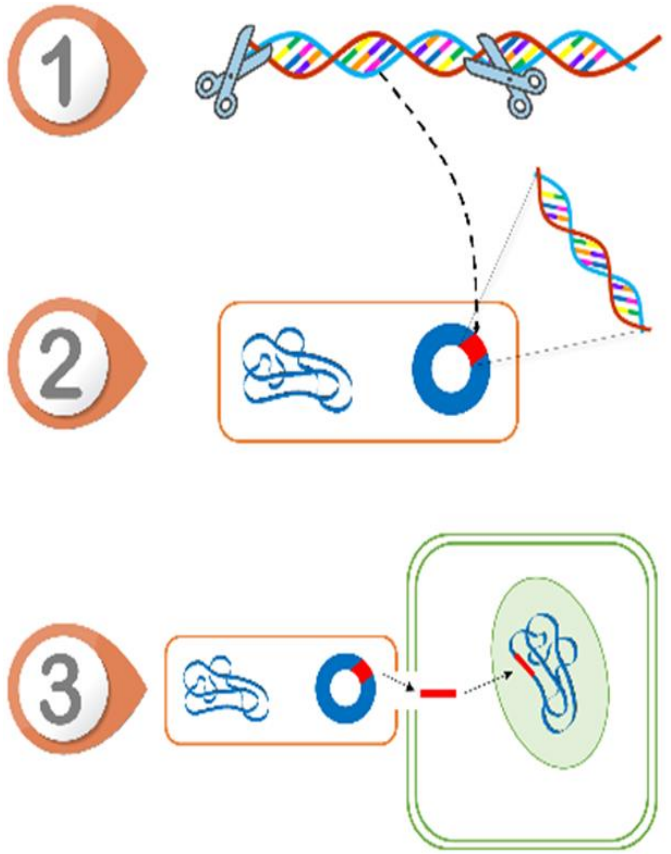
How does genetic modification work? غير مطلوب

First, a gene of interest is selected.

This is then transferred to a plant cell, usually through one of two main methods:

being fired from a device known as a ‘gene gun’ into the cell.

being inserted into a specialised piece of DNA in bacteria that are capable of transferring this information to plants (see image).



A gene of interest is located and cut out (either from the same species or a different one).

The gene is inserted into a specialised piece of DNA called a ‘plasmid’ in a bacterium.

The bacteria that are selected have the ability to transfer a piece of their DNA into plant cells. By replacing this DNA with the gene of interest, it is incorporated into the plant’s DNA.

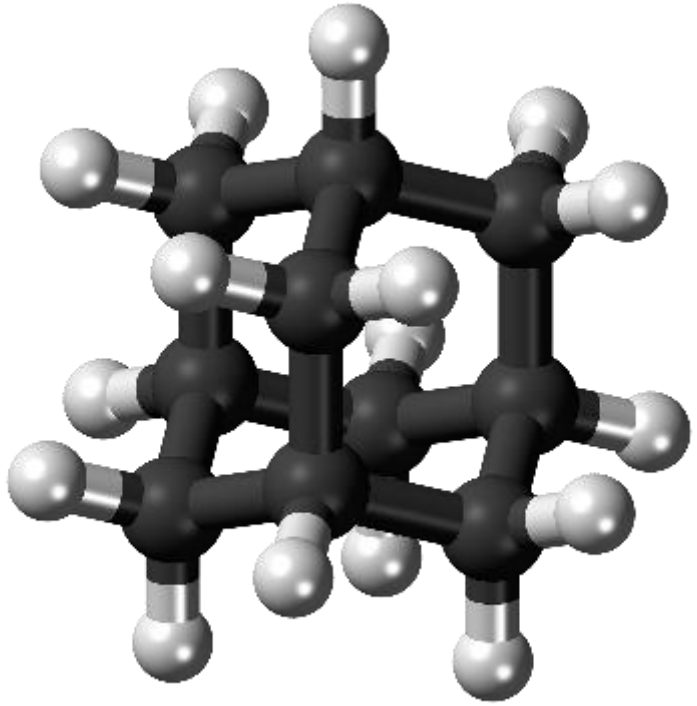
What is nanotechnology?

Nanotechnology is the manufacture and use of materials and structures at the nanometre scale (a nanometre is one millionth of a millimetre).

At this small size, particles can often have unique properties.

Therefore, nanotechnology offers a wide range of opportunities for the development of innovative products and applications for food packaging.

Some conventional foods already contain nanoparticles (e.g. milk, which is a ‘nanoemulsion’ of tiny droplets of fat in water).



Nanotechnology applications in the food

1\Nanotechnology applications in the food sector are on the increase worldwide and are expected to grow rapidly in the future, e.g. the use of nano-carbohydrate particles which bind with bacteria so they can be detected and eliminated.

2\ **Other applications** include making nanoparticles of salt, which allow a saltier taste with less total salt in the product.

3 \The flavour of a food can be changed with bitter blockers or sweet and salty enhancers

4\Nanoencapsulation can help to protect and preserve flavours in foods, by surrounding molecules with a fine protective coating.

5\ Nanotechnology can also be incorporated into food packaging, rather than the food itself. For example, silver nanoparticles have been found to extend the shelf-life of foods such as nuts as they can inhibit bacteria.