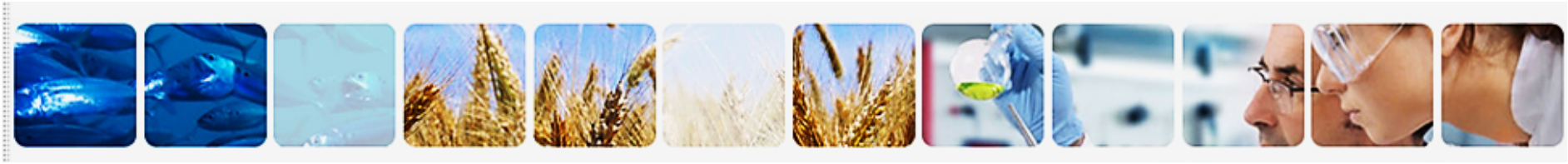

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Objectives:

To understand that food and drinks can be reformulated to improve their taste and/or nutrient profile.

Be able to define modern biotechnologies and understand how they are used in food and drink production.

To consider the possible future developments in biotechnology for food production.

To explain the scientific principles of different modern biotechnologies e.g. genetically modified organisms.

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Food technology: reformulation

What does it mean?

Products can be developed again (formulated), often changing or improving the end product.

For example:

- reducing saturated fat, sugar or salt of a product;
- increasing nutrient availability;
- improving the taste of a product.

Food technology: reformulation

There are many initiatives underway to reformulate foods in the EU, led by industry and governments.

Many focus on reducing or removing salt, saturated fat, *trans* fats or sugars. There is also a focus on portion size.

Some strategies are focused on a particular food whilst others are simply about raising consumer awareness.

Food technology: reformulation strategies

There are a number of issues that have to be considered in product reformulation. These include:

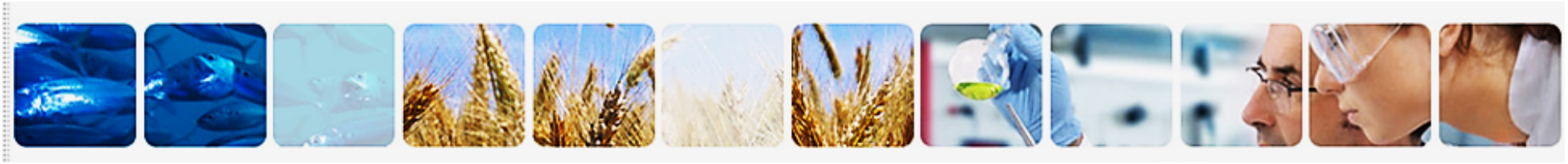
- technical issues of food structure and food safety;
- possible negative health impacts of substitutes; replacements or additions;
- consumer acceptance – taste, quality, price;
- the cost of reformulation to the food industry;
- government standards that may affect the potential to reformulate.

Food technology: reformulation strategies

Example: reducing fat and sugar

- foods high in saturated fat can be reformulated using ingredients with lower saturated fat content;
- added sugar can be taken out and be replaced by sweeteners.

There are limits to how far these nutrients can be reduced in different products without adversely affecting the safety or structure of food or compromising taste.



Food technology: reformulation strategies

Example: reducing fat

Technological approaches can be used to reformulate a product.

Microparticulation uses special production techniques in conjunction with fat replacers to create a more appealing texture.
It has been used successfully in the production of reduced fat ice cream.

Food technology: reformulation strategies

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Example: Microparticulation

Whey proteins are used in a wide variety of food products for their functional properties and high nutritional value. Microparticulated whey proteins behave like fats and can be used as fat substitutes in dairy products such as cheese, desserts, yogurt and ice cream.

Whey protein concentrate undergoes a process resulting in uniform protein particles. The microparticulation process denatures the protein so it is less likely to clump and stick together and gel when heated.

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Food technology: reformulation strategies

Example: Fat mimetics

Fat mimetics (replacers) can be carbohydrates or proteins and are used to replace fat in foods because of their textural or organoleptic properties.

Carbohydrate based fat mimetics can be described as modified starches or maltodextrins. The are totally digestible and have a caloric value from 1 to 4 kcal/g (4 to 16 kJ/g).

Food technology: reformulation portion size

Research in some EU Member States showed that portion size has remained fairly constant in food products. There were exceptions in the following:

- ready meals;
- white sliced bread;
- some fast food meals.

The portion size of these have increased and contributed significantly to intakes of salt, saturated fat and overall energy intake.

In addition, larger multi-packs have become more readily available.

Food technology: reformulation portion size

Though this is not a reformulation of the nutrient profile, this approach reformulates the size of the foods offered. This could lead to reduced fat or sugar intakes.

Several studies show that reducing energy density at the same time as decreasing portion size has a greater impact than what could be achieved by just doing one or the other.

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What is biotechnology?

Biotechnology is defined as the “use of living systems, organisms, or parts of organisms to manipulate natural processes in order to develop products, systems, or environments to benefit people”.

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Biotechnology is widely used in industry, agriculture and medicine.

It has the potential to improve efficiency of agriculture and allow sustainable food production.

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Traditional biotechnology

The use of biotechnology in food production is not new. It has been used for thousands of years.

Early examples of biotechnology include the domestication of animals, planting of crops and the use of micro-organisms to make cheese, yogurt, bread, beer and wine.

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Fermentation

The Romans used fermentation; the term comes from a Latin word *fermentare.*

The process is anaerobic and uses the breakdown of a nutrient molecule e.g. sugar to produce energy. Other by-products may also be produced, e.g. the production of alcohol when yeast breaks down fruit sugars in grapes.

The process is used widely to:

- brew beer;
- make wine and vinegar;
- make yogurt;
- help create materials such as drugs, flavours or enzymes.

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A wide range of fermented food and drink is available in many different countries.

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The fermentation process:

- offers a method of preservation, e.g. by producing acid which lowers the acidity (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).

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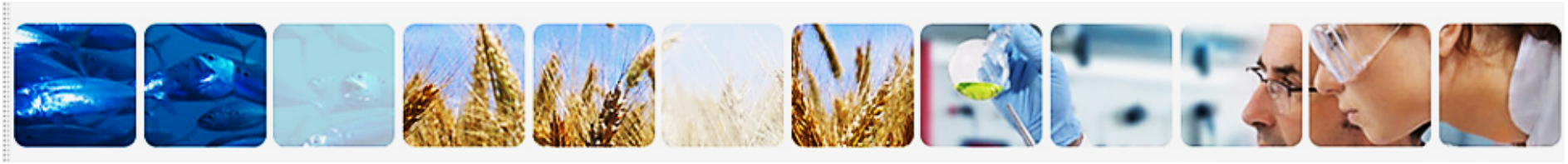

Examples of fermented foods

Cheese – rennet (from the enzyme renin) is used to coagulate milk, forming curds and whey.

Alcoholic beverages – glucose is fermented by yeast enzymes.

Bread – enzymes within the flour break down starch, eventually producing glucose. This is fermented by enzymes present in yeast producing alcohol and carbon dioxide.

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Food ingredients are produced by industrial fermentation of micro-organisms.

Examples include:

- citric acid made from a fungus;
- monosodium glutamate made from a bacterium;
- yeast extracts used as flavourings.

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Other uses of traditional biotechnology

The ancient Egyptians used honey for respiratory infections and as an ointment for wounds. Honey is a natural antibiotic, so it would have prevented wounds from becoming infected.

Moulds from soyabean curds were used by the Chinese to treat infected wounds. The moulds released natural anitbiotics and killed bacteria.

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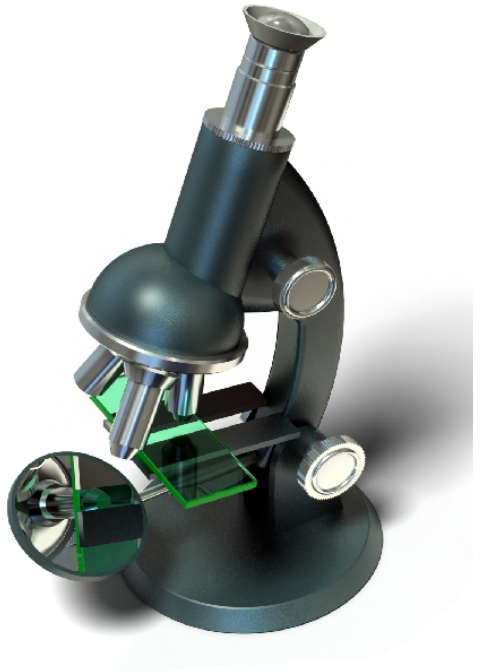
Modern biotechnology

A monk named Gregor Mendel identified genes as the unit of inheritance in 1865.

It took another 90 years of research before scientists discovered that genes were made of DNA.

This discovery was the beginning of modern biotechnology.



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Modern biotechnology

Modern biotechnologies involve making useful products from whole organisms or parts of organisms, such as molecules, cells, tissues and organs.

Biotechnologies have an important role in meeting human needs and demands in:

- medicine;
- agriculture;
- forensics;
- bioremediation;
- biocontrol.

Medicine

Gene modification or transgenesis are used to produce therapeutic human proteins in cells or whole organisms. An example is human insulin.

Antibiotics and vaccines are products of microorganisms that are used to treat disease. Modern biotechnologies involve changing vaccines so they are more effective or can be delivered by different routes.

Gene therapy technologies are being developed to treat certain diseases.

Agriculture

Gene technology can be used in agriculture and food production to:

- increase crop or animal resistance to pests while reducing the use of chemicals;
- increase crop or animal tolerance to chemicals that are used to kill harmful pests;
- create disease resistance in crops and animals;
- improve the food yield per plant or animal;
- make plants and animals more suited to environmental conditions e.g. drier regions or salty water;
- improve the nutritional quality of the food produced by the plant or animal.

Forensics

DNA profiling is used in forensic analysis to identify DNA samples at a crime scene.

Bioremediation

Organisms or parts of organisms can be used to clean up pollution in soil, water or air.

Biocontrol

Biocontrol is when one organism is used to control the levels of another. Biocontrol methods can be used to control invasive plants and insects.

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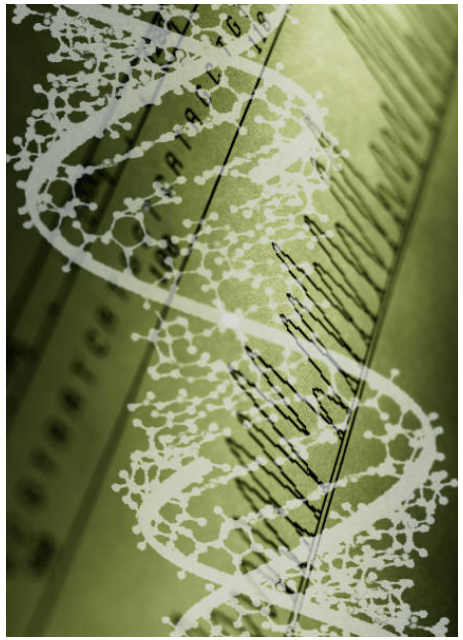
Modern biotechnology is based on a range of genetic discoveries in 1950-75.



These included finding that DNA is the substance which carries genetic information and the discovery of the structure of DNA.

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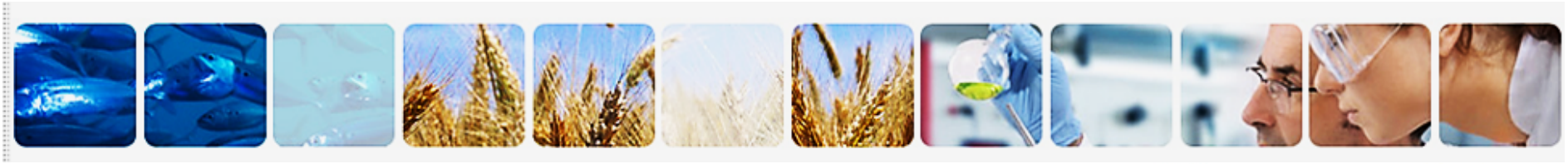

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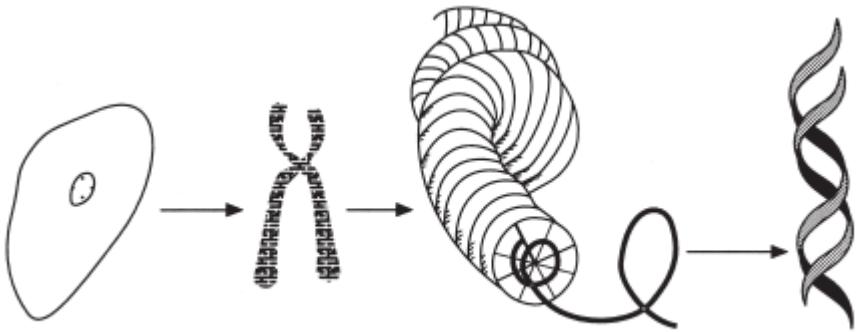
Genes

Every cell in plants and animals, including humans, contains genes.

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



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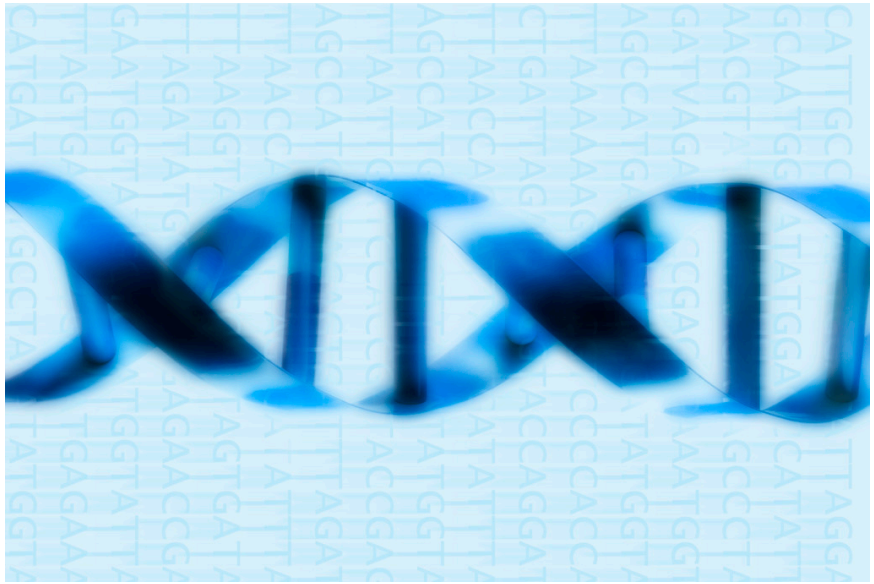
Genes

Gene technology involves the modification of deoxyribonucleic acid (DNA), the chemical that makes up the genetic code of living things.



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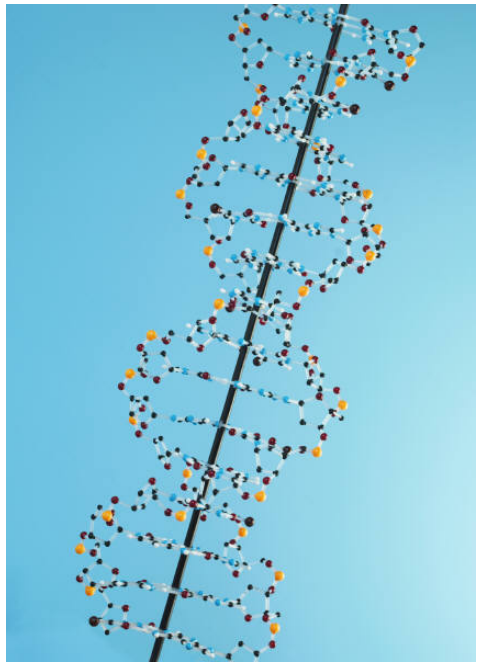
DNA

DNA has a double helix of sugar and phosphate molecules.



It has an identical structure in all living things.

This means that the information it contains can be transferred between different species of animals, plants or bacteria.

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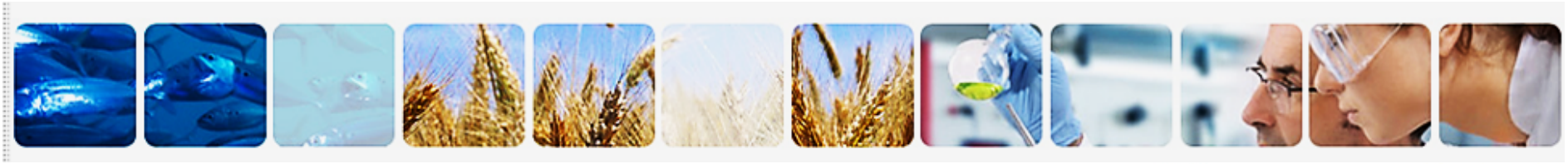

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Genes

Altered or new genes change the way in which cells function. This changes the characteristics of the organism.

When DNA from an organism is modified using gene technology, the organism is then referred to as a genetically modified organism (GMO).

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Gene technology

The use of gene technology to produce a genetically modified organism may involve:

- removing a gene;
- altering a gene;
- adding extra copies of an existing gene;
- adding a gene from another organism.

It is also possible to switch off undesirable characteristics such as the production of a particular protein.

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Some examples of gene technology:

The gene for a bacterial protein which kills insect pests has been introduced into crops. This reduces the need for chemical insecticides.

Switching off the gene that causes softening in tomatoes, gives the product improved keeping qualities.

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Genetic modification

Genetic modification (GM) is any process that changes the genetic material of an organism (plant, animal, bacteria or virus) so that it is capable of producing new substances or performing new or different functions.

Examples:

- a genetically modified cloned cow produces milk lacking the whey protein beta-lactoglobulin (BLG), a protein to which an estimated 2–6% children are allergic to;
- genetically engineered bacteria can be used to clean up an oil spill at sea.

Genetic modification

A number of ethical and safety issues need to be considered with genetic modification.

Some concerns expressed by consumers include fears that the results of genetic modification could harm the environment and pose a danger to humans.

Genetically modified (GM) food

Foods which have been produced from genetically modified organisms (GMOs) are likely to appear no different from food produced by traditional means.

A series of laboratory tests would be needed to show that genes had been changed.

Genetically modified (GM) foods can only be authorised in the European Union if they have passed a rigorous safety assessment. For further information, visit:

www.efsa.europa.eu

Genetically modified (GM) food

In the EU, if a food contains or consists of genetically modified organisms (GMOs), or contains ingredients produced from GMOs, this must be indicated on the label.

The GM Food and Feed Regulation lays down rules to cover all GM food and animal feed, regardless of the presence of any GM material in the final product.

Genetically modified (GM) food labelling

This means products such as flour, oils and glucose syrups have to be labelled as GM if they are from a GM source.

Products produced with GM technology (cheese produced with GM enzymes, for example) do not have to be labelled.

Products such as meat, milk and eggs from animals fed on GM animal feed also do not need to be labelled.

Examples of labelling requirements under EC Regulation

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MO type	Hypothetical examples	Labelling required?
GM plant	Chicory	Yes
GM seed	Maize seeds	Yes
GM food	Maize, soybean, tomato	Yes
Food produced from GMOs	Maize flour, highly refined soya oil, glucose syrup from maize starch	Yes
Food from animals fed GM animal feed	Meat, milk, eggs	No
Food produced with help from a GM enzyme	Cheese, bakery products produced with the help of amylase	No
Food additive/flavouring produced from GMOs	Highly filtered lecithin extracted from GM soybeans used in chocolate	Yes
Feed additive produced from a GMO	Vitamin B2 (Riboflavin)	No
GMM used as a food ingredient (genetically modified micro-organism)	Yeast extract	Yes

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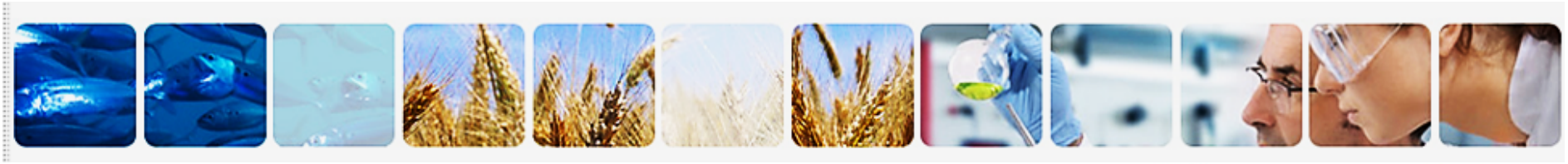

Future biotechnology

It is estimated that global population is to rise to around eight billion by 2030 and probably to over nine billion by 2050. (The Future of Food and Farming: Challenges and choices for global sustainability 2011)

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Challenges include:

- sustainable, affordable food supply and demand;
- stability in food supplies;
- achieving global access to food and ending hunger;
- reducing the impact of food production on the world's environmental systems.

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What about the future?

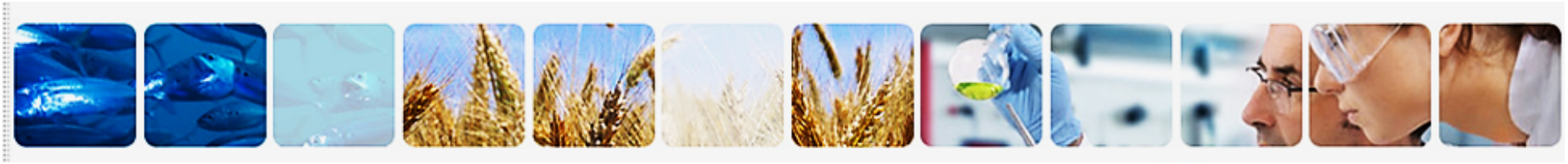
Biotechnology is a continually developing science.

Medicine:

- Gene therapy – replacing defective genes with new functional genes. Still developing.

- Drug delivery systems - microscopic particles called microspheres with holes just large enough to dispense drugs to their targets.

- Personalised treatments.



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Bio-engineering:

- 3D-printing of organic materials, is a new and advancing technology.
- It is being used for bone and organ bio-engineering.

Food:

- Scientists in Kansas USA, have developed a technique that enriches minced beef with omega-3 fatty acids.
- Other omega-3 enriched foods include: pork, chicken, cheese, milk, butter and ice cream.

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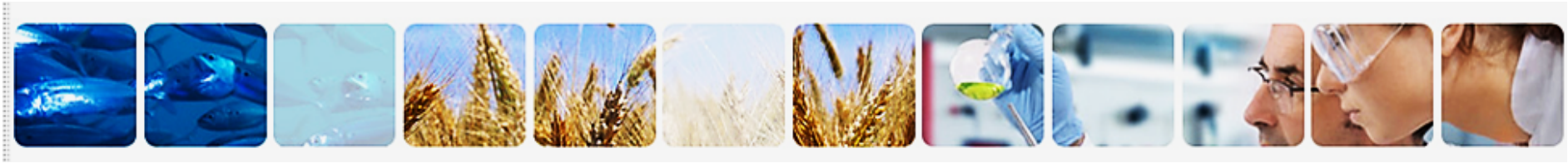

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Food:

- Engineered to produce a bacterial toxin, "Bt corn" resists attack by corn rootworm, a pest that feeds on roots and can cause annual losses of up to $1 billion.
- Scientists from Britain, Germany and the United States have unlocked key components of the genetic code for wheat. This will help to create varieties that are more productive and better able to cope with disease, drought and other crop stresses. (November 2012)

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Using technology in food and nutrition

Functional food is defined as a food with health promoting benefits and/or disease preventing properties.

Examples are:

- plant stanol-enriched margarines that help reduce cholesterol levels;
- omega-3 enriched ice cream or baked products that provide protection against heart disease.

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Nutraceuticals are foodstuffs which provide health benefits in addition to their basic nutritional value.

Nutrigenomics is the study of how food and genes interact. The main aim is to use information about genes to work out the effects that foods can have on an individual's health, performance, and risk of disease.

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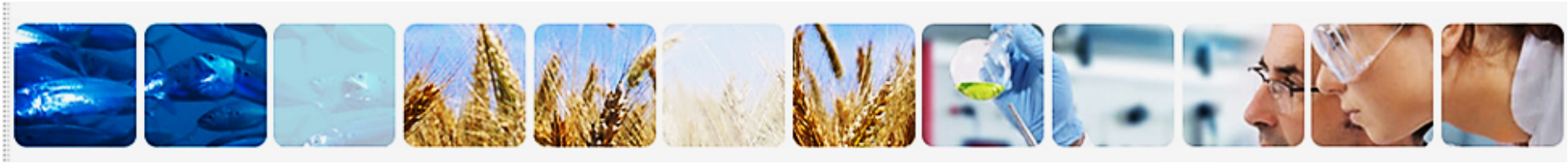

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