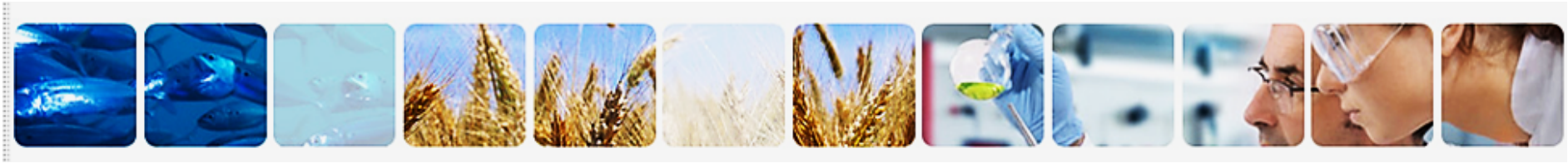

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Education
Phase 3
What is biotechnology?

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Objectives:

To define biotechnology.

To understand areas of:

- traditional biotechnology;
- modern biotechnology;
- future uses of biotechnology;

To understand the basic scientific principles of biotechnology.

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What is biotechnology?

Biotechnology is the use of living organisms
- to make products;
- to improve plants or animals;
- to develop microbes for specific uses.

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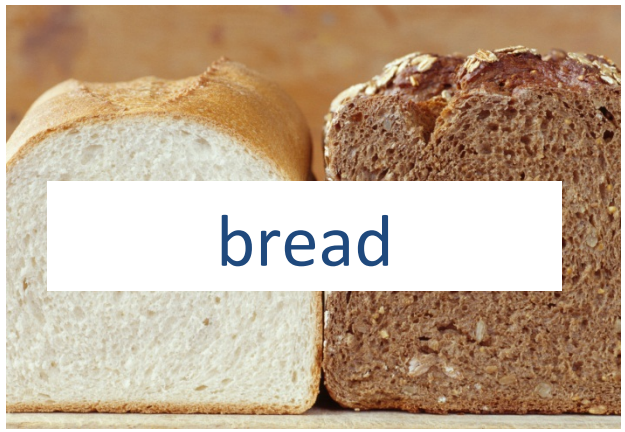

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Biotechnology is widely used in industry, agriculture and medicine.

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, for example:

- wild plants were collected and cultivated and the best-flavoured, highest-yielding plants were chosen for sowing the next season;
- beer is recorded in Egyptian medical texts from 1600 BC, and primitive cheese-making tools have been found in Iron Age settlements.

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Can you think of some other examples?

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Grape juice ferments to give wine

Milk stored in bags made from camels' stomachs turns into a form of soft cheese.

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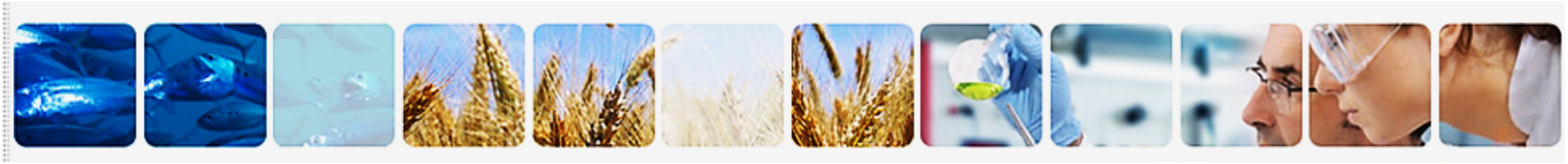

Fermentation

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

Fermentation is the anaerobic (without oxygen) process of converting sugars into alcohols or acids + carbon dioxide by micro-organisms, e.g. yeast or bacteria.

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 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).

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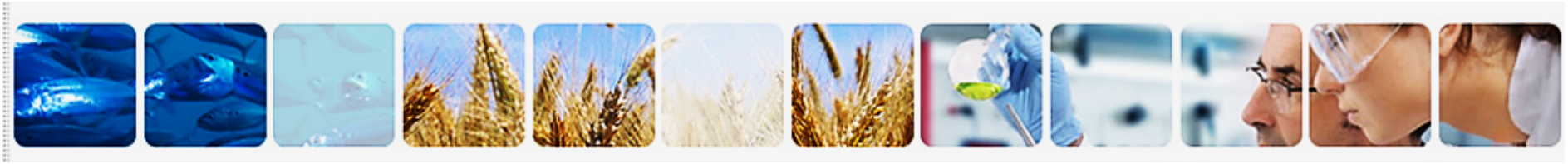

Examples of fermentation

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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Modern biotechnology

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

Modern biotechnology can be used to change cells in other living things to make products.

Work is based on changing the characteristics of plants, animals and micro-organisms including fungi.

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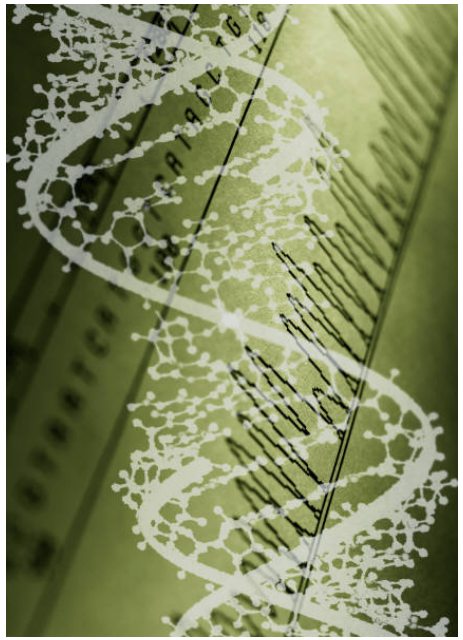
Modern biotechnology is based on a range of genetic discoveries during 1950-75.

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



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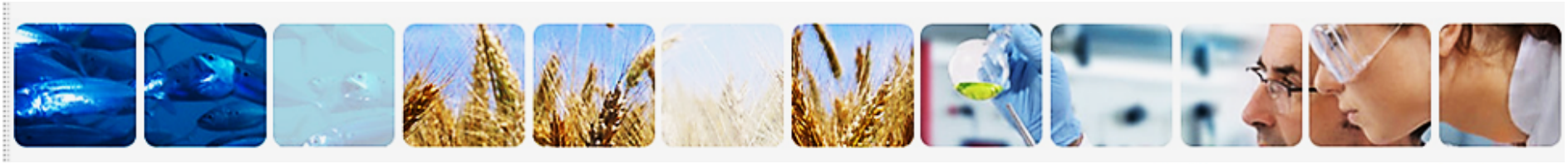

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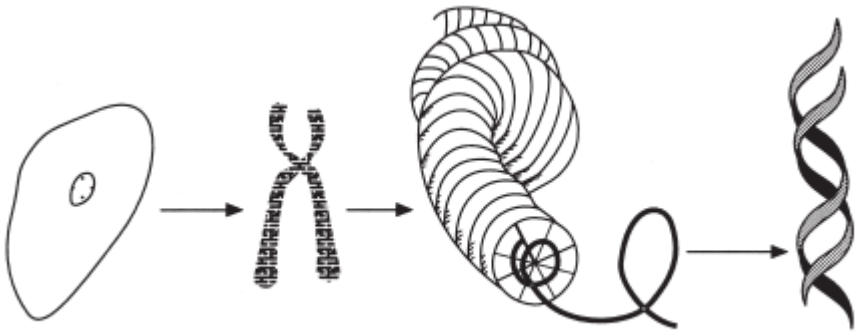
Genes

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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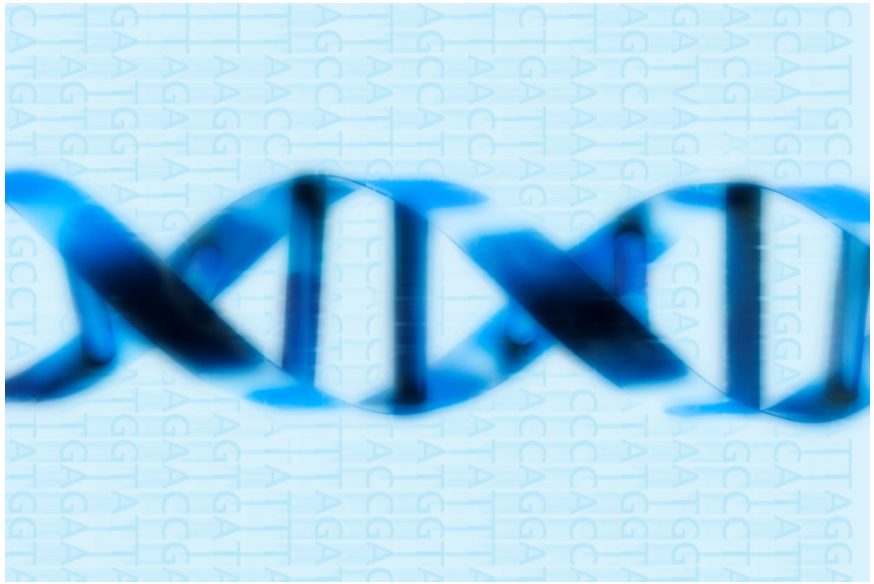
Genes

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



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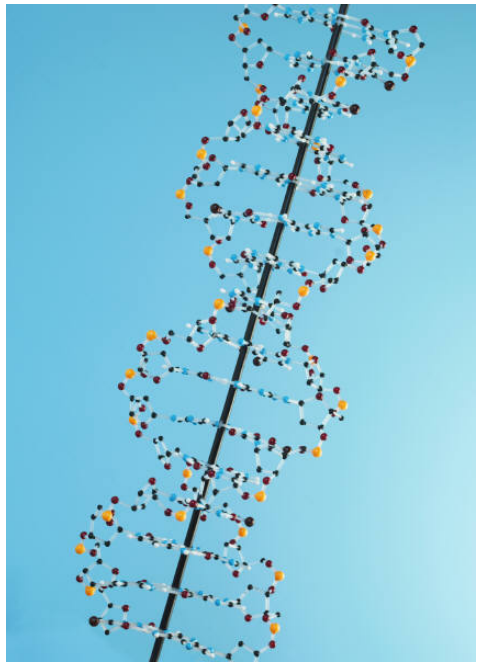
DNA

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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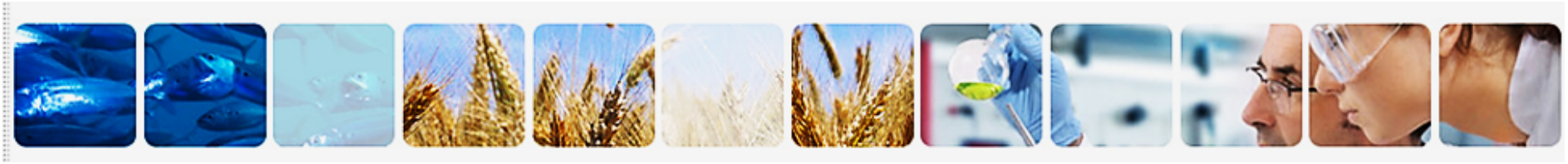

Genetically modified organisms

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).

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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Gene technology

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.

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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

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) 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.

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. This area is under development.

- 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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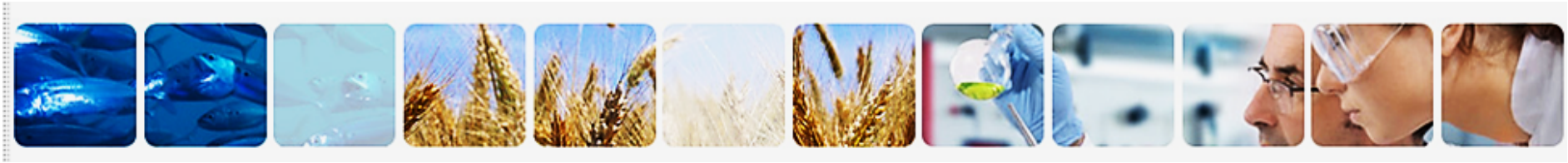
Conclusion

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

Recent developments in biotechnology include genetically modified plants and animals, cell therapies and nanotechnology.

These products are not in everyday use but may be of benefit to us in the future.



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What is biotechnology?

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Student name:
Date:

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Biotechnology

1) Define biotechnology.

_____

_____

_____

2) Give three examples of where an increase in the use of biotechnology has occurred.

i)

_____

_____

ii)

_____

_____

iii)

_____

_____

3) How is the process of fermentation used in traditional biotechnology?

i)

_____

_____

ii)

_____

_____

iii)

_____

_____

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4) Where does the emphasis of modern biotechnology lie?

_____

_____

5) How has the understanding of deoxyribonucleic acid (DNA) affected biotechnology?

_____

_____

_____

_____

6) True or false?

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

_____

7) When does a food need to be labeled as genetically modified?

i)

_____

_____

ii)

_____

_____

iii)

_____

_____

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8) What are some of the challenges to food supply that will be encountered as the global population rises?

_____

_____

_____

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Student name:

Date:

Think about some of the reasons why food is processed and write them in the first column. In the second column, write down the processing techniques and foods that that are good examples of each reason. In the third column, list the benefit of each technique.

Reasons foods are processed	**Examples of techniques and foods**	**Benefits**
To make them last longer before they spoil	Pasteurised milk	Consumers can keep food longer

Why are processed food sometime fortified?

……

……

……

What are functional foods?

……

……

……

SEVENTH FRAMEWORK PROGRAMME

Student name:

Date:

Food safety

1. What is the name of the organisation that oversees food safety in Europe?

_____

2. Name four areas that are covered by the EU's food safety strategy.

_____

_____

_____

_____

3. What are the two main functions of the EU'S Rapid Alert System for Food and Feed?

_____

_____

4. Name four things that can have an impact on animal welfare.

_____

_____

_____

_____

5. What are the 'Five Freedoms' that are reflected in the EU Animal Welfare strategy?

_____

_____

_____

_____

6. List 3 standards that protect the welfare of fish.

_____

_____

_____

_____

Student name:
Date:

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Nanotechnology

1) Define nanotechnology.

_____

_____

2) Give three examples of how nanotechnology is used in food processing.

i)

_____

_____

ii)

_____

_____

iii)

_____

_____

3) What are the potential benefits of using nanotechnologies?

i)

_____

_____

ii)

_____

_____

iii)

_____

_____

4) How does food packaging technology make use of nano science?

_____

_____

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5) How is the use of nanotechnology regulated in Europe?

_____

_____

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Student name:

Date:

Reducing food waste in Europe

A resource-efficient Europe (flagship initiative of the Europe 2020 Strategy)

The main initiative for a resource-efficient Europe provides a long-term framework for actions in many areas:

- supporting policy agendas for climate change;
- energy;
- transport;
- industry;
- raw materials;
- agriculture;
- fisheries;
- biodiversity;
- regional development.

The European Commission's Roadmap to a Resource Efficient Europe targets the disposal of edible food waste to be halved in the EU by 2020.

Challenges for businesses are outlined:

- The manufacturing sector will have to increase use of its waste as by-products;
- The retail sector will need to improve its stock management and selling methods to prevent products reaching their end-of-life before being sold;
- The restaurant and catering sectors will need to manage their systems and services to reduce drastically their food waste losses.

Challenges for consumers are complicated. The reasons why people waste edible food are diverse and include:

- cultural attitudes;
- lack of knowledge of good conservation and storage practices;
- over-sized portions;
- lack of awareness about how to re-use leftovers.

This highlights the importance of giving the right information to consumers. The European Commission has the 'Generation Awake' Resource Efficiency Campaign (www.generationawake.eu) to help consumers understand how they can play an important part in reducing waste.

Activity

Small but simple actions by consumers and food retailers could dramatically cut the 1.3bn tonnes of food lost or wasted across the world each year. In food manufacturing and in retail shops, large quantities of food are wasted because of inefficient practices, quality standards that over-emphasise appearance and confusion over date labels. Consumers throw away edible food due to over-buying, inappropriate storage and preparing meals that are too large.

Per capita waste by consumers is estimated at between 95kg and 115kg a year in Europe.

1. In your group plan and produce a set of guidelines for consumers to explain how they can reduce food waste. The information should be clear and easy to follow.

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2. Make a dish that demonstrates how to reduce food waste. You might include for example, using up left-over rice or pasta or batch cooking using seasonal ingredients.

3. Consider other areas in which you can help conserve resources.

Student name:
Date:

Sustainable food production and processing

Activity 1

There are a number of ways we can reduce the impact of producing, processing and manufacturing foods on the environment.

These 3 possible steps to a more sustainable food future are:

- eating seasonally;
- eating locally;
- eating organically.

In your group discuss the following questions. Agree on your response. At the end of the given time each group will report back on their discussion.

1. What are the benefits of eating food in season? How does it help to reduce carbon emissions?

2. All countries in the EU will grow a wide range of food. Why is it a good idea to eat foods that are grown locally or regionally?

3. What does 'organic' mean? What are the benefits and challenges about buying and eating organic food?

……

Activity 2

Research the species of fish that can be obtained from sustainable sources. You can check labelling schemes used in different countries to help you.

Prepare and cook a dish that uses fish or seafood from a sustainable source.

Take a photograph of your finished dish. Use it to design and make an electronic recipe card that could be used to help promote the use sustainable fish.

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