

Curriculum Links

Activity 2D – Bacterial cellulase

The Department for Education is conducting a review of the primary and secondary National Curriculum. The links below relate to the statutory programmes of study for science in the National Curriculum, 2007 and specific sections of common science qualifications offered in UK schools.

Key stage 3

1.1 Scientific thinking

b. critically analysing and evaluating evidence from observations and experiments.

1.2 Applications and implications of science

a. exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.

2.1 Practical and enquiry skills

Pupils should be able to:

- use a range of scientific methods and techniques to develop and test ideas and explanations
- assess risk and work safely in the laboratory, field and workplace
- plan and carry out practical and investigative activities, both individually and in groups.

3.3 Organisms, behaviour and health

d. all living things show variation, can be classified and are interdependent, interacting with each other and their environment

3.4 The environment, Earth and universe

c. human activity and natural processes can lead to changes in the environment.

Key stage 4

1 How science works

1.1 Data, evidence, theories and explanations

Pupils should be taught:
b. how interpretation of data, using creative thought, provides evidence to test ideas and develop theories
c. how explanations of many phenomena can be developed using scientific theories, models and ideas

1.2 Practical and enquiry skills

Pupils should be taught to:
a. plan to test a scientific idea, answer a scientific question, or solve a scientific problem
b. collect data from primary or secondary sources, including using ICT sources and tools
c. work accurately and safely, individually and with others, when collecting first-hand data
d. evaluate methods of collection of data and consider their validity and reliability as evidence.

1.4 Applications and implications of science

Pupils should be taught:
a. about the use of contemporary scientific and technological developments and their benefits, drawbacks and risks

b. to consider how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions

2.1 Organisms and health

In their study of science, the following should be covered:
a. organisms are interdependent and adapted to their environments
b. variation within species can lead to evolutionary changes and similarities and differences between species can be measured and classified
c. the ways in which organisms function are related to the genes in their cells

2.2 Chemical and material behaviour

In their study of science, the following should be covered:
c. new materials are made from natural resources by chemical reactions

2.3 Energy, electricity and radiations

In their study of science, the following should be covered:
a. energy transfers can be measured and their efficiency calculated, which is important in considering the economic costs and environmental effects of energy use

2.4 Environment, Earth and universe

In their study of science, the following should be covered:

Curriculum Links

- a. the effects of human activity on the environment can be assessed using living and non-living indicators
- b. the surface and the atmosphere of the Earth have changed since the Earth's origin and are changing at present

AQA Physics and Science A GCSE

P1.4.1 Generating electricity

a) In some power stations an energy source is used to heat water. The steam produced drives a turbine that is coupled to an electrical generator.

Energy sources include:

- the fossil fuels (coal, oil and gas) which are burned to heat water or air
- biofuels that can be burned to heat water.

AQA Chemistry and Science GCSE

Unit C1.4 Crude oil and Fuels C1.4.3 Hydrocarbon fuels

e) Biofuels, including biodiesel and ethanol, are produced from plant material. There are economic, ethical and environmental issues surrounding their use.

C1.5 Other useful substances from crude oil

evaluate the advantages and disadvantages of making ethanol from renewable and non-renewable sources.

Additional guidance:

Candidates should be able to compare the environmental impact of producing ethanol from renewable and non-renewable sources.

AQA Science B GCSE

3.4.2.3 Generation and distribution of electricity

Candidates need to:

1. Define the terms renewable and non-renewable in the context of energy sources.
5. Explain the problems of using nuclear fuels (problems of radioactive emissions, disposal of waste) and of using renewable energy sources (unreliability and possible effects on the environment).

Within this context, candidates should be able to use scientific data and evidence to discuss, evaluate or suggest implications of the following:

- the environmental impact over time of energy production by comparing the advantages and disadvantages of using alternative energy sources
- the economic impact of using alternative energy sources

AQA Environmental Science GCSE

A2.4 What alternative energy technologies are available?

Scientists have developed alternative technologies to harness energy from sources other than fossil fuels. Environmental scientists use their knowledge to assess these alternatives for their efficiency and potential environmental impact.

Scientists have also developed methods of electricity generation from renewable resources that may be used instead of fossil fuels.

Candidates should know and understand that:

- renewable energy resources are usually sustainable:
- not depleted by use including wind power
- capable of rapid replacement including biofuels
- most renewable energy resources:
- use kinetic energy to turn generators, which produce electricity (exceptions include solar water heating, photovoltaics, geothermal and biofuels)
- usually need larger areas than thermal power stations to yield the same amount of energy

Curriculum Links

- may be unreliable or cannot provide a constant supply of energy
- may detract from the appearance of a land/seascape (A1)
- may affect wildlife populations or habitat (B1)

Agricultural scientists have developed plant crops, together with the use of animal and plant waste to produce renewable biofuels.

Candidates should know and understand that:

- biofuels, eg biogas, bioethanol, biodiesel, are also renewable and can:
 - be burned to produce heat but release carbon dioxide
 - be used as vehicle fuel
 - be 'carbon neutral' or 'green' as carbon dioxide taken out of the air by photosynthesis when energy crops grow is returned when the fuel is burnt so that no extra is added to the atmosphere (B2)
 - be a waste product eg from sewage plants, poultry farms (A1)
 - be environmentally damaging when land is cleared, and biodiversity (B1) and food-producing farmland are lost (A1)
 - *have a lower energy density than fossil fuel*

Environmental scientists use their knowledge of chemistry, physics and biology to consider both the advantages and disadvantages of various energy resources. They consider a number of factors before making conclusions and recommendations.

Candidates should be able to:

- describe: biofuels
- in terms of:
 - efficiency
 - predictability
 - intermittency
 - energy density*
 - potential environmental impact including:
 - emissions to air/water
 - mining/quarrying land take
 - disturbance to sediment patterns/water flow
 - hazardous waste
 - disruption of wildlife
 - noise/radio disturbance
 - loss of landscape value

Opportunities to investigate using scientific knowledge and skills:

- the amount of energy produced by different vegetable oils/alcohols
- the rise in temperature in a compost heap over time
- public attitudes towards different energy producing technologies

OCR Biology A 21st Century GCSE

Module B7: Further Biology B7.5 New technologies

2. understand that bacteria and fungi can be grown on a large scale (fermentation) to include production of: d. enzymes for commercial products, such as washing powders and to make biofuels

OCR Physics and Science A 21st Century GCSE

Module P3: Sustainable energy P3.1 How much energy do we use?

1. understand that the demand for energy is continually increasing and that this raises issues about the availability of energy sources and the environmental effects of using these sources
2. recall the main primary energy sources that humans use: fossil fuels (oil, gas, coal), nuclear fuels, biofuels, wind, waves, and radiation from the Sun
4. understand that power stations which burn fossil fuels produce carbon dioxide which contributes to global warming and climate change

OCR Biology B Gateway GCSE

Module B6: Beyond the Microscope Item B6e: Life in soil

Summary: Life above ground is obvious. Life below ground is just as diverse and essential in maintaining the recycling of important elements and providing the correct conditions for plant growth. Without the action of soil life we would have to climb over dead dinosaur bodies to get to school and many important elements would be unavailable.

Curriculum Links

Suggested practical and research activities

Assessable learning outcomes Foundation Tier only: low demand

Carry out an experiment to show that life is present in a soil sample (using lime water or bicarbonate indicator). Investigate the humus, air and water content of soil.

Describe the main components of soil as being:

- different sized mineral particles
- dead material
- living organisms
- air
- water.

Identify soil fauna and flora using identification keys. Examine microscopic soil life using light and binocular microscopes. Describe the role of bacteria and fungi as decomposers.

Module B6: Beyond the Microscope Item B6d: Biofuels

Assessable learning outcomes both tiers: standard demand

Describe different methods of transferring energy from biomass, to include:

- fermenting biomass using bacteria or yeast.

Given data, evaluate different methods of transferring energy from biomass.

Describe the advantages of using biofuels, to include:

- alternative sources to fossil fuels
- no increase in greenhouse gas levels
- no particulates produced.

Recall that a mixture of petrol and alcohol:

- is called gasohol
- is used for cars in countries such as Brazil.

Assessable learning outcomes Higher Tier only: high demand

Explain why the burning of biofuels does not cause a net increase in greenhouse gas levels if:

- they are burnt at the same rate as the biomass is being produced
- areas of land are not cleared of other vegetation in order to grow crops for biofuels.

Explain how, in some areas, the use of large areas of land to produce biofuels is resulting in:

- habitat loss
- extinction of species.

Understand why gasohol is more economically viable in countries that have ample sugar cane and small oil reserves.

Edexcel Biology GCSE

Unit B3: Using Biology Topic 3 Biotechnology

3.2 Describe a fermenter as a vessel used to cultivate microorganisms for the production of biomolecules on a large scale

3.3 Explain the need to supply suitable conditions in fermenters, and the effect they have on growth rates, including:

- aseptic precautions
- nutrients
- optimum temperature
- pH
- oxygenation
- agitation

3.19 Demonstrate an understanding of the advantages and disadvantages of replacing fossil fuels with biofuels, including the facts that biofuels are renewable and that their production uses carbon dioxide but that growing the crops to make them requires land and may affect the availability of land for growing food.

Curriculum Links

SQA Standard Grade Science

Topic 3: Energy and its Uses Renewable Sources of Energy

1 Fossil fuels and nuclear fuels are non-renewable, but waves, wind, hydroelectricity and the sun are renewable sources of energy.

2 As the stocks of fossil fuels are depleted these alternative sources of energy will become more important.

Credit Level

3 Other renewable sources of energy include sugar alcohol and geothermal heat.

In sugar-growing countries, sugar can be fermented into alcohol which can be used as a fuel.

4 There are advantages and disadvantages in the use of each alternative or renewable energy source, to include: cost, the technology involved, visual pollution, and reliability of the energy source.

SQA Standard Grade Biology

Topic 4: Sub-Topic d – Investigating Enzymes

Topic 7: Biotechnology Sub-Topic a – Living Factories b- problems and profit with waste

SQA Standard Grade Chemistry

Topic 15: Carbohydrates and Related Substances

Cambridge Biology iGCSE (with significant similarity to Coordinated and Combined Science iGCSE)

Section II: Organisation and maintenance of the organism 5. Enzymes

- Define enzymes as proteins that function as biological catalysts
- Investigate and describe the effect of changes in temperature and pH on enzyme activity

Cambridge Chemistry iGCSE (with significant similarity to Physical science, Coordinated and Combined Science iGCSE)

14. Organic chemistry 14.8 Macromolecules 14.8 (b) Natural macromolecules

- Describe complex carbohydrates in terms of a large number of sugar units, considered as HO OH, „joined together by condensation polymerisation
- Describe the acid hydrolysis of complex carbohydrates (e.g. starch) to give simple sugars
- Describe the fermentation of simple sugars to produce ethanol (and carbon dioxide)

Cambridge Physics iGCSE (with significant similarity to Coordinated and Combined Science iGCSE)

1. General physics 1.6 Energy, work and power 1.6 (b) Energy resources

- Distinguish between renewable and non-renewable sources of energy
- Give advantages and disadvantages of each method in terms of cost, reliability, scale and environmental impact

Cambridge Environmental Management iGCSE

5. Action on the lithosphere

5.2 technologies and viability of alternative energy sources

solar, wind, wave, geothermal, hydro-electric, biomass

5.3 strategies for conservation and management of mineral and fossil fuel resources

increased efficiency in use, insulation, recycling, power from waste, new technology

5.5 industrial materials, technologies, and approaches which can contribute to solving environmental problems

monitoring, remedial action, recycling (processing wastes and industrial products at end of life), low waste

Curriculum Links

technology (developing cleaner processes and products, conservation and efficiency)

19 Managing agriculture 19.2 harvesting energy from living resources to provide power

biomass, biogas (methane), fuel from organic waste

Key stage 5

OCR Biology A-level

3.2 AS Unit F212: Molecules, Biodiversity, Food and Health

2.1.3 Enzymes Candidates should be able to:

- (a) state that enzymes are globular proteins, with a specific tertiary structure, which catalyse metabolic reactions in living organisms;
- (b) state that enzyme action may be intracellular or extracellular;
- (d) describe and explain the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity;
- (e) describe how the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity can be investigated experimentally;

WJEC Biology and Human Biology A-level

Unit BY4: Metabolism, Microbiology and Homeostasis. 4.4 Microbiology

- (a) Bacteria may be classified according to their shape and by their reaction to the Gram stain. *
- (b) Culture of microorganisms in the laboratory. Conditions necessary for growth. Principles of aseptic technique.

Suggested Practical Activities: Examination of bacteria in order to recognise bacilli and cocci. Safe handling using aseptic technique. Use of simple stains e.g. methylene blue for staining bacteria (from milk) and examination using the light microscope. Gram staining and microscopic investigation of yoghurt. Investigation into the numbers of bacteria in fresh and stale milk, using techniques of serial dilution, plating and counting colonies.

SQA Biotechnology Higher

Unit 1 Microbiology

Structure of Microorganisms

Microbial Metabolism

Unit 2 Microbiological Techniques

Microbiological Techniques

Identification of micro-organisms

Unit 3 Biotechnology

Biotechnological processing

AQA Environmental Studies A-level

A2 Unit 3 – ENV3 Energy Resources and Environmental Pollution 3.3.1 Energy

Renewable energy resources

Examples should be used to illustrate the factors affecting the ease of use of renewable energy resources and therefore their likely use in the future

Energy density: biofuels have medium energy densities

Ease of storage: Energy can be stored as potential energy of water in reservoirs and chemical energy in biofuels

Future energy supplies New technologies

New technologies may increase the amount of energy available for use by

- increasing the amount of energy available from existing energy resources

Curriculum Links

- allowing new resources to be exploited

Atmospheric pollution

- incomplete combustion of fossil fuels and biofuels

AQA Science in Society A-level

Unit 1 AS Exploring key scientific issues 3.1.3 Transport issues

Technical ways of reducing the impact of transport on local air quality and on greenhouse gases.

The advantages and disadvantages of different fuels, to include: fossil fuels, bio-fuels, fuel cells and hydrogen.

Fuels are valuable because they are concentrated sources of energy. There is a finite amount of fossil fuel (coal, oil, natural gas) on Earth. Other energy sources (wind, wave, biomass such as wood) are renewable. They can be replaced in the same sort of time scale as they are used.

Unit 3 A2 Exploring key scientific issues 3.3.5 Energy futures The context

The context for this topic is the challenge of reconciling the growing demand for energy resources worldwide, especially the demand for electricity, with the policy imperative to cut down the emission of carbon dioxide and other greenhouse gases. People want the benefits of a readily available supply of electricity but must balance this against the cost of each method of generation and its environmental impact.

Renewable sources of energy are naturally and continually replenished; they include wind, solar power, geothermal, hydropower, and various forms of biomass.