

# Glossary

**Adapted from Royal Society *Sustainable biofuels* publication, Nuffield bioethics publication and using [www.biology-online.org](http://www.biology-online.org) dictionary**

This glossary is designed to provide some simple definitions that will enable students to understand and explain the terminology used by BBSRC to explain bioenergy research. Some terms have been simplified and others will be too advanced for younger students. A student word list for Key Stage 2 and 3 students is also provided.

**Advanced plant breeding strategy** - a type of plant breeding strategy in which the genetic basis of a trait is screened for in the progeny of a cross using a lab-based test. This saves time and labour compared with conventional plant breeding. There are two types of advanced plant breeding strategy: *marker-assisted breeding* and *genomics-assisted breeding*.

**Aerobic** - With oxygen.

**Alcohol** - An organic chemical containing one or more hydroxyl groups.

**Algae** - Phototrophic eukaryotic microorganisms.

**Anaerobic** - Without oxygen.

**Arable land** - land that is suitable for crop production.

**Asexual reproduction** - Reproduction involving only one parent, producing offspring that are genetically identical to each other and to the parent.

**Atmosphere** - A layer of gases that surrounds the Earth.

**Bacteria** - Microscopic, single-celled organisms belonging to Kingdom Monera that possess a prokaryotic type of cell structure.

**Barley** - A valuable grain, of the family of grasses, genus *Hordeum*, used for food, and for making malt, from which are prepared beer, ale, and whisky.

**BBSRC** - Biotechnology and Biological Sciences Research Council.

**Biobutanol** - Butanol produced by some strains of bacteria, such as *Clostridium acetobutylicum*.

**Bioenergy** - Energy including, heat, electricity and liquid fuels, derived from non-food feedstocks or from inedible elements and waste from food crops.

**Biodiesel** - An organic compound derived by processing and transesterification of plant oil or animal fats that can be used as a transport fuel in replacement of diesel derived from fossil fuel.

**Biodiversity** - Shorthand for biological diversity. This is the variability among living organisms from all ecosystems and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems.

**Bioethanol** - Biofuel consisting of ethanol produced by the fermentation of plant material rich in sugar or lignocellulose.

**Biofuel** - A renewable fuel produced from biological material such as recently dead plants, animals or their waste.

**Biogas** - Renewable gaseous fuel comprised of methane (approximately 60%) and carbon dioxide, produced by anaerobic digestion of organic material by microorganisms. Can be used as a transport fuel or, as a replacement for natural gas.

**Biomass** - Any biological material that can be used either directly as a fuel, converted to a fuel or used in industrial or fibre production.

**Biomass** - The term for the dry weight of a living thing.

**Bio-oil** - A carbon-rich liquid produced by pyrolysis of plant material, which can be used to produce chemicals and fuels.

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**Bioprospecting** - The search for useful organic compounds or organisms in the environment.

**Carbohydrate** - An essential food group found in our diet (includes sugar, starch and fibre).

**Carbon cycle** - How carbon is cycled between living organisms and the air.

**Carbon dioxide** (CO<sub>2</sub>) - A gas produced by cell respiration and the burning of fuels. Used by plants for photosynthesis.

**Carbon neutral** - applies to a process which occurs without any change in the total amount of carbon dioxide present in the atmosphere.

**Catalyst** - A substance, including enzymes, that increases the rate of a chemical reaction but is not consumed during the process.

**Cell** - The basic unit that living things are made of.

**Cellulose** - Major material from which the plant cell walls are made.

**Centrifuge** - A piece of equipment used to separate substances according to their density by rotation.

**Chemical energy** - Energy that is stored in chemical form, such as in coal, oil or food.

**Chemical reaction** - A chemical change in which new substances are formed but there is no change in the number of atoms of each element.

**Chlorophyll** - The green chemical in plants that absorbs light energy and converts it into chemical energy through photosynthesis.

**Chloroplasts** - The compartments inside plant cells that contain chlorophyll, where photosynthesis occurs.

**Chromatography** - A method of separating substances. The substances are separated as they move, in a solvent, through a material, e.g. paper. The substances often move at different speeds.

**Combustion** - An oxidation reaction in which energy is released.

**Complete combustion** - An oxidation reaction that takes place when oxygen gas is in excess.

**Compound** - A substance containing two or more elements chemically joined together.

**Crops** - A plant grown to be harvested for agricultural use.

**Crystalline** - A material that has some regular arrangement of particles.

**Decomposers** - Organisms that break down dead organisms (e.g. bacteria and fungi).

**Digester** - A large vessel used to carry out biological decomposition.

**Directed evolution** - A method used to alter the proteins or RNA produced by organisms through mutation and selection or screening of variants with desirable properties.

**Distillation** - A process in which a liquid is converted into vapour by heating and then condensed back into a liquid. It is used to purify and to separate a liquid mixture.

**Element** - A substance that cannot be broken down into anything simpler by chemical reactions. An element consists of one type of atom.

**Energy** - The ability to do work or produce change.

**Enzyme** - A protein that speeds up reactions in living things.

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**Extremophile** - Microorganisms that live optimally at relatively extreme conditions e.g. of acidity, salinity, temperature or pressures. Enzymes isolated from these organisms are used in some industrial manufacturing processes.

**Fatty acid** - A group of long chain hydrocarbons derived from the breakdown of fats with a single carboxylic group and aliphatic tail.

**Fermentation** - An anaerobic (without oxygen) cellular process in which organic foods are converted into simpler compounds such as alcohol, and chemical energy (ATP) is produced.

**Fertilisers** - Substances added to soil to replace lost nutrients and help plant growth

**First generation biofuels** - refers commonly to biofuels that are made from the food parts of food crops, such as sugar cane and oil palm, including bioethanol fermented from sugars and broken-down starch, and biodiesel derived from plant oils. Biogas is also known as a first generation biofuel.

**Fossil fuels** - Non-renewable fuels, such as coal, oil and gas, formed over millions of years from the decomposition, in anaerobic conditions, of plant and animal remains.

**Fuel** - A substance that can undergo a chemical change to release energy, usually as heat, in a controlled way.

**Gasification** - A process that converts materials, such as coal, petroleum or biomass, into synthesis gas (or 'syngas'), which comprises mainly carbon monoxide and hydrogen.

**Genetic modification (GM)** - The technology entailing all processes of altering the genetic material of a cell to make it capable of performing the desired functions, such as producing novel substances

**Gene** - Part of a chromosome. One gene contains the 'instructions' for a particular characteristic such as flower colour. The fundamental, physical, and functional unit of heredity

**Global warming** - The steady increase in the temperature of the Earth's atmosphere.

**Glucose** - The specific sugar made by photosynthesis.

**Glycerol** - A compound with the molecular formula  $C_3H_5(OH)_3$  which is a by-product of the production of biodiesel via transesterification. Can be used in other industries, e.g. pharmaceuticals, cosmetics etc

**Glycosidic bonds** - A type of covalent bond that joins carbohydrate (sugar) molecules together in di- or polysaccharides

**Greenhouse gas** - Gas such as carbon dioxide that traps heat in the atmosphere

**Gribbles** - Marine wood borers

**Hazard** - A property of something that could cause harm to health or the environment.

**Hexose** - Monosaccharide containing six carbon atoms

**Hydrocarbon** - Chemicals that are made only from hydrogen and carbon. Fuels contain large amounts of this chemical group.

**Hydrolysis** - A chemical reaction where a compound, such as starch or cellulose, is broken down by reaction with water into smaller components. In the case of biofuels, this can use enzymes or acid

**Incomplete combustion** - An oxidation reaction that takes place when oxygen gas is in a limited supply.

**Iodine solution** - This solution is used to indicate the presence of starch in a leaf - it turns blue-black in contact with starch.

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**Life Cycle** - The sequence of events that happen to a material from obtaining the raw materials for its manufacture to its disposal as waste

**Life Cycle Assessment** - An examination of every stage in the manufacture and use of a material for a particular purpose, comparing its economic and environmental costs with other potential materials.

**Lignin** - Organic substance which act as a binder for the cellulose fibres in wood and certain plants and adds strength and stiffness to the cell walls.

**Lignocellulose** - Plant cell walls are composed of lignin and cellulose, which provide mechanical strength. Can be broken down to lignin and cellulose or used directly as a feedstock.

**Maize** - A cereal crop commonly known as corn that is grown predominantly in the USA, Canada and Australia.

**Methane** - A gas that is found with crude oil and produced in decomposition. At home we use cookers and boilers to react it with oxygen to provide heat.

**Methanogens** - Methane producing microorganisms.

**Microbe** - A very small living thing that can only be seen with a microscope. Some are harmful and some are useful.

**Miscanthus** - A fast-growing tall grass species that is grown as an energy crop.

**Molecule** - A particle made up of two or more atoms joined together.

**Natural Gas** - Found in association with hydrocarbon fuels, primarily coal, and consisting mainly of methane.

**Non-renewable resource** - A resource that cannot be renewed at the same rate as it is being used and will eventually run out.

**Organic compound** - A compound that contains carbon-carbon bonds.

**Pascal** - The unit for measuring pressure. It equals one Newton per m<sup>2</sup>.

**Pentose** - Any monosaccharide sugar containing five atoms of carbon per molecule.

**Perennial** - Lasting through the year or for several years.

**Phloem** - A tissue in a vascular plant that functions primarily in transporting organic food materials (e.g. sucrose) from the photosynthetic organ (leaf) to all the parts of the plant.

**pH** - A measure of the acidity of a solution; the lower the pH number the stronger the acid.

**Photosynthesis** - A process carried out in green plants that uses light energy captured by chlorophyll to convert carbon dioxide and water to carbohydrates and oxygen.

**Pollutant** - A substance present in the environment as a result of human activity that can harm the environment or health.

**Polysaccharide** - A complex carbohydrate composed of a chain of monosaccharides joined together by glycosidic bonds.

**Product** - The substances formed during a chemical reaction.

**Reactant** - The substance present at the start of a reaction A chemical that undergoes a chemical change in a chemical reaction.

**Renewable resource** - A resource that can be renewed more quickly or at the same rate as it is being used or is unlikely to run out due to inexhaustible supplies.

**Risk** - An estimate of how dangerous a hazard is in a particular situation.

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**Saccharification** - The process of converting complex carbohydrate (e.g. starch) into simple monosaccharide components (e.g. glucose) through hydrolysis.

**Saturated compound** - A compound with only single bonds between its atoms.

**Second generation** – Bioenergy solutions that either make use of waste or rely on non-food crops that can be grown on marginal land.

**Selective breeding** - The process of allowing certain animals or plants to breed so as desirable characteristics are found in the next generation.

**Species** - (In evolution) a group of organisms with the same characteristics, (living) a group of organisms with the same characteristics that can breed with each other.

**Starch** - An insoluble carbohydrate found in plants and plant products. The storage molecule for the surplus glucose made by photosynthesis.

**Straw** - The stalks of harvested cereal crops such as wheat and barley.

**Substrate** - The substance acted upon by an enzyme.

**Sugar** - A carbohydrate that is a source of energy in respiring cells. Glucose belongs to this food group.

**Sustainable development** – A programme of developing new energy technology that does not harm the environment or use up non-renewable resources.

**Sustainability** - The use of resources to meet the need of present generations without compromising the need of future generations by balancing environmental, social and economic factors.

**Synthetic biofuels** - Fuels produced via thermochemical conversion of biological material, such as biodiesel, which have exactly the same properties as fuels derived from fossil fuels. These are defined differently to synthetic fuels, because synthetic fuels can also be made from coal, gas and oil.

**Synthetic biology** - A new and growing science that focuses on re-designing and re-building natural biological systems synthetically from the ground up.

**Transesterification** - A reaction that is catalysed by an acid or a base, where the alkoxy group of an ester compound is replaced by another alcohol. This process can be used to produce biodiesel.

**Unsaturated compound** - A hydrocarbon that contains double or triple bonds.

**van der Waals** - Electrodynamic forces arising between atoms or molecules.

**Variety** - A subgroup of a species which has a slightly different set of characteristics.

**Viscosity** - A measurement of the 'thickness' of a fluid.

**Water** - Combined with CO<sub>2</sub> in photosynthesis to produce glucose.

**Willow** - Any tree or shrub of the genus *Salix*, including many species.

**Xylem** - A type of vascular tissue in terrestrial plants primarily involved in transporting water and nutrient (from the roots to the shoot and leaves) and providing structural support.

**Yeast** - Colloquial name for the fungus that is characteristically single-celled most of its life, eukaryotic, reproduce asexually by budding or binary fission, capable of fermenting carbohydrates. used in the production of ethanol.

**Yield** - A measure of the amount of crop produced.

# Keywords in school science

To help you pitch the language used to communicate your research to students a list of keywords encountered in Key Stage 2 and 3 Science that may relate to bioenergy topics are provided below. Keywords are words that help students to communicate ideas in science clearly and with understanding. The key words in the following list are from the *Framework for teaching science: Years 7, 8 and 9 (2002, crown copyright)* and originally appeared in the 'Language for learning' sections of units in the Science Key Stage 3 schemes of work developed by the Qualification and Curriculum Authority.

## Year 6

### Sc1 Scientific enquiry

accurate, average, bar line graph, bar chart, collect, compare, conclusion, data, graph, explain, evaluate, evidence, fair test, idea, identify, interpret, limitation, line graph, observation, measurement, pattern, predict, present, record, repeat measurements, repeat observations, results, secondary data, test

### Sc2 Life processes and living things

alcohol, carbohydrate, dissolve, energy, fat, fertiliser, fibre, food chain, germ, germination/germinate, growth, health, life cycle, petal, plant food, microbe, nutrients, ovary, oxygen, pollen, pollination/pollinate, producer, reproduction/reproduce, starch, sepal, stamen, stigma, style,

### Sc3 Materials and their properties

air, ash, baking powder, bath salts, bicarbonate of soda, boiling temperature, bubbles, carbon dioxide, change, change of state, charcoal, condense, conditions, dissolve, evaporation/evaporate, filter, freeze, gas, hazard, heat, insoluble, irreversible, liquid, melt, mixture, natural gas, oxygen, reversible, solid/solidify, soluble, solution, state, steam, water cycle

### Sc4 Physical processes

air, gravity, insulator, light, light beam, newton, opaque, reflection/reflect, revolve, rotation/rotate, sound, sphere/spherical, spin, stationary, tension, water, weight

## Year 7

### Sc1 Scientific enquiry

correlation, data logger, generalisation, line of best fit, prediction, reliability, repeat reading, sample size, strength of evidence, theory

### Sc2 Life processes and living things

cell, hereditary, inherited, nucleus, tissues, consumer, dormant, food web, habitat, insulation, interdependence, light intensity, organisms, producer, association, characteristics, classify, feature, multi-cellular, species, taxonomic group, variation

### Sc3 Materials and their properties

acid, alkali, colour change, corrosive, equation, hazard, hydrochloric acid, hydroxides, indicator, litmus, neutral, pH range, reaction, risk, carbon, carbonates, combustion reactions, element, hydrogen, line graph, methane, oxide, oxygen, product, reactant, word equation, zinc

compressible, diffusion, expansion, gas pressure, particle, particle theory, proximity, attracted, chromatography, chromatogram, compound, distillation, filtration, insoluble, saturated solution, separate, solute, solution, solvent, suspension, trace

# Keywords in school science

## Sc4 Physical processes

conservation, density, energy transfer, friction, fuel, lubricants, magnitude, mass, atmosphere,

## Year 8

### Sc1 Scientific enquiry

anomalous results, data search, environmental conditions, evaluate, hypothesis, opinion, population size, precision, quadrat sampling, qualitative, quantitative, range, reliable data, repeats, sample size, sequence of events, sufficient data, transect, trial, measurements, using secondary sources, variable

### Sc2 Life processes and living things

absorption, digestion, enzyme, minerals, molecules, starch, sugars, aerobic, glucose, bacteria, fungi, microorganisms, sterilising, community, distribution, ecosystem, habitat, humidity, population sizes, pyramid of numbers, transect

### Sc3 Materials and their properties

atom, chlorides, chlorine, compound, element, equation, formula, molecule, reactants, sodium, symbol, composition, oxides, cooling rates, crystals, deposit, mineral, precipitation,

### Sc4 Physical processes

conduction, convection, insulator, joule, radiation, radiation, spectrum, translucent, transmission, transparent, frequency, wave

## Year 9

### Sc1 Scientific enquiry

carrying out a survey, control accuracy, controlling variables, dependent variable, developing a technique, independent variable, most appropriate equipment, precision, proportional, quantitative data, reliability/trustworthiness of data, sampling, scientific method, trial run, validity of conclusions

### Sc2 Life processes and living things

asexual, breed, classification, clone, characteristics, gamete, gene, genetically modified, grafting, selective breeding, species, variety, biomass, chlorophyll, Elodea, etiolation, palisade cell, photosynthesis, xylem, balance, compete, competition, deficiency, fungicide, insecticide, nitrates, nutrient, pesticide, sustainable development, toxin, weedkiller, yield

### Sc3 Materials and their properties

carbonates, product, salt, sulfates/sulphates, displacement, order of reactivity, acid rain, catalyst, global warming, neutralisation, vegetation cover, prefixes: di-, mono-, poly-; suffixes: -ate, -ide, -ite

### Sc4 Physical processes

dissipation, electric generator, kinetic energy, potential energy,

## Further Reading

The Royal Society, January 2008. *Sustainable biofuels: prospects and challenges*, Policy document 01/08, ISBN 978 0 85403 662 2.

Nuffield Council on Bioethics, April 2011, *Biofuels: ethical issues* ISBN: 978-1-904384-22-9 [www.nuffieldbioethics.org/biofuels-0](http://www.nuffieldbioethics.org/biofuels-0)

Algal Research in the UK: A Scoping study for BBSRC, July 2011.

Society for General Microbiology (SGM), 2010, *Microbiology – A resource for Key Stage 5* ISBN: 0 95368 384 2

King, T. And Reiss, M. with Roberts, M., 2001, *Practical Advanced Biology*. Cheltenham, Nelson Thornes Ltd

The Association for Science Education and University of Cambridge International Examinations, 2006. *International Practical Science Guide: advice and activities for primary and secondary science in the classroom* ISBN: 0 86357 410 6 (ISBN: 978 0 86357 411 5)

Renewable Fuels Agency, 2008, *The Gallagher Review of the indirect effects of biofuels production*

Bioenergy – 20 years of pioneering Great British bioscience [www.bbsrc.ac.uk/news/industrial-biotechnology/2014/140521-f-great-british-bioscience-bioenergy.aspx](http://www.bbsrc.ac.uk/news/industrial-biotechnology/2014/140521-f-great-british-bioscience-bioenergy.aspx)

Growing the bioenergy field. BBSRC business spring 2011

# Weblinks

[www.bbsrc.ac.uk/](http://www.bbsrc.ac.uk/) Biotechnology and Biological Sciences Research Council

[www.cleapss.org.uk/](http://www.cleapss.org.uk/) Provides a health and safety school advisory service and teaching resources.

[www.saps.org.uk/](http://www.saps.org.uk/) Science and Plants for Schools (SAPS) - Teaching resources for photosynthesis and biofuels  
[www.ase.org.uk/](http://www.ase.org.uk/) Association for Science Education (ASE) Topics in Safety, Third edition, 2001., College Lane, Hatfield, Herts. AL10 9AA

[www.ncbe.reading.ac.uk/menu.html](http://www.ncbe.reading.ac.uk/menu.html) National Centre for Biotechnology Education (NCBE) – Teaching materials and resources for microbiology, photosynthesis and biofuels.

[www.practicalbiology.org/](http://www.practicalbiology.org/) Practical activities and teaching resources from the Society of Biology, Nuffield Foundation and CLEAPSS.

[www.bio-rad.com](http://www.bio-rad.com) Bio-Rad Laboratories – Biofuel enzyme kit for investigating the activity of cellobiase.

[www.plants4products.org.uk](http://www.plants4products.org.uk) Renewables don't run out teaching resource for 9-12 year olds from Chemical Industry Education Centre at the University of York.

<http://practicalaction.org/renewable-energy-5> Renewable energy teaching resources for Key Stages 2-4.

[www.defra.gov.uk/](http://www.defra.gov.uk/) The Department for Environment, Food and Rural Affairs (Defra)

[www.bis.gov.uk/](http://www.bis.gov.uk/) The Department for Business, Innovation and Skills (BIS)

[www.nnfcc.co.uk/](http://www.nnfcc.co.uk/) National Non-Food Crops centre. The UK's National Centre for Biorenewable Energy, Fuels and Materials

[Reference/webpage no longer available – October 2016] The BIOMASS Energy Centre aims to be a one stop shop able to provide information, advice and guidance to UK individuals and organizations - signposting to other specialised sources of advice as necessary - on a wide range of biomass fuels and conversion technologies. The BIOMASS Energy Centre (BEC) is owned and managed by the UK Forestry Commission, via Forest Research, its research agency.

[www.dft.gov.uk/topics/sustainable/biofuels/](http://www.dft.gov.uk/topics/sustainable/biofuels/) Department for Transport. Provides links to statistics and legislation relating to biofuels as well as the Renewable Transport Fuels Obligation (RTFO).

[www.ukerc.ac.uk/](http://www.ukerc.ac.uk/) UK Energy Research Centre. The UKERC carries out research into sustainable future energy systems.

[www.environment-agency.gov.uk/](http://www.environment-agency.gov.uk/) Environment Agency. The Environment Agency is an Executive non-departmental public body (NDPB) that reports to the Secretary of State for Environment, Food and Rural Affairs. The main focus of their interest in Bioenergy is around the use of biofuels. Bioenergy is one of their designated business areas and it is split into four subsections; biogas, biodiesel, bioethanol and biomass. The Environment Agency has a position statement in relation to biofuels for transport.

[www.carbontrust.co.uk/](http://www.carbontrust.co.uk/) The Carbon Trust provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies.

# Curriculum Links

The Department for Education has conducted a review of the primary and secondary National Curriculum and is currently rolling out a new curriculum that will be in effect for all ages from September 2016. The links in this document relate to the new key stage 3 statutory programmes of study (POS), key stage 4 science POS in the National Curriculum 2007 and specific sections of common science qualifications offered in UK schools. These qualifications include the GCSEs and iGCSE Certificates for teaching 2011, SQA Standard and Higher grades and revised A-levels in science subjects. Relevant links to broader topics such as global warming, fossil fuels and the carbon cycle are not routinely specified.

## Key Stage 3

### Working Scientifically

Through the content across all three disciplines, pupils should be taught to:

#### Scientific attitudes

- pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility
- understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review
- evaluate risks.

#### Experimental skills and investigations

- ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience
- make predictions using scientific knowledge and understanding
- select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate
- use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety
- make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements
- apply sampling techniques.

#### Analysis and evaluation

- apply mathematical concepts and calculate results
- present observations and data using appropriate methods, including tables and graphs
- interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions
- present reasoned explanations, including explaining data in relation to predictions and hypotheses
- evaluate data, showing awareness of potential sources of random and systematic error
- identify further questions arising from their results.

#### Measurement

- understand and use SI units and IUPAC (International Union of Pure and Applied Chemistry) chemical nomenclature
- use and derive simple equations and carry out appropriate calculations
- undertake basic data analysis including simple statistical techniques.

### Subject content

#### Biology

Cells and organisation  
Nutrition and digestion  
Photosynthesis  
Cellular respiration  
Inheritance, chromosomes, DNA and genes

#### Chemistry

Pure and impure substances  
Chemical reactions  
Earth and atmosphere

#### Physics

Calculation of fuel uses and costs in the domestic context  
Energy changes and transfers  
Changes in systems  
Physical changes  
Energy in matter

## Key Stage 4

### 1 How science works

- 1.1 Data, evidence, theories and explanations
- 1.2 Practical and enquiry skills
- 1.3 Communication skills
- 1.4 Applications and implications of science
- 2.1 Organisms and health
- 2.2 Chemical and material behaviour
- 2.3 Energy, electricity and radiations
- 2.4 Environment, Earth and universe

# Curriculum Links

## Summary of links to Key stage 4 and 5 qualifications

### Biogas generator

OCR Additional Science A and Biology A GCSE

Module B4: The processes of life B4.3 How do living organisms obtain energy?

AQA Biology GCSE

B3.4 Humans and their environment B3.4.3 Biofuels

OCR Gateway Science GCSE Biology B

Module B6: Beyond The Microscope Item B6d: Biofuels

### Oil extraction

AQA Chemistry GCSE and Science GCSE

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

C1.6 Plant oils and their uses C1.6.1 Vegetable oils

OCR Chemistry and Additional Science B Gateway GCSE

Module C3: Chemical Economics Item C3g

SQA Higher Chemistry

SQA Intermediate Chemistry

AQA Biology A-level

Unit 1 BIOL1 Biology and disease 3.1.3

OCR Biology A-level

3.2 AS Unit F212: Molecules, Biodiversity, Food and Health Module 1 Biological Molecules

### Oil viscosity

AQA Science B GCSE

SQA Intermediate Chemistry

OCR Chemistry A A-level

2.1.2 Alkanes Hydrocarbons from crude oil Hydrocarbons as fuels

How Science Works 6a, 7b:

4.1.3 Carboxylic Acids and Esters. Esters, triglycerides, unsaturated and saturated fats

How Science Works 7c:

OCR Chemistry B Salters A-level

Unit F331: Chemistry for Life Developing Fuels. Organic functional groups

AQA Biology B A-level

Unit 1 BIOL1 Biology and disease 3.1.3

OCR Biology A-level

3.2 AS Unit F212: Molecules, Biodiversity, Food and Health Module 1 Biological Molecules

SQA Biology: Advanced Higher Course

Unit: Cell and Molecular Biology. Structure and function of cell components

SQA Chemistry Higher

Unit 2: The World of Carbon c) Reactions of carbon compounds

### Biodiesel production

AQA Chemistry GCSE and Science GCSE

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

C1.6 Plant oils and their uses C1.6.1 Vegetable oils

OCR Physics and Science A 21st Century GCSE

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

# Curriculum Links

Edexcel Chemistry A-level

Unit 4 General Principles of Chemistry I – Rates, Equilibria and Further 4.8 Further Organic Chemistry 4  
Carboxylic acid derivatives

AQA Biology A-level

Unit 1 BIOL1 Biology and disease 3.1.3

OCR Biology A-level

3.2 AS Unit F212: Molecules, Biodiversity, Food and Health Module 1 Biological Molecules

## Extracting sugar from sugar beet

Edexcel Chemistry GCSE

Unit C3: Chemistry in Action Topic 5 Organic chemistry

AQA Chemistry GCSE and Science GCSE

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

## Carbohydrate testing

Edexcel Chemistry GCSE

Unit C3: Chemistry in Action Topic 5 Organic chemistry

AQA Biology A-level

Unit 1 BIOL1 Biology and disease 3.1.3

OCR Biology A-level

3.2 AS Unit F212: Molecules, Biodiversity, Food and Health Module 1 Biological Molecules

SQA Standard Grade Biology

SQA Access Chemistry

SQA Intermediate Chemistry

## Yeast fermentation

AQA Chemistry and Science A GCSE

C1.5 Other useful substances from crude oil

C1.5.3 Ethanol

OCR Biology Gateway GCSE

Item B6d: Biofuels

OCR Biology A 21st Century GCSE

Module B7: Further Biology

B7.5 New technologies

Edexcel Chemistry GCSE

Unit C3: Chemistry in Action Topic 5 Organic chemistry

Edexcel Biology GCSE

Unit B3: Using Biology Topic 3 Biotechnology

SQA Access and Intermediate Biology

Unit D024 09 Biotechnological Industries

SQA Access and Intermediate Chemistry

SQA Higher Biotechnology

Unit: D042 12 Microbiological Techniques

SQA Higher Chemistry

# Curriculum Links

## Plant Material Testing

SQA Standard Grade Biology

OCR Biology A-level

3.1 AS Unit F211: Cells, Exchange and Transport Module 1: Cells

WJEC Biology A-level

BY2 : Biodiversity and physiology of Body Systems. Adaptations for Transport

## Hydrolysis of biofuel feedstocks

OCR Biology A 21st Century GCSE

Module B7: Further Biology B7.5 New technologies

SQA Intermediate Chemistry

AQA Biology A-level

Unit 1 BIOL1 Biology and disease 3.1.3

OCR Biology A-level

3.2 AS Unit F212: Molecules, Biodiversity, Food and Health Module 1 Biological Molecules

SQA Higher Chemistry

## Fermentation of lignocelluloses

OCR Biology A 21st Century GCSE

Module B7: Further Biology, B7.5 New technologies

AQA Biology GCSE

B3.4.3 Biofuels

OCR Biology and Additional Science B Gateway GCSE

Module B4: It's A Green World, Item B4b: Photosynthesis

SQA Access and Intermediate Biology

Unit D024 09 Biotechnological Industries

SQA Higher Biotechnology

Unit: D042 12 Microbiological Techniques

SQA Higher Chemistry

OCR Biology A-level

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

## Bacterial cellulase

Gateway science suite GCSE Biology B

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

OCR Biology A-level

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

WJEC Biology and Human Biology A-level

Unit BY4: Metabolism, Microbiology and Homeostasis. 4.4 Microbiology

SQA Biotechnology Higher

Unit 1 Microbiology

Unit 2 Microbiological Techniques

Unit 3 Biotechnology

# Curriculum Links

## Cellulase enzyme activity

AQA Biology and Additional Science GCSE  
B2.3 Photosynthesis

AQA Biology A-level  
Unit 1 BIOL1 Biology and disease 3.1.3

OCR Biology A-level  
3.2 AS Unit F212: Molecules, Biodiversity, Food and Health

SQA Higher Chemistry

## Culturing Algae

AQA Biology and Science GCSE  
B1.5.1 Energy in biomass  
B1.6.2 The carbon cycle

AQA Biology, Science and Additional Science GCSE  
B2.3.1 Photosynthesis

AQA Science B  
3.3.2.3 The importance of carbon

OCR Biology A-level  
Module 3: Photosynthesis

## Algal photosynthesis

AQA Biology and Science GCSE  
B1.5.1 Energy in biomass  
B1.6.2 The carbon cycle

AQA Biology, Science and Additional Science GCSE  
B2.3.1 Photosynthesis

AQA Science B  
3.3.2.3 The importance of carbon

OCR Biology A-level  
Module 3: Photosynthesis

## Algae chromatography

OCR Additional Science B Gateway GCSE  
Module C3: Chemical Economics Item C3g: Batch or continuous?

AQA Biology GCSE  
B2.3 Photosynthesis

AQA Biology and Science GCSE  
B1.5.1 Energy in biomass  
B1.6.2 The carbon cycle

AQA Biology, Science and Additional Science GCSE  
B2.3.1 Photosynthesis

AQA Science B GCSE  
3.3.2.3 The importance of carbon

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