OCR
RECOGNISING ACHIEVEMENT

GCSE

Biology B

Gateway Science Suite

OCR GCSE in Biology B J263

Second Draft Version August 2010

Revised Specification Content

This document comprises the 2nd Draft of the content section (section 3) of GCSE Biology B Specification J263. This document is still subject to accreditation by Ofqual, and may change as a result of final proof reading.

The 2nd Draft is provided to assist teachers who are intending to start teaching the new specification from September 2010, before the accreditation process is complete. Changes from the 1st Draft (April 2010) are highlighted in yellow.

The full specification and specimen assessment materials will be published after accreditation.

Content of GCSE Biology B

3.1 Summary of content

The specification content is presented as six modules which are listed below. Within each module the content is shown as eight items (eg B1a, B1b, B1c, B1d, B1e, B1f, B1g, and B1h). Thus, the specification content contains a total of 48 teaching items. Each item requires approximately 2½ hours teaching time.

Module B1: Understanding Ourselves	Module B2: Understanding Our Environment	Module B3: Living and Growing
a Fitness and Health	a Classification	a Molecules of Life
b Human Health and Diet	b Energy Flow	b Proteins and Mutations
c Staying Healthy	c Recycling	c Respiration
d The Nervous System	d Interdependence	d Cell Division
e Drugs and You	e Adaptations	e The Circulatory System
f Staying in Balance	f Natural Selection	f Growth and Development
g Controlling Plant Growth	g Population and Pollution	g New Genes for Old
h Variation and Inheritance	h Sustainability	h Cloning
Module B4: It's a Green World	**Module B5: The Living Body**	**Module B6: Beyond the Microscope**
a Ecology in the Local Environment	a Skeletons	a Understanding Microbes
b Photosynthesis	b Circulatory Systems and the Cardiac Cycle	b Harmful Microorganisms
c Leaves and Photosynthesis	c Running Repairs	c Useful Microorganisms
d Diffusion and Osmosis	d Respiratory Systems	d Biofuels
e Transport in Plants	e Digestion	e Life in Soil
f Plants need Minerals	f Waste Disposal	f Microscopic Life in Water
g Decay	g Life Goes On	g Enzymes in Action
h Farming	h Growth and Repair	h Gene Technology

3.2 Fundamental Scientific Processes

FUNDAMENTAL SCIENTIFIC PROCESSES

Item Sa: How Science Works

Summary: In addition to knowledge of the scientific explanations that are detailed in sections 3.4 – 3.9 below, candidates require an understanding of the fundamental scientific processes that underpin these explanations.

Aspects of Fundamental Scientific Processes and opportunities to develop them in the specification	Assessable learning outcomes Foundation Tier only: low demand
Developing Scientific Explanations	
B3a, B3b, B4d, B4d, B5b	Describe a simple scientific idea using a simple model.
B2f, B1h, B4b, B5b	Identify two different scientific views or explanations of scientific data.
B2e, B2f, B3a, B4b	Recall that scientific explanations (hypotheses) are • used to explain observations • tested by collecting data / evidence.
B2f, B2f, B3a, B3a, B4b, B5b	Describe examples of how a famous scientist used a scientific idea to explain experimental observations or results.
B2f	Recognise that science explanations are provisional because they only explain the current evidence and that some evidence/observations cannot yet be explained.
Science in Society	
B2g, B1b, B1c, B2f, B3g, B4g, B5h, B5h, B6d	Identify different views that might be held regarding a given scientific or technological development.
B1h, B2e, B2g, B2g, B3g, B3g, B3f, B3h, B4g, B5h, B5g, B6d, B6d, B6h	Identify how a scientific or technological development could affect different groups of people or the environment.
B1c, B1a, B1c, B1b, B2g, B1h, B3g, B3h, B5g	Describe risks from new scientific or technological advances.
Institutions and social practices	
B2g, B4b	Identify information and data from different sources, without consideration of issues of misrepresentation.
B2f, B3a	Recognise the importance of the peer review process in which scientists check each other's work.
Methods of Science	
B1a, B1b, B1c, B1e, B1e, B2b, B2d, B3f, B3c, B4a, B5d, B5h, B6f	Present data as tables, pie charts or line graphs and identify trends in the data and process data using simple statistical methods such as calculating a mean.
B1a, B1e, B4a, B5h	Explain how a conclusion is based on the scientific evidence which has been collected.

FUNDAMENTAL SCIENTIFIC PROCESSES

Summary (cont.): Studying these processes will provide candidates with some understanding of

- how scientific explanations have been developed,
- something of their limitations, and
- how they may impact on individuals and society as a whole.

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Explain a scientific process, using ideas or models.	Explain a complex scientific process, using abstract ideas or models.
Describe (without comparing) the scientific evidence which supports or refutes opposing scientific explanations.	Evaluate and critically compare opposing views, justifying why one scientific explanation is preferred to another.
Explain how a scientific idea has changed as new evidence has been found.	Identify the stages in the development of a scientific theory in terms of the way the evidence base has developed over time alongside the development of new ways of interpreting this evidence.
Describe examples of how a famous scientist planned a series of investigations / made a series of observations in order to develop new scientific explanations.	Understand that unexpected observations or results can lead to new developments in the understanding of science.
Recognise that science explanations are provisional but more convincing if predictions can be made and subsequently confirmed.	Recognise that confidence increases in provisional scientific explanations if observations match predictions, but this does not prove the explanation is correct.
Explain how the application of science and technology depends on economic, social and cultural factors.	Describe the ways in which the values of society have influenced the development of science and technology.
Identify some arguments for and against a scientific or technological development, in terms of its impact on different groups of people or the environment.	Evaluate the application of science and technology, recognising the need to consider what society considers right or wrong, and the ideal that the best decision will have the best outcome for the majority of the people involved.
Suggest ways of limiting risks and recognise the benefits of activities that have a known risk.	Analyse personal and social choices in terms of a balance of risk and benefit.
Distinguish between claims/opinions and scientific evidence in sources.	Evaluate critically the quality of scientific information or a range of views, from a variety of different sources, in terms of shortcomings in the explanation, misrepresentation or lack of balance.
Explain how publishing results through scientific conferences and publications enables results to be checked and further evidence to be collected.	Explain the importance of using teams of scientists to enable different interpretations of data to be considered and further work to be undertaken, so that an agreed explanation can be reached.
Choose the most appropriate format for presenting data, and process data using mathematical techniques such as statistical methods or calculating the gradients of graphs.	Identify complex relationships between variables, including inverse relationships, using several mathematical steps.
Determine the level of confidence for a conclusion based on the identification of a qualitative relationship between variables and describe how further predictions can lead to more evidence being obtained.	Identify and critically analyse conflicting evidence, or weaknesses in the data, which lead to different interpretations, and explain what further data would help to make the conclusion more secure.

Module B1: Understanding Ourselves

Item B1a: Fitness and Health

Summary: This item looks at the differences between health and fitness, concentrating on the causes and prevention of heart disease, which is responsible for most deaths in the UK.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure blood pressure.	Explain that blood in arteries is under pressure: • due to contraction of heart muscles • so that it reaches all parts of the body.
Visit a fitness centre, or have a visit from a representative and prepare a report on an individual fitness programme, including how ICT is used in assessing and monitoring fitness.	
Use websites to plan for a lower cholesterol intake. Produce a poster or leaflet encouraging a healthy lifestyle by reducing the risk of heart disease.	Recognise that the risk of developing heart disease can be increased by a number of factors, to include: • high blood pressure • smoking • eating high levels of salt • eating high levels of saturated fat. Describe how cholesterol can restrict or block blood flow in arteries by forming plaques. Present data that shows the changing incidence of heart disease in the UK.

Module B1: Understanding Ourselves

Item B1a: Fitness and Health
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise that blood pressure measurements consist of diastolic and systolic information in mmHg. Describe the factors that increase blood pressure: • being overweight • stress • high alcohol intake • smoking. Describe the factors that decrease blood pressure: • regular exercise • balanced diet.	Explain the possible consequences of having high blood pressure: • burst blood vessels, which can cause • damage to brain • stroke • kidney damage. Explain the possible consequences of having low blood pressure: • dizziness • fainting • poor circulation.
Explain the difference between fitness (ability to do physical activity) and health (free from disease).	Describe different ways of measuring fitness (strength, stamina, flexibility, agility, speed, as well as cardiovascular efficiency).
Explain how smoking increases blood pressure: • carbon monoxide reduces the oxygen-carrying capacity of the blood so heart rate increases to compensate • nicotine increases heart rate. Explain that diet can increase the risk of heart disease because of: • saturated fats which can lead to a build up of cholesterol (a plaque) in arteries • high levels of salt which can elevate blood pressure Analyse data that shows a correlation between the amount of saturated fat eaten and the incidence of heart disease.	Explain that carbon monoxide combines with red blood cells preventing them carrying as much oxygen. Explain how narrowed coronary arteries, together with a thrombosis, increase the risk of a heart attack.

Module B1: Understanding Ourselves

Item B1b: Human Health and Diet

Summary: The populations of many countries in the world are either underweight and starving or obese with associated health problems. This item looks at food as a source of energy and raw materials and considers the effects of diet on candidates' bodies. This item provides the opportunity to collect and analyse scientific data from primary and secondary sources, including the use of ICT tasks, when investigating individuals' energy intake and countries facing food emergencies. Research on countries having food emergencies provides the opportunity to discuss ethical issues raised by science and technology.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Compare the food and nutritional value of different breakfast cereals. Record a day's food intake and calculate the total energy intake. Investigate energy content in different foods. Carry out simple food tests on a variety of food types.	Recall that food is defined as being an energy source for living organisms. Recall the main uses of carbohydrates and fats as high energy sources. Recognise that a balanced diet should also include: • minerals (limited to iron to make haemoglobin) • vitamins (limited to vitamin C to prevent scurvy) • fibre (to prevent constipation) • water and recall that these substances do not provide energy.
Use ICT tasks, including video clips, to research countries having food emergencies and facing starvation. Calculate personal EAR for protein. Record a day's intake and calculate the amount of protein. Calculate a BMI and use provided information to make a decision as to what it indicates.	Interpret simple data on diet. Explain that: • protein is needed in a balanced diet for growth and repair • a high protein diet is necessary for growing teenagers • in many parts of the world diets are deficient in protein • proteins are only used as an energy source in a shortage. Recall that being very overweight (obese) is linked to increased health risks to include arthritis, heart disease, diabetes, breast cancer.

Module B1: Understanding Ourselves

Item B1b: Human Health and Diet
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that: • carbohydrates are made up of simple sugars such as glucose • fats are made up of fatty acids and glycerol • proteins are made up of amino acids. Explain how a balanced diet will vary depending on the age, gender, activity, religion, personal choice (to include vegetarians, vegans) and medical issues (to include food allergies).	Explain that: • carbohydrates are stored in the liver as glycogen or converted to fats • fats are stored under the skin and around organs as adipose tissue • proteins are not stored.
Describe why protein deficiency (kwashiorkor) is common in developing countries, limited to: • overpopulation • limited investment in agricultural techniques. Calculate the estimated average daily requirement (EAR) for protein using the formula EAR in g = 0.6 x body mass in kg Calculate the Body Mass Index given the formula: BMI = mass in kg/(height in m)^2 and use it as a guide to understand the terms underweight, normal, overweight, obese. Explain how low self-esteem, poor self-image and desire for perfection can lead to a poor diet and the increased risks involved.	Explain that: • proteins of animal origin are called 'first class proteins' because they contain all essential amino acids (these cannot be made by the body) • plant proteins are called 'second class proteins'. Explain that the EAR is an estimated daily figure for an average person of a certain body mass. Explain why the EAR for protein may vary depending on age, pregnancy and lactation.

Module B1: Understanding Ourselves

Item B1c: Staying Healthy

Summary: This item aims to help candidates understand the causes, preventative measures and cures of some diseases, while understanding that not all diseases are easily controlled or cured. This item provides the opportunity to analyse, interpret, apply and question scientific information and ideas, including some questions that science cannot currently answer in cancer treatment and drug testing. These topics also allow the discussion of ethical issues raised and develop the skills of scientific argument and presentation of data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out a survey of diseases suffered by candidates in class or year (limited to flu/colds, athlete's foot, "stomach upsets") using primary or secondary sources. Case studies involving malaria.	Explain that infectious diseases are caused by pathogens (disease-causing microorganisms): • fungi • bacteria • viruses • protozoa. Recall one example of a disease caused by each type of pathogen limited to athlete's foot (fungus), flu (virus), cholera (bacteria) and malaria (protozoa).
	Describe how the human body is defended against pathogens: • skin provides a barrier • blood clotting prevents entry of pathogens • pathogens are trapped by mucus in airways • hydrochloric acid in the stomach kills pathogens. Describe the difference between infectious and non-infectious diseases. Explain that some disorders have other causes, to include genetic causes.
Chart the immunisation programme recommended in the UK for children up to the age of 16. Carry out the role-playing exercise and data analysis, from SATIS 9, The Chinese Cancer Detectives. Use a world map to plan holidays and estimate the risk of exposure to diseases such as malaria, cholera, hepatitis, polio and typhoid.	Recall that immunisation (vaccination) gives protection from certain pathogens. Describe how pathogens that enter the body are destroyed by the immune system (white blood cells): • engulfed by white blood cells • destroyed by antibodies. Interpret data on the incidence of disease around the world to show links with climate and socio-economic factors.
	Describe the reasons why new medical treatments/drugs are tested before use: • to see if they are safe • to see if they work

Module B1: Understanding Ourselves

Item B1c: Staying Healthy
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall the meaning of the terms parasite and host with reference to malaria. Describe how vectors spread disease • limited to mosquito.	Explain how knowledge of the way in which vectors spread disease can help control infections • limited to mosquito.
Describe that disease and other disorders can be caused by vitamin deficiency (lack of vitamin C causes scurvy), mineral deficiency (lack of iron causes anaemia), body disorders (diabetes, cancer). Describe changes in lifestyle and diet which may reduce the risk of some cancers.	Describe the difference between benign and malignant tumours. Interpret data on types of cancer and survival/mortality rates.
Explain that the symptoms of an infectious disease are caused by cell damage or by toxins produced by the pathogens. Explain that antibodies lock on to antigens leading to the death of the pathogens. Describe how immunity to pathogens comes from prior infection. Explain the difference between passive (receive antibodies) and active immunity (make own antibodies). Recall that antibiotics can be used to treat bacterial and fungal infections.	Explain how each pathogen has its own antigens and that specific antibodies are needed. Explain the process of immunisation (vaccination): • harmless pathogen given which carries antigens • antigens trigger immune response by and white blood cells produce antibodies • immunity remains (memory cells produced). Describe the benefits and risks (possible side effects) associated with immunisation. Explain the need for careful use of antibiotics to prevent the increase of strains such as MRSA.
Describe how new treatments are tested using animals, human tissue, computer models and understand objections to some forms of testing.	Describe the use of blind and double blind trials in testing new drugs against placebos or the best existing treatment.

Module B1: Understanding Ourselves

Item B1d: The Nervous System

Summary: Our bodies have to respond to changes that happen both inside and outside the body. The nervous system plays a major part in this. This item provides the opportunity to collect and analyse primary scientific data when investigating frequency of nerve endings in different skin areas and secondary data when researching reaction times in races. Theories and ideas can be tested in the investigation of binocular vision. This item develops safe and accurate work skills, along with analysis of ideas.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to test ranges of vision using cardboard marked out in degrees or moving outstretched arms forward. Demonstrate binocular vision by bringing pencil points together at arm's length using one then two eyes.	Describe the body's sense organs (receptors) and the information they gather, limited to: • skin – pressure, temperature and pain (touch) • tongue – chemicals in food (taste) • nose – chemicals in air (smell) • eyes – light (sight) • ears – sound (hearing) and balance. Name and locate the main parts of the eye: cornea, iris and pupil, lens, retina, optic nerve, blind spot.
Investigate why some animals have binocular vision and others do not.	Describe the difference between monocular (seeing objects with one eye) and binocular vision (seeing objects with both eyes).
Carry out a survey on eye defects (candidates wearing glasses/contact lens) or use second hand data, in class or year group. Use colour vision deficiency charts.	Describe the main problems in vision limited to long-sight, short-sight and red-green colour blindness.
Carry out an experiment using blunt needles or forceps to determine the density of nerve endings in different skin areas. Carry out experiments on reaction times using ICT. Research allowable reaction times in races.	Name and locate the main parts of the nervous system, to include: • the central nervous system (CNS) (brain and spinal cord); • the peripheral nervous system. Describe the nerve impulse as an electrical signal that is carried by nerve cells called neurones. Describe reflex actions as fast, automatic and protective responses. Recall examples of reflex actions such as knee jerk, pupil reflex, withdrawing hand from a hot plate. Recognise that voluntary responses are under the conscious control of the brain.

Module B1: Understanding Ourselves

Item B1d: The Nervous System
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the functions of the main parts of the eye: • cornea - refracts light • iris - controls how much light enters pupil • lens - focuses light on to retina • retina - contains light receptors • optic nerve - carries impulses to the brain. Describe the pathway of light through the eyeball, being refracted by the cornea and lens.	Explain how the eye focuses light (accommodation) from distant objects: • ciliary muscle relaxes • suspensory ligaments tighten • lens pulled into a less rounded shape. Explain how the eye focuses light (accommodation) from close objects: • ciliary muscle contracts • suspensory ligaments slacken • the lens' elasticity makes it a more rounded shape.
Explain the advantages and disadvantages of: • monocular vision: wider field of view but poorer judgement of distance • binocular vision: narrower field of view but better judgement of distance.	Explain how binocular vision helps to judge distances by comparing the images from each eye – the more similar the images, the further away the object.
Explain how long and short-sight is caused by the eyeball or the lens being the wrong shape. Explain that red-green colour blindness is the result of a lack of specialised cells in the retina.	Explain the problems of slow or poor eye accommodation in older people. Explain how long and short-sight can be corrected by corneal surgery or by different lenses in glasses or contact lenses: convex lenses for long sight and concave lenses for short sight.
Name and locate the parts of a motor neurone: cell body, axon, sheath. Recall that the nerve impulse passes along the axon of a neurone. Describe a reflex arc: stimulus → receptor →sensory neurone → central nervous system → motor neurone → effector → response. Describe the path taken by a spinal reflex involving a receptor, sensory neurone, relay neurone, motor neurone and effector.	Explain how neurones are adapted to their function by their length, insulating sheath and branched endings (dendrites). Recall that the gap between neurones is called a synapse. Describe how an impulse triggers the release of a transmitter substance in a synapse and how it diffuses across to bind with receptor molecules in the membrane of the next neurone causing the impulse to continue.

Module B1: Understanding Ourselves

Item B1e: Drugs and You

Summary: Candidates are exposed to many influences that encourage their natural urge to experiment. This item considers the scientific knowledge and explanations of drugs, their effects and the risks involved. Many drugs are also used legitimately and some of these are considered. This item provides the opportunity to find out about the use of contemporary scientific and technological developments in the detection and analysis of different drugs used in sport. Data from secondary sources can be collected and analysed using ICT tools. There is the opportunity to discuss how scientific knowledge and ideas change over time when investigating the link between smoking and lung cancer.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Arrange visit from the relevant police departments or rehabilitation centres.	Recognise that drugs can be beneficial or harmful. Explain why some drugs are only available on prescription; misuse could cause harm. Explain the terms: addiction, withdrawal symptoms, tolerance and rehabilitation.
Research the drug testing programmes in sport. Research and present information about the effects of different drugs on the body.	Describe the general effects of each drug category: • depressants: slow down brain's activity • pain killers: block nerve impulses • stimulants: increase brain's activity • performance enhancers: muscle development • hallucinogens: distort what is seen and heard.
Carry out the smoking machine experiment to compare high, medium and low tar brands. Research a time line of the link between smoking and lung cancer. Discuss the current anti-smoking laws.	Recall that tobacco smoking can cause emphysema, bronchitis, cancer (mouth, throat, oesophagus, lung and throat) and heart disease. Recall that a burning cigarette produces carbon monoxide, nicotine, tar and particulates.
Produce a poster to warn drivers about the dangers of drink driving.	Describe short term effects of alcohol on the brain and nervous system (impaired judgment, balance and muscle control, blurred vision, slurred speech, drowsiness, increased blood flow to skin) and long term effects (liver and brain damage). Explain why there is a legal limit for the level of alcohol in the blood/breath for drivers and pilots.

Module B1: Understanding Ourselves

Item B1e: Drugs and You
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the basis of the legal classification of drugs: • class A being the most dangerous with the heaviest penalties • class C being the least dangerous with the lightest penalties.	
Recall examples of drugs: • depressants limited to alcohol, solvents and temazepan • pain killers limited to aspirin and paracetamol • stimulants limited to nicotine, ecstasy and caffeine • performance enhancers limited to anabolic steroids • hallucinogens limited to LSD.	Explain the action of depressants and stimulants on the synapses of the nervous system: • depressants bind with receptor molecules in the membrane of the next neurone blocking the transmission of the impulses • stimulants cause more neurotransmitter to cross the synapse.
Describe the effects of: • carbon monoxide (lack of oxygen, heart disease) • nicotine (addictive) • tars (irritant, carcinogenic) • particulates (accumulation in lung tissue). Describe how cigarette smoke affects ciliated epithelial cells lining the trachea, bronchi and bronchioles and how this is linked to a 'smokers cough'. Interpret data on the effects of smoking (to include cancer, heart disease, emphysema and birth weights of babies born to mothers who smoke).	
Describe how the liver can become damaged as it removes toxic alcohol (cirrhosis). Interpret data on the alcohol content (measured in units of alcohol) of different alcoholic drinks.	Interpret information on reaction times, accident statistics and alcohol levels.

Module B1: Understanding Ourselves

Item B1f: Staying in Balance

Summary: Many complex chemical processes take place in our cells and organs to ensure an optimum state. This item looks at how a constant internal environment is achieved. This item provides the opportunity to collect and analyse primary data and present information using scientific and mathematical conventions in the 'changing skin temperatures' experiment. The use of a data-logger can provide an opportunity to use an ICT tool. Discussing the use of thermal blankets as a contemporary application of science, along with work on heat stroke provides the opportunity to look at the benefits of technological developments.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Discuss automatic control systems in candidates' lives eg central heating, air conditioning, cruise control in cars, incubators.	Recognise that the body works to maintain steady levels of temperature, water, and carbon dioxide and that this is essential to life.
Carry out an experiment on the changing skin temperature down an arm or a leg and plot the results accurately on a graph. Measure body temperature using a range of different procedures. Discuss the use of thermal first aid blankets after activities such as marathons. Produce a poster warning older people about hypothermia and telling them how to prevent it.	Recall that the core temperature of the human body is normally maintained at approximately 37°C. Describe appropriate procedures to measure body temperature: • where (ear, finger, mouth, anus) • how (clinical thermometer, sensitive strips, digital recording probes, thermal imaging). Describe how heat can be gained or retained (respiration, shivering, exercise, less sweating, less blood flow near skin surface, clothing). Describe how heat can be lost (by sweating, more blood flow near skin). Explain that temperature extremes are dangerous to the body.
Research diabetes and how it can be managed. www.abpischools.org.uk	Name and locate the pancreas. Recall that the pancreas produces the hormone insulin. Explain that Type 1 diabetes is caused by the failure of the pancreas to produce insulin. Describe that insulin travels around the body through the blood.

Module B1: Understanding Ourselves

Item B1f: Staying in Balance
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that maintaining a constant internal environment involves balancing bodily inputs and outputs and is called homeostasis. Explain that factors are kept at steady levels by automatic control systems so that cells can function at their optimum level (limited to temperature, water content and carbon dioxide).	Explain how negative feedback mechanisms are used to maintain a constant internal environment.
Describe how sweating increases heat transfer to the environment by evaporation of sweat which requires and removes heat from the skin. Describe how high temperatures can cause heat stroke and dehydration and if untreated, death. Describe how very low temperatures can cause hypothermia and if untreated, death.	Describe how vasodilation and vasoconstriction increase or reduce heat transfer to the environment. Recall that the body temperature of 37°C is linked to enzyme action. Explain that blood temperature is monitored by the brain which will bring about temperature control mechanisms.
Explain that insulin controls blood sugar levels. Explain how Type 2 diabetes can often be controlled by diet but that Type 1 diabetes also needs to be treated by insulin dosage. Explain that because hormones travel in the blood to target organs, the body's reactions to hormones are usually slower than nervous reactions.	Explain how insulin helps to regulate blood sugar levels by converting excess blood glucose to glycogen in the liver. Explain that the dosage of insulin needed to be taken by a person with Type 1 diabetes depends upon diet and activity.

Module B1: Understanding Ourselves

Item B1g: Controlling Plant Growth

Summary: Growth and development in plants are controlled by plant growth regulators (hormones). This item examines some examples of this, as well as how humans can use plant hormones to aid the efficient production of food. Experiments on seed growth allow the development of safe and accurate working, the presenting of results, evaluation of data collection and the validity and reliability of the data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to test whether cress seedlings grow towards light. Carry out an experiment to test whether bean roots always grow downwards. Use ICT to watch and compare time lapse videos of plant tropisms.	Recognise that plants as well as animals respond to changes in their environment. Explain that plant growth (limited to growth of shoots and roots, flowering, fruit ripening) is controlled by chemicals called plant hormones. Describe an experiment to show that shoots grow towards light. Explain that roots grow downwards in response to gravity.
Take cuttings using rooting powder to encourage root growth. Research how seedless grapes are produced. Investigate bananas ripening more quickly if already-ripened bananas are close by; research why this happens.	Recognise that plant hormones can be used in agriculture to speed up or slow down plant growth.

Module B1: Understanding Ourselves

Item B1g: Controlling Plant Growth
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe shoots as positively phototropic but negatively geotropic. Describe roots as negatively phototropic but positively geotropic. Describe that the group of plant hormones called auxins: • move through the plant in solution • are involved in the response to light (phototropism) • are involved in the response to gravity (geotropism).	Interpret data from phototropism experiments in terms of auxin action: • auxin made in tip • unequally distributed in response to light. Explain how auxin brings about shoot curvature in terms of cell elongation.
Relate the action of plant hormones to their commercial uses: • selective weedkillers • rooting powder • fruit ripening (delay or acceleration) • control of dormancy.	

Module B1: Understanding Ourselves

Item B1h: Variation and Inheritance

Summary: This item looks at the causes of variation and how we can use our knowledge of inheritance to help predict the characteristics of children.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Use poppit beads to show combinations due to chance. Toss coins to show expected and 'real' ratios. Use a genetics kit to show the results of a monohybrid cross. Debate the arguments for and against parents knowing a baby's gender before birth.	Analyse human characteristics to determine those caused by the environment, to include: • scars • spoken language. those controlled by genes and so inherited, to include: • earlobe shape • eye colour • nose shape. and those which are a result of both environmental and inherited factors, to include: • intelligence • body mass • height. Explain that chromosomes are held in the nucleus and they carry information in the form of genes. Recognise that most body cells contain chromosomes in matching pairs.
	Recognise that some disorders are inherited: red-green colour blindness, sickle cell anaemia, cystic fibrosis.

Module B1: Understanding Ourselves

Item B1h: Variation and Inheritance
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Identify inherited characteristics as dominant or recessive when given the results of a breeding experiment. Describe how sex (in mammals) is determined by sex chromosomes: XX (female) and XY (male). Explain that genetic variation can be caused by: • mutations (changes to the genes) • gamete formation • fertilisation. Recall that most body cells have the same number of chromosomes but this number varies between species (humans have 23 pairs). Recall that gametes have half the number of chromosomes of body cells.	Recognise that there is a debate over the relative importance of genetic and environmental factors in determining some human attributes: intelligence, sporting ability, health. Explain that dominant and recessive characteristics depend on dominant and recessive alleles: • dominant alleles are those expressed if present • recessive alleles are those only expressed if the dominant allele is absent. Recognise that alleles are different versions of the same gene. Explain a monohybrid cross involving dominant and recessive alleles: genetic diagrams using letters to represent alleles. Use and explain genetic terms: • homozygous – two identical alleles • heterozygous- two different alleles. • genotype – the genetic makeup • phenotype – the characteristics expressed. Explain sex inheritance using genetic diagrams: production of equal numbers of male and female offspring.
Explain that inherited disorders are caused by faulty genes.	Explain that inherited disorders are caused by faulty alleles, most of which are recessive. Use genetic diagrams to predict the probabilities of inherited disorders passing to the next generation. Discuss the issues raised by knowledge of inherited disorders in a family.

Module B2: Understanding Our Environment

Item B2a: Classification

Summary: We are surrounded by a huge variety of living organisms. Through classifying them according to their similarities and differences, we can better understand their evolutionary and ecological relationships between living organisms. The ability to correctly classify organisms is crucial if we are to identify and maintain global stability.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Place different plants and animals into groups.	Identify characteristics of animals or plants, limited to: • animals cannot make their own food • plants can make their own food by photosynthesis.
Collect plants/animals from local surroundings and develop a simple key. Use a simple key to identify some plants/animals.	Identify animals as vertebrates or invertebrates. Describe the difference between vertebrates and invertebrates. Identify vertebrates as fish, amphibians, reptiles, birds or mammals.
Research the work of John Ray and Carl Linnaeus in developing a modern classification system.	Recognise that organisms of the same species: • may show great variation • have more features in common than they do with organisms of a different species.
	Recognise that similar species tend to live in similar types of habitats.

Module B2: Understanding Our Environment

Item B2a: Classification
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the characteristics that are used to place organisms into the animal or plant kingdoms: • animals move from one place to another in order to find food and have a compact body shape • plants do not move, have chloroplasts to make their own food and grow in a spreading manner.	Explain why some organisms, such as fungi, are classified as neither animal nor plant. Discuss the problems of classification in organisms such as Euglena (plant and animal characteristics).
Interpret characteristics and use them to place organisms into the different classes of vertebrates, limited to: • fish – wet scales, gills • amphibians – moist permeable skin • reptiles – dry scales • birds – feathers, beak • mammals – fur, produce milk.	Recognise the problems of classification in organisms such as Archaeopteryx (bird and reptile characteristics).
Define the term 'species' as a group of organisms which are capable of interbreeding to produce fertile offspring. Use the binomial system as a basis for naming species.	Describe some of the problems of classifying organisms into species, to include: • hybrids such as mules • organisms such as bacteria that only reproduce asexually.
Explain that closely related species: • share a relatively recent ancestor. • may have different features if they live in different types of habitats.	Explain that similarities and differences between species need to be explained in terms of both evolutionary relationships and ecological relationships. Explain why dolphins and whales are classified as mammals but appear similar to fishes such as sharks.

Module B2: Understanding Our Environment

Item B2b: Energy Flow

Summary: All living things need energy to live. Ultimately this energy comes from the sun. This item explains how energy from the sun flows through ecosystems and how humans can harness it. The work on energy transfer provides the opportunity to examine the ethical issues raised by decisions on plant use and the environmental effects of such decisions.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Construct a mobile to illustrate trophic levels. Play food web card games.	Explain the terms: • producer • consumer • trophic level. Interpret how changes in one organism in a food chain or web may affect the other organisms.
Survey peers on vegetarian diet. Consider and compare sources of food.	Describe that energy enters food chains when plants absorb sunlight. Explain that all other organisms in food chains rely directly or indirectly on plants.

Module B2: Understanding Our Environment

Item B2b: Energy Flow
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that pyramids of numbers show the numbers of organisms at each stage of a food chain. Explain that pyramids of biomass show the mass of living material at each stage of a food chain. Construct pyramids of biomass or pyramids of biomass from given information. Distinguish between pyramids of numbers and pyramids of biomass.	Explain the difficulties in constructing pyramids limited to: • organisms may belong to more than one different trophic level • the problems with measuring dry biomass.
Explain that energy from the sun flows through food chains by photosynthesis and feeding. Interpret data on energy flow in food chains and webs. Explain how some energy is transferred to less useful forms at each stage (trophic level) in the food chain, to include: • heat from respiration • excretion • egestion.	Explain how the efficiency of energy transfer explains the shape of pyramids of biomass. Explain how the efficiency of energy transfer explains the limited length of food chains. Calculate the efficiency of energy transfer. Explain that excretory products and uneaten parts can be used as the starting point for other food chains.

Module B2: Understanding Our Environment

Item B2c: Recycling

Summary: We are encouraged to recycle to save the Earth's resources, but natural recycling is nothing new. The survey of local recycling schemes provides the opportunity to use ICT sources and tools to collect secondary data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of local recycling schemes. Compare local recycling schemes with national and international recycling schemes. Compositing activities. Observation/measurement of leaf decomposition in edges/hedges.	Recognise that as animals and plants grow they take in chemicals and incorporate elements from these into their bodies. Recall that two of the most important elements that are required are: • carbon • nitrogen. Recall that carbon is taken up by plants as carbon dioxide. Explain that when animals and plants die and decay the elements in their bodies are recycled. Recognise that many soil bacteria and fungi are decomposers, decaying dead organisms. Describe the importance of this decay process in making elements available again to living organisms.
Carry out an experiment to test soil for nitrates. Examine clover roots to see nodules. Make a nitrogen cycle snakes and ladders game. Investigate nitrogen fixing bacteria (see Practical Microbiology for Secondary Schools).	Recall that nitrogen is taken up by plants as nitrates. Recall the abundance of nitrogen in the air (78%). Explain that nitrogen gas can't be used directly by animals or plants because it is too unreactive.

Module B2: Understanding Our Environment

Item B2c: Recycling
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how carbon is recycled in nature, limited to: • plants removing carbon dioxide from the air by photosynthesis • feeding passing carbon compounds along a food chain or web • plants and animals releasing carbon dioxide into the air, as a product of respiration • burning of fossil fuels (combustion) releasing carbon dioxide. • soil bacteria and fungi, acting as decomposers, releasing carbon dioxide into the air.	Explain that soil bacteria and fungi, acting as decomposers, release carbon dioxide into the air by respiration. Explain how carbon is recycled in nature, limited to: • marine organism making shells made of carbonates • shells becoming limestone • carbon returning to the air as carbon dioxide during volcanic eruption or weathering. • oceans absorbing carbon dioxide, acting as carbon sinks.
Explain how nitrogen is recycled in nature, limited to • plants taking in nitrates from the soil to make protein for growth • feeding passing nitrogen compounds along a food chain or web • nitrogen compounds in dead plants and animals being broken down by decomposers and returning to the soil.	Explain how nitrogen is recycled in nature, limited to • soil bacteria and fungi, acting as decomposers, converting proteins and urea into ammonia • the conversion of this ammonia to nitrates by nitrifying bacteria • the conversion of nitrates to nitrogen gas by denitrifying bacteria • the fixing of nitrogen gas by nitrogen-fixing bacteria living in root nodules or in the soil or by the action of lightning.

Module B2: Understanding Our Environment

Item: B2d: Interdependence

Rationale: This item seeks to help candidates understand that there is a struggle for existence and the survival of animals and plants depends on how they cope with competition and predation. There are also other types of interdependence to include parasitism and organisms co-existing to their mutual benefit.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey a habitat and produce a display to show the plants/animals competing in the habitat. For example, why are 'weeds' successful competitors? Research invasive species, for example Himalayan balsam, Japanese knotweed, cressula etc.	Explain that animals compete for food, water, shelter and mates in order to survive and breed. Explain that plants compete for light, water and minerals. Interpret data which shows that animals and plants can be affected by competition for resources, including population sizes and distribution data.
	Explain what is meant by the terms predator and prey. Recognise organisms as predators or prey when given details of their feeding relationships.
Examine root nodules using a hand lens. Research examples of mutualism and other associations between organisms. Research how parasites are adapted to survive in or on their particular hosts.	Recognise that some organisms benefit from the presence of organisms of a different species. Describe one example of such a relationship limited to cleaner species, to include oxpecker and buffalo.

Module B2: Understanding Our Environment

Item: B2d: Interdependence
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how competition may influence the distribution and population size of animals or plants, related to the availability of food, water, shelter, light and minerals. Describe how organisms within a species compete in order to survive and breed.	Explain how similar animals in the same habitat will be in close competition (to include different species of ladybirds, grey and red squirrels). Explain what is meant by the term ecological niche. Explain that similar organisms will occupy similar ecological niches.
Explain how the size of a predator population will affect the numbers of prey and vice versa.	Explain how the populations of predators and their prey regulate one another and result in cyclical fluctuations in numbers.
Describe other types of interdependence between organisms to include: • parasitism, where the parasite benefits to the living host's detriment, including fleas and tapeworms • mutualism, where both species benefit including cleaner species and pollination by insects.	Explain how the interdependence of organisms determines their distribution and abundance. Explain why nitrogen-fixing bacteria in the root nodules of leguminous plants are an example of mutualism, due to: • bacteria gaining sugars • plants gaining compounds containing nitrogen.

Module B2: Understanding Our Environment

Item B2e: Adaptations

Summary: Our environment is constantly changing. This affects animal and plant distributions. This item develops ideas about how some plants and animals successfully adapt to suit their changing environment.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Observe a worm using a hand lens, list all of its adaptations that make it successful for life in the soil. Make models of plants and discuss the adaptations that make it successful. Research organisms that have lost/reduced features that are no longer required eg blind cave fish have lost eyes. Carry out an internet search to find pictures of animals or plants with successful camouflage and other adaptations. Identify predators and discuss the adaptations that will make them successful. Use ICT to make a poster to explain how an organism is adapted to its habitat.	Recognise that animals are adapted to their habitats such as fish (water), bird (air) and worm (soil). Recognise that plants are adapted to their habitats to include: • cactus (hot, dry deserts) • rubber plant (hot, wet conditions). Describe how some animals are adapted to be successful predators, to include: • eyes to the front of the head to judge size and distance • camouflage to avoid being seen by prey • sharp teeth and claws • built for speed. Describe how some animals are adapted to avoid being caught as prey, to include: • eyes on side of head for wide field of view; • camouflage • live in groups • built for speed • defences such as stings or poison.
Discuss possible climate changes and predict which animals and plants will successfully adapt to survive in the new conditions.	Recall that animals and plants that are adapted to their habitats are better able to compete for limited resources.

Module B2: Understanding Our Environment

Item B2e: Adaptations
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how a polar bear is adapted to cold arctic conditions, to include: • thick white fur for camouflage and insulation • a layer of fat (blubber) for insulation • sharp claws and teeth • strong legs for running and swimming • large size and small ears to reduce surface area (relative to size) to reduce heat losses • large feet to spread load on snow • fur on soles of paws for insulation and grip. Explain how some plants are adapted for wind pollination, to include: • feathery stigmas • small light pollen. Explain how some plants are adapted for insect pollination, to include: • colourful petals • nectar • 'sticky' pollen.	Explain how a cactus is adapted to hot dry conditions, to include: • rounded shape providing a reduced surface area/volume ratio to reduce water losses • a thick cuticle to reduce water losses • leaves reduced to spines to reduce surface area and to discourage animals • a green stem for photosynthesis • storage of water to withstand droughts • long roots to reach water. Explain how a camel is adapted to dry desert conditions, to include: • a hump containing fat so it doesn't insulate whole body • tolerance to body temperature rises so it doesn't need to sweat • bushy eyelashes and hair-lined nostrils that can close to stop sand entering • large feet to spread load on sand.
Explain how animals and plants that are adapted to an environment are better able to compete for limited resources.	Explain that some organisms are: • specialists, which are well suited to only certain habitats • generalists, which can live in a range of habitats but can easily be out-competed.

Module B2: Understanding Our Environment

Item B2f: Natural Selection

Summary: The concept of evolution is well known. However, the mechanism of evolution by natural selection is commonly misunderstood. This item discusses evidence for evolution as well as its mechanism. It also looks at how scientific theories develop and why some become accepted and some do not.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Draw a poster to show how natural selection takes place. Design a newspaper article telling people about Charles Darwin's observations and theories. Research the role of Alfred Russell Wallace in developing the theory of natural selection. Research about Charles Darwin and his voyages. Plot the distribution of the peppered moth on a map showing major cities. Research resistant bacteria and discuss the problems they cause in hospitals. Research species that do not appear to have evolved but have stayed as they are for millions of years, so called 'living fossils', eg coelacanth, crocodiles, sharks, Ginkgo and suggest why they do not appear to have changed.	Identify variations within a population of organisms of the same species. Apply knowledge that animals and plants that are better adapted to their environment are more likely to survive. Recognise that over long periods of time, groups of organisms can change and that this is called evolution. Explain that when environments change, some animal and plant species survive or evolve but many become extinct.
Research about Lamarck and his ideas about evolution	Recognise that: • many theories have been put forward to explain how evolution may occur • most scientists accept the theory of natural selection first put forward by Charles Darwin.

Module B2: Understanding Our Environment

Item B2f: Natural Selection
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that animals and plants that are better adapted to their environment are more likely to survive. Recognise that this is part of Charles Darwin's theory of natural selection. Explain that adaptations are controlled by genes and that these genes can be passed on to the next generation. Describe examples of change by natural selection occurring today, to include: • the frequency of dark or pale forms of the peppered moth in areas with different levels of pollution • bacteria becoming resistant to antibiotics • rats that are resistant to the rat poison warfarin.	Explain the main steps in Darwin's theory of natural selection leading to the evolution or extinction of organisms: • presence of natural variation • competition for limited resources • 'survival of the fittest' • inheritance of 'successful' adaptations • extinction of species unable to compete. Explain that over long periods of time the changes brought about by natural selection may result in the formation of new species.
Explain the reasons why the theory of evolution by natural selection met with an initially hostile response (social and historical context). Recognise that natural selection as a theory is now widely accepted • because it explains a wide range of observations • has been discussed and tested by a wide range of scientists	Explain how Lamarck's idea of evolution by the inheritance of acquired characteristics was different from Darwin's theory. Explain that Lamarck's theory was discredited as acquired characteristics do not have a genetic basis. Recognise that although the theory of natural selection explains many observations, this does not prove that the explanation is correct.

Module B2: Understanding Our Environment

Item B2g: Population and pollution

Summary: Young people are aware of the increasing human population and how this is related to an increase in pollution levels. The use of living and non-living indicators of pollution is considered.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Plot the increase in population and compare with the increase in a pollutant. Draw a poster to show the percentage of items of household waste found in the average family dustbin. Investigate the germination of seeds and the growth of seedlings in different levels of acid rain.	Recognise that the human population is increasing. Recognise that the human population uses resources, some of which are finite, to include: • fossil fuels • minerals. Explain that an increasing population will increase the use of resources. Explain that this increased use of resources will lead to an increase in pollutants, limited to: • household waste • sewage • sulfur dioxide from burning fossil fuels • carbon dioxide from burning fossil fuels.
Research to show the methods used to measure the increase in levels of carbon dioxide in the past 200 years. Research possible links between the data concerning carbon dioxide levels and global temperatures. Explore impacts of chemicals on plant growth (www-saps.plantsci.cam.ac.uk)	Explain that pollution can affect the number and type of organisms that can survive in a particular place.

Module B2: Understanding Our Environment

Item B2g: Population and Pollution
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that as the human population increases, there is a related increase in use of resources and therefore more pollution is created. Explain the causes and consequences of: • global warming from increasing levels of carbon dioxide • ozone depletion from CFCs in upper atmosphere • acid rain from sulfur dioxide.	Explain that the developed countries of the world, with a small proportion of the world's population, have the greatest impact on the use of resources and the creation of pollution. Explain the term 'carbon footprint' in terms of the amount of greenhouse gases given off in a certain period of time. Explain that the human population is increasing exponentially. Discuss the possible consequences of exponential growth.
Explain that there are indicator species whose presence/absence helps to indicate the level of pollution: • water pollution - waterlouse, sludgeworm, rat-tailed maggot, mayfly larva • air pollution – lichen. Describe how pollution can be measured: • by direct measurement of pollutant levels • by measuring the occurrence of indicator species.	Interpret data on indicator species. Describe the advantages and disadvantages of using living and non-living methods of measuring levels of pollution.

Module B2: Understanding Our Environment

Item B2h: Sustainability

Summary: Sustainable development is a term that is becoming more widely used and refers to the economic exploitation of the environment in a way that can be maintained without causing permanent damage. We are also conscious of the damage that has already been done and are trying to protect endangered habitats and species. This item develops ideas about our choices and responsibilities with particular reference to whales.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Make a display of endangered and extinct plants and animals. Research organisms that used to exist in the UK. Use ICT to produce an information leaflet on one endangered species, showing reasons for its predicament and suggestions for its protection IUCN red list Research the use of seed banks (Extinct plants project at Kew)	Recall examples of extinct animals, limited to: • mammoth • dodo • sabre toothed tiger. Describe an endangered species as a plant or animal that is in danger of becoming extinct. Recall examples of endangered species, limited to: • panda • gorilla. Recognise that some species in Britain are endangered and need protection, limited to: • stag beetle • white-tailed eagle • red squirrel • osprey. Recognise the importance of conserving endangered species and habitats.
Web search for information on an endangered species. Class discussion on nature reserves 'Why should we have zoos/marine park/nature reserves?' Plot the distribution of different whale species on a world map.	Interpret data on different whale species which shows different distributions according to their feeding habitat. Discuss the reasons why certain whale species are close to extinction.
	Recognise that a sustainable resource can be removed from the environment without it running out. Explain that some resources can be maintained, limited to: • fish stocks • woodland.

Module B2: Understanding Our Environment

Item B2h: Sustainability
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe reasons why animals become extinct or endangered, to include: • climate change • habitat destruction • hunting • pollution • competition. Describe how endangered species can be helped, to include: • protecting habitats • legal protection • education programmes • captive breeding programmes • seed banks • creating artificial ecosystems.	Explain reasons for conservation programmes, to include: • protecting human food supply • ensuring minimal damage to food chains • future identification of plants for medical purposes • cultural aspects.
Recognise that both living and dead whales have commercial value: tourism when alive; food, oil and cosmetics when dead. Consider issues arising from keeping whales in captivity: entertainment, research, captive breeding programmes and lack of freedom.	Recognise that some aspects of whale biology are still not fully understood: communication, migration patterns and survival at extreme depths. Describe issues concerning whaling, to include: getting international agreement, policing and enforcing such agreements and culling for research.
Explain the term sustainable development as providing for the needs of an increasing population without harming the environment. Explain how fish stocks and woodland can be sustained and yet developed using: • education • quotas on fishing • re-plantation of woodland.	Recognise the importance of population size, waste products, food and energy demands in the achievement of sustainable development. Recognise that sustainability requires planning and co-operation at local, national, and international levels. Describe how sustainable development may protect endangered species.

Module B3: Living and Growing

Item B3a: Molecules of Life

Summary: The fundamental processes of life occur inside cells. This item examines the role of DNA in the production of proteins, the building blocks of living things. This item provides the opportunity to explain phenomena using scientific theories, models and ideas. Using the discovery of the structure of DNA it also illustrates the collaborative nature of science and the need for new discoveries to be validated.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Make a cheek cell slide and examine using a microscope.	Describe the structure and function of a cheek cell, to include the: • nucleus carrying genetic information • cell membrane controlling the movement of substances in and out of cells • cytoplasm where many chemical reactions happen.
Use of 'Cake Workshop': • 'Recipe for life' – an activity to demonstrate use of a recipe (code); See www.bbsrc.ac.uk Examine a model of DNA Carry out role playing exercise to demonstrate base pairings. Research the Human Genome Project and efforts to sequence the genome of other organisms.	Describe that chromosomes in the nucleus: • carry coded information in the form of genes • are made of a molecule called DNA. Recall that the information in genes is in the form of coded instructions called the genetic code. Explain that the genetic code controls cell activity and consequently some characteristics of the organism. Recall that DNA controls the production of different proteins. Recall that proteins are needed for the growth and repair of cells.
Research the roles of Watson, Crick and others in increasing our understanding of the structure of DNA	Recall that the structure of DNA was first worked out by two scientists called Watson and Crick.

Module B3: Living and Growing

Item B3a: Molecules of Life
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Identify the mitochondria in an animal cell. Explain that respiration occurs in the mitochondria providing energy for life processes.	Explain that: • some structures in cells, such as ribosomes, are too small to be seen with the light microscope • ribosomes are in the cytoplasm and are the site of protein synthesis.
Describe chromosomes as long, coiled molecules of DNA, divided up into regions called genes. Recall that DNA molecules contain chemicals called bases and that there are four different bases. Describe the structure of DNA as a double helix with cross links formed by pairs of bases. Explain that each gene contains a different sequence of bases. Explain that each gene codes for a particular protein.	Recall that the four bases of DNA are A, T, C and G (full names will not be required). Describe the complementary base pairings: A -T and G – C. Explain how protein structure is determined by the DNA base code, to include: • the base sequence determines amino acid sequence • each amino acid is coded for by a sequence of 3 bases. Explain that the code needed to produce a protein is carried from the DNA to the ribosomes by a molecule called mRNA. Explain how DNA controls cell function by controlling the production of proteins, some of which are enzymes.
Describe how Watson and Crick used data from other scientists to build a model of DNA, to include: • X-ray data showing that there were two chains wound in a helix • data indicating that the bases occurred in pairs.	Explain why new discoveries, such as Watson and Crick's, are not accepted or rewarded immediately, to include: • the importance of other scientists repeating or testing the work.

Module B3: Living and Growing

Item B3b: Proteins and Mutations

Summary: The genetic material in the form of DNA codes for the production of proteins. This item looks at the structure and functions of proteins in living organisms, including the role of enzymes. It also introduces mutations and how they can alter the proteins that a cell produces. The study of enzyme action provides the opportunity to gain the skills of working accurately and safely, individually and with others to collect first-hand data and to test a scientific idea using scientific theories, models and ideas.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
	Recall some examples of proteins to include: • collagen • insulin • haemoglobin.
Build plasticine models to illustrate 'lock and key' mechanism. Investigate the effects of changing temperature or pH on enzyme activity.	Describe enzymes as • proteins • molecules that speed up a chemical reaction • working best at a particular temperature.
	Recognise that different cells and different organisms will produce different proteins. Describe gene mutations as changes to genes.

Module B3: Living and Growing

Item B3b: Proteins and Mutations
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise that proteins are made of long chains of amino acids. Describe some functions of proteins, to include: • structural (limited to collagen) • hormones (limited to insulin) • carrier molecules (limited to haemoglobin) • enzymes.	Explain that each protein has its own number and sequence of amino acids, resulting in different shaped molecules, which have different functions.
Describe enzymes as: • biological catalysts • catalysing the chemical reactions occurring in living cells: respiration, photosynthesis, protein synthesis • having a high specificity for their substrate. Describe how changing temperature and pH, away from the optimum, will change the rate of reaction of an enzyme-catalysed reaction	Explain the specificity of enzymes in terms of the 'lock and key' mechanism. Explain how enzyme activity is affected by pH and temperature, to include: • lower collision rates at low temperatures • denaturing at extremes of pH and high temperatures • denaturing as an irreversible change inhibiting enzyme function • denaturing changing the shape of the active site.
Explain that mutations may lead to the production of different proteins. Explain that mutations occur spontaneously but can be made to occur more often by radiation or chemicals. Explain that mutations are often harmful but may be beneficial.	Explain that only some of the full set of genes are used in any one cell; some genes are switched off. Explain that gene mutations change the DNA base sequence thus altering, or preventing the production of, the protein that the gene normally codes for.

Module B3: Living and Growing

Item B3c: Respiration

Summary: Restoration is a vital reaction that takes place inside cells. It releases the energy that is needed to drive many other metabolic reactions. This item provides candidates with the opportunity to collect and analyse scientific data concerning respiration rates. They can also gain the skills of working accurately and safely, individually and with others to collect first-hand data when investigating pulse recovery times.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Use lime water or hydrogen-carbonate indicator to compare rates of respiration.	Describe the process of respiration as the reaction of glucose with oxygen in order to release energy. Recognise that the energy provided by respiration is needed for all life processes in plants and in animals.
Carry out a fist clenching exercise with arm raised and then lowered to demonstrate muscle fatigue. Carry out a weight lifting exercise by a finger to show muscle fatigue. Carry out experiments on pulse recovery times and compare data using ICT skills.	Describe why during exercise, breathing and pulse rates increase: • to deliver oxygen and glucose to muscles more quickly • to remove carbon dioxide from muscles more quickly. Describe an experiment to measure resting pulse rate and recovery times after exercise. Analyse given data from a pulse rate experiment.

Module B3: Living and Growing

Item B3c: Respiration
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe examples of life processes that require energy from respiration, to include: • muscle contraction • protein synthesis • control of body temperature in mammals. Recall and use the word equation for respiration with oxygen (aerobic respiration) glucose + oxygen → carbon dioxide + water Use data from experiments to compare respiration rates, to include: • increased oxygen consumption • increased carbon dioxide production.	Recall and use the symbol equation for aerobic respiration $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ Explain that aerobic respiration requires oxygen, so the rate of oxygen consumption is an estimate of metabolic rate. Explain that respiration is an enzyme controlled reaction and so its rate is influenced by changes in temperature and pH.
Explain that during hard exercise, the oxygen supply is insufficient to meet energy demands so anaerobic respiration takes place in addition to aerobic respiration. Explain that this produces lactic acid which accumulates in muscles causing pain and fatigue. Recall and use the word equation for anaerobic respiration glucose → lactic acid (+ energy) Recognise that anaerobic respiration releases much less energy than aerobic respiration.	Explain fatigue in terms of lactic acid build up (oxygen debt) and how this is removed during recovery, to include: • hard exercise causing lack of oxygen in cells • the incomplete breakdown of glucose • continued panting replacing oxygen allowing aerobic respiration • increased heart rate ensuring that blood carries lactic acid away to the liver.

Module B3: Living and Growing

Item B3d: Cell Division

Summary: As living things grow, the number of cells in them increases. This brings significant advantages, and requires the development of complex organ systems.

This item looks at the two ways cells divide, mitosis and meiosis, and the differences between these types of cell division. Software simulations and video clips which show cell division are uses of ICT in teaching and learning.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
	Explain that some simple organisms are unicellular but more complex organisms are multicellular.
Watch a video, examine photographs, use software simulations on cell division. Use models to illustrate cell division, using eg wool or plasticine. Examine prepared microscope slides to show cell division. Prepare a stained microscope slide of a root tip squash to show mitosis (eg garlic or hyacinth). Use bacterial or yeast growing kits.	Explain that organisms grow by cells dividing. Recognise that most body cells contain chromosomes in matching pairs. Explain that to produce new cells for growth the chromosomes have to be copied. Explain that this type of cell division is also needed for: • replacement of worn out cells • repair to damaged tissue • asexual reproduction.
Examination of bull's sperm using a microscope. Examine a hen's egg to show the large amount of stored food. Examine pollen using a microscope.	Describe that in sexual reproduction sex cells (gametes) join (fertilisation). Recall that gametes have half the number of chromosomes of body cells Describe that sexual reproduction in animals is the joining of a sperm and egg to produce a new individual and half the genes come from each parent. Explain how sperm cells are adapted to their function, to include: • small size and tail for swimming • nucleus to carry the genes • produced in large numbers to increase the chance of fertilisation. Explain how the structure of an egg cell is adapted to its function, to include: • large size as it contains a food source • nucleus to carry the genes.

Module B3: Living and Growing

Item B3d: Cell Division
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the advantages of being multicellular: • allows organism to be larger • allows for cell differentiation • allows organism to be more complex.	Explain that becoming multicellular requires the development of specialised organ systems for: • communication between cells • supplying the cells with nutrients • controlling exchanges with the environment.
Explain that new cells for growth are produced by mitosis and that these cells are genetically identical. Explain that in mammals, body cells are diploid (two copies of each chromosome). Explain that before cells divide, the DNA copies itself (DNA replication).	Explain how, prior to mitosis, DNA replication occurs, to include: • 'unzipping' to form single strands • new double strands forming by complementary base pairing. Explain that in mitosis the chromosomes: • line up along the centre of the cell • they then divide • the copies move to opposite poles of the cell.
Describe that gametes: • are produced by meiosis • are haploid (contain chromosome from each pair). Explain that at fertilisation: • gametes combine to form a diploid zygote • genetic material from both parents combines to produce a unique individual. Recall that meiosis introduces genetic variation. Explain how the structure of a sperm cell is adapted to its function, to include: • many mitochondria to provide energy • an acrosome that releases enzymes to digest the egg membrane.	Explain that in meiosis the: • chromosome number is halved and each cell is genetically different • one chromosome from each pair separate to opposite poles of the cell in the first division • chromosomes divide and copies move to opposite poles of the cell in the second division.

Module B3: Living and Growing

Item B3e: The Circulatory System

Summary: The development of larger, multicellular organisms has resulted in the development of complex organ systems. This item describes one of these systems, the circulatory system. It explains why blood is vital for life as it transports materials around the body to and from different cells. Research and presentation of a report on disorders of the blood allows the opportunity to use ICT in teaching and learning to present information using scientific language and conventions.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Research and present a report on disorders of the blood eg haemophilia, sickle cell anaemia, leukaemia.	Describe the functions of cells in the blood: • red blood cells to transport oxygen • white blood cells to defend against disease • platelets to help blood clotting.
Research what to do if someone has a cut and is bleeding badly.	Recall that the blood moves around the body in: • arteries • veins • capillaries.
Examine an animal heart (or model).	Describe the functions of the heart in the pumping of blood, to include: • the right side of the heart pumping blood to the lungs • the left side of the heart pumping blood to the rest of the body. Recall that blood in arteries is under higher pressure than that in the veins.

Module B3: Living and Growing

Item B3e: The Circulatory System
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how the structure of a red blood cell is adapted to its function: size, shape, contains haemoglobin, lack of nucleus. Describe the function of plasma in transporting foods, hormones, antibodies, water, waste products around the body.	Explain how the structure of a red blood cell is adapted to its function: • small size provides large surface area to volume ratio. Explain that haemoglobin in red blood cells reacts with oxygen in the lungs forming oxyhaemoglobin and the reverse of this reaction happens in the tissues.
Describe how the parts of the circulatory system work together to bring about the transport of substances around the body, to include: • arteries transporting blood away from the heart • veins transporting blood to the heart • capillaries exchanging materials with tissues.	Explain how the adaptations of arteries, veins and capillaries relate to their functions, to include: • thick muscular and elastic wall in arteries • large lumen and presence of valves in veins • permeability of capillaries.
Identify the names and positions of the parts of the heart and describe their functions, to include: • left and right ventricles to pump blood • left and right atria to receive blood • semilunar, tricuspid and bicuspid valves to prevent backflow • four main blood vessels of the heart. Explain why the left ventricle has a thicker muscle wall than the right ventricle.	Explain the advantage of the double circulatory system in mammals, to include: • higher pressures • therefore greater rate of flow to the tissues.

Module B3: Living and Growing

Item B3f: Growth and Development

Summary: The growth of organisms can be measured in different ways. Whilst there are similarities in the patterns of growth and development in all organisms there are some major variations between plants and animals. This item explores some of these differences. Research about human stem cells and cancer provides opportunities to discuss how and why decisions about science are made and the related ethical issues. These discussions can also provide the opportunity to show that there are some questions that science cannot currently answer.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Make an onion cell slide and examine it using a microscope.	Identify the chloroplasts, vacuole and cell wall in a plant cell. Describe the functions of parts of a plant cell to include: • vacuole containing cell sap and providing support • the cell wall, made of cellulose to provide support. Describe how to make a stained slide of an onion cell. Recognise that bacterial cells are smaller and simpler than plant and animal cells.
Grow seedlings from seeds and measure their growth rate using different measurements. Plot data on weight gain of baby using a case study or collected data. See Personal Child Health Record from Local Health Authority.	Recognise that growth can be measured as an increase in height or mass. Describe the shape of a typical S shaped growth curve. Interpret data on a typical growth curve.
Research about human stem cells. Research cancer (uncontrolled growth of undifferentiated cells).	Describe the process of growth as cell division followed by cells becoming specialised.
	Understand that animals grow in early stages in their lives whereas plants grow continually. Understand that all parts of an animal are involved in growth whereas plants grow at specific parts of the plant.

Module B3: Living and Growing

Item B3f: Growth and Development
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the similarities and differences between plant and animal cells: • nucleus, membrane, cytoplasm in plant and animal cells • chloroplasts, cell wall, large vacuole in plant cells only. Identify simple differences between bacterial cells and plant and animal cells. Recall that bacterial cells lack: • a 'true' nucleus • mitochondria • chloroplasts.	
Recognise that growth can be measured as an increase in wet or dry mass. Recognise that dry mass is the best measure of growth. Describe the main phases of a typical growth curve. Describe that in human growth there are two phases of rapid growth, one just after birth and the other in adolescence.	Explain the advantages and disadvantages of measuring growth by: • length • wet mass • dry mass. Explain why the growth of different parts of an organism may differ from the growth rate of the whole organism.
Recall that the process of cells becoming specialised is called differentiation. Recognise that undifferentiated cells called stem cells can develop into different cells, tissues and organs. Explain that stem cells can be obtained from embryonic tissue and could potentially be used to treat medical conditions.	Discuss issues arising from stem cell research in animals.
Describe that animal and plant growth are different because: • animals tend to grow to a finite size but many plants can grow continuously • plant cell division is mainly restricted to areas called meristems which are found at the tips of shoots and roots.	Explain that plant growth differs from animal growth due to: • cell enlargement being the main method by which plants gain height • many plant cells retaining the ability to differentiate but most animal cells losing it at an early stage.

Module B3: Living and Growing

Item B3g: New Genes for Old

Summary: Genetic engineering and genetic modification are relatively recent terms but humans have been genetically modifying animals and plants using selective breeding for thousands of years. Debating the arguments for and against GM and gene therapy provides opportunities to discuss how and why decisions about science are made. These discussions demonstrate the limitations of science to providing factual information and new techniques. The decisions as to whether to use these techniques need to be taken by representatives of the whole population.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Research examples of different animal and plant breeds that have been produced by selective breeding.	Describe selective breeding as a process of producing organisms with desired characteristic through a breeding program. Identify features of plants and animals that might be selected for enhancement in a breeding programme.
Survey foods that contain GM ingredients. Research and present evidence for the benefits and risks of GM food. Research the differences between gene therapy and germ line treatment as possible treatments for genetic disorders.	Explain that: • selected genes can be artificially transferred from one living organism to another • this transfer of genes is called genetic engineering or genetic modification • the transfer of genes can produce organisms with different characteristics. Identify features of plants and animals that might be selected for in a genetic engineering programme.
	Recognise that in the future it may be possible to use genetic engineering to change a person's genes and cure certain disorders.

Module B3: Living and Growing

Item B3g: New Genes for Old
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the process of selective breeding involving the: • selection of desired characteristics • cross breeding • selection of suitable offspring over many generations. Explain how selective breeding can contribute to improved agricultural yields.	Explain that a selective breeding programme may reduce the gene pool leading to problems of inbreeding, to include: • accumulation of harmful recessive characteristics • reduction in variation.
Explain some potential advantages and risks of genetic engineering: • advantage – organisms with desired features are produced rapidly • disadvantage – inserted genes may have unexpected harmful effects. Describe, in outline only, some examples of genetic engineering: • taking the genes from carrots that control beta-carotene production and putting them into rice. Humans can then convert the beta-carotene from rice into Vitamin A (solving the problem of parts of the world relying on rice but lacking in vitamin A) • the production of human insulin by genetically engineered bacteria • transferring resistance to herbicides, frost damage or disease to crop plants.	Describe the principles of genetic engineering, to include: • selection of desired characteristics • isolation of genes responsible • insertion of the genes into other organisms • replication of these organisms. Discuss the moral and ethical issues involved in genetic modification weighed against the potential benefits.
Recall that changing a person's genes in an attempt to cure disorders is called gene therapy.	Describe that gene therapy can involve body cells or gametes. Explain why gene therapy involving gametes is controversial.

Module B3: Living and Growing

Item B3h: Cloning

Summary: Human individuals are unique, yet modern science has the ability to create genetically identical copies of complex organisms. This item considers the advantages and disadvantages of using this scientific knowledge. Finding out about the techniques used to produce Dolly the first cloned animal provides the opportunity to illustrate the use of ICT in science, ethical issues about contemporary scientific developments and the role of the science community in validating changes in scientific knowledge.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Research information on the techniques used to produce Dolly, the first cloned mammal. Research the current scientific and legal position on xenotransplants.	Interpret information on cloning techniques to show that: • cloning is an example of asexual reproduction • cloning produces genetically identical copies (clones). Recall that Dolly the sheep was the first mammal cloned from an adult. Recognise that identical twins are naturally occurring clones.
Carry out a meristem tissue culture using cauliflower.	Describe that in asexual reproduction, cell division produces new individuals. Recognise that plants grown from cuttings or tissue culture are clones. Describe how spider plants, potatoes and strawberries reproduce asexually. Describe how to take a cutting.

Module B3: Living and Growing

Item B3h: Cloning
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the process of nuclear transfer that was used to produce Dolly, limited to: • taking a nucleus from a body cell • placing the nucleus into an egg cell that has had the nucleus removed. Describe some possible uses of cloning, limited to: • mass producing animals with desirable characteristics • producing animals that have been genetically engineered to provide human products • producing human embryos to supply stem cells for therapy.	Describe in outline the cloning technique used to produce Dolly, to include: • nucleus removed from an egg cell • egg cell nucleus replaced with the nucleus from an udder cell • egg cell given an electric shock to make it divide • embryo implanted into a surrogate mother sheep • embryo grows into a clone of the sheep from which the udder cell came. Describe the benefits and risks of using cloning technology. Explain the possible implications of using genetically modified animals to supply replacement organs for humans. Discuss the ethical dilemmas concerning human cloning.
Describe the advantages and disadvantages associated with the commercial use of cloned plants, to include: • advantage - can be sure of the characteristics of the plant since all plants will be genetically identical • advantage - it is possible to mass produce plants that may be difficult to grow from seed • disadvantage - if plants become susceptible to disease or to change in environmental conditions then all plants will be affected • disadvantage - lack of genetic variation.	Describe plant cloning by tissue culture, to include: • selection for characteristics; • large number of small pieces of tissue • aseptic technique • use of suitable growth medium and conditions. Explain that cloning plants is easier than cloning animals because many plant cells retain ability to differentiate unlike animal cells which usually lose this ability at an early stage.

3.6 Module B4: It's a Green World

Module B4: It's a Green World

Item B4a: Ecology in the Local Environment

Summary: We are surrounded by a huge variety of living organisms, many of which go unnoticed. This item seeks to help the candidates appreciate this variety. Candidates are introduced to methods of sampling and mapping animals and plants. It also provides an appreciation of the biodiversity of some artificial ecosystems.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Use a variety of sampling techniques to include pooters, nets, pit-fall traps, quadrats, tullgren funnel, belt transects. Estimate the number of weeds in a field. Examine the variety of life in a one metre quadrat of turf or from a sample of leaf litter.	Describe how to use collecting/ counting methods, to include: • pooters • nets • pit-fall traps • quadrats Describe a method to show that a variety of plants and animals live in a small area such as a 1 m quadrat. Use keys to identify plants and animals.
Describe plants from two different habitats. Describe animals from two different habitats. Compare the communities of two different habitats. Use sensors and data-loggers to collect data such as temperature, light intensity, soil pH; link this with the animals and plants found in different places. Map the distribution of plant species at different distances from a pond / tree.	Explain the terms habitat and community. Recognise that organisms are not distributed at random in a habitat.
Compare a cultivated area with an uncultivated area.	Define biodiversity as the variety of different species living in a habitat. Identify native woodlands and lakes as natural ecosystems and forestry plantations and fish farms as artificial ecosystems.

Module B4: It's a Green World

Item B4a: Ecology in the Local Environment
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Use data from collecting/ counting methods to calculate an estimate of the population size based on: • scaling up from a small sample area • the use of capture-recapture data, given the formula: population size = number in 1st sample x number in 2nd sample number in 2nd sample previously marked	Explain the effect of sample size on the accuracy of an estimate of population size. Explain the need to make certain assumptions when using capture-recapture data, to include: • no death, immigration or emigration • identical sampling methods • marking not affecting survival rate.
Explain the terms ecosystem and population. Describe how to map the distribution of organisms in a habitat using a transect line. Interpret data from kite diagrams showing the distribution of organisms. Explain how the distribution of organisms in a habitat is affected by the presence of other living organisms as well as physical factors.	Explain that an ecosystem is self supporting in all factors other than an energy source. Describe zonation as a gradual change in the distribution of species across a habitat. Explain how a gradual change of an abiotic factor can result in the zonation of organisms in a habitat.
Compare the biodiversity of natural ecosystems with artificial ecosystems to include: • native woodlands and lakes with forestry plantations and fish farms.	Explain reasons for the differences between the biodiversity of native woodlands and lakes compared with forestry plantations and fish farms

Module B4: It's a Green World

Item B4b: Photosynthesis

Summary: Virtually everything we eat can be traced back to plants. Either we eat food from plants or we eat food from animals, that in turn have eaten plants. This item looks at how plants make food themselves in the first place and what they then do with it.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Test leaves for starch: variegated and non-variegated leaves, leaves deprived of light or carbon dioxide. Investigate the release of oxygen by pondweed.	Explain that plants make their own food by a process called photosynthesis. Explain that plants make glucose by photosynthesis and release oxygen. Explain that plants need carbon dioxide, water, light and chlorophyll to carry out photosynthesis.
Draw a poster to show what happens to the glucose made in photosynthesis.	Describe that glucose is converted to starch and stored. Explain that glucose and starch can be converted to other substances in plants to be used for energy, growth and storage products.
Investigate the effect of changing light intensity, temperature or carbon dioxide on the rate of photosynthesis by measuring the rate of oxygen release from pondweed. Research how commercial greenhouses maximise the growth of crops by maximising the rate of photosynthesis.	Explain why plants grow faster in the summer because of more: • light • warmth.
	Understand that plants carry out respiration as well as photosynthesis.

Module B4: It's a Green World

Item B4b: Photosynthesis
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the development of the understanding of the process of photosynthesis, to include: • the view of Greek scientists that plants gained mass only by taking in minerals from the soil • Van Helmont's experimental conclusion that plant growth cannot be solely due to nutrients from the soil • Priestley's experiment which showed that oxygen is produced by plants. Recall and use the word equation for photosynthesis (light energy) carbon dioxide + water → glucose + oxygen (chlorophyll)	Recall and use the balanced symbol equation for photosynthesis (light energy) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (chlorophyll)
Explain that the glucose made in photosynthesis is transported as soluble sugars but is stored as insoluble starch. Explain that glucose and starch can be converted to other substances in plants and used for different things: • glucose for energy (respiration) • cellulose for cell walls • proteins for growth and repair • starch, fats and oils for storage.	Explain why insoluble substances such as starch are used for storage: • does not move away in solution from storage areas • does not affect water concentration inside cells.
Describe how photosynthesis can be increased by providing: • more carbon dioxide • more light • higher temperature.	Explain the effects of limiting factors on the rate of photosynthesis: • CO_2 • light • temperature.
Explain why plants carry out respiration all the time.	Explain why plants take in carbon dioxide and give out oxygen during the day and do the reverse at night, in terms of both photosynthesis and respiration.

Module B4: It's a Green World

Item B4c: Leaves and Photosynthesis

Summary: To most teenagers, plants are there to be eaten and sometimes admired for their colourful flowers. This item seeks to consolidate understanding of how green plants work. Preparing and examining slides of leaves provides the opportunity to work accurately and safely and present information using scientific and mathematical conventions.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine a variety of leaves to look at common features. Design the 'ideal' leaf. Make leaf prints and examine stomata under a microscope. Examine prepared microscope slides showing internal structure of leaves. Use ICT to examine leaves (www.plantscienceimages.org.uk)	Identify the chloroplasts, vacuole and cell wall in a plant cell. Recognise that chloroplasts absorb light energy for photosynthesis. Understand that photosynthesis occurs mainly in the leaves. Describe the entry points of materials required for photosynthesis: • water through roots • carbon dioxide through leaf pores. Describe the exit point of materials produced in photosynthesis: • oxygen through leaf pores.

Module B4: It's a Green World

Item B4c: Leaves and Photosynthesis
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Name and locate the parts of a leaf: • cuticle • upper and lower epidermis • palisade and spongy mesophyll layers • stomata and guard cells • veins. Explain how leaves are adapted for efficient photosynthesis: • broad so large surface area • thin so short distance for gases to travel • contain chlorophyll to absorb light • have a network of veins for support and transport • stomata for gas exchange. Understand that the exchange of gases is by diffusion. Explain how the structure of a leaf palisade cell is related to its function: • contains many chloroplasts.	Explain how the cellular structure of a leaf is adapted for efficient photosynthesis: • epidermis is transparent • palisade layer at the top containing most of the chloroplasts • air spaces in the spongy mesophyll allow diffusion between stomata and photosynthesising cells • internal surface area/volume ratio very large.

Module B4: It's a Green World

Item B4d: Diffusion and Osmosis

Summary: The materials used in, and produced by, life processes, move through living organisms in several ways, one of the most important of these being diffusion. One such material is water which is needed for key life processes such as photosynthesis, support and transport of materials. Water enters plants by a type of diffusion, osmosis.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Demonstrate diffusion e.g. spread of perfume across a room, potassium permanganate in water. Investigate the rate of diffusion of food dye through agar jelly.	Recognise that substances move in and out of cells by diffusion through the cell membrane.
Carry out experiments to demonstrate osmosis using visking tubing and different concentration solutions.	Recognise that water moves in and out of plant cells by osmosis through the cell membrane.
Investigate the effects of changing solute concentration on potato discs/strips.	Describe that the plant cell wall provides support. Understand that lack of water can cause plants to droop (wilt).
Make leaf prints of upper and lower surfaces of leaves and examine with microscope to investigate number/distribution of stomata.	Recognise that carbon dioxide and oxygen move in and out of plants through the leaves.
	Recognise that water moves in and out of animal cells through the cell membrane.

Module B4: It's a Green World

Item B4d: Diffusion and Osmosis
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe diffusion as the movement of a substance from a region of high to low concentration. Describe how molecules enter and leave cells by diffusion through the cell membrane.	Explain that diffusion is the net movement of particles from an area of high concentration to an area of low concentration and is a consequence of the random movement of individual particles. Explain that the rate of diffusion is increased by: • a shorter distance • a greater concentration difference (gradient) • a greater surface area.
Describe osmosis as the movement of water across a partially-permeable membrane from an area of high water concentration (ie dilute solution) to an area of low water concentration (ie concentrated solution). Recall that osmosis is a type of diffusion. Explain the term partially-permeable.	Explain that osmosis is the net movement of water molecules from an area of high water concentration to an area of low water concentration across a partially-permeable membrane and is a consequence of the random movement of individual particles. Predict the direction of water movement in osmosis.
Describe that the both the inelastic cell wall and water are essential for the support of plants.	Explain how plants are supported by the turgor pressure within cells: • water pressure acting against inelastic cell wall. Explain wilting in terms of a lack of turgor pressure. Explain the terms: flaccid, plasmolysed, turgid.
Describe how carbon dioxide and oxygen diffuse in and out of plants through the leaves.	Explain how leaves are adapted to increase the rate of diffusion of carbon dioxide and oxygen.
Describe the effects of the uptake and loss of water on animal cells.	Explain how the differences in the effects of water uptake and loss on plant and animal cells depend on the presence/absence of an inelastic cell wall. Use the terms: crenation and lysis.

Module B4: It's a Green World

Item B4e: Transport in Plants

Summary: The materials used in, and produced by, life processes in plants, move through plants in several ways. The suggested activities each provide the opportunity to plan to test a scientific idea, analyse and interpret data using qualitative techniques, present information and draw a conclusion using scientific and technical conventions. Investigating factors affecting transpiration rate can include the use of ICT in teaching and learning and illustrates the use of models in explaining scientific phenomena.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine stained cells in celery left in ink.	Relate plant structure to function: • stem – support, transport • leaf – photosynthesis • flower – reproduction • root – water and mineral uptake and anchorage.
Carry out experiments to estimate transpiration • loss of water by plants: • plants lose water through their leaves • which surface of a leaf loses most water • weighing potted plants – loss of mass.	Describe how water travels through a plant: • absorption from soil through root hairs • transport through the plant, up the stem to the leaves • evaporation from the leaves (transpiration).
Carry out an experiment to show factors that affect transpiration rate: • light • wind • temperature • humidity. ICT data logging opportunity.	Describe experiments to show that transpiration rate is affected by: • light intensity • temperature • air movement • humidity.
Investigate how quickly detached leaves dry out when different surfaces are covered with petroleum jelly.	Explain that healthy plants must balance water loss with water uptake.

Module B4: It's a Green World

Item B4e: Transport in Plants
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the arrangement of xylem and phloem in a dicotyledonous root, stem and leaf • vascular bundles. Relate xylem and phloem to their function: • xylem - transpiration - movement of water and minerals from the roots to the shoot and leaves • phloem - translocation - movement of food substances (sugars) up and down stems to growing and storage tissues. Describe that both xylem and phloem form continuous systems in leaves, stems and roots.	Describe the structure of xylem and phloem • xylem vessels - thick strengthened cellulose cell wall with a hollow lumen (dead cells) • phloem – columns of living cells.
Describe how transpiration helps cause water to be moved up xylem vessels. Describe transpiration as the evaporation and diffusion of water from inside leaves.	Explain that transpiration and water loss from leaves are a consequence of the way in which leaves are adapted for efficient photosynthesis.
Describe how transpiration rate is increased by: • increase in light intensity • increase in temperature • increase in air movement • decrease in humidity.	Explain why transpiration rate is increased by: • increase in light intensity • increase in temperature • increase in air movement • decrease in humidity.
Explain that root hairs, by increasing surface area, increase the ability of roots to take up water by osmosis. Recall that transpiration provides plants with water for: • cooling • photosynthesis • support • movement of minerals. Describe how the structure of a leaf is adapted to reduce excessive water loss: • waxy cuticle • small number of stomata on upper surface.	Explain how the cellular structure of a leaf is adapted to reduce water loss: • changes in guard cell turgidity (due to light intensity and availability of water) to regulate stomatal apertures • number, distribution, position and size of stomata.

Module B4: It's a Green World

Item B4f: Plants Need Minerals

Summary: Candidates should appreciate that a balanced diet contains minerals and vitamins. The actual amounts needed are small but without them our health will suffer. Plants also need minerals and without them their growth will suffer. The survey of the contents of 'plant foods' provides the opportunity to use ICT sources and tools to collect secondary data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey the contents of fertilisers such as 'plant foods'. Practicals available from SAPS (HSW practical activities)	Describe that fertilisers contain minerals such as nitrates, phosphates, potassium and magnesium compounds and that these are needed for plant growth. Interpret data on NPK values to show the relative proportions of nitrates, phosphates and potassium in fertilisers.
Carry out an experiment to show the results of mineral deficiencies in plants. Investigate the contents and manufacture of organic and synthetic fertilisers.	Explain that poor plant growth may be caused by a lack of one or more minerals in the soil.
	Explain that dissolved minerals are absorbed by the roots from the soil.

Module B4: It's a Green World

Item B4f: Plants need Minerals
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that plants require: • nitrates for proteins which are needed for cell growth • phosphates for respiration and growth • potassium compounds for respiration and photosynthesis • magnesium compounds for photosynthesis.	Describe that the production of many important compounds by plants requires elements that are obtained from soil minerals: • nitrogen to make amino acids • phosphorus to make DNA and cell membranes • potassium to help enzymes (in photosynthesis and respiration) • magnesium to make chlorophyll.
Explain that mineral deficiencies result in poor plant growth: • nitrate – poor growth and yellow leaves • phosphate – poor root growth and discoloured leaves • potassium – poor flower and fruit growth and discoloured leaves • magnesium – yellow leaves.	
Recognise that minerals are usually present in soil in quite low concentrations.	Explain that minerals are taken up into root hair cells by active transport. Explain that active transport can move substances from low concentrations to high concentrations (against the concentration gradient). Explain that active transport uses energy from respiration.

Module B4: It's a Green World

Item B4g: Decay

Summary: We try to prevent food going off (decaying) but we want decay to happen when sewage is treated or compost made. This item is concerned with the process of decay and some examples. The experiments on decay provide the opportunity to plan to test a scientific idea, analyse and interpret data using qualitative and quantitative techniques, present information and draw a conclusion using scientific and technical conventions. The survey of preservation techniques provides the opportunity to use ICT sources and tools to collect secondary data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine results (e.g. photographs) of long term decay of compost.	Describe the key factors in the process of decay: • presence of microorganisms • temperature • oxygen • moisture. Identify materials that can decay and therefore be recycled. Explain that decay releases minerals needed for plant growth
Carry out an experiment to show decay e.g. bread/ fruit. Investigate the effect of temperature on decay.	Describe how to carry out an experiment to show that decay is caused by decomposers bacteria and fungi.
Make a compost heap compost column. Visit a sewage works.	Describe that microorganisms are used to: • break down human waste (sewage) • break down plant waste (compost).
Survey different food preservation methods and explain how each works. Investigate different food preservation methods.	Recognise that food preservation techniques reduce the rate of decay: • canning • cooling • freezing • drying • adding salt/sugar • adding vinegar.

Module B4: It's a Green World

Item B4g: Decay
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the effects on the rate of decay of changing: • temperature • amount of oxygen • amount of water.	Explain the effects of changing temperature, and the amounts of oxygen and water on the rate of decay: • effect on microbial respiration • effect on growth and reproduction of micro-organisms.
Describe that detritivores feed on dead and decaying material (detritus): • earthworms, maggots, woodlice. Explain how detritivores increase the rate of decay: • produce larger surface area.	Explain the term saprophyte. Explain that saprophytic fungi release enzymes to digest dead material.
Explain how food preservation methods reduce the rate of decay: • canning – prevents entry of decomposers • cooling – slows reproduction of decomposers • freezing – stops reproduction of decomposers • drying – removes water • adding salt/sugar – kills decomposers by removing water by osmosis • adding vinegar – acid kills decomposers.	

Module B4: It's a Green World

Item B4h: Farming

Summary: Organic farming has become more widespread but intensive farming techniques are more common. This item looks at the issues concerning sustainable food production. Discussing different farming methods provides many opportunities to investigate why decisions about science and technology are made and the ethical issues raised. This can be developed to look at the social, economic and environmental effects of such decisions.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Arrange visit to a local farm/garden centre/small holding.	Analyse data to show that farmers can produce more food if they use pesticides and other intensive practices, but that these practices can cause harm to the environment and to health. Understand that pesticides kill pests which are any organisms that damage crops. Recall that examples of pesticides include: • insecticides to kill insects • fungicides to kill fungi • herbicides to kill plants (weeds).
Role-play exercise to highlight different view points on intensive farming.	Describe how intensive farming methods can increase productivity: • fish farming • glasshouses • hydroponics • battery farming.
Survey use of organic food and reasons for choice. Grow lettuce/tomato plants using hydroponics. Investigate web sites such as DEFRA, LEAF.	Describe organic farming methods: • no artificial fertilisers • no pesticides.
	Describe how pests can be controlled biologically by introducing predators.

Module B4: It's a Green World

Item B4h: Farming
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that intensive farming means trying to produce as much food as possible from the land, plants and animals available. Explain that intensive farming methods may be efficient but they raise ethical dilemmas. Describe how intensive farming produces more food but: • pesticides may enter and accumulate in food chains • pesticides may harm organisms which are not pests.	Explain how intensive food production improves the efficiency of energy transfer by reducing energy transfer: • to pests, including competing plants (weeds) • as heat from farm animals by keeping them penned indoors (battery farming) – warm and less movement. Explain how pesticides may accumulate in food chains.
Describe how plants can be grown without soil (hydroponics). Describe possible uses of hydroponics: • glasshouse tomatoes • plant growth in areas of barren soil.	Explain the advantages and disadvantages of hydroponics: • better control of mineral levels • better control of disease • lack of support for plant • required addition of fertilisers.
Describe organic farming techniques: • use of animal manure and compost • crop rotation • use of nitrogen-fixing crops • weeding • varying seed planting times.	Explain the advantages and disadvantages of organic farming techniques.
Explain the advantages and disadvantages of biological control, to include: • advantages: no need for chemical pesticides, does not need repeated treatment • disadvantages: predator may not eat pest, may eat useful species, may increase out of control, may not stay in the area where it is needed. Explain how removing or removing organisms from a food chain or web may affect other organisms.	

Module B5: The Living Body

Item B5a: Skeletons

Summary: Movement is part of our daily lives. Efficient movement relies on a functioning skeletal and muscular system. Accidents do happen and bones can be broken. This item aims at providing the necessary science to understand the structure of bones and joints, and how damage can be detected, using contemporary technological developments.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine X-rays of skeleton: • child and adult • arthritic joint • with rickets • with fractures. Examine human and animal skeletons and identify some of the bones.	Recognise that: • some animals, including worms, do not have a skeleton made of hard material • some animals, including insects, have an external skeleton • some animals, including humans, have an internal skeleton. Recall that an insect's external skeleton is made of chitin. Recognise that some animals have an internal skeleton: • made only of cartilage (limited to sharks) • made mainly of bone with some cartilage (outer ear, nose, end of long bones) (to include humans).
Research technologies which assess health of bones e.g. bone density scan.	Describe the different types of fractures of bones: • simple • compound • green stick. Recall that X-rays are used to detect fractures.
Carry out an experiment to compare strengths of solid and hollow structures.	Describe a joint as the place where two or more bones meet (joined by ligaments) and recognise that the bones are moved by muscles (attached by tendons). Identify the locations in the human body of a fixed joint (skull), hinge joint (elbow, knee), and ball and socket joint (shoulder, hip).
	Identify the main bones (humerus, ulna, radius) and muscles (biceps, triceps) in a human arm.

Module B5: The Living Body

Item B5a: Skeletons
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the advantages of an internal skeleton compared with an external skeleton: • framework of body • can grow with body • easy to attach muscles • flexibility. Recognise that cartilage and bone are living tissues. Describe the structure of a long bone: • head with covering of cartilage • shaft containing bone marrow with blood vessels. Explain that as long bones are hollow, this makes them lighter than solid bones but still strong.	Explain that cartilage and bone are susceptible to infection but can grow and repair themselves. Explain that in humans, the skeleton starts off being cartilage which is slowly replaced by the addition of calcium and phosphorus (ossification) and that whether a person is still growing can be determined by the amount of cartilage present.
Explain that, despite being very strong, bones can easily be broken by a sharp knock. Explain that elderly people are more prone to fractures due to soft bones (osteoporosis).	Explain that it can be dangerous to move a person with a suspected fracture because of the risks of further injury (especially spinal injury).
Describe the structure of synovial joints: synovial fluid, synovial membrane, ligaments, cartilage. Describe the types and range of movement in: • a ball and socket • hinge joint.	Explain the functions in a synovial joint of: • synovial fluid • synovial membrane • cartilage • ligaments.
Describe how the biceps and triceps muscles operate (by contraction and relaxation) as antagonistic muscles to bend or straighten the arm.	Explain how the arm bending and straightening is an example of a lever: • the elbow is the pivot (fulcrum) • a larger distance is moved by the hand than the muscles • a larger force is exerted by the muscles than is exerted by the hand.

Module B5: The Living Body

Item B5b: Circulatory Systems and the Cardiac Cycle

Summary: Our heart beats automatically from before birth until we die; it also adjusts itself to varying levels of activity. The history of discoveries about blood circulation is an interesting story culminating in our increasing use of modern technology.

Using video clips to show heart action is an example of using ICT in teaching and learning while ECG traces illustrate the use of ICT in science.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Listen/watch Tony Hancock's classic "The blood donor". Construct a time-line of discoveries about blood circulation using various sources. Research heart disease in the world and display the information using charts and graphs.	Recognise that: • some animals, including Amoeba, do not have a blood circulatory system • some animals, including insects, have an open circulatory system • some animals, including humans, have a closed circulatory system. Recall that in a closed circulatory system blood will flow in arteries, veins and capillaries.
Watch video/flash clips on heart action.	
Interpret an ECG trace of a normal beat (PQRS wave).	Describe the heart as made of powerful muscles which are supplied with food and oxygen by the coronary artery. Describe the pulse as a measure of the heart beat (muscle contraction) to put the blood under pressure and recognise that it can be detected at various places (wrist, ear, temple).

Module B5: The Living Body

Item B5b: Circulatory Systems and the Cardiac Cycle
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that many animals need a blood circulatory system because diffusion alone is not sufficient for the efficient transport of materials. Describe a single circulatory system as being one circuit from the heart. Recognise that a single circulatory system is found in fish. Describe a double circulatory system as being two circuits from the heart. Recognise that a double circulatory system is found in mammals, including humans.	Describe the contribution of Galen (2nd century) (importance of the pulse, the heart as a pump) and William Harvey (17th century) (circulation) towards the understanding of blood circulation. Explain why a single circulatory system links to a two-chambered heart. Explain why a double circulatory system links to a four-chambered heart. Explain that the blood is under a higher pressure in a double circulatory system compared with a single circulatory system and that this transports materials more quickly around the body.
Interpret data on pressure changes in arteries, veins and capillaries.	Describe the cardiac cycle and interpret associated graphs and charts. Explain the sequence of contraction of the atria and ventricles and the sequence of opening of the semilunar and atrio-ventricular valves.
Describe how heart rate is linked to activity. Understand that heart muscle contraction is controlled by groups of cells called the pacemakers and that these cells produce a small electric current which stimulates muscle contraction. Recognise that artificial pacemakers are now commonly used to control heart beat. Recognise that techniques such as ECG and echocardiograms are used to investigate heart action. Explain that heart rate can also be increased by the hormone adrenaline.	Describe how the pacemaker cells (SAN and AVN) coordinate heart muscle contraction: • impulses from the SAN cause the atria to contract and stimulate the AVN • impulses from the AVN cause the ventricles to contract. Interpret data from ECG and echocardiograms.

Module B5: The Living Body

Item B5c: Running Repairs

Summary: Our heart and circulation can go wrong. We need to understand how our lifestyle can cause this. We also need to know how these faults can be detected and how they can be put right using modern surgical techniques. This item allows discussion on some of the decisions and ethical issues around blood donation.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine models of heart and heart valves. Watch videos/ flash clips to show action of valves. Research types of heart valves. Research causes of heart disease.	Recognise that there are many heart conditions and diseases, to include: • irregular heart beat • hole in the heart • damaged or weak valves • coronary heart disease and heart attacks.
Research the incidence of haemophilia in Europe's royal families. Visit or listen to a presentation from the National Blood Service.	Describe reasons for blood donation.. Recognise that there are different blood groups called A, B, AB and O, which are further subdivided into Rhesus positive and negative. Describe the function of blood clots at cuts and appreciate that they sometimes occur abnormally inside blood vessels. Recall that anti-coagulant drugs can be used to reduce clotting.

Module B5: The Living Body

Item B5c: Running Repairs
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that a 'hole in the heart': • means that blood can move directly from the right side to the left side of the heart • results in less oxygen in the blood • can be corrected by surgery. Explain that damaged or weak valves in the heart: • reduce effective blood circulation • can be replaced by artificial valves. Explain that a blocked coronary artery: • reduces blood flow to the heart muscle • can be treated by by-pass surgery. Recognise that there are "heart assist" devices as well as heart transplants.	Explain that a 'hole in the heart' results in less oxygen in the blood because deoxygenated blood and oxygenated blood can mix. Explain that unborn babies all have a 'hole in the heart' as they receive their oxygen from the mother via the placenta. The hole closes soon after birth. Explain the advantages and disadvantages of a heart pacemaker and heart valves (over a heart transplant): • advantage: less risk of rejection • advantage: less traumatic operation • disadvantage: may need replacing.
Describe the processes of: • blood donation • blood transfusion. Recognise that haemophilia is an inherited condition in which the blood does not easily clot. Recognise that substances such as Vitamin K, alcohol, green vegetables and cranberries affect clotting. Recall that drugs such as warfarin, heparin and aspirin are used to control clotting.	Explain that unsuccessful blood transfusions cause agglutination (blood clumping). Explain how the presence of agglutinins in red blood cells and blood serum determines how blood groups react and therefore successful blood transfusion. Describe which blood groups (A, B, AB, O) have which agglutinins, limited to: • antigens A and B • antibodies anti-A and anti-B. Explain which blood groups can be used to donate blood to which other blood groups. Describe the process of blood clotting, limited to: • platelets are exposed to air, causing a series of chemical reactions leading to the formation of a mesh of fibrin fibres (clot).

Module B5: The Living Body

Item B5d: Respiratory Systems

Summary: With today's polluted atmosphere, many people suffer from respiratory diseases. This unit looks at how respiratory systems work and at respiratory problems, their causes and possible treatments. The experimental work on measuring lung capacities, respiration and peak flow develop the ability to present and analyse information using technical and mathematical language.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to show the different amounts of carbon dioxide in inhaled and exhaled air.	Recognise that most living things use oxygen to release energy from food (respiration). Describe how small simple organisms such as amoeba and earthworms take in oxygen through their skin which must be moist and permeable. Recognise that larger, more complex animals have special organs such as gills and lungs.
Examine a model of a bell jar and rubber sheet to explain breathing. Measure lung capacities.	Identify the main parts of the human respiratory system (trachea, bronchus, bronchioles, lungs, air sacs, pleural membranes, ribs, intercostal muscles and diaphragm). Explain the terms, breathing, respiration, inspiration (inhalation) and expiration (exhalation) . Describe that oxygen enters the blood in the lungs and leaves the blood in body tissues. Describe that carbon dioxide enters the blood in body tissues and leaves via the lungs.
Carry out an experiment to test peak flow of individuals. Research one or more industrial respiratory diseases and present the information in a poster or leaflet.	Recognise that there are many conditions and diseases of the respiratory system, to include: • asthma, bronchitis, pneumonia and lung cancer.

Module B5: The Living Body

Item B5d: Respiratory Systems
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that the methods of gaseous exchange of amphibians and fish restrict them to their habitats: • amphibians need moist habitats • fish gills only work in water. Describe ventilation in fish: • water enters mouth • mouth closes and forces water out across gills.	Explain why the methods of gaseous exchange of amphibians and fish restrict them to their habitats: • the permeable skin of amphibians makes them susceptible to excessive water loss • fish gills work by forcing water across the filaments. Describe how the structure of a fish gill allows efficient gaseous exchange in water: • gill bar supports filaments. • filaments have a large surface area and are well supplied with blood.
Describe the terms tidal air, vital capacity air and residual air as part of the total lung capacity. Describe ventilation (breathing) in humans • how the intercostal muscles and diaphragm change volume and pressure inside the chest. Describe gaseous exchange within alveoli by diffusion between air and blood.	Explain how the alveoli are adapted for efficient gaseous exchange (permeable, moist surface, large surface area, good blood supply, thin lining (one cell thick)). Interpret data on lung capacities (from a spirometer).
Describe how the respiratory system protects itself from disease by mucus and ciliated cells in the trachea and bronchi. Recognise that there are lung diseases: • with industrial causes (such as asbestosis) • with genetic causes (such as cystic fibrosis) • caused by life style (such as lung cancer) and briefly describe each disease • asbestosis – asbestos fibres are trapped in air sacs limiting gas exchange • cystic fibrosis – too much mucus in the bronchioles • lung cancer – cells grow rapidly reducing surface area in lungs. Describe the symptoms of asthma (difficulty breathing, wheezing, tight chest) and its treatment (inhalers).	Explain that the respiratory system is prone to diseases since the lungs are “a dead end”. Explain what happens during an asthma attack: • lining of airways becomes inflamed • fluid builds up in airways • muscles around bronchioles contract constricting airways.

Module B5: The Living Body

Item B5e: Digestion

Summary: Food provides the raw materials for growth as well as being the source of the energy we release through respiration. The different parts of the digestive system are each adapted for their own roles in digesting and absorbing food.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate the digestion of starch, protein and fat using simple food tests.	Explain that physical digestion is breaking food into smaller pieces to pass more easily through the digestive system: • chewing in the mouth • squeezing in the stomach. Name and locate the main parts of the human digestive system: • mouth • gullet (oesophagus) • stomach • small intestine • large intestine.
Investigate the movement of food molecules across partially permeable membranes.	Recognise that food enters the blood in the small intestine and leaves in body tissues.

Module B5: The Living Body

Item B5e: Digestion
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that in chemical digestion the digestive enzymes break down large food molecules into smaller ones for absorption into the blood plasma or lymph. Describe that carbohydrates, fats and proteins are digested by specific enzymes in the mouth, stomach and small intestine • carbohydrase breaks down starch to sugar (glucose) • lipase breaks down fat to fatty acids and glycerol • protease breaks down protein to amino acids. Describe that stomach acid aids protease function. Describe the function of the parts of the human digestive system: • gullet (oesophagus) – peristalsis • stomach – digestion • small intestine – digestion and absorption of food • large intestine – absorption of water.	Describe that bile from the gall bladder enters the small intestine to aid fat digestion. Explain that bile improves fat digestion by the emulsification of fat droplets providing a larger surface area for enzyme action. Explain that stomach acid provides the optimum pH for the protease enzymes in the stomach, but that other enzymes in the mouth and small intestine have higher optimum pHs.
Describe how small digested food molecules are absorbed into the blood in the small intestine by diffusion.	Explain how the small intestine is adapted for the efficient absorption of food: • long • large surface area (villi and microvilli) • permeable surface • thin lining • good blood supply.

Module B5: The Living Body

Item B5f: Waste Disposal

Summary: Our bodies produce waste, which is often toxic. To avoid poisoning ourselves, we must get rid of this waste. What role do our kidneys, skin and liver play in this process? Researching methods of respiratory and kidney failure can be used to illustrate contemporary scientific and technological developments.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out experiments to test mock urine samples. Research kidney failure and its treatment.	Describe the difference between getting rid of solid waste through the anus (egestion) and getting rid of waste produced by the body (excretion). Name and locate position of the main organs of excretion: • lungs • kidneys • liver • skin. Recall that the kidneys excrete urea, water and salt.
Investigate the effect of exercise on rate of breathing.	Describe that carbon dioxide produced by respiration, is removed from the body through the lungs.
	Identify the basic parts of the skin (epidermis, dermis, hair follicle, sweat gland). Describe that the skin excretes sweat containing water and salt.

Module B5: The Living Body

Item B5f: Waste Disposal
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the gross structure of a kidney and associated blood vessels (cortex, medulla, ureter, renal artery, renal vein). Explain how kidneys work: • filter blood at high pressure • re-absorb water and useful substances. Describe that urea, produced in the liver (from excess amino acids) is removed by the kidneys. Describe how the amount of urine produced is affected by water intake, heat and exercise.	Explain how the structure of the kidney tubule (nephron) is related to filtration of the blood and formation of urine: • a filter unit of glomerulus and capsule • a region for selective reabsorption • a region for salt and water regulation. Explain the principle of a dialysis machine and how in a patient with kidney failure it removes urea and maintains levels of sodium and glucose in the blood. Explain how the concentration of urine is controlled by the anti-diuretic hormone (ADH), released by the pituitary gland: • ADH increases permeability of kidney tubules so more water is reabsorbed back into the blood • ADH production is controlled by a negative feedback mechanism.
Explain that high levels of carbon dioxide must be removed from the body.	Explain that when increased carbon dioxide levels in the blood are detected by the brain an increased rate of breathing results.
Explain that sweat evaporates to cool down the skin.	

Module B5: The Living Body

Item B5g: Life Goes On

Summary: Humans, like all other animals have basic needs for survival and reproduction to carry on our species. When things do not work as they should we expect modern techniques to solve our problem. Sometimes solutions raise other issues.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine microscope slides of testes and ovary. Examine models of a developing foetus.	Describe fertilisation as the result of fusion between a male gamete (sperm) and a female gamete (egg). Name and locate the parts of the male reproductive system and their functions: • testes produce sperm • sperm ducts carry sperm • scrotum keeps testes outside body (cooler) which is at a better temperature for sperm development • penis to transfer sperm. Name and locate the parts of the female reproductive system and their functions: • ovaries produce eggs • oviduct carries eggs to uterus • uterus where embryo develops • vagina through which baby is born.
Role play or debate about using infertility treatments.	Recognise that fertilisation and pregnancy are not guaranteed for all couples and in some, but not all, cases this can be achieved by the help of fertility treatment.
	Name and locate human endocrine glands and name the hormones produced: • ovaries - oestrogen, progesterone • testes – testosterone.

Module B5: The Living Body

Item B5g: Life Goes On
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the main stages of the menstrual cycle: • menstruation – uterus lining breaks down (period) • thickening of uterus lining • ovulation – egg released by ovary.	Explain the role of hormones in the menstrual cycle • oestrogen causes the repair of the uterus wall • progesterone maintains the uterus wall • FSH (follicle-stimulating hormone) stimulates an egg to develop • LH (luteinising hormone) controls ovulation. Recall that FSH and LH are released by the pituitary gland in the brain.
Describe treatments for infertility to include: • artificial insemination • use of FSH • "in vitro" fertilisation (IVF) • egg donation • surrogacy • ovary transplants.	Describe the arguments for and against such infertility treatments.
Explain how foetal development can be checked to identify conditions such as Down's syndrome using amniocentesis and chromosomal analysis.	Describe the ethical issues raised by foetal screening to include: • risk of miscarriage • decision whether to continue pregnancy.
Describe the effects of male and female sex hormones on secondary sexual characteristics: • males – voice breaks, hair grows on face and body, more muscular body, genitals develop, sperm production • females – breast develop, hips widen, periods start, pubic hair and hair under arms grow. Describe that fertility in humans can be controlled by the artificial use of sex hormones: contraceptive pill; fertility drugs.	Explain how fertility can be reduced by the use of female hormones (contraception) which prevent ovulation by mimicking pregnancy – inhibiting FSH release. Explain how infertility due to lack of eggs can be treated by the use of FSH to stimulate egg production.

Module B5: The Living Body

Item B5h: Growth and Repair

Summary: We start life as a microscopic fertilised egg and grow at different rates at different times of our lives and are sometimes surprised to find we have reached a height of nearly two metres. However, as people live longer, parts of their bodies are wearing out or going wrong. This item encourages discussion about possible treatments and ethical issues involved. It also provides the opportunity to debate the issues.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure heights of candidates in your class/year and display as normal distributions for boys and girls. Collect data from another year group and compare distributions. Use web sites/ visit museums/ use reference books to find out average heights during history (look at suits of armour, door heights in old buildings, height requirements for the Armed Forces).	Explain that growth can be measured as an increase in height or mass. Explain that a person's final height and mass is determined by: • their genes • diet and exercise • hormones • health/disease. Describe the main stages of human growth and identify them on a human growth curve: • infancy (up to 2 years) • childhood (from 2 to 11 years) • adolescence (puberty) (from 11 to 13/15 years) • maturity (adulthood) (the longest stage) • old age (above 60/65 years).
Research donor cards and other donor organisations such as the Anthony Nolan Trust.	Recognise the variety of body parts which can be mechanically replaced, limited to: • kidney • knee and hip joints • heart • lens of eye. Recognise the variety of body parts that can be biologically replaced, limited to: • blood • cornea • heart • lungs • kidney and bone marrow.
Research the history of one organ transplant.	Recognise that organs that can be donated by living or dead donors.

Module B5: The Living Body

Item B5h: Growth and Repair
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that extremes in height are usually caused by genes or hormone imbalance. Describe how diet and exercise can influence growth. Recognise that different parts of a foetus and a baby grow at different rates. Describe that babies' length, mass and head size are regularly monitored during their first months to provide early warning of growth problems. Understand that these measurements are plotted on average growth charts to highlight any growth problems. Explain that life expectancy has greatly increased during recent times and suggest possible causes, to include: less industrial disease, healthier diet and life style, modern treatments and cures for disease, better housing.	Explain that the human growth hormone is produced by the pituitary gland and that it stimulates general growth especially in long bones. Explain that average growth charts are simply a guide to show a comparison. Describe possible consequences of more people living longer, on a personal and national level.
Explain problems in supply of donor organs, limited to: • shortage of donors • tissue match • size and age. Explain problems of using mechanical replacements, limited to: • size • power supply • materials used • body reactions. Recall that some mechanical replacements such as the heart and lung machine, kidney dialysis and mechanical ventilators are used outside the body.	Describe the ethical issues concerning organ donation. Describe problems with transplants, limited to: • rejection • immuno-suppressive drug treatment.
Explain why donors can be living and what makes a suitable living donor. Describe the criteria needed for a dead person to be a suitable donor.	Describe the advantages and disadvantages of the idea of a register of donors. Interpret data on transplants and success rates.

Module B6: Beyond The Microscope

Item B6a: Understanding Microbes

Summary: We are used to talking about plants and animals that can be seen and touched. Microscopic organisms such as bacteria, viruses and fungi tend to be either ignored or cause fear. This unit considers the characteristics of these organisms and gives some appreciation of the importance of scale in biology. Practical work with microorganisms develops the skills of working safely and accurately.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine greatly magnified images of bacteria and calculate magnification. 'How big would a cat be if we magnified it by the same factor?' is a useful problem to solve. Prepare a culture of bacteria on an agar plate using aseptic technique.	Recall that the size of a typical bacterial cell is just a few microns (thousandths of a mm). Identify and label parts of a flagellate bacillus as shown by *E. coli*, to include: • flagellum • cell wall • bacterial DNA. Recognise that bacteria can be classified by their shape. Describe how bacteria reproduce by splitting into two. Recognise that bacteria can be grown in large fermenters.
Make a slide of yeast and stain it with methylene blue and examine it under a microscope.	Recall that yeast is a fungus. Identify and label parts of a yeast cell, to include: • nucleus • cytoplasm • cell wall • bud. Describe how yeast reproduces asexually by budding.
	Describe viruses as structures that are • not living cells • much smaller than bacteria and fungi.

Module B6: Beyond The Microscope

Item B6a: Understanding Microbes
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the function of the parts of a bacterial cell, to include: • flagellum for movement • cell wall to maintain shape, and to stop it from bursting • DNA to control the cell's activities and replication of the cell. Describe the main shapes of bacteria as: • spherical • rod • spiral • curved rods. Recall that bacteria reproduce by a type of asexual reproduction called binary fission. Describe aseptic technique for culturing bacteria on an agar plate.	Explain that since some bacteria can consume organic nutrients and others can make their own, this means that: • they can survive on an enormous range of energy sources • they can exploit a very wide range of habitats. Explain the consequences of very rapid bacterial reproduction in terms of food spoilage and disease. Explain reasons for the safe handling of bacteria.
Recognise that yeast can reproduce at a fast rate, its optimum growth rate being controlled by: • food availability • temperature • pH • and removal of waste products.	Describe how yeast growth rate doubles for every 10°C rise in temperature until the optimum is reached.
Describe the structure of viruses as: • a protein coat • surrounding a strand of genetic material. Explain that viruses: • can only reproduce in other living cells • only attack specific cells • may attack plant, bacterial or animal cells.	Explain how a virus reproduces, to include: • attaching itself to a specific host cell • injecting its genetic material into the cell • using the cell to make the components of new viruses • causing the host cell to split open to release the viruses.

Module B6: Beyond The Microscope

Item B6b: Harmful Microorganisms

Summary: Despite giving a range of useful products, some microorganisms are dangerous to humans. Each year millions of deaths are directly caused by bacteria and viruses. The work of Lister, Pasteur and Fleming illustrates how uncertainties in scientific knowledge change over time and the role of the scientific community in validating these changes.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
	Recognise that some microorganisms can cause disease. Describe how disease-causing organisms can enter the body, limited to: • nose (airborne microorganisms) • mouth (contaminated food and water) • skin (insect bites, cuts, infected needles) • reproductive organs (contact). Relate different types of microorganisms to the disease they can cause, limited to • cholera and food poisoning, caused by bacteria • influenza and chickenpox, caused by viruses • athlete's foot caused by a fungus.
Research how aid agencies such as the Red Cross respond rapidly to an emergency. Research incidence of disease following a recent natural disaster.	Explain that diseases such as cholera and food poisoning can be a major problem following a natural disaster such as earthquakes and erupting volcanoes.
Compare the effectiveness of different antiseptics/antibiotics using a culture of bacteria on an agar plate (by measuring and comparing the diameters of the halos).	Recognise that harmful bacteria can be controlled by antibiotics.

Module B6: Beyond The Microscope

Item B6b: Harmful Microorganisms
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise that some bacteria are pathogens (disease-causing). Describe the transmission of: • food poisoning • cholera • athlete's foot • influenza. Describe the stages in an infectious disease, to include: • entry into the body • rapid growth, the incubation period • production of many toxins • appearance of symptoms such as fever.	Recall the organisms involved in: • food poisoning (Salmonella, E. coli) • cholera (Vibrio) • athlete's foot (Trichophyton) Interpret data on the incidence of influenza, food poisoning and cholera.
Describe how natural disasters cause a rapid spread of diseases, to include: • damaged sewage systems and water supplies • damaged electrical supplies causing rapid food decay • displaced people • disrupted health services.	
Describe the pioneering work of the following scientists in the treatment of disease, limited to: • Pasteur and the germ theory of disease • Lister and the development of antiseptics • Fleming and the discovery of penicillin. Describe how antiseptics and antibiotics are used in the control of disease. Understand that viruses are unaffected by antibiotics. Understand that bacteria can develop resistance to antibiotics.	Explain how some strains of bacteria are developing resistance to antibiotics by natural selection. Explain the importance of various procedures in the prevention of antibiotic resistance to include: • only prescribing antibiotics when necessary • completion of the dose.

Module B6: Beyond The Microscope

Item B6c: Useful Microorganisms

Summary: As we begin to understand how microorganisms work, we can develop new ways of using them as well as making existing processes more efficient.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Make yoghurt using freshly pasteurised milk and a starter culture of live yoghurt. Measure and record the pH of milk as it is converted to yoghurt using pH paper/pH meter/data logger. Consider adverts for 'pro-biotic' yoghurts.	Recognise that some bacteria are useful in: • yoghurt making • cheese production • vinegar production • silage production • composting.
Brewing beer, cider or wine. A 'home brew' beer or wine kit can be used to demonstrate the principles of fermentation. Collect gas from fermenting sugar and test it for carbon dioxide. Experiments to show how yeast activity is affected by temperature.	Describe fermentation as the breakdown of sugars by yeast in the absence of oxygen. Recall some of the drinks produced by fermentation and the source from which they are made, limited to: • wine from grapes • beer from malted barley • cider from apples. Recall that a gas, carbon dioxide, is also produced during fermentation.
	Recall that some products of fermentation can be further treated to increase the alcohol concentration to produce spirits.

Module B6: Beyond The Microscope

Item B6c: Useful Microorganisms
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the main stages in making yoghurt, to include: • sterilisation of equipment • pasteurisation of milk • incubation of culture • sampling • addition of flavours, colours then packaging.	Describe the action of Lactobacillus bacteria in yogurt making, to include: • the breakdown of lactose in milk • the production of lactic acid.
Recall and use the word equation for fermentation (anaerobic respiration in yeast). glucose (sugar) → ethanol (alcohol) + carbon dioxide Explain that yeast can be used to deal with water contaminated by sugars from food processing factories. Describe the main stages in brewing beer or wine, to include: • extracting sugar from source material • adding hops for beer flavouring • adding yeast, keeping it warm • preventing entry of air and other micro-organisms • clarifying/clearing drawing off the wine/beer. • pasteurising, casking or bottling.	Recall and use the balanced chemical equation for fermentation (anaerobic respiration). $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ Explain that yeast can undergo aerobic or anaerobic respiration and the implications of this to the fermentation process. Interpret data on breakdown of sugar by yeast in different conditions such as changing temperature, presence or absence of oxygen. Describe what is meant by the term pasteurisation and explain why this needs to be done in the case of bottled beers.
Recall the sources of spirits limited to: • rum from cane sugar • whisky from malted barley • vodka from potatoes. Describe the process of distillation to increase the alcoholic concentration, and understand that this commercial process needs licensed premises.	Explain that fermentation is limited by the increasing level of alcohol eventually killing the yeast. Recognise that different strains of yeast can tolerate different levels of alcohol.

Module B6: Beyond The Microscope

Item B6d: Biofuels

Summary: With problems of declining stocks of fossil fuels and long term problems of nuclear energy, many countries are developing cleaner fuels which only need simple technology. Many of these processes involve the use of microorganisms.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
	Explain that plants produce biomass when they photosynthesise. Recognise examples of fuels from biomass, to include: • alcohol • biogas • wood.
Research the use of biogas in Nepal. Design a biogas digester and display the plans as a chart. Research use of biogas in cities such as Newcastle and Leeds.	Describe the importance of biogas in certain remote parts of the world lacking a mains electricity supply or mains sewage system. Describe that the rotting of organic material such as dead plants and animal waste: • occurs in marshes, septic tanks and animal digestive systems • produces a mixture of gases including methane • is caused by the action of bacteria. Explain that biogas can be produced on a large scale using a digester. Describe the dangers of methane being released from landfill sites (it can burn or explode preventing use of the site for many years).
	Recall that alcohol: • can be made from yeast • can be used as a biofuel by mixing with petrol.

Module B6: Beyond The Microscope

Item B6d: Biofuels
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe different methods of transferring energy from biomass, to include: • burning fast growing trees • fermenting biomass using bacteria or yeast. Describe the advantages of using biofuels, to include: • alternative sources to fossil fuels • no increase in greenhouse gas levels • no particulates produced.	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.
Recall that biogas contains: • mainly methane • some carbon dioxide • traces of hydrogen, nitrogen and hydrogen sulphide. Describe how methane can be produced on a large scale using a continuous flow method of providing organic waste and removing the gas and remaining solids. Describe the uses of biogas, to include: • burning to generate electricity • burning to produce hot water and steam for heating systems • used as a fuel for vehicles. Describe how biogas production is affected by temperature.	Explain that biogas containing more than 50% methane can be burnt in a controlled way but a lower percentage of about 10% is explosive. Describe how different types of bacteria are needed to break down organic material to produce biogas. Explain that biogas is a 'cleaner' fuel than diesel and petrol but does not contain as much energy as natural gas. Explain why biogas production is affected by temperature.
Recall that a mixture of petrol and alcohol: • is called gasohol • is used for cars in countries such as Brazil.	Explain that gasohol is more economically viable in countries that have ample sugar cane and small oil reserves.

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.

Suggested practical and research activities to select from	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, 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.	Recognise that the living organisms in soil include fungi: • microscopic protozoans • nematode worms • earthworms • insects • snails, slugs • bacteria.
Compare the composition of different soils.	Recognise that most soil life depends on a supply of oxygen and water. Describe the importance of soil for the majority of plants to include: • anchorage • a source of minerals • water.
Set up a wormery.	Recognise that earthworms can improve soil structure and fertility.

Module B6: Beyond The Microscope

Item B6e: Life in Soil
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that a sandy soil has larger mineral particles than a clay soil. Recall that loam is a soil that contains a mixture of clay and sand. Explain that if the dead material in soil is largely decomposed it is called humus. Describe simple experiments to compare the humus, air and water content of different soils.	Explain how particle size affects the air content and permeability of soils. Explain the results of soil experiments in terms of mineral particle size and organic matter content.
Describe a typical food web in a soil, to include: • herbivores such as slugs, snails, wire worms • detritivores such as earthworms, millipedes, springtails • carnivores such as centipedes, spiders and ground beetles.	Interpret data on soil food webs.
Explain why some life in soil depends on a supply of oxygen and water. Explain the importance of humus in the soil, limited to: • decomposition to release minerals • increasing the air content.	Explain why aerating and draining will improve soils. Describe why neutralising acid soils and mixing up soil layers is important.
Describe the importance of earthworms to soil structure and fertility, to include: • burying organic material for decomposition by bacteria and fungi • aerating and draining the soil • mixing up soil layers • neutralising acid soil.	Recognise the part played by Charles Darwin in highlighting the importance of earthworms in agriculture.

Module B6: Beyond The Microscope

Item B6f: Microscopic Life in Water

Summary: About two thirds of the Earth's surface is covered by water, mostly sea water. Life in water is different from life on land yet it shows the same incredible variation. Some of this life is obvious, due to its size but it all depends on microscopic plankton for a source of food. Since there seems to be so much water, we have unfortunately used it to dispose of waste causing extensive damage to aquatic life.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine microscopic life in pond water.	Recognise that there is a wide variety of micro-organisms living in water.
Examine living Daphnia to observe internal structures such as its heart and digestive system.	Recognise that plankton are microscopic plants (phytoplankton) and microscopic animals (zooplankton). Recognise that phytoplankton are capable of photosynthesis and are producers in aquatic food chains and webs. Explain that plankton : • have limited movement and so rely on water currents • show seasonal variations in numbers due to variations in light, temperature and minerals.
Research the effect of marine pollution on whale species and other marine organisms.	Recall that the variety and numbers of aquatic micro-organisms can be affected by pollution and acid rain. Recognise various pollutants of water, to include: oil, sewage, PCBs, fertilisers, pesticides and detergents. Analyse data on water pollution to determine pollution source.

Module B6: Beyond The Microscope

Item B6f: Microscopic Life in Water
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the advantages of life in water, limited to: • no problem of water shortage and dehydration • less variation in temperature • more support • easy disposal of waste products. Explain the disadvantages of life in water, limited to: • regulating water content • resistance to movement.	Explain the problems of water balance caused by osmosis. Describe the action of contractile vacuoles in microscopic animals such as amoeba.
Explain how factors affecting photosynthesis vary at different depths and in different seasons in water, to include: • light • temperature • minerals. Interpret data on seasonal fluctuations in phytoplankton and zooplankton.	Interpret data on marine food webs. Explain that 'grazing food webs' are most common in the oceans but some food chains rely on: • 'marine snow' • bacteria, deep in the ocean, acting as producers.
Explain how sewage and fertiliser run-off can cause eutrophication, to include: • rapid growth of algae • resulting death and decay • using up oxygen • causing the death of animals unable to respire. Describe how certain species of organisms are used as biological indicators for pH and oxygen levels.	Explain the accumulative, long term effect of PCBs and DDT on animals such as whales.

Module B6: Beyond The Microscope

Item B6g: Enzymes in Action

Summary: Many effects of microorganisms are based on the enzymes they contain. Enzymes are specific and catalyse many reactions which are useful to humans. They enable reactions which normally take place at much higher temperatures to work at low temperatures (thus saving energy).

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate the effectiveness of a biological washing powder in removing food stains. Plan or perform an investigation to find the effects of temperature, soaking time or concentration of washing powder solution on the efficiency of stain removal.	Describe everyday uses of enzymes, limited to: • biological washing powders and stain removers • cheese making and juice extraction • the preparation of medical products such as reagent sticks • altering the flavour of food products. Recognise that biological washing powders do not work at high temperature and extremes of pH .
Demonstrate the use of 'clinistix' or 'dextrostix' to determine the glucose concentration of a series of 'spoof urines'. (glucose dissolved in a solution of water, a trace of marmite & 1 drop of washing up liquid so it looks like urine).	Describe how and why people with diabetes test their urine (using either Benedict's test or reagent strip sticks) for the presence of glucose.
Immobilise enzymes in an alginate beads and investigate its effect on a substrate.	Describe that some enzymes can be immobilised: • in gel beads • on reagent sticks. Recognise that immobilised enzymes on reagent sticks can be used to measure glucose levels in the blood.

Module B6: Beyond The Microscope

Item B6g: Enzymes in Action
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that enzymes in biological washing powders include: • amylases - to digest carbohydrates such as starch • lipases - to digest fat and remove fatty stains • proteases - to digest protein and remove protein stains. Explain why biological washing powders work best at moderate temperatures.	Explain that the products of digestion are soluble and so will then easily wash out of clothes. Explain why biological washing powders may not work in acidic or alkaline tap water.
Describe how sucrose can be broken down by the use of an enzyme called sucrase (invertase). Recognise that, when sucrose is broken down by enzymes, the product is much sweeter making it useful to the food industry.	Explain that: • invertase converts sucrose into glucose and fructose • these sugars are much sweeter than the sucrose • foods can be therefore be sweetened without adding so much sugar (e.g. in low calorie foods).
Describe how enzymes can be immobilised in gel beads by: • mixing the enzyme with alginate • dropping the mixture into calcium chloride solution. Explain advantages of immobilising enzymes, to include: • the mixture not becoming contaminated with the enzyme • immobilised enzymes in alginate beads can be used in continuous flow processing.	Explain that people with lactose intolerance cannot produce the enzyme lactase and so bacteria in the gut ferment lactose, producing diarrhoea and wind. Explain the principles behind the production of lactose-free milk for people with lactose intolerance , to include: • immobilised lactase converting lactose in milk into glucose and galactose • these simple sugars can then be absorbed. Describe how the same idea is used to produce cat milk since cats cannot digest lactose in milk.

Module B6: Beyond The Microscope

Item B6h: Gene Technology

Summary: Biotechnology is "using life to make things". Genetic engineering has the potential to alter life on Earth in a very short time span by transferring genes from one organism to another. It is possible due to the use of enzymes that can be used to manipulate DNA. The same enzymes can be used to produce DNA 'fingerprints'.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Extract DNA from onions, kiwi fruit or wheat germ.	Describe genetic engineering as an alteration in the genetic code of an organism. Recognise that genes from one organism can work in another. Describe the process of genetic engineering as: • removing a gene from one organism • inserting it into another organism • the gene works in the new organism.
Use gene splicing kits (using a luminous gene from jelly fish).	Explain that bacteria can be genetically engineered to produce useful human proteins, to include: • insulin • human growth hormone. Recognise that these bacteria can be grown in large fermenters to produce large quantities of proteins.
Examine DNA 'fingerprinting' results Use DNA fingerprinting kits (using lambda phage DNA).	Recall that a person's DNA can be used to produce a DNA 'fingerprint'. Explain that this can be used to identify a person because a person's DNA is unique.

Module B6: Beyond The Microscope

Item B6h: Gene Technology
Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that genetic engineering alters the genetic code of an organism by inserting genes. Recall that the new type of organism is called a transgenic organism. Describe the main stages in genetic engineering: • identification of a desired gene in one organism • removal of gene from DNA • cutting open the DNA in another organism • inserting the new gene into the DNA • gene works in transgenic organism • transgenic organism can be cloned to produce identical copies. Explain that the cutting and inserting of DNA is achieved using enzymes.	Explain that genetic engineering is possible because the genetic code is universal. Explain how: • restriction enzymes cut open DNA to leave 'sticky ends' • the 'sticky ends' allow ligase enzymes to rejoin DNA strands.
Describe how bacteria can be used in genetic engineering to produce human insulin, to include the gene for producing human insulin is cut out of human DNA: • a loop of bacterial DNA is cut open • the insulin gene is inserted into the loop • the loop is inserted into a bacterium • the bacteria are then able to produce insulin • transgenic bacteria are cultured by cloning • large quantities of insulin are harvested.	Recall that bacteria have loops of DNA called plasmids in their cytoplasm. Explain that these plasmids can be taken up by bacteria and so can be used as 'vectors' in genetic engineering. Explain that assaying techniques are used to check that the new gene has been correctly transferred.
Interpret data on DNA 'fingerprinting' for identification. Describe the arguments for and against the storage of DNA 'fingerprints'.	Describe the stages in the production of a DNA 'fingerprint', to include: • extraction of DNA from sample • fragmentation of DNA using restriction enzymes • separation using electrophoresis • visualising pattern using a radioactive probe.