3.4 Module B1: Understanding Organisms

Module B1: Understanding Organisms

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 the most common cause of death in the UK.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure blood pressure.	Explain why 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 to reduce 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. Analyse data that show the changing incidence of heart disease in the UK.

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Module B1: Understanding Organisms

Item B1a: Fitness and health

Links to other items: B1b: Human health and diet, B1e: Drugs and you, B3c: Respiration, B3e: The circulatory system, B5c: Running repairs

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that blood pressure measurements consist of diastolic and systolic data 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. Explain the possible consequences of having low blood pressure.
Explain the difference between fitness (the ability to do physical activity) and health (free from disease). Analyse the results of different ways of measuring fitness (strength, stamina, flexibility, agility, speed and cardiovascular efficiency).	Evaluate different ways of measuring fitness.
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 how diet can increase the risk of heart disease to include: • saturated fats leading to a build up of cholesterol (a plaque) in arteries • high levels of salt elevating blood pressure. Interpret data showing possible links between the amount of saturated fat eaten, the build up of cholesterol plaques and the incidence of heart disease.	Explain why carbon monoxide reduces the carrying capacity of red blood cells, using the idea that it combines with the haemoglobin preventing the oxygen transport. Explain how narrowed coronary arteries, together with a thrombosis, increase the risk of a heart attack.

Module B1: Understanding Organisms

Item B1b: Human health and diet

Summary: The populations of many countries 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 nutritional value of various breakfast cereals. Record a day's food intake and calculate the total energy intake. Investigate energy content in various foods. Carry out simple food tests on a variety of food types.	Explain why a balanced diet should include: • protein • carbohydrates and fats • minerals (limited to iron) • vitamins (limited to vitamin C) • fibre • water.
Use ICT tasks, including video clips, to research countries having food emergencies and facing starvation. Calculate personal estimated average daily requirement (EAR) for protein. Record a day's food intake and calculate the amount of protein. Calculate a Body Mass Index (BMI) and use provided information to make a decision as to what it indicates.	Interpret simple data on diet. Explain why: • a high protein diet is necessary for teenagers • in many parts of the world diets are deficient in protein. Recall that proteins are only used as an energy source when fats or carbohydrates are unavailable. Recall that being very overweight (obese) is linked to increased health risks, to include arthritis, heart disease, diabetes and breast cancer.

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Module B1: Understanding Organisms

Item B1b: Human health and diet

Links to other items: B1a: Fitness and health, B1e: Drugs and you, B3b: Proteins and mutations, B5c: Running repairs, B5d: Respiratory systems

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall 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 age, gender, activity, religion, personal choice (to include vegetarians and vegans) and medical issues (to include food allergies).	Describe the storage of biological molecules, to include: • 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.
Explain 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 × 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 and 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 why vegetarians need to eat proteins from a wide range of sources compared to people who eat proteins of animal origin. Understand 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 Organisms

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 candidates to discuss 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 a class or year (limited to flu/colds, athlete's foot and 'stomach upsets') using primary or secondary sources. Case studies involving malaria.	Recall that infectious diseases are caused by pathogens (disease-causing microorganisms). Recall one example of a disease caused by each type of pathogen limited to athlete's foot (fungi), flu (viruses), 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. Understand 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.
	Explain why new medical treatments/drugs are tested before use.

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Module B1: Understanding Organisms

Item B1c: Staying healthy

Links to other items: B3b Proteins and mutations, B6a Understanding microbes, B6b Harmful microorganisms

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 life cycle of a disease and the way in which vectors spread disease can help control infections: • limited to malaria and the mosquito.
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 how pathogens cause the symptoms of an infectious disease by cell damage or by production of toxins. Recall that antibodies lock on to antigens leading to the death of the pathogens. Explain the difference between passive (receive antibodies) and active immunity (make own antibodies). Recall the difference between antibiotics and antiviral drugs.	Explain how each pathogen has its own antigens so specific antibodies are needed. Explain the process of immunisation (vaccination): • harmless pathogen given which carries antigens • antigens trigger immune response by white blood cells which 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 resistant strains such as MRSA.
Describe how new treatments are tested using animals, human tissue and computer models and understand objections to some forms of testing.	Explain why blind and double blind trials are used in testing new drugs against placebos or the best existing treatment.

Module B1: Understanding Organisms

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 density 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 how animals detect changes in their environment (stimuli) using receptors which generate nerve impulses. Name and locate the main parts of the eye: cornea, iris, pupil, lens, retina, optic nerve and blind spot.
Investigate why some animals have binocular vision and others do not.	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.
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. Recognise that voluntary responses are under the conscious control of the brain.

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Module B1: Understanding Organisms

Item B1d: The nervous system

Links to other items: B1e: Drugs and you, B1g: Controlling plant growth, B2e: Adaptations

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, some sensitive to light of different colours • optic nerve – carries impulses to the brain. Describe the pathway of light through the eyeball, being refracted by the cornea and lens and brought to focus on the retina.	Explain how the eye focuses light (accommodation) from near and distant objects.
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 a cause of red-green colour blindness as the lack of specialised cells in the retina.	Explain how long and short-sight can be corrected by corneal surgery or by different lenses in glasses or contact lenses.
Name and locate the parts of a motor neurone: cell body, axon and 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 Organisms

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 a 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. 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 and lung) and heart disease. Describe the effects of: • carbon monoxide (lack of oxygen, heart disease) • nicotine (addictive) • tars (irritant, carcinogenic) • particulates (accumulation in lung tissue).
Produce a poster to warn drivers about the dangers of drink driving.	Recognise the short term and long term effects of alcohol on the body: • short term (impaired judgment, balance and muscle control, blurred vision, slurred speech, drowsiness and increased blood flow to the skin) • 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.

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Module B1: Understanding Organisms

Item B1e: Drugs and you

Links to other items: B1a: Fitness and health, B1b: Human health and diet, B1d: The nervous system, B5d: Respiratory systems, B5f: Waste disposal

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 temazepam • 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 how cigarette smoke affects ciliated epithelial cells lining the trachea, bronchi and bronchioles. Explain why damage to ciliated epithelial cells can lead to a 'smokers cough'.	Evaluate data on the effects of smoking in populations (to include, cancer, heart disease, emphysema and birth weights of babies born to mothers who smoke).
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.	Describe how the liver can become damaged as it removes alcohol (cirrhosis), to include: • enzymes in liver breakdown alcohol • toxic products of alcohol breakdown cause liver damage

Module B1: Understanding Organisms

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 e.g. 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, or anus) • how (using a clinical thermometer, sensitive strips, digital recording probes, or thermal imaging). Describe how heat can be gained or retained (by respiration, shivering, exercise, less sweating, less blood flow near skin surface, or clothing). Describe how more heat can be lost (by sweating, or more blood flow near skin).
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. Recall that Type 1 diabetes is caused by the failure of the pancreas to produce insulin. Describe how insulin travels around the body.

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Module B1: Understanding Organisms

Item B1f: Staying in balance

Links to other items: B2e: Adaptations, B5f: Waste disposal

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that maintaining a constant internal environment involves balancing bodily inputs and outputs and is called homeostasis. Explain why factors are kept at steady levels by automatic control systems (limited to temperature, water content and carbon dioxide).	Explain how negative feedback mechanisms are used to maintain a constant internal environment.
Explain how sweating increases heat transfer to the environment by evaporation of sweat which requires heat, so removing heat from the skin. Understand that the body temperature of 37°C is the optimum temperature for the action of many enzymes. 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.	Explain how vasodilation and vasoconstriction increase or reduce heat transfer to the environment. Understand that the body temperature of 37°C is linked to enzyme action. Explain how blood temperature is monitored by the brain which will bring about temperature control mechanisms via the nervous and hormonal systems.
Recall 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 why responses controlled by hormones are usually slower than responses controlled by the nervous system.	Explain how insulin helps to regulate blood sugar levels. Explain how the dosage of insulin needed to be taken by a person with Type 1 diabetes depends upon diet and activity.

Module B1: Understanding Organisms

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 and evaluation of data collection and the quality 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. Understand that plant growth (limited to growth of shoots and roots, flowering and fruit ripening) is controlled by chemicals called plant hormones. Describe an experiment to show that shoots grow towards light. Understand how growth towards light increases the plant's chance of survival. Understand why roots grow downwards.
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.

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Module B1: Understanding Organisms

Item B1g: Controlling plant growth

Links to other items: B1d: The nervous system, B4c: Leaves and photosynthesis, B4h: Farming

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. Recall 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 Organisms

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 that are a result of both environmental and inherited factors, to include: • intelligence • body mass • height. Recall that chromosomes are held in the nucleus and that they carry information in the form of genes, which control inherited characteristics. Recognise that most body cells contain chromosomes in matched pairs. Recall that gametes have half the number of chromosomes of body cells.
	Recognise that some disorders are inherited: red-green colour blindness, sickle cell anaemia and cystic fibrosis.

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Module B1: Understanding Organisms

Item B1h: Variation and inheritance

Links to other items: B2a: Classification, B2f: Natural selection, B3a: Molecules of life, B3d: Cell division, B5g: Life goes on

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. Explain the causes of genetic variation, to include: • 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 alleles are different versions of the same gene. Describe how sex (in mammals) is determined by sex chromosomes: XX (female) and XY (male).	Understand the debate over the relative importance of genetic and environmental factors in determining some human attributes: intelligence, sporting ability and health. Explain how 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. Explain a monohybrid cross involving dominant and recessive alleles using genetic diagrams with letters representing 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, including the production of equal numbers of male and female offspring, using genetic diagrams.
Understand that inherited disorders are caused by faulty genes. Understand the issues raised by knowledge of inherited disorders in a family.	Recall 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.

3.5 Module B2: Understanding Our Environment

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 the evolutionary and ecological relationships between living organisms. The ability to correctly classify organisms is crucial if we are to identify and maintain global biodiversity.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Place different organisms into groups.	Understand that organisms can be classified into groups according to shared characteristics. Describe the characteristics used to place organisms into the five Kingdoms.
Collect invertebrates from local surroundings and develop a simple key. Use a simple key to identify some invertebrates.	Use characteristics to place organisms into the different classes of arthropod, limited to: • insects • arachnids • crustaceans • myriapods.
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.
	Understand why similar species tend to live in similar types of habitats.

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Module B2: Understanding Our Environment

Item B2a: Classification

Links to other items: B1h: Variation and inheritance, B2f: Natural selection, B4a: Ecology in the local environment, B6a: Understanding microbes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that the variety of life is a continuous spectrum which makes it difficult to place organisms into distinct groups. Describe the classification of organisms into kingdom, phylum, class, order, family, genus and species. Explain the importance of classification of species in terms of identifying evolutionary and ecological relationships.	Describe classification systems to include natural (based on evolutionary relationships) and artificial (for purposes of identification). Explain how the use of DNA sequencing information has led to changes in understanding of classification. Understand why systems of classification change over time.
Understand that the evolutionary relationships between organisms can be displayed using evolutionary trees.	Understand how the evolutionary relationships of organisms in a group can be modelled by analysing multiple characteristics and how this has been facilitated by ICT.
Define the term 'species' as a group of organisms which are capable of interbreeding to produce fertile offspring. Explain the importance of the binomial system as the international basis of naming species.	Explain some of the problems of classifying organisms into species, to include: • hybrids • organisms that only reproduce asexually • evolution as a continuing process.
Recall that closely related species: • share a relatively recent ancestor • may have different features if they live in different types of habitats.	Explain how similarities and differences between species can be explained in terms of both evolutionary and ecological relationships.

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
Research food chains in different habitats.	Explain the term trophic level. Understand that there are organisms other than green plants that are producers. Explain why some organisms are both primary and secondary consumers. Explain how changes in the population of one organism may affect the other organisms in a food web.
Survey peers on vegetarian diet. Consider and compare sources of food.	Explain how energy from the Sun flows through food webs. Interpret data on energy flow in food webs.

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Module B2: Understanding Our Environment

Item B2b: Energy flow

Links to other items: B2c: Recycling, B2d: Interdependence, B4b: Photosynthesis, B6c: Useful microorganisms, B6f: Microscopic life in water

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand how pyramids of biomass show the dry mass of living material at each stage of a food chain. Construct pyramids of biomass from given information. Explain why pyramids of numbers and pyramids of biomass for the same food chains can be different shapes.	Explain the difficulties in constructing pyramids limited to: • organisms may belong to more than one trophic level • the problems with measuring dry biomass.
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. Describe how excretory products, faeces and uneaten parts can be used as the starting point for other food chains.	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.

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. Composting activities. Observation/measurement of leaf decomposition in hedges.	Recall that when animals and plants die and decay the elements in their bodies are recycled. Recognise that many soil bacteria and fungi are decomposers, which decay dead organisms. Describe the importance of this decay process in making elements available again to living organisms. 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.
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 why nitrogen gas cannot be used directly by animals or plants, in terms of its reactivity.

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Module B2: Understanding Our Environment

Item B2c: Recycling

Links to other items: B2b: Energy flow, B3c: Respiration, B4b: Photosynthesis, B4f: Plants need minerals, B4g: Decay, B4h: Farming, B6e: Life in soil

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why recycling of nutrients takes longer in waterlogged or acidic soils than it does in well drained neutral soils. Explain how carbon is recycled in nature, limited to: • plants removing carbon dioxide from the air by photosynthesis • feeding passes 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 how carbon is recycled in nature, limited to: • marine organisms 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 passes 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

Summary: 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 and American crayfish.	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. Interpret data which shows that animals and plants can be affected by competition for resources, including population sizes and distribution data.
	Explain how the size of a predator population will affect the numbers of prey and vice versa.
Examine root nodules using a hand lens. Research examples of mutualism and other associations between organisms. Research how parasites are adapted to survive in/on their particular hosts.	Recall 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.

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Module B2: Understanding Our Environment

Item B2d: Interdependence

Links to other items: B2b: Energy flow, B2c: Recycling, B2e: Adaptations, B2f: Natural selection

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how similar animals in the same habitat will be in close competition. Describe how organisms within a species compete in order to survive and breed.	Use the terms interspecific and intraspecific to describe given examples of competition and explain why intraspecific competition is often more significant. Explain what is meant by the term ecological niche. Understand that similar organisms will occupy similar ecological niches.
Explain how the populations of some predators and their prey show cyclical fluctuations in numbers.	Explain why the cycles of population for predator and prey are out of phase with each other.
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.

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
Using a hand lens, observe a worm and list all of its adaptations that make it successful for life in the soil. Make a model of a plant and discuss the adaptations that make it successful. Research organisms that have lost/reduced features that are no longer required e.g. blind cave fish that 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.	Explain how some animals are adapted to be successful predators, to include: • binocular vision to judge distance and size • hunting strategy • breeding strategy. Explain how some animals are adapted to avoid being caught as prey, to include: • eyes on side of head for wide field of view • living in groups (herds or shoals) to reduce the chance of being caught • cryptic and warning colouration • mimicry • breeding strategy (synchronous breeding).
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.

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Module B2: Understanding Our Environment

Item B2e: Adaptations

Links to other items: B2d: Interdependence, B2f: Natural selection, B3e: The circulatory system, B3g: New genes for old, B4a: Ecology in the local environment, B4c: Leaves and photosynthesis, B4d: Diffusion and osmosis, B4e: Transport in plants, B5d: Respiratory systems, B5e: Digestion

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how adaptations to cold environments help organisms survive, to include: • anatomical methods of reducing heat loss, including insulation and surface area • behavioural adaptations, including migration and hibernation. Explain how adaptations to hot environments help organisms survive to include: • behavioural and anatomical methods of increasing heat loss • behavioural methods of reducing heat gain. Explain how adaptations to dry environments help organisms survive to include: • behavioural, anatomical and physiological methods for coping with lack of water.	Analyse surface area to volume ratios in the context of different environmental stresses. Explain how counter-current heat exchange systems (e.g. in penguins) minimise heat loss. Understand that some organisms are biochemically adapted to extreme conditions, including different optimum temperatures for enzymes in extremophiles and organisms with antifreeze proteins.
Explain how animals and plants that are adapted to an environment are better able to compete for limited resources.	Describe how 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 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', e.g. coelacanth, crocodiles, sharks and Ginkgo and suggest why they do not appear to have changed.	Identify variations within a population of organisms of the same species. Explain why 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. Understand how when environments change, some animal and plant species survive or evolve but many become extinct.
Research Lamarck and his ideas about evolution.	Recall 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.

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Module B2: Understanding Our Environment

Item B2f: Natural selection

Links to other items: B1h: Variation and inheritance, B2a: Classification, B2d: Interdependence, B2e: Adaptations, B3g: New genes for old, B6e: Life in soil

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand Darwin's theory of evolution by natural selection to include: • presence of natural variation • competition for limited resources • survival of the fittest • inheritance of 'successful' adaptations. Recall that adaptations are controlled by genes and that these genes can be passed on to the next generation.	Explain how over long periods of time the changes brought about by natural selection may result in the formation of new species. Understand why speciation requires geographical or reproductive isolation of populations.
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 • because it 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 why Lamarck's theory was discredited: his explanation did not have a genetic basis. Recognise that the theory of natural selection has developed as new discoveries have been made, to include the understanding of inheritance.

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 are 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 different types 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 how as the human population increases, resource use increases and therefore more pollution is created; pollutants limited to: • household waste • sewage • sulfur dioxide from burning fossil fuels • carbon dioxide from burning fossil fuels.
Research 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.	Understand that pollution can affect the number and type of organisms that can survive in a particular place.

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Module B2: Understanding Our Environment

Item B2g: Population and pollution

Links to other items: B2h: Sustainability, B4a: Ecology in the local environment, B6d: Biofuels

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that the human population is increasing exponentially. Understand that population growth is the result of the birth rate exceeding the death rate. Explain the causes and consequences of: • global warming • ozone depletion • acid rain.	Explain how 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. Discuss the possible consequences of exponential growth.
Explain how the presence/absence of indicator species helps to indicate the level of pollution, to include: • water pollution – waterlouse, sludgeworm, rat-tailed maggot and 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, using the IUCN red list. Research the use of seed banks (extinct plants project at Kew).	Explain why organisms become extinct or endangered, to include: • climate change • habitat destruction • hunting • pollution • competition. Describe how endangered species can be conserved, to include: • protecting habitats • legal protection • education programmes • captive breeding programmes • seed banks • creating artificial ecosystems.
Search the internet for information on an endangered species. Class discussion on nature reserves: 'Why should we have zoos/marine parks/nature reserves?'. Plot the distributions of whale species on a world map.	Interpret data which shows that whale species' distributions depend on their feeding habitats. 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. Recall that some resources can be maintained, limited to: • fish stocks • woodland.

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Module B2: Understanding Our Environment

Item B2h: Sustainability

Links to other items: B2f: Natural selection, B2g: Population and pollution

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
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. Explain why species are at risk of extinction if the number of individuals or habitats falls below a critical level.	Explain why species are at risk of extinction if there is not enough genetic variation in the population. Evaluate a given example of a conservation programme in terms of: • genetic variation of key species • viability of populations • available habitats • interaction between species.
Recognise that both living and dead whales have commercial value: tourism when alive; food, oil and cosmetics when dead. Describe 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 hunting 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 developed using: • education • quotas on fishing • re-planting of woodland.	Explain the importance of population size, waste products and food and energy demands in the achievement of sustainable development. Understand that sustainability requires planning and co-operation at local, national and international levels. Describe how sustainable development may protect endangered species.

3.6 Module B3: Living And Growing

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 stained cheek cell slide and examine it using a microscope.	Identify the mitochondria in an animal cell. Recall that respiration occurs in the mitochondria providing energy for life processes.
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.	Recall 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. Understand 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.

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Module B3: Living And Growing

Item B3a: Molecules of life

Links to other items: B1h: Variation and inheritance, B3b: Proteins and mutations, B3d: Cell division, B3g: New genes for old, B6h: Gene technology

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why liver and muscle cells have large numbers of mitochondria.	Recall 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 the structure of DNA as two strands coiled to form a double helix, each strand containing chemicals called bases, of which there are four different types, with cross links between the strands formed by pairs of bases. Describe chromosomes as long, coiled molecules of DNA, divided up into regions called genes. Recall that each gene: • contains a different sequence of bases • codes for a particular protein. Recall that proteins are made in the cytoplasm and understand why a copy of the gene is needed: the gene itself cannot leave the nucleus.	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 how 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 explanation 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 the '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. Understand that enzymes have active sites that substrate molecules fit into when a reaction takes place.
	Recognise that different cells and different organisms will produce different proteins. Describe gene mutations as changes to genes.

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Module B3: Living And Growing

Item B3b: Proteins and mutations

Links to other items: B1b: Human health and diet, B1c: Staying healthy, B1h: Variation and inheritance, B3a: Molecules of life, B5e: Digestion, B6g: Enzymes in action

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 how each protein has its own number and sequence of amino acids, which results in differently shaped molecules, which have different functions.
Describe enzymes as: • biological catalysts • catalysing chemical reactions occurring in living cells: respiration, photosynthesis, protein synthesis • having a high specificity for their substrate. Explain the specificity of enzymes in terms of the 'lock and key' mechanism. Describe how changing temperature and pH, away from the optimum, will change the rate of reaction of an enzyme-catalysed reaction.	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. Calculate and interpret the Q_{10} value for a reaction over a 10°C interval, given graphical or numerical data, using the formula: $Q_{10} = \frac{\text{rate at higher temperature}}{\text{rate at lower temperature}}$
Recall that gene mutations may lead to the production of different proteins. Understand that mutations occur spontaneously but can be made to occur more often by radiation or chemicals. Understand that mutations are often harmful but may be beneficial or have no effect.	Understand that only some of the full set of genes are used in any one cell; some genes are switched off. Understand that the genes switched on determine the functions of a cell. Explain how changes to genes alter, or prevent the production of the protein which is normally made.

Module B3: Living And Growing

Item B3c: Respiration

Summary: Respiration 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.	Recognise that the energy provided by respiration is needed for all life processes in plants and in animals. Recall and use the word equation for aerobic respiration: glucose + oxygen → carbon dioxide + water Describe examples of life processes that require energy from respiration, to include: • muscle contraction • protein synthesis • control of body temperature in mammals.
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.	Explain why breathing and pulse rates increase during exercise. Describe an experiment to measure resting pulse rate and recovery time after exercise. Analyse given data from a pulse rate experiment.

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Module B3: Living And Growing

Item B3c: Respiration

Links to other items: B1a: Fitness and health, B2c: Recycling, B4b: Photosynthesis, B5d: Respiratory systems, B6c: Useful microorganisms

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall and use the symbol equation for aerobic respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ Use data from experiments to compare respiration rates, to include: • increased oxygen consumption • increased carbon dioxide production. Calculate the respiratory quotient (RQ) using the formula (data provided): $RQ = \frac{\text{carbon dioxide produced}}{\text{oxygen used}}$	Recall that respiration results in the production of ATP and that ATP is used as the energy source for many processes in cells. Explain how the rate of oxygen consumption can be used as an estimate of metabolic rate because aerobic respiration requires oxygen. Explain why the rate of respiration is influenced by changes in temperature and pH.
Explain why anaerobic respiration takes place during hard exercise in addition to aerobic respiration. Recall that this produces lactic acid which accumulates in muscles causing pain and fatigue. Recall and use the word equation for anaerobic respiration which releases energy: glucose → lactic acid Understand that anaerobic respiration releases much less energy per glucose molecule 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
	Describe the difference between simple organisms which are unicellular and more complex organisms which are multicellular.
Watch a video, examine photographs and use software simulations of cell division. Use models to illustrate cell division, using wool or plasticine. Examine prepared microscope slides to show cell division. Prepare a stained microscope slide of a root tip squash to show mitosis (e.g. garlic or hyacinth). Use bacterial or yeast growing kits.	Recall that most body cells contain chromosomes in matching pairs. Explain why the chromosomes have to be copied to produce new cells for growth. Recall that this type of cell division is also needed for: • replacement of worn out cells • repair to damaged tissue • asexual reproduction.
Examine bull's sperm using a microscope. Examine a hen's egg to show the large amount of stored food. Examine pollen using a microscope.	Recall that in sexual reproduction gametes join in fertilisation. Recall that gametes have half the number of chromosomes of body cells. Understand that in sexual reproduction to produce a unique individual half the genes come from each parent. Explain why sperm cells are produced in large numbers: to increase the chance of fertilisation.

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Module B3: Living And Growing

Item B3d: Cell division

Links to other items: B1h: Variation and inheritance, B3f: Growth and development, B4d: Diffusion and osmosis, B6a: Understanding microbes

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 why becoming multicellular requires the development of specialised organ systems, limited to: • communication between cells • supplying the cells with nutrients • controlling exchanges with the environment.
Recall that new cells for growth are produced by mitosis. Explain why these new cells are genetically identical. Recall that in mammals, body cells are diploid (two copies of each chromosome). Explain why DNA replication must take place before cells divide.	Describe how, prior to mitosis, DNA replication occurs, to include: • 'unzipping' to form single strands • new double strands forming by complementary base pairing. Describe how in mitosis the chromosomes: • line up along the centre of the cell • they then divide • the copies move to opposite poles of the cell.
Recall that gametes are produced by meiosis. Describe gametes as haploid (contain one chromosome from each pair). Explain why fertilisation results in genetic variation, limited to: • gametes combine to form a diploid zygote • genes on the chromosomes combine to control the characteristics of the zygote. 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 why, in meiosis, the chromosome number is halved and each cell is genetically different, to include: • one chromosome from each pair separate to opposite poles of the cell in the first division • chromosomes divide and the 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 e.g. haemophilia, sickle cell anaemia and leukaemia.	Describe the functions of components of the blood: • red blood cells • white blood cells • platelets.
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 blood in the veins. Explain, in terms of pressure difference, why blood flows from one area to another.

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Module B3: Living And Growing

Item B3e: The circulatory system

Links to other items: B1a: Fitness and health, B4d: Diffusion and osmosis, B5b: Circulatory system and the cardiac cycle, B5c: Running repairs

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.	Explain how the structure of a red blood cell is adapted to its function in terms of the small size providing a large surface area to volume ratio. Describe how haemoglobin in red blood cells reacts with oxygen in the lungs to form oxyhaemoglobin and how 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 into 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.	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. Understand 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 a baby using a case study or collected data. See Personal Child Health Record from Local Health Authority.	Recall that growth can be measured as an increase in height, wet mass or dry mass. Interpret data on a typical growth curve for an individual.
Research human stem cells. Research cancer (uncontrolled growth of cells).	Describe the process of growth as cell division followed by cells becoming specialised. Recall that the process of cells becoming specialised is called differentiation.
	Understand that animals grow in the early stages of 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.

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Module B3: Living And Growing

Item B3f: Growth and development

Links to other items: B3d: Cell division, B5h: Growth and repair, B6a: Understanding microbes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Identify simple differences between bacterial cells and plant and animal cells. Recall that bacterial cells lack: • a 'true' nucleus • mitochondria • chloroplasts.	Describe the difference between the arrangement of DNA in a bacterial cell and a plant/animal cell, to include: • presence/absence of a nucleus • single circular strand/chromosomes.
Recall that dry mass is the best measure of growth. Interpret data on increase in mass (including wet and dry mass). Describe the main phases of a typical growth curve. Recall 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 parts of an organism may differ from the growth rate of the whole organism.
Recall that undifferentiated cells called stem cells can develop into different cells, tissues and organs. Recall 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.	Explain the difference between adult and embryonic stem cells.
Explain why plant growth differs from animal growth, to include: • animals tend to grow to a finite size but many plants can grow continuously • plant cell division is mainly restricted to areas called meristems • cell enlargement is the main method by which plants gain height • many plant cells retain the ability to differentiate but most animal cells lose 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 the process of selective breeding as 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.
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.	Recall 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.

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Module B3: Living And Growing

Item B3g: New genes for old

Links to other items: B3a: Molecules of life, B3h: Cloning, B6h: Gene technology

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise that a selective breeding programme may lead to inbreeding, which can cause health problems within the species.	Explain how 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 • risks – inserted genes may have unexpected harmful effects. Describe, in outline only, some examples of genetic engineering: • taking the genes 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 vitamin A) • the production of human insulin by genetically engineered bacteria • transferring resistance to herbicides, frost damage or disease to crop plants. Discuss the ethical issues involved in genetic modification.	Understand 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.
Recall that changing a person's genes in an attempt to cure disorders is called gene therapy.	Recall that gene therapy could 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.	Recall 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.	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.

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Module B3: Living And Growing

Item B3h: Cloning

Links to other items: B1h: Variation and inheritance, B3d: Cell division, B3g: New genes for old

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that Dolly the sheep was produced by the process of nuclear transfer and that nuclear transfer involves placing the nucleus of a body cell into an egg cell. 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. Understand the ethical dilemmas concerning human cloning.	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.
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 why cloning plants is easier than cloning animals: many plant cells retain ability to differentiate unlike animal cells which usually lose this ability at an early stage.

3.7 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 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, pitfall 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 • pitfall traps • quadrats. Describe a method to show the variety of plants and animals living in a small area such as a 1m quadrat. Use keys to identify plants and animals.
Compare the communities of two different habitats. Use sensors and data loggers to collect data such as temperature, light intensity and soil pH then 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 how the distribution of organisms within a habitat is affected by the presence of other living organisms as well as physical factors.
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.

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Module B4: It's A Green World

Item B4a: Ecology in the local environment

Links to other items: B2a: Classification, B2e: Adaptations, B2g: Population and pollution, B6e: Life in soil, B6f: Microscopic life in water

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 = $\frac{\text{number in 1st sample} \times \text{number in 2nd sample}}{\text{number in 2nd sample previously marked}}$	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 differences between: • ecosystem and habitat • community 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 what it means for an ecosystem to be described as 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 and 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 in the first place and what they 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 and leaves deprived of light or carbon dioxide. Investigate the release of oxygen by pondweed.	Recall and use the word equation for photosynthesis: $\text{carbon dioxide + water} \xrightarrow[\text{(chlorophyll)}]{\text{(light energy)}} \text{glucose + oxygen}$ Understand that oxygen is a waste product in this reaction.
Draw a poster to show what happens to the glucose made in photosynthesis.	Recall that the glucose made in photosynthesis is transported as soluble sugars but is stored as insoluble starch. Recall 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 concentration on the rate of photosynthesis by measuring the rate of oxygen released from pondweed. Research how commercial glasshouses 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.

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Module B4: It's A Green World

Item B4b: Photosynthesis

Links to other items: B2b: Energy flow, B2c: Recycling, B3c: Respiration, B4c: Leaves and photosynthesis, B4d: Diffusion and osmosis, B4e: Transport in plants

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall and use the balanced symbol equation for photosynthesis: $6CO_2 + 6H_2O \xrightarrow{\text{(light energy)}}{\text{(chlorophyll)}} C_6H_{12}O_6 + 6O_2$ 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.	Explain how experiments using isotopes have increased our understanding of photosynthesis, to include: that oxygen produced by photosynthesis comes from the water and not the carbon dioxide. Describe photosynthesis as a two stage process: • light energy is used to split water, releasing oxygen gas and hydrogen ions • carbon dioxide gas combines with the hydrogen to make glucose.
Describe the conversion of glucose and starch to other substances in plants and their use: • 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 the internal structure of leaves. Use ICT to examine leaves www.plantscienceimages.org.uk.	Understand why chloroplasts are not found in all plant cells. Recall that chlorophyll pigments in chloroplasts absorb light energy for photosynthesis. Recall the entry points of materials required for photosynthesis: • water through root hairs • carbon dioxide through stomata. Recall the exit point of materials produced in photosynthesis: • oxygen through stomata. Understand that broader leaves enable more sunlight to be absorbed.

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Module B4: It's A Green World

Item B4c: Leaves and photosynthesis

Links to other items: B1g: Controlling plant growth, B4b: Photosynthesis, B4d: Diffusion and osmosis

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 • vascular bundle. Explain how leaves are adapted for efficient photosynthesis: • broad so large surface area • thin so short distance for gases to diffuse • contain chlorophyll and other pigments to absorb light from different parts of the spectrum • have a network of vascular bundles for support and transport • guard cells which open and close the stomata.	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 to volume ratio very large. Interpret data on the absorption of light by photosynthetic pigments (chlorophyll a and b, carotene and xanthophyll) to explain how plants maximise the use of energy from the Sun.

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 called 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.	Recall that substances move in and out of cells by diffusion through the cell membrane. Describe diffusion as the movement of a substance from a region of high to low concentration.
Carry out experiments to demonstrate osmosis using visking tubing and solutions of various concentrations.	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.	Recall 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 a microscope to investigate number/distribution of stomata.	Describe how carbon dioxide and oxygen diffuse in and out of plants through the leaves.
	Recall that water moves in and out of animal cells through the cell membrane.

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Module B4: It's A Green World

Item B4d: Diffusion and osmosis

Links to other items: B3d: Cell division, B3e: The circulatory system, B4c: Leaves and photosynthesis, B5d: Respiratory systems, B5e: Digestion, B5f: Waste disposal

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the net movement of particles by diffusion from an area of high concentration to an area of low concentration, as a consequence of the random movement of individual particles. Describe how molecules enter and leave cells by diffusion through the cell membrane.	Explain how 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 (i.e. dilute solution) to an area of low water concentration (i.e. concentrated solution). Recall that osmosis is a type of diffusion. Explain the term partially-permeable.	Explain the net movement of water molecules by osmosis from an area of high water concentration to an area of low water concentration across a partially-permeable membrane, as a consequence of the random movement of individual particles. Predict the direction of water movement in osmosis.
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 and turgid.
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 why there are differences in the effects of water uptake and loss on plant and animal cells. 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 a test of 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 tissues of some species of plants.	
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.	Understand that healthy plants must balance water loss with water uptake.

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Module B4: It's A Green World

Item B4e: Transport in plants

Links to other items: B4b: Photosynthesis, B4d: Diffusion and osmosis

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, to include 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. Understand 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.
Recall transpiration as the evaporation and diffusion of water from inside leaves. Describe how transpiration causes water to be moved up xylem vessels.	Explain how transpiration and water loss from leaves are a consequence of the way in which leaves are adapted for efficient photosynthesis.
Describe the effect on transpiration rate of: • increase in light intensity • increase in temperature • increase in air movement • decrease in humidity. Interpret data from experiments on transpiration rate.	Explain why transpiration rate is increased by: • increase in light intensity • increase in temperature • increase in air movement • decrease in humidity.
Explain how root hairs 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. Explain 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 (How Science Works practical activities).	Recall 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.	Describe experiments to show the effects on plants of mineral deficiencies: • soil-less culture • each trial missing one mineral.
	Describe how minerals are absorbed, to include: • dissolved in solution • by the root hairs • from the soil.

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Module B4: It's A Green World

Item B4f: Plants need minerals

Links to other items: B2c: Recycling, B4g: Decay, B4h: Farming

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why 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 how elements obtained from soil minerals are used in the production of compounds in plants, limited to: • nitrogen to make amino acids • phosphorus to make DNA and cell membranes • potassium to help enzymes (in photosynthesis and respiration) • magnesium to make chlorophyll.
Relate mineral deficiencies to the resulting 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.	
Recall that minerals are usually present in soil in quite low concentrations.	Explain how minerals are taken up into root hair cells by active transport. Understand that active transport can move substances from low concentrations to high concentrations (against the concentration gradient), across a cell membrane, using 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 when compost is made. This item is concerned with the process of decay and some examples. The experiments on decay provide the opportunity to plan a test of 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.	Recall the key factors in the process of decay: • presence of microorganisms • temperature • oxygen • moisture. Explain why decay is important for plant growth.
Carry out an experiment to show decay e.g. bread or fruit. Investigate the effect of temperature on decay.	Describe how to carry out an experiment to show that decay is caused by the decomposers bacteria and fungi.
Make a compost column. Visit a sewage works.	Recall 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.

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Module B4: It's A Green World

Item B4g: Decay

Links to other items: B3c: Respiration, B4f: Plants need minerals, B4h: Farming, B6d: Biofuels, B6e: Life in soil

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 why changing temperature, and the amounts of oxygen and water, affect the rate of decay in terms of the: • effect on microbial respiration • effect on growth and reproduction of microorganisms.
Recall that detritivores, including earthworms, maggots and woodlice, feed on dead and decaying material (detritus). Explain how detritivores increase the rate of decay by producing a larger surface area.	Explain the term saprophyte. Explain how saprophytic fungi digest dead material, in terms of extracellular digestion.
Explain how food preservation methods reduce the rate of decay.	

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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 a visit to a local farm/garden centre/small holding.	Analyse data to show that farmers can produce more food if they use pesticides and understand that these practices can cause harm to the environment and to health. Recall 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.	Recall that intensive farming means trying to produce as much food as possible from the land, plants and animals available. Describe how intensive farming methods can increase productivity methods limited to: • fish farming • glasshouses • hydroponics • battery farming.
Survey use of organic food and reasons for choice. Grow lettuce/tomato plants using hydroponics. Investigate websites such as DEFRA, LEAF.	Describe organic farming methods: • no artificial fertilisers • no pesticides.
	Describe how pests can be controlled biologically by introducing predators.

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Module B4: It's A Green World

Item B4h: Farming

Links to other items: B1g: Controlling plant growth, B4a: Ecology in the local environment, B4f: Plants need minerals, B4g: Decay, B6d: Biofuels

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the disadvantages of using pesticides: • pesticides may enter and accumulate in food chains • pesticides may harm organisms which are not pests • some pesticides are persistent.	
Describe how plants can be grown without soil (hydroponics). Describe possible uses of hydroponics, to include: • glasshouse tomatoes • plant growth in areas of barren soil. Understand that intensive farming methods may be efficient but they raise ethical dilemmas.	Explain the advantages and disadvantages of hydroponics: • better control of mineral levels and disease • lack of support for plant • required addition of fertilisers. 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) so that they are warm and move around less.
Describe organic farming techniques: • use of animal manure and compost • crop rotation including 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. In the context of biological control, explain how removing one or more organisms from a food chain or web may affect other organisms.	

3.8 Module B5: The Living Body

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 to provide 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 skeletons: • child and adult • arthritic joint • with rickets • with fractures. Examine human and animal skeletons and identify some of the bones.	Recall 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. Describe the different forms of 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 the health of bones e.g. bone density scans.	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 the 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.

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Module B5: The Living Body

Item B5a: Skeletons

Links to other items: B1a: Fitness and health

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why an internal skeleton is advantageous compared with an external skeleton: • framework of body • can grow with body • easy to attach muscles • flexibility. Understand 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 why long bones that are hollow are advantageous, in terms of weight and strength.	Understand that cartilage and bone are susceptible to infection but can grow and repair themselves. Describe how, in humans, the skeleton starts off as cartilage but is ossified: cartilage 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.
Recall that, despite being very strong, bones can easily be broken by a sharp knock. Explain why elderly people are more prone to fractures, limited to osteoporosis.	Explain why it can be dangerous to move a person with a suspected fracture.
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.

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.	Recall 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. Understand the difference between open and closed circulatory systems. Recall that in a closed circulatory system, blood will flow in arteries, veins and capillaries.
Watch video/flash clips on heart action.	Understand how heart muscle causes blood to move.
Interpret an electrocardiograph (ECG) trace of a normal beat (PQRS wave).	Describe the heart as made of powerful muscles which are supplied with food substances, including glucose, and oxygen by the coronary artery. Understand why the heart needs a constant supply of glucose and oxygen. 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).

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Module B5: The Living Body

Item B5b: Circulatory systems and the cardiac cycle

Links to other items: B3e: The circulatory system, B5c: Running repairs

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why many animals need a blood circulatory system. Describe a single circulatory system as being one circuit from the heart. Describe a double circulatory system as being two circuits from the heart. Compare the circulatory systems of fish and mammals.	Describe the contribution of Galen (2nd century) (importance of the pulse, the difference between blood in arteries and veins) 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. Understand that the blood is under a higher pressure in a double circulatory system compared with a single circulatory system and how this allows materials to be transported 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 how heart muscle contraction is controlled: by groups of cells called the pacemakers which produce a small electric current that 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. Recall that heart rate can 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 the 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. Recall 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.

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Module B5: The Living Body

Item B5c: Running repairs

Links to other items: B1a: Fitness and health, B3e: The circulatory system, B5b: Circulatory systems and the cardiac cycle, B5h: Growth and repair

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the consequences of a 'hole in the heart': • blood can move directly from one side of the heart to the other side of the heart • less oxygen in the blood • can require correction by surgery. Explain the consequences of damaged or weak valves in the heart: • reduce effective blood circulation • can require replacement by artificial valves. Explain the consequences of a blocked coronary artery: • reduces blood flow to the heart muscle • can require treatment by bypass surgery. Recognise that there are 'heart assist' devices as well as heart transplants.	Explain how a 'hole in the heart' results in less oxygen in the blood. Understand why unborn babies can all have a 'hole in the heart' and do not need a double circulatory system and why the hole closes soon after birth. Explain the advantages and disadvantages of a heart pacemaker or artificial heart valves over a heart transplant.
Describe the processes of: • blood donation • blood transfusion. Recall that haemophilia is an inherited condition in which the blood does not easily clot. Recall that drugs such as warfarin, heparin and aspirin are used to control clotting. Describe the process of blood clotting, limited to: • platelets in contact with damaged blood vessels, causing a series of chemical reactions leading to the formation of a mesh of fibrin fibres (clot).	Recall that unsuccessful blood transfusions cause agglutination (blood clumping). Explain how the presence of antigens and antibodies in red blood cells and blood serum determines how blood groups react and therefore whether a blood transfusion is successful. Describe which blood groups (A, B, AB and O) have: • 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.

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.	Understand why most living things need oxygen to release energy from food. Understand that small simple organisms, including amoeba and earthworms, take in oxygen through their moist and permeable external surfaces. Recognise that larger, more complex animals have special organs for exchange of gases, such as gills and lungs. Understand how surface area affects the exchange of gases.
Examine a model of a bell jar and rubber sheet to explain breathing. Measure lung capacities.	Describe the functions of the main parts of the human respiratory system (trachea, bronchus, bronchioles, lungs, alveoli, pleural membranes, ribs, intercostal muscles and diaphragm). Explain the terms breathing, respiration, inspiration (inhalation) and expiration (exhalation). Describe the direction of exchange of carbon dioxide and oxygen at the lungs and in tissues.
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.	Recall that there are many conditions and diseases of the respiratory system, to include: • asthma, bronchitis, pneumonia and lung cancer.

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Module B5: The Living Body

Item B5d: Respiratory systems

Links to other items: B1b: Human health and diet, B1e: Drugs and you, B3c: Respiration, B4d: Diffusion and osmosis

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise 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.	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.
Understand the process of ventilation in terms of changing volume and pressure to include breathing in humans. Explain the terms tidal air, vital capacity air and residual air as part of the total lung capacity. Explain how gaseous exchange occurs within alveoli by diffusion between air and blood.	Explain how gaseous exchange surfaces are adapted for efficient gaseous exchange (permeable, moist surface, large surface area, good blood supply and 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 – inflammation and scarring 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 why the respiratory system is prone to diseases. Describe 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.	Describe the position and function of the parts of the human digestive system: • salivary glands • stomach • pancreas • liver and gall bladder • small intestine • large intestine. Describe the process of physical digestion as breaking food into smaller pieces by: • chewing in the mouth • squeezing in the stomach. Understand that in chemical digestion the digestive enzymes breakdown large food molecules into smaller ones so they can be absorbed into the blood.
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.

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Module B5: The Living Body

Item B5e: Digestion

Links to other items: B1b: Human health and diet, B3b: Proteins and mutations, B4d: Diffusion and osmosis

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the importance of physical digestion: • to pass more easily through the digestive system • to provide a larger surface area. Explain how carbohydrates, proteins and fats are digested by specific enzymes in the mouth, stomach and small intestine respectively, limited to: • carbohydrase breaks down starch to sugar • protease breaks down protein to amino acids • lipase breaks down fat to fatty acids and glycerol. Recall that stomach acid aids protease function.	Explain how bile, from the gall bladder, improves fat digestion. Explain why the pH in the stomach is maintained at acidic levels, whereas the pH in the mouth and small intestine is alkaline or neutral. Understand that the breakdown of starch is a two step process involving the breakdown of starch into maltose and maltose into glucose.
Understand why large molecules need to be broken down into small molecules. Describe how small digested food molecules are absorbed into the blood plasma or lymph in the small intestine by diffusion.	Explain how the small intestine is adapted for the efficient absorption of food.

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 lungs 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.	Explain the difference between egestion and excretion. Name and locate the positions of the main organs of excretion: • lungs • kidneys • skin. Recall that the kidneys excrete urea, water and salt in urine. Understand that the amount and concentration of urine produced is affected by water intake, temperature and exercise.
Investigate the effect of exercise on rate of breathing.	Recall that carbon dioxide produced by respiration, is removed from the body through the lungs.

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Module B5: The Living Body

Item B5f: Waste disposal

Links to other items: B1e: Drugs and you, B1f: Staying in balance, B4d: Diffusion and osmosis

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand the importance of maintaining a constant concentration of water molecules in blood plasma. 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. Recall that urea, produced in the liver (from excess amino acids), is removed from the blood by the kidneys. Explain why the amount and concentration 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 it removes urea and maintains levels of sodium and glucose in the blood of a patient with kidney failure. Explain how the concentration of urine is controlled by the antidiuretic 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 why carbon dioxide must be removed from the body, limited to the toxic effect of high levels.	Explain how the body responds to increased carbon dioxide levels in the blood: • detected by the brain • increased rate of breathing results.

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 ovaries. Examine models of a developing foetus.	Describe the function of the scrotum: • keeps the testes outside the body where the temperature is better for sperm development. Describe the main stages of the menstrual cycle: • menstruation – uterus lining breaks down (period) • thickening of uterus lining • ovulation – egg released by ovary.
Role play or debate about using infertility treatments.	Understand that fertilisation and pregnancy are not guaranteed for all couples. Understand the causes of infertility, limited to: • blockage of fallopian tubes or sperm ducts • eggs not developed or released from ovaries • insufficient fertile sperm produced by testes. Recognise that in some, but not all, cases pregnancy can be achieved with the help of fertility treatment.
	Understand reasons for checking foetal development.
	Name and locate human endocrine glands and name the hormones produced: • ovaries – oestrogen, progesterone • testes – testosterone.

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Module B5: The Living Body

Item B5g: Life goes on

Links to other items: B1h: Variation and inheritance, B5h: Growth and repair

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe 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.	Explain how negative feedback mechanisms affect hormone production in the menstrual cycle.
Explain treatments for infertility to include: • artificial insemination • use of FSH • "in vitro" fertilisation (IVF) • egg donation • surrogacy • ovary transplants. Explain the arguments for and against such infertility treatments.	Evaluate infertility treatments in terms of moral issues, risks and benefits.
Describe how foetal development can be checked to identify conditions such as Down's syndrome using amniocentesis and chromosomal analysis. Explain why foetal screening raises ethical issues.	
Recall that fertility in humans can be controlled by the artificial use of sex hormones: contraceptive pill and fertility drugs.	Explain how fertility can be reduced by the use of female hormones (contraception) which prevent ovulation by mimicking pregnancy – inhibiting FSH release.

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 wear out or go 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 websites/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).	Recall that growth can be measured as an increase in height or mass. Understand that a person's final height and mass is determined by a number of factors, including: • 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.	Recall that, due to disease or trauma, it is sometimes necessary to replace body parts with biological or mechanical parts. Recall that some mechanical replacements such as the heart and lung machine, kidney dialysis and mechanical ventilators are used outside the body.
Research the history of one organ transplant.	Understand that organs can be donated by living or dead donors.

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Module B5: The Living Body

Item B5h: Growth and repair

Links to other items: B3f: Growth and development, B5c: Running repairs

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that extremes of 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. Understand why a baby's length, mass and head size are regularly monitored during their first months: to provide early warning of growth problems. Understand the use of average growth charts. Explain possible causes of the increase in life expectancy during recent times, to include: less industrial disease, healthier diet and life style, modern treatments and cures for disease and better housing.	Recall that the human growth hormone is produced by the pituitary gland and that it stimulates general growth especially in long bones. 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. 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 a register of donors. Interpret data on transplants and success rates.

3.9 Module B6: Beyond The Microscope

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. Understand that bacteria can reproduce very rapidly in suitable conditions. 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.
	Understand that viruses are: • not living cells • much smaller than bacteria and fungi.

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Module B6: Beyond The Microscope

Item B6a: Understanding microbes

Links to other items: B1c: Staying healthy, B2a: Classification, B3d: Cell division, B4g: Decay, B6b: Harmful microorganisms

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how the parts of bacterial cells relate to their function, 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 techniques for culturing bacteria on an agar plate.	Explain how bacteria: • can survive on an enormous range of energy sources • can exploit a very wide range of habitats because some bacteria can consume organic nutrients and others can make their own. Explain the consequences of very rapid bacterial reproduction in terms of food spoilage and disease. Explain reasons for the safe handling of bacteria.
Describe how yeast growth rate can be increased, its optimum growth rate being controlled by: • food availability • temperature • pH • 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. Understand 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
	Understand that some microorganisms are pathogens. Describe how pathogens 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.	Recall 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. Understand that bacteria can develop resistance to antibiotics.

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Module B6: Beyond The Microscope

Item B6b: Harmful microorganisms

Links to other items: B1c: Staying healthy, B6a: Understanding microbes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand how the transmission of diseases can be prevented, limited to disease transmitted by: • food • water • contact • airborne droplets. Describe the stages of an infectious disease, to include: • entry into the body • rapid growth, the incubation period • production of many toxins • appearance of symptoms such as fever.	Interpret data on the incidence of influenza, food poisoning and cholera.
Explain why natural disasters cause a rapid spread of diseases, to include: • damage to sewage systems and water supplies • damage to electrical supplies causing rapid food decay • displacement of people • disruption to 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. Recall that viruses are unaffected by 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.

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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.	Recall 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. Carry out experiments to show how yeast activity is affected by temperature.	Describe fermentation as the production of alcohol, including wine and beer, by the breakdown of sugars by yeast in the absence of oxygen. 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.

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Module B6: Beyond The Microscope

Item B6c: Useful microorganisms

Links to other items: B3c: Respiration, B6a: Understanding microbes

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 and 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 Describe the main stages in brewing beer or wine, to include: • extracting sugar from source material • adding yeast, keeping it warm • preventing entry of air and other microorganisms • 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 the implications for the fermentation process of yeast being able to undergo aerobic or anaerobic respiration. Interpret data on the breakdown of sugar by yeast in different conditions such as changing temperature and the 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.
Describe the process of distillation to increase the alcohol concentration, and understand that this commercial process needs licensed premises.	Understand how fermentation is limited by the effects of increasing levels of alcohol. Understand 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 need only 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 how plants produce biomass. 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.	Understand why biogas (mainly methane) is an important energy resource in certain remote parts of the world lacking a mains electricity supply or mains sewage system. Recall 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. Recall that biogas can be produced on a large scale using a digester. Explain why methane being released from landfill sites is dangerous: 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.

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Module B6: Beyond The Microscope

Item B6d: Biofuels

Links to other items: B2g: Population and pollution, B4h: Farming

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. Given data, evaluate different methods of transferring energy from biomass. Describe the advantages of using biofuels, to include: • alternative sources to fossil fuels • no increase in greenhouse gas levels • no particulates produced.	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 sulfide. 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.	Recall that biogas containing more than 50% methane can be burnt in a controlled way but a lower percentage of about 10% is explosive. Understand 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.	Understand why 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 and water content of soil.	Describe the main components of soil as being: • different sized mineral particles • dead material • living organisms • air • water.
Identify soil fauna and flora using identification keys. Examine microscopic soil life using light and binocular microscopes.	Describe a typical food web in a soil, to include: • herbivores such as slugs, snails and wire worms • detritivores such as earthworms, millipedes and springtails • carnivores such as centipedes, spiders and ground beetles. Describe the role of bacteria and fungi as decomposers.
Compare the composition of different soils.	Explain why soil is important for the majority of plants.
Set up a wormery.	Recognise that earthworms can improve soil structure and fertility.

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Module B6: Beyond The Microscope

Item B6e: Life in soil

Links to other items: B2b: Energy flow, B2c: Recycling, B4a: Ecology in the local environment, B4g: Decay

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the difference between a sandy soil and a clay soil in terms of particle size. Recall that loam is a soil that contains a mixture of clay and sand. Recall 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.
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. Explain why neutralising acidic soils and mixing up soil layers is important.
Explain why earthworms are important 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 acidic 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: More than 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 are a wide variety of microorganisms 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). Recall that phytoplankton are capable of photosynthesis and are producers in aquatic food chains and webs. Understand 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 microorganisms 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 the pollution source.

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Item B6f: Microscopic life in water

Links to other items: B2b: Energy flow, B4a: Ecology in the local environment

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.
Describe 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. Understand 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.

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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. Recall 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 people with diabetes test their urine (using either Benedict's test or reagent strip sticks) for the presence of glucose.
Immobilise enzymes in alginate beads and investigate the effect on a substrate.	Recall how some enzymes can be immobilised: • in gel beads • on reagent sticks. Recall that immobilised enzymes on reagent sticks can be used to measure glucose levels in the blood.

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Item B6g: Enzymes in action

Links to other items: B3b: Proteins and mutations

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the enzymes in biological washing powders, to include: • amylases – to digest the carbohydrate 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 why the products of digestion will easily wash out of clothes, in terms of their solubility. 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 how foods are sweetened using invertase: • invertase converts sucrose into glucose and fructose • these sugars are much sweeter than the sucrose • foods can 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 the 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 the condition of lactose intolerance: • they cannot produce the enzyme lactase • so bacteria in the gut ferment lactose • fermentation produces 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.

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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. Genetic engineering is possible due to the availability 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.	Define genetic engineering as altering the genetic code of an organism by inserting genes. Understand that genes from one organism can work in another. Describe the process of genetic engineering: • 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).	Recall that bacteria can be genetically engineered to produce useful human proteins, to include: • insulin • human growth hormone. Describe how 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'. Understand that this can be used to identify a person because a person's DNA is unique.

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Module B6: Beyond The Microscope

Item B6h: Gene technology

Links to other items: B3a: Molecules of life, B3g: New genes for old

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that the new type of organism produced by genetic engineering 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. Recall that the cutting and inserting of DNA is achieved using enzymes.	Explain why genes from one organism can work in another, making genetic engineering possible. 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 how, because these plasmids can be taken up by bacteria, they can be used as 'vectors' in genetic engineering. Recall 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.