# KS4 Combined Science Trilogy Scheme of Work - Biology

| Lesson Title | Objectives | Activities | Outcomes |
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| Topic 1 Cell Biology<br>Cells | Plant and animal cells are eukaryotic cells which have a membrane, cytoplasm and a nucleus.<br><br>Bacterial cells are prokaryotic cells. They are smaller than eukaryotic cells and have a cell wall, membrane and cytoplasm, but do not have a nucleus. Their genetic material is a single loop of DNA or several small rings of DNA called plasmids in the cytoplasm. | Display diagrams of a plant and animal cell – students spot the difference between the two.<br><br>Label diagrams of plant and animal and bacterial cells.<br>Complete a card sort to match the organelle to the function.<br><br>Construct a table to compare animal to plant cells. Include organelles and processes that they carry out (eg respiration, photosynthesis and protein synthesis).<br><br>Prepare slides and observe using a microscope. | Identify plant, animal and bacterial cells and classify them as eukaryotic or prokaryotic cells.<br>Label diagrams of plant, animal and bacterial cells.<br><br>Describe the differences between eukaryotic and prokaryotic cells in terms of structure and size. |
| Microscopy<br>Stem Cells | An electron microscope has a much higher magnification and resolution than a light microscope, so it can be used to study cells in much finer detail and show organelles.<br><br>$$real\ size = \frac{image\ size}{magnification}$$<br><br>Stem cells are unspecialised cells that can differentiate to form many different types of cells.<br>Stem cells may be used to treat paralysis and diabetes in the future. | Calculate the real size of microscope images, and convert units as appropriate.<br>Rearrange the equation to calculate a different unknown.<br><br>Video on the use of stem cells.<br><br>Evaluate risks and benefits, as well as the social and ethical issues concerning the use of stem cells from embryos in medical research and treatments. | Describe the differences in magnification and resolution of light and electron microscopes.<br>Explain how electron microscopy has increased understanding of organelles.<br>Calculate the magnification of a light microscope.<br>Carry out calculations using the formula:<br><br>$$real\ size = \frac{image\ size}{magnification}$$<br><br>Rearrange the equation to calculate image size or magnification. |

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| | | | Convert values for the units: cm, mm, µm and nm.<br>Define the term 'stem cell'.<br><br>Describe where stem cells can be found in animals and plants.<br><br>Describe how stem cells could be used to help treat some medical conditions. Evaluate risks and benefits, as well as the social and ethical issues concerning the use of stem cells from embryos in medical research and treatments. |
| Diffusion, Osmosis and Active Transport | Substances can move into and out of cells across membranes by diffusion.<br>Definition of diffusion and factors affecting rate.<br><br>Water may move across cell membranes by osmosis.<br>Osmosis is the movement of water from a dilute solution to a more concentrated solution through a partially permeable membrane<br><br>Active transport involves the movement of a substance against a concentration gradient and requires energy from respiration.<br><br>Mineral ions can be absorbed by active transport into plant root hairs from very dilute solutions in the soil.<br><br>Sugar can be absorbed by active transport from the gut into the blood. | Observe demos and suggest explanations:<br>• Time how long it is before students can smell a perfume placed in a corner of the room.<br>• Is the rate of diffusion different for different gases? Use concentrated ammonium hydroxide and hydrochloric acid in a large glass tube.<br>• Does temperature affect the rate of diffusion? Fresh beetroot placed in iced water and warm water.<br>Record observations and suggest explanations.<br>Observe and explain the effects of water and concentrated salt solution on cells of a potato. | Define the term 'diffusion'.<br><br>Explain how temperature, concentration gradient and surface area affect the rate of diffusion.<br><br>Give examples of substances that diffuse into and out of cells.<br><br>Define the term 'osmosis'.<br><br>Describe where active transport occurs in humans and plants and what is transported.<br><br>Explain why active transport requires energy. |

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| | | Introduce active transport as absorption against the concentration gradient. Discuss when this might be useful. | |
| Topic 2 Organisation<br><br>Principals of organisation and the digestive system | Cells are the building blocks of living organisms.<br>A tissue is a group of cells with a similar structure and function.<br>Organs are groups of tissues working together.<br>Organs are organised into organ systems.<br>An organism is made up of several organ systems.<br>The human digestive system<br>The structure and functions of the digestive system. | Produce a flow diagram showing organisation in large organisms and relate to size.<br>Label a diagram of the digestive system and colour areas where digestion, digestion and absorption of food and absorption of water occur.<br>Watch a video of digestion | Explain the terms cell, tissue, organ, organ system and organism, and be able to give examples of each.<br>Have an understanding of the size and scale of cells, tissues, organs, organ systems and organisms.<br>Describe the main systems in the human body and their functions.<br>Describe the functions of the digestive system to digest and absorb foods.<br>Identify the positions of the main organs on a diagram of the digestive system.<br>Know that food molecules must be small and soluble in order to be absorbed into the blood.<br>Describe the functions of the organs in the system<br>Explain how the small intestine is adapted for its function |
| Enzymes | Properties of enzymes<br>Enzymes are biological catalysts.<br>The lock and key theory and collision theory can be used to explain enzyme action. | Demo: the action of an inorganic catalyst and catalase, using living and dead tissues, on the breakdown of hydrogen peroxide. Use the observations to lead into the properties of enzymes. | Define the terms ‘catalyst’ and ‘enzyme’.<br>Describe the properties of enzymes. |

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| | Required practical:<br><br>Investigate the effect of pH on the rate of reaction of amylase enzyme. | Required practical: Carry out a safe, controlled investigation to measure the rate of the catalase reaction under different conditions. Draw a diagram of the apparatus and write a method. Identify variables. Present and analyse the results: calculate rates of reaction using raw data and graphs. Draw conclusions and give explanations for the results. | Explain why enzymes are specific and are denatured by high temperatures and extremes of pH.<br><br>Use the lock and key theory and collision theory to explain enzyme action.<br>Carry out a safe, controlled investigation to measure the rate of the catalase under different conditions.<br><br>Draw a diagram of the apparatus and write a method. Identify variables. Present and analyse the results: calculate rates of reaction using raw data and graphs. Draw conclusions and give explanations for the results. |
| Digestive Enzymes and Food Tests | Human digestive enzymes<br><br>Enzymes in the digestive system chemically digest food into small, soluble molecules that can be absorbed.<br><br>Names of enzymes with substrates, products and sites of production.<br><br>Bile is made by the liver and stored in the gall bladder. It helps in the digestion of fats by neutralising acid from the stomach and emulsifying fats.<br><br>Different enzymes work best at different temperatures and pH values.<br><br>Required practical: Food tests<br><br>Use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for | Introduce the names of the three groups of digestive enzymes, what they digest and the products formed. Present the information in a table.<br><br>Discuss the role of bile and demonstrate the action of washing up liquid on fats.<br><br>Using a model or large poster of the digestive system identify where each type of enzyme and bile is produced.<br><br>Add labels to the digestive system diagram to show where the different enzymes and bile are produced.<br><br>Food test Practical | Explain why foods need to be digested into small, soluble molecules.<br><br>Describe the three types of enzymes involved in digestion, including the names of the substrates, products and where the enzymes are produced.<br><br>Explain how bile helps in the digestion of fats.<br><br>Interpret graphs to determine the optimum temperature or pH for an enzyme.<br><br>Carry out other enzyme controlled investigations as appropriate. |

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| | sugars; iodine test for starch; and Biuret reagent for protein. | | Calculate the rate of enzyme controlled reactions.<br>Interpret the results from enzyme controlled reactions. |
| The Lungs and Gas Exchange | How the lungs are adapted for efficient gas exchange. | Label a diagram of the gas exchange system.<br>Label a diagram of the alveoli and explain how they are adapted for efficient gas exchange. | Label the main structures in the gas exchange system – trachea, bronchi, alveoli and capillary network around alveoli.<br>Explain how the alveoli are adapted for efficient gas exchange. |
| The Heart and Blood Vessels | How the heart is adapted for its function.<br>The names of the blood vessels associated with the heart.<br>Pacemaker cells regulate the beating of the heart.<br>Artificial pacemakers correct irregularities in heart rate. | Show pictures of a single and a double circulatory system. Pupils write down similarities and differences. Discuss the reasons why.<br>Use computer simulation to show the flow of blood around the heart, lungs and body.<br>Label a diagram of the heart and colour to show oxygenated and deoxygenated blood. | Describe the functions of the heart and circulatory system<br>Describe and label a diagram of the heart showing four chambers, vena cava, pulmonary artery, pulmonary vein and aorta.<br>Describe the flow of blood from the body, through the heart and lungs and back to the body.<br>Explain how the heart is adapted for its function.<br>Describe the heart as a double pump and explain why this is efficient.<br>Describe the function of the pacemaker cells and coronary arteries. |
| Structure and function of arteries, veins, capillaries and blood. | Structure and function of arteries, veins and capillaries | Use computer simulation or video clip showing the three types of blood vessels and comparing their functions. Extract | Explain how the blood vessels are adapted for their function.<br>Describe the four main components of blood. |

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| | Blood is a tissue consisting of plasma, red blood cells, white blood cells and platelets.<br>Plasma transports dissolved chemicals and proteins around the body.<br>Red blood cells transport oxygen attached to haemoglobin.<br>White blood cells help to protect the body against infection.<br>Platelets are fragments of cells involved in blood clotting. | information to explain the structure of the blood vessels.<br>Label diagrams of the three types of blood vessel.<br>Produce a table to compare the structure of the vessels and relate to their function.<br>Discuss the functions of blood and describe the four main components of blood.<br>Draw and label diagrams of red blood cells, white blood cells and platelets. | Explain how each component is adapted for its function.<br>Identify pictures of the different blood cells. |
| Coronary Heart Disease | Fatty material builds up in coronary arteries reducing blood flow to the heart muscle.<br>Stents can be used to keep the coronary arteries open.<br>Statins reduce cholesterol levels, so fatty material is deposited more slowly.<br>Faulty heart valves can be replaced with biological or mechanical ones.<br>Heart failure can be treated with a heart and lung transplant.<br>Artificial hearts can be used whilst waiting for a transplant, or to allow the heart to rest | Watch video clip about coronary heart disease.<br>Discuss the different types of heart problems that can occur and how they are treated –blocked coronary arteries, heart attack, faulty valves, hole in the heart, drugs, transplants, artificial hearts and replacement valves. Produce a report or PowerPoint presentation on each type.<br>Observe illustrations of artificial hearts and replacement valves. | Describe problems associated with the heart and explain how they can be treated.<br>Evaluate the use of drugs, mechanical devices and transplants to treat heart problems, including religious and ethical issues. |
| Non-Communicable Diseases | Health issues and Effect of lifestyle on non-communicable diseases | Carry out research using textbooks and the internet and write a report on the effects of diet, stress, smoking, alcohol | Give examples of communicable and non-communicable diseases. |

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| | Health is the state of physical and mental well-being.<br><br>Different diseases may interact: defects in the immune system increase the chance of catching an infectious disease.<br><br>Physical ill-health can lead to depression and mental illness.<br><br>Various risk factors are linked to some non-communicable disease.<br><br>Cancers (malignant tumours) result from uncontrolled cell division.<br>Cancer cells may invade neighbouring tissues, or break off and spread to other parts of the body in the blood, where they form secondary tumours. | and exercise on health, to include risk factors for specific diseases.<br><br>Analyse data about health risks and diseases.<br><br>Research the causes of cancer and cancer treatment.<br><br>Explore activities and information on cancer research site. | Describe examples of how diseases may interact.<br><br>Describe the effects of diet, smoking, alcohol and exercise on health.<br><br>Explain how and why the Government encourages people to lead a healthy lifestyle.<br><br>Give risk factors associated with cardiovascular disease, Type 2 diabetes, lung diseases and cancers.<br>Describe some causes of cancer, eg viruses, smoking, alcohol, carcinogens and ionising radiation.<br><br>Describe the difference between benign and malignant tumours.<br><br>Explain how cancer may spread from one site in the body to form a secondary tumour in another part of the body. |
| Topic 3 Infection and Response<br><br>Communicable Diseases | Communicable diseases are infectious diseases caused by pathogens.<br><br>Pathogens may be viruses, bacteria, protists or fungi. They may infect plants or animals.<br><br>Pathogens can be spread by direct contact, by water or by air.<br><br>The spread of diseases can be reduced or prevented by:<br>• simple hygiene measures<br>• destroying vectors<br>• isolation of infected individuals | Provide images of bacteria, viruses, protists and fungi on the internet.<br><br>Construct a table comparing fungi, virus, bacteria and protists to include size, site of reproduction and effects in the body.<br><br>Use card sort matching diseases to transmission and prevention. | Define the term pathogen and state the four main groups of pathogen.<br><br>Explain how pathogens can be spread to plants or animals and cause infection.<br><br>Describe the main differences between bacteria and viruses.<br><br>Explain how the spread of disease can be reduced or prevented. |

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| | vaccination | | |
| Viral, bacterial, protist and fungal diseases in humans | Viral diseases include measles and AIDS, which is caused by the HIV.<br><br>Viral disease cannot be treated with antibiotics.<br><br>Bacterial diseases include salmonella food poisoning and the sexually transmitted disease gonorrhoea.<br><br>Humans can also be infected with fungal diseases.<br><br>Protist diseases – malaria<br><br>Malaria is caused by a protist transmitted by mosquitos.<br><br>Spread of malaria is controlled by preventing the vectors (mosquitos) from breeding and by using mosquito nets to avoid being bitten. | Small group project using ICT, researching to find out about the symptoms, mode of transmission, prevention and treatment for measles, HIV and AIDS, salmonella and gonorrhoea.<br><br>Present findings in a table and illustrate with images of these microorganisms.<br><br>Watch a BBC video clip showing the effect of the malarial protest on red blood cells).<br><br>Research the symptoms, mode of transmission, prevention and treatment for malaria. | Describe the symptoms, mode of transmission, prevention and treatment for measles, HIV and AIDS, salmonella and gonorrhoea.<br><br>Describe colds and flu as viral diseases.<br><br>Describe athlete's foot as a fungal disease.<br><br>Describe the life cycle of the malarial protist.<br><br>Describe the symptoms, mode of transmission, prevention and treatment for malaria. |
| Human Defence Systems | The body defends itself against the entry of pathogens<br><br>Bacteria may produce toxins that make us feel ill and damage tissues.<br><br>Viruses live and reproduce inside cells, causing damage.<br><br>The immune system tries to destroy pathogens that enter the body.<br><br>White blood cells help to defend against pathogens by:<br>• phagocytosis<br>• antibody production<br>antitoxin production. | Label a diagram to show how the body defends itself against the entry of pathogens.<br><br>Watch a BBC video clip showing phagocytosis.<br><br>Research how white blood cells defend the body.<br><br>Draw diagrams or a cartoon strip to show the actions of white blood cells using key words: ingest, phagocytosis, antibodies and antitoxins. | Explain how microbes make us feel ill and how viruses damage cells.<br><br>Explain how the immune system defends against disease<br><br>Describe what white blood cells do.<br><br>Explain why antibodies are specific for one pathogen/ antigen. |

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| Vaccination | A vaccine contains a small amount of dead or inactive pathogens. These stimulate white blood cells to produce antibodies.<br><br>Immunity allows a person to produce specific antibodies quickly to prevent infection.<br><br>If a large proportion of the population is immune to a pathogen, the spread of the pathogen is very much reduced. | Watch a BBC video about Edward Jenner. Evaluate the method he used in developing the first vaccine and compare with modern methods.<br><br>Discuss what a vaccine contains and how it works.<br><br>Interpret graph showing primary and secondary response to a pathogen<br><br>Evaluate risks related to vaccinations. | Describe what a vaccine contains.<br><br>Explain how vaccines prevent disease.<br><br>Explain the idea of 'herd immunity'. |
| Antibiotics and Painkillers | Antibiotics, eg penicillin, are used to kill infective bacteria inside the body.<br><br>Specific bacteria should be treated with specific antibiotics.<br><br>The emergence of strains resistant to antibiotics is of great concern.<br><br>Antibiotics cannot kill viral pathogens.<br><br>Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens.<br><br>Alexander Fleming discovered penicillin from the Penicillium mould. | Describe the importance of antibiotics and the impact of antibiotic resistance. Explain how this has impacted on cleaning practices in Britain's hospitals. Research MRSA and C. difficile infections and treatment.<br><br>Suggest what patients, doctors and scientists should do to ensure we will have effective antibiotics in the future.<br><br>Discussion starter – imagine the world we would live in if antibiotics stopped working.<br><br>Brainstorm symptoms of diseases and medicines used to relieve symptoms and treat disease; names of some antibiotics. | Explain how antibiotics treat only bacterial diseases and how this has saved lives.<br><br>Describe the problems associated with antibiotic resistance.<br><br>Give examples of painkillers and other medicines used to treat symptoms.<br><br>Interpret data about painkillers and other medicines.<br><br>Describe Fleming's discovery and explain its importance. |
| Discovery and Development of Drugs | Traditionally drugs were extracted from plants and microorganisms.<br><br>Most new drugs are synthesised by chemists; the starting point may still be a chemical extracted from a plant. | Discuss drug safety and how drugs are tested today.<br><br>Use cards/cut-outs to sequence the stages in drug testing and trialling and explain the purpose of each stage. | State which drugs come from plants and microorganisms.<br><br>Explain why drugs need to be tested before they can be prescribed. |

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| | New drugs are tested for toxicity, efficacy and dose.<br><br>Preclinical testing in the lab, then clinical trials involving healthy volunteers and then patients.<br><br>In a double blind trial, some patients are given a placebo; neither the doctors nor the patients know who has received a placebo and who has received the drug | Create flow diagram of stages in process.<br><br>Answer past questions about drug testing. | Describe the main steps in the development and testing of a new drug.<br><br>Give reasons for the different stages in drug testing.<br><br>Explain the terms placebo and double-blind trial. |
| Topic 4 Bioenergetics Plants and Photosynthesis | Word and symbol equation for photosynthesis. | Discuss what plants need to survive and how plants are useful to other organisms in order to come up with the word equation for photosynthesis.<br><br>Set up experiments or demos. Test leaves in following lesson.<br><br>Set up a demo to show that plants produce oxygen.<br><br>Write word and symbol equations for photosynthesis – produce cards for equation and put into correct order.<br><br>Test leaves for starch, putting the results for all the different experiments into a table. | Write the word and symbol equation for photosynthesis<br><br>Explain why photosynthesis is important for the survival of other organisms.<br><br>Investigate the need for light, carbon dioxide and chlorophyll to make glucose.<br><br>Explain why plants should be de-starched before photosynthesis experiments and describe how this is done.<br><br>Describe experiments to show that plants produce oxygen in the light.<br><br>Test to see if a leaf contains starch.<br><br>Explain why the leaves are tested for starch and not for sugar.<br><br>Describe the test for oxygen.<br><br>Interpret results and relate to photosynthesis equation. |

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| Plant Organs and Plant Tissue | Plant organs and Plant tissues.<br><br>The leaf<br><br>Plant organs include stems, roots and leaves.<br><br>Organs are made up of different tissues, eg meristem tissue at growing tips.<br><br>The leaf is the organ of photosynthesis.<br><br>Examples of tissues in a leaf: epidermis, palisade and spongy mesophyll, xylem, phloem, guard cells and stomata. How these tissues are adapted for their function. | Label a diagram of a plant with names and functions of organs.<br><br>Label a diagram of a cross section through a leaf.<br><br>Describe how the tissues are adapted for their role in photosynthesis.<br><br>Dip leaves into hot water and make nail varnish imprints of stomata and observe under the microscope. Suggest reasons why there are more stomata on the lower surface.<br><br>Explain how the guard cells and stomata control water loss and gas exchange. | Label the main organs of a plant and describe their functions.<br><br>Identify the tissues in a leaf and describe their functions. Relate the structure of each tissue to its function in photosynthesis.<br><br>Explain why there are more stomata on the lower surface of a leaf.<br><br>Describe the role of stomata and guard cells to control water loss and gas exchange. |
| Plant Transport Systems | The roots, stem and leaves form a plant transport system.<br><br>Root hair cells absorb water by osmosis and mineral ions by diffusion and active transport. (See next lesson).<br><br>Xylem tissue transports water and dissolved ions. The flow of water from the roots to leaves is called the transpiration stream.<br><br>Xylem tissue is composed of hollow tubes strengthened with lignin.<br><br>Phloem tissue transports dissolved sugars from the leaves to other parts of the plant. The movement of food through phloem is called translocation. | Demonstrate transport of coloured dye in celery or a plant stem then allow students to take sections and observe the dye in the xylem vessels under the microscope.<br><br>Observe and draw xylem, phloem and root hair cells. Estimate the size of the cells. Describe how they are adapted for their functions.<br><br>Label a diagram of a plant to show that water enters via the roots and travels in the xylem to the leaves; carbon dioxide enters leaves via stomata; light is absorbed by chlorophyll in leaves; dissolved sugars are transported from the leaves in the phloem to other parts of the plant. | Describe the organs that make up the plant transport system.<br><br>Describe the role of xylem, phloem and root hair cells and explain how they are adapted for their functions.<br><br>Define the terms ‘transpiration’ and ‘translocation’. |

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| Rate of Photosynthesis and Limiting Factors | The rate of photosynthesis may be limited by:<br>• low temperature<br>• shortage of $CO_2$<br>• shortage of light<br>• shortage of chlorophyll.<br>Required Practical: Photosynthesis<br>Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.<br>Factors that can limit the rate of photosynthesis are called limiting factors.<br>Limiting factors are important economically in greenhouses. | Discuss how the rate of photosynthesis could be measured and consider different methods.<br>Required practical: carry out an investigation, collect, present and analyse the results.<br>Interpret graphs and explain limiting factors.<br>Design a greenhouse to maintain optimum growth of plants on the moon. Explain all its design features.<br>Compare growth in different areas and relate to photosynthesis. | State factors that can limit the rate of photosynthesis.<br>Interpret data showing how factors affect the rate of photosynthesis.<br>Required practical: carry out an investigation, collect, present and analyse the results.<br>Calculate the rate using numerical information or graphs.<br>Interpret graphs to decide which factor is limiting the rate.<br>Explain how conditions in greenhouses can be controlled to optimise the growth of plants.<br>Relate limiting factors to the cost effectiveness of adding heat, light or carbon dioxide to greenhouses. |
| Aerobic and Anaerobic Respiration | Respiration can take place aerobically or anaerobically to transfer energy.<br>Respiration is an exothermic reaction.<br>Organisms need energy for chemical reactions, movement and to keep warm.<br>During aerobic respiration glucose and oxygen react to release energy.<br>Word and symbol equation for aerobic respiration. | Discuss substance the body uses as a source of energy and what aerobic means in order to build up the word equation for aerobic respiration.<br>Discuss how to show that humans transfer energy and produce water and carbon dioxide. Relate these observations to the word equation for aerobic respiration.<br>Interpret data on heart rate, temperature and depth of breathing during exercise.<br>Interpret data to compare how fit different people are. | State that all animals and plants produce carbon dioxide and water all the time as a by-product of aerobic respiration.<br>Write the word equation for aerobic respiration.<br>Define the term ‘aerobic’.<br>Describe what organisms need energy for.<br>Explain why anaerobic respiration is less efficient than aerobic respiration. |

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| | Anaerobic respiration is the incomplete oxidation of glucose so less energy is released than in aerobic respiration.<br><br>Word equation for anaerobic respiration in muscle cells.<br><br>Word and symbol equation for anaerobic respiration in some plant and yeast cells. | Discuss causes and effects of muscle fatigue and relate these to lactic acid build up. | Write the word equation for anaerobic respiration in animal cells.<br><br>Write the word and symbol equation for anaerobic respiration in yeast cells.<br><br>State that anaerobic respiration in yeast is called fermentation.<br><br>Describe and explain the changes that occur in the body during exercise. |
| Topic 5 Homeostasis and Response<br><br>Introduction to Homeostasis<br>Structure and Function of the nervous system | Homeostasis is the regulation of internal conditions to maintain optimal conditions for enzyme action and cell function.<br><br>Structure and function of the nervous system.<br><br>Functions: to detect and react to stimuli; to coordinate behaviour.<br><br>Structure: the CNS is made up of the brain and spinal cord; receptors, different types of neurones, coordinator as brain or spinal cord, effectors, synapses. | Explain how detection of stimuli protects the body from danger.<br><br>Demo: response to different temperatures.<br><br>Detecting different tastes on the tongue – draw results on diagram of tongue.<br><br>Investigate sensitivity of different areas of the body. | Describe the roles of the nervous system and the endocrine system in homeostasis.<br><br>Explain the importance of being able to respond to environmental changes and coordinate behaviour.<br><br>Explain how the nervous system is adapted for its functions.<br><br>Describe the functions of the main structures in the nervous system.<br><br>Explain the role of chemicals at synapses. |
| Investigating Reaction Time<br>Reflex Actions | Reaction time. Plan and investigate the effect of a factor on human reaction time.<br><br>Reflex actions; The brain<br><br>Reflex actions are automatic and rapid to protect the body from harm. | Label a diagram of a reflex arc.<br><br>Draw a flow diagram or use cards to show the sequence in a reflex action. | Explain the importance of reflex actions and give examples.<br><br>Describe the differences between voluntary and reflex actions.<br><br>Describe the stages of a reflex action. |
| The Endocrine System | The system is composed of endocrine glands that secrete hormones into the | Label a diagram of the endocrine system using information on the cards | Describe the endocrine system and define the term hormone. |

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| | blood to be carried to a target organ where it has an effect.<br><br>The positions of the pituitary, thyroid, adrenal glands, ovaries and testes.<br><br>The pituitary is the master gland. It secretes many hormones that affect other glands.<br><br>Hormones are chemical messengers.<br><br>The effects of the endocrine system are slower, but longer acting than the nervous system. | Write definitions for endocrine system and hormone.<br><br>Discuss why the pituitary gland is called the master gland.<br><br>Compare the actions of the endocrine system with the nervous system. | Relate hormone release and hormone action to the control system model.<br><br>Label a diagram of the organs in the endocrine system.<br><br>Explain why the pituitary gland is often called the master gland.<br><br>Compare the actions of the nervous and endocrine systems. |
| Hormones in Reproduction | During puberty hormones cause sexual characteristics to develop.<br><br>In females oestrogen is produced by the ovaries. Eggs mature and are released (ovulation) every 28 days.<br><br>In males testosterone is produced by the testes and stimulates sperm production.<br><br>The roles of FSH, LH, oestrogen and progesterone in the menstrual cycle of a woman. | Watch BBC video clip about puberty.<br><br>Describe the changes that occur in boys and girls during puberty and discuss what causes these changes.<br><br>Watch BBC video clips of ovulation and the menstrual cycle. Discuss how hormones control the changes seen.<br><br>Use a model, eg diagram, chart, animation etc to show the names, sites of production and effects of FSH, LH, oestrogen and progesterone in the menstrual cycle. | Describe secondary sexual characteristics of boys and girls.<br><br>Explain the cause of these changes in boys and girls and their relevance in reproduction.<br><br>Describe the menstrual cycle and fertility including the role of hormones.<br><br>Oestrogen is secreted by the ovaries. It inhibits production of FSH and stimulates release of LH. It makes the uterus lining grow again after menstruation.<br><br>Progesterone is secreted by the empty follicle in the ovary after ovulation. It inhibits FSH and LH production and maintains the lining of the uterus during the second half of the cycle. |

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| Fertility and Contraception | Fertility can be controlled using hormonal and non-hormonal contraceptives.<br><br>Women can be given a 'fertility drug' containing FSH and LH to stimulate ovulation.<br><br>In IVF treatment FSH and LH are given to stimulate many eggs to mature. These are collected and fertilised by sperm in a lab. Embryos form, and some are inserted into the woman's uterus.<br><br>The advantages and disadvantages of fertility treatment, eg stress, success rate and multiple births. | Complete a table summarising: method of action, hormone name, how they work, advantages, disadvantages<br><br>Discuss possible causes of infertility in men and women and treatments available.<br><br>Research the process of IVF and produce a leaflet for a doctor's surgery to describe the main stages involved in IVF treatment. | Describe hormonal and non-hormonal methods of contraception.<br><br>Explain how hormonal and non-hormonal contraceptives work.<br><br>Describe the use of fertility drugs in women with low FSH levels.<br><br>Use a model, eg a flow diagram to explain the process of In Vitro Fertilisation (IVF).<br><br>Evaluate the use of fertility treatments. |
| Control of Blood Glucose Concentration | Blood glucose concentration is monitored and controlled by the pancreas. It produces insulin, which causes glucose from the blood to enter cells.<br><br>Glucose is converted to glycogen in liver and muscle cells for storage.<br>In Type 1 diabetes the pancreas does not produce enough insulin. Glucose levels may rise too high.<br><br>Type 1 diabetes is usually treated with insulin injections.<br><br>In Type 2 diabetes the cells do not respond properly to insulin.<br><br>Type 2 diabetes is usually treated by diet, exercise and drugs. Obesity is a risk factor for Type 2 diabetes. | Research and produce a report to explain the cause, effects, treatment and problems associated with Type 1 diabetes. diabetes.org.uk is a good resource.<br><br>Research how treatment of diabetes has developed including use of human insulin produced by bacteria, current research into pancreas cell transplants and stem cell research.<br><br>Discuss the causes, treatment and problems associated with Type 2 diabetes.<br><br>Compare Type 1 and Type 2 diabetes and present the information in a suitable format. | Describe how blood glucose concentration is monitored and controlled.<br><br>Explain when insulin is produced and how it helps to control blood glucose levels.<br><br>Describe glycogen as a stored carbohydrate.<br><br>HT: Explain when glucagon is produced by the pancreas and its effect on blood glucose levels.<br><br>Explain how insulin and glucagon work together to control blood glucose levels. |

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| | | | Explain the cause, effects, treatment and problems associated with Type 1 diabetes.<br><br>Interpret glucose tolerance test results.<br><br>Evaluate modern methods of treating diabetes. |
| Topic 6 Inheritance, Variation and Evolution<br><br>Sexual and Asexual Reproduction<br>Mitosis and Meiosis | Sexual reproduction involves the joining (fusion) of male and female gametes, sperm and eggs in animals and pollen and ovule cells in flowering plants. This mixing of genetic information leads to variation in the offspring. Gametes are produced by meiosis.<br><br>Asexual reproduction involves only one parent and no fusion of gametes. There is no mixing of genetic information. This leads to genetically identical offspring (clones). Only mitosis is involved.<br><br>Mitosis occurs during growth or to produce replacement cells.<br>During mitosis:<br>• copies of the genetic material separate<br>• the cell then divides once to form two genetically identical cells.<br>Mitosis forms part of the cell cycle.<br><br>Cells in reproductive organs divide by meiosis to form gametes.<br><br>When a cell divides to form gametes: copies of the genetic information are | Draw simple diagrams to describe the cell cycle and mitosis.<br>Watch video clip showing mitosis.<br><br>Discuss how organisms grow and relate this to cell division.<br><br>Consider fusion of sex cells at fertilisation and explain why gametes have only one set of chromosomes – use models or diagrams.<br><br>Watch BBC video clip and access information on mitosis and meiosis.<br><br>Produce a poster to compare mitosis and meiosis. | Explain why sexual reproduction produces variation in the offspring, but asexual reproduction does not.<br><br>Describe simply how and why body cells divide by. Knowledge and understanding of the stages in mitosis are **not** required.<br><br>Draw simple diagrams to describe mitosis.<br><br>Draw a simple diagram to describe the cell cycle in terms of:<br>• cell growth, when the number of organelles increases<br>• replication of chromosomes, so the genetic material is doubled<br>• separation of the chromosomes: division of the nucleus<br>division of the cell to form two identical cells.<br><br>Explain the term gametes and describe their genetic material. |

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| | made and the cell divides twice to form four gametes, each with a single set of chromosomes.<br><br>All gametes are genetically different from each other.<br><br>Gametes join at fertilisation to restore the normal number of chromosomes. The new cell divides by mitosis, and as the embryo develops cells differentiate. | | Explain why sexual reproduction results in variety.<br><br>Draw diagrams to explain how gametes are formed in meiosis.<br><br>Explain the number of chromosomes in the gametes during meiosis and fertilisation.<br><br>Describe how an embryo is formed.<br><br>Compare mitosis and meiosis. |
| DNA and Sex Determination | DNA is a polymer made up of two strands forming a double helix.<br><br>DNA is found in chromosomes.<br><br>A gene is a small section of DNA.<br><br>Each gene codes for a sequence of amino acids to form a particular protein.<br><br>The genome is all the genetic material of an organism.<br><br>The human genome has been studied and will be important for medicine in the future.<br><br>Human body cells contain 23 pairs of chromosomes.<br><br>22 pairs control characteristics only. The 23rd pair carries the genes that determine sex. In females the sex chromosomes are the same (XX); in males the chromosomes are different (XY). | Extract DNA from fruits such as onions or kiwi fruit. Observe the long strands which are the polymer.<br><br>Look at male and female karyotypes and identify the number of pairs of chromosomes and each pair of sex chromosomes.<br><br>Use a Punnett square and a genetic cross diagram to illustrate the inheritance of sex; evaluate the chance of producing a male or female. | Describe the structure of chromosomes, DNA and genes.<br><br>Explain that a gene is a small section of DNA that codes for a particular sequence of amino acids to make a specific protein**.**<br><br>Describe what the genome is.<br><br>Explain how knowledge of the human genome will help medicine in the future, eg identifying genes linked to cancers, understanding and treating inherited disorders. It will also help trace human migration patterns.<br><br>Explain the ethical issues related to DNA sequencing.<br><br>Explain using a Punnett square and genetic diagram how sex is determined in humans.<br><br>Explain the probability of having a child that is a boy or a girl. |

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| Genetic Inheritance and Inherited Disorders | Some characteristics are controlled by a single gene. Each gene may have different forms called alleles.<br><br>The genes present, or genotype, operate at a molecular level to develop characteristics that are expressed as a phenotype.<br><br>A dominant allele is expressed if only present on one chromosome.<br><br>A recessive allele is only expressed if present on both chromosomes.<br><br>If the two alleles present are the same the person is homozygous for that trait, but if the alleles are different they are heterozygous.<br><br>Most characteristics are a result of multiple genes interacting.<br><br>Some disorders are inherited, eg polydactyly and cystic fibrosis.<br><br>A Punnett square can be constructed to predict the outcome of a monohybrid cross. | Discuss variation in families and why offspring have some characteristics of their mother and some of their father and often strongly resemble their grandparents.<br><br>Complete Punnett squares.<br><br>Show images of polydactyly. Interpret family trees to determine chance of inheriting disorders.<br><br>Watch a video to explain what cystic fibrosis is, how it is inherited and to illustrate the severity of the disorder.<br><br>Evaluate genetic modification to treat cystic fibrosis.<br><br>Produce notes and complete genetic diagrams to explain how polydactyly and cystic fibrosis are inherited.<br><br>Interpret genetic diagrams relating to these disorders. | Give examples of characteristics controlled by a single gene and describe their alleles.<br><br>Give examples of characteristics controlled by multiple genes.<br><br>Define and use the terms: gametes, genotype, phenotype, dominant recessive, homozygous and heterozygous.<br><br>Complete a Punnett square to show the outcomes of genetic crosses.<br><br>Interpret the results of a genetic cross diagram and use direct proportion and simple ratios to express the outcomes. Describe the genotypes and phenotypes of the offspring.<br><br>Describe the inherited disorders polydactyly and cystic fibrosis.<br><br>Use genetic cross diagrams to explain inheritance and carriers.<br><br>Make informed judgements about the economic, social and ethical issues concerning embryo screening. |
| Genetic Engineering | Genetic engineering involves modifying the genome of an organism to introduce a desired characteristic.<br><br>Genes can be cut from the chromosome of a human or other organism and | List examples of genetic engineering.<br><br>Produce a leaflet for a doctor's surgery to explain how human insulin is produced by bacteria and discuss the advantages of this over porcine insulin. | Define the term genetic engineering.<br><br>Describe the process of genetic engineering and its advantages.<br><br>HT: Describe in detail the process of genetic engineering. |

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| | transferred into the cells of other organisms.<br><br>Examples of genetic engineering.<br><br>Concerns about GM crops, eg effect on populations of wild flowers and insects, and uncertainty about safety of eating them. | Interpret information about genetic engineering techniques.<br><br>Research advantages and disadvantages of GM crops. What characteristics may be modified? Produce a web page or a table of benefits versus concerns for homework.<br>Research the use of genetic engineering in medicine. | Evaluate the use of genetic engineering in medicine, eg in gene therapy and production of hormones and some vaccines.<br><br>Interpret information about genetic engineering techniques.<br><br>Make informed judgements about the economic, social and ethical issues concerning genetic engineering and GM crops.<br><br>Explain advantages and disadvantages of genetic engineering. |
| Variation and Selective Breeding | Differences in the characteristics of individuals may be due to:<br>• genes they have inherited<br>• environmental causes<br>• a combination of genetic and environmental causes.<br><br>Selective breeding (artificial selection) is the process by which humans breed plants and animals for useful characteristics.<br><br>The steps involved in selective breeding.<br><br>Selective breeding of food plants has produced disease or weather resistant crops, more attractive or better flavoured fruits and crops that are easier to harvest.<br><br>Selective breeding of animals has produced cows that produce more milk, animals that produce more, better flavoured or leaner meat. | Discuss why organisms of the same species show variation. Use the terms: genetic and environmental variation, continuous and discontinuous variation.<br><br>Include in the table whether each characteristic is due to genetic or environmental causes, or both.<br><br>Images of different dogs. Students 'breed' and name a new dog from selecting any 2 – draw a picture of their new breed.<br><br>Draw a flow diagram to explain the steps involved in selective breeding.<br><br>Give examples of characteristics that are selectively bred in plants and animals.<br><br>Discuss the advantages and risks of selective breeding in plants and animals. | Classify characteristics as being due to genetic, environmental or a combination of these causes.<br><br>Give examples of continuous and discontinuous variation.<br><br>Explain why humans selectively breed plants and animals.<br><br>Describe selective breeding as a type of sexual reproduction.<br><br>Describe the process of selective breeding and give examples.<br><br>Explain the benefits and risks of selective breeding in plants and animals. |

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| | Selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects. Some breeds of dogs suffer from inbred defects. | | |
| Evolution and Extinction | Darwin's theory of evolution by natural selection states that all species evolved from simple life forms that first developed more than three billion years ago.<br><br>The main stages of natural selection. Mutations are changes in the DNA code. They may lead to more rapid evolution, although mutations that result in a new phenotype are rare.<br><br>Organisms of the same species can interbreed to produce fertile offspring. Evidence for evolution – Fossils and Resistant bacteria.<br><br>Fossils are the 'remains' of organisms from many years ago, which are found in rocks.<br><br>Scientists cannot be certain about how life began on Earth because many early forms of life were soft-bodied, so few traces remain.<br><br>Extinction may be caused by:<br>• changes to the environment over geological time<br>• new predators<br>• new diseases<br>• new, more successful competitors | Watch a BBC video clip illustrating survival of the fittest.<br><br>Watch video clip about ancestor of horses from BBC Walking with Beasts.<br><br>Draw a flow diagram to explain natural selection.<br><br>Peppered moth game; explain in terms of natural selection.<br><br>Look at pictures of Darwin's finches and match up with the Galapagos Island they lived on based on food available there.<br><br>Discuss how you could show that a donkey and a horse are different species.<br><br>Interpret evolutionary trees.<br><br>Observe fossils or pictures of fossils.<br><br>Discuss how fossils provide evidence for evolution.<br><br>Give a list of extinct organisms and ask students to print images. Suggest reasons to explain why they died out.<br><br>Produce a poster of pictures of extinct organisms. Discuss the evidence we have that they looked like this. | Describe Darwin's theory of evolution by natural selection.<br><br>Describe the main stages of natural selection as:<br>• individual organisms within a particular species may show a wide range of phenotype variation because of differences in their genes<br>• individuals with characteristics most suited to the environment are more likely to survive to breed successfully<br>• the genes that have enabled these individuals to survive are then passed on to the next generation.<br><br>Define the term mutation.<br><br>Explain why mutation may lead to more rapid change in a species.<br><br>Define the term species.<br><br>Identify organisms that are of different species.<br><br>Interpret evolutionary trees.<br>Define the term 'fossil'.<br><br>Describe how fossils may be formed: |

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| | a single catastrophic event, eg massive volcanic eruptions or collisions with asteroids. | Explain why some organisms are endangered. Give examples. Give reasons why it is important to prevent species from becoming extinct. | • from parts of organisms that have not decayed because one or more of the conditions needed for decay are absent<br>• when parts of the organism are replaced by other materials as they decay<br>• as preserved traces of organisms, eg footprints, burrows and rootlet traces.<br>Explain why scientists cannot be certain how life began on Earth.<br>Explain how fossils provide evidence for evolution.<br>Define the term extinction.<br>Explain how extinction may be caused.<br>Explain that organisms become extinct because something changes and the species cannot adapt quickly enough to the new circumstances. |
| Topic 7 Ecology<br><br>Classification | Traditionally organisms have been classified into groups depending on their structure and characteristics.<br>Organisms were classified into smaller and smaller groups.<br>Carl Linnaeus studied the similarities and differences between organisms to classify them. He developed the binomial system to name organisms by genus and species.<br>Today powerful microscopes are used to see internal structures. This and | Watch BBC video clips about Linnaeus and classification (see resources).<br>Compare the classification of related and unrelated organisms using the Linnaeus system.<br>Look at the variety of names given to the same plant and discuss why the binomial system is more useful.<br>Sort picture cards into the three domains and give reasons. | Classify organisms based on their similarities.<br>Describe classification using:<br>• Kingdom<br>• Phylum<br>• Class<br>• Order<br>• Family<br>• Genus<br>• Species. |

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| | biochemical analysis has led to new classification systems.<br><br>Carl Woese developed the three domain system to classify organisms as:<br>• Archaea (primitive bacteria)<br>• Bacteria (true bacteria)<br>Eukaryota (protists, fungi, plants and animals). | | Explain why the importance of the binomial system to name organisms.<br><br>Explain how modern technologies have affected how organisms are classified today.<br><br>Describe Carl Woese's system of classification and classify organisms into the three mains. |
| Communities | Organisms need a supply of materials from their surroundings and other organisms to survive and reproduce.<br><br>One species depends on others for food, shelter, pollination, seed dispersal etc. This is called interdependence.<br><br>Plants compete for light, space, water and mineral ions.<br><br>Animals compete for food, mates and territory.<br><br>Biotic factors are living factors that can affect a community.<br><br>Abiotic factors are non-living factors which can affect a community. | Look at pictures of different habitats and brainstorm factors that affect the survival of organisms in a habitat.<br><br>Discuss how organisms depend on each other for survival and introduce the term 'interdependence'.<br><br>Discuss factors that may affect the numbers or distribution of plants and animals in a habitat. | Understand and use the terms ecosystem, community, competition, habitat, interdependence.<br><br>Describe factors that affect the survival of organisms in their habitat.<br><br>Explain how one species depends on others for survival.<br><br>Describe a stable community as one where all the species and environmental factors are in balance, so population sizes remain fairly constant. Give an example of a stable community.<br><br>Describe resources that plants and animals compete for in a given habitat.<br><br>Name biotic factors in a habitat and explain how a change in a biotic factor might affect a community, eg:<br>• availability of food<br>• new predators arriving<br>• new disease organisms |

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| | | | • one species out-competing another so the numbers are no longer sufficient to breed.<br>Name abiotic factors in a habitat and explain how a change in a biotic factor might affect a community, eg:<br>• light intensity<br>• temperature<br>• moisture levels<br>• soil pH and mineral content<br>• wind intensity and direction<br>• carbon dioxide levels for plants<br>• oxygen levels for aquatic animals. |
| Distribution of Organisms | Quantitative data on the distribution and abundance of organisms can be obtained by:<br>• random sampling with quadrats<br>• sampling along a transect.<br>Required practical: Field investigations<br>Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species. | Look at distribution of Pleurococcus on walls, fences or trees.<br>Estimate percentage cover using diagrams/ photographs and plastic squares as 'mini quadrats'.<br>or<br>Investigate patterns of grass growth under trees and see if it is linked to abiotic factor(s).<br>Use transect lines and quadrats to collect data.<br>Analyse ecological data from quadrats and transects.<br>Interpret various types of diagrams that illustrate the distribution of organisms in a habitat. | Describe how to carry out random sampling of organisms using a quadrat.<br>Describe when and how a transect should be used.<br>Evaluate data gathered by using a quadrat and transect.<br>Calculate area, mean, median, mode and range.<br>Explain why sample size is important to obtain valid results. |

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| Adaptation and Organisation | Organisms have adaptations for survival, they may be structural, behavioural or functional.<br>Extremophiles can survive in very extreme environments, such as high temperature or pressure, or in high salt concentration.<br>Feeding relationships can be represented by food chains.<br>A food chain begins with a producer which synthesises, molecules.<br>Producers are eaten by consumers.<br>Consumers that eat other animals are predators, and those eaten are prey.<br>In a stable community the numbers of predators and prey rise and fall in cycles. | Watch video clip showing adaptations.<br>Produce a poster or media presentation to show plants, animals and microorganisms with labels to explain how their adaptations help them to survive in their habitat.<br>Construct food chains and identify the producer and consumers.<br>Research producers that are not green plants.<br>Interpret population curves. | Describe and explain how structural, behavioural and functional adaptations, in a range of organisms, help them to survive in their habitat.<br>Define the term extremophile and give general examples.<br>Explain what a food chain shows.<br>Explain that photosynthetic organisms are the producers of biomass for life on Earth.<br>Identify producers, primary, secondary and tertiary consumers in a food chain.<br>Interpret and explain population curves, eg hare and lynx, red and grey squirrels, and native and American crayfish. |
| Cycle of Materials | Materials are recycled to provide the building blocks for future organisms.<br>The main processes involved in recycling carbon in the carbon cycle.<br>The main processes in the water cycle.<br>The decay cycle returns carbon to the atmosphere as carbon dioxide and mineral ions to the soil. | Recap how carbon dioxide is used by plants in photosynthesis and why this is of use to animals. Discuss what happens next to eventually return carbon to the air.<br>Draw diagrams of the carbon and water cycles. | Interpret and explain the processes in diagrams of the carbon, water and decay cycles.<br>Explain the importance of these cycles to living things.<br>Explain the carbon cycle.<br>Explain the water cycle.<br>Explain the role of microorganisms in cycling materials through an ecosystem. |