Biology Unit 1 – Cell Biology

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| **4.1.1 Cell Structure** | **😊** | **☹** |
| Plant and animal cells (eukaryotic cells) have a cell membrane, cytoplasm and genetic material enclosed in a nucleus. |  |  |
| Bacterial cells (prokaryotic cells) are much smaller in comparison. They have cytoplasm and a cell membrane surrounded by a cell wall. The genetic material is not enclosed in a nucleus. It is a single DNA loop and there may be one or more small rings of DNA called plasmids. |  |  |
| Understand of the scale and size of cells and be able to make order of magnitude calculations, including the use of standard form. |  |  |
| Most animal cells have the following parts: • a nucleus • cytoplasm • a cell membrane • mitochondria • ribosomes |  |  |
| In addition to the parts found in animal cells, plant cells often have: • chloroplasts • a permanent vacuole filled with cell sap. Plant and algal cells also have a cell wall made of cellulose, which strengthens the cell. |  |  |
| Explain how the main sub-cellular structures, including the nucleus, cell membranes, mitochondria, chloroplasts in plant cells and plasmids in bacterial cells are related to their functions. |  |  |
| Use estimations and explain when they should be used to judge the relative size or area of sub-cellular structures. |  |  |
| Cells may be specialised to carry out a particular function: • sperm cells, nerve cells and muscle cells in animals • root hair cells, xylem and phloem cells in plants. Explain how the structure of different types of cell relate to their function. |  |  |
| As an organism develops, cells differentiate to form different types of cells. • Most types of animal cell differentiate at an early stage. • Many types of plant cells retain the ability to differentiate throughout life.  |  |  |
| In mature animals, cell division is mainly restricted to repair and replacement. As a cell differentiates it acquires different sub-cellular structures to enable it to carry out a certain function. It has become a specialised cell. Explain the importance of cell differentiation. |  |  |
| An electron microscope has much higher magnification and resolving power than a light microscope. This means that it can be used to study cells in much finer detail. This has enabled biologists to see and understand many more sub-cellular structures. • understand how microscopy techniques have developed over time • explain how electron microscopy has increased understanding of sub-cellular structures. Limited to the differences in magnification and resolution. |  |  |
| Carry out calculations involving magnification, real size and image size using the formula: magnification = size of image/size of real object. Express answers in standard form if appropriate. |  |  |
| **4.1.2 Cell division** |
| The nucleus of a cell contains chromosomes made of DNA molecules. Each chromosome carries a large number of genes. In body cells the chromosomes are normally found in pairs. |  |  |
| Cells divide in a series of stages called the cell cycle. Describe the stages of the cell cycle, including mitosis. During the cell cycle the genetic material is doubled and then divided into two identical cells.  |  |  |
| Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as ribosomes and mitochondria. The DNA replicates to form two copies of each chromosome. |  |  |
| In mitosis one set of chromosomes is pulled to each end of the cell and the nucleus divides. Finally the cytoplasm and cell membranes divide to form two identical cells. |  |  |
| Recognise and describe situations in given contexts where mitosis is occurring. Cell division by mitosis is important in the growth and development of multicellular organisms. |  |  |
| A stem cell is an undifferentiated cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation. Describe the function of stem cells in embryos, in adult animals and in the meristems in plants. |  |  |
| Stem cells from human embryos can be cloned and made to differentiate into most different types of human cells. Stem cells from adult bone marrow can form many types of cells including blood cells. Meristem tissue in plants can differentiate into any type of plant cell, throughout the life of the plant. |  |  |
| Treatment with stem cells may be able to help conditions such as diabetes and paralysis. |  |  |
| In therapeutic cloning an embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient’s body so they may be used for medical treatment. The use of stem cells has potential risks such as transfer of viral infection, and some people have ethical or religious objections. |  |  |
| Stem cells from meristems in plants can be used to produce clones of plants quickly and economically. • Rare species can be cloned to protect from extinction. • Crop plants with special features such as disease resistance can be cloned to produce large numbers of identical plants for farmers. |  |  |
| **4.1.3 Transport in cells** |
| Substances may move into and out of cells across the cell membranes via diffusion. Diffusion is the spreading out of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of higher concentration to an area of lower concentration. |  |  |
| Some of the substances transported in and out of cells by diffusion are oxygen and carbon dioxide in gas exchange, and of the waste product urea from cells into the blood plasma for excretion in the kidney. |  |  |
| Explain how different factors affect the rate of diffusion. Factors which affect the rate of diffusion are: • the difference in concentrations (concentration gradient) • the temperature • the surface area of the membrane. |  |  |
| A single-celled organism has a relatively large surface area to volume ratio. This allows sufficient transport of molecules into and out of the cell to meet the needs of the organism. |  |  |
| Calculate and compare surface area to volume ratios. Explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area to volume ratio. |  |  |
| Explain how the small intestine and lungs in mammals, gills in fish, and the roots and leaves in plants, are adapted for exchanging materials. |  |  |
| In multicellular organisms, surfaces and organ systems are specialised for exchanging materials. This is to allow sufficient molecules to be transported into and out of cells for the organism’s needs. The effectiveness of an exchange surface is increased by: • having a large surface area • a membrane that is thin, to provide a short diffusion path • (in animals) having an efficient blood supply • (in animals, for gaseous exchange) being ventilated. |  |  |
| Water may move across cell membranes via osmosis. Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane. |  |  |
| Use simple compound measures of rate of water uptake. Use percentiles. Calculate percentage gain and loss of mass of plant tissue.  |  |  |
| Plot, draw and interpret appropriate graphs. |  |  |
| Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). This requires energy from respiration. |  |  |
| Active transport allows mineral ions to be absorbed into plant root hairs from very dilute solutions in the soil. Plants require ions for healthy growth. It also allows sugar molecules to be absorbed from lower concentrations in the gut into the blood which has a higher sugar concentration. Sugar molecules are used for cell respiration. |  |  |
| Describe how substances are transported into and out of cells by diffusion, osmosis and active transport and explain the differences between the three processes. |  |  |

**Videos:**

<https://goo.gl/v6oa4L> - broken into 17 short videos here

<https://www.my-gcsescience.com/aqa/biology/> - cell biology videos

**Revision guide reference:**

Higher page: 11 -23

Foundation page: 11 -23

Biology Unit 2 – Organisation

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| **4.2.1 Principles of organisation** | **😊** | **☹** |
| Explain organisational hierarchy. Cells are the basic building blocks of all living organisms. A tissue is a group of cells with a similar structure and function. Organs are aggregations of tissues performing specific functions. Organs are organised into organ systems, which work together to form organisms. |  |  |
| **4.2.2 Animal tissues, organs and organ systems**  |
| The digestive system is an organ system - several organs working together to digest and absorb food.  |  |  |
| Relate knowledge of enzymes to metabolism |  |  |
| Describe the structure function and optimum conditions for enzymes. Enzymes catalyse specific reactions in living organisms due to the shape of their active site. |  |  |
| Explain what is meant by denaturation of enzymes and the effect changing pH or temperature has on enzyme action.  |  |  |
| Use the ‘lock and key theory’ as a simplified model to explain enzyme action. |  |  |
| Digestive enzymes convert food into small soluble molecules that can be absorbed into the bloodstream. Recall the sites of production and the action of amylase, proteases and lipases. |  |  |
| Carbohydrases break down carbohydrates to simple sugars. Amylase is a carbohydrase which breaks down starch. Proteases break down proteins to amino acids. Lipases break down lipids (fats) to glycerol and fatty acids. |  |  |
| Understand simple word equations but no chemical symbol equations are required for enzyme action.  |  |  |
| The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used in respiration. |  |  |
| Bile is made in the liver and stored in the gall bladder. It is alkaline to neutralise hydrochloric acid from the stomach. It also emulsifies fat to form small droplets which increases the surface area. The alkaline conditions and large surface area increase the rate of fat breakdown by lipase. |  |  |
| **4.2.2.2 The heart and blood vessels** |
| Know the structure and functioning of the human heart and lungs, including how lungs are adapted for gaseous exchange. |  |  |
| The heart is an organ that pumps blood around the body in a double circulatory system. The right ventricle pumps blood to the lungs where gas exchange takes place. The left ventricle pumps blood around the rest of the body. |  |  |
| Identify the aorta, vena cava, pulmonary artery, pulmonary vein and coronary arteries on the heart.  |  |  |
| Identify the trachea, bronchi, alveoli and the capillary network surrounding the alveoli in the lungs.  |  |  |
| The natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker. Artificial pacemakers are electrical devices used to correct irregularities in the heart rate. |  |  |
| The body contains three different types of blood vessel: • arteries • veins • capillaries. Explain how the structure of these vessels relates to their functions. |  |  |
| Calculate measures such as rate and carry out rate calculations for blood flow. |  |  |
| **4.2.2.3 Blood** |
| Blood is a tissue consisting of plasma, in which the red blood cells, white blood cells and platelets are suspended. Know the functions of each of these blood components. |  |  |
| Recognise different types of blood cells in a photograph or diagram, and explain how they are adapted to their functions. |  |  |
| **4.2.2.4 Coronary heart disease: a non-communicable disease** |
| Evaluate the advantages and disadvantages of treating cardiovascular diseases by drugs, mechanical devices or transplant |  |  |
| In coronary heart disease layers of fatty material build up inside the coronary arteries, narrowing them. This reduces the flow of blood through the coronary arteries, resulting in a lack of oxygen for the heart muscle. Stents are used to keep the coronary arteries open. Statins are widely used to reduce blood cholesterol levels which slows down the rate of fatty material deposit. |  |  |
| In some people heart valves may become faulty, preventing the valve from opening fully, or the heart valve might develop a leak. Students should understand the consequences of faulty valves. Faulty heart valves can be replaced using biological or mechanical valves. |  |  |
| In the case of heart failure a donor heart, or heart and lungs can be transplanted. Artificial hearts are occasionally used to keep patients alive whilst waiting for transplant, or to allow the heart to rest. |  |  |
| **4.2.2.5 Health Issues** |
| Describe the relationship between health and disease and the interactions between different types of disease. |  |  |
| Health is the state of physical and mental well-being. |  |  |
| Diseases, both communicable and non-communicable, are major causes of ill health. Other factors including diet, stress and life situations may have a profound effect on both physical and mental health. |  |  |
| Different types of disease may interact. • Defects in the immune system mean that an individual is more likely to suffer from infectious diseases. • Viruses living in cells can be the trigger for cancers. • Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma. • Severe physical ill health can lead to depression and other mental illness. |  |  |
| Translate disease incidence information between graphical and numerical forms, construct and interpret frequency tables and diagrams, bar charts and histograms, and use a scatter diagram to identify a correlation between two variables |  |  |
| **4.2.2.6 The effect of lifestyle on some non-communicable diseases** |
| Discuss the human and financial cost of these non-communicable diseases to an individual, a local community, a nation or globally |  |  |
| Explain the effect of lifestyle factors including diet, alcohol and smoking on the incidence of non-communicable diseases at local, national and global levels. |  |  |
| Risk factors are linked to an increased rate of a disease. They can be: • aspects of a person’s lifestyle • substances in the person’s body or environment. |  |  |
| A causal mechanism has been proven for some risk factors, but not in others. • The effects of diet, smoking and exercise on cardiovascular disease. • Obesity as a risk factor for Type 2 diabetes. • The effect of alcohol on the liver and brain function. • The effect of smoking on lung disease and lung cancer. • The effects of smoking and alcohol on unborn babies. • Carcinogens, including ionising radiation, as risk factors in cancer. Many diseases are caused by the interaction of a number of factors. |  |  |
| Use a scatter diagram to identify a correlation between two variables in terms of risk factors. |  |  |
| **4.2.2.7 Cancer** |
| Describe cancer as the result of changes in cells that lead to uncontrolled growth and division. |  |  |
| Benign tumours are growths of abnormal cells which are contained in one area, usually within a membrane. They do not invade other parts of the body. |  |  |
| Malignant tumour cells are cancers. They invade neighbouring tissues and spread to different parts of the body in the blood where they form secondary tumours. |  |  |
| Scientists have identified lifestyle risk factors for various types of cancer. There are also genetic risk factors for some cancers. |  |  |
| **4.2.3 Plant tissues, organs and systems** |
| Explain how the structures of plant tissues are related to their functions. Plant tissues include: • epidermal tissues • palisade mesophyll • spongy mesophyll • xylem and phloem • meristem tissue found at the growing tips of shoots and roots. |  |  |
| The leaf is a plant organ. Knowledge limited to epidermis, palisade and spongy mesophyll, xylem and phloem, and guard cells surrounding stomata. |  |  |
| Explain how the structure of root hair cells, xylem and phloem are adapted to their functions. |  |  |
| Explain the effect of changing temperature, humidity, air movement and light intensity on the rate of transpiration. |  |  |
| The roots, stem and leaves form a plant organ system for transport of substances around the plant. |  |  |
| Describe the process of transpiration and translocation, including the structure and function of the stomata. |  |  |

**Videos:**

<https://goo.gl/284T9r> - 17 videos covering whole topic

<https://goo.gl/HvRLUK> - 20min video on whole topic

**Revision guide:**

Higher pages: 24-42

Foundation page: 24 – 41

Biology Unit 3 – Infection and response

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| **4.3.1 Communicable diseases** | **😊** | **☹** |
| Pathogens are microorganisms that cause infectious disease. Pathogens may be viruses, bacteria, protists or fungi. They may infect plants or animals and can be spread by direct contact, by water or by air. Explain how diseases caused by viruses, bacteria, protists and fungi are spread in animals and plants. |  |  |
| Explain how the spread of diseases can be reduced or prevented. |  |  |
| Explain how bacteria and viruses may reproduce rapidly inside the body. Bacteria may produce poisons (toxins) that damage tissues and make us feel ill. Viruses live and reproduce inside cells, causing cell damage. |  |  |
| **4.3.1.2 – 4.3.1.5 Examples of Diseases That Could Be In Your Exam** |
| Measles is a viral disease showing symptoms of fever and a red skin rash. Measles is a serious illness that can be fatal if complications arise. For this reason most young children are vaccinated against measles. The measles virus is spread by inhalation of droplets from sneezes and coughs. |  |  |
| HIV initially causes a flu-like illness. Unless successfully controlled with antiretroviral drugs the virus attacks the body’s immune cells. Late stage HIV infection, or AIDS, occurs when the body's immune system becomes so badly damaged it can no longer deal with other infections or cancers. HIV is spread by sexual contact or exchange of body fluids such as blood which occurs when drug users share needles. |  |  |
| Tobacco mosaic virus (TMV) is a widespread plant pathogen affecting many species of plants including tomatoes. It gives a distinctive ‘mosaic’ pattern of discolouration on the leaves which affects the growth of the plant due to lack of photosynthesis. |  |  |
| Salmonella food poisoning is spread by bacteria ingested in food, or on food prepared in unhygienic conditions. In the UK, poultry are vaccinated against Salmonella to control the spread. Fever, abdominal cramps, vomiting and diarrhoea are caused by the bacteria and the toxins they secrete. |  |  |
| Gonorrhoea is a sexually transmitted disease (STD) with symptoms of a thick yellow or green discharge from the vagina or penis and pain on urinating. It is caused by a bacterium and was easily treated with the antibiotic penicillin until many resistant strains appeared. Gonorrhoea is spread by sexual contact. The spread can be controlled by treatment with antibiotics or the use of a barrier method of contraception such as a condom. |  |  |
| Rose black spot is a fungal disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as photosynthesis is reduced. It is spread in the environment by water or wind. Rose black spot can be treated by using fungicides and/or removing and destroying the affected leaves. |  |  |
| The pathogens that cause malaria are protists. The malarial protist has a life cycle that includes the mosquito. Malaria causes recurrent episodes of fever and can be fatal. The spread of malaria is controlled by preventing the vectors, mosquitos, from breeding and by using mosquito nets to avoid being bitten. |  |  |
| **4.3.1.6 Human Defence Systems** |
| Describe the non-specific defence systems of the human body against pathogens, including the: • skin • nose • trachea and bronchi • stomach. |  |  |
| Explain the role of the immune system in the defence against disease. If a pathogen enters the body the immune system tries to destroy the pathogen. White blood cells help to defend against pathogens by: • phagocytosis • antibody production • antitoxin production. |  |  |
| **4.3.1.7 Vaccination** |
| Explain how vaccination will prevent illness in an individual, and how the spread of pathogens can be reduced by immunising a large proportion of the population. |  |  |
| Vaccination involves introducing small quantities of dead or inactive forms of a pathogen into the body to stimulate the white blood cells to produce antibodies. If the same pathogen re-enters the body the white blood cells respond quickly to produce the correct antibodies, preventing infection. |  |  |
| **4.3.1.8 Antibiotics and Painkillers** |
| Explain the use of antibiotics and other medicines in treating disease. Antibiotics, such as penicillin, are medicines that help to cure bacterial disease by killing infective bacteria inside the body. It is important that specific bacteria should be treated by specific antibiotics. |  |  |
| The use of antibiotics has greatly reduced deaths from infectious bacterial diseases. However, the emergence of strains resistant to antibiotics is of great concern. |  |  |
| Antibiotics cannot kill viral pathogens. Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens. It is difficult to develop drugs that kill viruses without also damaging the body’s tissues. |  |  |
| **4.3.1.9 Discovery and Development of Drugs**  |
| Describe the process of discovery and development of potential new medicines, including preclinical and clinical testing. |  |  |
| Traditionally drugs were extracted from plants and microorganisms. • The heart drug digitalis originates from foxgloves. • The painkiller aspirin originates from willow. • Penicillin was discovered by Alexander Fleming from the Penicillium mould. |  |  |
| Most new drugs are synthesised by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant. |  |  |
| New medical drugs have to be tested and trialled before being used to check that they are safe and effective. New drugs are extensively tested for toxicity, efficacy and dose. Preclinical testing is done in a laboratory using cells, tissues and live animals. |  |  |
| Clinical trials use healthy volunteers and patients. • Very low doses of the drug are given at the start of the clinical trial. • If the drug is found to be safe, further clinical trials are carried out to find the optimum dose for the drug. • In double blind trials, some patients are given a placebo. |  |  |

**Videos:**

<https://goo.gl/VyvBB8> - 14 videos on topic

<https://goo.gl/142GWY> - 20min video on whole topic

**Revision guide reference:**

Higher pages: 43 - 49

Foundation pages: 42 – 49

Biology Unit 4 – Bioenergetics

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| **4.4.1 Photosynthesis** | **😊** | **☹** |
| Photosynthesis is represented by the equation:  lightcarbon dioxide + water  glucose + oxygen Recognise the chemical symbols: CO2, H2O, O2 and C6H12O6. |  |  |
| Describe photosynthesis as an endothermic reaction in which energy is transferred from the environment to the chloroplasts by light. |  |  |
| **4.4.1.2 Rate of Photosynthesis** |
| Explain the effects of temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll on the rate of photosynthesis. |  |  |
| Measure and calculate rates of photosynthesis • extract and interpret graphs of photosynthesis rate involving one limiting factor • plot and draw appropriate graphs selecting appropriate scale for axes • translate information between graphical and numeric form |  |  |
| (HT only) These factors interact and any one of them may be the factor that limits photosynthesis. Explain graphs of photosynthesis rate involving two or three factors and decide which is the limiting factor. |  |  |
| (HT only) Understand and use inverse proportion – the inverse square law and light intensity in the context of photosynthesis. Limiting factors are important in the economics of enhancing the conditions in greenhouses to gain the maximum rate of photosynthesis while still maintaining profit. |  |  |
| **4.4.1.3 Uses of Glucose from Photosynthesis** |
| The glucose produced in photosynthesis may be: • used for respiration • converted into insoluble starch for storage • used to produce fat or oil for storage • used to produce cellulose, which strengthens the cell wall • used to produce amino acids for protein synthesis. To produce proteins, plants also use nitrate ions that are absorbed from the soil. |  |  |
| **4.4.2 Respiration** |
| Describe cellular respiration as an exothermic reaction which is continuously occurring in living cells. The energy transferred supplies all the energy needed for living processes. |  |  |
| Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen), to transfer energy. Compare the processes of aerobic and anaerobic respiration with regard to the need for oxygen, the differing products and the relative amounts of energy transferred. |  |  |
| Organisms need energy for: • chemical reactions to build larger molecules • movement • keeping warm. |  |  |
| Aerobic respiration is represented by the equation: glucose + oxygen  carbon dioxide + water |  |  |
| Anaerobic respiration in muscles is represented by the equation: glucose  lactic acid As the oxidation of glucose is incomplete in anaerobic respiration much less energy is transferred than in aerobic respiration. |  |  |
| Anaerobic respiration in plant and yeast cells is represented by the equation: glucose  ethanol + carbon dioxideAnaerobic respiration in yeast cells is called fermentation and has economic importance in the manufacture of bread and alcoholic drinks |  |  |

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| **4.4.2.2 Response to Exercise** |
| During exercise the human body reacts to the increased demand for energy. The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood. |  |  |
| If insufficient oxygen is supplied anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a build-up of lactic acid and creates an oxygen debt. During long periods of vigorous activity muscles become fatigued and stop contracting efficiently. |  |  |
| (HT only) Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose. Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells. |  |  |
| **4.4.2.3 Metabolism** |
| Explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids. |  |  |
| Metabolism is the sum of all the reactions in a cell or the body. The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules. |  |  |
| Metabolism includes: • conversion of glucose to starch, glycogen and cellulose • the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids • the use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins • respiration • breakdown of excess proteins to form urea for excretion. |  |  |

**Videos:**

<https://goo.gl/PzgLbc> - 7 videos on whole topic

<https://goo.gl/8QYqR6> - 1 x 11 minute video on whole topic

**Revision guide reference:**

Higher page: 50 – 57

Foundation: 50 – 56

Paper 2

Biology Unit 5 – Homeostasis and response

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| **4.5.1 Homeostasis** | **😊** | **☹** |
| Explain that homeostasis is the regulation of the internal conditions of a cell or organism to maintain optimum conditions for function in response to internal and external changes, enzyme action and cell functions. |  |  |
| In the human body, these include control of: • blood glucose concentration • body temperature • water levels. |  |  |
| These automatic control systems may involve nervous responses or chemical responses. |  |  |
| All control systems include: • cells called receptors, which detect stimuli (changes in the environment) • coordination centres (such as the brain, spinal cord and pancreas) that receive and process information from receptors • effectors, muscles or glands, which bring about responses which restore optimum levels. |  |  |
| **4.5.2 The human nervous system** |
| Explain how the structure of the nervous system is adapted to its functions. |  |  |
| State the main function of the nervous system - enabling humans to react to their surroundings and to coordinate their behaviour. |  |  |
| Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS). The CNS is the brain and spinal cord. The CNS coordinates the response of effectors which may be muscles contracting or glands secreting hormones. |  |  |
| Describe the roles of sensory neurones, relay neurones, motor neurones, synapses and effectors in a reflex action, and state that reflex actions are automatic and rapid and do not involve the conscious part of the brain.  |  |  |
| Describe the sequence in a nervous response: stimulus  receptor  coordinator  effector  response |  |  |
| Extract and interpret data from graphs, charts and tables, about the functioning of the nervous system. |  |  |
| Translate information about reaction times between numerical and graphical forms. |  |  |
| **4.5.3 Hormonal coordination in humans** |
| The endocrine system is composed of glands which secrete chemicals called hormones directly into the bloodstream. The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system the effects are slower but act for longer |  |  |
| The pituitary gland in the brain is a ‘master gland’ which secretes several hormones into the blood in response to body conditions. These hormones in turn act on other glands to stimulate other hormones to be released to bring about effects. |  |  |
| Identify the position of the following on a diagram of the human body: • pituitary gland • pancreas • thyroid • adrenal gland • ovary • testes. |  |  |

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| **4.5.3.2 Control of blood glucose concentration** |  |  |
| Blood glucose concentration is monitored and controlled by the pancreas. If the blood glucose concentration is too high, the pancreas produces the hormone insulin that causes glucose to move from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage. |  |  |
| Explain how insulin controls blood glucose (sugar) levels in the body. |  |  |
| Compare Type 1 and Type 2 diabetes and explain how they can be treated. |  |  |
| Type 1 diabetes is a disorder in which the pancreas fails to produce sufficient insulin. It is characterised by uncontrolled high blood glucose levels and is normally treated with insulin injections.  |  |  |
| In Type 2 diabetes the body cells no longer respond to insulin produced by the pancreas. A carbohydrate controlled diet and an exercise regime are common treatments. Obesity is a risk factor for Type 2 diabetes. |  |  |
| Extract information and interpret data from graphs that show the effect of insulin in blood glucose levels in both people with diabetes and people without diabetes. |  |  |
| **(HT only) If the blood glucose concentration is too low, the pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood.** |  |  |
| **(HT only) Explain how glucagon interacts with insulin in a negative feedback cycle to control blood glucose (sugar) levels in the bod** |  |  |
| **4.5.3.3 Hormones in human reproduction** |  |  |
| Describe the roles of hormones in human reproduction, including the menstrual cycle. |  |  |
| During puberty reproductive hormones cause secondary sex characteristics to develop. Oestrogen is the main female reproductive hormone produced in the ovary. At puberty eggs begin to mature and one is released approximately every 28 days. This is called ovulation. Testosterone is the main male reproductive hormone produced by the testes and it stimulates sperm production. |  |  |
| Several hormones are involved in the menstrual cycle of a woman. • Follicle stimulating hormone (FSH) causes maturation of an egg in the ovary. • Luteinising hormone (LH) stimulates the release of the egg. • Oestrogen and progesterone are involved in maintaining the uterus lining. |  |  |
| **(HT only) Explain the interactions of FSH, oestrogen, LH and progesterone, in the control of the menstrual cycle.** |  |  |
| **(HT only) Extract and interpret data from graphs showing hormone levels during the menstrual cycle.** |  |  |
| **4.5.3.4 Contraception** |  |  |
| Evaluate the different hormonal and non-hormonal methods of contraception. |  |  |
| Fertility can be controlled by a variety of hormonal and non-hormonal methods of contraception. These include: • oral contraceptives that contain hormones to inhibit FSH production so that no eggs mature • injection, implant or skin patch of slow release progesterone to inhibit the maturation and release of eggs for a number of months or years • barrier methods such as condoms and diaphragms which prevent the sperm reaching an egg • intrauterine devices which prevent the implantation of an embryo or release a hormone • spermicidal agents which kill or disable sperm • abstaining from intercourse when an egg may be in the oviduct • surgical methods of male and female sterilisation. |  |  |
| **4.5.3.5 The use of hormones to treat infertility (HT only)** |  |  |
| **(HT only) Explain the use of hormones in modern reproductive technologies to treat infertility. This includes giving FSH and LH in a 'fertility drug' to a woman. She may then become pregnant in the normal way.** |  |  |
| **(HT only) In Vitro Fertilisation (IVF) treatment. • IVF involves giving a mother FSH and LH to stimulate the maturation of several eggs. • The eggs are collected from the mother and fertilised by sperm from the father in the laboratory. • The fertilised eggs develop into embryos. • At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb).** |  |  |
| **(HT only) Although fertility treatment gives a woman the chance to have a baby of her own: • it is very emotionally and physically stressful • the success rates are not high • it can lead to multiple births which are a risk to both the babies and the mother.** |  |  |
| **4.5.3.6 Negative feedback (HT only)** |  |  |
| **(HT only) Explain the roles of thyroxine and adrenaline in the body.** |  |  |
| **(HT only) Adrenaline is produced by the adrenal glands in times of fear or stress. It increases the heart rate and boosts the delivery of oxygen and glucose to the brain and muscles, preparing the body for ‘flight or fight’. Thyroxine from the thyroid gland stimulates the basal metabolic rate. It plays an important role in growth and development. Thyroxine levels are controlled by negative feedback.** |  |  |

**Videos:**

<https://goo.gl/9v7fEX> - control in the body

<https://goo.gl/qHKpr2> - the nervous system

<https://goo.gl/UXMiFr> - the reflex

<https://goo.gl/9686oj> - menstrual cycle

<https://goo.gl/YjZGLx> - hormones controlling fertility

<https://goo.gl/HDguWx> - homeostasis and response

**Revision guide reference:**

Higher page: 58 – 67

Foundation: 57 – 65

Biology Unit 6 – Inheritance, variation & evolution

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| **4.6.1.1 Sexual and Asexual Reproduction** | **😊** | **☹** |
| Meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed. |  |  |
| Sexual reproduction involves the joining (fusion) of male and female gametes: • sperm and egg cells in animals • pollen and egg cells in flowering plants. |  |  |
| In sexual reproduction there is mixing of genetic information which leads to variety in the offspring. The formation of gametes involves meiosis. |  |  |
| 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. |  |  |
| **4.6.1.2 Meiosis** |
| Explain how meiosis halves the number of chromosomes and fertilisation restores the full number of chromosomes. |  |  |
| Cells in reproductive organs divide by meiosis to form gametes. When a cell divides to form gametes: • copies of the genetic information are made • the cell divides twice to form four gametes, each with a single set of chromosomes • all gametes are genetically different from each other. |  |  |
| Gametes join at fertilisation to restore the normal number of chromosomes. The new cell divides by mitosis. The number of cells increases. As the embryo develops cells differentiate. |  |  |
| **4.6.1.3 DNA and the Genome** |
| Describe the structure of DNA and define genome. The genetic material in the nucleus of a cell is composed of a chemical called DNA. DNA is a polymer made up of two strands forming a double helix. The DNA is contained in structures called chromosomes. |  |  |
| A gene is a small section of DNA on a chromosome. Each gene codes for a particular sequence of amino acids. |  |  |
| The genome of an organism is the entire genetic material of that organism. The whole human genome has now been studied and this will have great importance for medicine in the future. |  |  |
| Discuss the importance of understanding the human genome. This is limited to the: • search for genes linked to different types of disease • understanding and treatment of inherited disorders • use in tracing human migration patterns from the past. |  |  |
| **4.6.1.4 Genetic Inheritance** |
| Explain the terms: • gamete • chromosome • gene • allele • dominant • recessive • homozygous • heterozygous • genotype • phenotype. |  |  |
| Some characteristics are controlled by a single gene, such as: fur colour in mice; and red-green colour blindness in humans. Each gene may have different forms called alleles. |  |  |
| The alleles present operate at a molecular level to develop characteristics that can be expressed as a phenotype. |  |  |
| A dominant allele is always expressed, even if only one copy is present. A recessive allele is only expressed if two copies are present (therefore no dominant allele present). |  |  |
| If the two alleles present are the same the organism is homozygous for that trait, but if the alleles are different they are heterozygous. Most characteristics are a result of multiple genes interacting, rather than a single gene. |  |  |
| Understand the concept of probability in predicting the results of a single gene cross, but recall that most phenotype features are the result of multiple genes rather than single gene inheritance. Use direct proportion and simple ratios to express the outcome of a genetic cross. Complete a Punnett square diagram and extract and interpret information from genetic crosses and family trees. |  |  |
| (HT only) Construct a genetic cross by Punnett square diagram and use it to make predictions. |  |  |
| **4.6.1.5 Inherited Disorders** |
| Some disorders are inherited. These disorders are caused by the inheritance of certain alleles. • Polydactyly is caused by a dominant allele. • Cystic fibrosis (a disorder of cell membranes) is caused by a recessive allele. |  |  |
| Make informed judgements about the economic, social and ethical issues concerning embryo screening, given appropriate information. |  |  |
| **4.6.1.6 Sex Determination** |
| Ordinary human body cells contain 23 pairs of chromosomes. 22 pairs control characteristics only, but one of the pairs carries the genes that determine sex. • In females the sex chromosomes are the same (XX). • In males the chromosomes are different (XY). |  |  |
| Carry out a genetic cross to show sex inheritance. Students should understand and use direct proportion and simple ratios in genetic crosses. |  |  |
| **4.6.2.1 Variation** |
| Describe simply how the genome and its interaction with the environment influence the development of the phenotype of an organism. |  |  |
| Differences in the characteristics of individuals in a population is called variation and may be due to differences in: • the genes they have inherited (genetic causes) • the conditions in which they have developed (environmental causes) • a combination of genes and the environment. |  |  |
| State that there is usually extensive genetic variation within a population of a species and recall that all variants arise from mutations. Most have no effect on the phenotype; some influence phenotype; very few determine phenotype. |  |  |
| Mutations occur continuously. Very rarely a mutation will lead to a new phenotype. If the new phenotype is suited to an environmental change it can lead to a relatively rapid change in the species. |  |  |
| **4.6.2.2 Evolution** |
| Describe evolution as a change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of a new species. |  |  |
| The theory of evolution by natural selection states that all species of living things have evolved from simple life forms that first developed more than three billion years ago. |  |  |
| Explain how evolution occurs through natural selection of variants that give rise to phenotypes best suited to their environment. |  |  |
| If two populations of one species become so different in phenotype that they can no longer interbreed to produce fertile offspring they have formed two new species. |  |  |
| **4.6.2.3 Selective Breeding** |
| Explain the impact of selective breeding of food plants and domesticated animals. Selective breeding (artificial selection) is the process by which humans breed plants and animals for particular genetic characteristics. Humans have been doing this for thousands of years since they first bred food crops from wild plants and domesticated animals. |  |  |
| Selective breeding involves choosing parents with the desired characteristic from a mixed population. They are bred together. From the offspring those with the desired characteristic are bred together. This continues over many generations until all the offspring show the desired characteristic. |  |  |
| The characteristic can be chosen for usefulness or appearance: • Disease resistance in food crops. • Animals which produce more meat or milk. • Domestic dogs with a gentle nature. • Large or unusual flowers. Selective breeding can lead to ‘inbreeding’ where some breeds are particularly prone to disease or inherited defects. |  |  |
| **4.6.2.4 Genetic Engineering** |
| Describe genetic engineering as a process which involves modifying the genome of an organism by introducing a gene from another organism to give a desired characteristic. Plant crops have been genetically engineered to be resistant to diseases or to produce bigger better fruits. |  |  |
| Bacterial cells have been genetically engineered to produce useful substances such as human insulin to treat diabetes. |  |  |
| Explain the potential benefits and risks of genetic engineering in agriculture and in medicine and that some people have objections. |  |  |
| In genetic engineering, genes from the chromosomes of humans and other organisms can be ‘cut out’ and transferred to cells of other organisms. |  |  |
| Crops that have had their genes modified in this way are called genetically modified (GM) crops. GM crops include ones that are resistant to insect attack or to herbicides. GM crops generally show increased yields. |  |  |
| Concerns about GM crops include the effect on populations of wild flowers and insects. Some people feel the effects of eating GM crops on human health have not been fully explored. |  |  |
| Modern medical research is exploring the possibility of genetic modification to overcome some inherited disorders. |  |  |
| (HT only) Describe the main steps in the process of genetic engineering. In genetic engineering: • enzymes are used to isolate the required gene; this gene is inserted into a vector, usually a bacterial plasmid or a virus • the vector is used to insert the gene into the required cells • genes are transferred to the cells of animals, plants or microorganisms at an early stage in their development so that they develop with desired characteristics. |  |  |
| **4.6.3.1 Evidence for Evolution** |
| Describe the evidence for evolution including fossils and antibiotic resistance in bacteria.  |  |  |
| The theory of evolution by natural selection is now widely accepted. Evidence for Darwin’s theory is now available as it has been shown that characteristics are passed on to offspring in genes. There is further evidence in the fossil record and the knowledge of how resistance to antibiotics evolves in bacteria. |  |  |
| **4.6.3.2 Fossils** |
| Fossils are the ‘remains’ of organisms from millions of years ago, which are found in rocks. |  |  |
| Fossils may be formed: • from parts of organisms that have not decayed because one or more of the conditions needed for decay are absent • when parts of the organism are replaced by minerals as they decay • as preserved traces of organisms, such as footprints, burrows and rootlet traces. |  |  |
| Many early forms of life were soft-bodied, which means that they have left few traces behind. What traces there were have been mainly destroyed by geological activity. This is why scientists cannot be certain about how life began on Earth. |  |  |
| Fossils tell us how much or how little different organisms have changed as life developed on Earth. |  |  |
| Extract and interpret information from charts, graphs and tables such as evolutionary trees. |  |  |
| **4.6.3.3 Extinction** |
| Extinctions occur when there are no remaining individuals of a species still alive. You should be able to describe factors which may contribute to the extinction of a species. |  |  |
| **4.6.3.4 Resistant Bacteria** |
| Bacteria can evolve rapidly because they reproduce at a fast rate. Mutations of bacterial pathogens produce new strains. Some strains might be resistant to antibiotics, and so are not killed. They survive and reproduce, so the population of the resistant strain rises. The resistant strain will then spread because people are not immune to it and there is no effective treatment. |  |  |
| MRSA is resistant to antibiotics. To reduce the rate of development of antibiotic resistant strains: • doctors should not prescribe antibiotics inappropriately, such as treating non-serious or viral infections • patients should complete their course of antibiotics so all bacteria are killed and none survive to mutate and form resistant strains • the agricultural use of antibiotics should be restricted. |  |  |
| The development of new antibiotics is costly and slow. It is unlikely to keep up with the emergence of new resistant strains. |  |  |
| **4.6.4 Classification of Living Organisms** |
| Traditionally living things have been classified into groups depending on their structure and characteristics in a system developed by Carl Linnaeus. |  |  |
| Linnaeus classified living things into kingdom, phylum, class, order, family, genus and species. Organisms are named by the binomial system of genus and species. |  |  |
| Describe the impact of developments in biology on classification systems. |  |  |
| As evidence of internal structures became more developed due to improvements in microscopes, and the understanding of biochemical processes progressed, new models of classification were proposed. |  |  |
| Due to evidence available from chemical analysis there is now a ‘three-domain system’ developed by Carl Woese. In this system organisms are divided into: • Archaea (primitive bacteria usually living in extreme environments) • Bacteria (true bacteria) • Eukaryota (which includes protists, fungi, plants and animals). |  |  |
| Evolutionary trees are a method used by scientists to show how they believe organisms are related. They use current classification data for living organisms and fossil data for extinct organisms. |  |  |

**Videos:**

<https://goo.gl/VqJDWU> - 33 minute video on whole topic

<https://goo.gl/rxuKye> - 3 x videos on the topic

**Revision guide reference:**

Higher pages: 68 - 82

Foundation: 66 - 82

Biology Unit 7 – Ecology

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| **4.7.1 Adaptations, Interdependence and Competition** | **😊** | **☹** |
| Describe: • different levels of organisation in an ecosystem from individual organisms to the whole ecosystem • the importance of interdependence and competition in a community. |  |  |
| When provided with appropriate information: • suggest the factors for which organisms are competing in a given habitat • suggest how organisms are adapted to the conditions in which they live. |  |  |
| An ecosystem is the interaction of a community of living organisms (biotic) with the non-living (abiotic) parts of their environment. |  |  |
| To survive and reproduce, organisms require a supply of materials from their surroundings and from the other living organisms there. |  |  |
| Plants in a community or habitat often compete with each other for light and space, and for water and mineral ions from the soil. Animals often compete with each other for food, mates and territory. |  |  |
| Within a community each species depends on other species for food, shelter, pollination, seed dispersal etc. If one species is removed it can affect the whole community. This is called interdependence. A stable community is one where all the species and environmental factors are in balance so that population sizes remain fairly constant. |  |  |
| Extract and interpret information from charts, graphs and tables relating to the interaction of organisms within a community. |  |  |
| Explain how a change in a biotic or an abiotic factor would affect a given community given appropriate data or context. |  |  |
| Abiotic (non-living) factors which can affect a community are: • light intensity • temperature • moisture levels • soil pH and mineral content • wind intensity and direction • carbon dioxide levels for plants • oxygen levels for aquatic animals |  |  |
| Biotic (living) factors which can affect a community are: • availability of food • new predators arriving • new pathogens • one species outcompeting another so the numbers are no longer sufficient to breed. |  |  |
| Explain how organisms are adapted to live in their natural environment, given appropriate information. |  |  |
| Organisms have features (adaptations) that enable them to survive in the conditions in which they normally live. These adaptations may be structural, behavioural or functional. |  |  |
| Some organisms live in environments that are very extreme, such as at high temperature, pressure, or salt concentration. These organisms are called extremophiles. Bacteria living in deep sea vents are extremophiles. |  |  |
| **4.7.2 Organisation of an Ecosystem** |
| Understand that photosynthetic organisms are the producers of biomass for life on Earth. |  |  |
| Feeding relationships within a community can be represented by food chains. All food chains begin with a producer which synthesises molecules. This is usually a green plant or alga which makes glucose by photosynthesis. |  |  |
| A range of experimental methods using transects and quadrats are used by ecologists to determine the distribution and abundance of species in an ecosystem. |  |  |
| In relation to abundance of organisms students should be able to: • understand the terms mean, mode and median • calculate arithmetic means • plot and draw appropriate graphs selecting appropriate scales for the axes. |  |  |
| Producers are eaten by primary consumers, which in turn may be eaten by secondary consumers and then tertiary consumers. |  |  |
| Consumers that kill and eat other animals are predators, and those eaten are prey. In a stable community the numbers of predators and prey rise and fall in cycles. |  |  |
| Interpret graphs used to model these cycles. |  |  |
| Recall that many different materials cycle through the abiotic and biotic components of an ecosystem and explain the importance of the carbon and water cycles to living organisms. |  |  |
| All materials in the living world are recycled to provide the building blocks for future organisms. |  |  |
| The carbon cycle returns carbon from organisms to the atmosphere as carbon dioxide to be used by plants in photosynthesis. |  |  |
| The water cycle provides fresh water for plants and animals on land before draining into the seas. Water is continuously evaporated and precipitated. |  |  |
| Explain the role of microorganisms in cycling materials through an ecosystem by returning carbon to the atmosphere as carbon dioxide and mineral ions to the soil. |  |  |
| **4.7.3 Biodiversity and the Effect of Human Interaction on Ecosystems** |
| Biodiversity is the variety of all the different species of organisms on earth, or within an ecosystem. |  |  |
| A great biodiversity ensures the stability of ecosystems by reducing the dependence of one species on another for food, shelter and the maintenance of the physical environment. |  |  |
| The future of the human species on Earth relies on us maintaining a good level of biodiversity. Many human activities are reducing biodiversity and only recently have measures been taken to try to stop this reduction. |  |  |
| Rapid growth in the human population and an increase in the standard of living mean that increasingly more resources are used and more waste is produced. Unless waste and chemical materials are properly handled, more pollution will be caused. |  |  |
| Pollution can occur: • in water, from sewage, fertiliser or toxic chemicals • in air, from smoke and acidic gases • on land, from landfill and from toxic chemicals. Pollution kills plants and animals which can reduce biodiversity. |  |  |
| Humans reduce the amount of land available for other animals and plants by building, quarrying, farming and dumping waste. |  |  |
| The destruction of peat bogs, and other areas of peat to produce garden compost, reduces the area of this habitat and thus the variety of different plant, animal and microorganism species that live there (biodiversity). The decay or burning of the peat releases carbon dioxide into the atmosphere. |  |  |
| Large-scale deforestation in tropical areas has occurred to: • provide land for cattle and rice fields • grow crops for biofuels. |  |  |
| Describe some of the biological consequences of global warming. |  |  |
| Levels of carbon dioxide and methane in the atmosphere are increasing, and contribute to ‘global warming’. |  |  |
| Describe both positive and negative human interactions in an ecosystem and explain their impact on biodiversity. |  |  |
| Scientists and concerned citizens have put in place programmes to reduce the negative effects of humans on ecosystems and biodiversity. These include: • breeding programmes for endangered species • protection and regeneration of rare habitats • reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop • reduction of deforestation and carbon dioxide emissions by some governments • recycling resources rather than dumping waste in landfill. |  |  |

**Videos:**

<https://goo.gl/njjj4h> - competition and adaptations

<https://goo.gl/A8v4ru> - adaptations of arctic animals

<https://goo.gl/gHFssL> - adaptations of desert animals

<https://goo.gl/4FquQY> - adaptations

<https://goo.gl/KXvLQK> - human impact on the environment

**Revision guide reference:**

Higher page: 83 – 95

Foundation: 83 – 95

Biology required practicals

**Paper 1**

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| **Required practical activity 1:** Use a light microscope to observe, draw and label a selection of plant and animal cells |

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| **Required practical activity 2 (Triple science only):** Investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition |

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| **Required practical activity 3:** Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue. |

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| **Required practical activity 4:** Use qualitative reagents to test for a range of carbohydrates, lipids and proteins.To include: Benedict’s test for sugars; iodine test for starch; and Biuret reagent for protein. |

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| **Required practical activity 5:** Investigate the effect of pH on the rate of reaction of amylase enzyme.Use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater |

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| **Required practical activity 6:** Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed |

**Paper 2**

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| **Required practical activity 7:** Plan and carry out an investigation into the effect of a factor on human reaction time |

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| **Required practical activity 8 (Triple science only):** Investigate the effect of light or gravity on the growth of newly germinated seedlings Record results both as length measurements and as accurate, labelled biological drawings to show the effects |

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| **Required practical activity 9:** 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 |

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| **Required practical activity 10 (Triple science only):** Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change |

**Videos:**

Required practical 1: <https://goo.gl/NEFzKg>

Required practical 2:

Required practical 3: <https://goo.gl/UwCgMN>

Required practical 4: <https://goo.gl/2Pc1xf>

Required practical 5: <https://goo.gl/dyxo6c>

Required practical 6: <https://goo.gl/zEcFnH>

Required practical 7: <https://goo.gl/m53nx9>

Required practical 8: <https://goo.gl/8kXs6L>

Required practical 9:

Required practical 10: <https://goo.gl/4oWaCM>