KS4 Biology Curriculum Coverage:

Sequenced	**Cellular Biology**	**Organisation**
Key Knowledge	**To know:** ● The similarities and differences between eukaryotic and prokaryotic cells and estimate their relative size or area. ● How the structure of different types of cells relate to their function in a tissue, an organ or organ system. ● The importance of cell differentiation in both animals and plants and how it leads to specialised cells. ● How microscopy techniques have developed over time how to carry out calculations involving magnification, real size and image size. ● That an electron microscope has a much higher magnification and resolution than a light microscope. ● How bacteria divide (binary fission), how they can be grown and how to prepare an uncontaminated culture using an aseptic technique. ● That the nucleus contains chromosomes (in pairs) made of DNA. Each chromosome contains many genes. ● How to describe how cells divide via mitosis and knowing how it fits within the stages of the cell cycle. ● The function of stem cells in embryos, in adult animals and in the meristems of plants. ● Substances move in and out of cells across the cell membrane by diffusion, osmosis and active transport.	**To know:** ● The human digestive system, which provides the body with nutrients. ● The respiratory system, which provides oxygen and removes carbon dioxide. ● Both systems provide dissolved materials that must be transported quickly via the circulatory system. ● Damage to these systems can be debilitating or fatal. ● While surgical techniques have greatly improved (e.g. for coronary heart disease), ● Many medical interventions could be avoided with better diet and lifestyle choices. ● A plant's transport system depends on environmental conditions. ● This system ensures leaf cells receive water and carbon dioxide for photosynthesis. ● 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.
Key Skills	**To be able to:** ● Demonstrate an understanding of the scale and size of cells and make calculations with the use of standard form. ● Recognise, draw and interpret images of cells using a light microscope and a magnification scale. ● Convert and use prefixes centi, milli, micro and nano. ● Calculate the number of the number of bacteria in a population or the cross-sectional area of a colony using πr^2 ● Use models or analogies to develop explanations about how cells divide and recognise contexts when mitosis is occurring. ● Evaluate the practical risks, benefits, social and ethical issues of the use of stem cells in medical research and treatments. ● Recognise, draw and interpret diagrams that model diffusion and osmosis. ● Calculate and compare surface area to volume ratios ● Use percentages and to measure the rate of water uptake. and calculate percentage gain/loss of mass in plant tissue ● Plot, draw and interpret appropriate graphs.	**To be able to:** ● Develop an understanding of size and scale in relation to cells, tissues, organs and systems. ● Required practical activity 4: use qualitative reagents to test for a range of carbohydrates, lipids and proteins. ● Required practical activity 5: investigate the effect of pH on the rate of reaction of amylase enzyme. ● Use simple compound measures such as rate and carry out rate calculations for blood flow. ● Recognise different types of blood cells in a photograph or diagram, and explain how they are adapted to their functions. ● Evaluate methods of treatment bearing in mind the benefits and risks associated with the treatment. ● Understand the principles of sampling as applied to scientific data, including epidemiological data. ● Interpret data about risk factors for specified diseases.
Subject specific Vocabulary	Eukaryotic, prokaryotic, organelles, nucleus, cell membrane, cytoplasm, mitochondria, ribosome, cell wall, vacuole, chloroplast, differentiation, specialisation, microscopy, magnification, resolution, binary fission, aseptic, chromosomes, gene, mitosis, embryo, meristem, diffusion, osmosis, active transport	Organ, Organ system, Tissue, Cell, Specialised cell, Enzyme, Catalyst, Active site, Substrate, Digestive system, Amylase, Protease, Lipase, Carbohydrase, Starch, Glucose, Amino acids, Fatty acids, Glycerol, Bile, pH, Denature, Circulatory system, Heart, Blood, Artery, Vein, Capillary, Red blood cell, White blood cell, Platelet, Plasma, Coronary heart disease, Stent, Statin, Artificial heart, Pacemaker, Health, Communicable disease, Non-communicable disease, Cancer, Tumour, Benign, Malignant, Risk factor, Lifestyle, Epidemiology, Plant tissues, Xylem, Phloem, Transpiration, Translocation, Stomata, Guard cells

KS4 Biology Curriculum Coverage:

Sequenced	**Infection and Response**	**Bioenergetics**
Key Knowledge	**To know:** ● 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. ● 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. ● Pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. They depend on their host to provide the conditions and nutrients that they need to grow and reproduce. They frequently produce toxins that damage tissues and make us feel ill. ● If a pathogen enters the body the immune system tries to destroy the pathogen. White blood cells help to defend against pathogens. ● 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. ● Antibiotics are medicines that help to cure bacterial disease by killing infective bacteria inside the body. ● 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. ● Traditionally drugs were extracted from plants and microorganisms. ● Most new drugs are synthesised by chemists in the pharmaceutical industry. ● 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. ● (BIO ONLY) Monoclonal antibodies are produced from a single clone of cells. The antibodies are specific to one binding site on one protein antigen and so are able to target a specific chemical or specific cells in the body. ● (BIO ONLY) Monoclonal antibodies create more side effects than expected. They are not yet as widely used as everyone hoped when they were first developed. ● (BIO ONLY) Plants can be infected by a range of viral, bacterial and fungal pathogens as well as by insects. Knowledge of plant diseases is restricted to tobacco mosaic virus as a viral disease, black spot as a fungal disease and aphids as insects. ● (BIO ONLY) Knowledge of plant diseases is restricted to tobacco mosaic virus as a viral disease, black spot as a fungal disease and aphids as insects.	**To know:** ● Photosynthesis is represented by the equation: carbon dioxide + water light glucose + oxygen ● Required practical activity 6: investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed. ● 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. ● 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. ● 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 dioxide ● Anaerobic respiration in yeast cells is called fermentation and has economic importance in the manufacture of bread and alcoholic drinks. ● 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 buildup 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. ● 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.
Key Skills	**To be able to:** ● 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. ● Describe various pathogens including - measles, HIV, Tobacco mosaic virus (TMV), Salmonella, Gonorrhoea, Rose black spot, Malaria. ● Describe the non-specific defence systems of the human body against pathogens and explain the role of the immune system in the defence against disease. ● 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. ● Explain the use of antibiotics and other medicines in treating disease. ● Evaluate the global use of vaccination in the prevention of disease. ● Calculate the number of bacteria in a population after a certain time if given the mean division time. (SEP Links to Cellular biology) ● Calculate cross-sectional areas of colonies or clear areas around colonies using πr2. (SEP Links to Cellular biology) ● Describe the process of discovery and development of potential new medicines, including preclinical and clinical testing. ● Understand that the results of testing and trials are published only after scrutiny by peer review. ● Evaluate the advantages and disadvantages of monoclonal antibodies. (SEP) ● Identify and diagnose plant diseases using different methods (SEP) ● Describe physical and chemical plant defence responses. (SEP)	**To be able to:** ● Recognise the chemical symbols: CO_2 , H_2O, O_2 and $C_6H_{12}O_6$. Students should be able to describe photosynthesis as an endothermic reaction in which energy is transferred from the environment to the chloroplasts by light. ● Explain the effects of temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll on the rate of photosynthesis. ● Solve simple algebraic equations. ● 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. ● Students should be able to describe cellular respiration as an exothermic reaction which is continuously occurring in living cells. ● 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. ● Recognise the chemical symbols: $C_6H_{12}O_6$, O_2 , CO_2 and H_2O. ● Use data to relate limiting factors to the cost effectiveness of adding heat, light or carbon dioxide to greenhouses. (HT Only) ● Test to identify starch, glucose and proteins using simple qualitative reagents. (Links to organisation) ● Plan and conduct investigations into how exercise affects the body ● Explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids.
Subject specific Vocabulary	Virus, Bacteria, Fungi, Protist, Pathogen, Vector, HIV, TMV, Measles, Salmonella, Gonorrhea, Rose black spot, Malaria, Lymphocyte, Phagocyte, Phagocytosis, Antibodies, Antigen, Antitoxin, Vaccination, Immunity, Pre-clinical, Clinical trials, Placebo, Penicillin. SEP keywords Monoclonal antibodies, Chlorosis, Deficiency, Physical defences, Mechanical defences, Chemical defences.	Photosynthesis, Chlorophyll, Chloroplast, Light intensity, Carbon dioxide concentration, Temperature, Limiting factor, Glucose, Starch, Cellulose, Nitrate, Magnesium, Respiration, Aerobic respiration, Anaerobic respiration, Oxygen debt, Lactic acid, Muscle fatigue, Metabolism, Mitochondria, Fermentation, Yeast, Ethanol, Carbon dioxide, Energy, Exercise, Recovery, Oxygen, Enzyme-controlled reactions

KS4 Biology Curriculum Coverage:

Sequenced	**Homeostasis & Response**	**Inheritance, variation and Evolution**
Key Knowledge	**To know:** ● Cells can only survive within narrow physical and chemical limits. ● They need a constant temperature, pH, and supply of dissolved food and water. ● The body uses control systems to monitor and adjust blood and tissue composition. ● Control systems include: Receptors to detect changes, Effectors to bring about responses, The nervous system controls fast responses. ● The hormonal system brings about slower changes. ● Hormonal coordination is key in reproduction, especially in controlling the menstrual cycle. ● Understanding reproductive hormones has led to: The development of contraceptive drugs, The creation of fertility treatments. ● (Biology only) The brain controls complex behaviour. It is made of billions of interconnected neurones and has different regions that carry out different functions. ● (Biology only) =The cerebral cortex, cerebellum and medulla on a diagram of the brain, and describe their functions. ● (Biology Only) The structures of the eye and their functions ● (Biology Only) Body temperature is monitored and controlled by the thermoregulatory centre in the brain. The thermoregulatory centre contains receptors sensitive to the temperature of the blood. ● (Biology Only) - The effect on cells of osmotic changes in body fluids. ● (HT only) The digestion of proteins from the diet results in excess amino acids which need to be excreted safely. ● (HT only) The effect of ADH on the permeability of the kidney tubules. ● (HT only) The water level in the body is controlled by the hormone ADH which acts on the kidney tubules. ● (HT only) The interactions of FSH, oestrogen, LH and progesterone, in the control of the menstrual cycle. ● (HT Only) The use of hormones in modern reproductive technologies to treat infertility. ● (Biology Only) Plants produce hormones to coordinate and control growth and responses to light (phototropism) and gravity (gravitropism or geotropism).	**To know:** ● Differences between sexual and asexual reproduction, including examples of organisms that reproduce sexually, asexually, or both ● Sexual reproduction involves meiosis and produces non-identical gametes; asexual reproduction uses mitosis and produces genetically identical offspring ● Advantages and disadvantages of both types of reproduction (variation, speed, energy use) ● Meiosis and fertilisation: how meiosis forms gametes and fertilisation restores the diploid number ● DNA structure: double helix with two strands; genes are sections of DNA coding for proteins ● The genome is the full set of genetic material; benefits of studying the human genome in medicine ● Using Punnett squares to predict inheritance, calculate probabilities/ratios, and understand sex determination (XX/XY) ● Inherited disorders: polydactyly (dominant), cystic fibrosis (recessive), and how carriers can pass them on ● Interpreting family trees/pedigrees to trace inheritance ● Embryo screening: process, pros and cons (social, ethical, economic) ● Causes of variation: genetic, environmental, or both ● Mutations: usually neutral, sometimes harmful or beneficial; can lead to new alleles ● Evolution via natural selection: variation → survival → reproduction → speciation ● Fossils as evidence of evolution; fossil formation and limitations of the fossil record ● Antibiotic-resistant bacteria as evidence for evolution; importance of completing antibiotic courses ● Selective breeding process, examples, and risks (reduced gene pool) ● Genetic engineering: gene transfer, GM bacteria for insulin, GM crops (benefits/risks) ● Cloning: plant cloning (cuttings, tissue culture); animal cloning (embryo transplants, adult cell cloning)
Key Skills	**To be able to:** ● Required practical activity 7: plan and carry out an investigation into the effect of a factor on human reaction time. ● (HT Only) Evaluate the benefits and risks of procedures carried out on the brain and nervous system. ● Describe the roles of hormones in human reproduction, including the menstrual cycle. ● Evaluate information around the relationship between obesity and diabetes, and make recommendations taking into account social and ethical issues. ● Describe how kidney dialysis works. ● Evaluate the advantages and disadvantages of treating organ failure by mechanical device or transplant. ● Show why issues around contraception cannot be answered by science alone. ● Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments. ● Understand social and ethical issues associated with IVF treatments. ● Evaluate from the perspective of patients and doctors the methods of treating infertility. ● Explain the roles of thyroxine and adrenaline in the body. ● Investigate the effect of light or gravity on the growth of newly germinated seedlings. ● Describe the effects of some plant hormones and the different ways people use them to control plant growth. ● Understand how the everyday use of hormones as weedkillers has an effect on biodiversity.	**To be able to:** ● Model behaviour of chromosomes during meiosis. ● Describe historical developments of our understanding of the causes and preventiaon of malaria. ● Interpret a diagram of DNA structure but will not be required to reproduce it. ● (HT) Model insertions and deletions in chromososmes to illustrate mutations. ● Appreciate that embryo screening and gene therapy may alleviate suffering but consider the ethical issues which arise. ● Use the theory of evolution by natural selection in an explanation. ● Explain the benefits and risks of selective breeding given appropriate information and consider related ethical issues. ● (HT) Interpret information about genetic engineering techniques and to make informed judgements about issues concerning cloning and genetic engineering, including GM crops. ● (Biology Only) Explain the potential benefits and risks of cloning in agriculture and in medicine and that some people have ethical objections. ● Appreciate that the theory of evolution by natural selection developed over time and from information gathered by many scientists ● (Biology) .Describe how the theory of speciation has developed over time. ● (Biology) Describe how our current understanding of genetics has developed over time. ● Extract and interpret information from charts, graphs and tables. ● Understand how scientific methods and theories develop over time. ● Understand how scientific methods and theories develop over time. ● Interpret evolutionary trees.
Subject specific Vocabulary	Homeostasis, Internal environment, Receptor, Stimulus, Coordination centre, Effector, Negative feedback, Nervous system, Neurone, Sensory neurone, Relay neurone, Motor neurone, Synapse, Reflex, Reflex arc, Endocrine system, Hormone, Gland, Target organ, Insulin, Glucagon, Diabetes, Thermoregulation, Vasodilation, Vasoconstriction, Sweating, Shivering	DNA, Gene, Chromosome, Genome, Allele, Dominant, Recessive, Homozygous, Heterozygous, Genotype, Phenotype, Inheritance, Punnett square, Genetic diagram, Gamete, Fertilisation, Sexual reproduction, Asexual reproduction, Mitosis, Meiosis, Variation, Mutation, Natural selection, Evolution, Selective breeding, Genetic engineering, Genetically modified (GM), Cloning, Fossil, Extinction, Speciation, Resistant bacteria, Classification, Binomial system, Carl Linnaeus, Evolutionary tree

KS4 Biology Curriculum Coverage:

Sequenced	**Ecology**
Key Knowledge	**To know:** ● Levels of organisation in an ecosystem: individual → population → community → ecosystem ● How abiotic (non-living) and biotic (living) factors affect communities ● The interdependence of organisms in a community (e.g. food chains, pollination) ● How organisms are adapted to their environments, including extremophiles ● Required practical: measuring population size using quadrats and transects ● The carbon cycle and water cycle – how materials are recycled in nature ● The importance of decomposers in ecosystems ● Biodiversity – what it is, why it's important, and how human activities affect it ● The impact of waste, deforestation, global warming, and pollution ● Maintaining biodiversity: conservation, breeding programmes, habitat protection, etc. ● Trophic levels: producers → primary consumers → secondary → tertiary ● How to use pyramids of biomass ● Calculating efficiency of biomass transfer between trophic levels ● How farming and fishing can be managed to be sustainable ● Food security: factors affecting access to food globally ● New methods to improve food production: e.g. GM organisms, biotechnology, fermenters
Key Skills	**To be able to:** ● Record first-hand observations of organisms. ● Extract and interpret information from charts, graphs and tables. ● Interpret graphs used to model predator-prey cycles. ● 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. ● Interpret and explain the processes in diagrams of the carbon cycle, the water cycle. ● Required practical activity 10: investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change. ● Explain how waste, deforestation and global warming have an impact on biodiversity. ● Understand the conflict between the need for cheap available compost to increase food production and the need to conserve peat bogs and peatlands as habitats for biodiversity and to reduce carbon dioxide emissions. ● Evaluate the environmental implications of deforestation. ● Understand that the scientific consensus about global warming and climate change is based on systematic reviews of thousands of peer reviewed publications. ● Explain why evidence is uncertain or incomplete in a complex context. ● Evaluate given information about methods that can be used to tackle problems caused by human impacts on the environment. ● Explain and evaluate the conflicting pressures on maintaining biodiversity given appropriate information. ● (Biology) Calculate the efficiency of biomass transfer between trophic levels. ● (Biology) Interpret population and food production statistics to evaluate food security. ● Understand that some people have ethical objections to some modern intensive farming methods. ● Evaluate the advantages and disadvantages of modern farming techniques. ● Understand how application of different fishing techniques promotes recovery of fish stocks.
Subject specific Vocabulary	Ecosystem, Habitat, Population, Community, Abiotic factor, Biotic factor, Interdependence, Competition, Predator, Prey, Adaptation, Extremophile, Producer, Consumer, Decomposer, Food chain, Food web, Biomass, Trophic level, Pyramid of biomass, Biodiversity, Quadrat, Transect, Distribution, Pollution, Global warming, Climate change, Deforestation, Peat bog, Carbon cycle, Water cycle, Decay, Compost, Anaerobic decay, Biogas, Conservation, Reforestation, Indicator species, Eutrophication