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ACADEMY WEYMOUTH
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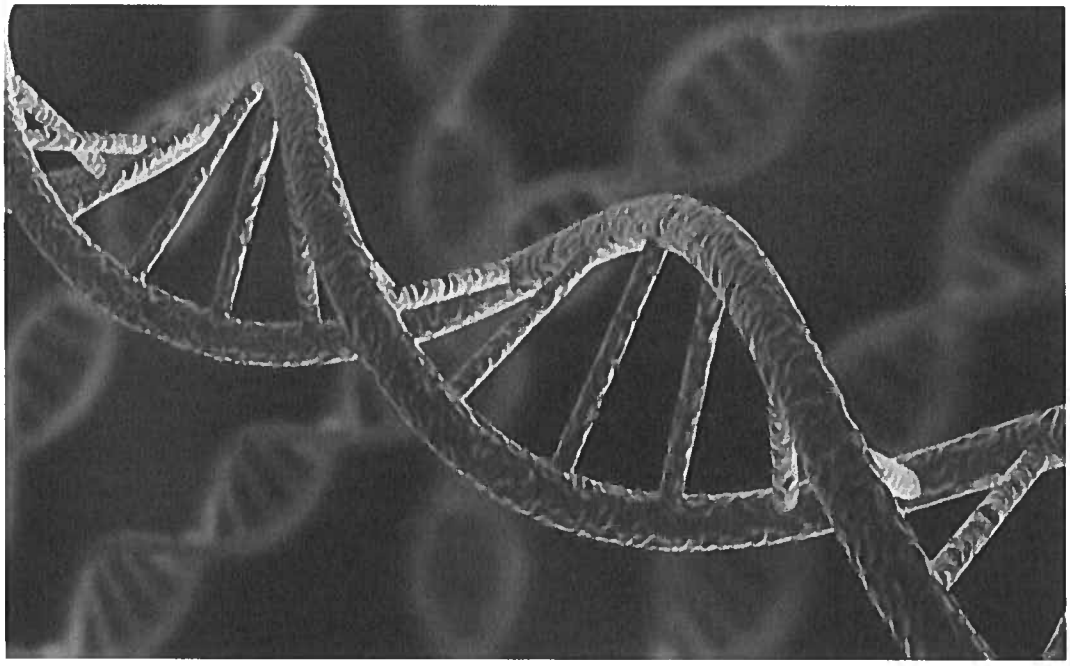
A Level Biology Course handbook

Exam board OCR Biology A



Budmouth Academy

A Level Biology Checklist

	Notes	☺	😐	☹	Revised	Grade
Module 2: Foundations in Biology						
2.1.1 Cell Structure *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
(a) the use of microscopy to observe and investigate different types of cell and cell structure in a range of eukaryotic organisms. *To include an appreciation of the images produced by a range of microscopes: light microscope, transmission electron microscope, scanning electron microscope and laser scanning confocal microscope*						
(b) the preparation and examination of microscope slides for use in light microscopy *Including the use of an eyepiece graticule and stage micrometer PAG1*						
(c) the use of staining in light microscopy. *To include the use of differential staining to identify different cellular components and cell types PAG1*						
(d) the representation of cell structure as seen under the light microscope using drawings and annotated diagrams of whole cells or cells in sections of tissue *PAG1*						
(e) the use and manipulation of the magnification formula *magnification = image size ÷ object size M0.1, M0.2, M0.3, M1.1, M1.8, M2.2, M2.3, M2.4*						
(f) the difference between magnification and resolution. *To include an appreciation of the differences in resolution and magnification that can be achieved by a light microscope, a transmission electron microscope and a scanning electron microscope M0.2, M0.3*						
(g) the ultrastructure of eukaryotic cells and the functions of the different cellular components. *To include the following cellular components and an outline of their functions: nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum (ER), Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplasts, plasma membrane, centrioles, cell wall, flagella and cilia. M0.2*						
(h) photomicrographs of cellular components in a range of eukaryotic cells. *To include interpretation of transmission and scanning electron microscope images.*						
(i) the interrelationship between the organelles involved in the production and secretion of proteins. *No detail of protein synthesis is required.*						
(j) the importance of the cytoskeleton. *To include providing mechanical strength to cells, aiding transport within cells and enabling cell movement.*						
(k) the similarities and differences in the structure and ultrastructure of prokaryotic and eukaryotic cells. *PAG1*						
2.1.2 Biological Molecules *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) how hydrogen bonding occurs between water molecules, and relate this, and other properties of water, to the role of water for living organisms *A range of roles that relate to the properties of water including solvent, transport medium, coolant and as a habitat* **AND** *role illustrated using examples of prokaryotes and eukaryotes*						
(b) the concept of monomers and polymers and the importance of condensation and hydrolysis reactions in a range of biological molecules						
(c) the chemical elements that make up biological molecules. *To include: C, H and O for carbohydrates C, H and O for lipids C, H, O, N and S for proteins C, H, O, N and P for nucleic acids*						
(d) the ring structure and properties of glucose as an example of a hexose monosaccharide and the structure of ribose as an example of a pentose monosaccharide. *To include the structural difference between an α- and a β-glucose molecule AND the difference between a hexose and a pentose monosaccharide.*						
(e) the synthesis and breakdown of a disaccharide and polysaccharide by the						

formation and breakage of glycosidic bonds. *To include the disaccharides sucrose, lactose and maltose.*						
(f) the structure of starch (amylose and amylopectin), glycogen and cellulose molecules						
(g) how the structures and properties of glucose, starch, glycogen and cellulose molecules relate to their functions in living organisms						
(h) the structure of a triglyceride and a phospholipid as examples of macromolecules. *To include an outline of saturated and unsaturated fatty acids.*						
(i) the synthesis and breakdown of triglycerides by the formation (esterification) and breakage of ester bonds between fatty acids and glycerol						
(j) how the properties of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms. *To include hydrophobic and hydrophilic regions and energy content AND illustrated using examples of prokaryotes and eukaryotes.*						
(k) the general structure of an amino acid						
(l) the synthesis and breakdown of dipeptides and polypeptides, by the formation and breakage of peptide bonds						
(m) the levels of protein structure. *To include primary, secondary, tertiary and quaternary structure AND hydrogen bonding, hydrophobic and hydrophilic interactions, disulfide bonds and ionic bonds.*						
(n) the structure and function of globular proteins including a conjugated protein *To include haemoglobin as an example of a conjugated protein (globular protein with a prosthetic group), a named enzyme and insulin. An opportunity to use computer modelling to investigate the levels of protein structure within the molecule. PAG10*						
(o) the properties and functions of fibrous proteins *To include collagen, keratin and elastin (no details of structure are required).*						
(p) the key inorganic ions that are involved in biological processes *including: cations: calcium ions (Ca^{2+}), sodium ions (Na^+), potassium ions (K^+), hydrogen ions (H^+), ammonium ions (NH_4^+); anions: nitrate (NO_3^-), hydrogencarbonate (HCO_3^-), chloride (Cl^-), phosphate (PO_4^{3-}), hydroxide, (OH^-).*						
(q) how to carry out and interpret the results of the following chemical tests: • biuret test for proteins • Benedict's test for reducing and non-reducing sugars • reagent test strips for reducing sugars • iodine test for starch • emulsion test for lipids *PAG9*						
(r) quantitative methods to determine the concentration of a chemical substance in a solution *To include colorimetry and the use of biosensors (an outline only of the mechanism is required). PAG5*						
(s) (i) the principles and uses of paper and thin layer chromatography to separate biological molecules / compounds *To include calculation of retention (Rf) values.* (ii) practical investigations to analyse biological solutions using paper or thin layer chromatography. *For example the separation of proteins, carbohydrates, vitamins or nucleic acids. M0.1, M0.2, M1.1, M1.3, M2.2, M2.3, M2.4 PAG6*						
2.1.3 Nucleotides and Nucleic Acids ***Learners should be able to demonstrate and apply their knowledge and understanding of:***						
	N	☺	😐	☹	R	
(a) the structure of a nucleotide as the monomer from which nucleic acids are made *Including the difference between DNA and RNA nucleotides, the identification of the purines and pyrimidines, the type of pentose sugar. PAG 10*						
(b) the synthesis and breakdown of polynucleotides by the formation and						

breakage of phosphodiester bonds						
(c) the structure of ADP and ATP as phosphorylated Nucleotides *Comprising a pentose sugar (ribose), a nitrogenous base (adenine) and inorganic phosphates.*						
(d) (i) the structure of DNA (deoxyribonucleic acid) (ii) practical investigations into the purification of DNA by precipitation *To include how hydrogen bonding between complementary base pairs (A to T, G to C) on two antiparallel DNA polynucleotides leads to the formation of a DNA molecule, and how the twisting of DNA produces its 'double-helix' shape. PAG9*						
(e) semi-conservative DNA replication *To include the roles of the enzymes helicase and DNA polymerase, the importance of replication in conserving genetic information with accuracy and the occurrence of random, spontaneous mutations.*						
(f) the nature of the genetic code *To include the triplet, non-overlapping, degenerate and universal nature of the code and how a gene determines the sequence of amino acids in a polypeptide (the primary structure of a protein).*						
(g) transcription and translation of genes resulting in the synthesis of polypeptides. *To include, the roles of RNA polymerase, messenger (m)RNA, transfer (t)RNA, ribosomal (r)RNA.*						
2.1.4 Enzymes *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the role of enzymes in catalysing reactions that affect metabolism at a cellular and whole organism level *Including the idea that enzymes affect both structure and function*						
(b) the role of enzymes in catalysing both intracellular and extracellular reactions *To include catalase as an example of an enzyme that catalyses intracellular reactions and amylase and trypsin as examples of enzymes that catalyse extracellular reactions.*						
(c) the mechanism of enzyme action *To include the tertiary structure, specificity, active site, lock and key hypothesis, induced-fit hypothesis, enzyme-substrate complex, enzyme product complex, product formation and lowering of activation energy.*						
(d) (i) the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity *To include reference to the temperature coefficient (Q10).* (ii) practical investigations into the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity *M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6 PAG4*						
(e) the need for coenzymes, cofactors and prosthetic groups in some enzyme-controlled reactions *To include Cl^- as a cofactor for amylase, Zn^{2+} as a prosthetic group for carbonic anhydrase and vitamins as a source of coenzymes. PAG4*						
(f) the effects of inhibitors on the rate of enzyme controlled reactions. *To include competitive and non-competitive and reversible and non-reversible inhibitors with reference to the action of metabolic poisons and some medicinal drugs, and the role of product inhibition AND inactive precursors in metabolic pathways (covered at A level only). M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6 PAG4*						
2.1.5 Biological membranes *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the role of membranes within cells and the surface of cells *including the roles of membranes as: partially permeable barriers, sites of chemical reactions; sites of cell communication in cell signalling*						
(b) the fluid mosaic model of membrane structure and the roles of its components *Including phospholipids, cholesterol, glycolipids, proteins and glycoproteins* **AND** *the role of membrane-bound receptors as sites where hormones and drugs can bind*						
(c) (i) factors affecting membrane structure and permeability (ii) practical investigations into factors affecting membrane structure and						

permeability *To include the effects of temperature and solvents. M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6 PAG8*						
(d) (i) the movement of molecules across membranes (ii) practical investigations into the factors affecting diffusion rates in model cells *To include diffusion and facilitated diffusion as passive methods AND active transport, endocytosis and exocytosis as processes requiring adenosine triphosphate (ATP) as an immediate source of energy.* *M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.11, M2.1, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1 PAG8*						
(e) (i) the movement of water across membranes by osmosis and the effects that solutions of different water potential can have on plant and animal cells (ii) practical investigations into the effects of solutions of different water potential on plant and animal cells. *Osmosis to be explained in terms of a water potential gradient across a partially-permeable membrane. M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.10, M1.11, M2.1, M3.1, M3.2, M4.1 PAG8*						
2.1.6 Cell division, cell diversity and cellular organisation *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the cell cycle *to include the processes taking place in interphase, mitosis and cytokinesis, leading to genetically identical cells*						
(b) how the cell cycle is regulated *To include an outline of the use of checkpoints to control the cycle.*						
(c) the main stages of mitosis *To include the changes in the nuclear envelope, chromosomes, chromatids, centromere, centrioles, spindle fibres and cell membrane.*						
(d) sections of plant tissue showing the cell cycle and stages of mitosis *To include the examination of stained sections and squashes of plant tissue and the production of labelled diagrams to show the stages observed. PAG1*						
(e) the significance of mitosis in life cycles *To include growth, tissue repair and asexual reproduction in plants, animals and fungi.*						
(f) the significance of meiosis in life cycles *To include the production of haploid cells and genetic variation by independent assortment and crossing over.*						
(g) the main stages of meiosis *To include interphase, prophase 1, metaphase 1, anaphase 1, telophase 1, prophase 2, metaphase 2, anaphase 2, telophase 2 (no details of the names of the stages within prophase 1 are required) and the term homologous chromosomes. PAG1*						
(h) how cells of multicellular organisms are specialised for particular functions *To include erythrocytes, neutrophils, squamous and ciliated epithelial cells, sperm cells, palisade cells, root hair cells and guard cells.*						
(i) the organisation of cells into tissues, organs and organ systems *To include squamous and ciliated epithelia, cartilage, muscle, xylem and phloem as examples of tissues.*						
(j) the features and differentiation of stem cells *To include stem cells as a renewing source of undifferentiated cells.*						
(k) the production of erythrocytes and neutrophils derived from stem cells in bone marrow						
(l) the production of xylem vessels and phloem sieve tubes from meristems						
(m) the potential uses of stem cells in research and medicine. *To include the repair of damaged tissues, the treatment of neurological conditions such as Alzheimer's and Parkinson's, and research into developmental biology.*						

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Module 3: Exchange and transport						
3.1.1 Exchange surfaces *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the need for specialised surfaces for exchange *To include surface area: volume, metabolic activity, single celled and multi-cellular organisms*						
(b) the features of an efficient exchange surface *To include,* *•increased surface area – root hair cells* *•thin layer – alveoli* *•good blood supply/ventilation to maintain gradient – gills/alveolus.*						
(c) the structures and functions of the components of the mammalian gaseous exchange system *To include the distribution and functions of cartilage, ciliated epithelium, goblet cells, smooth muscle and elastic fibres in the trachea, bronchi, bronchioles and alveoli. PAG1*						
(d) the mechanism of ventilation in mammals *To include the function of the rib cage, intercostal muscles (internal and external) and diaphragm.*						
(e) the relationship between vital capacity, tidal volume, breathing rate and oxygen uptake *To include analysis and interpretation of primary and secondary data e.g. from a data logger or spirometer. M0.1, M0.2, M0.4, M1.3 PAG10*						
(f) the mechanisms of ventilation and gas exchange in bony fish and insects *To include:* *•bony fish – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates); countercurrent flow* *•insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid.*						
(g) the dissection, examination and drawing of the gaseous exchange system of a bony fish and/or insect trachea *PAG2*						
(h) the examination of microscope slides to show the histology of exchange surfaces. *PAG1*						
3.1.2 Transport in animals *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the need for transport systems in multicellular animals ***Including an appreciation of size, metabolic rate and surface area : volume*** ***M0.1,M0.3,M0.4,M1.1,M2.1,M4.1***						
(b) the different types of circulatory systems *To include single, double, open and closed circulatory systems in insects, fish and mammals.*						
(c) the structure and functions of arteries, arterioles, capillaries, venules and veins *To include the distribution of different tissues within the vessel walls. PAG2*						
(d) the formation of tissue fluid from plasma *To include reference to hydrostatic pressure, oncotic pressure and an explanation of the differences in the composition of blood, tissue fluid and lymph.*						
(e) (i) the external and internal structure of the mammalian heart *PAG2* (ii) the dissection, examination and drawing of the external and internal structure of the mammalian heart						
(f) the cardiac cycle To include the role of the valves and the pressure changes occurring in the heart and associated vessels.						
(g) how heart action is initiated and coordinated *To include the roles of the sino-atrial node (SAN), atrio-ventricular node (AVN), purkyne tissue and the myogenic nature of cardiac muscle (no detail of hormonal and nervous control is required at AS level).*						

(h) the use and interpretation of electrocardiogram (ECG) traces *To include normal and abnormal heart activity e.g. tachycardia, bradycardia, fibrillation and ectopic heartbeat. M0.1, M1.1, M1.3, M2.4*						
(i) the role of haemoglobin in transporting oxygen and carbon dioxide *To include the reversible binding of oxygen molecules, carbonic anhydrase, haemoglobinic acid, HCO_3^- and the chloride shift.*						
(j) the oxygen dissociation curve for fetal and adult human haemoglobin. *To include the significance of the different affinities for oxygen AND the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect). M3.1*						
3.1.3 Transport in plants *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the need for transport systems in multicellular plants *To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V). M0.1, M0.3, M0.4, M1.1, M2.1, M4.1*						
(b) (i) the structure and function of the vascular system in the roots, stems and leaves of herbaceous dicotyledonous plants (ii) the examination and drawing of stained sections of plant tissue to show the distribution of xylem and phloem *PAG1* (iii) the dissection of stems, both longitudinally and transversely, and their examination to demonstrate the position and structure of xylem vessels *To include xylem vessels, sieve tube elements and companion cells. PAG2*						
(c) (i) the process of transpiration and the environmental factors that affect transpiration rate (ii) practical investigations to estimate transpiration rates *To include an appreciation that transpiration is a consequence of gaseous exchange.* *To include the use of a potometer. M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1 PAG5, PAG11*						
(d) the transport of water into the plant, through the plant and to the air surrounding the leaves *To include details of the pathways taken by water AND the mechanisms of movement, in terms of water potential, adhesion, cohesion and the transpiration stream.*						
(e) adaptations of plants to the availability of water in their environment *To include xerophytes (cacti and marram grass) and hydrophytes (water lilies).*						
(f) the mechanism of translocation. *To include translocation as an energy-requiring process transporting assimilates, especially sucrose, in the phloem between sources (e.g. leaves) and sinks (e.g. roots, meristem) AND details of active loading at the source and removal at the sink.*						
Module 4: Biodiversity, evolution and disease						
4.1 Communicable diseases, disease prevention and the immune system **4.1.1 Communicable diseases, disease prevention and the immune system** *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the different types of pathogen that can cause communicable disease in plants and animals *To include: bacteria (TB, bacterial meningitis, ring rot); virus (HIV/AIDS, influenza, tobacco mosaic virus); protoctista (malaria, potato/tomato late blight); fungi (black sigatoka, ring worm, athlete's fot)*						
(b) the means of transmission of animal and plant communicable pathogens *To include direct and indirect transmission, reference to vectors, spores and living conditions - e.g. climate, social factors (no detail of the symptoms of specific diseases is required). M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.5, M1.7, M3.1, M3.2*						
(c) plant defences against pathogens *To include production of chemicals AND plant responses that limit the spread of the pathogen (e.g. callose deposition).*						

(d) the primary non-specific defences against pathogens in animals *Non-specific defences to include skin, blood clotting, wound repair, inflammation, expulsive reflexes and mucous membranes (no detail of skin structure is required).*						
(e) (i) the structure and mode of action of phagocytes (ii) examination and drawing of cells observed in blood smears *To include neutrophils and antigen-presenting cells AND the roles of cytokines, opsonins, phagosomes and lysosomes. PAG1*						
(f) the structure, different roles and modes of action of B and T lymphocytes in the specific immune response *To include the significance of cell signalling (reference to interleukins), clonal selection and clonal expansion, plasma cells, T helper cells, T killer cells and T regulator cells.*						
(g) the primary and secondary immune responses *To include T memory cells and B memory cells. M1.3*						
(h) the structure and general functions of antibodies *To include the general structure of an antibody molecule.*						
(i) an outline of the action of opsonins, agglutinins and anti-toxins						
(j) the differences between active and passive immunity, and between natural and artificial immunity *To include examples of each type of immunity.*						
(k) autoimmune diseases *To include an appreciation of the term autoimmune disease and a named example e.g. arthritis, lupus.*						
(l) the principles of vaccination and the role of vaccination programmes in the prevention of epidemics *To include routine vaccinations AND reasons for changes to vaccines and vaccination programmes (including global issues). M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.5, M1.7, M3.1, M3.2*						
(m) possible sources of medicines *To include examples of microorganisms and plants (and so the need to maintain biodiversity) AND the potential for personalised medicines and synthetic biology.*						
(n) the benefits and risks of using antibiotics to manage bacterial infection. *To include the wide use of antibiotics following the discovery of penicillin in the mid-20th century AND the increase in bacterial resistance to antibiotics (examples to include Clostridium difficile and MRSA) and its implications.*						
4.2 Biodiversity **4.2.1 Biodiversity** *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	☹	☹	R	
(a) how biodiversity may be considered at different levels *To include habitat biodiversity, species biodiversity, and genetic biodiversity*						
(b) (i) how sampling is used in measuring the biodiversity of a habitat and the importance of sampling (ii) practical investigations collecting random and non-random samples in the field *To include how sampling can be carried out i.e. random sampling and non-random sampling (e.g. opportunistic, stratified and systematic) and the importance of sampling the range of organisms in a habitat. M0.2, M1.3, M1.5, M1.4, M1.6, M1.7, M1.9, M1.10, M3.2 PAG3*						
(c) how to measure species richness and species evenness in a habitat *M1.1, M1.5, M2.3, M2.4*						
(d) the use and interpretation of Simpson's Index of Diversity (D) to calculate the biodiversity of a habitat *To include the formula: $D = 1 - (\Sigma(n/N)^2)$ AND the interpretation of both high and low values of Simpson's Index of Diversity (D). M1.1, M1.5, M2.3, M2.4*						
(e) how genetic biodiversity may be assessed, including calculations *To include calculations of genetic diversity within isolated populations, for example the percentage of gene variants (alleles) in a genome.* *proportion of polymorphic gene loci = number of polymorphic gene loci/total number of loci* *Suitable populations include zoos (captive breeding), rare breeds and pedigree animals. M1.1, M1.5, M2.3, M2.4*						

(f) the factors affecting biodiversity *To include human population growth, agriculture (monoculture) and climate change. M1.3, M1.7, M3.1*						
(g) the ecological, economic and aesthetic reasons for maintaining biodiversity *Ecological, including protecting keystone species (interdependence of organisms) and maintaining genetic resource* *•economic, including reducing soil depletion (continuous monoculture)* *•aesthetic, including protecting* *•landscapes.*						
(h) in situ and ex situ methods of maintaining biodiversity *•In situ conservation including marine conservation zones and wildlife reserves* *•ex situ conservation including seed banks, botanic gardens and zoos.*						
(i) international and local conservation agreements made to protect species and habitats. *Historic and/or current agreements, including the Convention on International Trade in Endangered Species (CITES), the Rio Convention on Biological Diversity (CBD) and the Countryside Stewardship Scheme (CSS).*						
4.2.2 Classification and evolution *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) biological classification of species *To include the taxonomic hierarchy of kingdom, phylum, class, order, family, genus, species and domain.*						
(b) the binomial system of naming species and the advantage of such a system						
(c) (i) the features used to classify organisms into the five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae, Animalia (ii) the evidence that has led to new classification systems, such as the three domains of life, which clarifies relationships *To include the use of similarities in observable features in original classification.* *To include the more recent use of similarities in biological molecules and other genetic evidence AND details of the three domains and a comparison of the kingdom and domain classification systems.*						
(d) the relationship between classification and Phylogeny *(covered in outline only at AS level)*						
(e) the evidence for the theory of evolution by natural selection *To include the contribution of Darwin and Wallace in formulating the theory of evolution by natural selection AND fossil, DNA (only genomic DNA at AS level) and molecular evidence.*						
(f) the different types of variation *To include intraspecific and interspecific variation AND the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms AND both genetic and environmental causes of variation. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two populations and/or the Spearman's rank correlation coefficient to consider the relationship of the data. M1.2, M1.3, M1.6, M1.7, M1.10*						
(g) the different types of adaptations of organisms to their environment *Anatomical, physiological and behavioural adaptations AND why organisms from different taxonomic groups may show similar anatomical features, including the marsupial mole and placental mole.*						
(h) the mechanism by which natural selection can affect the characteristics of a population over time *To include an appreciation that genetic variation, selection pressure and reproductive success (or failure) results in an increased proportion of the population possessing the advantageous characteristic(s). M0.3*						
(i) how evolution in some species has implications for human populations. *To include the evolution of pesticide resistance in insects and drug resistance in microorganisms.*						

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Module 5: Communication, Homeostasis and Energy						
5.1.1 Communication and Homeostasis *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
(a) the need for communication systems in multicellular organisms *To include the need for animals and plants to respond to changes in the internal and external environment and to coordinate the activities of different organs.*						
(b) the communication between cells by cell signalling *including signalling between adjacent cells and signalling between distant cells.*						
(c) the principles of homeostasis *To include the differences between receptors and effectors, and the differences between negative feedback and positive feedback.*						
(d) the physiological and behavioural responses involved in temperature control in ectotherms and endotherms. *Including endotherms - peripheral temperature receptors, the role of the hypothalamus and effectors in skin and muscles; behavioural responses; ectotherms - behavioural responses. PAG 11*						
5.1.2 Excretion as an example of homeostatic control *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the term excretion and its importance in maintaining metabolism and homeostatisis. *To include reference to the importance of removing metabolic wastes, including carbon dioxide and nitrogenous waste from the body.*						
(b) (i) the structure and functions of the mammalian liver (ii) the examination and drawing of stained sections to show the histology of liver tissue *To include the gross structure and histology of the liver AND the roles of the liver in storage of glycogen, detoxification and the formation of urea (the ornithine cycle covered in outline only).* *PAG 1*						
(c) (i) the structure, mechanisms of action and functions of the mammalian kidney (ii) the dissection, examination and drawing of the external and internal structure of the kidney (iii) the examination and drawing of stained sections to show the histology of nephrons *To include the gross structure and histology of the kidney including the detailed structure of a nephron and its associated blood vessels AND the processes of ultrafiltration, selective reabsorption and the production of urine.* *M0.1, M0.3, M1.1, M1.3, M2.1, M3.1 PAG1 , PAG2*						
(d) the control of the water potential of the blood *To include the role of osmoreceptors in the hypothalamus, the posterior pituitary gland, ADH and its effect on the walls of the collecting ducts.*						
(e) the effects of kidney failure and its potential treatments *to include the problems that arise from kidney failure including the effect on glomerular filtration rate (GFR) and electrolyte balance* **AND** *the use of renal dialysis and transplants for the treatment of kidney failure.*						
(f) how excretory products can be used in medical diagnosis. *To include the use of urine samples in diagnostic tests, with reference to the use of monoclonal antibodies in pregnancy testing and testing for anabolic steroids and drugs. PAG 9*						

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5.1.3 Neuronal communication *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the roles of mammalian sensory receptors in converting different types of stimuli into nerve impulses *To include an outline of the roles of sensory receptors (e.g. Pacinian corpuscle) in responding to specific types of stimuli and their roles as transducers.*						
(b) the structure and functions of sensory, relay and motor neurones *To include differences between the structure and function of myelinated and non-myelinated neurones.*						
(c) the generation and transmission of nerve impulses in mammals *To include how the resting potential is established and maintained and how an action potential is generated (including reference to positive feedback) and transmitted in a myelinated neurone* ***AND*** *the significance of the frequency of impulse transmission.* *M1.3, M3.1*						
5.1.4 Hormonal communication *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
(a) endocrine communication by hormones *To include secretion of hormones into the blood, transport by the blood, and detection by target cells or tissues.*						
(b) the structure and functions of the adrenal glands *Adrenal glands as an example of endocrine glands, to include the hormones secreted by the cortex and medulla and their functions.*						
(c) (i) the histology of the pancreas (ii) the examination and drawing of stained sections of the pancreas to show the histology of the endocrine tissues *To include the endocrine tissues.* *PAG 1*						
(d) how blood glucose concentration is regulated *To include the action of insulin and glucagon as an example of negative feedback, and the role of the liver* ***AND*** *the control of insulin secretion, with reference to potassium channels and calcium channels in the beta cells of the pancreas.*						
(e) the differences between Type 1 and Type 2 diabetes mellitus *To include the causes of Type 1 and Type 2 diabetes and the treatments used for each.*						
(f) the potential treatments for diabetes mellitus. *To include the use of insulin produced by genetically modified bacteria and the potential use of stem cells to treat diabetes mellitus.*						

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5.1.5 Plant and animal responses *Learners should be able to demonstrate and apply their knowledge and understanding of:*	N	☺	😐	☹	R	
(a) (i) the types of plant responses (ii) practical investigations into phototropism and geotropism *To include the response to abiotic stress and herbivory e.g. chemical defences (such as tannins, alkaloids and pheromones), folding in response to touch (Mimosa pudica) AND the range of tropisms in plants.* *M1.3, M1.6 PAG11*						
(b) the roles of plant hormones *To include the role of hormones in leaf loss in deciduous plants, seed germination and stomatal closure.*						
(c) the experimental evidence for the role of auxins in the control of apical dominance						
(d) the experimental evidence for the role of gibberellin in the control of stem elongation and seed germination						
(e) practical investigations into the effect of plant hormones on growth *M0.2, M1.1, M1.2, M1.3, M1.4, M1.6, M1.9, M1.10, M3.1, M3.2 PAG11*						
(f) the commercial use of plant hormones *To include the use of hormones to control ripening, the use of rooting powders and hormonal weed killers.*						
(g) the organisation of the mammalian nervous system *To include the structural organisation of the nervous system into the central and peripheral systems* ***AND*** *the functional organisation into the somatic and autonomic nervous systems.*						
(h) the structure of the human brain and the functions of its parts *To include the gross structure of the human brain* ***AND*** *the functions of the cerebrum, cerebellum, medulla oblongata, hypothalamus and pituitary gland.*						
(i) reflex actions *To include knee jerk reflex and blinking reflex, with reference to the survival value of reflex actions.* *M0.1, M0.2, M1.1, M1.2, M1.3, M1.6 PAG11*						
(j)the coordination of responses by the nervous and endocrine systems *To include the 'fight or flight' response to environmental stimuli in mammals* ***AND*** *the action of hormones in cell signalling (studied in outline only) with reference to adrenaline (first messenger), activation of adenylyl cyclase, and cyclic AMP (second messenger).*						
(k) the effects of hormones and nervous mechanisms on heart rate *An opportunity to monitor physiological functions, for example with pulse rate measurements before, during and after exercise or sensors to record electrical activity in the heart.* *An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two sets of data.* *M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.10, M3.1 PAG10, PAG11*						
(l) (i) the structure of mammalian muscle and the mechanism of muscular contraction (ii) the examination of stained sections or photomicrographs of skeletal muscle. *To include the structural and functional differences between skeletal, involuntary and cardiac muscle AND the action of neuromuscular junctions AND the sliding filament model of muscular contraction and the role of ATP, and how the supply of ATP is maintained in muscles by creatine phosphate.* *PAG1, PAG10, PAG11*						

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5.2 Energy for Biological Processes

5.2.1 Photosynthesis

Learners should be able to demonstrate and apply their knowledge and understanding of:

	N	☺	😐	☹	R
(a) the interrelationship between the process of photosynthesis and respiration *To include the relationship between the raw materials and products of the two processes.* *M0.1, M0.3, M0.4, M3.4*					
(b) the structure of a chloroplast and the sites of the two main stages of photosynthesis *The components of a chloroplast including outer membrane, lamellae, grana, thylakoid, stroma and DNA.*					
(c) (i) the importance of photosynthetic pigments in photosynthesis (ii) practical investigations using thin layer chromatography (TLC) to separate photosynthetic pigments *To include reference to light harvesting systems and photosystems.* *M0.1, M0.2, M1.1, M1.3, M2.2, M2.3, M2.4* ***PAG6***					
(d) the light-dependent stage of photosynthesis *To include how energy from light is harvested and used to drive the production of chemicals which can be used as a source of energy for other metabolic processes (ATP and reduced NADP) with reference to electron carriers and cyclic and non-cyclic photophosphorylation* ***AND*** *the role of water.*					
(e) the fixation of carbon dioxide and the light-independent stage of photosynthesis *To include how the products of the light-dependent stage are used in the light-independent stage (Calvin cycle) to produce triose phosphate (TP) with reference to ribulose bisphosphate (RuBP), ribulose bisphosphate carboxylase (RuBisCO) and glycerate 3-phosphate (GP) -* ***no*** *other biochemical detail is required.*					
(f) the uses of triose phosphate (TP) *To include the use of TP as a starting material for the synthesis of carbohydrates, lipids and amino acids* ***AND*** *the recycling of TP to regenerate the supply of RuBP.*					
(g) (i) factors affecting photosynthesis (ii) practical investigations into factors affecting the rate of photosynthesis *To include limiting factors in photosynthesis with reference to carbon dioxide concentration, light intensity and temperature, and the implications of water stress (stomatal closure) AND the effect on the rate of photosynthesis, and on levels of GP, RuBP and TP, of changing carbon dioxide concentration, light intensity and temperature.* *M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.4, M3.5, M3.6, M4.1 PAG4, PAG10, PAG11*					

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5.2.2 Respiration *Learners should be able to demonstrate and apply their knowledge and understanding of:*	N	☺	😐	☹	R	
(a) the need for cellular respiration *To include examples of why plants, animals and microorganisms need to respire (suitable examples could include active transport and an outline of named metabolic reactions).*						
(b) the structure of the mitochondrion *The components of a mitochondrion including inner and outer michondrial membranes, cristae, matrix and mitochondrial DNA.*						
(c) the process and site of glycolysis *To include the phosphorylation of glucose to hexose bisphosphate, the splitting of hexose bisphosphate into two triose phosphate molecules and further oxidation to pyruvate* **AND** *the production of a small yield of ATP and reduced NAD.*						
(d) the link reaction and its site in the cell *To include the decarboxylation of pyruvate to acetate, the reduction of NAD, and the combination of acetate with coenzyme A.*						
(e) the process and site of the Krebs cycle *To include the formation of citrate from acetate and oxaloacetate and the reconversion of citrate to oxaloacetate (names of intermediate compounds are not required)* **AND** *the importance of decarboxylation, dehydrogenation, the reduction of NAD and FAD, and substrate level phosphorylation.*						
(f) the importance of coenzymes in cellular respiration *With reference to NAD, FAD and coenzyme A.*						
(g) the process and site of oxidative phosphorylation *To include the roles of electron carriers, oxygen and the mitochondrial cristae.*						
(h) the chemiosmotic theory *To include the electron transport chain, proton gradients and ATP synthase in oxidative phosphorylation and photophosphorylation.*						
(i) (i) the process of anaerobic respiration in eukaryotes (ii) practical investigations into respiration rates in yeast, under aerobic and anaerobic conditions *To include anaerobic respiration in mammals and yeast and the benefits of being able to respire anaerobically AND why anaerobic respiration produces a much lower yield of ATP than aerobic respiration.* *M0.1, M0.2, M1.1, M1.3, M2.4, M3.1, M3.2 PAG4, PAG10, PAG11*						
(j) the difference in relative energy values of carbohydrates, lipids and proteins as respiratory substrates						
(k) the use and interpretation of the respiratory quotient (RQ) To include calculating the respiratory quotient (RQ) using the formula: *RQ = CO_2 produced O_2 consumed* *M0.1, M0.2, M1.1, M1.3, M2.3*						
(l) practical investigations into the effect of factors such as temperature, substrate concentration and different respiratory substrates on the rate of respiration. For example the use of respirometers. *M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.10, M2.4, M3.2, M3.3, M3.5, M3.6 PAG4, PAG10, PAG11*						

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Module 6: Genetics, evolution and ecosystems						
6.1.1 Cellular control *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) types of gene mutations and their possible effects on protein production and function *To include substitution, insertion or deletion of one or more nucleotides **AND** the possible effects of these gene mutations (i.e. beneficial, neutral or harmful).*						
(b) the regulatory mechanisms that control gene expression at the transcriptional level, post-transcriptional level and post-translational level *To include control at the,* *transcriptional level: lac operon, and transcription factors in eukaryotes.* *post-transcriptional level: the editing of primary mRNA and the removal of introns to produce mature mRNA.* *post-translational level: the activation of proteins by cyclic AMP.*						
(c) the genetic control of the development of body plans in different organisms *Homeobox gene sequences in plants, animals and fungi are similar and highly conserved **AND** the role of Hox genes in controlling body plan development.*						
(e) the importance of mitosis and apoptosis as mechanisms controlling the development of body form. *To include an appreciation that the genes which regulate the cell cycle and apoptosis are able to respond to internal and external cell stimuli e.g. stress.*						
6.1.2 Patterns of Inheritance *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a)(i) the contribution of both environmental and genetic factors to phenotypic variation (ii) how sexual reproduction can lead to genetic variation within a species *To include examples of both genetic and environmental contributions - environmental examples could include diet in animals and etiolation or chlorosis in plants. Meiosis and the random fusion of gametes at fertilisation.*						
(b)(i) genetic diagrams to show patterns of inheritance (ii) the use of phenotypic ratios to identify linkage (autosomal and sex linkage) and epistasis *To include monogenic inheritance, dihybrid inheritance, multiple alleles, sex linkage and codominance.* *To include explanations of linkage and epistasis.* *M0.3, M1.4*						
(c) using the chi-squared (χ^2) test to determine the significance of the difference between observed and expected results The formula for the chi-squared (χ^2) test will be provided. *M0.3, M1.4, M1.9, M2.1*						
(d) the genetic basis of continuous and discontinuous variation *To include reference to the number of genes that influence each type of variation.*						
(e) the factors that can affect the evolution of a species *To include stabilising selection and directional selection, genetic drift, genetic bottleneck and founder effect.*						
(f) the use of the Hardy-Weinberg principle to calculate allele frequencies in populations The equations for the Hardy-Weinberg principle will be provided.						

M0.2, M2.1, M2.2, M2.3						
(g) the role of isolating mechanisms in the evolution of new species *To include geographical mechanisms (allopatric speciation) and reproductive mechanisms (sympatric speciation).*						
(h) (i) the principles of artificial selection and its uses (ii) the ethical considerations surrounding the use of artificial selection. *To include examples of selective breeding in plants and animals AND an appreciation of the importance of maintaining a resource of genetic material for use in selective breeding including wild types. To include a consideration of the more extreme examples of the use of artificial selection to 'improve' domestic species e.g. dog breeds.*						
6.1.3 Manipulating Genomes *Learners should be able to demonstrate and apply their knowledge and understanding of:*						
	N	☺	😐	☹	R	
(a) the principles of DNA sequencing and the development of new DNA sequencing techniques *To include the rapid advancements of the techniques used in sequencing, which have increased the speed of sequencing and allowed whole genome sequencing e.g. high-throughput sequencing.*						
(b) (i) how gene sequencing has allowed for genome-wide comparisons between individuals and between species how gene sequencing has allowed for the sequences of amino acids in polypeptides to be predicted (iii) how gene sequencing has allowed for the development of synthetic biology *With reference to bioinformatics and computational biology and how these fields are contributing to biological research into genotype-phenotype relationships, epidemiology and searching for evolutionary relationships.* *PAG10*						
(c) the principles of DNA profiling and its uses *To include forensics and analysis of disease risk.*						
(d) the principles of the polymerase chain reaction (PCR) and its application in DNA analysis						
(e) the principles and uses of electrophoresis for separating nucleic acid fragments or proteins						
(f) the principles of genetic engineering the techniques used in genetic engineering *To include the isolation of genes from one organism and the placing of these genes into another organism using suitable vectors.* *To include the use of restriction enzymes, plasmids and DNA ligase to form recombinant DNA with the desired gene and electroporation.*						
(g) the ethical issues (both positive and negative) relating to the genetic manipulation of animals (including humans), plants and microorganisms *To include insect resistance in genetically modified soya, genetically modified pathogens for research and 'pharming' i.e. genetically modified animals to produce pharmaceuticals* ***AND*** *issues relating to patenting and technology transfer e.g. making genetically modified seed available to poor farmers*						
(h) the principles of, and potential for, gene therapy in medicine *To include the differences between somatic cell gene therapy and germ line cell gene therapy.*						

6.2.1 Cloning and biotechnology *Learners should be able to demonstrate and apply their knowledge and understanding of:*	N	☺	😐	☹	R
(a) (i) natural clones in plants and the production of natural clones for use in horticulture (ii) how to take plant cuttings as an example of a simple cloning technique *To include examples of natural cloning and the methods used to produce clone (various forms of vegetative propagation).* *Dissection of a selection of plant material to produce cuttings.* *PAG2*					
(b)(i) the production of artificial clones of plants by micropropagation and tissue culture (ii) the arguments for and against artificial cloning in plants					
(c) natural clones in animal species *To include examples of natural clones (twins formed by embryo splitting).*					
(d) (i) how artificial clones in animals can be produced by artificial embryo twinning or by enucleation and somatic cell nuclear transfer (SCNT) (ii) the arguments for and against artificial cloning in animals *To include an evaluation of the uses of animal cloning (examples including in agriculture and medicine, and issues of longevity of cloned animals).*					
(e) the use of microorganisms in biotechnological processes *To include reasons why microorganisms are used e.g. economic considerations, short life cycle, growth requirements* ***AND*** *processes including brewing, baking, cheese making, yoghurt production, penicillin production, insulin production and bioremediation.*					
(f) the advantages and disadvantages of using microorganisms to make food for human consumption *To include bacterial and fungal sources.*					
(g) (i) how to culture microorganisms effectively, using aseptic techniques (ii) the importance of manipulating the growing conditions in batch and continuous fermentation in order to maximise the yield of product required *PAG7*					
(h) (i) the standard growth curve of a microorganism in a closed culture (ii) practical investigations into the factors affecting the growth of microorganisms *M0.1, M0.3, M0.5, M1.1, M1.3, M2.5, M3.1, M3.2, M3.4, M3.5, M3.6 PAG7*					
(i) the uses of immobilised enzymes in biotechnology and the different methods of immobilisation. *To include methods of enzyme immobilisation* ***AND*** *an evaluation of the use of immobilised enzymes in biotechnology* *examples could include:* *glucose isomerase for the conversion of glucose to fructose* *penicillin acyclase for the formation of semi-synthetic penicillins (to which some penicillin-resistant organisms are not resistant)* *lactase for the hydrolysis of lactose to glucose and galactose* *aminoacyclase for production of pure samples of L-amino acids* *glucoamylase for the conversion of dextrins to glucose* *nitrilase for the conversion of acrylonitrile to acrylamide (for use in the plastics industry).* *M0.2, M0.3, M1.2, M1.3, M1.4, M1.6, M1.10, M3.2, M4.1 PAG4*					

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6.3 Ecosystems

6.3.1 Ecosystems

Learners should be able to demonstrate and apply their knowledge and understanding of:

	N	☺	😐	☹	R	
(a) ecosystems, which range in size, are dynamic and are influenced by both biotic and abiotic factors *To include reference to a variety of ecosystems of different sizes (e.g. a rock pool, a playing field, a large tree) and named examples of biotic and abiotic factors.*						
(b) biomass transfers through ecosystems *To include how biomass transfers between trophic levels can be measured **AND** the efficiency of biomass transfers between trophic levels **AND** how human activities can manipulate the transfer of biomass through ecosystems.* *M0.1, M0.2, M0.3, M0.4, M1.1, M1.3, M1.6*						
(c) recycling within ecosystems *To include the role of decomposers and the roles of microorganisms in recycling nitrogen within ecosystems (including Nitrosomonas, Nitrobacter, Azotobacter and Rhizobium) **AND** the importance of the carbon cycle to include the role of organisms (decomposition, respiration and photosynthesis) and physical and chemical effects in the cycling of carbon within ecosystems.*						
(d) the process of primary succession in the development of an ecosystem *To include succession from pioneer species to a climax community **AND** deflected succession*						
(e) (i) how the distribution and abundance of organisms in an ecosystem can be measured (ii) the use of sampling and recording methods to determine the distribution and abundance of organisms in a variety of ecosystems. *M1.3, M1.4, M1.5, M1.7, M1.9, M1.10, M3.1, M3.2 PAG3*						

6.3.2 Populations and Sustainability

Learners should be able to demonstrate and apply their knowledge and understanding of:

	N	☺	😐	☹	R	
(a) the factors that determine size of a population *To include the significance of limiting factors in determining the carrying capacity of a given environment and the impact of these factors on final population size.* *M0.1, M0.2, M0.3, M0.4, M0.5, M1.3, M2.5, M3.1, M3.2*						
(b) interactions between populations *To include predator-prey relationships considering the effects on both predator and prey populations **AND** interspecific and intraspecific competition*						
(c) the reasons for, and differences between, conservation and preservation *To include the economic, social and ethical reasons for conservation of biological resources.*						
(d) how the management of an ecosystem can provide resources in a sustainable way *Examples to include timber production and fishing.*						
(e) the management of environmental resources and the effects of human activities *include how ecosystems can be managed to balance the conflict between conservation/ preservation and human needs e.g. the Masai Mara region in Kenya and the Terai region of Nepal, peat bogs **AND** the effects of human activities on the animal and plant populations and how these are controlled in environmentally sensitive ecosystems e.g. the Galapagos Islands, Antarctica, Snowdonia National Park, the Lake District.*						

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A Level Biology Mathematical Skills Checklist

M0 – Arithmetic and numerical computation							
Skill Code	**Skill**	**You may be tested on your ability to:**	**Skill appears in the following parts of the specification:**	**Completed**	**RAG Rating**		
M0.1	Recognise and make use of appropriate units in calculations	- convert between units e.g. mm^3 to cm^3 as part of volumetric calculations - work out the unit for a rate e.g. breathing rate	2.1.1(e), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.1(e), 3.1.2(a), 3.1.2(h), 3.1.3(a), 3.1.3(c), 4.1.1(b), 4.1.1(l), 5.1.2(c), 5.1.5(i), 5.1.5(k), 5.2.1(a), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.2.1(h), 6.3.1(b), 6.3.2(a)		☹	😐	☺
M0.2	Recognise and use expressions in decimal and standard form	- use an appropriate number of decimal places in calculations, e.g. for a mean - carry out calculations using numbers in standard and ordinary form, e.g. use of magnification - understand standard form when applied to areas such as size of organelles - convert between numbers in standard and ordinary form understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. 0.0050 mol dm^{-3} is equivalent to 5.0×10^{-3} mol dm^{-3}.	2.1.1(e), 2.1.1(f), 2.1.1(g), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(b), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(b), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.1.2(f), 6.2.1(i), 6.3.1(b), 6.3.2(a)		☹	😐	☺
M0.3	Use ratios, fractions and percentages	-calculate percentage yields -calculate surface area to volume ratio -use scales for measuring represent phenotypic ratios (monohybrid and dihybrid crosses).	2.1.1(e), 2.1.1(f), 2.1.4(d), 2.1.4(f), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 4.1.1(b), 4.1.1(l), 4.2.2(h), 5.1.2(c), 5.1.5(k), 5.2.1(a), 5.2.1(g), 6.1.2(b), 6.1.2(c), 6.2.1(h), 6.2.1(i), 6.3.1(b), 6.3.2(a)		☹	😐	☺

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M0.4	Estimate results	-estimate results to sense check that the calculated values are appropriate.	3.1.1(a), 3.1.1(e), 3.1.2(a), 3.1.3(a), 5.2.1(a), 6.3.1(b), 6.3.2(a)		☹	😐	☺
M0.5 (full A Level only)	Use calculators to find and use power, exponential and logarithmic functions	-estimate the number of bacteria grown over a certain length of time.	6.2.1(h), 6.3.2(a)		☹	😐	☺
M1 - Handling Data							
M1.1	Use an appropriate number of significant figures	-report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures -understand that calculated results can only be reported to the limits of the least accurate measurement.	2.1.1(e), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.2(h), 3.1.3(a), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(c), 4.2.1(d), 4.2.1(e), 5.1.2(c), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.2.1(h), 6.3.1(b)		☹	😐	☺
M1.2	Find arithmetic means	-find the mean of a range of data, e.g. the mean number of stomata in the leaves of a plant.	2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.2(f), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.2(l), 6.2.1(i)		☹	😐	☺
M1.3	Construct and interpret frequency tables and diagrams, bar charts and histograms	-represent a range of data in a table with clear headings, units and consistent decimal places -interpret data from a variety of tables, e.g. data relating to organ function -plot a range of data in an appropriate format, e.g. enzyme activity over time represented on a graph -interpret data for a variety of graphs, e.g. explain electrocardiogram traces.	2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(e), 3.1.2(h), 3.1.3(c), 4.1.1(b), 4.1.1(g), 4.1.1(l), 4.2.1(b), 4.2.1(f), 4.2.2(f), 5.1.2(c), 5.1.3(c), 5.1.5(a), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.1(c), 5.2.1(g), 5.2.2(i), 5.2.2(k), 5.2.2(l), 6.2.1(h), 6.2.1(i), 6.3.1(b), 6.3.1(e), 6.3.2(a)		☹	😐	☺

M1.4	Understand simple probability	-use the terms probability and chance appropriately -understand the probability associated with genetic inheritance.	4.2.1(b), 5.1.5(e), 6.1.2(b), 6.1.2(c), 6.2.1(i), 6.3.1(e)		☹	😐	☺
M1.5	Understand the principles of sampling as applied to scientific data	-analyse random data collected by an appropriate means, e.g. use Simpson's index of diversity to calculate the biodiversity of a habitat.	4.1.1(b), 4.1.1(l), 4.2.1(b), 4.2.1(c), 4.2.1(d), 4.2.1(e), 6.3.1(e)				
M1.6	Understand the terms mean, median and mode	-calculate or compare the mean, median and mode of a set of data, e.g. height/mass/ size of a group of organisms.	2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.2.1(b), 4.2.2(f), 5.1.5(a), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.2.2(l), 6.2.1(i), 6.3.1(b)		☹	😐	☺
M1.7	Use a scatter diagram to identify a correlation between two variables	-interpret a scattergram, e.g. the effect of lifestyle factors on health.	4.1.1(b), 4.1.1(l), 4.2.1(b), 4.2.1(f), 4.2.2(f), 6.3.1(e)		☹	😐	☺
M1.8	Make order of magnitude calculations	-use and manipulate the magnification formula magnification = size of image/size of real object	2.1.1(e)		☹	😐	☺
M1.9	Select and use a statistical test	-the chi squared test (χ2) to test the significance of the difference between observed and expected results -the Student's t-test -the Spearman's rank correlation coefficient.	4.2.1(b), 5.1.5(e), 6.1.2(c), 6.3.1(e)		☹	😐	☺
M1.10	Understand measures of dispersion, including	-calculate the standard deviation -understand why standard deviation might be a more useful measure of dispersion for a given set of data e.g.	2.1.5(e), 4.2.1(b), 4.2.2(f), 5.1.5(e), 5.1.5(k), 5.2.2(l), 6.2.1(i), 6.3.1(e)		☹	😐	☺

	standard deviation and range	where there is an outlying result.					
M1.11	Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	-calculate percentage error where there are uncertainties in measurement.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 5.2.1(g)		☹	😐	☺
M2 – Algebra							
M2.1	Understand and use the symbols: =,1, <, «, », >, ~, a		2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 5.1.2(c), 6.1.2(c)		☹	😐	☺
M2.2	Change the subject of an equation	-use and manipulate equations, e.g. magnification.	2.1.1(e), 2.1.2(s), 5.2.1(c), 6.1.2(f)		☹	😐	☺
M2.3	Substitute numerical values algebraic equations using appropriate units for physical quantities	-use a given equation e.g. Simpson's-index of diversity	2.1.1(e), 2.1.2(s), 4.2.1(c), 4.2.1(d), 4.2.1(e), 5.2.1(c), 5.2.2(k), 6.1.2(f)		☹	😐	☺
M2.4	Solve algebraic equations	-solve equations in a biological context, e.g. cardiac output = stroke volume × heart rate	2.1.1(e), 2.1.2(s), 3.1.2(h), 4.2.1(c), 4.2.1(d), 4.2.1(e), 5.2.1(c), 5.2.2(i), 5.2.2(l)		☹	😐	☺
M2.5 (full A Level only)	Use logarithms in relation to quantities that	-use a logarithmic scale in the context of microbiology, e.g. growth rate of a microorganism such as yeast.	6.2.1(h), 6.3.2(a)		☹	😐	☺

	range over several orders of magnitude						
M3 - Graphs							
M3.1	Translate information between graphical, numerical and algebraic forms	-understand that data may be presented in a number of formats and be able to use these data, e.g. dissociation curves.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.2(j), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(f), 5.1.2(c), 5.1.3(c), 5.1.5(e), 5.1.5(k), 5.2.1(g), 5.2.2(i), 6.2.1(h), 6.3.1(e), 6.3.2(a)		☹	😐	☺
M3.2	Plot two variables from experimental or other data	-select an appropriate format for presenting data, bar charts, histograms, graphs and scattergrams.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(b), 5.1.5(e), 5.2.1(g), 5.2.2(i), 5.2.2(l), 6.2.1(h), 6.2.1(i), 6.3.1(e), 6.3.2(a)		☹	😐	☺
M3.3	Understand that $y = mx + c$ represents a linear relationship	-predict/sketch the shape of a graph with a linear relationship, e.g. the effect of substrate concentration on the rate of an enzyme controlled reaction with excess enzyme.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c), 5.2.2(l)		☹	😐	☺
M3.4 (full A Level only)	Determine the intercept of a graph	-read off an intercept point from a graph, e.g. compensation point in plants.	5.2.1(a), 5.2.1(g), 6.2.1(h)		☹	😐	☺
M3.5	Calculate rate of change from a graph showing a linear relationship	-calculate a rate from a graph, e.g. rate of transpiration.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c), 5.2.1(g), 5.2.2(l), 6.2.1(h)		☹	😐	☺
M3.6	Draw and use the slope of a tangent to a curve as a measure of rate of change	-use this method to measure the gradient of a point on a curve, e.g. amount of product formed plotted against time when the concentration of enzyme is fixed.	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c), 5.2.1(g), 5.2.2(l), 6.2.1(h)		☹	😐	☺

Budmouth Academy

M4 - Geometry and Trigonometry							
M4.1	Calculate the circumferences, surface areas and volumes of regular shapes	-calculate the circumference and area of a circle -calculate the surface area and volume of rectangular prisms, of cylindrical prisms and of spheres -e.g. calculate the surface area or volume of a cell.	2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 3.1.3(c), 5.2.1(g), 6.2.1(i)		☹	😐	☺

Practical Skills in A Level Biology

Module 1: Development of Practical Skills in Biology

1.1.1 Planning *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) experimental design, including to solve problems set in a practical context Including selection of suitable apparatus, equipment and techniques for the proposed experiment. *Learners should be able to apply scientific knowledge based on the content of the specification to the practical context.*
(b) identification of variables that must be controlled, where appropriate
(c) evaluation that an experimental method is appropriate to meet the expected outcomes.
1.1.2 Implementing *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) how to use a wide range of practical apparatus and techniques correctly
(b) appropriate units for measurements
(c) presenting observations and data in an appropriate format.
1.1.3 Analysis *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) processing, analysing and interpreting qualitative and quantitative experimental results Including reaching valid conclusions, where appropriate.
(b) use of appropriate mathematical skills for analysis of quantitative data
(c) appropriate use of significant figures M1.1
(d) plotting and interpreting suitable graphs from experimental results, including: (i) selection and labelling of axes with appropriate scales, quantities and units M3.2 (ii) measurement of gradients and intercepts. M3.3, M3.4, M3.5
1.1.4 Evaluation *Learners should be able to demonstrate and apply their knowledge and understanding of:*
(a) how to evaluate results and draw conclusions
(b) the identification of anomalies in experimental measurements
(c) the limitations in experimental procedures
(d) precision and accuracy of measurements and data, including margins of error, percentage errors and uncertainties in apparatus M1.11
(e) the refining of experimental design by suggestion of improvements to the procedures and apparatus.

Practical Endorsement

Practical Activity Group (PAG)	Techniques and Skills covered	Specification references	Activity Covered
1 Microscopy	- Use of a light microscope at high power and low power, use of a graticule - Production of scientific drawings from observations with annotations	2.1.1(b), 2.1.1(c), 2.1.1(d), 2.1.1(k), 2.1.6(d), 2.1.6(g), 2.1.6(h), 3.1.1(c), 3.1.1(h), 3.1.3(b), 4.1.1(e),5.1.2(b), 5.1.2(c), 5.1.4(c), 5.1.5(l)	
2 Dissection	- Safe use of instruments for dissection of an animal or plant organ - Use of a light microscope at high power and low power, use of a graticule Production of scientific drawings from observations with annotations	3.1.1(g), 3.1.2(c), 3.1.2(e), 3.1.3(b), 5.1.2(c), 6.2.1(a)	
3 Sampling techniques	- Use of sampling techniques in fieldwork - Production of scientific drawings from observations with annotations	4.2.1(b), 6.3.1(e)	

4 Rates of enzyme controlled reactions	- Use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH) - Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of ICT such as computer modelling, or data logger to collect data, or use of software to process data	2.1.4(d), 2.1.4(e), 2.1.4(f), 5.2.1(g), 5.2.2(i), 5.2.2(l)	
5 Colorimeter or potometer	- Use of appropriate instrumentation to record quantitative measurements, such as a colorimeter - Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions	2.1.2(r), 3.1.3(c)	
6 Chromatography OR electrophoresis	- Separation of biological compounds using thin layer / paper chromatography or electrophoresis	2.1.2(s), 5.2.1(c), 6.1.3(e)	
7 Microbiological techniques	- Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of microbiological aseptic techniques, including the use of agar plates and broth	6.2.1(g), 6.2.1(h)	
8 Transport in and out of cells	- Use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH) - Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of ICT such as computer modelling, or data logger to collect data, or use of software to process data	2.1.5(c), 2.1.5(d), 2.1.5(e)	
9 Qualitative testing	- Use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions - Use of qualitative reagents to identify biological molecules	2.1.2(q), 2.1.3(d), 5.1.2(f)	
10 Investigation using a data logger OR computer modelling	- Use of ICT such as computer modelling, or data logger to collect data, or use of software to process data	2.1.2(n), 2.1.3(a), 3.1.1(e), 5.1.5(k), 5.1.5(l), 5.2.1(g), 5.2.2(i), 5.2.2(l), 6.1.3(b)	

11 Investigation into the measurement of plant or animal responses	- Safe and ethical use of organisms to measure plant or animal responses and physiological functions	3.1.3(c), 5.1.1(d), 5.1.5(a), 5.1.5(e), 5.1.5(i), 5.1.5(k), 5.1.5(l), 5.2.1(g), 5.2.2(i), 5.2.2(l)	
12 Research skills	- *Apply investigative approaches* - *Use online and offline research skills* - *Correctly cite sources of information*		
It is expected that the following skills will be developed across all activities, regardless of the exact selection of activities. The ability to: •safely and correctly use a range of practical equipment and materials (1.2.1 b) •follow written instructions (1.2.1 c) •keep appropriate records of experimental activities (1.2.1 e) •make and record observations/measurements (1.2.1 d) •present information and data in a scientific way (1.2.1 f) •use a wide range of experimental and practical instruments, equipment and techniques (1.2.1 j).			

Year 12 Curriculum Overview

Week	Statements Teacher 1	Statements Teacher 2
1	**Biological Molecules** **2.1.2(a)** how hydrogen bonding occurs between water molecules, and relate this, and other properties of water, to the roles of water for living **organisms; transport, solvent,** transport medium, **coolant** and as a **habitat**	**Cell Structure** **2.1.1(a)** the use of microscopy to observe and investigate different types of cell and cell structure in a range of eukaryotic organisms to include: images produced by a range of microscopes; **light, transmission electron**, **scanning electron** and **laser scanning confocal** microscopes
	2.1.2(b) the concept of **monomers** and **polymers** and the importance of **condensation** and **hydrolysis** reactions in a range of biological molecules	**2.1.1(b)** the preparation and examination of microscope slides for use in light microscopy Including the use of an eyepiece graticule and stage micrometre
2	**2.1.2(c)** the chemical elements that make up biological molecules **2.1.2(d)** the ring structure and properties of **glucose** as an example of a **hexose monosaccharide** and the structure of **ribose** as an example of a **pentose monosaccharide**	**2.1.1(c)** the use of staining in light microscopy to include the use of differential staining to identify different cellular components and cell types
	2.1.2(e) the synthesis and breakdown of a disaccharide and polysaccharide by the formation and breakage of **glycosidic bonds**; **sucrose, lactose, maltose**	**2.1.1(d)** the representation of cell structure as seen under the light microscope using drawings and annotated diagrams of whole cells or cells in sections of tissues
3	**2.1.2(f)** the structure of starch (**amylose** and **amylopectin**), **glycogen** and **cellulose** molecules	**2.1.1(e)** the use and manipulation of the magnification formula *magnification = image size object size* *M0.2 Recognise and use expressions in decimal and standard form*
	2.1.2(g) how the structures and properties of glucose, starch, glycogen and cellulose molecules relate to their **functions** in living organisms	**2.1.1(f)** the difference between magnification and resolution achieved by a light, a transmission electron and a scanning electron microscope.

4	**2.1.2 (q)** PAG 9 **Benedict's** test for reducing and non reducing sugars	**2.1.1(g)** the ultrastructure of eukaryotic cells and the functions of the different cellular components to include: nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum (ER), Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplasts, plasma membrane, centrioles, cell wall, flagella and cilia
	2.1.2 (q) PAG 9 The **iodine** test for starch Reagent test strips for reducing sugars	**2.1.1(g)** the ultrastructure of eukaryotic cells and the functions of the different cellular components to include: nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum (ER), Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplasts, plasma membrane, centrioles, cell wall, flagella and cilia
5	**2.1.2(h)** the structure of a **triglyceride** and a **phospholipid** as examples of macromolecules; saturated and unsaturated fatty acids	**2.1.1(h)** photomicrographs of cellular components in a range of eukaryotic cells to include interpretation of transmission and scanning electron microscope images
	2.1.2(i) the synthesis and breakdown of triglycerides by the formation (**esterification**) and breakage of ester bonds between fatty acids and glycerol	**2.1.1(i)** the interrelationship between the organelles involved in the production and secretion of proteins **2.1.1(j)** the importance of the cytoskeleton provide mechanical strength to cells, aiding transport within cells and enabling cell movement
6	**2.1.2(j)** how the properties of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms to include **hydrophobic** and **hydrophilic** regions and **energy content** AND illustrated using examples of prokaryotes and eukaryotes	**2.1.1(k)** the similarities and differences in the structure and ultrastructure of prokaryotic and eukaryotic cells
	2.1.2 (q) PAG 9 **emulsion** test for lipids	PAG 1 Microscopy
7	**2.1.2(k)** the general structure of an amino acid	**Biological Membranes**

	2.1.2(l) the synthesis and breakdown of **dipeptides** and polypeptides, by the formation and breakage of **peptide bonds**	**2.1.5(a)** the roles of membranes within cells and at the surface of cells **2.1.5(b)** the fluid mosaic model of membrane structure and the roles of its components: partially permeable barriers between the cell and its environment, between organelles and the cytoplasm and within organelles, sites of chemical reactions and cell communication (cell signalling).
	2.1.2(m) the levels of protein structure to include **primary**, **secondary**, **tertiary** and **quaternary** structure AND **hydrogen bonding**, **hydrophobic** and **hydrophilic** interactions, **disulfide** bonds and **ionic** bonds	**2.1.5(c)** (i) factors affecting membrane structure and permeability to include solvents and temperature (ii) practical investigations into factors affecting membrane structure and permeability **PAG 5** - The effect of temperature on membrane permeability (beetroot) using a colorimeter
8	**2.1.2(n)** the structure and function of globular proteins including a conjugated protein to include **haemoglobin** as an example of a conjugated protein (globular protein with a prosthetic group), a named enzyme and insulin	**PAG 5** - The effect of temperature on membrane permeability (beetroot) using a colorimeter
	2.1.2(o) the properties and functions of fibrous proteins to include **collagen**, **keratin** and **elastin** (no details of structure are required)	**2.1.5(d)** (i) the movement of molecules across membranes (ii) practical investigations into the factors affecting diffusion rates in model cells
9	**2.1.2 (q)** **PAG 9** **biuret** test for proteins	**2.1.5(e)** (i) the movement of water across membranes by osmosis and the effects that solutions of different water potential can have on plant and animal cells
	2.1.2(p) the key inorganic ions that are involved in biological processes to include the correct chemical symbols for the following; **cations**: calcium ions (Ca^{2+}), sodium ions (Na^+), potassium ions (K^+), hydrogen ions (H^+), ammonium ions (NH_4^+) **anions**: nitrate (NO_3^-), hydrogencarbonate (HCO_3^-), chloride (Cl^-), phosphate (PO_4^{3-}), hydroxide, (OH^-)	(ii) practical investigations into the effects of solutions of different water potential on plant and animal cells **PAG 8** **An investigation into the water potential of potato**

10	**2.1.2(r)** quantitative methods to determine the concentration of a chemical substance in a solution **PAG 5** To Include the **colorimetry** on serial dilutions	(ii) practical investigations into the effects of solutions of different water potential on plant and animal cells **PAG 8 An investigation into the water potential of potato**
	2.1.2(s) (i) the principles and uses of paper and thin layer chromatography to separate biological molecules / compounds (ii) practical investigations to analyse biological solutions using paper or thin layer chromatography **PAG 6** Identification of amino acids using paper and TLC - to include calculation of retention (**Rf**) values.	**Enzymes** **2.1.4(a)** the role of enzymes in catalysing reactions that affect metabolism at a cellular and whole organism level **2.1.4(b)** the role of enzymes in catalysing both intracellular and extracellular reactions eg catalase - intracellular, amylase and trypsin catalyse extracellular reactions
11	**Nucleotides and Nucleic Acids** **2.1.3(a)** the structure of a nucleotide as the monomer from which nucleic acids are made to include the differences between **RNA** and **DNA** nucleotides, the identification of the **purines** and **pyrimidines** and the type of pentose sugar	**2.1.4(c)** the mechanism of enzyme action to include the tertiary structure, specificity, active site, lock and key hypothesis, induced-fit hypothesis, enzyme-substrate complex, enzyme product complex, product formation and lowering of activation energy
	2.1.3(b) the synthesis and breakdown of polynucleotides by the formation and breakage of phosphodiester bonds	**2.1.4(c)** the mechanism of enzyme action to include the tertiary structure, specificity, active site, lock and key hypothesis, induced-fit hypothesis, enzyme-substrate complex, enzyme product complex, product formation and lowering of activation energy
12	**2.1.3(c)** the structure of **ADP** and **ATP** as phosphorylated nucleotides **2.1.3(d)** (i) the structure of **DNA** (deoxyribonucleic acid) to include how **hydrogen** bonding between complementary base pairs (A to T, G to C) on two **antiparallel** DNA polynucleotides leads to the formation of a DNA molecule, and how the twisting of DNA produces its '**double-helix**' shape	**2.1.4(d)** (i) the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity To include reference to the temperature coefficient (Q10)
	(ii) practical investigations into the purification of DNA by precipitation	**2.1.4(d)** (i) the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity

		To include reference to the temperature coefficient (Q10)
13	PAG 10 RasMol used to investigate DNA structure	(ii) practical investigations into the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity PAG 4 Rates of enzyme controlled reactions
	2.1.3(e) semi-conservative DNA replication to include the roles of the enzymes **helicase** and **DNA polymerase**, the importance of replication in **conserving** genetic information with accuracy and the occurrence of **random**, **spontaneous** mutations	PAG 4 Rates of enzyme controlled reactions **M3.6** Draw and use the slope of a tangent to a curve as a measure of rate of change **M3.5** Calculate rate of change from a graph showing a linear relationship
14	**2.1.3(f)** the nature of the genetic code to include the **triplet**, **non-overlapping**, **degenerate** and **universal** nature of the code and how a gene determines the sequence of amino acids in a polypeptide (the primary structure of a protein)	**2.1.4(e)** the need for coenzymes, cofactors and prosthetic groups in some enzyme-controlled reactions to include Cl – as a cofactor for amylase, Zn2+ as a prosthetic group for carbonic anhydrase and vitamins as a source of coenzymes.
	2.1.3(g) transcription and translation of genes resulting in the synthesis of polypeptides to include, the roles of **RNA polymerase**, **messenger (m)RNA, transfer (t)RNA**, **ribosomal (r)RNA**	**2.1.4(f)** the effects of inhibitors on the rate of enzyme controlled reactions to include competitive and non-competitive and reversible and non-reversible inhibitors with reference to the action of metabolic poisons and some medicinal drugs, and the role of product inhibition
15	**Cell Division, Cell Diversity and Cellular Organisation** **2.1.6(a)** the cell cycle to include the processes taking place during interphase (G1, S and G2), mitosis and cytokinesis, leading to genetically identical cells	**2.1.4(f)** the effects of inhibitors on the rate of enzyme controlled reactions to include competitive and non-competitive and reversible and non-reversible inhibitors with reference to the action of metabolic poisons and some medicinal drugs, and the role of product inhibition
	2.1.6(b) how the cell cycle is regulated to include an outline of the use of checkpoints to control the cycle	Enzyme summary

16	**2.1.6(c)** the main stages of mitosis to include the changes in the nuclear envelope, chromosomes, chromatids, centromere, centrioles, spindle fibres and cell membrane	**Exchange Surfaces** **3.1.1(a)** the need for specialised exchange surfaces to include surface area to volume ratio (SA:V), metabolic activity, single-celled and multicellular organisms. Ratio = Volume/Surface Area
	2.1.6(d) sections of plant tissue showing the cell cycle and stages of mitosis **PAG 1** Using a light microscope to study mitosis in garlic root tips	**M4.1** Calculate the circumferences, surface areas and volumes of regular shapes eg. cubes, spheres and cylinders
17	**2.1.6(e)** the significance of mitosis in life cycles ie growth, repair, asexual rpeoduction	**3.1.1(b)** the features of an efficient exchange surface to include: • increased surface area – root hair cells • thin layer – alveoli • good blood supply/ventilation to maintain gradient – gills/alveolus
	2.1.6(f) the significance of meiosis in life cycles ie haploid cells, genetic variation by crossing over and independent assortment **2.1.6 (g)** the main stages involved; prophase, metaphase, anaphase, telophase 1and 2, term homologous	**3.1.1(b)** the features of an efficient exchange surface to include: • increased surface area – root hair cells • thin layer – alveoli • good blood supply/ventilation to maintain gradient – gills/alveolus
18	**2.1.6(h)** how cells of multicellular organisms are specialised for particular functions **2.1.6(i)** the organisation of cells into tissues, organs and organ systems	**3.1.1(c)** the structures and functions of the components of the mammalian gaseous exchange system to include the distribution and functions of cartilage, ciliated epithelium, goblet cells, smooth muscle and elastic fibres in the trachea, bronchi, bronchioles and alveoli
	PAG 1 Using a light microscope to study squamous and epithelial cells, sperm cells, palisade cells, root hair cells and guard cells	**PAG 1** Mammalian lung tissue

19	**2.1.6(j)** the features and differentiation of stem cell to include stem cells as a renewing source of undifferentiated cells **2.1.6(k)** the production of erythrocytes and neutrophils derived from stem cells in bone marrow **2.1.6(l)** the production of xylem vessels and phloem sieve tubes from meristems	**3.1.1(d)** the mechanism of ventilation in mammals, rib cage, intercostal muscles (internal external) amd diaphragm
	2.1.6(m) the potential uses of stem cells in research and medicine to include; neurological conditions such as Alzheimer's, Parkinson's and research into Developmental Biology	**3.1.1(e)** the relationship between vital capacity, tidal volume, breathing rate and oxygen uptake eg from a spirometer
20	**Communicable Disease, Prevention and the Immune System** **4.1.1(a)** the different types of pathogen that can cause communicable diseases in plants and animals bacteria – tuberculosis (TB), bacterial meningitis, ring rot (potatoes, tomatoes) • viruses – HIV/AIDS (human), influenza (animals), Tobacco Mosaic Virus (plants) • protoctista – malaria, potato/tomato late blight • fungi – black sigatoka (bananas), ringworm (castle), athlete's foot (humans)	**3.1.1(f)** the mechanisms of ventilation and gas exchange in bony fish and insects • bony fsh – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates); countercurrent flow • insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid.
	4.1.1(b) the means of transmission of animal and plant communicable pathogens to include direct and indirect transmission, reference to vectors, spores and living conditions – e.g. climate, social factors (no detail of the symptoms of specific diseases is required)	**3.1.1(f)** the mechanisms of ventilation and gas exchange in bony fish and insects • bony fsh – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates); countercurrent flow • insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid.
21	**4.1.1(c)** plant defences against pathogens to include production of chemicals AND plant responses that limit the spread of the pathogen (e.g. callose deposition)	**3.1.1(h)** the examination of microscope slides to show the histology of exchange surfaces such as fish gills, cross section of arteries and veins as well as insect tracheoles

	4.1.1(d) the primary non-specific defences against pathogens in animals to include skin, blood clotting, wound repair, inflammation, expulsive reflexes and mucous membranes (no detail of skin structure or all the steps involved in the clotting cascade are required)	**Transport in Animals** **3.1.2(a)** the need for transport systems in multicellular animals to include an appreciation of size, **metabolic rate** and surface area to volume ratio (SA:V) **3.1.2(b)** the different types of circulatory systems to include single, double, open and closed circulatory systems in insects, fish and mammals
22	**4.1.1(e) (i)** the structure and mode of action of phagocytes	**3.1.2(c)** the structure and functions of arteries, arterioles, capillaries, venules and veins to include the **distribution** of different tissues within the vessel walls such as cartilage and muscle
	PAG 1 Using a light microscope to to examine and draw cells in a blood smear	**3.1.2(d)** the formation of tissue fluid from plasma, hydrostatic pressure, oncotic pressure and compositions of blood, tissue fluid and lymph
23	**4.1.1(f)** the structure, different roles and modes of action of B and T lymphocytes in the specific immune response; cell signalling, clonal selection, clonal expansion, plasma cells, T helper, T killer and T regulatory cells	**3.1.2(e)** (i) the external and internal structure of the mammalian heart
	4.1.1(g) the primary and secondary immune responses; B and T memory cells	**PAG 2** (ii) the dissection, examination and drawing of the external and internal structure of the mammalian heart
24	**4.1.1(h)** the structure and general functions of antibodies **4.1.1(i)** an outline of the action of opsonins, agglutinins and anti-toxins	**3.1.2(f)** the cardiac cycle to include the role of the **valves** and the **pressure changes** occurring in the heart and associated vessels cardiac output = heart rate X stroke volume
	4.1.1(j) the differences between active and passive immunity, and between natural and artificial immunity	**3.1.2(f)** the cardiac cycle to include the role of the **valves** and the **pressure changes** occurring in the heart and associated vessels cardiac output = heart rate X stroke volume

25	**4.1.1(k)** autoimmune diseases eg. arthritis and lupus	**3.1.2(g)** how heart action is initiated and coordinated to include the roles of the sino-atrial node (SAN), atrio-ventricular node (AVN), purkyne tissue and the myogenic nature of cardiac muscle
	4.1.1(l) the principles of vaccination and the role of vaccination programmes in the prevention of epidemics	**3.1.2(h)** the use and interpretation of electrocardiogram (ECG) traces to include normal and abnormal heart activity e.g. tachycardia, bradycardia, fibrillation and ectopic heartbeat
26	**4.1.1(m)** possible sources of medicines to include microorganisms and plants as well as personalised medicine	**3.1.2(i)** the role of haemoglobin in transporting oxygen and carbon dioxide to include the reversible binding of oxygen molecules, carbonic anhydrase, haemoglobinic acid, HCO3 – and the chloride shift
	4.1.1(n) the benefits and risks of using antibiotics to manage bacterial infection; discovery of penicillin against antibiotic resistance (examples to include Clostridium difficile and MRSA)	**3.1.2(j)** the oxygen dissociation curve for fetal and adult human haemoglobin to include the significance of the different affinities for oxygen AND the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect)
27	**Classification and Evolution** **4.2.2(a)** the biological classification of species to include the taxonomic hierarchy of kingdom, phylum, class, order, family, genus and species AND domain. **4.2.2(b)** the binomial system of naming species and the advantage of such a system	**3.1.2(j)** the oxygen dissociation curve for fetal and adult human haemoglobin to include the significance of the different affinities for oxygen AND the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect)
	4.2.2(c) (i) the features used to classify organisms into the five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae, Animalia **(ii)** the evidence that has led to new classification systems, such as the three domains of life, which clarifies relationships	**Transport in Plants** **3.1.3(a)** the need for transport systems in multicellular plants to include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V) **3.1.3(b)** (i) the structure and function of the vascular system in the **roots**, **stems** and **leaves** of herbaceous dicotyledonous plants
28	**4.2.2(d)** the relationship between classification and phylogeny	**PAG 2** Dissection of a plant tissue

	4.2.2(e) the evidence for the theory of evolution by natural selection to include the contributions of Darwin and Wallace in formulating the theory of evolution by natural selection	(ii) the examination and drawing of stained sections of plant tissue to show the distribution of xylem and phloem (iii) the dissection of stems, both longitudinally and transversely, and their examination to demonstrate the position and structure of xylem vessels
	4.2.2(f) the different types of variation to include intraspecific and interspecific variation AND the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms AND both genetic and environmental causes of variation	**PAG 2** Dissection of a plant tissue (ii) the examination and drawing of stained sections of plant tissue to show the distribution of **xylem** and **phloem** (iii) the dissection of stems, both **longitudinally** and **transversely**, and their examination to demonstrate the position and structure of xylem vessels
29	**M1.2** Find arithmetic means **M1.10** Understand measures of dispersion, including **Standard Deviation** and range M1.3 Construct and interpret frequency tables and diagrams, bar charts and histograms	**3.1.3(c)** (i) the process of transpiration and the environmental factors that affect transpiration rate to include an appreciation that transpiration is a consequence of gaseous exchange
	the **Spearman's Rank** correlation coefficient to consider the relationship of the data (t-test covered in Year 13)	**3.1.3(c)** (i) the process of transpiration and the environmental factors that affect transpiration rate to include an appreciation that transpiration is a consequence of gaseous exchange
30	**4.2.2(g)** the different types of adaptations of organisms to their environment: anatomical, physiological and behavioural adaptations AND why organisms from different taxonomic groups may show similar anatomical features, including the marsupial mole and placental mole	(ii) practical investigations to estimate transpiration rates **PAG 5** use of appropriate measurements to record quantitative measurements such a potometer
	4.2.2(h) the mechanism by which natural selection can affect the characteristics of a population over time **4.2.2(i)** how evolution in some species has implications for human populations; pesticide resistance in insects and drug resistance in microorganisms	(ii) practical investigations to estimate transpiration rates **PAG 5** use of appropriate measurements to record quantitative measurements such a potometer

31	**Biodiversity** **4.2.1(a)** how biodiversity may be considered at different levels **4.2.1(c)** how to measure species richness and species evenness in a habitat	**3.1.3(d)** the transport of water into the plant, through the plant and to the air surrounding the leaves to include details of the pathways taken by water AND the mechanisms of movement, in terms of **water potential**, **adhesion**, **cohesion** and the **transpiration stream**
	4.2.1(d) the use and interpretation of **Simpson's Index of Diversity (D)** to calculate the biodiversity of a habitat **4.2.1(b)** (i) how sampling is used in measuring the biodiversity of a habitat and the importance of sampling (ii) practical investigations collecting random and non-random samples in the field	**3.1.3(e)** adaptations of plants to the availability of water in their environment to include xerophytes (cactus and marram grass) and hydrophytes (water lilies)
32	**PAG 3.1** Simpson's Index of Diversity on the school field	**3.1.3(f)** the mechanism of translocation to include translocation as an energy-requiring process transports assimilates, especially sucrose, in the phloem between **sources** (e.g. leaves) and **sinks** (e.g. roots, meristem) AND details of active loading at the source and removal at the sink
	4.2.1(e) how genetic biodiversity may be assessed, including calculations; the proportion of polymorphic gene loci = the number of polymorphic/total number of loci	Summary and recap on plants
33	**4.2.1(f)** the factors affecting biodiversity; human population growth,agriculture and climate change	
	4.2.1(g) the ecological, economic and aesthetic reasons for maintaining biodiversity **4.2.1(h)** in situ and ex situ methods of maintaining biodiversity	
34	**4.2.1(i)** international and local conservation agreements made to protect species and habitats	

Year 13 Curriculum Overview

Week	Teacher 1	Teacher 2
1	**Respiration** **5.2.2(a)** the need for cellular respiration,examples of why plants, animals and microorganisms need to respire eg. active transport and an outline of named metabolic reactions. **5.2.2(f)** the importance of coenzymes in cellular respiration	**Communication and Homeostasis** **5.1.1(a)** the need for communication systems in multicellular organisms, plant and animals, internal and external
	5.2.2(c) the process and site of glycolysis, the phosphorylation of glucose to hexose bisphosphate, the splitting of hexose bisphosphate into two triose phosphate molecules and further oxidation to pyruvate AND the production of a small yield of ATP and reduced NAD	**5.1.1(b)** the communication between cells by cell signalling between adjacent cells and distant cells
2	**5.2.2(b)** the structure of the mitochondrion, inner and outer mitochondrial membranes, cristae, matrix and mitochondrial DNA	**5.1.1(c)** the principles of homeostasis, receptors, effectors, negative and positive feedback
	5.2.2(d) the link reaction and its site in the cell, formation of Acetyl CoA by the decarboxylation of pyruvate and the reduction of NAD to NADH **5.2.2(e)** the process and site of the Krebs cycle, formation of citrate from the acetyl group of acetyl CoA and oxaloacetate and the reconversion of citrate to oxaloacetate the importance of decarboxylation, dehydrogenation, the reduction of NAD and FAD, and substrate level phosphorylation	**5.1.1(d)** the physiological and behavioural responses involved in temperature control in ectotherms and endotherms: hypothalamus, receptors, effectors and behavioural responses

3	**5.2.2(g)** the process and site of oxidative phosphorylation, roles of electron carriers, oxygen and the mitochondrial cristae **5.2.2(h)** the chemiosmotic theory, electron transport chain, proton gradients and ATP synthase in oxidative phosphorylation and photophosphorylation	**Excretion as a Homeostatic Mechanism** **5.1.2(a)** the term excretion and its importance in maintaining metabolism and homeostasis including removal of carbon dioxide and nitrogenous waste
	5.2.2(i) (i) the process of anaerobic respiration in eukaryotes; mammals and yeast and the benefits of being able to respire anaerobically AND why anaerobic respiration produces a much lower yield of ATP than aerobic respiration	**5.1.2(b)** (i) the structure and functions of the mammalian liver the roles of the liver in storage of glycogen, detoxification and the formation of urea (the ornithine cycle covered in outline only)
4	**5.2.2(j)** the difference in relative energy values of carbohydrates, lipids and proteins as respiratory substrates **5.2.2(k)** the use and interpretation of the respiratory quotient (RQ): RQ = CO2 produced /O2 consumed	**5.1.2(c)** (i) the **structure**, mechanisms of action and functions of the mammalian kidney
	(ii) practical investigations into respiration rates in yeast, under aerobic and anaerobic conditions **PAG 12** Yeast	**5.1.2(c)** (i) the structure, **mechanisms of action and functions of the mammalian kidney**
5	**5.2.2(l)** practical investigations into the effect of factors such as temperature, substrate concentration and different respiratory substrates on the rate of respiration using a respirometer	**5.1.2(c)** (i) the structure, **mechanisms of action and functions of the mammalian kidney** (iii) the examination and drawing of stained sections to show the **histology of nephrons**
	Photosynthesis **5.2.1(a)** the interrelationship between the process of photosynthesis and respiration, relationship between the raw materials and products of the two processes	(ii) the dissection, examination and drawing of the external and internal structure of the kidney **PAG 1 and 2**
6	**5.2.1(b)** the structure of a chloroplast and the sites of the two main stages of photosynthesis; outer membrane, lamellae, grana, thylakoid, stroma and DNA	**5.1.2(d)** the control of the water potential of the blood : the role of osmoreceptors in the hypothalamus, the posterior pituitary gland, ADH and its effect on the walls of the collecting ducts

	5.2.1(c) (i) the importance of photosynthetic pigments in photosynthesis, light harvesting systems and photosystems	**5.1.2(e)** the effects of kidney failure and its potential treatments to include effect on glomerular filtration rate (GFR) and electrolyte balance and haemodialysis and peritoneal dialysis as well as transplants - possible research
7	(ii) practical investigations using thin layer chromatography (TLC) to separate photosynthetic pigments **PAG 6** Chromatography	**5.1.2(f)** how excretory products can be used in medical diagnosis, the use of urine samples in diagnostic tests, with reference to the use of monoclonal antibodies in pregnancy testing, testing for anabolic steroids and drugs
	ii) practical investigations using thin layer chromatography (TLC) to separate photosynthetic pigments **PAG 6** Chromatography	**Hormonal Communication** **5.1.4(a)** endocrine communication by hormones, secretion into blood detected by target cells and tissues **5.1.4(b)** the structure and functions of the adrenal glands to include hormones secreted by the cortex and medulla and their functions
8	**5.2.1(d)** the light-dependent stage of photosynthesis,energy from light is harvested and used to drive the production of chemicals which can be used as a source of energy for other metabolic processes (ATP and reduced NADP) with reference to electron carriers and cyclic and non-cyclic photophosphorylaton AND the role of water	**5.1.4(b)** the structure and functions of the adrenal glands to include hormones secreted by the cortex and medulla and their functions
	5.2.1(e) the fixation of carbon dioxide and the light independent stage of photosynthesis, products of the LDR are used in the LIR (Calvin cycle) to produce triose phosphate (TP) with reference to ribulose bisphosphate (RuBP), ribulose bisphosphate carboxylase (RuBisCO) and glycerate 3-phosphate (GP)	**5.1.4(c)** (i) the histology of the pancreas (ii) the examination and drawing of stained sections of the pancreas to show the histology of the endocrine tissues
9	**5.2.1(f)** the uses of triose phosphate as a starting material for the synthesis of carbohydrates, lipids and amino acids AND the recycling of TP to regenerate the supply of RuBP	**5.1.4(d)** how blood glucose concentration is regulated, the action of insulin and glucagon as an example of negative feedback, and the role of the liver AND the control of insulin secretion, with reference to potassium channels and calcium channels in the beta cells of the pancreas

	5.2.1(g) (i) factors affecting photosynthesis, **carbon dioxide concentration**, **light intensity** and **temperature**, and the implications of **water stress** (stomatal closure)	**5.1.4(d)** how blood glucose concentration is regulated, the action of insulin and glucagon as an example of negative feedback, and the role of the liver AND the control of insulin secretion, with reference to potassium channels and calcium channels in the beta cells of the pancreas
10	**5.2.1(g)** (i) factors affecting photosynthesis on levels of **GP**, **RuBP** and **TP**	**5.1.4(e)** the difference between type 1 and 2 diabetes **5.1.4(f)** the potential treatments for diabetes mellitus, the use of insulin produced by genetically modified bacteria and the potential use of stem cells to treat diabetes mellitus - possible research homework
	(ii) practical investigations into factors affecting the rate of photosynthesis **PAG 12** Rate of Photosynthesis	**Neuronal Communication** **5.1.3(a)** the roles of mammalian sensory receptors in converting different types of stimuli into nerve impulses (e.g. Pacinian corpuscle)
11	(ii) practical investigations into factors affecting the rate of photosynthesis **PAG 12** Rate of Photosynthesis	**5.1.3(b)** the structure and functions of sensory, relay and motor neurons to include myelinated and non-myelinated neurones
	Animal Response **5.1.5(g)** the organisation of the mammalian nervous system, central and peripheral systems AND the functional organisation into the somatic and autonomic nervous systems	**5.1.3(c)** the generation and transmission of nerve impulses in mammals, resting potential, action potential, positive feedback and frequency of impulse
12	**5.1.5(h)** the structure of the human brain and the functions of its parts AND the functions of the cerebrum, cerebellum, medulla oblongata, hypothalamus and pituitary gland.	**5.1.3(d)** the structure and roles of synapses in neurotransmission to include a cholinergic synapse, the action of neurotransmitters at the synapse and the importance of synapses in summaton and control, including inhibitory and excitatory synapses
	5.1.5(i) Reflex actions to include knee jerk reflex and blinking reflex, with reference to the survival value of reflex action	**Plant Responses 5.1.5(a)** (i) the types of plant responses, the response to abiotic stress and herbivory e.g. chemical defences (such as tannins, alkaloids and pheromones), folding in response to touch (Mimosa pudica) (ii) practical investigations into phototropism and geotropism

13	**5.1.5(j)** the coordination of responses by the nervous and endocrine systems, 'fight or flight' response to environmental stimuli in mammals AND the action of hormones in cell signalling (studied in outline only) with reference to adrenaline (first messenger), activation of adenylyl cyclase, and cyclic AMP (second messenger)	**5.1.5(b)** the roles of plant hormones in leaf loss in deciduous plants, seed germination and stomatal closures
	5.1.5(k) the effects of hormones and nervous mechanisms on heart rate	**5.1.5(c)** the experimental evidence for the role of auxins in the control of apical dominance **5.1.5(d)** the experimental evidence for the role of gibberellin in the control of stem elongation and seed germination
14	**5.1.5(l)** (i) the structure of mammalian muscle and the mechanism of muscular contraction, structural and functional differences between skeletal, involuntary and cardiac muscle	**5.1.5(e)** practical investigations into the effect of plant hormones on growth **5.1.5(f)** the commercial use of plant hormones, to control ripening, the use of rooting powders and hormonal weed killers
	5.1.5(l) the action of neuromuscular junctions AND the sliding filament model of muscular contraction and the role of ATP, and how the supply of ATP is maintained in muscles by creatine phosphate (ii) the examination of stained sections or photomicrographs of skeletal muscle	**Cloning and Biotechnology** **6.2.1(a)** (i) natural clones in plants and the production of natural clones for use in horticulture
15	**PAG 11** Investigation into the measurement of an animal response - exercise and pulse rate	(ii) how to take plant cuttings as an example of a simple cloning technique, dissection of a selection of plant material to produce cuttings
	Cellular Control Recap of DNA, transcription and translation from Year 12, including RNA polymerase, mRNA, tRNA, rRNA, codon, anticodon and triplet code	**6.2.1(b)** (i) the production of artificial clones of plants by micropropagation and tissue culture (ii) the arguments for and against artificial cloning in plants
16	**6.1.1(a)** types of gene mutations and their possible effects on protein production and function, substitution, insertion or	**6.2.1(c)** natural clones in animal species, examples (twins formed by embryo splitting)

	deletion of one or more nucleotides AND the possible effects of these gene mutations (i.e. beneficial, neutral or harmful)	**6.2.1(d)** (i) how artificial clones in animals can be produced by artificial embryo twinning or by enucleation and somatic cell nuclear transfer (SCNT) (ii) the arguments for and against artificial cloning in animals - possible research
	6.1.1(b) the regulatory mechanisms that control gene expression at the transcriptional level, posttranscriptional level and post-translational level • transcriptional level: lac operon, and transcription factors in eukaryotes • post-transcriptional level: the editing of primary mRNA and the removal of introns to produce mature mRNA • post-translational level: the activation of proteins by cyclic AMP	**6.2.1(d)** (i) how artificial clones in animals can be produced by artificial embryo twinning or by enucleation and somatic cell nuclear transfer (SCNT) (ii) the arguments for and against artificial cloning in animals - possible research
17	**6.1.1(c)** the genetic control of the development of body plans in different organisms, homeobox gene sequences in plants, animals and fungi are similar and highly conserved AND the role of Hox genes in controlling body plan development	**6.2.1(e)** the use of microorganisms in biotechnological processes e.g. economic considerations, short life cycle, growth requirements AND processes including brewing, baking, cheese making, yoghurt production, penicillin production, insulin production and bioremediation
	6.1.1(d) the importance of mitosis and apoptosis as mechanisms controlling the development of body form,an appreciation that the genes which regulate the cell cycle and apoptosis are able to respond to internal and external cell stimuli e.g. stress.	**6.2.1(f)** the advantages and disadvantages of using microorganisms to make food for human consumption include bacterial and fungal sources
18	**Manipulating Genomes** **6.1.3(e)** the principles and uses of electrophoresis for separating nucleic acid fragments or proteins	**6.2.1(g)** (i) how to culture microorganisms effectively, using aseptic techniques, an opportunity for serial dilutions and culturing on agar plates **PAG 7** Microbial Techniques and Serial Dilutions
	6.1.3(a) the principles of DNA sequencing and the development of new DNA sequencing techniques, rapid advancements of the techniques used in sequencing, which	(ii) the importance of manipulating the growing conditions in batch and continuous fermentation in order to maximise the yield of product required

	have increased the speed of sequencing and allowed whole genome sequencing e.g. high-throughput sequencing	**6.2.1(h)** (i) the standard growth curve of a microorganism in a closed culture, include the formula for number of individual organisms
19	**6.1.3(b)** (i) how gene sequencing has allowed for genome-wide comparisons between individuals and between species (ii) how gene sequencing has allowed for the sequences of amino acids in polypeptides to be predicted (iii) how gene sequencing has allowed for the development of synthetic biology	**6.2.1(i)** the uses of immobilised enzymes in biotechnology and the different methods of immobilisation, methods of enzyme immobilisation AND an evaluation of the use of immobilised enzymes in biotechnology
	6.1.3(d) the principles of the polymerase chain reaction (PCR) and its application in DNA analysis	**6.2.1(i)** practical - immobilised enzymes and yeast cells
20	**6.1.3(c)** the principles of DNA profiling and its uses; forensics and analysis of disease risk	**Ecosystems** **6.3.1(a)** ecosystems, which range in size, are dynamic and are influenced by both biotic and abiotic factors, all terminology
	6.1.3(f) (i) the principles of genetic engineering	**6.3.1(b)** biomass transfers through ecosystems, how biomass transfers between trophic levels can be measured AND the efficiency of biomass transfers between trophic levels, efficiency calculation, manipulation by humans
21	(ii) the techniques used in genetic engineering, use of restriction enzymes, plasmids and DNA ligase to form recombinant DNA with the desired gene and electroporation	**6.3.1(c)** recycling within ecosystems, nitrogen cycle
	6.1.3(g) the ethical issues (both positive and negative) relating to the genetic manipulation of animals (including humans), plants and microorganisms, insect resistance in genetically modified soya, genetically modified pathogens for research and 'pharming' i.e. genetically modified animals to produce pharmaceuticals AND issues relating to patenting	**6.3.1(c)** recycling within ecosystems, carbon cycle

	and technology transfer e.g. making genetically modified seed available to poor farmers	
22	**6.1.3(h)** the principles of, and potential for, gene therapy in medicine, differences between somatic cell gene therapy and germ line cell gene therapy	**6.3.1(d)** the process of primary succession in the development of an ecosystem, from pioneer species to a climax community AND deflected succession
	Inheritance **6.1.2(a)** (i) the contribution of both environmental and genetic factors to phenotypic variation, examples of both genetic and environmental contributions – environmental examples could include diet in animals and etolaton or chlorosis in plants	**6.3.1(e)** (i) how the distribution and abundance of organisms in an ecosystem can be measured (ii) the use of sampling and recording methods to determine the distribution and abundance of organisms in a variety of ecosystems
23	ii) how sexual reproduction can lead to genetic variation within a species, meiosis and the random fusion of gametes at fertlisaton	**Populations and Sustainability** **6.3.2(a)** the factors that determine size of a population, the significance of limiting factors in determining the carrying capacity of a given environment and the impact of these factors on final population size
	6.1.2(b) (i) genetic diagrams to show patterns of inheritance and **mono**genic inheritance	**6.3.2(b)** interactions between populations, predator–prey relationships considering the effects on both predator and prey populations AND interspecific and intraspecific competition
24	(i) **di**hybrid inheritance, multple alleles, sex linkage and codominance	**6.3.2(c)** the reasons for, and differences between, conservation and preservation,economic, social and ethical reasons for conservation of biological resources
	(ii) the use of phenotypic ratios to identify linkage (autosomal and sex linkage) and epistasis	**6.3.2(d)** how the management of an ecosystem can provide resources in a sustainable way, timber production and fishing
25	**6.1.2(c)** using the chi-squared ($\chi 2$) test to determine the significance of the difference between observed and expected results - equation provided	**6.3.2(e)** the management of environmental resources eg. the Masai Mara region in Kenya and the Terai region of Nepal, peat bogs **and** the effects of human activities eg. Galapagos Islands, Antarctica, Snowdonia National Park, the Lake District

	6.1.2(d) the genetic basis of continuous and discontinuous variation, reference to the number of genes that influence each type of variation	
26	**6.1.2(e)** the factors that can affect the evolution of a species, stabilising selection and directional selection, genetic drift, genetic bottleneck and founder effect	
	6.1.2(f) the use of the Hardy–Weinberg principle to calculate allele frequencies in populations - equation provided	
27	**6.1.2(g)** the role of isolating mechanisms in the evolution of new species, geographical mechanisms (allopatric speciation) and reproductive mechanisms (sympatric speciation)	
	6.1.2(h) (i) the principles of artificial selection and its uses, examples of selective breeding in plants and animals AND an appreciation of the importance of maintaining a resource of genetic material for use in selective breeding including wild types., (ii) the ethical considerations surrounding the use of artificial selection, more extreme examples of the use of artificial selection to 'improve' domestic species e.g. dog breeds	