

Water and carbohydrates

Can you explain how the dipole nature of water makes it a good solvent and why this is important in transport in organisms?



Can you describe the structure of monosaccharides (glucose, fructose, galactose), disaccharides (maltose, lactose, sucrose) and polysaccharides (glycogen and starch: amylose and amylopectin)?



Can you relate the structures of monosaccharides, disaccharides and polysaccharides to their roles in providing and storing energy?



Can you use a semi-quantitative method with Benedict's reagent to estimate the concentration of reducing sugars, and iodine solution to estimate starch concentration, using colour standards (CP₁)?



Can you describe how monosaccharides join by condensation reactions to form glycosidic bonds in disaccharides and polysaccharides?



Can you describe how glycosidic bonds are broken by hydrolysis to release monosaccharides?

**Lipids**

Can you describe how a triglyceride is synthesised by the formation of ester bonds in condensation reactions between glycerol and three fatty acids?



Can you explain the differences between saturated and unsaturated lipids?

**Heart and circulation**

Can you explain why many animals have a heart and circulation (mass transport to overcome the limitations of diffusion)?



Can you explain how the structures of arteries, veins and capillaries relate to their functions?



Can you describe the cardiac cycle (atrial systole, ventricular systole and cardiac diastole) and relate the structure of the mammalian heart to its operation?

**Haemoglobin and gas transport**

Can you explain the role of haemoglobin in the transport of oxygen and carbon dioxide?



Can you interpret the oxygen dissociation curve of haemoglobin, including the Bohr effect?



Can you explain the significance of the oxygen dissociation curve of fetal haemoglobin compared with adult haemoglobin?



Atherosclerosis and blood clotting

Can you describe the course of events that leads to atherosclerosis (endothelial damage, inflammatory response, plaque formation, raised blood pressure)?



Can you describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin, fibrinogen to fibrin) and its role in cardiovascular disease (CVD)?

**T1b Diet, Risk and CVD****Risk factors and antioxidants**

Can you explain how factors such as genetics, diet, age, gender, high blood pressure, smoking and inactivity increase the risk of CVD?



Can you evaluate the evidence that dietary antioxidants (e.g. vitamin C) reduce the risk of CVD?



Can you investigate the vitamin C content of food and drink (CP₂)?

**Interpreting data and studies**

Can you analyse and interpret quantitative data on illness and mortality rates to determine health risks, distinguishing between correlation and causation?



Can you evaluate the design of studies used to determine health risk factors, including sample selection and sample size?



Can you explain why people's perceptions of risk often differ from the actual risks of diet-related heart disease?



Can you analyse data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs)?



Can you describe the evidence for a causal relationship between blood cholesterol levels and CVD?

**Reducing risk and treatment**

Can you use knowledge of energy budgets and diet (including energy intake versus output) to explain how diet affects the risk of coronary heart disease?



Can you use indicators of obesity, including body mass index (BMI) and waist-to-hip ratio, to assess health risk?



Can you explain how exercise and stopping smoking can reduce the risk of coronary heart disease?



Can you discuss the benefits and risks of treatments for CVD, including antihypertensives, statins, anticoagulants and platelet inhibitors?



Gas exchange

Can you explain how the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thin barrier, steep concentration gradient) increase the rate of diffusion?



Can you explain how the rate of diffusion depends on these properties and can be calculated using Fick's Law of diffusion?



Can you explain how the structure of the mammalian lung is adapted for rapid gaseous exchange?

**Membranes and transport**

Can you describe the structure and properties of cell membranes?



Can you explain how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes?



Can you investigate membrane properties, including the effect of alcohol and temperature on membrane permeability (CP₃)?



Can you explain osmosis in terms of the movement of free water molecules through a partially permeable membrane down a water potential gradient?



Can you explain the movement of molecules across membranes by passive transport, active transport, endocytosis and exocytosis?



Can you explain the involvement of carrier and channel proteins in membrane transport?

**Proteins**

Can you describe the basic structure of an amino acid (amine, R group and carboxyl group)?



Can you describe how amino acids join by condensation to form peptide bonds in polypeptides?



Can you explain how the primary structure of a protein determines its secondary, tertiary and quaternary structure and so its properties?



Can you compare the structure and properties of globular proteins (e.g. haemoglobin) and fibrous proteins (e.g. collagen) and relate them to their functions?

**Enzymes**

Can you explain the mechanism of action and specificity of enzymes in terms of their three-dimensional structure and active site?



Can you explain that enzymes are biological catalysts that reduce activation energy?



Can you explain that there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes produced by cells that catalyse reactions outside cells?



Can you investigate the effect of temperature, pH, enzyme concentration and substrate concentration on the initial rate of enzyme-catalysed reactions (CP_4)?



T2b

DNA, Gene Expression and Inheritance

Nucleic acids and replication

Can you describe the basic structure of mononucleotides (deoxyribose or ribose, phosphate group and a base) and the structures of DNA and RNA?



Can you explain how complementary base pairing and hydrogen bonding between two complementary strands form the DNA double helix?



Can you describe the process of DNA replication, including the role of DNA polymerase?



Can you explain how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of semi-conservative replication of DNA?



Genetic code and protein synthesis

Can you describe the nature of the genetic code (triplet, non-overlapping and degenerate)?



Can you define a gene as a sequence of bases on a DNA molecule that codes for a sequence of amino acids in a polypeptide chain?



Can you describe the process of protein synthesis, including transcription and translation and the roles of mRNA, tRNA and ribosomes?



Can you explain the roles of the template (antisense) DNA strand, codons on mRNA and anticodons on tRNA in protein synthesis?



Mutation

Can you explain how errors in DNA replication can give rise to mutations?



Can you explain why some mutations result in cancer or genetic disorders, while others have no effect?



Inheritance

Can you explain the terms gene, allele, genotype, phenotype, recessive, dominant, codominance, homozygote and heterozygote?



Can you explain monohybrid inheritance, including the interpretation of genetic pedigree diagrams, for disorders such as cystic fibrosis, albinism, thalassaemia, haemophilia and sickle cell disease?



Can you explain sex-linked (X-linked) inheritance, including the inheritance of red-green colour blindness?



Can you explain how the expression of a mutated cystic fibrosis allele affects the gas exchange, digestive and reproductive systems?



Genetic screening

Can you describe the uses of genetic screening, including identification of carriers, pre-implantation genetic diagnosis (PGD) and prenatal testing (amniocentesis and chorionic villus sampling)?



Can you discuss the implications of prenatal genetic screening?



Can you identify and discuss the ethical and social issues relating to genetic screening from a range of ethical viewpoints?



Cells and organisation

Can you explain that all living organisms are made of cells sharing some common features?



Can you explain how cells are organised into tissues, tissues into organs and organs into organ systems?

**Eukaryotic and prokaryotic cells**

Can you describe the ultrastructure of an animal (eukaryotic) cell, including the nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes and Golgi apparatus?



Can you describe the functions of the nucleus, nucleolus, ribosomes, rough and smooth ER, mitochondria, centrioles, lysosomes and Golgi apparatus?



Can you explain the role of the rough endoplasmic reticulum and the Golgi apparatus in protein transport within cells, including the production of extracellular enzymes?



Can you describe the ultrastructure of a prokaryotic cell, including the cell wall, capsule, plasmid, flagellum, pili, ribosomes, mesosomes and circular DNA?



Can you describe the functions of the structures found in prokaryotic cells?



Can you recognise the organelles of animal cells from electron microscope (EM) images?

**Microscopy**

Can you explain the meaning of the terms magnification and resolution and compare light and electron microscopy?



Can you explain why staining is needed when viewing specimens with a microscope?



Can you use a light microscope to make observations and labelled drawings of suitable animal cells (CP₅)?



Can you use a graticule with a microscope to make measurements and understand the concept of scale (CP₅)?

**Chromosomes and meiosis**

Can you explain that a locus is the location of a gene on a chromosome?



Can you explain the linkage of genes on a chromosome and how this affects inheritance?



Can you explain how meiosis results in haploid gametes and produces genetic variation through independent assortment (metaphase I) and crossing over (prophase I)?



Gametes and fertilisation

Can you describe how mammalian gametes are specialised for their functions, including the acrosome in sperm and the zona pellucida in the egg?



Can you describe the process of fertilisation in mammals, including the acrosome reaction, the cortical reaction and the fusion of nuclei?



Can you describe the process of fertilisation in flowering plants, from the growth of the pollen tube to the fusion of nuclei (double fertilisation)?



T3c

Cell Cycle, Stem Cells and Gene Expression

Mitosis and the cell cycle

Can you describe the cell cycle and the stages of mitosis, and explain how mitosis produces genetically identical daughter cells for growth and asexual reproduction?



Can you prepare and stain a root tip squash to observe the stages of mitosis (CP₆)?



Can you calculate mitotic indices from observations of cells?



Stem cells

Can you explain what is meant by the terms stem cell, pluripotency, totipotency, morula and blastocyst?



Can you discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies?



Gene expression and variation

Can you explain how cells become specialised through differential gene expression, producing active mRNA and so modified proteins, in animals and plants?



Can you explain how one gene can give rise to more than one protein through post-transcriptional changes to mRNA (splicing of introns and exons)?



Can you explain how phenotype is the result of an interaction between genotype and the environment?



Can you explain how epigenetic modification, including DNA methylation and histone modification, can alter the activation of certain genes?



Can you explain how epigenetic modifications can be passed on following cell division?



Can you explain how some phenotypes are affected by multiple alleles for the same gene or by polygenic inheritance, as well as the environment, and how this gives rise to continuous variation?



T4a

Plant Structure and Function

Plant cells

Can you compare the ultrastructure of plant cells (cell wall, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) with that of animal cells?



Can you describe the functions of the cell wall, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella?



Can you recognise the organelles of plant cells from electron microscope (EM) images?



Starch, cellulose and plant fibres

Can you compare the structures and functions of starch and cellulose, including the formation of hydrogen bonds between β -glucose molecules to form cellulose microfibrils?



Can you explain how the arrangement of cellulose microfibrils and secondary thickening in plant cell walls contributes to the physical properties of xylem vessels and sclerenchyma fibres, and how these are exploited as plant fibres?



Can you compare the similarities and differences between sclerenchyma fibres, xylem vessels and phloem, including their position in a stem and their functions?



Can you use a light microscope to make plan diagrams of transverse sections of roots, stems and leaves (CP₇)?



Can you use a light microscope to make drawings of cells from plant tissues (CP₇)?



Can you identify sclerenchyma fibres, phloem sieve tubes and xylem vessels and their location within stems through a light microscope (CP₇)?



Can you explain how the uses of plant fibres and starch may contribute to sustainability, including plant-based products replacing oil-based plastics?



Water and mineral ions

Can you explain the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants?



Can you determine the tensile strength of plant fibres (CP₈)?



T4b

Antimicrobials and Drug Testing

Bacteria and plant-derived drugs

Can you describe the conditions required for bacterial growth?



Can you explain how some substances obtained from plants have antimicrobial properties and other therapeutic uses?



Can you investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria (CP₉)?



Drug testing

Can you describe the development of drug testing from historic to contemporary protocols, including William Withering's digitalis soup, double-blind trials, placebos and three-phase testing?

**T4c**

Classification, Biodiversity and Conservation

Classification

Can you explain that classification is a means of organising the variety of life based on relationships between organisms (phenotypic and genotypic) and is built around the concept of species?



Can you explain the process and importance of critical evaluation of new data by the scientific community, including the use of molecular evidence that led to the three-domain system (Archaea, Bacteria and Eukarya)?



Biodiversity

Can you explain that there is a wide variety of living organisms and that this variety is threatened by human activities?



Can you define the terms biodiversity and endemism?



Can you describe how biodiversity can be measured within a habitat using species richness, and within a species using genetic diversity, e.g. calculating the heterozygosity index (number of heterozygotes divided by number of individuals in the population)?



Can you use the formula for the index of diversity, $D = N(N - 1) / \sum n(n - 1)$, to compare the biodiversity of different habitats?



Can you explain the concept of niche and describe examples of behavioural, anatomical and physiological adaptations of organisms to their environment?



Evolution and speciation

Can you use the Hardy-Weinberg equation ($p^2 + 2pq + q^2 = 1$ and $p + q = 1$) to calculate allele frequencies and determine whether a change in allele frequency is occurring in a population over time?



Can you explain how mutation and natural selection can lead to a change in allele frequency in a population?



Can you explain how reproductive isolation can lead to the formation of new species?

**Conservation**

Can you discuss and evaluate the methods used by zoos and seed banks in the conservation of endangered species and their genetic diversity, including scientific research, captive breeding programmes, reintroduction programmes and education?



Planning

Can you identify the apparatus required for an investigation?	☐	☐	☐
Can you identify the dependent and independent variables and the variables that should be standardised (controlled)?	☐	☐	☐
Can you describe how to measure the relevant variables using the most appropriate instrument and correct technique?	☐	☐	☐
Can you identify and state how to control all other relevant variables to make it a fair test?	☐	☐	☐
Can you discuss whether repeat readings are appropriate?	☐	☐	☐
Can you identify health and safety issues and discuss how they may be dealt with?	☐	☐	☐
Can you discuss how the data collected will be used?	☐	☐	☐
Can you identify possible sources of uncertainty and/or systematic error and explain how they could be reduced or eliminated?	☐	☐	☐
Can you comment on the implications of the biology (e.g. benefits and risks) and its context (e.g. social, environmental, historical)?	☐	☐	☐

Implementation and measurements

Can you comment on the number of readings taken?	☐	☐	☐
Can you comment on the range of measurements taken?	☐	☐	☐
Can you comment on the significant figures used in recorded data?	☐	☐	☐
Can you check and identify a reading that is inconsistent with the others, such as a point that lies off the line of a graph?	☐	☐	☐
Can you comment on how an experiment may be improved, possibly using additional apparatus to reduce errors?	☐	☐	☐

Processing results

Can you perform calculations using the correct number of significant figures?	☐	☐	☐
Can you plot results on a graph using an appropriate scale?	☐	☐	☐
Can you use the correct units throughout?	☐	☐	☐
Can you comment on the relationship obtained from a graph?	☐	☐	☐
Can you determine the relationship between two variables, or a constant, from a graph, e.g. a gradient using a large triangle?	☐	☐	☐

Can you suggest realistic modifications to reduce errors?



Can you suggest realistic modifications to improve an experiment?



Can you discuss uncertainties qualitatively and quantitatively?



ATP and the photosynthesis equation

Can you describe the overall reaction of photosynthesis as requiring energy from light to split water into hydrogen and oxygen, with hydrogen being added to carbon dioxide to form glucose and oxygen released as a waste product?



Can you explain how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an immediate supply of energy for biological processes?

**Light-dependent and light-independent reactions**

Can you describe the light-dependent reactions, in which light energy excites electrons in chlorophyll, generating ATP and reduced NADP by cyclic and non-cyclic photophosphorylation, and photolysis of water produces oxygen?



Can you describe the light-independent reactions as the reduction of carbon dioxide using the products of the light-dependent reactions (the Calvin cycle), including the roles of GP, GALP, RuBP and RUBISCO?



Can you explain that the products of the Calvin cycle are simple sugars that are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules?



Can you relate the structure of the chloroplast to its role in photosynthesis?

**Pigments and rate of photosynthesis**

Can you explain the meaning of the terms absorption spectrum and action spectrum?



Can you use chromatography to separate and identify chloroplast pigments using R_f values?



Can you investigate the effects of light intensity, light wavelength, temperature and availability of carbon dioxide on the rate of photosynthesis using a suitable aquatic plant (CP₁₀)?

**Productivity**

Can you explain the relationship between gross primary productivity (GPP), net primary productivity (NPP) and plant respiration (R)?



Can you calculate net primary productivity using $NPP = GPP - R$?



Can you calculate the efficiency of biomass and energy transfers between trophic levels?



Ecosystems

- | | |
|---|---|
| Can you define the terms population, community, habitat and ecosystem? | ☐ ☐ ☐ |
| Can you explain how the numbers and distribution of organisms in a habitat are controlled by biotic and abiotic factors? | ☐ ☐ ☐ |
| Can you explain how the concept of niche accounts for the distribution and abundance of organisms in a habitat? | ☐ ☐ ☐ |
| Can you carry out a study of the ecology of a habitat, using quadrats and transects to determine abundance and distribution of species, and measure abiotic factors appropriate to the habitat (CP ₁₁)? | ☐ ☐ ☐ |
| Can you describe the stages of succession from colonisation to a climax community? | ☐ ☐ ☐ |

T5c

Climate Change and Evolution

A-LEVEL ONLY

Evidence and causes of climate change

- | | |
|--|---|
| Can you analyse data for evidence of climate change, including carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology? | ☐ ☐ ☐ |
| Can you distinguish between correlation and causation when interpreting evidence for climate change? | ☐ ☐ ☐ |
| Can you explain the causes of anthropogenic climate change, including the role of greenhouse gases in the greenhouse effect? | ☐ ☐ ☐ |
| Can you apply knowledge of the carbon cycle to methods of reducing atmospheric levels of carbon dioxide? | ☐ ☐ ☐ |
| Can you explain how data can be extrapolated to make predictions using models of future climate change? | ☐ ☐ ☐ |
| Can you discuss the limitations of models of future climate change? | ☐ ☐ ☐ |

Effects of climate change

- | | |
|--|---|
| Can you explain the effects of climate change (changing rainfall patterns and changes in seasonal cycles) on plants and animals, including distribution of species, development and life cycles? | ☐ ☐ ☐ |
| Can you explain the effect of temperature on the rate of enzyme activity and its impact on plants, animals and microorganisms, including the use of the temperature coefficient Q ₁₀ ? | ☐ ☐ ☐ |
| Can you investigate the effects of temperature on the development of organisms (e.g. seedling growth rate or brine shrimp hatch rates), taking into account the safe and ethical use of organisms (CP ₁₂)? | ☐ ☐ ☐ |

Evolution and speciation

Can you explain how evolution (a change in allele frequency) can come about through gene mutation and natural selection?



Can you explain how isolation reduces gene flow between populations, leading to allopatric or sympatric speciation?

**Science, society and sustainability**

Can you discuss how the conclusions of different investigations into controversial issues such as climate change may depend on the people who draw them?



Can you evaluate the use of reforestation and sustainable resources, including biofuels, as ways of managing the conflict between human needs and conservation?

**T6a****Microbiology and Infection****A-LEVEL ONLY****Culturing and growth of microorganisms**

Can you describe the principles and techniques involved in culturing microorganisms, using aseptic technique?



Can you describe the different methods of measuring the growth of microorganisms, including cell counts, dilution plating, mass and optical methods (turbidity)?



Can you describe the phases of a bacterial growth curve (lag, exponential, stationary and death phase) and calculate exponential growth rate constants?



Can you investigate the rate of growth of microorganisms in a liquid culture, taking into account the safe and ethical use of organisms (CP₁₃)?

**Bacteria and viruses**

Can you compare the structure of bacteria and viruses (nucleic acid, capsid and envelope) with reference to Ebola virus, tobacco mosaic virus (TMV), HIV and λ (lambda) phage?



Can you describe the lytic and latency (lysogenic) cycles of viruses?



Can you explain how Mycobacterium tuberculosis and the human immunodeficiency virus (HIV) infect human cells, causing a sequence of symptoms that may result in death?

**T6b****Immunity, Antibiotics and Forensics****A-LEVEL ONLY****Barriers and non-specific responses**

Can you describe the major routes pathogens may take when entering the body?



Can you explain the role of barriers in protecting the body from infection, including skin, stomach acid, and gut and skin flora?



Can you explain the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon and phagocytosis?



Specific immune response

Can you explain the roles of antigens and antibodies in the body's immune response, including the involvement of plasma cells, macrophages and antigen-presenting cells?



Can you explain the roles of B cells (B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response?



Can you explain how individuals may develop immunity, including natural, artificial, active and passive immunity?



Can you discuss how the theory of an evolutionary race between pathogens and their hosts is supported by the evasion mechanisms shown by pathogens?



Antibiotics and infection control

Can you explain the difference between bacteriostatic and bactericidal antibiotics?



Can you investigate the effect of different antibiotics on bacteria (CP_{14})?



Can you describe the causes of hospital-acquired infections and the codes of practice relating to antibiotic prescription and infection control that hospitals have adopted?



Decomposition and forensics

Can you explain the role of microorganisms in the decomposition of organic matter and the recycling of carbon?



Can you describe how DNA can be amplified using the polymerase chain reaction (PCR)?



Can you describe how gel electrophoresis can be used to separate DNA fragments of different lengths?



Can you explain how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals)?



Can you describe how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction (rigor mortis)?



T7a

Respiration

A-LEVEL ONLY

Overview of respiration

Can you describe the overall reaction of aerobic respiration as splitting of the respiratory substrate to release carbon dioxide as a waste product and reuniting of hydrogen with atmospheric oxygen with the release of a large amount of energy?



Can you explain that respiration is a many-stepped process with each step controlled and catalysed by a specific intracellular enzyme?



Stages of respiration

Can you explain the roles of glycolysis in aerobic and anaerobic respiration, including phosphorylation of hexoses, production of ATP, reduced coenzyme and pyruvate acid, and lactate?



Can you explain the role of the link reaction and the Krebs cycle in the complete oxidation of glucose and formation of carbon dioxide (decarboxylation), ATP, reduced NAD and reduced FAD (dehydrogenation)?



Can you state the locations of glycolysis (cytoplasm) and of the link reaction and Krebs cycle (mitochondrial matrix)?



Can you explain how ATP is synthesised by oxidative phosphorylation, including the roles of the electron transport chain, chemiosmosis and ATP synthase?



Can you explain what happens to lactate after a period of anaerobic respiration in animals?



RQ and respiration practicals

Can you explain the meaning of the term respiratory quotient (RQ) and calculate and interpret RQ values?



Can you use an artificial hydrogen carrier (redox indicator) to investigate respiration in yeast (CP₁₅)?



Can you use a simple respirometer to determine the rate of respiration and RQ of a suitable material, e.g. germinating seeds or small invertebrates (CP₁₆)?



T7b

Muscles, Heart and Exercise

A-LEVEL ONLY

Muscles and movement

Can you explain the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors?



Can you describe the structure of a mammalian skeletal muscle fibre?



Can you explain the structural and physiological differences between fast and slow twitch muscle fibres?



Can you explain the process of contraction of skeletal muscle in terms of the sliding filament theory, including the roles of actin, myosin, troponin, tropomyosin, calcium ions (Ca^{2+}), ATP and ATPase?



Control of the heart

Can you explain the myogenic nature of cardiac muscle?



Can you explain how the normal electrical activity of the heart coordinates the heartbeat, including the roles of the sinoatrial node (SAN), atrioventricular node (AVN), bundle of His and Purkyne fibres?



Can you explain how an electrocardiogram (ECG) can be used to diagnose abnormal heart rhythms?



Exercise physiology

Can you calculate cardiac output using cardiac output = stroke volume x heart rate?



Can you explain how variations in ventilation and cardiac output enable rapid delivery of oxygen to tissues and removal of carbon dioxide, including how heart rate and ventilation rate are controlled by the cardiovascular control centre and the ventilation centre in the medulla oblongata?



Can you explain the role of adrenaline in the fight or flight response?



Can you investigate the effects of exercise on tidal volume, breathing rate, respiratory minute ventilation and oxygen consumption using data from spirometer traces (CP_{17})?



T7c

Homeostasis and the Kidney

A-LEVEL ONLY

Homeostasis

Can you explain the principle of negative feedback and positive feedback?



Can you explain how negative feedback maintains systems within narrow limits?



Can you discuss the concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus in thermoregulation?



The kidney

Can you describe the gross and microscopic structure of the mammalian kidney (cortex, medulla, nephron, glomerulus, Bowman's capsule, collecting duct)?



Can you explain how excess amino acids are deaminated in the liver to form urea, and how urea is removed from the blood by ultrafiltration in the kidney?



Can you explain how solutes are selectively reabsorbed in the proximal tubule?



Can you explain how the loop of Henle acts as a countercurrent multiplier to increase the reabsorption of water?



Can you explain the control of mammalian plasma concentration and blood volume by negative feedback, including the roles of the pituitary gland, osmoreceptors in the hypothalamus and antidiuretic hormone (ADH)?



Hormones and gene switching

Can you explain how genes can be switched on and off by DNA transcription factors, including peptide hormones acting via receptors on the cell surface and steroid hormones acting inside the cell?



T8a

The Nervous System

A-LEVEL ONLY

Neurones and reflexes

Can you describe the structure and function of sensory, relay and motor neurones, including the role of Schwann cells and myelination?



Can you explain how the nervous system of organisms can cause effectors to respond to a stimulus?



Can you describe the structure and function of a spinal reflex arc, including the grey matter and white matter of the spinal cord?



Nerve impulses

Can you explain how a nerve impulse (action potential) is conducted along an axon, including changes in membrane permeability to sodium ions (Na^+) and potassium ions (K^+)?



Can you explain the role of myelination in saltatory conduction?



Synapses and drugs

Can you describe the structure and function of synapses in nerve impulse transmission, including the role of neurotransmitters such as acetylcholine?



Can you explain how the pupil dilates and contracts in response to light intensity?



Can you explain how the effects of drugs can be caused by their influence on nerve impulse transmission, including nicotine, lidocaine, cobra venom alpha toxin, L-DOPA (Parkinson's disease) and MDMA (ecstasy)?



Vision and habituation

Can you explain how stimulation of rod cells in the mammalian retina results in an action potential in the bipolar neurone, including the roles of rhodopsin, opsin, retinal, sodium ions, cation channels and hyperpolarisation of the rod cell?



Can you explain the process of habituation to a stimulus?



Can you describe the organisation of the nervous system into the central and peripheral nervous systems?

**T8b****Plant Responses and the Brain****A-LEVEL ONLY****Plant coordination**

Can you explain the roles of phytochrome, auxin (IAA) and gibberellins in plant responses to environmental stimuli, including their effects on transcription?



Can you investigate the production of amylase in germinating cereal grains (CP₁₈)?

**Coordination in animals**

Can you compare the mechanisms of coordination by the nervous system and by hormones in animals?



Can you describe the location and main functions of the cerebral hemispheres, hypothalamus, pituitary gland, cerebellum and medulla oblongata of the human brain?

**Brain imaging and imbalances**

Can you describe the use of magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), positron emission tomography (PET) and computed tomography (CT) in medical diagnosis and investigating brain structure and function?



Can you explain how imbalances in certain naturally occurring brain chemicals can contribute to ill health, e.g. dopamine in Parkinson's disease and serotonin in depression, and to the development of new drugs?

**T8c****Gene Technology****A-LEVEL ONLY****Genetic modification**

Can you describe how drugs can be produced using genetically modified organisms (plants, animals and microorganisms)?



Can you describe how recombinant DNA is produced, including the roles of restriction endonucleases and DNA ligase?



Can you describe how recombinant DNA can be inserted into other cells (e.g. using plasmid or viral vectors, gene guns, liposomes)?



Can you discuss the risks and benefits associated with the use of genetically modified organisms?



Microarrays and bioinformatics

Can you explain how microarrays can be used to identify the active genes in a cell?



Can you explain what is meant by the term bioinformatics and its role in analysing large amounts of biological data?



Planning

Can you identify the most appropriate apparatus, giving details such as the range and resolution of instruments and relevant dimensions (e.g. quadrat area)?



Can you formulate a null hypothesis for an investigation?



Can you identify the dependent and independent variables and the variables that should be standardised (controlled)?



Can you discuss the calibration of instruments, e.g. checking that a meter reads zero before taking measurements?



Can you describe how to measure the relevant variables using the most appropriate instruments and techniques?



Can you identify and state how to control all other relevant variables to make it a fair test?



Can you discuss whether repeat readings are appropriate?



Can you identify health and safety issues and discuss how they may be dealt with?



Can you identify any ethical issues involved in using living organisms?



Can you discuss how the data collected will be used, including the choice of a suitable statistical test?



Implementation and measurements

Can you comment on how an experiment could be improved, possibly using additional apparatus to reduce errors?



Can you comment on the number of readings taken?



Can you comment on the range of measurements taken?



Can you comment on significant figures, including identifying and rounding incorrectly recorded figures in a table of results?



Can you identify and amend incorrect units?



Can you identify and check a reading that is inconsistent with the others, such as a point that lies off the line of a graph?



Analysis

Can you explain how data should be tabulated, with appropriate headings and units?



Can you perform calculations, including statistical tests, using the correct number of significant figures?



Can you plot results on a graph using an appropriate scale and units, including logarithmic scales where needed?



Can you use the correct units throughout?



Can you comment on the trend or pattern obtained?



Can you determine the relationship between two variables, or a constant, from a graph, e.g. a gradient using a large triangle?



Can you suggest realistic modifications to reduce errors?



Can you suggest realistic modifications to improve an experiment?



Core practical activities

CP1 Can you use a semi-quantitative method with Benedict's reagent to estimate reducing sugar concentration, and iodine solution to estimate starch concentration, using colour standards?	☐	☐	☐
CP2 Can you investigate the vitamin C content of food and drink?	☐	☐	☐
CP3 Can you investigate membrane properties, including the effect of alcohol and temperature on membrane permeability?	☐	☐	☐
CP4 Can you investigate the effect of temperature, pH, enzyme concentration and substrate concentration on the initial rate of enzyme-catalysed reactions?	☐	☐	☐
CP5 Can you use a light microscope to make labelled drawings of suitable animal cells and use a graticule to make measurements and understand scale?	☐	☐	☐
CP6 Can you prepare and stain a root tip squash to observe the stages of mitosis?	☐	☐	☐
CP7 Can you use a light microscope to make plan diagrams of transverse sections of roots, stems and leaves, draw cells from plant tissues and identify sclerenchyma fibres, phloem sieve tubes and xylem vessels?	☐	☐	☐
CP8 Can you determine the tensile strength of plant fibres?	☐	☐	☐
CP9 Can you investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria?	☐	☐	☐
CP10 Can you investigate the effects of light intensity, light wavelength, temperature and availability of carbon dioxide on the rate of photosynthesis using a suitable aquatic plant?	☐	☐	☐
CP11 Can you carry out a study of the ecology of a habitat, using quadrats and transects to determine abundance and distribution of species, and measure abiotic factors?	☐	☐	☐
CP12 Can you investigate the effects of temperature on the development of organisms (e.g. seedling growth rate or brine shrimp hatch rates), taking into account safe and ethical use of organisms?	☐	☐	☐
CP13 Can you investigate the rate of growth of microorganisms in a liquid culture, taking into account safe and ethical use of organisms?	☐	☐	☐
CP14 Can you investigate the effect of different antibiotics on bacteria?	☐	☐	☐
CP15 Can you use an artificial hydrogen carrier (redox indicator) to investigate respiration in yeast?	☐	☐	☐
CP16 Can you use a simple respirometer to determine the rate of respiration and RQ of a suitable material (e.g. germinating seeds or small invertebrates)?	☐	☐	☐
CP17 Can you investigate the effects of exercise on tidal volume, breathing rate, respiratory minute ventilation and oxygen consumption using data from spirometer traces?	☐	☐	☐

CP18 Can you investigate the production of amylase in germinating cereal grains?

