

3.1 BIOLOGICAL MOLECULES

R A G

3.1.1 Monomers and polymers

Can you explain that the biochemical basis of life is similar across all organisms despite their variety?	☐	☐	☐
Can you define a monomer and a polymer?	☐	☐	☐
Can you name monosaccharides, amino acids and nucleotides as examples of monomers?	☐	☐	☐
Can you describe a condensation reaction as joining two molecules with a chemical bond and removing water?	☐	☐	☐
Can you describe a hydrolysis reaction as breaking a chemical bond between two molecules using water?	☐	☐	☐

3.1.2 Carbohydrates

Can you name glucose, galactose and fructose as common monosaccharides?	☐	☐	☐
Can you describe how a glycosidic bond forms by condensation between two monosaccharides?	☐	☐	☐
Can you state the monomers of maltose, sucrose and lactose?	☐	☐	☐
Can you draw and distinguish the structures of alpha-glucose and beta-glucose?	☐	☐	☐
Can you explain how polysaccharides form by condensation of many glucose units?	☐	☐	☐
Can you state that glycogen and starch are made of alpha-glucose and cellulose of beta-glucose?	☐	☐	☐
Can you relate the structures of glycogen, starch and cellulose to their functions in animal and plant cells?	☐	☐	☐
Can you describe Benedict's test for reducing sugars and for non-reducing sugars?	☐	☐	☐
Can you describe the iodine/potassium iodide test for starch?	☐	☐	☐

3.1.3 Lipids

Can you name triglycerides and phospholipids as two groups of lipids?	☐	☐	☐
Can you describe how a triglyceride forms from one glycerol and three fatty acids by condensation?	☐	☐	☐
Can you describe the ester bond formed between glycerol and a fatty acid?	☐	☐	☐
Can you recognise saturated and unsaturated fatty acid R-groups from diagrams?	☐	☐	☐
Can you describe how a phospholipid differs from a triglyceride?	☐	☐	☐
Can you explain how the different properties of triglycerides and phospholipids relate to their structures?	☐	☐	☐
Can you describe the emulsion test for lipids?	☐	☐	☐

3.1.4.1 Proteins: general properties

Can you draw the general structure of an amino acid with its amine group, carboxyl group and R-group?	☐	☐	☐
Can you state that the 20 amino acids common in all organisms differ only in their R-group?	☐	☐	☐
Can you describe how a peptide bond forms by condensation between two amino acids?	☐	☐	☐
Can you define a dipeptide and a polypeptide?	☐	☐	☐
Can you explain that a functional protein may contain one or more polypeptides?	☐	☐	☐

Can you describe the roles of hydrogen bonds, ionic bonds and disulfide bridges in protein structure?	☐ ☐ ☐
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Can you describe primary, secondary, tertiary and quaternary structure and relate them to function?	☐ ☐ ☐
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Can you describe the biuret test for proteins?	☐ ☐ ☐
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3.1.4.2 Many proteins are enzymes

Can you explain that enzymes lower the activation energy of the reaction they catalyse?	☐ ☐ ☐
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Can you describe the induced-fit model of enzyme action and how models of enzyme action have changed?	☐ ☐ ☐
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Can you explain how the tertiary structure of the active site determines enzyme properties and specificity?	☐ ☐ ☐
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Can you explain how enzyme concentration and substrate concentration affect the rate of reaction?	☐ ☐ ☐
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Can you explain how competitive and non-competitive inhibitors affect the rate of reaction?	☐ ☐ ☐
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Can you explain how pH and temperature affect the rate of an enzyme-controlled reaction?	☐ ☐ ☐
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Can you explain that enzymes catalyse both intracellular and extracellular reactions?	☐ ☐ ☐
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3.1.5.1 Structure of DNA and RNA

Can you describe the roles of DNA in holding genetic information and RNA in transferring it to ribosomes?	☐ ☐ ☐
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Can you state that ribosomes are made of RNA and proteins?	☐ ☐ ☐
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Can you describe the components of a DNA nucleotide and an RNA nucleotide?	☐ ☐ ☐
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Can you describe how phosphodiester bonds form by condensation to make a polynucleotide?	☐ ☐ ☐
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Can you describe the DNA double helix, complementary base pairing and hydrogen bonding?	☐ ☐ ☐
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Can you describe RNA as a relatively short single polynucleotide chain?	☐ ☐ ☐
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Can you explain why scientists once doubted that DNA carried the genetic code?	☐ ☐ ☐
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3.1.5.2 DNA replication

Can you explain how semi-conservative replication ensures genetic continuity between generations of cells?	☐ ☐ ☐
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Can you describe the role of DNA helicase in unwinding DNA and breaking hydrogen bonds?	☐ ☐ ☐
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Can you describe how free nucleotides pair with exposed bases on each template strand?	☐ ☐ ☐
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Can you describe the role of DNA polymerase in joining adjacent nucleotides by condensation?	☐ ☐ ☐
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Can you evaluate the work of scientists, including Meselson and Stahl, in validating semi-conservative replication?	☐ ☐ ☐
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3.1.6 ATP

Can you describe ATP as a nucleotide derivative made of ribose, adenine and three phosphate groups?	☐ ☐ ☐
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Can you describe the hydrolysis of ATP to ADP and Pi catalysed by ATP hydrolase?	☐ ☐ ☐
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Can you explain how ATP hydrolysis is coupled to energy-requiring reactions in cells?	☐ ☐ ☐
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Can you explain how inorganic phosphate is used to phosphorylate other compounds, making them more reactive?	☐ ☐ ☐
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Can you describe the resynthesis of ATP by ATP synthase in respiration and photosynthesis?	☐ ☐ ☐
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3.1.7 Water

Can you explain the role of water as a metabolite in condensation and hydrolysis reactions?	☐	☐	☐
Can you explain the importance of water as a solvent for metabolic reactions?	☐	☐	☐
Can you explain how the high specific heat capacity of water buffers temperature changes?	☐	☐	☐
Can you explain how the large latent heat of vaporisation of water provides cooling?	☐	☐	☐
Can you explain how cohesion supports columns of water in plants and produces surface tension?	☐	☐	☐

3.1.8 Inorganic ions

Can you explain that inorganic ions occur in solution in cytoplasm and body fluids with specific roles?	☐	☐	☐
Can you describe the roles of hydrogen ions (pH), iron ions (haemoglobin), sodium ions (co-transport) and phosphate ions (DNA and ATP)?	☐	☐	☐

3.2 CELLS

R A G

3.2.1.1 Structure of eukaryotic cells

Can you describe the structure and function of the cell-surface membrane and the nucleus, including nucleoli?	☐	☐	☐
Can you describe the structure and function of mitochondria and chloroplasts?	☐	☐	☐
Can you describe the structure and function of the Golgi apparatus, Golgi vesicles and lysosomes?	☐	☐	☐
Can you describe the structure and function of ribosomes and rough and smooth endoplasmic reticulum?	☐	☐	☐
Can you describe the cell wall in plants, algae and fungi and the cell vacuole in plants?	☐	☐	☐
Can you explain how cells are organised into tissues, organs and organ systems?	☐	☐	☐
Can you apply knowledge of these features to explain the adaptations of eukaryotic cells?	☐	☐	☐

3.2.1.2 Structure of prokaryotic cells and viruses

Can you describe how prokaryotic cells differ from eukaryotic cells in size, organelles and ribosomes?	☐	☐	☐
Can you describe prokaryotic DNA as a single circular molecule free in the cytoplasm and not bound to proteins?	☐	☐	☐
Can you describe the prokaryotic cell wall containing murein?	☐	☐	☐
Can you name plasmids, a capsule and flagella as possible features of prokaryotic cells?	☐	☐	☐
Can you describe viruses as acellular and non-living, with genetic material, a capsid and attachment proteins?	☐	☐	☐

3.2.1.3 Methods of studying cells

Can you describe the principles and limitations of optical microscopes, TEMs and SEMs?	☐	☐	☐
Can you measure the size of an object viewed with an optical microscope?	☐	☐	☐
Can you explain the difference between magnification and resolution?	☐	☐	☐
Can you use magnification = size of image / size of real object?	☐	☐	☐
Can you describe the principles of cell fractionation and ultracentrifugation?	☐	☐	☐
Can you explain how scientists distinguished between artefacts and cell organelles?	☐	☐	☐

3.2.2 All cells arise from other cells

Can you explain that not all cells in a multicellular organism keep the ability to divide?	☐	☐	☐
Can you describe the cell cycle, including DNA replication during interphase?	☐	☐	☐
Can you describe the behaviour of chromosomes in prophase, metaphase, anaphase and telophase?	☐	☐	☐
Can you describe the role of spindle fibres attached to centromeres in separating chromatids?	☐	☐	☐
Can you describe cytokinesis producing two new cells?	☐	☐	☐
Can you recognise each stage of mitosis and explain the appearance of cells in each stage?	☐	☐	☐
Can you explain how uncontrolled cell division causes tumours and cancers, and how some treatments control the rate of division?	☐	☐	☐
Can you describe binary fission in prokaryotes, including replication of circular DNA and plasmids?	☐	☐	☐
Can you describe how viruses replicate after injecting their nucleic acid into a host cell?	☐	☐	☐
Can you calculate a mitotic index and actual size = size of image / magnification?	☐	☐	☐

3.2.3 Transport across cell membranes

Can you explain that the cell-surface membrane and organelle membranes share the same basic structure?	☐	☐	☐
Can you describe the fluid-mosaic model, including phospholipids, proteins, glycoproteins and glycolipids?	☐	☐	☐
Can you explain the role of cholesterol in restricting the movement of other molecules in the membrane?	☐	☐	☐
Can you explain the limitations the phospholipid bilayer places on simple diffusion?	☐	☐	☐
Can you describe facilitated diffusion involving carrier proteins and channel proteins?	☐	☐	☐
Can you explain osmosis in terms of water potential?	☐	☐	☐
Can you describe active transport involving carrier proteins and the hydrolysis of ATP?	☐	☐	☐
Can you describe co-transport of sodium ions and glucose in the mammalian ileum?	☐	☐	☐
Can you explain how surface area, number of channel or carrier proteins and gradients affect the rate of transport?	☐	☐	☐
Can you explain the adaptations of specialised cells for rapid transport across membranes?	☐	☐	☐

3.2.4 Cell recognition and the immune system

Can you explain how surface molecules allow the immune system to identify pathogens, cells from other organisms, abnormal cells and toxins?	☐	☐	☐
Can you define an antigen and explain the effect of antigen variability on disease and disease prevention?	☐	☐	☐
Can you describe phagocytosis and the destruction of ingested pathogens by lysozymes?	☐	☐	☐
Can you describe the response of T lymphocytes to a foreign antigen (the cellular response)?	☐	☐	☐
Can you describe the role of antigen-presenting cells in the cellular response?	☐	☐	☐
Can you describe how helper T cells stimulate cytotoxic T cells, B cells and phagocytes?	☐	☐	☐
Can you describe the response of B lymphocytes, clonal selection and the release of monoclonal antibodies (the humoral response)?	☐	☐	☐
Can you define an antibody and describe its structure?	☐	☐	☐
Can you describe the formation of an antigen-antibody complex leading to agglutination and phagocytosis?	☐	☐	☐
Can you describe the roles of plasma cells and memory cells in the primary and secondary responses?	☐	☐	☐
Can you explain the use of vaccines to protect individuals and populations, including herd immunity?	☐	☐	☐
Can you explain the differences between active and passive immunity?	☐	☐	☐
Can you describe the structure of HIV and its replication in helper T cells?	☐	☐	☐
Can you explain how HIV causes the symptoms of AIDS and why antibiotics are ineffective against viruses?	☐	☐	☐
Can you describe the use of monoclonal antibodies to target medication and in medical diagnosis?	☐	☐	☐
Can you describe the use of antibodies in the ELISA test?	☐	☐	☐
Can you discuss ethical issues and evaluate evidence relating to vaccines and monoclonal antibodies?	☐	☐	☐

3.3.1 Surface area to volume ratio

Can you explain the relationship between the size of an organism and its surface area to volume ratio?	☐	☐	☐
Can you explain how changes to body shape and specialised exchange systems help larger organisms?	☐	☐	☐
Can you explain the relationship between surface area to volume ratio and metabolic rate?	☐	☐	☐

3.3.2 Gas exchange

Can you explain gas exchange across the body surface of a single-celled organism?	☐	☐	☐
Can you describe the tracheal system of an insect: tracheae, tracheoles and spiracles?	☐	☐	☐
Can you describe the gills of fish: gill lamellae, gill filaments and the counter-current principle?	☐	☐	☐
Can you describe gas exchange in the leaves of dicotyledonous plants: mesophyll and stomata?	☐	☐	☐
Can you explain the compromise between gas exchange and limiting water loss in terrestrial insects and xerophytic plants?	☐	☐	☐
Can you describe the gross structure of the human gas exchange system: lungs, trachea, bronchi, bronchioles and alveoli?	☐	☐	☐
Can you explain the essential features of the alveolar epithelium as a surface for gas exchange?	☐	☐	☐
Can you explain ventilation, including the diaphragm and antagonistic internal and external intercostal muscles?	☐	☐	☐
Can you interpret information on how lung disease affects gas exchange and ventilation?	☐	☐	☐
Can you analyse data on pollution, smoking and other risk factors and the incidence of lung disease?	☐	☐	☐
Can you distinguish between correlation and a causal relationship?	☐	☐	☐

3.3.3 Digestion and absorption

Can you explain that digestion hydrolyses large molecules into smaller molecules that can be absorbed?	☐	☐	☐
Can you describe the digestion of carbohydrates by amylases and membrane-bound disaccharidases?	☐	☐	☐
Can you describe the digestion of lipids by lipase, including the action of bile salts?	☐	☐	☐
Can you describe the digestion of proteins by endopeptidases, exopeptidases and membrane-bound dipeptidases?	☐	☐	☐
Can you describe the absorption of amino acids and monosaccharides by co-transport in the ileum?	☐	☐	☐
Can you describe the role of micelles in the absorption of lipids?	☐	☐	☐

3.3.4.1 Mass transport in animals

Can you describe haemoglobins as a group of chemically similar proteins with a quaternary structure?	☐	☐	☐
Can you explain the loading, transport and unloading of oxygen in relation to the oxyhaemoglobin dissociation curve?	☐	☐	☐
Can you explain the cooperative nature of oxygen binding?	☐	☐	☐

Can you explain the effect of carbon dioxide concentration on the dissociation curve (the Bohr effect)?	☐	☐	☐
Can you explain how different haemoglobins are adapted to different environments?	☐	☐	☐
Can you describe the general pattern of blood circulation in a mammal and name the major blood vessels?	☐	☐	☐
Can you describe the gross structure of the human heart?	☐	☐	☐
Can you explain the pressure and volume changes and valve movements during the cardiac cycle?	☐	☐	☐
Can you relate the structures of arteries, arterioles and veins to their functions?	☐	☐	☐
Can you describe capillaries as exchange surfaces and explain the formation and return of tissue fluid?	☐	☐	☐
Can you analyse and interpret data on the cardiac cycle and on risk factors for cardiovascular disease?	☐	☐	☐

3.3.4.2 Mass transport in plants

Can you explain the cohesion-tension theory of water transport in the xylem?	☐	☐	☐
Can you explain the mass flow hypothesis for translocation in the phloem?	☐	☐	☐
Can you interpret evidence from tracer and ringing experiments and evaluate the mass flow hypothesis?	☐	☐	☐

3.4.1 DNA, genes and chromosomes

Can you compare DNA in prokaryotic cells with DNA in eukaryotic cells, including histones and chromosomes?	☐	☐	☐
Can you describe the DNA in mitochondria and chloroplasts?	☐	☐	☐
Can you define a gene as a base sequence coding for a polypeptide or functional RNA?	☐	☐	☐
Can you define a locus?	☐	☐	☐
Can you explain that a sequence of three bases codes for an amino acid?	☐	☐	☐
Can you explain that the genetic code is universal, non-overlapping and degenerate?	☐	☐	☐
Can you describe introns, exons and non-coding multiple repeats in eukaryotic DNA?	☐	☐	☐

3.4.2 DNA and protein synthesis

Can you define the genome and the proteome?	☐	☐	☐
Can you describe the structures of mRNA and tRNA?	☐	☐	☐
Can you describe transcription, including the role of RNA polymerase?	☐	☐	☐
Can you explain the splicing of pre-mRNA to mRNA in eukaryotes?	☐	☐	☐
Can you describe translation, including the roles of ribosomes, tRNA and ATP?	☐	☐	☐
Can you relate base sequences to amino acid sequences using genetic code data?	☐	☐	☐
Can you interpret data from experiments on the role of nucleic acids?	☐	☐	☐

3.4.3 Genetic diversity from mutation and meiosis

Can you describe gene mutations as base deletions and substitutions during DNA replication?	☐	☐	☐
Can you explain why some base substitutions do not change the amino acid sequence?	☐	☐	☐
Can you explain that mutagenic agents increase the rate of gene mutation?	☐	☐	☐
Can you explain how non-disjunction causes mutations in chromosome number?	☐	☐	☐
Can you explain how meiosis produces genetically different haploid daughter cells?	☐	☐	☐
Can you explain how independent segregation and crossing over produce variation?	☐	☐	☐
Can you complete diagrams showing chromosomes after the first and second divisions of meiosis?	☐	☐	☐
Can you explain the differences between mitosis and meiosis and recognise meiosis in unfamiliar life cycles?	☐	☐	☐
Can you explain how random fertilisation increases genetic variation?	☐	☐	☐
Can you use 2^n to calculate possible chromosome combinations?	☐	☐	☐

3.4.4 Genetic diversity and adaptation

Can you define genetic diversity as the number of different alleles of genes in a population?	☐	☐	☐
Can you explain how natural selection increases the frequency of advantageous alleles?	☐	☐	☐
Can you explain directional selection, using antibiotic resistance as an example?	☐	☐	☐
Can you explain stabilising selection, using human birth weight as an example?	☐	☐	☐
Can you describe anatomical, physiological and behavioural adaptations?	☐	☐	☐
Can you use unfamiliar information and data to explain the effects of selection?	☐	☐	☐

3.4.5 Species and taxonomy

Can you define a species in terms of producing fertile offspring?	☐	☐	☐
Can you explain the role of courtship behaviour in species recognition and successful mating?	☐	☐	☐
Can you explain phylogenetic classification and the hierarchy from domain to species?	☐	☐	☐
Can you use the binomial naming system?	☐	☐	☐
Can you explain how immunology and genome sequencing have clarified evolutionary relationships?	☐	☐	☐

3.4.6 Biodiversity within a community

Can you explain biodiversity at scales from a local habitat to the whole Earth?	☐	☐	☐
Can you define species richness?	☐	☐	☐
Can you calculate and interpret an index of diversity using $d = \frac{N(N-1)}{\sum n(n-1)}$?	☐	☐	☐
Can you explain how farming reduces biodiversity and the balance between conservation and farming?	☐	☐	☐

3.4.7 Investigating diversity

Can you compare genetic diversity using characteristics, DNA base sequences, mRNA and amino acid sequences?	☐	☐	☐
Can you interpret similarities and differences in sequences to suggest relationships between organisms?	☐	☐	☐
Can you explain how gene technology has changed the methods used to investigate diversity?	☐	☐	☐
Can you design and carry out a random sampling method?	☐	☐	☐
Can you calculate a mean and standard deviation?	☐	☐	☐

3.5.1 Photosynthesis

Can you explain photoionisation of chlorophyll in the light-dependent reaction?	☐	☐	☐
Can you explain how the electron transfer chain and ATP synthase produce ATP by chemiosmosis?	☐	☐	☐
Can you explain the production of reduced NADP?	☐	☐	☐
Can you explain the photolysis of water to produce protons, electrons and oxygen?	☐	☐	☐
Can you explain how carbon dioxide reacts with RuBP, catalysed by rubisco, to form glycerate 3-phosphate (GP)?	☐	☐	☐
Can you explain how ATP and reduced NADP reduce GP to triose phosphate?	☐	☐	☐
Can you explain how triose phosphate regenerates RuBP and forms other organic substances in the Calvin cycle?	☐	☐	☐
Can you identify environmental factors that limit the rate of photosynthesis?	☐	☐	☐
Can you evaluate data on agricultural practices used to overcome limiting factors?	☐	☐	☐

3.5.2 Respiration

Can you describe glycolysis: phosphorylation of glucose, triose phosphate and oxidation to pyruvate?	☐	☐	☐
Can you state the net yield of ATP and reduced NAD from glycolysis?	☐	☐	☐
Can you explain how pyruvate is converted to ethanol or lactate in anaerobic respiration to regenerate NAD?	☐	☐	☐
Can you describe the link reaction: pyruvate oxidised to acetate and combined with coenzyme A?	☐	☐	☐
Can you describe the Krebs cycle, including reduced coenzymes, substrate-level phosphorylation and CO ₂ release?	☐	☐	☐
Can you explain oxidative phosphorylation: the electron transfer chain and chemiosmosis?	☐	☐	☐
Can you explain how lipids and amino acids can be used as respiratory substrates?	☐	☐	☐

3.5.3 Energy and ecosystems

Can you explain how plants synthesise organic compounds and use most sugars as respiratory substrates?	☐	☐	☐
Can you describe how biomass is measured and how calorimetry estimates its chemical energy?	☐	☐	☐
Can you define gross primary production (GPP)?	☐	☐	☐
Can you use $NPP = GPP - R$?	☐	☐	☐
Can you use $N = I - (F + R)$ for consumers?	☐	☐	☐
Can you calculate primary and secondary productivity, for example in $\text{kJ ha}^{-1} \text{ year}^{-1}$?	☐	☐	☐
Can you calculate the efficiency of energy transfers?	☐	☐	☐
Can you explain how farming practices increase the efficiency of energy transfer?	☐	☐	☐

3.5.4 Nutrient cycles

Can you explain the role of microorganisms and saprobionts in recycling nutrients?	☐	☐	☐
Can you explain the role of mycorrhizae in the uptake of water and inorganic ions?	☐	☐	☐
Can you describe saprobial nutrition, ammonification, nitrification, nitrogen fixation and denitrification?	☐	☐	☐

Can you describe the phosphorus cycle?	☐	☐	☐
Can you explain the use of natural and artificial fertilisers?	☐	☐	☐
Can you explain the environmental issues of leaching and eutrophication?	☐	☐	☐

3.6.1.1 Survival and response

Can you explain how responding to the environment increases survival?	☐	☐	☐
Can you explain how IAA controls cell elongation in shoots and roots?	☐	☐	☐
Can you explain gravitropism and phototropism in flowering plants?	☐	☐	☐
Can you explain how taxes and kineses keep organisms in a favourable environment?	☐	☐	☐
Can you describe a simple reflex involving three neurones and explain its protective role?	☐	☐	☐

3.6.1.2 Receptors

Can you explain receptor specificity using the Pacinian corpuscle?	☐	☐	☐
Can you describe the structure of a Pacinian corpuscle?	☐	☐	☐
Can you explain how deformation of stretch-mediated sodium channels sets up a generator potential?	☐	☐	☐
Can you explain differences in sensitivity, colour vision and visual acuity between rods and cones?	☐	☐	☐
Can you explain the differences in optical pigments and connections to the optic nerve in rods and cones?	☐	☐	☐

3.6.1.3 Control of heart rate

Can you explain that the heart is myogenic?	☐	☐	☐
Can you describe the roles of the SAN, AVN, bundle of His and Purkyne tissue?	☐	☐	☐
Can you explain the roles of chemoreceptors and pressure receptors?	☐	☐	☐
Can you explain the roles of the autonomic nervous system and effectors in controlling heart rate?	☐	☐	☐
Can you calculate cardiac output using cardiac output = heart rate x stroke volume?	☐	☐	☐

3.6.2.1 Nerve impulses

Can you describe the structure of a myelinated motor neurone?	☐	☐	☐
Can you explain how a resting potential is established and maintained?	☐	☐	☐
Can you explain depolarisation and the generation of an action potential?	☐	☐	☐
Can you explain the all-or-nothing principle?	☐	☐	☐
Can you explain how an action potential passes along non-myelinated and myelinated axons?	☐	☐	☐
Can you explain the refractory period and its importance?	☐	☐	☐
Can you explain how myelination, saltatory conduction, axon diameter and temperature affect speed of conduction?	☐	☐	☐

3.6.2.2 Synaptic transmission

Can you describe the structure of a synapse and a neuromuscular junction?	☐	☐	☐
Can you describe the sequence of events at a cholinergic synapse?	☐	☐	☐
Can you explain unidirectionality, temporal summation and spatial summation?	☐	☐	☐
Can you explain inhibition by inhibitory synapses?	☐	☐	☐
Can you compare transmission at a cholinergic synapse and a neuromuscular junction?	☐	☐	☐

Can you predict and explain the effects of drugs on synapses from information provided?	☐	☐	☐
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3.6.3 Skeletal muscles

Can you explain how muscles act in antagonistic pairs against an incompressible skeleton?	☐	☐	☐
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Can you describe the gross and microscopic structure of skeletal muscle?	☐	☐	☐
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Can you describe the ultrastructure of a myofibril?	☐	☐	☐
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Can you explain the roles of actin, myosin, calcium ions and ATP in contraction?	☐	☐	☐
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Can you explain the roles of calcium ions and tropomyosin in the actinomyosin cross-bridge cycle?	☐	☐	☐
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Can you explain the roles of ATP and phosphocreatine in muscle contraction?	☐	☐	☐
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Can you compare the structure, location and properties of slow and fast muscle fibres?	☐	☐	☐
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3.6.4.1 Principles of homeostasis and negative feedback

Can you explain the importance of a stable core temperature and blood pH for enzyme activity?	☐	☐	☐
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Can you explain the importance of a stable blood glucose concentration?	☐	☐	☐
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Can you explain negative feedback and why separate mechanisms control departures in different directions?	☐	☐	☐
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Can you interpret information on negative and positive feedback?	☐	☐	☐
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3.6.4.2 Control of blood glucose concentration

Can you describe factors that influence blood glucose concentration?	☐	☐	☐
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Can you explain the role of the liver in glycogenesis, glycogenolysis and gluconeogenesis?	☐	☐	☐
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Can you explain the action of insulin, including receptors, channel proteins and enzyme activation?	☐	☐	☐
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Can you explain the action of glucagon and adrenaline?	☐	☐	☐
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Can you explain the second messenger model: adenylate cyclase, cyclic AMP and protein kinase?	☐	☐	☐
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Can you explain the causes of type I and type II diabetes and how each is controlled?	☐	☐	☐
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Can you evaluate the positions of health advisers and the food industry on type II diabetes?	☐	☐	☐
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3.6.4.3 Control of blood water potential

Can you define osmoregulation?	☐	☐	☐
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Can you describe the structure of the nephron?	☐	☐	☐
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Can you explain the formation of glomerular filtrate?	☐	☐	☐
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Can you explain reabsorption of glucose and water by the proximal convoluted tubule?	☐	☐	☐
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Can you explain how the loop of Henle maintains a sodium ion gradient in the medulla?	☐	☐	☐
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Can you explain reabsorption of water by the distal convoluted tubule and collecting duct?	☐	☐	☐
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Can you explain the roles of the hypothalamus, posterior pituitary and ADH?	☐	☐	☐
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3.7.1 Inheritance

Can you define genotype and phenotype?	☐	☐	☐
Can you explain dominant, recessive and codominant alleles and multiple alleles?	☐	☐	☐
Can you explain homozygous and heterozygous at a locus in a diploid organism?	☐	☐	☐
Can you use genetic diagrams for monohybrid and dihybrid crosses?	☐	☐	☐
Can you use genetic diagrams for crosses involving sex-linkage?	☐	☐	☐
Can you use genetic diagrams for crosses involving autosomal linkage?	☐	☐	☐
Can you use genetic diagrams for crosses involving multiple alleles and epistasis?	☐	☐	☐
Can you use the chi-squared test to compare observed and expected phenotypic ratios?	☐	☐	☐

3.7.2 Populations

Can you define a population, a gene pool and allele frequency?	☐	☐	☐
Can you explain the Hardy-Weinberg principle and the conditions under which it applies?	☐	☐	☐
Can you use $p + q = 1$ and $p^2 + 2pq + q^2 = 1$ to calculate allele, genotype and phenotype frequencies?	☐	☐	☐

3.7.3 Evolution may lead to speciation

Can you explain how genetic and environmental factors cause phenotypic variation?	☐	☐	☐
Can you explain mutation, meiosis and random fertilisation as sources of genetic variation?	☐	☐	☐
Can you explain natural selection in terms of differential survival and reproduction?	☐	☐	☐
Can you explain stabilising, directional and disruptive selection?	☐	☐	☐
Can you define evolution as a change in allele frequencies in a population?	☐	☐	☐
Can you explain how reproductive isolation leads to speciation?	☐	☐	☐
Can you explain allopatric and sympatric speciation?	☐	☐	☐
Can you explain the importance of genetic drift in small populations?	☐	☐	☐

3.7.4 Populations in ecosystems

Can you define a community, an ecosystem and a niche?	☐	☐	☐
Can you explain carrying capacity and how abiotic factors, competition and predation affect it?	☐	☐	☐
Can you estimate population size using randomly placed quadrats or belt transects?	☐	☐	☐
Can you estimate population size using mark-release-recapture and state its assumptions?	☐	☐	☐
Can you explain primary succession from pioneer species to a climax community?	☐	☐	☐
Can you explain how organisms change the abiotic environment during succession?	☐	☐	☐
Can you explain how succession is managed to conserve habitats?	☐	☐	☐
Can you evaluate evidence and conflicting views on conservation of species and habitats?	☐	☐	☐

3.8.1 Alteration of the sequence of bases in DNA

Can you describe addition, deletion, substitution, inversion, duplication and translocation mutations?	☐	☐	☐
Can you explain that mutations occur spontaneously and that mutagenic agents increase their rate?	☐	☐	☐
Can you explain why some single-triplet mutations do not change the amino acid sequence?	☐	☐	☐
Can you explain how frame-shift mutations affect all following triplets?	☐	☐	☐
Can you relate the nature of a gene mutation to its effect on the encoded polypeptide?	☐	☐	☐

3.8.2.1 Most of a cell's DNA is not translated

Can you explain totipotency and how translation of only part of the DNA leads to specialisation?	☐	☐	☐
Can you describe pluripotent, multipotent and unipotent cells and where they are found?	☐	☐	☐
Can you explain how induced pluripotent stem cells are produced from adult somatic cells?	☐	☐	☐
Can you evaluate the use of stem cells in treating human disorders?	☐	☐	☐

3.8.2.2 Regulation of transcription and translation

Can you explain how transcription factors moving into the nucleus stimulate or inhibit transcription?	☐	☐	☐
Can you explain the role of oestrogen in initiating transcription?	☐	☐	☐
Can you define epigenetics?	☐	☐	☐
Can you explain how increased DNA methylation and decreased histone acetylation inhibit transcription?	☐	☐	☐
Can you explain the relevance of epigenetics to the development and treatment of disease, especially cancer?	☐	☐	☐
Can you explain how RNA interference (RNAi) inhibits translation of mRNA?	☐	☐	☐
Can you evaluate data on the relative influence of genetic and environmental factors on phenotype?	☐	☐	☐

3.8.2.3 Gene expression and cancer

Can you compare the main characteristics of benign and malignant tumours?	☐	☐	☐
Can you explain the roles of tumour suppressor genes and oncogenes in tumour development?	☐	☐	☐
Can you explain the role of abnormal methylation of tumour suppressor genes and oncogenes?	☐	☐	☐
Can you explain the role of increased oestrogen concentrations in some breast cancers?	☐	☐	☐
Can you evaluate evidence linking genetic and environmental factors with cancer?	☐	☐	☐

3.8.3 Using genome projects

Can you explain how sequencing projects have read the genomes of a wide range of organisms?	☐	☐	☐
Can you explain how the proteome of simpler organisms can be determined and used, for example in vaccines?	☐	☐	☐
Can you explain why the genome of complex organisms cannot easily be translated into the proteome?	☐	☐	☐

Can you explain that sequencing methods are continuously updated and automated? ☐ ☐ ☐

3.8.4.1 Recombinant DNA technology

Can you explain that the universal genetic code allows transferred DNA to be translated in a host? ☐ ☐ ☐

Can you describe producing DNA fragments using reverse transcriptase, restriction enzymes and a gene machine? ☐ ☐ ☐

Can you explain the principles of the polymerase chain reaction (PCR)? ☐ ☐ ☐

Can you explain in vivo amplification, including promoter and terminator regions? ☐ ☐ ☐

Can you explain the use of restriction endonucleases and ligases to insert DNA into vectors? ☐ ☐ ☐

Can you explain transformation of host cells and the use of marker genes? ☐ ☐ ☐

Can you relate recombinant DNA technology to gene therapy? ☐ ☐ ☐

Can you evaluate the ethical, financial and social issues of recombinant DNA technology? ☐ ☐ ☐

3.8.4.2 Identification and diagnosis of heritable conditions

Can you explain how labelled DNA probes and DNA hybridisation locate specific alleles? ☐ ☐ ☐

Can you explain the use of DNA probes to screen for heritable conditions, drug responses and health risks? ☐ ☐ ☐

Can you explain the use of screening in genetic counselling and personalised medicine? ☐ ☐ ☐

3.8.4.3 Genetic fingerprinting

Can you explain what VNTRs are and why they are unlikely to be identical in two individuals? ☐ ☐ ☐

Can you explain the principles of genetic fingerprinting, including PCR and gel electrophoresis? ☐ ☐ ☐

Can you interpret the results of gel electrophoresis? ☐ ☐ ☐

Can you explain the uses of genetic fingerprinting in forensics, medical diagnosis and breeding? ☐ ☐ ☐

The 12 required practical activities

1	Can you investigate the effect of a named variable on the rate of an enzyme-controlled reaction?	3.1.4	☐	☐	☐
2	Can you prepare root tip squashes, identify the stages of mitosis and calculate a mitotic index?	3.2.2	☐	☐	☐
3	Can you use a dilution series and calibration curve to find the water potential of plant tissue?	3.2.3	☐	☐	☐
4	Can you investigate the effect of a named variable on the permeability of cell-surface membranes?	3.2.3	☐	☐	☐
5	Can you dissect an animal or plant gas exchange or mass transport system, or an organ within it?	3.3.4	☐	☐	☐
6	Can you use aseptic techniques to investigate the effect of antimicrobial substances on microbial growth?	3.4.4	☐	☐	☐
7	Can you use chromatography to investigate the pigments in leaves of different plants?	3.5.1	☐	☐	☐
8	Can you investigate the effect of a named factor on dehydrogenase activity in chloroplast extracts?	3.5.1	☐	☐	☐
9	Can you investigate the effect of a named variable on the respiration rate of single-celled organisms?	3.5.2	☐	☐	☐
10	Can you investigate the effect of an environmental variable on animal movement using a choice chamber or maze?	3.6.1	☐	☐	☐
11	Can you use a glucose dilution series and colorimetry to find the glucose concentration of an unknown sample?	3.6.4	☐	☐	☐
12	Can you investigate the effect of a named environmental factor on the distribution of a species?	3.7.4	☐	☐	☐