

1.1 Carbohydrates

1.1 Carbohydrates

Can you distinguish between monosaccharides, disaccharides and polysaccharides?	☐ ☐ ☐
Can you draw and recognise the structures of alpha glucose, beta glucose and ribose?	☐ ☐ ☐
Can you explain how glucose, fructose and galactose join by condensation reactions to form the disaccharides sucrose, lactose and maltose, forming glycosidic bonds?	☐ ☐ ☐
Can you explain how polysaccharides (amylose and amylopectin in starch, and glycogen) are formed by condensation reactions?	☐ ☐ ☐
Can you explain how hydrolysis reactions break glycosidic bonds in disaccharides and polysaccharides?	☐ ☐ ☐
Can you relate the structures of glucose, starch, glycogen and cellulose to their functions?	☐ ☐ ☐

1.2 Lipids

1.2 Lipids

Can you explain how a triglyceride is synthesised from glycerol and three fatty acids by condensation reactions forming ester bonds?	☐ ☐ ☐
Can you describe the differences between saturated and unsaturated lipids?	☐ ☐ ☐
Can you relate the structure of lipids to their roles in energy storage, waterproofing and insulation?	☐ ☐ ☐
Can you relate the structure and properties of phospholipids to their role in cell membranes?	☐ ☐ ☐

1.3 Proteins

1.3 Proteins

Can you draw the general structure of an amino acid?	☐ ☐ ☐
Can you explain how polypeptides and proteins are formed from amino acids by condensation reactions forming peptide bonds?	☐ ☐ ☐
Can you explain the roles of ionic bonds, hydrogen bonds and disulfide bonds in the structure of proteins?	☐ ☐ ☐
Can you explain how primary, secondary, tertiary and quaternary structure determine the properties of fibrous and globular proteins, using collagen and haemoglobin as examples?	☐ ☐ ☐

Can you relate the structures of collagen and haemoglobin to their functions?



1.4 DNA and protein synthesis

DNA structure and replication

Can you describe the structure of DNA, including nucleotides, purines and pyrimidines, complementary base pairing, the two sugar-phosphate backbones, phosphodiester bonds and hydrogen bonds?



Can you explain the process of semi-conservative DNA replication, including the roles of DNA helicase, DNA polymerase and DNA ligase?



Can you state that a gene is a sequence of bases on a DNA molecule that codes for the sequence of amino acids in a polypeptide chain?



RNA and protein synthesis

Can you describe the structure of mRNA, including its nucleotides, sugar-phosphate backbone and the role of hydrogen bonds?



Can you describe the structure of tRNA, including its nucleotides, hydrogen bonding and the anticodon?



Can you explain transcription in the nucleus, including the roles of the sense and antisense strands of DNA and mRNA?



Can you explain translation at the ribosome, including the roles of mRNA, tRNA and ribosomes?



Can you explain the nature of the genetic code, including triplets, start and stop codons, and its degenerate and non-overlapping nature?



Can you explain that not all of the genome codes for proteins?



Gene mutations

Can you describe gene mutations as base deletions, insertions or substitutions?



Can you explain how a point mutation can alter the amino acid sequence of a polypeptide, using sickle cell anaemia as an example?



1.5 Enzymes

1.5 Enzymes

Can you state that enzymes are globular proteins?



Can you explain enzyme specificity, including the induced fit hypothesis?



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



Can you explain how temperature, pH, substrate concentration and enzyme concentration affect the rate of enzyme activity?



Can you explain how the initial rate of an enzyme-catalysed reaction is measured and why it is important?



Can you explain the effects of competitive, non-competitive and end-product inhibition on enzymes?



Can you state that enzymes catalyse both intracellular and extracellular reactions?



1.6-1.7 Inorganic ions and water

1.6 Inorganic ions

Can you explain the role of nitrate ions in plants, in making DNA and amino acids?



Can you explain the role of calcium ions in plants, in forming calcium pectate in the middle lamellae?



Can you explain the role of magnesium ions in plants, in making chlorophyll?



Can you explain the role of phosphate ions in plants, in making ADP and ATP?



1.7 Water

Can you explain how the dipole nature of water leads to hydrogen bonding between water molecules?



Can you explain the significance to organisms of water's high specific heat capacity and its role as a polar solvent?



Can you explain the significance to organisms of water's surface tension, incompressibility and maximum density at 4 °C?



2.1**Eukaryotic and prokaryotic cell structure and function****Cell theory and organisation**

Can you explain cell theory as a unifying concept in biology?



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

**Prokaryotic cells**

Can you describe the ultrastructure of prokaryotic cells, including the nucleoid, plasmids, 70S ribosomes and cell wall?



Can you distinguish between Gram-positive and Gram-negative bacterial cell walls and explain why each reacts differently to some antibiotics?

**Eukaryotic cells**

Can you describe the ultrastructure and function of the nucleus, nucleolus, 80S ribosomes, rough and smooth endoplasmic reticulum and Golgi apparatus?



Can you describe the structure and function of mitochondria, centrioles, lysosomes, the cell wall, chloroplasts, the vacuole and the tonoplast?

**Microscopy**

Can you explain how magnification and resolution are achieved in light microscopy and electron microscopy?



Can you explain the importance of staining specimens in microscopy?

**2.2****Viruses****2.2 Viruses**

Can you explain how viruses are classified by their structure and nucleic acid, using lambda phage (DNA), tobacco mosaic virus and Ebola (RNA) and HIV (RNA retrovirus) as examples?



Can you describe the lytic cycle and latency in viruses?



Can you explain why, as viruses are not living cells, antiviral drugs must work by inhibiting viral replication?



Can you explain why the control of viral disease focuses on preventing spread, using the 2014 Ebola outbreak in West Africa as an example?



Can you evaluate the ethical issues of using untested drugs during an epidemic?



2.3**Eukaryotic cell cycle and division****Cell cycle and mitosis**

Can you describe the cell cycle as a regulated process producing two genetically identical daughter cells, with the stages interphase, mitosis and cytokinesis?



Can you explain the changes to the genetic material during the cell cycle, including the stages of mitosis?



Can you explain the role of mitosis in growth, repair and asexual reproduction?

**Meiosis and chromosome mutations**

Can you explain how meiosis produces haploid gametes, including its stages?



Can you explain how meiosis produces genetic variation through recombination of alleles, independent assortment and crossing over?



Can you explain chromosome mutations, using translocations as an example?



Can you explain how non-disjunction can lead to polysomy (e.g. Down's syndrome) and monosomy (e.g. Turner's syndrome)?

**2.4-2.5****Sexual reproduction****2.4 Sexual reproduction in mammals**

Can you describe the processes of oogenesis and spermatogenesis?



Can you describe the process of fertilisation in mammals, from the first contact between gametes to the fusion of nuclei?



Can you describe the early development of the embryo up to the blastocyst stage?

**2.5 Sexual reproduction in plants**

Can you describe the formation of pollen grains in the anther and the embryo sac in the ovule?



Can you explain how the male nuclei from the generative nucleus reach the embryo sac, including the roles of the tube nucleus, pollen tube and enzymes?



Can you explain double fertilisation, forming a triploid endosperm and a diploid zygote?



3.1 Classification

3.1 Classification

Can you list the taxonomic hierarchy of domain, kingdom, phylum, class, order, family, genus and species?



Can you explain the limitations of defining a species as a group of organisms with similar characteristics that interbreed to produce fertile offspring?



Can you explain why it is often difficult to assign organisms to a species or to identify new species?



Can you explain how gel electrophoresis is used to distinguish between species and determine evolutionary relationships?



Can you explain how DNA sequencing and bioinformatics are used to distinguish between species and determine evolutionary relationships?



Can you explain the roles of scientific journals, peer review and scientific conferences in validating evidence for evolution?



Can you describe the evidence for the three-domain model as an alternative to the five-kingdom model, and the role of the scientific community in validating it?



3.2 Natural selection

3.2 Natural selection

Can you explain how natural selection acting on variation leads to adaptation and evolution?



Can you explain how organisms occupy niches through physiological, behavioural and anatomical adaptations?



Can you explain how reproductive isolation can lead to allopatric and sympatric speciation?



Can you explain the evolutionary race between pathogens and the development of new medicines?



3.3 Biodiversity

3.3 Biodiversity

Can you assess biodiversity within a habitat at species level using the index of diversity formula?



Can you assess biodiversity within a species at genetic level by looking at the variety of alleles in the gene pool?



Can you explain the ethical and economic (ecosystem services) reasons for maintaining biodiversity?



Can you describe ex-situ conservation (zoos and seed banks) and the issues involved?



Can you describe in-situ conservation (protected habitats) and the issues involved?



4.1-4.2

Surface area and cell transport

4.1 Surface area to volume ratio

Can you explain how surface area to volume ratio affects the transport of molecules in living organisms?



Can you explain why larger organisms need mass transport systems and specialised gas exchange surfaces?



4.2 Cell transport mechanisms

Can you describe the structure of the cell surface membrane using the fluid mosaic model?



Can you explain passive transport by diffusion, facilitated diffusion (carrier and channel proteins) and osmosis?



Can you explain how the solubility, size and charge of molecules affect how they are transported across membranes?



Can you explain how large molecules are moved by vesicles in endocytosis and exocytosis?



Can you calculate water potential using $\psi = \psi_s + \psi_p$ (osmotic potential plus pressure potential)?



Can you explain active transport, including the role of ATP?



Can you explain that phosphorylation of ADP requires energy and that hydrolysis of ATP provides a readily usable energy source?



4.3

Gas exchange

4.3 Gas exchange

Can you explain how insects are adapted for efficient gas exchange?



Can you explain how bony fish are adapted for efficient gas exchange, including counter-current flow?



Can you explain how mammals are adapted for efficient gas exchange?



Can you explain gas exchange in flowering plants, including the roles of stomata, leaf gas exchange surfaces and lenticels?



Heart and blood vessels

Can you describe the structure of the heart, arteries, veins and capillaries and relate it to their functions?



Can you explain the advantages of the mammalian double circulation over the single circulation of bony fish, including higher pressure delivery and separation of oxygenated and deoxygenated blood?



Can you describe the sequence of events in the cardiac cycle?



Can you explain the myogenic stimulation of the heart, including the roles of the SAN, AVN and bundle of His?



Can you interpret ECG traces and pressure changes during the cardiac cycle?

**Blood**

Can you describe the structure of blood, including plasma, erythrocytes and leucocytes (neutrophils, eosinophils, monocytes and lymphocytes)?



Can you describe the functions of blood in transport, defence and the formation of tissue fluid and lymph?



Can you describe the sequence of blood clotting, including platelets forming a plug and releasing thromboplastin, prothrombin being converted to thrombin, and soluble fibrinogen being converted to insoluble fibrin?

**Atherosclerosis**

Can you describe the stages of atherosclerosis, its effects on health and its risk factors?

**4.5 Transport of gases in the blood**

Can you explain the structure of haemoglobin and its role in transporting respiratory gases, including the Bohr effect?



Can you interpret the oxygen dissociation curve of haemoglobin?



Can you compare the similarities and differences between haemoglobin and myoglobin?



Can you explain the significance of fetal haemoglobin having a higher affinity for oxygen than adult haemoglobin?



4.6 Transfer of materials between the circulatory system and cells

Can you explain the formation and reabsorption of tissue fluid, including the roles of hydrostatic pressure and oncotic pressure?



Can you explain how tissue fluid that is not reabsorbed is returned to the blood via the lymphatic system?

**4.7 Transport in plants****4.7 Transport in plants**

Can you relate the structure of xylem and phloem to their roles in transport?



Can you explain the apoplastic and symplastic pathways for the movement of water through plant tissues?



Can you explain the cohesion-tension model of water transport from roots to shoots?



Can you explain the effects of temperature, light, humidity and air movement on the rate of transpiration?



Can you evaluate the strengths and weaknesses of the mass flow hypothesis for the movement of sugars in the phloem?



5.1-5.3**Aerobic respiration, glycolysis and Krebs cycle****5.1 Aerobic respiration**

Can you explain that respiration produces ATP for use in metabolic reactions and also generates heat?



Can you name the stages of aerobic respiration (glycolysis, link reaction, Krebs cycle and oxidative phosphorylation) and state where each occurs?

**5.2 Glycolysis**

Can you describe glycolysis in the cytoplasm, including the phosphorylation of hexose by ATP, its breakdown to glycerate 3-phosphate (GP) and the production of reduced NAD and ATP?

**5.3 Link reaction and Krebs cycle**

Can you state that the link reaction and Krebs cycle take place in the mitochondrial matrix?



Can you explain how pyruvate is completely oxidised in the link reaction and Krebs cycle, removing carbon as CO_2 and producing reduced NAD and ATP?

**5.4-5.5****Oxidative phosphorylation and anaerobic respiration****5.4 Oxidative phosphorylation**

Can you state that the electron transport chain is located in the inner mitochondrial membrane?



Can you explain how the electron transport chain generates ATP by oxidative phosphorylation?



Can you explain the role of oxygen as the terminal electron acceptor, forming water?



Can you explain the synthesis of ATP by chemiosmosis?



Can you explain the importance of the mitochondrial membranes in oxidative phosphorylation?

**5.5 Anaerobic respiration**

Can you explain anaerobic respiration as the partial breakdown of hexoses giving a limited yield of ATP in the absence of oxygen?



Can you compare the yield of ATP per hexose molecule under aerobic and anaerobic conditions?



Can you explain how lactate, a by-product of anaerobic respiration, affects muscle contraction in mammals?



Can you describe the formation of ethanol during anaerobic respiration in plants?



5.6 Photosynthetic pigments

5.6 Photosynthetic pigments

Can you interpret and compare absorption spectra and action spectra?



Can you explain why many plants have a variety of different photosynthetic pigments?



5.7 Photosynthesis

Chloroplast structure

Can you describe the structure of a chloroplast, including the envelope, stroma, grana and lamellae?



Light-dependent stage

Can you explain the role of the thylakoid membranes in the light-dependent stage?



Can you explain how cyclic and non-cyclic photophosphorylation produce reduced NADP, ATP and oxygen?



Light-independent stage

Can you explain the role of the stroma in the light-independent stage?



Can you explain how carbon dioxide is fixed by combining with RuBP to form GP, catalysed by RUBISCO?



Can you explain how reduced NADP and ATP are used to convert GP into GALP and to regenerate RuBP in the Calvin cycle?



Can you explain how GALP is used as a raw material to make monosaccharides, amino acids and other molecules?



Can you explain how carbon dioxide concentration, light intensity and temperature act as limiting factors on the rate of photosynthesis?



6.1 Microbial techniques

6.1 Microbial techniques

- | | |
|--|---|
| Can you describe basic aseptic techniques used when culturing microorganisms? | ☐ ☐ ☐ |
| Can you explain the principles and techniques involved in culturing microorganisms? | ☐ ☐ ☐ |
| Can you describe the use of different media, including broth cultures, agar and selective media? | ☐ ☐ ☐ |
| Can you describe methods of measuring bacterial growth, including cell counts, dilution plating, mass and optical (turbidity) methods? | ☐ ☐ ☐ |
| Can you describe the lag, log, stationary and death phases of a bacterial growth curve? | ☐ ☐ ☐ |
| Can you calculate exponential growth rate constants for bacterial populations? | ☐ ☐ ☐ |

6.2-6.4 Bacteria, antibiotics and resistance

6.2 Bacteria as pathogens

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|---|---|
| Can you explain how bacteria cause infection by invading and destroying host tissues and by producing toxins? | ☐ ☐ ☐ |
| Can you explain the pathogenic effects of exotoxins, using Staphylococcus species as an example? | ☐ ☐ ☐ |
| Can you explain the pathogenic effects of endotoxins, using Salmonella species as an example? | ☐ ☐ ☐ |
| Can you explain the pathogenic effects of invasion of host tissues, using Mycobacterium tuberculosis as an example? | ☐ ☐ ☐ |

6.3 Action of antibiotics

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|---|---|
| Can you distinguish between bactericidal and bacteriostatic antibiotics, using penicillin and tetracycline as examples? | ☐ ☐ ☐ |
|---|---|

6.4 Antibiotic resistance

- | | |
|---|---|
| Can you explain how antibiotic resistance develops and spreads in bacteria? | ☐ ☐ ☐ |
| Can you describe methods used to control the spread of antibiotic resistance and the difficulties involved? | ☐ ☐ ☐ |

6.5-6.6**Other pathogens and endemic disease****6.5 Other pathogenic agents**

Can you describe the transmission, mode of infection and pathogenic effect of stem rust fungus (*Puccinia graminis*) on wheat?



Can you describe the transmission, mode of infection and pathogenic effect of the influenza virus?



Can you describe the transmission, mode of infection and pathogenic effect of the malarial parasite (*Plasmodium* species)?

**6.6 Problems of controlling endemic diseases**

Can you evaluate the social, economic and ethical implications of different methods of controlling endemic malaria?



Can you explain the role of the scientific community in validating new methods of controlling malaria?

**6.7****Response to infection****Non-specific and specific responses**

Can you describe the mode of action of macrophages, neutrophils and lymphocytes?



Can you explain the humoral immune response, including the roles of antigen-presenting cells, T helper cells and cytokines, B cells, clonal selection, plasma cells and antibodies?



Can you explain the cell-mediated immune response, including the roles of antigen-presenting cells, T helper cells and cytokines, and T killer cells?



Can you explain the role of T and B memory cells in the secondary immune response?

**Immunity and vaccination**

Can you distinguish between natural and artificial immunity, and between active and passive immunity?



Can you explain the role of vaccination in controlling disease and in developing herd immunity?



Can you discuss the potential issues that arise when a proportion of a population chooses not to be vaccinated?



7.1 Using gene sequencing

7.1 Using gene sequencing

Can you explain the meaning of the term genome?	☐	☐	☐
Can you explain how PCR is used to amplify DNA samples?	☐	☐	☐
Can you explain how gene sequencing is used to predict amino acid sequences and identify links to genetically determined conditions?	☐	☐	☐
Can you explain how DNA profiling is used in forensic science, including identifying criminals and testing paternity?	☐	☐	☐

7.2 Factors affecting gene expression

7.2 Factors affecting gene expression

Can you explain that transcription factors are proteins that bind to DNA?	☐	☐	☐
Can you explain the role of transcription factors in regulating gene expression?	☐	☐	☐
Can you explain how post-transcriptional modification of mRNA in eukaryotes (RNA splicing) can produce different products from a single gene?	☐	☐	☐
Can you explain how epigenetic modification, including non-coding RNA, histone modification and DNA methylation, can change gene expression?	☐	☐	☐
Can you explain the importance of epigenetic modification in cell differentiation?	☐	☐	☐

7.3 Stem cells

7.3 Stem cells

Can you explain the meaning of the term stem cell and distinguish between totipotent, pluripotent and multipotent stem cells?	☐	☐	☐
Can you discuss how pluripotent embryonic stem cells offer potential medical advances, and the ethical issues involved?	☐	☐	☐
Can you explain how epigenetic modification takes totipotent embryo cells to pluripotent blastocyst cells and then to fully differentiated somatic cells?	☐	☐	☐
Can you explain how differentiated fibroblasts can be reprogrammed into induced pluripotent stem (iPS) cells by artificially introducing named genes?	☐	☐	☐
Can you explain why iPS cells may be less problematic than embryonic stem cells?	☐	☐	☐

7.4 Gene technology

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



Can you explain how recombinant DNA is inserted into other cells using vectors, including viruses and gene guns?



Can you explain how antibiotic resistance marker genes and replica plating are used to identify recombinant cells?



Can you explain the use of knockout mice as an animal model to investigate the function of genes?



Can you explain how soya beans have been genetically modified to improve production, including altering the fatty acid balance to prevent oxidation?



Can you discuss the advantages and disadvantages of GM crops and other transgenic processes in the context of public debate?



8.1-8.2**Variation and transfer of genetic information****8.1 Origins of genetic variation**

Can you explain that mutations are the source of new genetic variation, while random assortment and crossing over in meiosis produce new combinations of alleles in gametes?



Can you explain how random fertilisation in sexual reproduction produces genetic variation?

**8.2 Transfer of genetic information**

Can you define genotype, phenotype, homozygote, heterozygote, dominant, recessive, codominance and multiple alleles?



Can you construct and interpret genetic cross diagrams and pedigree diagrams?



Can you explain the inheritance of two non-interacting, unlinked genes (dihybrid inheritance)?



Can you explain autosomal linkage using crosses explained by meiosis, including body colour (black or grey) and wing length (long or vestigial) in *Drosophila*?



Can you explain sex linkage on the X chromosome, including haemophilia in humans?



Can you use the chi squared test to assess the significance of differences between observed and expected results?

**8.3****Gene pools****8.3 Gene pools**

Can you explain how selection pressures change allele frequencies, including stabilising selection maintaining continuity and disruptive selection leading to change or speciation?



Can you explain how chance changes in allele frequency, including genetic drift, occur?



Can you explain how population bottlenecks and the founder effect influence allele frequencies?



Can you use the Hardy-Weinberg equation to calculate and monitor changes in allele frequencies in a population?



9.1-9.2

Homeostasis and chemical control in mammals

9.1 Homeostasis

Can you explain homeostasis as the maintenance of a state of dynamic equilibrium?



Can you explain the importance of maintaining pH, temperature and water potential in the body?



Can you explain the principles of negative feedback and positive feedback control?



9.2 Chemical control in mammals

Can you explain how hormones are produced by endocrine glands and act on target cells via receptors?



Can you explain how some hormones (e.g. adrenaline) bind to receptors on the cell surface membrane and trigger a second messenger that activates enzymes?



Can you explain how some hormones (e.g. oestrogen) enter cells and bind directly to transcription factors?



9.3

Chemical control in plants

9.3 Chemical control in plants

Can you describe the plant growth substances auxins, cytokinins and gibberellins?



Can you explain the effects of auxin on cell elongation, suppression of lateral buds (apical dominance) and promotion of root growth?



Can you explain interactions between plant growth substances, including the antagonistic effects of cytokinin and auxin on apical dominance?



Can you explain the role of phytochrome in controlling flowering and photomorphogenesis?



9.4

Mammalian nervous system

9.4 Structure and function of the mammalian nervous system

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



Can you describe the structure of the spinal cord?



Can you state the location and functions of the medulla oblongata (breathing and heart rate), cerebellum (balance and coordination) and cerebrum (initiating movement)?



Can you state the location and functions of the hypothalamus in temperature regulation and osmoregulation?



Can you describe the division of the peripheral nervous system into the autonomic and voluntary nervous systems?



Can you explain the division of the autonomic nervous system into the sympathetic and parasympathetic systems and how they act antagonistically?



9.5 Nervous transmission

9.5 Nervous transmission

Can you explain how a resting potential is established, including the properties of the axon membrane and the transport of Na^+ and K^+ ?



Can you explain how an action potential is formed and propagated along an axon?



Can you explain why transmission is faster in myelinated axons, including saltatory conduction?



Can you describe the structure and function of synapses, including the roles of acetylcholine and noradrenaline as transmitter substances?



Can you explain the formation and effects of excitatory and inhibitory postsynaptic potentials?



9.6-9.7 Drugs and the detection of light

9.6 Effects of drugs on the nervous system

Can you explain how nicotine affects synaptic transmission by mimicking acetylcholine?



Can you explain how lidocaine affects nervous transmission by blocking voltage-gated Na^+ channels?



Can you explain how cobra venom affects synaptic transmission by blocking acetylcholine receptors?



9.7 Detection of light by mammals

Can you describe the structure of the human retina?



Can you explain the role of rhodopsin in initiating action potentials in rod cells?



Can you explain how the distribution of rod and cone cells allows vision to be maintained at different light intensities?



9.8 Control of heart rate in mammals

9.8 Control of heart rate in mammals

Can you explain the roles of baroreceptors and chemoreceptors in the aorta and carotid arteries in controlling heart rate?



Can you explain the role of the cardiac centre in the medulla oblongata in controlling heart rate?



Can you explain how sympathetic nerves release noradrenaline at the SAN to increase heart rate?



Can you explain how parasympathetic nerves release acetylcholine at the SAN to decrease heart rate?



Can you explain how the autonomic nervous system causes the release of adrenaline to increase heart rate?



9.9 Osmoregulation and temperature regulation

Kidney and osmoregulation

Can you describe the gross and microscopic structure of the mammalian kidney?



Can you explain how urea is produced in the liver from excess amino acids and removed from the blood by ultrafiltration?



Can you explain selective reabsorption in the proximal tubule?



Can you explain how the loop of Henle acts as a counter-current multiplier?



Can you explain how the pituitary gland, osmoreceptors in the hypothalamus and ADH provide negative feedback control of plasma concentration?



Can you explain how the kidney of the kangaroo rat (*Dipodomys* species) is adapted for life in dry environments?



Temperature regulation

Can you distinguish between endotherms, which generate heat metabolically, and ectotherms, which rely on the external environment?



Can you explain temperature regulation in endotherms by behaviour and the autonomic nervous system, including the roles of thermoreceptors, the hypothalamus and the skin?



10.1 The nature of ecosystems

10.1 The nature of ecosystems

- | | |
|---|---|
| Can you define an ecosystem and describe the range of sizes of ecosystems? | ☐ ☐ ☐ |
| Can you explain the concept of trophic levels? | ☐ ☐ ☐ |
| Can you evaluate the advantages and disadvantages of pyramids of numbers, dry biomass and energy, and explain how biomass and energy are transferred within them? | ☐ ☐ ☐ |
| Can you describe techniques for assessing abundance and distribution, including quadrats, transects, ACFOR scales, percentage cover and individual counts? | ☐ ☐ ☐ |
| Can you select appropriate sampling techniques for a given ecosystem and organism? | ☐ ☐ ☐ |
| Can you use and interpret the t-test and the Spearman rank correlation coefficient? | ☐ ☐ ☐ |

10.2-10.3 Energy transfer and change in ecosystems

10.2 Energy transfer through ecosystems

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|---|---|
| Can you explain energy transfer between trophic levels using gross primary productivity and net primary productivity? | ☐ ☐ ☐ |
| Can you calculate the efficiency of energy transfer between trophic levels? | ☐ ☐ ☐ |
| Can you account for the energy lost at each trophic level? | ☐ ☐ ☐ |
| Can you explain the role of microorganisms in recycling nutrients within an ecosystem? | ☐ ☐ ☐ |

10.3 Changes in ecosystems

- | | |
|--|---|
| Can you explain how ecosystems develop over time, including colonisation, succession and climax communities? | ☐ ☐ ☐ |
| Can you explain the effects of biotic and abiotic factors on population size? | ☐ ☐ ☐ |

10.4 Human effects on ecosystems

10.4 Human effects on ecosystems

- | | |
|---|---|
| Can you analyse and interpret data on human influences on ecosystems, including climate change and the depletion of biological resources such as overfishing? | ☐ ☐ ☐ |
| Can you evaluate the effects of international treaties such as CITES on global biodiversity? | ☐ ☐ ☐ |

Can you explain how sustainability depends on managing the conflict between human needs and conservation, including fish stock conservation and reducing the causes of climate change?



Can you explain the role of scientific journals, peer review and scientific conferences in validating evidence for climate change?



Core practical activities

1 Can you investigate a factor affecting the initial rate of an enzyme-controlled reaction?	☐ ☐ ☐
2 Can you use a light microscope, including stage and eyepiece micrometers, to make observations and draw a small number of cells from a specialised tissue?	☐ ☐ ☐
3 Can you make a temporary squash preparation of a root tip to show the stages of mitosis in the meristem under a light microscope?	☐ ☐ ☐
4 Can you investigate the effect of sucrose concentration on pollen tube growth or germination?	☐ ☐ ☐
5 Can you investigate the effect of temperature on beetroot membrane permeability?	☐ ☐ ☐
6 Can you determine the water potential of a plant tissue?	☐ ☐ ☐
7 Can you dissect an insect to show its gas exchange system, using organisms safely and ethically?	☐ ☐ ☐
8 Can you use a potometer to investigate factors affecting the rate of water uptake by plant shoots?	☐ ☐ ☐
9 Can you use a respirometer to investigate factors affecting the rate of aerobic or anaerobic respiration, using organisms safely and ethically?	☐ ☐ ☐
10 Can you investigate the effects of different wavelengths of light on the rate of photosynthesis?	☐ ☐ ☐
11 Can you investigate the presence of different chloroplast pigments using chromatography?	☐ ☐ ☐
12 Can you investigate the rate of growth of bacteria in liquid culture, using organisms safely and ethically?	☐ ☐ ☐
13 Can you isolate individual species from a mixed bacterial culture using streak plating, using organisms safely and ethically?	☐ ☐ ☐
14 Can you investigate the effect of gibberellin on the production of amylase in germinating cereals using a starch agar assay?	☐ ☐ ☐
15 Can you investigate the effect of different sampling methods on estimates of the size of a population, using organisms safely and ethically?	☐ ☐ ☐
16 Can you investigate the effect of one abiotic factor on the distribution or morphology of one species, using organisms safely and ethically?	☐ ☐ ☐