CC1 Biological compounds

Inorganic ions and water

- Can you state the roles of the key inorganic ions magnesium (Mg^{2+}), iron (Fe^{2+}), calcium (Ca^{2+}) and phosphate (PO_4^{3-}) in living organisms?
- Can you explain how the polarity and hydrogen bonding of water give it properties such as surface tension and cohesion?
- Can you explain the importance of water as a solvent, its thermal properties and its role as a metabolite?

Carbohydrates

- Can you describe the structure, properties and functions of monosaccharides, including triose, pentose and hexose sugars?
- Can you describe the structure and functions of the disaccharides sucrose, lactose and maltose?
- Can you describe the structure and functions of the polysaccharides starch, glycogen, cellulose and chitin?
- Can you describe the alpha and beta structural isomers of glucose?
- Can you explain how alpha and beta glucose polymerise to form storage carbohydrates (starch, glycogen) and structural carbohydrates (cellulose, chitin)?
- Can you explain how the chemical and physical properties of starch and glycogen suit them for storage, and those of cellulose and chitin suit them for structural roles?

Lipids

- Can you describe the structure, properties and functions of lipids, using triglycerides and phospholipids as examples?
- Can you discuss the effects of saturated and unsaturated fats on human health?

Proteins and bonds

- Can you describe the general structure of an amino acid and the roles of amino acids and proteins?
- Can you describe the primary, secondary, tertiary and quaternary structure of proteins?
- Can you relate the fibrous and globular structures of proteins to their functions?
- Can you show, from given structural formulae, how peptide, glycosidic and ester bonds are formed by condensation and broken by hydrolysis?

CC2 Cell structure and organisation

Cell structure and organisation

- Can you describe the structure and function of mitochondria, rough and smooth endoplasmic reticulum, ribosomes, Golgi body and lysosomes?
- Can you describe the structure and function of centrioles, chloroplasts, vacuoles and plasmodesmata?
- Can you describe the structure and function of the nucleus, chromatin, nuclear envelope and nucleolus?
- Can you describe the structure of prokaryotic cells?
- Can you describe the structure of viruses?
- Can you state the cell theory and compare animal, plant, prokaryotic and viral cells, including using electron micrographs of prokaryotic and eukaryotic cells?
- Can you describe the levels of organisation from cells to tissues, organs and organ systems, including identifying epithelia, muscle and connective tissue on prepared slides?

CC3 Cell membranes and transport

Cell membranes and transport

- Can you describe the principal components of the plasma membrane and the fluid-mosaic model?
- Can you explain the factors that affect the permeability of the plasma membrane, such as temperature and solvents?
- Can you explain diffusion and the factors that affect its rate?
- Can you explain osmosis in terms of water potential, including solute potential and pressure potential?
- Can you explain facilitated diffusion through channel and carrier proteins?
- Can you explain active transport and the effect of cyanide on it?
- Can you describe bulk transport by phagocytosis, pinocytosis and secretion (exocytosis)?

CC4 Enzymes

Enzymes

- Can you describe metabolism as a series of enzyme-controlled reactions?
- Can you explain the protein nature of enzymes?
- Can you distinguish between enzymes that act intracellularly and those that act extracellularly?
- Can you explain the active site in terms of the three-dimensional structure of an enzyme?
- Can you describe the induced fit theory of enzyme action, illustrated by lysozyme?
- Can you explain catalysis in terms of lowering the activation energy?
- Can you explain the effects of temperature and pH on the rate of enzyme activity, including denaturation and inactivation?
- Can you explain the effects of substrate concentration and enzyme concentration on the rate of enzyme activity?
- Can you explain the role of buffers in maintaining a constant pH?
- Can you explain the principles of competitive and non-competitive inhibition?
- Can you explain the importance of immobilised enzymes in industry, including how immobilisation allows reuse and increases stability?

CC5 Nucleic acids and their functions

Nucleotides and ATP

- Can you describe the structure of a nucleotide as a pentose sugar, a phosphate group and an organic base?
- Can you describe the structure of ATP?
- Can you explain the importance of chemical energy in biological processes?
- Can you explain the role of ATP as the universal energy carrier and how its hydrolysis releases energy for cellular activity?

DNA and RNA structure and replication

- Can you describe the structure of DNA, including purine and pyrimidine bases, complementary base pairing, hydrogen bonds, the double helix and antiparallel strands?
- Can you compare the structures of RNA and DNA?

- Can you state the two major functions of DNA: replication and protein synthesis?
- Can you describe semi-conservative replication of DNA, including the roles of helicase and DNA polymerase?
- Can you explain how the Meselson and Stahl experiments provided evidence for semi-conservative replication?

Protein synthesis

- Can you explain what is meant by the genetic code?
- Can you explain the triplet code for amino acids, including its non-overlapping and degenerate nature?
- Can you distinguish between exons (coding DNA) and introns (non-coding DNA)?
- Can you describe transcription of DNA to form messenger RNA, including the splicing of pre-mRNA?
- Can you describe translation of mRNA by ribosomes, including the structure and role of transfer RNA?
- Can you explain the one gene, one polypeptide hypothesis?
- Can you explain how some polypeptides are further modified and combined, for example in the Golgi body?

1.1 Importance of ATP

Importance of ATP

- Can you explain how ATP is synthesised by protons flowing through ATP synthase by chemiosmosis down an electrochemical gradient?
- Can you explain how mitochondria and chloroplasts use similar membrane mechanisms to generate a proton gradient for ATP synthesis?
- Can you explain how proton pumps, driven by energy from excited electrons, maintain the proton gradient?
- Can you describe the electron transport chain as alternating proton pumps and electron carriers?

1.2 Photosynthesis

Chloroplasts and the light-dependent stage

- Can you explain how chloroplasts are distributed and positioned to maximise light trapping?
- Can you explain how chloroplasts convert light energy into chemical energy in ATP?
- Can you explain how chlorophyll and accessory pigments absorb different wavelengths of light, and how light-harvesting systems pass energy to reaction centres?
- Can you describe the basic features of photosystems I and II?
- Can you describe cyclic and non-cyclic photophosphorylation and how they supply electrons to the electron transport chain?
- Can you explain how photolysis of water supplies electrons to photosystem II?
- Can you explain how NADP is reduced by electrons and hydrogen ions in the stroma, helping to maintain the proton gradient?

Light-independent stage and limiting factors

- Can you explain how reduced NADP and ATP from the light-dependent stage are used in the light-independent stage?
- Can you describe how CO_2 is fixed by ribulose bisphosphate (RuBP) to form glycerate-3-phosphate, catalysed by Rubisco?
- Can you describe the reduction of glycerate-3-phosphate to triose phosphate and the regeneration of RuBP?
- Can you state that triose phosphate is used to make other carbohydrates, lipids and amino acids?

Can you explain the concept of limiting factors in photosynthesis, including light intensity, CO_2 concentration and temperature?	○ ○ ○
Can you explain the role of inorganic nutrients in plant metabolism, illustrated by nitrogen and magnesium?	○ ○ ○

1.3 Respiration

Respiration

Can you explain why all living organisms need to respire to release energy in cells?	○ ○ ○
Can you describe glycolysis, producing triose phosphate, pyruvate, ATP and reduced NAD?	○ ○ ○
Can you describe the link reaction forming acetyl coenzyme A?	○ ○ ○
Can you describe how the Krebs cycle releases energy from carbon-carbon bonds to produce ATP, reduced NAD and reduced FAD, and releases CO_2?	○ ○ ○
Can you explain how reduced NAD and reduced FAD supply electrons and protons to the electron transport system?	○ ○ ○
Can you compare the energy budget of glucose breakdown under aerobic and anaerobic conditions, including anaerobic pathways in animals and yeast?	○ ○ ○
Can you explain how lipids and amino acids can be used as respiratory substrates?	○ ○ ○

1.4 Microbiology

Microbiology

Can you classify bacteria by shape (cocci, bacilli, spirilla) and by their Gram stain reaction?	○ ○ ○
Can you explain how the Gram stain reaction depends on cell wall structure, and describe how to prepare and examine a Gram-stained slide?	○ ○ ○
Can you describe methods of culturing microorganisms in the laboratory?	○ ○ ○
Can you explain the conditions needed for bacterial growth and the principles of aseptic technique?	○ ○ ○
Can you describe how microbial populations are measured by viable counts using serial dilution, plating and colony counting?	○ ○ ○

1.5 Population size and ecosystems

Populations

- Can you explain population growth quantitatively in terms of birth rate, death rate, immigration and emigration? ○ ○ ○
- Can you interpret population growth curves, including the effects of competition and carrying capacity? ○ ○ ○
- Can you explain how populations are regulated by density-dependent and density-independent factors? ○ ○ ○
- Can you describe sampling techniques to assess the abundance and distribution of organisms in a habitat? ○ ○ ○

Ecosystems and energy

- Can you explain that ecosystems range in size from very large to very small? ○ ○ ○
- Can you explain that the Sun is the source of energy for ecosystems? ○ ○ ○
- Can you define the terms habitat and community? ○ ○ ○
- Can you describe the transfer of biomass from plants to animals through trophic levels, including efficiency of transfer? ○ ○ ○
- Can you distinguish gross and net production and interpret pyramids of biomass? ○ ○ ○
- Can you describe succession from bare rock to woodland? ○ ○ ○
- Can you define primary and secondary succession, pioneer species, sere and climax community? ○ ○ ○

Nutrient cycles

- Can you explain the importance of decomposition of organic matter in recycling nutrients? ○ ○ ○
- Can you describe the carbon cycle? ○ ○ ○
- Can you explain how human activities affect the carbon cycle, and how climate change alters species distribution and may cause extinction? ○ ○ ○
- Can you describe the role of bacteria in the nitrogen cycle, including nitrogen fixation, ammonification, nitrification and denitrification? ○ ○ ○
- Can you explain the importance of nitrates for making proteins and nucleic acids? ○ ○ ○
- Can you explain how ploughing and drainage create aerobic conditions that favour nitrification, and the economic importance of the nitrogen cycle for food production and fertiliser use? ○ ○ ○

Can you explain eutrophication and algal blooms, and the harmful effects of drainage on habitats?	○ ○ ○

1.6 Human impact on the environment

Human impact on the environment

Can you explain why species become endangered and describe the causes of extinction?	○ ○ ○
Can you describe how gene pools are conserved in the wild and in captivity?	○ ○ ○
Can you discuss the conflict between agricultural production and conservation, and possible resolutions, using deforestation and overfishing as examples?	○ ○ ○
Can you explain how increasing human pressures on the environment mean that sustainability requires changes in attitudes and informed choices?	○ ○ ○
Can you explain why political decisions should be based on sound scientific knowledge?	○ ○ ○
Can you explain the concept of planetary boundaries?	○ ○ ○

2.1 Evolutionary relationships

Classification

- Can you explain how classification places organisms into distinct, nested groups based on evolutionary relationships?
- Can you explain why classification is needed and why it is tentative?
- Can you compare the three-domain system with the five-kingdom system?
- Can you describe the features of the kingdoms Prokaryotae, Protoctista, Plantae, Fungi and Animalia?
- Can you explain how physical features and biochemical methods, such as DNA fingerprinting and enzyme studies, are used to assess relatedness, avoiding misleading similarities from convergent evolution?
- Can you explain the concept of a species?
- Can you use the binomial system to name organisms?

Biodiversity and adaptation

- Can you define biodiversity as the number and variety of organisms in a specified geographical region?
- Can you explain how biodiversity varies spatially and over time and is affected by many factors?
- Can you assess biodiversity in a habitat using Simpson's Diversity Index?
- Can you assess genetic biodiversity within a species using the proportion of polymorphic loci in the gene pool?
- Can you explain how DNA fingerprinting and sequencing are used to assess molecular biodiversity?
- Can you explain how natural selection has generated biodiversity?
- Can you describe anatomical, physiological and behavioural adaptations of organisms to their environments?

2.2 Cell division

Cell division

- Can you describe interphase and the main stages of mitosis?
- Can you explain how mitosis produces daughter cells with identical copies of genes, and describe cytokinesis?

Can you explain the role of mitosis in cell replacement, repair and healing, and how uncontrolled division can lead to cancer?	○ ○ ○
Can you describe the main stages of meiosis and cytokinesis?	○ ○ ○
Can you compare mitosis and meiosis, explaining why meiosis produces genetically different daughter cells (crossing over and independent assortment)?	○ ○ ○

2.3 Sexual reproduction in humans

Sexual reproduction in humans

Can you describe the structure and function of the male and female reproductive systems, including the histology of the ovary and testis?	○ ○ ○
Can you describe spermatogenesis and oogenesis, producing spermatozoa and secondary oocytes?	○ ○ ○
Can you describe intercourse, fertilisation and implantation?	○ ○ ○
Can you explain the hormonal control of the menstrual cycle by FSH, LH, oestrogen and progesterone?	○ ○ ○
Can you explain the hormonal control of pregnancy, birth and lactation, including hCG, oxytocin and prolactin?	○ ○ ○
Can you explain the role of the placenta, including its hormonal role?	○ ○ ○

2.4 Sexual reproduction in plants

Sexual reproduction in plants

Can you describe the general structure of a flower and compare wind-pollinated and insect-pollinated flowers?	○ ○ ○
Can you describe the development of pollen grains and ovules, including from prepared slides of anther and ovary?	○ ○ ○
Can you distinguish between cross-pollination and self-pollination?	○ ○ ○
Can you describe double fertilisation?	○ ○ ○
Can you describe the formation of seeds and fruits, using broad bean and maize as examples?	○ ○ ○
Can you describe the germination of Vicia faba (broad bean)?	○ ○ ○
Can you explain the role of gibberellin in germination, including amylase production?	○ ○ ○

2.5 Inheritance

Inheritance

- Can you define alleles as different forms of the same gene?
- Can you explain monohybrid inheritance, including crosses involving codominance?
- Can you explain dihybrid inheritance, including crosses involving linkage?
- Can you use the chi-squared test to assess the significance of differences between observed and expected results?
- Can you explain sex linkage, using haemophilia and Duchenne muscular dystrophy as examples?
- Can you explain gene mutation, using sickle cell anaemia as an example?
- Can you explain chromosome mutation, using Down's syndrome as an example?
- Can you describe the effects of mutagens, carcinogens and oncogenes?
- Can you explain epigenetics, where gene expression is controlled by factors other than changes in DNA base sequence (e.g. DNA methylation and histone modification)?

2.6 Variation and evolution

Variation and selection

- Can you explain how genetic and environmental factors cause variation between individuals?
- Can you distinguish continuous from discontinuous variation, and heritable from non-heritable variation?
- Can you explain how intraspecific and interspecific competition affect breeding success and survival?
- Can you describe how selective agents such as food supply, breeding sites, climate and human impact affect survival?
- Can you explain the concepts of gene pool and genetic drift?
- Can you explain how selection changes allele frequencies in a population?
- Can you use the Hardy-Weinberg principle and equations to calculate allele and genotype frequencies?
- Can you state the conditions under which the Hardy-Weinberg principle applies?

Speciation

- Can you explain the concepts of isolation and speciation?
- Can you describe how populations become isolated by geographical, behavioural, morphological, seasonal and other mechanisms, including hybrid sterility?
- Can you explain Darwin's theory that species arose from ancestral species by natural selection?

2.7 Application of reproduction and genetics

Genomes and gene technology

- Can you describe the Human Genome Project and its extension, the 100K Genome Project?
- Can you discuss the ethical issues of using genome knowledge to screen embryos for genetic disorders such as cystic fibrosis, Huntington's disease and thalassaemia?
- Can you describe the sequencing of other genomes, such as Anopheles gambiae and Plasmodium, and how this may help control malaria?
- Can you explain how PCR and electrophoresis produce a genetic fingerprint and how this is used in forensics?
- Can you explain how recombinant DNA is made by inserting foreign DNA into bacterial plasmids, and how cloned bacteria produce useful products such as insulin?

Applications and issues

- Can you discuss the issues around GM crops with genes for disease resistance (e.g. GM tomatoes) or desired traits (e.g. GM soya)?
- Can you evaluate the advantages and disadvantages of gene therapy, using muscular dystrophy as an example?
- Can you discuss how genomics may affect healthcare in the future?
- Can you discuss the issues surrounding the use of stem cells to replace damaged tissues and organs?

3.1 Adaptations for gas exchange

Animals

- Can you explain the adaptations for gas exchange that allow an increase in body size and metabolic rate?
- Can you explain how small animals exchange gases across their general body surface?
- Can you compare gas exchange in Amoeba, flatworm and earthworm?
- Can you describe the common features of specialised respiratory surfaces, and how gills suit fish to water and lungs suit mammals to land?
- Can you explain why large, active animals need ventilation mechanisms to maintain concentration gradients?
- Can you describe ventilation in bony fish and compare counter-current flow with parallel flow?
- Can you describe the structure and function of the human breathing system, including T.S. lung and trachea slides?
- Can you describe ventilation in humans and gas exchange in the alveoli?
- Can you explain the adaptations of the insect tracheal system to life on land?

Plants

- Can you describe the structure of the angiosperm leaf?
- Can you explain how leaf structures are adapted for effective photosynthesis?
- Can you explain the leaf as a gas exchange organ, including the opening and closing of stomata?

3.2 Adaptations for transport

Transport in animals

- Can you compare the circulatory systems of the earthworm (closed, with pumps and blood carrying respiratory gases) and insects (open, dorsal tube-shaped heart, no gases carried in blood)?
- Can you compare the single circulatory system of fish with the double circulatory system of mammals?
- Can you describe the structure and function of the mammalian heart and blood vessels, and name the main vessels joined to the human heart?
- Can you describe the cardiac cycle and interpret graphs of pressure changes during it?

- Can you explain the roles of the sino-atrial node, atrio-ventricular node and Purkyne fibres in coordinating the heartbeat?
- Can you analyse ECG traces to show the electrical activity of the heart?
- Can you describe the roles of red blood cells and plasma in transporting respiratory gases?
- Can you interpret oxygen dissociation curves of adult and foetal haemoglobin?
- Can you interpret dissociation curves of animals adapted to low-oxygen habitats, such as the llama and lugworm?
- Can you explain the Bohr effect and the chloride shift?
- Can you describe the transport of nutrients, hormones, excretory products and heat in the blood?
- Can you explain the formation of tissue fluid and its role as a link between blood and cells?

Transport in plants

- Can you describe the structure of a dicotyledon root from a T.S. slide?
- Can you explain how water is absorbed by the root?
- Can you describe the apoplast, symplast and vacuolar pathways of water movement through the root?
- Can you describe the structure and role of the endodermis, including the Casparian strip?
- Can you describe the detailed structure of xylem from light and electron micrographs, including in a T.S. dicotyledon stem?
- Can you explain the movement of water from root to leaf, including the transpiration stream and cohesion-tension theory?
- Can you explain how environmental factors affect the rate of transpiration?
- Can you describe the adaptations of hydrophytes and xerophytes, including T.S. of water lily and marram grass leaves?
- Can you describe the detailed structure of phloem from light and electron micrographs?
- Can you explain translocation from source to sink, including the mass flow hypothesis and alternative models such as diffusion and cytoplasmic streaming?
- Can you describe evidence that phloem transports solutes such as sucrose, including aphid stylet and autoradiograph experiments?

3.3 Adaptations for nutrition

Adaptations for nutrition

- Can you distinguish autotrophic and heterotrophic nutrition, and photoautotrophs from chemoautotrophs?
- Can you describe saprotrophic, holozoic and parasitic nutrition as forms of heterotrophic nutrition?
- Can you describe saprotrophic nutrition in fungi, with secretion of enzymes, external digestion and absorption of products?
- Can you describe holozoic nutrition as the internal digestion of food?
- Can you describe nutrition in Amoeba, where food is ingested and digested intracellularly?
- Can you describe the increasing specialisation of guts, from the sac-like gut with one opening in Hydra to a tube gut with separate openings and specialised regions?
- Can you explain the adaptations of the human gut to a mixed omnivorous diet, including duodenum and ileum slides?
- Can you explain why efficient digestion of different foods needs different enzymes and conditions?
- Can you explain the adaptations of the gut and dentition of herbivores, especially ruminants on a high-cellulose diet?
- Can you explain the adaptations of the gut and dentition of carnivores on a high-protein diet?
- Can you describe parasites as specialised organisms feeding at a host's expense, using Taenia and Pediculus as examples?

3.4 Homeostasis and the kidney

Homeostasis and the kidney

- Can you explain homeostasis and its importance in maintaining a dynamic equilibrium?
- Can you distinguish negative feedback, which restores conditions, from positive feedback, which increases the size of the stimulus?
- Can you describe the structure of the mammalian kidney and nephron, including from slides and electron micrographs?
- Can you explain the functions of the kidney in nitrogenous excretion and water regulation, including ultrafiltration and selective reabsorption?
- Can you describe the adaptations of proximal convoluted tubule cells for reabsorption?

- Can you explain how the posterior pituitary secretes ADH as an example of an endocrine gland contributing to homeostasis?
- Can you explain the role of ADH in osmoregulation?
- Can you describe the effects of kidney failure and its treatments, such as dialysis and transplant?
- Can you explain why different animals have different nitrogenous excretory products, and how the loop of Henle is adapted to different environments?

3.5 The nervous system

Nervous organisation

- Can you describe the components of a nervous response, from receptors detecting internal and external stimuli to effectors?
- Can you describe the main areas of the spinal cord, including from a T.S. slide?
- Can you describe the pattern of spinal nerves, including the dorsal and ventral roots?
- Can you describe the simple reflex arc as the basis of rapid, protective, involuntary actions?
- Can you describe the nerve net of Cnidaria and compare it with the nervous systems of more complex organisms?
- Can you draw and label the structure of a motor neurone?

Nerve impulses and synapses

- Can you explain the nature and transmission of a nerve impulse, including resting potential and action potential?
- Can you analyse oscilloscope traces showing the passage of an action potential?
- Can you explain the factors affecting the speed of conduction of nerve impulses, including in other organisms?
- Can you describe the structure and role of a synapse?
- Can you describe the process of synaptic transmission?
- Can you explain the effects of chemicals such as organophosphates and psychoactive drugs on synaptic transmission?

OptA Immunology and disease

OPTION

Disease

- Can you define pathogenic, infectious, carrier, disease reservoir, endemic, epidemic and pandemic?
- Can you define vaccine, antibiotic, antigen, antibody, resistance, vector, toxin and antigenic types?
- Can you describe the human body as a host to other living organisms?
- Can you describe the causative organism, source, tissue affected, transmission, prevention, control and treatment of cholera and tuberculosis?
- Can you describe the causative organism, source, tissue affected, transmission, prevention, control and treatment of smallpox and influenza?
- Can you describe the causative organism, source, tissue affected, transmission, prevention, control and treatment of malaria?
- Can you explain the link between the pathogenicity of viruses and their method of reproduction?

Antibiotics

- Can you distinguish bacteriostatic from bactericidal antibiotics, and broad-spectrum from narrow-spectrum antibiotics?
- Can you explain the modes of action of penicillin and tetracycline?
- Can you explain how the Gram-negative cell wall protects bacteria from antibiotics and immune defences?
- Can you explain how overuse of antibiotics has led to the spread of antibiotic resistance in pathogenic bacteria?

Immune response

- Can you describe natural barriers to infection, including skin flora, inflammation, phagocytosis, clotting, tears, mucus and ciliated epithelium?
- Can you explain how specific immune responses develop after exposure to foreign antigens?
- Can you describe the humoral response, with production and secretion of antigen-specific antibodies?
- Can you describe cell-mediated immunity, where cells destroy pathogens, infected cells and cancer cells by direct contact?
- Can you explain the roles of T and B lymphocytes in cell-mediated and humoral responses?

- Can you distinguish active (long-lived) and passive (short-term) immunity, each induced naturally or artificially?
- Can you explain how the active response is used to immunise without infection, using rubella as an example?
- Can you explain the use of passive immunity by antibody injection in emergencies, using rabies as an example?
- Can you explain why immunisation programmes are more effective against some diseases than others?
- Can you discuss the ethical issues in designing vaccination programmes?

OptB Human musculoskeletal anatomy

OPTION

Skeletal tissues

- Can you describe hyaline, yellow elastic and white fibrous cartilage?
- Can you describe the composition of compact bone matrix (about 30% organic, mainly collagen, and 70% inorganic, mainly hydroxyapatite)?
- Can you explain the functions of the organic and inorganic components of bone?
- Can you explain the roles of osteoblasts and osteoclasts and how bone is continually remodelled?
- Can you describe the structure and function of Haversian systems?
- Can you explain rickets and osteomalacia as disorders caused by calcium or vitamin D deficiency?
- Can you describe the causes, symptoms and treatment of osteoporosis and brittle bone disease?
- Can you describe the structure and ultrastructure of skeletal muscle?
- Can you explain the sliding filament theory, including the roles of actin, tropomyosin, troponin and myosin?
- Can you compare fast-twitch and slow-twitch muscle fibres?
- Can you explain the effects of anaerobic conditions in muscle, including the role of creatine phosphate and lactic acid build-up?
- Can you explain the roles of glycogen and protein as energy sources during muscle contraction?

Human skeleton

- Can you describe the axial and appendicular skeleton, including the pectoral and pelvic girdles and the fore and hind limbs?

- Can you describe the types of fracture and their causes?
- Can you describe the structure of a vertebra and relate the differences between cervical, thoracic and lumbar vertebrae to their functions?
- Can you describe medical conditions affecting posture, with their causes and treatment?
- Can you describe the functions of the skeleton: support, muscle attachment, protection, red blood cell production and calcium store?

Joints

- Can you describe immovable (fused), gliding, hinge and ball and socket joints?
- Can you describe the cause and treatment of osteoarthritis?
- Can you describe the cause and treatment of rheumatoid arthritis?
- Can you explain how joints act as levers, with examples of first, second and third order levers?
- Can you describe the structure of a synovial joint, including cartilage, synovial membrane, synovial fluid and ligaments?
- Can you explain antagonistic muscle action in the human forelimb, including the role of tendons?

OptC Neurobiology and behaviour OPTION

The brain

- Can you locate the cerebrum, hypothalamus, hippocampus, cerebellum and medulla oblongata?
- Can you describe the main functions of the cerebrum, hypothalamus, cerebellum and medulla oblongata?
- Can you describe the roles of the sympathetic and parasympathetic nervous systems?
- Can you explain the role of the hypothalamus as the link between nervous and endocrine regulation?
- Can you describe the roles of the sensory and motor areas of the cortex?
- Can you explain how the size of cortical areas relates to the complexity of innervation, using sensory and motor homunculi?
- Can you describe the areas of the cerebrum involved in language comprehension and speech (Wernicke's and Broca's areas)?

Neuroscience

- Can you describe non-invasive brain investigation techniques: fMRI, CT, PET and EEG?
- Can you explain brain development and critical periods for human learning and language acquisition?
- Can you explain neuroplasticity as changes in neural pathways allowing responses to environmental change and compensation for injury or disease?
- Can you explain how gene expression affects brain development and behaviour?
- Can you explain how altered gene expression in childhood could predispose adults to mental illness?

Behaviour

- Can you describe innate behaviour, including escape reflexes, kineses and taxes, using woodlice as an example?
- Can you describe learned behaviour, including habituation, imprinting, and classical and operant conditioning?
- Can you describe behaviour in primates, including humans, living in complex societies, including imitation and insight learning?
- Can you discuss the advantages and disadvantages of living in social groups?
- Can you describe the caste-based social structure of some insects, with communication based on innate behaviour?
- Can you describe dominance hierarchies in vertebrate societies, where individuals recognise each other and can learn?
- Can you explain how territorial and courtship behaviours increase reproductive success?
- Can you explain the role of sexual selection in the evolution of territorial and courtship behaviours?

SP Specified Practicals

Specified practical work

1 Can you carry out food tests: iodine for starch, Benedict's for reducing and non-reducing sugars, biuret for protein and the emulsion test for lipids?

2 Can you calibrate a light microscope at low and high power and calculate actual size and drawing magnification?

3 Can you prepare and make a scientific drawing of a slide of living cells (e.g. onion, rhubarb or Amoeba), calculating actual size and magnification?

4 Can you determine the water potential of a plant tissue by measuring changes in mass or length?

5 Can you determine solute potential by measuring the degree of incipient plasmolysis?

6 Can you investigate the permeability of cell membranes using beetroot?

7 Can you investigate the effect of temperature or pH on enzyme activity?

8 Can you investigate the effect of enzyme or substrate concentration on enzyme activity?

9 Can you carry out a simple extraction of DNA from living material?

10 Can you investigate dehydrogenase activity using an artificial hydrogen acceptor such as DCPIP, methylene blue or tetrazolium?

11 Can you separate chloroplast pigments by chromatography and calculate Rf values?

12 Can you investigate a factor affecting the rate of photosynthesis?

13 Can you investigate the roles of nitrogen and magnesium in plant growth?

14 Can you investigate a factor affecting the rate of respiration in yeast?

15 Can you compare the numbers of bacteria in fresh and stale milk using serial dilution, plating and colony counting?

16 Can you investigate the abundance and distribution of organisms in a habitat?

17 Can you investigate biodiversity in a habitat, for example using Simpson's Diversity Index?

18 Can you make scientific drawings of cells from root tip slides showing the stages of mitosis?

19 Can you make scientific drawings of cells from prepared slides of developing anthers showing the stages of meiosis?

20 Can you investigate starch digestion by germinating seeds using starch agar?

21 Can you dissect and compare wind-pollinated and insect-pollinated flowers?

22 Can you make a low-power plan drawing of a prepared anther slide, calculating actual size and magnification?

23 Can you carry out an experiment showing gene segregation and use the chi-squared test to assess the significance of the results?

24 Can you investigate continuous variation in a species, using Student's t-test?

25 Can you investigate stomatal numbers in leaves?

26 Can you dissect a fish head to show the gas exchange system?

27 Can you make a low-power plan drawing of a T.S. dicotyledon leaf (e.g. privet), calculating actual size and magnification?

28 Can you investigate transpiration using a simple potometer?

29 Can you make a low-power plan drawing of a T.S. artery and vein, calculating actual size and magnification?

30 Can you dissect a mammalian heart?

31 Can you dissect a kidney?