



The John Roan School Sixth Form

The best in everyone™

Part of United Learning

A-Level Biology

Exam board: OCR

Course code: H420

Student Handbook

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Inspired

Confident

Ambitious

At The John Roan Sixth Form,
students will be ***inspired*** by our
commitment to their destinations.

They will feel ***confident*** in their
abilities and prospects because of our
teaching and curriculum and they will
be ***ambitious*** because of the
opportunities we provide.

Welcome to Biology

Curriculum Aims (KS5)

The purpose of the Biology curriculum is to ensure that students develop their knowledge understanding and skills with respect to the practical subject that is Biology. The teaching takes a content led approach to the course. This is a flexible approach where the specification is divided into topics, each covering different key concepts of Biology. As learners progress through the course, they'll build on their knowledge of Biological systems and be able to relate these to real world situations.

Here we explore the John Roan curriculum principles in the context of the Biology curriculum:

- **Entitlement:** all pupils need to develop essential knowledge and understanding of different areas of the subject and how they relate to each other. Through their learning, they will develop and demonstrate a deep appreciation of the skills, knowledge and understanding of the scientific method. They will also develop competence and confidence in a variety of practical, mathematical and problem solving skills.
- **Coherence:** Our curriculum is carefully sequenced to maximise knowledge, skills and understanding. The course has 6 modules and there is a clear rationale for the order in which these are studied. The year 12 modules build on work from GCSE and then the year 13 modules further develop and enhance these foundations.
- **Mastery:** regular testing (low and high tariff questions) is embedded within the curriculum. This enables teachers to ensure that foundational knowledge, skills and concepts are secure. To support mastery pupils revisit prior learning on a lesson-by-lesson basis, while feedback is at the heart of the teaching process.
- **Adaptability:** the core curriculum is in line with the demands of the OCR specification and the focus is exam success for all. In addition, we are seeking to develop their interest in further study and careers associated with the subject. Teachers adapt lesson to meet the needs of their classes.
- **Representation:** All pupils will be able to see themselves within the Biology curriculum. Our curriculum aspires to take all students beyond their immediate experience and to build an understanding of how society make decisions about scientific issues and how the sciences contribute to the success of the economy and society as exemplified in 'How Science Works'.
- **Education with character:** Through the curriculum pupils are given regular opportunities to discuss and reflect upon a wide variety of scientific issues. There are opportunities to look into subjects that affect their daily lives, as well as go into areas beyond the specification. Targets for improvement or comments should be acted upon.

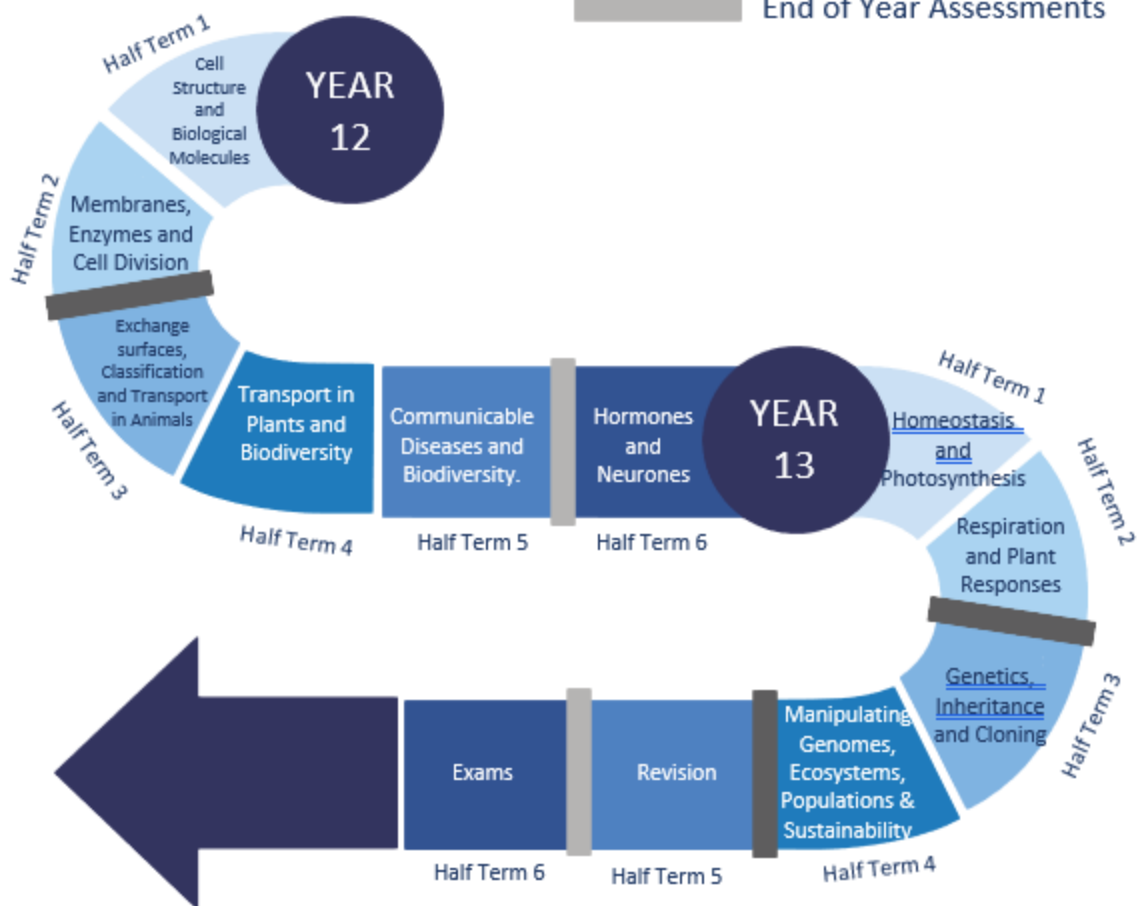


Biology

Key Stage 5

Key

- Mid-Year Assessments
- End of Year Assessments



Roadmap of the Biology Curricula

The roadmap diagram sets out the route that pupils take through our curriculum. The approach is thematic and is underpinned by a sound rationale. In Year 12 students study modules 2, 3 and 4 building on GCSE work and extending further into A level work. At the end of year 12, we start on module 5 with topics that build on the earlier modules and continue into year 13 expanding the knowledge at the frontiers of Biology.

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How we organise our work and learn in A-Level Biology

- Each lesson, you will be expected to work on file paper. Make sure you do the title and date for the work, and date each sheet you get. You will be expected to have with you a current folder with the current topics you are working on in. The day-to-day folder will also have spare file paper and graph paper. You will also be expected to bring your PAG book and all practical work will be completed into the PAG book. You will also keep the most recent half-term's worth of assessments in here.
- You will also need a lever arch file and dividers. This should be used to store completed topics. There should be 1 topic per division, and all notes, worksheets, homeworks (BHATs) and the end of topic test and evaluation should be stored in here.
- In addition, you will be given a set of blank revision cards at the start of the year. You will work on these after each lesson to build up a set of revision notes for yourself, adding in information from lessons, homeworks and end of topic tests to support your learning.
- The PAG book will be a record of your achievements with regards to the practical endorsement. Each piece of practical work should be headed with a title and date, both underlined. The front of the book should act as a contents table, so write the name of the practical and the page number here too. Each page will also need to be numbered. All practical sheets should be stuck into the book. You should adhere to the guidance in the practical skills section of this booklet for guidance on results table and graphs.
- Completed assessments and PAG activities should be marked off on the sheet in the front of your day-to-day folder.
- You will also have access to an online textbook as well as Uplearn. Use both of these to support your learning.
- In lessons, the lesson will start with a Do Now, which is recall knowledge. You should try to answer this without using your notes. After this, your teacher will connect your learning objectives for the lesson with the curriculum, teach and then get you to do a range of activities to check, practice and consolidate your learning.



Exam Specification

Content Overview	Assessment Overview	
Content is split into six teaching modules: - Module 1 – Development of practical skills in biology - Module 2 – Foundations in biology - Module 3 – Exchange and transport - Module 4 – Biodiversity, evolution and disease - Module 5 – Communication, homeostasis and energy - Module 6 – Genetics, evolution and ecosystems Component 01 assesses content from modules 1, 2, 3 and 5. Component 02 assesses content from modules 1, 2, 4 and 6. Component 03 assesses content from all modules (1 to 6).	Biological processes (01) 100 marks 2 hour 15 minutes written paper	37% of total A level
	Biological diversity (02) 100 marks 2 hour 15 minutes written paper	37% of total A level
	Unified biology (03) 70 marks 1 hour 30 minutes written paper	26% of total A level
	Practical endorsement in biology (04)* (non exam assessment)	Reported separately (see section 5g)



Exam Specification

The A Level in Biology A specification content is divided into six teaching modules and each module is further divided into key topics. Each module is introduced with a summary of the biology it contains and each topic is also introduced with a short summary text. The assessable content is divided into two columns: **Learning outcomes** and **Additional guidance**.

The Learning outcomes may all be assessed in the examinations (with the exception of some of the skills in section 1.2 which will be assessed directly through the Practical Endorsement). The Additional guidance column is included to provide further advice on delivery and the expected skills required from learners.

References to HSW (Section 5d) are included in the guidance to highlight opportunities to encourage a wider understanding of science.

The mathematical requirements in section 5e, are also referenced by the prefix *M* to link the mathematical skills required for A Level Biology to examples of biology content where those mathematical skills could be linked to learning.

The specification has been designed to be co-teachable with the standalone AS Level in Biology A qualification. The first four modules comprise the AS Level in Biology A course and learners studying the A level continue with the content of modules 5 and 6. The internally assessed Practical Endorsement skills also form part of the full A level (see module 1.2).

A summary of the content for the A level course is as follows:

Module 1 – Development of practical skills in biology

- 1.1 Practical skills assessed in a written examination
- 1.2 Practical skills assessed in the practical endorsement

Module 2 – Foundations in biology

- 2.1.1 Cell structure
- 2.1.2 Biological molecules
- 2.1.3 Nucleotides and nucleic acids

- 2.1.4 Enzymes

- 2.1.5 Biological membranes

- 2.1.6 Cell division, cell diversity and cellular organisation

Module 3 – Exchange and transport

- 3.1.1 Exchange surfaces

- 3.1.2 Transport in animals

- 3.1.3 Transport in plants

Module 4 – Biodiversity, evolution and disease

- 4.1.1 Communicable diseases, disease prevention and the immune system

- 4.2.1 Biodiversity

- 4.2.2 Classification and evolution

Module 5 – Communication, homeostasis and energy

- 5.1.1 Communication and homeostasis

- 5.1.2 Excretion as an example of homeostatic control

- 5.1.3 Neuronal communication

- 5.1.4 Hormonal communication

- 5.1.5 Plant and animal responses

- 5.2.1 Photosynthesis

- 5.2.2 Respiration

Module 6 – Genetics, evolution and ecosystems

- 6.1.1 Cellular control

- 6.1.2 Patterns of inheritance

- 6.1.3 Manipulating genomes

- 6.2.1 Cloning and biotechnology

- 6.3.1 Ecosystems

- 6.3.2 Populations and sustainability.



Exam Specification

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



Exam Specification

1.2.1 Practical skills			
Independent thinking (a) apply investigative approaches and methods to practical work. Including how to solve problems in a practical context.			
Use and application of scientific methods and practices (b) safely and correctly use a range of practical equipment and materials. Including identification of potential hazards. Learners should understand how to minimise the risks involved.			
(c) follow written instructions.			
(d) make and record observations/measurements.			
(e) keep appropriate records of experimental activities.			
(f) present information and data in a scientific way.			
(g) use appropriate software and tools to process data, carry out research and report findings.			
Research and referencing (h) use online and offline research skills including websites, textbooks and other printed scientific sources of information.			
(i) correctly cite sources of information. The Practical Skills Handbook provides guidance on appropriate methods for citing information.			
Instruments and equipment (j) use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding including in the specification.			
1.2.2 Use of apparatus and techniques			
(a) use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH).			
(b) use of appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer.			
(c) use of laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions.			
(d) use of a light microscope at high power and low power, including use of a graticule.			
(e) production of scientific drawings from observations with annotations.			
(f) use of qualitative reagents to identify biological molecules.			
(g) separation of biological compounds using thin layer/paper chromatography or electrophoresis.			
(h) safe and ethical use of organisms to measure: (i) plant or animal responses (ii) physiological functions.			
(i) use of microbiological aseptic techniques, including the use of agar plats and broth.			
(j) safe use of instruments for dissection of an animal or plant organ.			
(k) use of sampling techniques in fieldwork.			
(l) use of ICT such as computer modelling, or a data logger to collect data, or use of software to process data.			



Exam Specification

Module 2 Foundations in biology			
2.1.1 Cell structure			
Learning outcomes			
You will be required to show and apply knowledge and understanding of:			
(a) the use of microscopy to observe and investigate different types of <u>cell</u> and cell structure in a range of eukaryotic organisms To include an appreciation of the images produced by a range of microscopes: light microscope, transmission electron microscope, scanning electron microscope and laser scanning confocal microscope.			
(b) the preparation and examination of microscope slides for use in light microscopy. Including the use of an eye piece graticule and stage <u>micrometer</u> .			
(c) The use of staining in light microscopy. To include the use of differential staining to identify different cellular components and cell types.			
(d) the representation of cell structure as seen under the light microscope using drawings and annotated diagrams of whole cells or cells in sections of tissue.			
(e) the use and manipulation of the magnification formula. $\text{magnification} = \frac{\text{image size}}{\text{object size}}$			
(f) the difference between magnification and resolution. To include an appreciation of the differences in resolution and magnification that can be achieved by a light microscope, a transmission electron microscope and a scanning electron microscope.			
(g) the ultrastructure of eukaryotic cells and the functions of the different cellular components. To include the following cellular components and an outline of their functions: nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum (ER), Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplasts, plasma membrane, centrioles, cell wall, flagella and cilia.			
(h) Photomicrographs of cellular components in a range of eukaryotic cells. To include interpretation of transmission and scanning electron microscope images.			
(i) the interrelationship between the organelles involved in the production and secretion of proteins. No detail of protein synthesis is required.			
(j) the importance of the cytoskeleton. To include providing mechanical strength to cells, aiding transport within cells and enabling cell movement.			
(k) the similarities and differences in the structure and ultrastructure of prokaryotic and eukaryotic cells.			



Exam Specification

2.1.2 Biological molecules			
(a) how hydrogen bonding occurs between water molecules, and relate this, and other properties of water, to the roles of water for living organisms. A range of roles that relate to the properties of water, including solvent, transport medium, coolant and as a habitat AND roles illustrated using examples of prokaryotes and eukaryotes.			
(b) the concept of monomers and polymers and the importance of condensation and hydrolysis reactions in a range of biological molecules.			
(c) the chemical elements that make up biological molecules. To include C, H and O for carbohydrates C, H and O for lipids C, H, O, N and S for proteins C, H, O, N and P for nucleic acids.			
(d) the ring structure and properties of glucose as an example of a hexose monosaccharide and the structure of ribose as an example of a pentose monosaccharide. To include the structural difference between an α - and a β -glucose molecule AND the difference between a hexose and a pentose monosaccharide.			
(e) the synthesis and breakdown of a disaccharide and polysaccharide by the formation and breakage of glycosidic bonds. To include the disaccharides sucrose, lactose and maltose.			
(f) the structure of starch (amylose and amylopectin), glycogen and cellulose molecules.			
(g) how the structures and properties of glucose, starch, glycogen and cellulose molecules relate to their functions in living organisms.			
(h) the structure of a triglyceride and a phospholipid as examples of macromolecules. To include an outline of saturated and unsaturated fatty acids.			
(i) the synthesis and breakdown of triglycerides by the formation (esterification) and breakage of ester bonds between fatty acids and glycerol.			
(j) how the properties of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms. To include hydrophobic and hydrophilic regions and energy content AND illustrated using examples of prokaryotes and eukaryotes.			
(k) the general structure of an amino acid.			
(l) the synthesis and breakdown of dipeptides and polypeptides, by the formation and breakage of peptide bonds.			
(m) the levels of protein structure. To include primary, secondary, tertiary and quaternary structure AND hydrogen bonding, hydrophobic and hydrophilic interactions, disulfide bonds and ionic bonds.			
(n) the structure and function of globular proteins including a conjugated protein. To include haemoglobin as an example of a conjugated protein (globular protein with a prosthetic group), a named enzyme and insulin.			



Exam Specification

(o) the properties and functions of fibrous proteins. To include collagen, keratin and elastin (no details of structure are required).			
(p) the key inorganic ions that are involved in biological processes. To include the correct chemical symbols for the following cations and anions: cations: calcium ions (Ca^{2+}), sodium ions (Na^+), potassium ions (K^+), hydrogen ions (H^+), ammonium ions (NH_4^+) anions: nitrate (NO_3^-), hydrogencarbonate (HCO_3^-), <u>chloride</u> (Cl^-), phosphate (PO_4^{3-}), hydroxide, (OH^-).			
(q) how to carry out and interpret the results of the following chemical tests: • biuret test for proteins • Benedict's test for reducing and non-reducing sugars • reagent test strips for reducing sugars • iodine test for starch • emulsion test for lipids.			
(r) quantitative methods to determine the concentration of a chemical substance in a solution. To include colorimetry and the use of biosensors (an outline only of the mechanism is required).			
(s) (i) the principles and uses of paper and thin layer chromatography to separate biological molecules / compounds. To include calculation of retention (R_f) values. $R_f = \frac{\text{distance moved by the solute}}{\text{distance moved by the solvent}}$ (ii) practical investigations to analyse biological solutions using paper or thin layer chromatography. For example, the separation of proteins, carbohydrates, vitamins or nucleic acids.			



Exam Specification

2.1.3 Nucleotides and nucleic acids			
(a) the structure of a nucleotide as the monomer from which nucleic acids are made. To include the differences between RNA and DNA nucleotides, the identification of the purines and pyrimidines and the type of pentose sugar. An opportunity to use computer modelling to investigate nucleic acid structure.			
(b) the synthesis and breakdown of polynucleotides by the formation and breakage of phosphodiester bonds.			
(c) the structure of ADP and ATP as phosphorylated nucleotides. Comprising a pentose sugar (ribose), a nitrogenous base (adenine) and inorganic phosphates.			
(d) (i) the structure of DNA (deoxyribonucleic acid). (ii) practical investigations into the purification of DNA by precipitation. To include how hydrogen bonding between complementary base pairs (A to T, G to C) on two antiparallel DNA polynucleotides leads to the formation of a DNA molecule, and how the twisting of DNA produces its 'double-helix' shape.			
(e) semi-conservative DNA replication. To include the roles of the <u>enzymes</u> helicase and DNA polymerase, the importance of replication in conserving genetic information with accuracy and the occurrence of random, spontaneous mutations.			
(f) the nature of the genetic code. To include the triplet, non-overlapping, degenerate and universal nature of the code and how a gene determines the sequence of amino acids in a polypeptide (the primary structure of a protein).			
(g) transcription and translation of genes resulting in the synthesis of polypeptides. To include, the roles of RNA polymerase, messenger (m)RNA, transfer (t)RNA, ribosomal (r)RNA.			



Exam Specification

2.1.4 Enzymes			
(a) the role of enzymes in catalysing reactions that affect metabolism at a cellular and whole organism level. To include the ideas that enzymes affect both structure and function.			
(b) the role of enzymes in catalysing both intracellular and extracellular reactions. To include catalase as an example of an enzyme that catalyses intracellular reactions and amylase and trypsin as examples of enzymes that catalyse extracellular reactions.			
(c) the mechanism of enzyme action. To include the tertiary structure, specificity, active site, lock and key hypothesis, induced-fit hypothesis, enzyme-substrate complex, enzyme-product complex, product formation and lowering of activation energy.			
(d) (i) the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity. To include reference to the temperature coefficient (Q_{10}). $Q_{10} = \frac{R_2}{R_1}$ (ii) practical investigations into the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity.			
(e) the need for coenzymes, cofactors and prosthetic groups in some enzyme-controlled reactions. To include Cl^- as a cofactor for amylase, Zn^{2+} as a prosthetic group for carbonic anhydrase and vitamins as a source of coenzymes.			
(f) the effects of inhibitors on the rate of enzyme- controlled reactions. To include competitive and non-competitive and reversible and non-reversible inhibitors with reference to the action of metabolic poisons and some medicinal drugs, and the role of product inhibition AND inactive precursors in metabolic pathways (covered at A level only).			



Exam Specification

2.1.5 Biological membranes			
(a) the roles of membranes within cells and at the surface of cells. To include the roles of membranes as - partially permeable barriers between the cell and its environment, between organelles and the cytoplasm and within organelles - sites of chemical reactions - sites of cell communication (cell signalling).			
(b) the fluid mosaic model of membrane structure and the roles of its components. To include phospholipids, cholesterol, glycolipids, proteins and glycoproteins AND the role of membrane-bound receptors as sites where hormones and drugs can bind.			
(c) (i) factors affecting membrane structure and permeability. (ii) practical investigations into factors affecting membrane structure and permeability. To include the effects of temperature and solvents.			
(d) (i) the movement of molecules across membranes. (ii) practical investigations into the factors affecting diffusion rates in model cells. To include diffusion and facilitated diffusion as passive methods AND active transport, endocytosis and exocytosis as processes requiring adenosine triphosphate (ATP) as an immediate source of energy.			
(e) (i) the movement of water across membranes by osmosis and the effects that solutions of different water potential can have on plant and animal cells (ii) practical investigations into the effects of solutions of different water potential on plant and animal cells. Osmosis to be explained in terms of a water potential gradient across a partially-permeable membrane.			



Exam Specification

2.1.6 Cell division, cell diversity and cellular organisation			
(a) the cell cycle. To include the processes taking place during interphase (G_1 , S and G_2), mitosis and cytokinesis, leading to genetically identical cells.			
(b) how the cell cycle is regulated. To include an outline of the use of checkpoints to control the cycle.			
(c) the main stages of mitosis. To include the changes in the nuclear envelope, chromosomes, chromatids, centromere, centrioles, spindle fibres and cell membrane.			
(d) sections of plant tissue showing the cell cycle and stages of mitosis. To include the examination of stained sections and squashes of plant tissue and the production of labelled diagrams to show the stages observed.			
(e) the significance of mitosis in life cycles. To include growth, tissue repair and asexual reproduction in plants, animals and fungi.			
(f) the significance of meiosis in life cycles. To include the production of haploid cells and genetic variation by independent assortment and crossing over.			
(g) the main stages of meiosis. To include interphase, prophase 1, metaphase 1, anaphase 1, telophase 1, prophase 2, metaphase 2, anaphase 2, telophase 2 (no details of the names of the stages within prophase 1 are required) and the term <i>homologous chromosomes</i> .			
(h) how cells of multicellular organisms are specialised for <u>particular functions</u> . To include erythrocytes, neutrophils, squamous and ciliated epithelial cells, sperm cells, palisade cells, root hair cells and guard cells.			
(i) the organisation of cells into tissues, organs and organ systems. To include squamous and ciliated epithelia, cartilage, muscle, xylem and phloem as examples of tissues.			
(j) the features and differentiation of stem cells. To include stem cells as a renewing source of undifferentiated cells.			
(k) the production of erythrocytes and neutrophils derived from stem cells in bone marrow.			
(l) the production of xylem vessels and phloem sieve tubes from meristems.			
(m) the potential uses of stem cells in research and medicine. To include the repair of damaged tissues, the treatment of neurological conditions such as Alzheimer's and Parkinson's, and research into developmental biology			



Exam Specification

Module 3 Exchange and transport			
3.1.1 Exchange surfaces			
Learning outcomes You will be required to show and apply knowledge and understanding of:			
(a) the need for specialised exchange surfaces. To include surface area to volume ratio (<u>SA:V</u>), metabolic activity, single-celled and multicellular organisms. Ratio = $\frac{\text{Surface Area}}{\text{Volume}}$			
(b) the features of an efficient exchange surface. To include - increased surface area – root hair cells - thin layer – alveoli - good blood supply/ventilation to maintain gradient – gills/alveolus.			
(c) the structures and functions of the components of the mammalian gaseous exchange system. To include the distribution and functions of cartilage, ciliated epithelium, goblet cells, smooth muscle and elastic fibres in the trachea, bronchi, bronchioles and alveoli.			
(d) the mechanism of ventilation in mammals. To include the function of the rib cage, intercostal muscles (internal and external) and diaphragm.			
(e) the relationship between vital capacity, tidal volume, breathing rate and oxygen uptake. To include analysis and interpretation of primary and secondary data e.g. from a data logger or spirometer.			
(f) the mechanisms of ventilation and gas exchange in bony fish and insects. To include - bony fish – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates), <u>countercurrent flow</u> - insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid.			
(g) the dissection, examination and drawing of the gaseous exchange system of a bony fish and/or insect trachea.			
(h) the examination of microscope slides to show the histology of exchange surfaces.			



Exam Specification

3.1.2 Transport in animals			
(a) the need for transport systems in multicellular animals. To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V).			
(b) the different types of circulatory systems. To include the single, double, open and closed circulatory systems in insects, fish and mammals.			
(c) the structure and functions of arteries, arterioles, capillaries, venules and veins. To include the distribution of different tissues within the vessel walls.			
(d) the formation of tissue fluid from plasma. To include reference to hydrostatic pressure, oncotic pressure and an explanation of the differences in the composition of blood, tissue fluid and lymph.			
(e) (i) the external and internal structure of the mammalian heart. (ii) the dissection, examination and drawing of the external and internal structure of the mammalian heart.			
(f) the cardiac cycle. cardiac output = heart rate x stroke volume. To include the role of valves and the pressure changes occurring in the heart and associated vessels.			
(g) how heart action is initiated and coordinated. To include the roles of the sino-atrial node (SAN), atrio-ventricular node (AVN), purkyne tissue and the myogenic nature of cardiac muscle			
(h) the use and interpretation of electrocardiogram (ECG) traces. To include normal and abnormal heart activity e.g. tachycardia, bradycardia, fibrillation and ectopic heartbeat.			
(i) the role of haemoglobin in transporting oxygen and carbon dioxide. To include the reversible binding of oxygen molecules, carbonic anhydrase, haemoglobinic acid, HCO_3^- and the chloride shift.			
(j) the oxygen dissociation curve for fetal and adult human haemoglobin. To include the significance of the different affinities for oxygen AND the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect).			



Exam Specification

3.1.3 Transport in plants			
(a) the need for transport systems in multicellular plants. To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V).			
(b) (i) the structure and function of the vascular system in the roots, stems and leaves of herbaceous dicotyledonous plants To include xylem vessels, sieve tube elements and companion cells. (ii) the examination and drawing of stained sections of plant tissue to show the distribution of xylem and phloem (iii) the dissection of stems, both longitudinally and transversely, and their examination to demonstrate the position and structure of xylem vessels.			
(c) (i) the process of transpiration and the environmental factors that affect transpiration rate. To include an appreciation that transpiration is a consequence of gaseous exchange. (ii) practical investigations to estimate transpiration rates. To include the use of a potometer.			
(d) the transport of water into the plant, through the plant and to the air surrounding the leaves. To include details of pathways taken by water AND the mechanisms of movement, in terms of water potential, adhesion, cohesion and the transpiration stream.			
(e) Adaptations of plants to the availability of water in their environment. To include xerophytes (cacti and marram grass) and hydrophytes (water lilies).			
(f) the mechanism of translocation. To include translocation as an energy- requiring process transporting assimilates, especially sucrose, in the phloem between sources (e.g. leaves) and sinks (e.g. roots, meristem) AND details of active loading at the source and removal at the sink.			



Exam Specification

Module 4 Biodiversity, evolution and disease			
4.1.1 Communicable diseases, disease prevention and the immune system			
Learning outcomes			
You will be required to show and apply knowledge and understanding of:			
(a) the different types of <u>pathogen</u> that can cause communicable diseases in plants and animals. To include - bacteria - tuberculosis (TB), bacterial meningitis, ring rot (potatoes) - viruses - HIV/AIDS (human), influenza (animals), Tobacco Mosaic Virus (plants) <u>protocista</u> - malaria, potato/tomato late blight - fungi - black sigatoka (bananas), ringworm (cattle), athlete's foot (humans).			
(b) the means of transmission of animal and plant communicable pathogens. To include direct and indirect transmission, reference to vectors, spores and living conditions - e.g. climate, social factors (no detail of the symptoms of specific diseases is required).			
(c) plant defences against pathogens. To include production of chemicals AND plant responses that limit the spread of the pathogen (e.g. callose deposition).			
(d) the primary non-specific defences against pathogens in animals. Non-specific defences to include skin, blood clotting, wound repair, inflammation, expulsive reflexes and mucous membranes (no detail of skin structure or all the steps involved in the clotting cascade are required).			
(e) (i) the structure and mode of action of phagocytes. (ii) examination and drawing of cells observed in blood smears. To include <u>neutrophils</u> and antigen- presenting cells AND the roles of cytokines, <u>opsonins</u> , phagosomes and lysosomes.			
(f) the structure, different roles and modes of action of B and T lymphocytes in the specific immune response. To include the significance of cell signalling (reference to interleukins), clonal selection and clonal expansion, plasma cells, T helper cells, T killer cells and T regulator cells.			
(g) the primary and secondary immune responses. To include T memory cells and B memory cells.			
(h) the structure and general functions of antibodies. To include the general protein structure of an antibody molecule.			
(i) an outline of the action of <u>opsonins</u> , agglutinins and anti-toxins.			
(j) the differences between active and passive immunity, and between natural and artificial immunity. To include examples of each type of immunity.			
(k) autoimmune diseases. To include an appreciation of the term <i>autoimmune disease</i> and a named example e.g. arthritis, lupus.			



Exam Specification

(l) the principles of vaccination and the role of vaccination programmes in the prevention of epidemics. To include routine vaccinations AND reasons for changes to vaccines and vaccination programmes (including global issues).			
(m) possible sources of medicines. To include examples of microorganisms and plants (and so the need to maintain biodiversity) AND the potential for personalised medicines and synthetic biology.			
(n) the benefits and risks of using antibiotics to manage bacterial infection. To include the wide use of antibiotics following the discovery of penicillin in the mid-20 th century AND the increase in bacterial resistance to antibiotics (examples to include <i>Clostridium difficile</i> and MRSA) and its implications.			



Exam Specification

4.2.1 Biodiversity			
(a) how biodiversity may be considered at different levels. To include habitat biodiversity (e.g. sand dunes, woodland, meadows, streams), species biodiversity (species richness and species evenness) and genetic biodiversity (e.g. different breeds within a species).			
(b) (i) how sampling is used in measuring the biodiversity of a habitat and the importance of sampling (ii) practical investigations collecting random and non-random samples in the field. To include how sampling can be carried out i.e. random sampling and non-random sampling (e.g. opportunistic, stratified and systematic) and the importance of sampling the range of organisms in a habitat. Techniques to include use of sweeping nets, pitfall traps, pooters, Tullgren funnel and kick-sampling for collecting different samples.			
(c) how to measure species richness and species evenness in a habitat.			
(d) the use and interpretation of Simpson's Index of Diversity (D) to calculate the biodiversity of a habitat. $D = 1 - \left(\sum \left(\frac{n}{N} \right)^2 \right)$ AND the interpretation of both high and low values of Simpson's Index of Diversity (D).			
(e) how genetic biodiversity may be assessed, including calculations. To include calculations of genetic diversity within isolated populations, for example the percentage of gene variants (alleles) in a genome. $\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$ Suitable populations include zoos (captive breeding), rare breeds and pedigree animals.			
(f) the factors affecting biodiversity. To include human population growth, agriculture (monoculture) and climate change.			
(g) the ecological, economic and aesthetic reasons for maintaining biodiversity. - Ecological, including protecting keystone species (interdependence of organisms) and maintaining genetic resource - economic, including reducing soil depletion (continuous monoculture) - aesthetic, including protecting landscapes.			
(h) <i>in situ</i> and <i>ex situ</i> methods of maintaining biodiversity. <i>In situ</i> conservation including marine conservation zones and wildlife reserves <i>ex situ</i> conservation including seed banks, botanic gardens and zoos.			
(i) international and local conservation agreements made to protect species and habitats. Historic and/or current agreements, including the Convention on International Trade in Endangered Species (CITES), the Rio Convention on Biological Diversity (CBD) and the Countryside Stewardship Scheme (CSS).			



Exam Specification

4.2.2 Classification and evolution			
(a) the biological classification of species. To include the taxonomic hierarchy of kingdom, phylum, class, order, family, genus and species. AND domain.			
(b) the binomial system of naming species and the advantage of such a system.			
(c) (i) the features used to classify organisms into the five kingdoms: <u>Prokaryotae</u> , Protocista, Fungi, Plantae, Animalia. To include the use of similarities in observable features in original classification.			
(c) (ii) the evidence that has led to new classification systems, such as the three domains of life, which clarifies relationships. To include the more recent use of similarities in biological molecules and other genetic evidence AND details of the three domains and a comparison of the kingdom and domain classification systems.			
(d) the relationship between classification and phylogeny.			
(e) the evidence for the theory of evolution by natural selection. To include the contributions of Darwin and Wallace in formulating the theory of evolution by natural selection AND fossil, DNA and molecular evidence.			
(f) the different types of variation. To include intraspecific and interspecific variation AND the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms AND both genetic and environmental causes of variation. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two populations and/or the Spearman's rank correlation coefficient to consider the relationship of the data.			
(g) the different types of adaptations of organisms to their environment. Anatomical, physiological and behavioural adaptations AND why organisms from different taxonomic groups may show similar anatomical features, including the marsupial mole and placental mole.			
(h) the mechanism by which natural selection can affect the characteristics of a population over time. To include an appreciation that genetic variation, selection pressure and reproductive success (or failure) results in an increased proportion of the population possessing the advantageous characteristic(s).			
(i) how evolution in some species has implications for human populations. To include the evolution of pesticide resistance in insects and drug resistance in microorganisms.			



Exam Specification

Module 5 Communication, homeostasis and energy			
5.1.1 Communication and homeostasis			
Learning outcomes			
You will be required to show and apply knowledge and understanding of:			
(a) the need for communication systems in multicellular organisms To include the need for animals and plants to respond to changes in the internal and external environment and to coordinate the activities of different organs.			
(b) the communication between cells by cell signalling. To include signalling between adjacent cells and signalling between distant cells.			
(c) the principles of homeostasis. To include the differences between receptors and effectors, and the difference between negative feedback and positive feedback.			
(d) the physiological and behavioural responses involved in temperature control in ectotherms and endotherms. To include • endotherms - peripheral temperature receptors, the role of the hypothalamus and effectors in skin and muscles; behavioural responses • ectotherms - behavioural responses. An opportunity to monitor physiological functions in ectotherms and/or endotherms.			



Exam Specification

5.1.2 Excretion as an example of homeostatic control			
(a) the term <i>excretion</i> and its importance in maintaining metabolism and homeostasis. To include reference to the importance of removing metabolic wastes, including carbon dioxide and nitrogenous waste, from the body.			
(b) (i) the structure and functions of the mammalian liver. (ii) the examination and drawing of stained sections to show the histology of liver tissue. To include the gross structure and histology of the liver AND the roles of the liver in storage of glycogen, detoxification and the formation of urea (the ornithine cycle covered in outline only).			
(c) (i) the structure, mechanisms of action and functions of the mammalian kidney. To include the gross structure and histology of the kidney including the detailed structure of a nephron and its associated blood vessels AND the processes of ultrafiltration, selective reabsorption and the production of urine (ii) the dissection, examination and drawing of the external and internal structure of the kidney. (iii) the examination and drawing of stained sections to show the histology of nephrons.			
(d) the control of the water potential of the blood. To include the role of osmoreceptors in the hypothalamus, the posterior pituitary gland, ADH and its effect on the walls of the collecting ducts.			
(e) the effects of kidney failure and its potential treatments. To include the problems that arise from kidney failure including the effect on glomerular filtration rate (GFR) and electrolyte balance AND the use of renal dialysis (both haemodialysis and peritoneal dialysis) and transplants for the treatment of kidney failure.			
(f) how excretory products can be used in medical diagnosis. To include the use of urine samples in diagnostic tests, with reference to the use of monoclonal antibodies in pregnancy testing and testing for anabolic steroids and drugs.			



Exam Specification

5.1.3 Neuronal communication			
(a) the roles of mammalian sensory receptors in converting different types of stimuli into nerve impulses. To include an outline of the roles of sensory receptors (e.g. Pacinian corpuscle) in responding to specific types of stimuli and their roles as transducers.			
(b) the structure and functions of sensory, relay and motor neurones. To include differences between the structure and function of myelinated and non-myelinated neurones.			
(c) the generation and transmission of nerve impulses in mammals. To include how the resting potential is established and maintained and how an action potential is generated (including reference to positive feedback) and transmitted in a myelinated neurone AND the significance of the frequency of impulse transmission.			
(d) the structure and roles of synapses in neurotransmission. To include the structure of a cholinergic synapse AND the action of neurotransmitters at the synapse and the importance of synapses in summation and control, including inhibitory and excitatory synapses.			

5.1.4 Hormonal communication			
(a) endocrine communication by hormones. To include secretion of hormones into the blood, transport by the blood, and detection by target cells or tissues.			
(b) the structure and functions of the adrenal glands. Adrenal glands as an example of endocrine glands, to include the hormones secreted by the cortex and medulla and their functions.			
(c) (i) the histology of the pancreas To include the endocrine tissues. (ii) the examination and drawing of stained sections of the pancreas to show the histology of the endocrine tissues.			
(d) how blood glucose concentration is regulated. To include the action of insulin and glucagon as an example of negative feedback, and the role of the liver AND the control of insulin secretion, with reference to potassium channels and calcium channels in the beta cells of the pancreas.			
(e) the differences between Type 1 and Type 2 diabetes mellitus. To include the causes of Type 1 and Type 2 diabetes and the treatments for each.			
(f) the potential treatments for diabetes mellitus. To include the use of insulin produced by genetically modified bacteria and the potential use of stem cells to treat diabetes mellitus.			



Exam Specification

5.1.5 Plant and animal responses			
(a) (i) the types of plant responses To include the response to abiotic stress and herbivory e.g. chemical defences (such as tannins, alkaloids and pheromones), folding in response to touch (<i>Mimosa pudica</i>) AND The range of tropisms in plants. (ii) practical investigations into phototropism and geotropism.			
(b) the roles of plant hormones. To include the role of hormones in leaf loss in deciduous plants, seed germination and stomatal closure.			
(c) the experimental evidence for the role of auxins in the control of apical dominance.			
(d) the experimental evidence for the role of gibberellin in the control of stem elongation and seed germination.			
(e) practical investigations into the effect of plant hormones on growth. An opportunity for serial dilution. An opportunity to use standard deviation to measure the spread of a set of data.			
(f) the commercial use of plant hormones. To include the use of hormones to control ripening, the use of rooting powders and hormonal weed killers.			
(g) the organisation of the mammalian nervous system. To include the structural organisation of the nervous system into the central and peripheral systems AND the functional organisation into the somatic and autonomic nervous systems.			
(h) the structure of the human brain and the functions of its parts. To include the gross structure of the human brain AND the functions of the cerebrum, cerebellum, medulla oblongata, hypothalamus and pituitary gland.			
(i) reflex actions. To include knee jerk reflex and blinking reflex, with reference to the survival value of reflex actions.			
(j) the coordination of responses by the nervous and endocrine systems. To include the 'fight or flight' response to environmental stimuli in mammals AND the action of hormones in cell signalling (studied in outline only) with reference to adrenaline (first messenger), activation of adenylyl cyclase, and cyclic AMP (second messenger).			
(k) the effects of hormones and nervous mechanisms on heart rate. An opportunity to monitor physiological functions, for example with pulse rate measurements before, during and after exercise or sensors to record electrical activity in the heart. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two sets of data.			



Exam Specification

(l) (i) the structure of mammalian muscle and the mechanism of muscular contraction (ii) the examination of stained sections or photomicrographs of skeletal muscle. To include the structural and functional differences between skeletal, involuntary and cardiac muscle AND the action of neuromuscular junctions AND the sliding filament model of muscular contraction and the role of ATP, and how the supply of ATP is maintained in muscles by creatine phosphate. An opportunity to monitor muscle contraction and fatigue using sensors to record electrical activity.			
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Exam Specification

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



Exam Specification

5.2.2 Respiration			
(a) the need for cellular respiration. To include examples of why plants, animals and microorganisms need to respire (suitable examples could include active transport and an outline of named metabolic reactions).			
(b) the structure of the mitochondrion. The components of a mitochondrion including inner and outer mitochondrial membranes, cristae, matrix and mitochondrial DNA.			
(c) the process and site of glycolysis. To include the phosphorylation of glucose to hexose biphosphate, the splitting of hexose biphosphate into two triose phosphate molecules and further oxidation to pyruvate AND the production of a small yield of ATP and reduced NAD.			
(d) the link reaction and its site in the cell. To include the formation of Acetyl CoA by the decarboxylation of pyruvate and the reduction of NAD to NADH.			
(e) the process and site of the Krebs cycle. To include the formation of citrate from the acetyl group of acetyl CoA and oxaloacetate and the reconversion of citrate to oxaloacetate (names of intermediate compounds are not required) AND the importance of decarboxylation, dehydrogenation, the reduction of NAD and FAD, and substrate level phosphorylation.			
(f) the importance of coenzymes in cellular respiration. With reference to NAD, FAD and coenzyme A.			
(g) the process and site of oxidative phosphorylation. To include the roles of electron carriers, oxygen and the mitochondrial cristae.			
(h) the chemiosmotic theory. To include the electron transport chain, proton gradients and ATP synthase in oxidative phosphorylation and photophosphorylation.			
(i) (i) the process of anaerobic respiration in eukaryotes. To include anaerobic respiration in mammals and yeast and the benefits of being able to respire anaerobically AND why anaerobic respiration produces a much lower yield of ATP than aerobic respiration. (ii) practical investigations into respiration rates in yeast, under aerobic and anaerobic conditions. An opportunity to use sensors, data loggers and software to process data.			
(j) the difference in relative energy values of carbohydrates, lipids and proteins as respiratory substrates.			
(k) the use and interpretation of the respiratory quotient (RQ). To include calculating the respiratory quotient (RQ) using the formula: $RQ = \frac{CO_2 \text{ produced}}{O_2 \text{ consumed}}$			



Exam Specification

(l) practical investigations into the effect of factors such as temperature, substrate concentration and different respiratory substrates on the rate of respiration. For example, the use of respirometers. An opportunity to use sensors, data loggers and software to process data. An opportunity to use standard deviation to measure the spread of a set of data and/or Student's t-test to compare means of data values of two sets of data.			
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Module 6 Genetics, evolution and ecosystems			
6.1.1 Cellular control			
Learning outcomes You will be required to show and apply knowledge and understanding of:			
(a) types of gene mutations and their possible effects on protein production and function. To include substitution, insertion or deletion of one or more nucleotides AND the possible effects of these gene mutations (i.e. beneficial, neutral or harmful).			
(b) the regulatory mechanisms that control gene expression at the transcriptional level, post- transcriptional level and post-translational level. To include control at the - transcriptional level: <i>lac</i> operon, and transcription factors in eukaryotes - post-transcriptional level: the editing of primary mRNA and the removal of introns to produce mature mRNA - post-translational level: the activation of proteins by cyclic AMP.			
(c) the genetic control of the development of body plans in different organisms. Homeobox gene sequences in plants, animals and fungi are similar and highly conserved AND the role of Hox genes in controlling body plan development.			
(d) the importance of mitosis and apoptosis as mechanisms controlling the development of body form. To include an appreciation that the genes which regulate the cell cycle and apoptosis are able to respond to internal and external cell stimuli e.g. stress.			



Exam Specification

6.1.2 Patterns of inheritance			
(a) (i) the contribution of both environmental and genetic factors to phenotypic variation. To include examples of both genetic and environmental contributions – environmental examples could include diet in animals and etiolation or chlorosis in plants. (ii) how sexual reproduction can lead to genetic variation within a species. Meiosis and the random fusion of gametes at fertilisation.			
(b) (i) genetic diagrams to show patterns of inheritance. To include monogenic inheritance, dihybrid inheritance, multiple alleles, sex linkage and codominance. (ii) the use of phenotypic ratios to identify linkage (autosomal and sex linkage) and epistasis. To include explanations of linkage and epistasis.			
(c) using the chi-squared χ^2 test to determine the significance of the difference between observed and expected results. The formula for the chi-squared χ^2 test will be provided.			
(d) the genetic basis of continuous and discontinuous variation. To include reference to the number of genes that influence each type of variation.			
(e) the factors that can affect the evolution of a species. To include stabilising selection and directional selection, genetic drift, genetic bottleneck and founder effect.			
(f) the use of the Hardy-Weinberg principle to calculate allele frequencies in populations. The equations for the Hardy-Weinberg principle will be provided where needed in assessments and do not need to be recalled. $p^2 + 2pq + q^2 = 1$ $p + q = 1$			
(g) the role of isolating mechanisms in the evolution of new species. To include geographical mechanisms (allopatric speciation) and reproductive mechanisms (sympatric speciation).			
(h) (i) the principles of artificial selection and its uses. To include examples of selective breeding in plants and animals AND an appreciation of the importance of maintaining a resource of genetic material for use in selective breeding including wild types.			
(h) (ii) the ethical considerations surrounding the use of artificial selection. To include a consideration of the more extreme examples of the use of artificial selection to 'improve' domestic species e.g. dog breeds.			



Exam Specification

6.1.3 Manipulating genomes			
(a) the principles of DNA sequencing and the development of new DNA sequencing techniques. To include the rapid advancements of the techniques used in sequencing, which have increased the speed of sequencing and allowed whole genome sequencing e.g. high-throughput sequencing.			
(b) (i) how gene sequencing has allowed for genome-wide comparisons between individuals and between species (ii) how gene sequencing has allowed for the sequences of amino acids in polypeptides to be predicted (iii) how gene sequencing has allowed for the development of synthetic biology. With reference to bioinformatics and computational biology and how these fields are contributing to biological research into genotype-phenotype relationships, epidemiology and searching for evolutionary relationships.			
(c) the principles of DNA profiling and its uses. To include forensics and analysis of disease risk.			
(d) the principles of the polymerase chain reaction (PCR) and its application in DNA analysis.			
(e) the principles and uses of electrophoresis for separating nucleic acid fragments or proteins. Opportunity for practical use of electrophoresis.			
(f) (i) the principles of genetic engineering. To include the isolation of genes from one organism and the placing of these genes into another organism using suitable vectors. (ii) the techniques used in genetic engineering. To include the use of restriction enzymes, plasmids and DNA ligase to form recombinant DNA with the desired gene and electroporation.			
(g) the ethical issues (both positive and negative) relating to the genetic manipulation of animals (including humans), plants and microorganisms. To include insect resistance in genetically modified soya, genetically modified pathogens for research and 'pharming' i.e. genetically modified animals to produce pharmaceuticals AND issues relating to patenting and technology transfer e.g. making genetically modified seed available to poor farmers.			
(h) the principles of, and potential for, gene therapy in medicine. To include the differences between somatic cell gene therapy and germ line cell gene therapy.			



Exam Specification

6.2.1 Cloning and biotechnology			
(a) (i) natural clones in plants and the production of natural clones for use in horticulture To include examples of natural cloning and the methods used to produce clones (various forms of vegetative propagation). (ii) how to take plant cuttings as an example of a simple cloning technique. Dissection of a selection of plant material to produce cuttings.			
(b) (i) the production of artificial clones of plants by micropropagation and tissue culture. To include an evaluation of the uses of plant cloning in horticulture and agriculture. (ii) the arguments for and against artificial cloning in plants.			
(c) natural clones in animal species. To include examples of natural clones (twins formed by embryo splitting).			
(d) (i) how artificial clones in animals can be produced by artificial embryo twinning or by enucleation and somatic cell nuclear transfer (SCNT). To include an evaluation of the uses of animal cloning (examples including in agriculture and medicine, and issues of longevity of cloned animals). (ii) the arguments for and against artificial cloning in animals.			
(e) the use of microorganisms in biotechnological processes. To include reasons why microorganisms are used e.g. economic considerations, short life cycle, growth requirements AND processes including brewing, baking, cheese making, yoghurt production, penicillin production, insulin production and bioremediation.			
(f) the advantages and disadvantages of using microorganisms to make food for human consumption. To include bacterial and fungal sources.			
(g) (i) how to culture microorganisms effectively, using aseptic techniques An opportunity for serial dilutions and culturing on agar plates. (ii) the importance of manipulating the growing conditions in batch and continuous fermentation in order to maximise the yield of product required.			
(h) (i) the standard growth curve of a microorganism in a closed culture To include the formula for number of individual organisms $N = N_0 \times 2^n$ An opportunity for serial dilutions and the use of broth. (ii) practical investigations into the factors affecting the growth of microorganisms.			
(i) the uses of immobilised enzymes in biotechnology and the different methods of immobilisation. To include methods of enzyme immobilisation AND an evaluation of the use of immobilised enzymes in biotechnology. examples could include: • glucose isomerase for the conversion of glucose to fructose • penicillin acylase for the formation of semi-synthetic penicillins (to which some penicillin-resistant organisms are not resistant) • lactase for the hydrolysis of lactose to glucose and galactose • aminocyclase for production of pure samples of L-amino acids • glucoamylase for the conversion of dextrins to glucose.			



Exam Specification

6.3.1 Ecosystems			
(a) ecosystems, which range in size, are dynamic and are influenced by both biotic and abiotic factors. To include reference to a variety of ecosystems of different sizes (e.g. a rock pool, a playing field, a large tree) and named examples of biotic and abiotic factors.			
(b) biomass transfers through ecosystems. To include how biomass transfers between trophic levels can be measured AND the efficiency of biomass transfers between trophic levels $\text{efficiency} = \frac{\text{biomass transferred}}{\text{biomass intake}} \times 100$ AND how human activities can manipulate the transfer of biomass through ecosystems.			
(c) recycling within ecosystems. To include the role of decomposers and the roles of microorganisms in recycling nitrogen within ecosystems (including <i>Nitrosomonas</i> , <i>Nitrobacter</i> , <i>Azotobacter</i> and <i>Rhizobium</i>) AND the importance of the carbon cycle to include the role of organisms (decomposition, respiration and photosynthesis) and physical and chemical effects in the cycling of carbon within ecosystems.			
(d) the process of primary succession in the development of an ecosystem. To include succession from pioneer species to a climax community AND deflected succession.			
(e) (i) how the distribution and abundance of organisms in an ecosystem can be measured. (ii) the use of sampling and recording methods to determine the distribution and abundance of organisms in a variety of ecosystems.			
6.3.2 Populations and sustainability			
(a) the factors that determine size of a population. To include the significance of limiting factors in determining the carrying capacity of a given environment and the impact of these factors on final population size.			
(b) interactions between populations. To include predator-prey relationships considering the effects on both predator and prey populations AND interspecific and intraspecific competition.			
(c) the reasons for, and differences between, conservation and preservation. To include the economic, social and ethical reasons for conservation of biological resources.			
(d) how the management of an ecosystem can provide resources in a sustainable way. Examples to include timber production and fishing.			
(e) the management of environmental resources and the effects of human activities. To include how ecosystems can be managed to balance the conflict between conservation/preservation and human needs AND the effects of human activities on the animal and plant populations and how these are controlled			



Mark Scheme

The markscheme given here is for an extended response question. They are by their nature, generic, with specific criteria adapted to the question. To achieve the higher mark within the level, you need to do the bit in italics.

This one is for biodiversity:

Level 3 (5–6 marks)

A detailed description **and** explanation of the potential effects of small population size on genetic **and** species biodiversity.

There is a well-developed line of reasoning which is clear and logically structured. All the information presented is relevant and substantiated.

Level 2 (3–4 marks)

A basic description **and** explanation of potential effects of small population size on genetic **and** species biodiversity.

OR

A detailed description **and** explanation of the potential effects of small population size on genetic **or** species biodiversity.

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

A description of some potential effects for genetic **and** species biodiversity of small population size.

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks

No response or no response worthy of credit.



Practical Skills guidance

Tables

The following guidelines should be followed when presenting results in tables.

- All raw data in a single table with ruled lines and border.
- Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).
- Processed data (e.g. means, rates, s.d.) in columns to the far right.
- No calculations in the table, only calculated values.
- Each column headed with informative description (for qualitative data) or physical quantity and correct units (for quantitative data); units separated from physical quantity using either brackets or a solidus (slash).
- No units in the body of the table, only in the column headings.
- Raw data recorded to a number of decimal places appropriate to the resolution of the measuring equipment.
- All raw data of the same type recorded to the same number of decimal places.
- Processed data recorded to up to one significant figure more than the raw data.

Graphs

The following guidelines should be followed when presenting data in graphs.

- There should be an informative title.
- Scales should be chosen so that the plotted points occupy at least half the graph grid in both the x and y directions and that are easy to work with.
- Plotted points must be accurate to half a small square – so use a sharp pencil to plot them.
- A line of best fit should have a reasonable balance of points about the line. Using a clear ruler will help with this.
- For calculating gradients, the length of the hypotenuse of the triangle should be greater than half the length of the line which has been drawn.
- The values of Δx and Δy must be given to an accuracy of at least one small square and remember to give appropriate units for the gradient.
- The y-intercept must be read from the axis where $x=0$, otherwise calculate from $y=mx+c$.



GUIDANCE FOR BIOLOGICAL DRAWING

What equipment is needed?

- **Sharp pencil** – HB is generally preferred, but H, 2H or B (for emphasis) can all be used according to preference.
- **Pencil sharpener** – A nail file may also be useful to keep the point really sharp.
- **Eraser**
- **Ruler** – For label lines.
- **Plain paper**

General Principles

When assessing biological drawing, marks are awarded for both **quality** of drawing and **labelling**. The latter may include **annotation**. The general principles described below apply to all types of biological drawing:

- **Use a sharp pencil only.** Don't use pens or coloured pencils.
- **Use clear, continuous lines.** A line which encloses a shape, such as a circle, should join up neatly without obvious overlap. Overlapping lines is a common error in hastily drawn sketches and is easily spotted and penalised by examiners.
- **Don't use any form of shading.** This includes stippling, cross-hatching and shading. Students find this is a hard instruction to follow, and it is sometimes difficult to justify. Although shading may help to make the drawing look more realistic and/or to discriminate between areas of the specimen, it does not represent a permanent structural feature. Artistic impression is certainly not what is required.
- **Accuracy is paramount.** It shows good observation. Remember that observation is assisted by understanding, so a good knowledge of theory goes alongside good drawing. Pay particular attention to the outlines of structures and to the relative proportions of different parts of the specimen. Don't draw what you think you *should* see, for example text book style drawings. Draw what you observe.
- **Guidelines can help.** Faint sketching of the main areas of the specimen which can later be erased may help. Some students find a simple grid helps them.
- **Magnification and illumination.** To help in the drawing process it is often useful to use a hand lens or a magnifying glass for larger specimens and, for microscopy, both low and high power lenses when making preliminary observations. Field biologists usually carry a hand lens as standard equipment. Dissection, and drawing from a dissection, is greatly aided by good illumination of the specimen by a lamp and by a tripod lens placed over the material where possible.

- **Make the drawing large enough.** If the specimen is a relatively large structure such as a plant or a section of an organ, it should normally occupy more than half the available space on the page. In microscopy, individual cells drawn at high power should be about one to several centimetres in diameter.
- **Correct mistakes.** If you make a mistake, use a good quality eraser to rub out the lines completely.
- **Include a title.** Include a title stating what the specimen is.
- **Include a scale.** Include a scale if relevant (see **Labelling** below). If you are drawing from a microscope, it is useful to state the combined magnification of the eyepiece plus objective lenses used when making the drawing, e.g. x100 (low power) or x400 (high power). Note, though, that this is not the same as recording the scale.

Labelling

When labelling biological drawings, follow the guidance below:

- Use a sharp pencil.
- Label all relevant structures, including all tissues in the case of microscopy.
- Use a ruler for label lines and scale bars.
- Label lines should start exactly at the structure being labelled; don't use arrowheads.
- Arrange label lines neatly and make sure they don't cross over each other. It is visually attractive, though not essential, if the length of the label lines is adjusted so that the actual labels are right or left justified, i.e. line up vertically above each other on either side of the drawing.
- Labels should be written horizontally, as in a textbook, not written at the same angle as the label line.
- As previously mentioned, a title, stating what the specimen is, should be added at the top or bottom of the drawing.
- Add a scale bar immediately below the drawing if necessary (see below).



Assessment

Methods of formal assessment in Biology are as follows:

1. End of Unit Assessments
2. Mock Examinations

1. End of Unit Assessments

You will complete an end of unit assessment at the end of each unit of work as laid out in the table below. You will be given a minimum of 1 weeks' notice to prepare for each assessment and may be allocated revision tasks as homework or may have to complete this in your own time.

Module 2/3	Module 4
Foundations of Biology	Biodiversity, Evolution & disease
Components of living systems	Classification & Evolution
Biological Molecules Plasma Membranes	Biodiversity
Enzymes Cell division	Communicable diseases
Exchange & Transport Breathing and exchange surfaces	Defence against pathogens
Transport systems of plants & animals	Immunity
Module 5	Module 6
Communication, Homeostasis and Energy	Genetics, Evolution & Ecosystems
Neuronal communication	Genetics of living Systems
Hormonal communication	Patterns of inheritance
Homeostasis	Manipulating genomes
Plant responses	Cloning & Biotechnology
Energy for biological processes	Ecosystems
Respiration	Populations & Sustainability



Assessment

Methods of formal assessment in Biology are as follows:

1. End of Unit Assessments
2. Mock Examinations

2. Mock Examinations

Throughout Year 12 and 13 you will be entitled to rigorous mock examinations to simulate the real thing. By the time you sit your real exam in the Summer of year 13 you will have extensive experience completing each exam paper under simulated conditions. You will be sitting the following examinations for Biology:

Mock Examination	Papers
Mock Exam – Winter Term of Year 12	• Paper based on Modules 2 and 3
UCAS Exams – Summer of Year 12	• Paper 1: Breadth in Biology • Paper 2: Depth in Biology • Based on Modules 1, 2, 3 and 4.
Mock Exam – Winter Term of Year 13	• Paper 1: Biological Processes • Based on Modules 1, 2, 3 and 5. • Paper 2: Biological Diversity • Based on Modules 1, 2, 4 and 6.
Final Mock Exam – Spring Term of Year 13	• Paper 1: Biological Processes • Based on Modules 1, 2, 3 and 5. • Paper 2: Biological Diversity • Based on Modules 1, 2, 4 and 6. • Paper 3: Unified Biology • Based on All 6 modules.

The dates for these exams will be given to you at the beginning of the academic year. You will be given plenty of notice and time to revise, as well as a personalised exam table for each set of exams.

Access Arrangements

If at any time you feel you would benefit from additional access arrangements in an exam, such as the use of a laptop, please speak with your subject teacher as soon as possible.



Homework & Independent Work

Objectives of a Sixth Form Homework Policy

Objectives of a John Roan Sixth Form Homework policy are as follows:

- To enable our students to achieve the best grades that they are capable of at Post-16 through:
 - The consolidation and revision of learned material
 - The application of learned material
 - Preparation for lessons to enable access to challenging subject content
- To reinforce high expectations of our students as independent learners
- To equip our students with the study skills required for University and other destinations

Expectation of subject homework

At The John Roan Sixth Form we aim to teach students to become independent learners who use their private study time effectively. Students will be given guidance and support with creating revision schedules, effective note taking, essay writing and academic literacy, but will also be expected to practise and demonstrate these in their home learning.

As a benchmark, students should expect to receive an amount of homework per subject that is equivalent to twice the number of contact hours that they receive in school: six hours per subject which amounts to 18 hours per week.

Deadlines

Failure to meet deadlines for homework will result in a one hour detention after school the following day, while repeated failures to meet homework deadline will escalate to an academic support plan or school based exclusion. Students who are placed into detention will still be expected to complete missed homework. Students are encouraged to communicate with teachers about other deadlines in place so that they can be supportive of work set in other subjects.

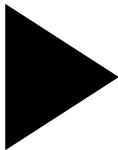
Homework setting

All homework will be set for students using Show My Homework which is available as an app which can be accessed via a mobile phone, or as a website that can be accessed via a computer. In some instances, homework will be set on software including Microsoft Teams. However, instructions for any homework set on these platforms will be repeated on Show My Homework to ensure consistency.



Homework & Independent Work

Examples of homework set at KS5 in A-Level Biology will typically include:

Revision	Application	Flipped-Learning
		
Revision homework tasks will enable you to consolidate your learning and eliminate gaps in subject knowledge, helping you to prepare for your exams.	Application homework tasks test for understanding of recently-acquired subject knowledge and develop your technique for exams.	Flipped learning homework tasks ensure that you are able to access challenging subject material and allow you to progress quickly through your course.
✓ Standing Homework of producing revision notes from the lesson. ✓ You can use your revision cards to do this. ✓ Creating mind maps and flashcards ✓ Creating / revising from check lists ✓ Creating glossaries of terms ✓ Creating flow charts ✓ Creating a topic quiz ✓ Revising for a topic quiz ✓ Completing past papers	✓ Standing homework of completing end of topic questions ✓ Completing PAG write up ✓ Completion of a practical follow up sheet. ✓ Completing a calculation sheet. ✓ Completing past papers questions ✓ Preparing a presentation for a lesson ✓ Completing coursework or another assignment for a deadline ✓ Independent or guided research on a lesson topic ✓ Completing a topic quiz	✓ Standing homework of pre-reading the next lesson's topic. ✓ Preparation of notes in advance of a next lesson ✓ Answering comprehension questions ahead of a new topic ✓ Preparing a presentation for a lesson ✓ Independent research in preparation for an experiment ✓ Independent or guided research ahead of a lesson

Inspired

Confident

Ambitious



How to get an A* at Biology A-Level

- To get an A* grade in Biology you will need to demonstrate in your exams that you have a detailed and comprehensive knowledge and understanding of scientific ideas, processes, techniques and procedures from the range covered in the specification, applying them to familiar and new contexts.
- You will need to select information carefully to ensure that it is relevant to the question, giving explanations that are lucid and well-structured and you will communicate this clearly and concisely using appropriate scientific terminology.
- You will be able to manipulate algebraic equations fluently and accurately, using significant figures, powers of ten and SI units, and carry out complex calculations yielding results that are error free and expressed with appropriate precision.
- You will demonstrate a firm grasp of the scientific reasons for using the whole range of practical procedures mentioned in the specification.
- You will use your knowledge and understanding to demonstrate wide-ranging insights into the development and refinement of most areas of practical designs and procedures.
- You will be able to suggest and make observations and measurements with appropriate precision, and use a range of qualitative and quantitative data to form a judgement or reach a conclusion.
- You will be able to select and link information and ideas from different parts of the specification in order to give explanations that are usually complete and accurate.
- You will analyse with fluency and accuracy, information and evidence that is provided in a wide variety of unfamiliar contexts selecting a full range of appropriate techniques involving theoretical and practical areas of the specification.
- You will get about 80% of the marks!



Essential Resources & Wider Reading



Podcasts

This Week In Science

The Infinite Monkey Cage

Radiolab

The Life Scientific

The Natural Selection

How to Vaccinate the World

Risky Talk

<http://podcasts.ox.ac.uk/> - Oxford Podcasts

Health report



Websites

<https://www.biochemistry.org/education/schools-and-fe-colleges/>

Biochemical Society

www.schoolscience.co.uk/ages-16-to-19/resources/biology/biochemistry - Biochemistry resources

<https://www.nationalgeographic.com/> - National Geographic

<https://institutions.newscientist.com/> - New Scientist (subscription required)

<http://www.ibiblio.org/virtualcell/index.htm> - An interactive cell biology site.

<http://www.accessexcellence.org/RC/VL/GG> - A web site showing illustrations of many processes of biotechnology.

<http://www.dnai.org/a/index.html> - Explore the genetic code.

<http://nobelprize.org> - Details of the history of the best scientific discoveries.

<http://nature.com> - The site of the scientific journal.

<http://royalsociety.org> - Podcasts, news and interviews with scientists about recent scientific developments.

<http://www.nhm.ac.uk> - The London Natural History Museum's website with lots of interesting educational material.

<http://www.bmj.com> - The website of the British Medical Journal.

http://www.bbc.co.uk/news/science_and_environment - The BBC news page for Science and the Environment.



Videos

<http://www.bbc.co.uk/sn/tvradio/programmes/horizon/> - Horizon TV Show

Everything David Attenborough has done - watch the lot!!



Essential Resources & Wider Reading



Books

"The selfish gene", "The ancestors' tale", "The Oxford Book of Modern Science Writing" and other books by Richard Dawkins.
"Y, the descent of man", "In the Blood: God, Genes and Destiny", "Almost Like a Whale: The 'Origin of Species' Updated", "The Language of the genes" by Steve Jones.
"The eighth day of creation: the makers of the revolution in biology" by Horace Judson.
"Power, sex and suicide - mitochondria and the meaning of life" and other books by Nick Lane.
"Advice to a young scientist" by Peter Medawar.
"Junk DNA" and "Epigenetics Revolution" by Nessa Carey
"Genome - autobiography of a species", "Nature via Nurture", "The Red Queen: Sex and the Evolution of Human Nature" and other books by Matt Ridley.
"The seven daughters of Eve" by Bryan Sykes.
"Life, chemistry and molecular biology", W. Pickering, C. Smith and E.J. Wood, pub. Portland Press.
"The Man Who Mistook His Wife For A Hat" by Oliver Sachs
"What A Plant Knows" by Daniel Chamovitz
"The Rough Guide to the Brain" by Barry Gibb
"Life at the Extremes" by Frances Ashcroft
"The Logic of Life" by C.A.R. Boyd, Denis Noble, Sir James Black



Books

"Conversations with Neil's Brain: The Natural Nature of Thought" by William Calvin
"Microbe Hunters" by P. De Kruif
"Elegance in Science" by I. Glynn
"Bad Science" by Ben Goldacre
"The Human Brain: A Guided Tour" by S. Greenfield
"The Music of Life: Biology beyond the Genome" by N. Noble
"Blood of the Isles" by B. Sykes
"One in Three" by A. Wishart
"Berne and Levy Principles of Physiology" by Matthew Levy, Bruce Stanton and Bruce Koeppen
"The Physiology of Excitable Cells" by D. Aidley
"Pharmacology" by H. Rang
"Biochemistry" by L. Stryer
"Introduction and Intuition in Scientific Thought" by P. Medawar
"The Unnatural Nature of Science" by L. Wolpert
"Nerve and Muscle" by R. Keynes and D. Aidley
"How we Live and Why we Die: The Secret Lives of Cells" by Lewis Wolpert
"Why Evolution is True" by J. Coyne
"Endless Forms Most Beautiful: The New Science of Evo Devo and the Making of the Animal Kingdom" by S. Carroll
"The Incredible Unlikelihood of Being" by A. Roberts
"Cuckoo, Cheating by Nature" by N. Davies



University Courses & Career Paths



Transferrable skills

**Critical thinking
Analysis
Problem Solving
Public speaking
Presentation skills**

**Teamworking
Numeracy
Communication
Time Management &
Organisation**

**IT skills
Research & Data
Analysis
Reasoning**



University Courses

**Biology, Biological Sciences
Natural Sciences, Biomedical Sciences, Biomedical Engineering, Medicine,
Pharmacy, Pharmacology,
Veterinary Medicine, Dentistry
Nursing, Midwifery,
Biochemistry, Genetics, Biotechnology, Microbiology, Neuroscience, Public
Health,
Animal Biology, Human Biology, Marine Biology
Molecular Biology, Diagnostic Radiography, Life Sciences,
Food Science, Zoology
Agricultural Engineering, Conservation,
Ecology, Ophthalmics and Optometry
Environmental Management, Horticulture, Botany,
Paramedic Science, Physiotherapy, Occupational Therapy, Speech Therapy,
Audiology, Nutrition, food and Beverage Studies, Archaeology, Chemistry,
Geology, Environment and Earth Science, Chemical Engineering, Psychology,
Anthropology, Sports Science,**



Career Paths

Jobs commonly associated with Biology A-level include doctor, dentist, neuroscientist, research scientist, Academic researcher, lecturer/ teacher, marine biologist, microbiologist, nature conservation officer, pharmacologist, soil scientist, laboratory technician, genetic counsellor, vet and science writer. However, this is a narrow idea of where Biology can take you. A large number of jobs do not require specific courses but, instead, want transferrable skills. From Biology, you will get a lot of logic, numerical, investigative and analytical skills that will be valued by many companies; it is not uncommon for biologists to become lawyers, for example.

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