

INTERNATIONAL ADVANCED LEVEL

# BIOLOGY

## SCHEME OF WORK

Pearson Edexcel International Advanced Subsidiary in Biology (XBI11)

Pearson Edexcel International Advanced Level in Biology (YBI11)

First teaching September 2018

First examination from January 2019

First certification from August 2019 (International Advanced Subsidiary)  
and August 2020 (International Advanced Level)

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## Introduction

The following scheme of work provides an overview of the content of the 2018 International Advanced Level Biology and shows how the content could be taught as a guideline approach only. It should be adapted by schools to fit their timetabling and staffing arrangements.

It is based upon a two-year delivery model where all IAS content is being taught in the first year and the remaining IA2 content in the second year.

The scheme of work is broken up into units and topics, so that there is greater flexibility for moving topics around to meet planning needs.

It includes:

- Recommended teaching time for topics, though of course this is adaptable according to individual teaching needs
- Classroom activities, teaching points and suggested teaching resources
- Objectives for students at the end of the topic area and integrated Transferable Skills\* that are being developed

The number of guided learning hours for Advanced Level is 360. Teachers should be aware that the estimated teaching hours are approximate and should be used as a guideline only.

## IAL Biology Assessment structure

Unit Title	Assessment
<b>Unit 1:</b> Molecules, diet, transport and health	20%, 1 hour and 30 minutes, 80 marks
<b>Unit 2:</b> Cells, development, biodiversity and conservation	20%, 1 hour and 30 minutes, 80 marks
<b>Unit 3:</b> Practical Skills in Biology I	10%, 1 hour and 20 minutes, 50 marks
<b>Unit 4:</b> Energy, environment, microbiology and immunity	20%, 1 hour and 45 minutes, 90 marks
<b>Unit 5:</b> Respiration, internal environment, coordination and gene technology	20%, 1 hour and 45 minutes, 90 marks
<b>Unit 6:</b> Practical Skills in Biology II	10%, 1 hour and 20 minutes, 50 marks

## Assessment Objectives

Assessment Objectives	
<b>A01</b>	Demonstrate knowledge and understanding of science.
<b>A02</b>	(a) Application of knowledge and understanding of science in familiar and unfamiliar contexts. (b) Analysis and evaluation of scientific information to make judgments and reach conclusions.
<b>A03</b>	Experimental skills in science, including analysis and evaluation of data and methods.

## Estimated teaching hours

### Year 1: IAS

Unit	Topic	Estimated teaching hours
<b>1</b>	1 Molecules, transport and health	40
	2 Membranes, proteins, DNA and gene expression	40
<b>2</b>	3 Cell structure, reproduction and development	40
	4 Plant structure and function, biodiversity and conservation	40
<b>4</b>	5 Energy flow, ecosystems and the environment (start)	20
	6	
<b>5</b>	7	
	8	
	<b>Total</b>	<b>180 hours</b>

**Year 2: IA2**

<b>Unit</b>	<b>Topic</b>	<b>Estimated teaching hours</b>
<b>1</b>	1	
	2	
<b>2</b>	3	
	3	
<b>4</b>	5 Energy flow, ecosystems and the environment (continued)	26
	6 Microbiology, immunity and forensics	50
<b>5</b>	7 Respiration, muscles and the internal environment	52
	8 Coordination, response and gene technology	52
	<b>Total</b>	<b>180 hours</b>

## \*Why transferable skills?

In recent years, higher education institutions and global employers have consistently identified the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work. To support the design of our qualifications, we have mapped them to a transferable skills framework. The framework includes cognitive, intrapersonal skills and interpersonal skills and each skill has been interpreted for each specification to ensure they are appropriate for the subject. Further information on transferable skills is available on the [website](#).

### Skills interpretation for IAL Biology

<b>NRC framework skill</b>	<b>Skill interpretation for IAL Biology</b>
Cognitive skills	
Cognitive Processes and Strategies	
Critical thinking	Use many pieces of information from different areas of the subject and synthesise the information to make judgments.
Problem solving	Apply unifying patterns and themes in biology and use them in new and changing situations.
Analysis	Analyse and interpret data, experimental methods and results, drawing conclusions which are consistent with evidence from experimental activities.
Reasoning	Evaluate evidence related to biology and then bring it together to form a conclusion.
Interpretation	Select, organise and present relevant information clearly and logically using appropriate vocabulary, definitions and conventions.
Decision making	Evaluate data, experimental methods and results, drawing conclusions that are consistent with evidence from secondary sources and other experimental activities. Suggest possible improvements and further investigations to extend an investigation.
Adaptive learning	Understand unifying patterns and themes in biology and apply them in new and possibly unfamiliar contexts.
Executive function	Plan investigations using knowledge and understanding of experimental and investigative skills, with due regard for correct and safe laboratory procedures. Evaluate the effectiveness of an investigation in terms of accuracy, repeatability and validity.
Creativity	

Creativity	Apply existing knowledge and understanding of biological processes to situations set in a new and possibly unfamiliar context.
Innovation	Use a novel strategy to apply existing knowledge and understanding of biological concepts in new and unfamiliar situations.
<b>Intrapersonal skills</b>	
Intellectual openness	
Adaptability	Select and apply knowledge and understanding of scientific processes, which is not prompted or provided, to problems in biology.
Personal and social responsibility	Appreciate the ethical and social issues in biology.
Continuous learning	Plan and reflect on own learning, setting goals, meeting and reviewing them regularly.
Intellectual interest and curiosity	Identify a problem under own initiative, plan a solution and carry this out.
Work ethic/conscientiousness	
Initiative	Use knowledge of biology independently, without guided learning, to further own understanding.
Self-direction	Plan and carry out investigations independently.
Responsibility	Take responsibility for any errors or omissions in own work and create a plan to improve.
Perseverance	Seek new ways to continue and improve own learning, despite setbacks.
Productivity	Develop a fluency in technical vocabulary so that sophisticated answers are produced in extended answers.
Self-regulation (metacognition, forethought, reflection)	Appreciate own knowledge of biology and understand a learning task. Develop and refine a strategy over time for applications of biology to different contexts, reflect on the success or otherwise of the strategy.
Ethics	Produce output with a specific moral purpose for which one is accountable.
Integrity	Take ownership of own work and willingly respond to questions and challenges.
<b>Positive Core Self Evaluation</b>	
Self-monitoring / self-evaluation / self-reinforcement	Plan and review own work as a matter of routine.

NRC framework skill	Skill interpretation in this subject
Interpersonal skills	
Teamwork and collaboration	
Communication	Communicate a biological process or technique, either verbally or written, to peers and teachers and answer questions.
Collaboration	Carry out a peer review and provide supportive, constructive feedback to another.
Teamwork	Work collaboratively with other students in practical work so that the contribution of every student is valued and effective.
Co-operation	Share own resources and learning techniques with other students.
Interpersonal skills	Use verbal and written communication skills in a dialogue about a topic in biology.
Empathy / perspective taking	Support the position of another in a piece of writing or in an oral presentation.
Negotiation	Debate an ethical topic or issue in biology, attempting to reach shared conclusions with others, compromising where appropriate using negotiation skills.
Leadership	
Leadership	Lead others in a group activity to effectively encourage and develop learning.
Responsibility	Take responsibility for the outcome of a team activity, even if one is not solely responsible for the outcome.
Assertive communication	Chair a debate, allowing representations and directing the discussions to a conclusion.
Self-presentation	Utilise a number of different opportunities to exhibit communication skills in a variety of ways including written and verbal, including presenting a topic to the class.

Weeks	Topic Area Aims and Learning Outcomes	Exemplar classroom activities, teaching points and suggested teaching resources	Integrated Transferable Skills
1	<p>the importance of water as a solvent in transport, including its dipole nature</p> <p>the difference between monosaccharides, disaccharides and polysaccharides, including glycogen and starch (amylose and amylopectin)</p> <p>relate the structures of monosaccharides, disaccharides and polysaccharides to their roles in providing and storing energy</p> <p><b>CORE PRACTICAL 1</b>  <b>Use a semi-quantitative method with Benedict's reagent to estimate the concentrations of reducing sugars and with iodine solution to estimate the concentrations of starch, using colour standards.</b></p>	<p>Use molecular models to show the structures of water and monosaccharides.</p> <p>Draw a summary table to compare the structures of disaccharides and polysaccharides.</p> <p>All students should carry out practical work. If a colorimeter is available, a calibration curve may be drawn using a range of starch solutions and standard iodine solution.</p>	<p><b>Continuous learning</b></p> <p>Plan and reflect on own learning, setting goals, meeting and reviewing them regularly.</p> <p>Students could prepare weekly targets for their learning of a particular topic, then using quick self-assessment questions to review their progress.</p> <p><b>Teamwork</b></p> <p>Work collaboratively with other students in practical work so that the contribution of every student is valued and effective.</p> <p>There are many opportunities for students to work together, in pairs or small groups, when carrying out core practical activities. Each student should be assigned a particular task within the group.</p>

<p><b>2</b></p>	<p>how monosaccharides (glucose, fructose and galactose) join together to form disaccharides (maltose, sucrose and lactose) and polysaccharides (glycogen, amylose and amylopectin) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions</p> <p>how a triglyceride is synthesised by the formation of ester bonds during condensation reactions between glycerol and three fatty acids</p> <p>the differences between saturated and unsaturated lipids</p>	<p>Practise making annotated diagrams to show the formation and hydrolysis of glycosidic bonds in disaccharides and polysaccharides.</p> <p>Practise making annotated diagrams to show the formation and hydrolysis of ester bonds in triglycerides.</p> <p>Produce a table to show the differences between saturated and unsaturated fatty acids.</p>	<p><b>Self-monitoring / self-evaluation / self-reinforcement</b></p> <p>Plan and review own work as a matter of routine.</p> <p>The regular use of self-assessment questions, including multiple choice, true / false, labelling diagrams, match lists and cloze passage will help students to review their work.</p>
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<p><b>3</b></p>	<p>why many animals have a heart and circulation (mass transport to overcome the limitations of diffusion in meeting the requirements of organisms)</p> <p>the cardiac cycle (atrial systole, ventricular systole and cardiac diastole)</p> <p>the structure and operation of the mammalian heart, including the major blood vessels, to its function</p> <p>how the structures of blood vessels (capillaries, arteries and veins) relate to their functions</p> <p><b>RECOMMENDED ADDITIONAL PRACTICAL</b>  <b>Investigate the structure of a mammalian heart by dissection.</b></p>	<p>Look at a model heart.</p> <p>View animation to show the cardiac cycle.</p> <p>Look at prepared slides or transparencies to show the structures of capillaries, arteries and veins.</p> <p>Dissect a mammalian heart (e.g. sheep heart from a butcher).</p>	
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<p><b>4</b></p>	<p>the role of haemoglobin in the transport of oxygen and carbon dioxide</p> <p>the oxygen dissociation curve of haemoglobin, the Bohr effect and the significance of the oxygen affinity of fetal haemoglobin compared with adult haemoglobin</p> <p>the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD)</p> <p>the course of events that leads to atherosclerosis (endothelial dysfunction, inflammatory response, plaque formation, raised blood pressure)</p>	<p>Compare dissociation curves for different types of haemoglobin.</p> <p>Prepare flow diagrams to show the sequence of events in blood clotting and the events leading to atherosclerosis.</p>	
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<p><b>5</b></p>	<p>how factors such as genetics, diet, age, gender, high blood pressure, smoking and inactivity increase the risk of cardiovascular disease (CVD)</p> <p>the link between dietary antioxidants and the risk of cardiovascular disease (CVD)</p> <p><b>CORE PRACTICAL 2</b>  <b>Investigate the vitamin C content of food and drink.</b></p>	<p>Research risk factors for cardiovascular disease.</p> <p>Use Food Tables to compare the vitamin C content of different fruits.</p> <p>All students should carry out practical work.</p>	<p><b>Intellectual interest and curiosity</b></p> <p>Identify a problem under own initiative, plan a solution and carry this out.</p> <p>Many of the core practicals lend themselves to further investigations. Even if students do not carry these out practically, they should be given the opportunity to plan an investigation, with careful consideration of the variables. This will help them to develop the skills needed to cope successfully with questions on Units 3 and 6.</p>
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<p><b>6</b></p>	<p>analyse and interpret quantitative data on illness and mortality rates to determine health risks, including distinguishing between correlation and causation and recognising conflicting evidence</p> <p>evaluate the design of studies used to determine health risk factors, including sample selection and sample size used to collect data that is both valid and reliable</p> <p>why people's perception of risks are often different from the actual risks, including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease</p>	<p>Research data on health risks and consider the validity of the studies.</p> <p>Prepare a questionnaire to gain information on lifestyle factors and perceived risks of the development of heart disease.</p>	<p><b>Integrity</b></p> <p>Take ownership of own work and willingly respond to questions and challenges.</p> <p>Students could work independently to prepare a short presentation on a topic of their own choice and be prepared to answer questions.</p>
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<p><b>7</b></p>	<p>analyse data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs)</p> <p>the evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and cardiovascular disease (CVD)</p> <p>how people use scientific knowledge about the effect of diet, including obesity indicators, such as body mass index and waist-to-hip ratio, exercise and smoking to reduce their risk of coronary heart disease</p> <p>the benefits and risks of treatments for cardiovascular disease (CVD) (antihypertensives, statins, anticoagulants and platelet inhibitors)</p>	<p>Analyse data from research on blood cholesterol and CVD.</p> <p>Plot correlations between cholesterol levels and CVD.</p> <p>Research benefits and risks of treatments for CVD.</p>	<p><b>Communication</b></p> <p>Communicate a biological process or technique, either verbally or written, to peers and teachers and answer questions.</p> <p>Written or verbal presentations of a specification topic of their choice give students opportunities to develop communication skills.</p> <p><b>Collaboration</b></p> <p>Carry out a peer review and provide supportive, constructive feedback to another.</p> <p>Students can work in pairs to appraise a short piece of written work and provide helpful feedback.</p> <p><b>Interpersonal skills</b></p> <p>Use verbal and written communication skills in a dialogue about a topic in biology.</p> <p>Written or verbal presentations of a specification topic of their choice give students opportunities to develop interpersonal skills.</p>
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<p><b>8</b></p>	<p>the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface and difference in concentration)</p> <p>how the rate of diffusion is dependent on these properties and can be calculated using Fick's Law of Diffusion</p> <p>how the structure of the mammalian lung is adapted for rapid gaseous exchange</p> <p>know the structure and properties of cell membranes</p> <p>how models such as the fluid mosaic model of membrane structure are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes</p> <p><b>CORE PRACTICAL 3</b>  <b>Investigate membrane properties including the effect of alcohol and temperature on membrane permeability.</b></p>	<p>Calculate the surface area: volume ratio for a series of cubes of different sizes.</p> <p>View animations of diffusion in liquids and gas.</p> <p>Summarise the factors that influence the rate of diffusion.</p> <p>All students should carry out practical work. Membrane properties can be investigated using fresh beetroot tissue and using the loss of pigment to indicate changes in membrane permeability.</p>	
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<p><b>9</b></p>	<p>what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane, down a water potential gradient</p> <p><b>RECOMMENDED ADDITIONAL PRACTICAL</b>  <b>Investigate tissue water potentials using plant tissue and graded concentrations of a solute.</b></p> <p>what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP as an immediate source of energy), endocytosis and exocytosis</p> <p>the involvement of carrier and channel proteins in membrane transport</p>	<p>View animations showing the movement of water by osmosis and other membrane transport processes.</p> <p>All students should carry out practical work. Tissue water potentials may be determined using suitable plant tissue, such as potato, and a range of sucrose solutions. This practical introduces students to quantitative work and evaluation of data.</p>	
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<p><b>10</b></p>	<p>know the basic structure of an amino acid</p> <p>the formation of polypeptides and proteins (amino acid monomers linked by condensation reactions to form peptide bonds)</p> <p>the significance of a protein's primary structure in determining its secondary structure, three-dimensional structure and properties (globular and fibrous proteins and the types of bonds involved in its three-dimensional structure)</p> <p>the molecular structure of a globular protein and a fibrous protein and understand how their structures relate to their functions (including haemoglobin and collagen)</p> <p><b>RECOMMENDED ADDITIONAL PRACTICAL</b></p> <p><b>Use a semi-quantitative method to estimate protein concentration using biuret reagent and colour standards.</b></p>	<p>Use molecular models to show the basic structure of an amino acid.</p> <p>Make annotated diagrams to show the formation and hydrolysis of a peptide bond.</p> <p>Use plasticine (or equivalent modelling clay) to make models showing levels of protein structure.</p> <p>All students should carry out practical work. Protein standards can be made using albumen powder.</p>	
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<p><b>11</b></p>	<p>the mechanism of action and the specificity of enzymes in terms of their three-dimensional structure</p> <p>enzymes are biological catalysts that reduce activation energy</p> <p>there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes catalysing reactions outside cells</p> <p><b>CORE PRACTICAL 4</b>  <b>Investigate the effect of temperature, pH, enzyme concentration and substrate concentration on the initial rate of enzyme-catalysed reactions.</b></p>	<p>View animations of enzyme activity.</p> <p>All students should carry out practical work. The practicals investigating enzyme activity could be organised as a 'circus arrangement' with each small group of students investigating one factor. They then share their methods, their results and evaluate the data.</p> <p>As with other quantitative investigations, it is essential to consider and identify the dependent variable, the independent variable and controlled (or standardised) variables.</p>	<p><b>Decision making</b></p> <p>Evaluate data, experimental methods and results, drawing conclusions that are consistent with evidence from secondary sources and other experimental activities. Suggest possible improvements and further investigations to extend an investigation.</p> <p>Critical evaluation of results from core practicals, including gathering class data, identification of anomalies and discussion of improvements and possible further investigations related to each practical activity.</p>
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<p><b>13</b></p>	<p>the process of protein synthesis (transcription and translation), including the role of RNA polymerase, translation, messenger RNA, transfer RNA, ribosomes and the role of start and stop codons</p> <p>the roles of the DNA template (antisense) strand in transcription, codons on messenger RNA and anticodons on transfer RNA</p> <p>how errors in DNA replication can give rise to mutations (substitution, insertion and deletion of bases)</p> <p>some mutations will give rise to cancer or genetic disorders, but many mutations will have no observable effect</p> <p>what is meant by the terms <i>gene, allele, genotype, phenotype, recessive, dominant, codominance, homozygote</i> and <i>heterozygote</i></p> <p>patterns of inheritance, including the interpretation of genetic pedigree diagrams, in the context of monohybrid inheritance</p> <p>sex linkage on the X chromosome, including red-green colour blindness in humans</p>	<p>View animations of the process of protein synthesis.</p> <p>Practise writing complementary DNA and mRNA base sequences.</p> <p>Start to prepare a glossary of terms.</p> <p>Research examples of monohybrid inheritance and X-linked examples of sex linkage.</p>	<p><b>Problem solving</b></p> <p>Apply unifying patterns and themes in biology and use them in new and changing situations.</p> <p>Students can work independently to attempt many questions relating to, for example, genetic crosses (monohybrid) and sex linkage. These should be supported with worked examples of correct answers.</p>
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<p><b>14</b></p>	<p>how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems</p> <p>the uses of genetic screening, including the identification of carriers, pre-implantation genetic diagnosis (PGD) and prenatal testing, including amniocentesis and chorionic villus sampling</p> <p>the implications of prenatal genetic screening</p> <p>the ethical and social issues relating to genetic screening from a range of ethical viewpoints, including religious, moral and social implications</p>	<p>Examine case studies of people with cystic fibrosis.</p> <p>Debate the ethical and social issues relating to genetic screening.</p>	<p><b>Personal and social responsibility</b></p> <p>Appreciate the ethical and social issues in biology.</p> <p>Students should be given an opportunity to work in small groups to consider some of the social, ethical and moral implications of genetic screening.</p> <p>This could take the form of a case study, in a hypothetical situation where, for example, two parents are known to be heterozygous for a debilitating genetic disorder but are considering having a child.</p> <p><b>Negotiation</b></p> <p>Debate an ethical topic or issue in biology, attempting to reach shared conclusions with others, compromising where appropriate using negotiation skills.</p> <p>Class discussion of ethical issues in biology, such as genetic screening or the use of animals in research, gives students opportunities to reach shared conclusions.</p>
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**15 REVISION**

**Responsibility**

Take responsibility for any errors or omissions in own work and create a plan to improve.

Constructive feedback of formative assignments gives students opportunities to take responsibility for errors or omissions and to create a plan to improve.

**Perseverance**

Seek new ways to continue and improve own learning, despite setbacks.

Positive and encouraging feedback on formative assignments, such as short homework activities, should help students to continue and improve their learning.

**Self-regulation  
(metacognition,  
forethought, reflection)**

Appreciate own knowledge of biology and understand a learning task. Develop and refine a strategy over time for applications of biology to different contexts, reflect on the success or otherwise of the strategy.

			<p>Students may find it helpful to prepare a list of 'key points' for a particular topic, to review and summarise the essential information.</p> <p><b>Co-operation</b></p> <p>Share own resources and learning techniques with other students.</p> <p>Working in small groups to discuss strategies for effective revision and learning.</p>
<p><b>16</b></p>	<p>all living organisms are made of cells, sharing some common features</p> <p>how the cells of multicellular organisms are organised into tissues, tissues into organs and organs into organ systems</p> <p>the ultrastructure of eukaryotic cells, including nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes and Golgi apparatus, and the function of these organelles</p> <p>the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells, including their role in the formation of extracellular enzymes</p>	<p>Examine electron micrographs of cells and identify organelles. These could be projected from transparencies or from web sources.</p> <p>Make drawings to show the characteristic features of organelles.</p> <p>Make an annotated diagram showing the role of the rER and Golgi apparatus in protein transport.</p>	

<p><b>17</b></p>	<p>the ultrastructure of prokaryotic cells, including cell wall, capsule, plasmid, flagellum, pili, ribosomes and circular DNA, and the function of these structures</p> <p>recognise the organelles in eukaryotic cells from electron microscope (EM) images</p> <p>how magnification and resolution can be achieved using light and electron microscopy</p> <p>the importance of staining specimens in microscopy</p> <p><b>CORE PRACTICAL 5</b></p> <p><b>(i) use a light microscope to make observations and labelled drawings of suitable animal cells</b></p> <p><b>(ii) use a graticule with a microscope to make measurements and understand the concept of scale</b></p>	<p>Examine electron micrographs (or other images) of prokaryotic cells and identify structures. These could be projected from transparencies or from web sources.</p> <p>Make a table to show differences between the structures of eukaryotic and prokaryotic cells.</p> <p>All students should carry out practical work. Prepared, stained slides of cheek (buccal) epithelial cells are suitable for this activity.</p>	
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<p><b>18</b></p>	<p>a locus is the location of genes on a chromosome</p> <p>the linkage of genes on a chromosome</p> <p>the role of mitosis and the cell cycle in producing genetically identical daughter cells for growth and asexual reproduction</p> <p><b>CORE PRACTICAL 6</b>  <b>Prepare and stain a root tip squash to observe the stages of mitosis.</b></p> <p>calculate mitotic indices</p>	<p>Make plasticine (or equivalent) models to show the process of mitosis.</p> <p>View time-lapse animations of mitosis.</p> <p>All students should carry out practical work. Actively growing garlic root tips provide suitable material for this activity.</p> <p>Mitotic indices can be calculated from representative photographs of meristematic cells.</p>	
<p><b>19</b></p>	<p>the role of meiosis in ensuring genetic variation through the production of non-identical gametes as a consequence of independent assortment of chromosomes in metaphase I and crossing over of alleles between chromatids in prophase I</p> <p>how mammalian gametes are specialised for their functions (including the acrosome in sperm and the zona pellucida in the egg cell)</p>	<p>Make plasticine (or equivalent) models to show the process of meiosis and of crossing over.</p> <p>View animations of meiosis.</p>	

<p><b>20</b></p>	<p>the process of fertilisation in mammals, including the acrosome reaction, the cortical reaction and the fusion of nuclei</p> <p>the process of fertilisation in flowering plants, starting with the growth of a pollen tube and ending with the fusion of nuclei</p> <p><b>RECOMMENDED ADDITIONAL PRACTICAL</b>  <b>Investigate factors affecting the growth of pollen tubes.</b></p>	<p>View animations of fertilisation in mammals.</p> <p>Dissect a large flower to see the anthers, stigma, style and ovary.</p> <p>View animations of the growth of a pollen tube and fertilisation in a flowering plant.</p> <p>All students should carry out practical work. This activity could involve the effect of sucrose concentration on the growth of pollen tubes.</p>	
<p><b>21</b></p>	<p>what is meant by the terms <i>stem cell</i>, <i>pluripotent</i> and <i>totipotent</i>, <i>morula</i> and <i>blastocyst</i></p> <p>discuss the ways in which society uses scientific knowledge to make decisions about the use of stem cells in medical therapies</p> <p>how cells become specialised through differential gene expression, producing active mRNA, leading to the synthesis of proteins which, in turn, control cell processes or determine cell structure in animals and plants</p>	<p>Add definitions of these terms to a glossary.</p> <p>Debate the use of stem cells in medical therapies.</p>	<p><b>Adaptive learning</b></p> <p>Understand unifying patterns and themes in biology and apply them in new and possibly unfamiliar contexts.</p> <p>Students will find it helpful to look at various sample questions related to these topics to gain confidence in answering questions of this type, to ensure that they are able to apply their knowledge and understanding of the topics in a new context.</p>

<p><b>22</b></p>	<p>how one gene can give rise to more than one protein through post-transcriptional changes to messenger RNA (mRNA)</p> <p>phenotype is the result of an interaction between genotype and the environment</p> <p>how epigenetic modification, including DNA methylation and histone modification, can alter the activation of certain genes</p> <p>how epigenetic modifications can be passed on following cell division</p> <p>how some phenotypes are affected by multiple alleles for the same gene, or by polygenic inheritance, as well as the environment, and how polygenic inheritance can give rise to phenotypes that show continuous variation</p>	<p>Look at case studies to illustrate the effect of the environment on gene expression and phenotype.</p>	<p><b>Reasoning</b></p> <p>Evaluate evidence related to biology and then bring it together to form a conclusion.</p> <p>Students can use questions from recent GCE A level past papers to reinforce the principles underlying these concepts in biology.</p> <p>Interpretation of data relating to discontinuous and continuous variables, such as ABO blood groups in humans and the mass of individual beans in a sample, will also help students to develop their mathematical and graphical skills.</p>
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<p><b>23</b></p>	<p>the structure and ultrastructure of plant cells including cell wall, chloroplast, amyloplast, vacuole, tonoplast, plasmodesmata, pits and middle lamella and compare it with animal cells</p> <p>the function of these structures</p> <p>recognise the organelles in plant cells from electron microscope (EM) images</p> <p>the structure and function of the polysaccharides starch and cellulose, including the role of hydrogen bonds between the <math>\beta</math>-glucose molecules in the formation of cellulose microfibrils</p> <p>how the arrangement of cellulose microfibrils and secondary thickening in plant cell walls contributes to the physical properties of xylem vessels and sclerenchyma fibres in plant fibres that can be exploited by humans</p>	<p>Use prepared slides of plant tissues and electron microscope images of plant tissue to show different plant organelles.</p> <p>Show diagrams of structure of cellulose and starch to illustrate structure related to function.</p> <p>Make a table to show the similarities and differences between the structure of a typical animal cell (e.g. a liver cell) and a typical plant cell (e.g. a leaf mesophyll cell).</p>	<p><b>Leadership</b></p> <p>Lead others in a group activity to effectively encourage and develop learning.</p> <p>Students could be given an opportunity to work in small groups to prepare a poster on a specification topic, such as 'plant cell structure' or 'animal and prokaryotic cell structure'. One student in each group takes overall responsibility for the organisation of the task.</p> <p><b>Responsibility</b></p> <p>Take responsibility for the outcome of a team activity, even if one is not solely responsible for the outcome.</p> <p>Preparation and presentation of a poster gives students opportunities to take responsibility for the task, where each student makes a contribution.</p> <p><b>Self-presentation</b></p> <p>Utilise a number of different opportunities to exhibit communication skills in variety of ways</p>
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			<p>including written and verbal, including presenting a topic to the class.</p> <p>Students can be given opportunities to give short, verbal accounts of their poster displays to the class and be prepared to answer questions.</p>
<p><b>24</b></p>	<p>the similarities and differences between the structures of, the position in the stem, and the function of sclerenchyma fibres (support), xylem vessels (support and transport of water and mineral ions) and phloem (translocation of organic solutes)</p> <p><b>CORE PRACTICAL 7</b></p> <p><b>Use a light microscope to:</b></p> <p><b>(i) make observations, draw and label plan diagrams of transverse sections of roots, stems and leaves</b></p> <p><b>(ii) make observations, draw and label cells of plant tissues</b></p> <p><b>(iii) identify sclerenchyma fibres, phloem, sieve tubes and xylem vessels and their location.</b></p> <p>how the uses of plant fibres and starch may contribute to sustainability, including plant-based products to replace oil-based plastics</p>	<p>Project images of plant stems to illustrate the appearance and position of tissues in a typical dicotyledonous stem (e.g. <i>Helianthus</i> or <i>Ranunculus</i>).</p> <p>All students should carry out practical work. This activity could be combined with the use of a graticule to make measurements, for example, to determine the mean diameter of a xylem vessel.</p>	

<p><b>25</b></p>	<p>understand the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants</p> <p><b>RECOMMENDED ADDITIONAL PRACTICAL</b></p> <p><b>Investigate plant mineral deficiencies.</b></p> <p><b>CORE PRACTICAL 8</b></p> <p><b>Determine the tensile strength of plant fibres.</b></p>	<p>Prepare a table summarising the importance of water and these inorganic ions to plants.</p> <p>All students should carry out practical work. The effect of plant mineral deficiencies could be set up as a demonstration. Measurement of tensile strength can be carried out by carefully adding masses to a suspended fibre until the fibre breaks. As with all quantitative experimental work, careful consideration of all the variables is important.</p>	<p><b>Executive function</b></p> <p>Plan investigations using knowledge and understanding of experimental and investigative skills, with due regard for correct and safe laboratory procedures. Evaluate the effectiveness of an investigation in terms of accuracy, repeatability and validity.</p> <p>Students can work together in small groups to plan investigations, based on their knowledge and understanding of the core practical activities and recommended additional practicals. The experimental principles can be applied in a new context, for example, how to investigate the effect of treatment with an alkali on the tensile strength of plant fibres.</p>
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<p><b>26</b></p>	<p>know that substances derived from plants can have antimicrobial and other therapeutic properties</p> <p>the conditions required for bacterial growth</p> <p><b>CORE PRACTICAL 9</b></p> <p><b>Investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria.</b></p> <p>the development of drug testing from historic to contemporary protocols, including William Withering's digitalis soup, double blind trials, placebo and three-phased testing</p>	<p>Research the potential use of plants in drug development, and drugs that are derived from plants.</p> <p>All students should carry out practical work. This activity introduces students to aseptic technique as preparation for practical work in Unit 4.</p> <p>Research William Withering's work and compare with modern drug development and testing protocols.</p>	<p><b>Empathy / perspective taking</b></p> <p>Support the position of another in a piece of writing or in an oral presentation.</p> <p>Students may be given opportunities to work in pairs to prepare and present a short talk on a specification topic, taking it in turns to deliver separate parts of the presentation. This helps to encourage mutual support and empathy.</p>
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<p><b>27</b></p>	<p>classification is a means of organising the variety of life based on relationships between organisms using differences and similarities in phenotypes and in genotypes, and is built around the species concept</p> <p>the process and importance of critical evaluation of new data by the scientific community leading to new taxonomic groupings, based on molecular evidence, including the three-domain system (Archaea, Bacteria and Eukarya)</p> <p>over time, the variety of life has become extensive but is now being threatened by human activity</p> <p>what is meant by the terms <i>biodiversity</i> and <i>endemism</i></p>	<p>Summarise the ways in which organisms are classified, based on structural similarities.</p> <p>Discuss the five-Kingdom and three-Domain systems of classification.</p> <p>Make a table to show the essential features of each of the three Domains.</p> <p>Consider the reasons why human activities (e.g. deforestation, pollution, combustion of fossil fuels) threatens the variety of life.</p> <p>Add definitions of these terms, with examples, to a glossary.</p>	
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how biodiversity can be measured within a habitat using species richness, and within a species using genetic diversity by calculating the heterozygosity index:

$$\text{heterozygosity index} = \frac{\text{number of heterozygotes}}{\text{number of individuals in the population}}$$

how biodiversity can be compared in different habitats using the formula to calculate an index of diversity

$$D = \frac{N(N - 1)}{\sum_n(n - 1)}$$

the concept of niche and be able to discuss examples of adaptations of organisms to their environment (behavioural, anatomical and physiological)

Use data to calculate the heterozygosity index and the index of diversity.

Tabulate examples of the ways in which organisms are adapted to their environment.

<b>29</b>	<p>how the Hardy-Weinberg equation can be used to see whether a change in allele frequency is occurring in a population over time</p> <p>changes in allele frequency can come about as a result of mutation and natural selection</p> <p>reproductive isolation can lead to accumulation of different genetic information in populations, potentially leading to the formation of new species</p> <p>the methods used by zoos and seed banks in the conservation of endangered species and their genetic diversity, including scientific research, captive breeding programmes, reintroduction programmes and education</p>	<p>Use data and the Hardy-Weinberg equation to calculate the numbers of genotypes in a population.</p> <p>Consider reasons why allele frequencies in a population may change over time.</p> <p>Research the ways in which zoos and seed banks (for example, the Millennium seed bank and the Svalbard seed bank) conserve endangered species.</p>	
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**Revision and AS exams**

**Initiative**

Use knowledge of biology independently, without guided learning, to further own understanding.

Students can use 'revision workbooks' which can include questions from past papers to help reinforce and consolidate learning.

**Productivity**

Develop a fluency in technical vocabulary so that sophisticated answers are produced in extended answers.

Students should be given opportunities to practise extended open-response questions from SAMs or, where appropriate, from GCE A level past papers. These questions usually have a mark allocation of 6. Class discussions of model answers and using 'mind maps' will help students to link together ideas and concepts related to a central theme.

<p><b>32</b></p>	<p>the overall reaction of photosynthesis, requiring energy from light to split apart the strong bonds in water molecules, storing the hydrogen in a fuel (glucose) by combining it with carbon dioxide and releasing oxygen into the atmosphere</p> <p>how photophosphorylation of ADP requires energy and that hydrolysis of ATP provides an immediate supply of energy for biological processes</p> <p>the light-dependent reactions of photosynthesis, including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, reducing NADP in cyclic and non-cyclic photophosphorylation and producing oxygen through photolysis of water</p>	<p>View animations to show the overall reaction of photosynthesis and the light-dependent reactions.</p> <p>View animations to show how the hydrolysis of ATP releases energy.</p>	
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<p><b>33</b></p>	<p>the light-independent reactions as reduction of carbon dioxide using the products of the light-dependent reactions (carbon fixation in the Calvin cycle, the role of GP, GALP, RuBP and RUBISCO)</p> <p>the products are simple sugars that are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules (polysaccharides, amino acids, proteins, lipids and nucleic acids)</p> <p>the structure of chloroplasts in relation to their role in photosynthesis</p> <p>what is meant by the terms <i>absorption spectrum</i> and <i>action spectrum</i></p> <p>chloroplast pigments can be separated using chromatography and the pigments identified using Rf values</p> <p><b>CORE PRACTICAL 10</b>  <b>Investigate the effects of light intensity, light wavelength, temperature and availability of carbon dioxide on the rate of photosynthesis using a suitable aquatic plant.</b></p>	<p>View animations to illustrate the light-dependent reactions of photosynthesis and how the products are used in the synthesis of new organic molecules.</p> <p>Project an electron micrograph of a chloroplast and identify the structures.</p> <p>Make an annotated diagram of a chloroplast to relate the structures to their functions.</p> <p>Add definitions of these terms to a glossary.</p> <p>View a video showing how chromatography can be used to separate chloroplast pigments and how the pigments can be identified using their Rf values. This can also be done by using ground up plant leaves or certain types of ink.</p> <p>All students should carry out practical work. When carrying out experiments to investigate the effect of factors on the rate of photosynthesis, the control of variables is very important and students should consider how these variables affect photosynthesis.</p>	
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Weeks	Topic Area Aims and Learning Outcomes	Exemplar classroom activities, teaching points and suggested teaching resources	Integrated Transferable Skills
1	<p><b>CORE PRACTICAL 11</b></p> <p><b>Carry out a study of the ecology of a habitat, such as using quadrats and transects to determine the distribution and abundance of organisms, and measuring abiotic factors appropriate to the habitat.</b></p> <p>the stages of succession from colonisation to the formation of a climax community</p>	<p>All students should carry out practical work. The choice of habitat will depend on what is available locally and it is important that students understand the principles of ecological sampling and the measurement of abiotic factors. It is also advisable to look at questions on past papers from the legacy spec that cover a very wide range of habitats.</p>	<p><b>Adaptability</b></p> <p>Select and apply knowledge and understanding of scientific processes, which is not prompted or provided, to problems in biology.</p> <p>Students should be given opportunities to apply their knowledge in new contexts, such as observing stages of succession occurring naturally and considering factors that could explain the changes observed.</p> <p><b>Self-direction</b></p> <p>Plan and carry out investigations independently.</p> <p>There are many opportunities to develop this skill, either in a laboratory or during fieldwork. Fieldwork in particular offers suitable opportunities for students to carry out small-scale individual investigations.</p>

<p><b>2</b></p>	<p>the different types of evidence for climate change and its causes, including records of carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology, recognising correlations and causal relationships</p> <p>the causes of anthropogenic climate change, including the role of greenhouse gases in the greenhouse effect</p> <p>how knowledge of the carbon cycle can be applied to methods to reduce atmospheric levels of carbon dioxide</p> <p>data can be extrapolated to make predictions and that these are used in models of future climate change</p> <p>models for climate change have limitations</p>	<p>Describe and analyse pollen records to discuss the evidence for and against global warming.</p> <p>Describe and analyse data from dendrochronology studies which provide evidence for and against global warming.</p> <p>Research and debate evidence for and against climate change.</p>	<p><b>Innovation</b></p> <p>Use a novel strategy to apply existing knowledge and understanding of biological concepts in new and unfamiliar situations.</p> <p>Students can work independently or in small groups to consider questions that involve analysis of data, looking for trends and patterns and supporting descriptions with suitable quantitative comments. Reference should be made to questions that test this skill from the SAMS or from past papers.</p>
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<p><b>3</b></p>	<p>the effects of climate change (changing rainfall patterns and changes in seasonal cycles) on plants and animals (distribution of species, development and lifecycles)</p> <p>the effect of temperature on the rate of enzyme activity and its impact on plants, animals and microorganisms, to include Q<sub>10</sub></p> <p><b>CORE PRACTICAL 12</b>  <b>Investigate the effects of temperature on the development of organisms (such as seedling growth rate or brine shrimp hatch rates), taking into account the ethical use of organisms.</b></p>	<p>All students should carry out practical work. Brine shrimp (<i>Artemia</i>) eggs are readily available and a 'brine shrimp hatchery' can be set up using artificial sea water.</p>	<p><b>Critical thinking</b></p> <p>Use many pieces of information from different areas of the subject and synthesise the information to make judgments.</p> <p>Questioning for feedback in the classroom; 'quick quizzes' (for example with one word answers) and immediate feedback.</p> <p>Homework assignments, for example, defining terms, or researching a topic using on-line resources.</p> <p>Objective self-assessment questions including multiple choice, true / false, labelling a diagram, match lists and cloze passage, all with feedback on correct and incorrect responses.</p>
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<p><b>4</b></p>	<p>how evolution (a change in allele frequency) can come about through gene mutation and natural selection</p> <p>how isolation reduces gene flow between populations, leading to allopatric or sympatric speciation</p> <p>the way in which scientific conclusions about controversial issues, such as what actions should be taken to reduce climate change, or the degree to which humans are affecting climate change, can sometimes depend on who is reaching the conclusions</p> <p>how reforestation and the use of sustainable resources, including biofuels, are examples of the effective management of the conflict between human needs and conservation</p>	<p>Look at case studies about natural selection and how it affects allele frequency.</p> <p>Put forward case of different conclusions from same evidence according to opposing standpoints or vested interests.</p>	<p><b>Interpretation</b></p> <p>Select, organise and present relevant information clearly and logically using appropriate vocabulary, definitions and conventions.</p> <p>Students can work individually to research topics such as reforestation and the use of sustainable resources and then write a short, illustrated report on each topic.</p>
<p><b>5</b></p>	<p>the principles and techniques involved in culturing microorganisms, using aseptic technique</p> <p>the different methods of measuring the growth of microorganisms, as illustrated by cell counts, dilution plating, mass and optical methods (turbidity)</p>	<p>Revise and reinforce the principles of aseptic technique from Core Practical 9.</p> <p>View animations of bacterial growth and methods for measuring growth.</p> <p>Plot growth curves, using logarithmic numbers, and calculate exponential growth rate constants (<math>k</math>).</p>	

<p><b>6</b></p>	<p>the different phases of a bacterial growth curve (lag phase, exponential phase, stationary phase and death phase)</p> <p>calculate exponential growth rate constants</p> <p><b>CORE PRACTIAL 13</b>  <b>Investigate the rate of growth of microorganisms in a liquid culture, taking into account the safe and ethical use of organisms.</b></p>	<p>All students should carry out practical work. As an alternative to growing bacteria in liquid culture, yeast can be used as a suitable organism to investigate the rate of growth of a microorganism.</p>	<p><b>Ethics</b></p> <p>Produce output with a specific moral purpose for which one is accountable.</p> <p>Class discussion of ethical, moral or safety issues relating to any practical that involves the use of living organisms will help students to develop this skill.</p>
<p><b>7</b></p>	<p>compare the structure of bacteria and viruses (nucleic acid, capsid structure and envelope) with reference to Ebola virus, tobacco mosaic virus (TMV), human immunodeficiency virus (HIV) and lambda phage (<math>\lambda</math> phage)</p> <p>what is meant by the terms <i>lytic</i> and <i>latency</i></p> <p>how <i>Mycobacterium tuberculosis</i> and human immunodeficiency virus (HIV) infect human cells, causing symptoms that may result in death</p>	<p>Make annotated drawings and prepare a comparable table to show the structure of these viruses.</p> <p>Add definitions of these terms to a glossary.</p> <p>Make a flow chart to show the sequence of events following infection with HIV and <i>Mycobacterium</i>.</p>	

<p><b>8</b></p>	<p>the major routes pathogens may take when entering the body</p> <p>the role of barriers in protecting the body from infection, including skin, stomach acid, and gut and skin flora</p> <p>the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon and phagocytosis</p> <p>the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages and antigen-presenting cells</p>	<p>Create a poster showing routes of pathogens into the body with defence mechanisms.</p> <p>Summarise the non-specific responses of the body to infection.</p> <p>Write short notes on the functions of plasma cells, macrophages and antigen-presenting cells.</p>	
<p><b>9</b></p>	<p>the differences between the roles of B cells (B memory and B effector cells), and T cells (T helper, T killer and T memory cells) in the host's immune response</p> <p>how individuals may develop immunity (natural, artificial, active and passive)</p>	<p>Make a table to summarise the roles of B and T cells in the immune response alternatively, make four posters that are linked with arrows.</p> <p>Make a table to summarise the features of active and passive immunity.</p>	

<p><b>10</b></p>	<p>how the theory of an 'evolutionary race' between pathogens and their hosts is supported by evasion mechanisms shown by pathogens</p> <p>the difference between bacteriostatic and bactericidal antibiotics</p> <p><b>CORE PRACTICAL 14</b>  <b>Investigate the effect of different antibiotics on bacteria.</b></p> <p>how an understanding of the contributory causes of hospital-acquired infections has led to codes of practice regarding antibiotic prescription and hospital practice that relate to infection prevention and control</p>	<p>Draw a graph to show the effect of bacteriostatic and bactericidal antibiotics on the growth of bacteria in a broth culture.</p> <p>All students should carry out practical work. Before starting this activity, identify any safety issues and how they are minimised.</p> <p>Research hospital codes of practice for antibiotic prescription and infection prevention and control.</p>	
<p><b>11</b></p>	<p>the role of microorganisms in the decomposition of organic matter and the recycling of carbon</p> <p>how DNA can be amplified using the polymerase chain reaction (PCR)</p> <p>how gel electrophoresis can be used to separate DNA fragments of different length</p>	<p>Prepare a table to show the roles of bacteria and fungi in decomposition of organic matter.</p> <p>Draw an annotated graph showing the temperature changes associated with PCR.</p> <p>View an animation of agarose gel electrophoresis of DNA fragments (interpretation of DNA fingerprints).</p> <p>Prepare a table to summarise the methods used for determining the time of death.</p>	

<b>12</b>	how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals)  how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction		
<b>13 and 14</b>	<b>Revision / exams</b>		

<p><b>15</b></p>	<p>the overall reaction of aerobic respiration as splitting of the respiratory substrate to release carbon dioxide as a waste product and reuniting hydrogen with atmospheric oxygen with the release of large amounts of energy</p> <p>respiration is a many-stepped process, with each step controlled and catalysed by a specific intracellular enzyme</p> <p>the roles of glycolysis in aerobic and anaerobic respiration, including the phosphorylation of hexoses, the production of ATP by substrate level phosphorylation, reduced coenzyme, pyruvate and lactate</p> <p>the role of the link reaction and the Krebs cycle in the complete oxidation of glucose and formation of carbon dioxide (CO<sub>2</sub>) by decarboxylation, ATP by substrate level phosphorylation, reduced NAD and reduced FAD by dehydrogenation and that these steps take place in mitochondria, unlike glycolysis which occurs in the cytoplasm</p>	<p>Use "black box" idea to identify input and output of respiration.</p> <p>Use animations to show respiration pathways.</p> <p>Prepare a table/posters linked by arrows to summarise the products of glycolysis, the link reaction and the Krebs cycle.</p>	
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<p><b>16</b></p>	<p>how ATP is synthesised by oxidative phosphorylation associated with the electron transport chain in mitochondria, including the role of chemiosmosis and ATP synthase</p> <p>what happens to lactate after a period of anaerobic respiration in animals</p> <p>what is meant by the term <i>respiratory quotient</i> (RQ)</p> <p><b>CORE PRACTICAL 15</b></p> <p><b>Use an artificial hydrogen carrier (redox indicator) to investigate respiration in yeast.</b></p> <p><b>CORE PRACTICAL 16</b></p> <p><b>Use a simple respirometer to determine the rate of respiration and RQ of a suitable material (such as germinating seeds or small invertebrates).</b></p>	<p>View an animation of oxidative phosphorylation.</p> <p>Make a flow diagram to show what happens to lactate after a period of anaerobic respiration.</p> <p>Add a definition of the term <i>respiratory quotient</i> to a glossary.</p> <p>All students should carry out practical work. The activity of dehydrogenases can be investigated using an actively respiring yeast suspension and dilute methylene blue as a redox indicator.</p> <p>A simple respirometer (look at different types for different organisms on the web) can be used to measure both the uptake of oxygen and the production of carbon dioxide.</p> <p>Calculate RQ values from data and from a balanced equation showing, for example, the complete oxidation of a fatty acid.</p>	
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<p><b>17</b></p>	<p>the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors</p> <p>the structure of a mammalian skeletal muscle fibre</p> <p>the structural and physiological differences between fast and slow twitch muscle fibres</p> <p>the process of contraction of skeletal muscle in terms of the sliding filament theory, including the role of actin, myosin, troponin, tropomyosin, calcium ions (<math>\text{Ca}^{2+}</math>), ATP and ATPase</p>	<p>Identify antagonistic muscle pairs, such as the biceps and triceps and explain their roles as extensors or flexors.</p> <p>View electron micrographs of striated muscle fibres and identify the bands.</p> <p>Prepare a table showing the differences between fast and slow twitch muscle fibres.</p> <p>View an animation showing the contraction of muscle to illustrate the sliding filament theory. Models using plasticine and drinking straws are also quite useful.</p>	
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<p><b>18</b></p>	<p>the myogenic nature of cardiac muscle</p> <p>how the normal electrical activity of the heart coordinates the heartbeat, including the roles of the sinoatrial node (SAN), the atrioventricular node (AVN), the bundle of His and the Purkyne fibres</p> <p>how the use of electrocardiograms (ECGs) can aid in the diagnosis of abnormal heart rhythms</p> <p>calculate cardiac output</p> <p>how variations in ventilation and cardiac output enable rapid delivery of oxygen to tissues and the removal of carbon dioxide from them, including how the heart rate and ventilation rate are controlled and the roles of the cardiovascular control centre and the ventilation centre in the medulla oblongata</p> <p>the role of adrenaline in the fight or flight response</p>	<p>View animations of the sequence of events during the cardiac cycle and showing how the cardiac cycle is coordinated.</p> <p>Research ECGs showing, for example, the normal heart rhythm and bradycardia.</p> <p>Calculate heart rates from ECGs.</p> <p>Calculate cardiac output, using the formula:  cardiac output = stroke volume x heart rate.</p> <p>Prepare a flow diagram to explain the changes in heart rate and ventilation rate in response to an increase in exercise.</p> <p>Make a table to summarise the effects of adrenaline.</p>	
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<p><b>19</b></p>	<p><b>CORE PRACTICAL 17</b>  <b>Investigate the effects of exercise on tidal volume, breathing rate, respiratory minute ventilation, and oxygen consumption using data from spirometer traces.</b></p> <p>what is meant by the terms <i>negative feedback</i> and <i>positive feedback control</i></p> <p>the principle of negative feedback in maintaining systems within narrow limits</p> <p>what is meant by the term <i>homeostasis</i> and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus in thermoregulation</p>	<p>All students should carry out practical work. The emphasis of this core practical is the interpretation of spirometer traces to find the tidal volume, breathing rate, respiratory minute volume (the volume of air inhaled or exhaled per minute) and oxygen consumption.</p> <p>Add definitions of these terms to a glossary.</p> <p>Prepare a flow chart to illustrate the regulation of body temperature and the principle of negative feedback.</p>	
<p><b>20</b></p>	<p>the gross and microscopic structure of the mammalian kidney</p> <p>how urea is produced in the liver from excess amino acids and how it is removed from the bloodstream by ultrafiltration</p> <p>how solutes are selectively reabsorbed in the proximal tubule and how the loop of Henle acts as a countercurrent multiplier to increase the reabsorption of water</p>	<p>View a sagittal section of a kidney (e.g. a lamb's kidney obtained from a butcher) and prepared microscope slides to show the histology.</p> <p>Prepare an annotated diagram of a nephron showing the processes involved in the formation of urine.</p> <p>View an animation to show the function of the loop of Henle.</p>	

<p><b>21</b></p>	<p>how the pituitary gland and osmoreceptors in the hypothalamus, combined with the action of antidiuretic hormone (ADH), bring about negative feedback control of mammalian plasma concentration and blood volume</p> <p>how genes can be switched on and off by DNA transcription factors, including the role of peptide hormones acting extracellularly and steroid hormones acting intracellularly</p>	<p>Prepare a flow diagram showing the homeostatic response of a person to, for example, drinking 1 dm<sup>3</sup> of water.</p> <p>View animations of gene switching in response to peptide and steroid hormones.</p>	
<p><b>22</b></p>	<p>the mammalian nervous system consists of the central and peripheral nervous systems</p> <p>the structure and function of sensory, relay and motor neurones, including Schwann cells and myelination</p> <p>how the nervous system of organisms can cause effectors to respond to a stimulus</p> <p>the structure and function of a spinal reflex arc, including grey matter and white matter of the spinal cord</p>	<p>Make annotated diagrams showing the structure and function of types of neurones.</p> <p>View animations showing the structure and function of a spinal reflex arc, for example, the knee jerk reflex.</p>	

<p><b>23</b></p>	<p>how a nerve impulse (action potential) is conducted along an axon, including changes in membrane permeability to sodium and potassium ions</p> <p>the role of myelination in saltatory conduction</p> <p>the structure and function of synapses in nerve impulse transmission, including the role of neurotransmitters and acetylcholine</p> <p>how the pupil dilates and contracts</p> <p>how the effects of drugs can be caused by their influence on nerve impulse transmission, illustrated by nicotine, lidocaine and cobra venom alpha toxin, the use of L-DOPA in the treatment of Parkinson's disease and the action of MDMA (ecstasy)</p>	<p>View an animation of the nerve impulse, showing the sequence of changes in the permeability of the membrane.</p> <p>Prepare an annotated diagram showing the structure and function of a synapse and illustrate the role of a transmitter substance.</p> <p>Make a table to summarise the effects of drugs on nerve impulse transmission.</p>	
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<p><b>24</b></p>	<p>how the nervous systems of organisms can detect stimuli with reference to rods in the retina of mammals, the roles of rhodopsin, opsin, retinal, sodium ions, cation channels and hyperpolarisation of rod cells in forming action potentials in the optic neurones</p> <p>what is meant by the term <i>habituation</i></p> <p><b>RECOMMENDED ADDITIONAL PRACTICAL</b></p> <p><b>Investigate habituation to a stimulus.</b></p>	<p>Add a definition of the term <i>habituation</i> to a glossary.</p> <p>View a video recording showing habituation in, for example, a snail in response to being touched gently.</p> <p>All students should carry out practical work.</p>	
<p><b>25</b></p>	<p>how phytochrome, auxin (IAA) and gibberellins bring about responses in plants, including their effects on transcription</p> <p><b>CORE PRACTICAL 18</b> <b>Investigate the production of amylase in germinating cereal grains.</b></p>	<p>Prepare a table to summarise the effects of these plant growth substances.</p> <p>Research the effects of gibberellins on amylase synthesis in cereal grains.</p> <p>All students should carry out practical work. The production of amylase in germinating cereal grains can be demonstrated using 'endosperm halves' of germinating grains placed on starch agar. After incubation, the area of starch hydrolysis can be visualised by adding dilute iodine solution.</p>	

<p><b>26</b></p>	<p>how coordination in animals is brought about through nervous and hormonal control</p> <p>the location and main functions of the cerebral hemispheres, hypothalamus, pituitary gland, cerebellum and medulla oblongata of the human brain</p> <p>how magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), positron emission tomography (PET) and computed tomography (CT) are used in medical diagnosis and the investigation of brain structure and function</p>	<p>Prepare a table to compare nervous and hormonal coordination.</p> <p>View photographs of a section through a brain and identify the main areas.</p> <p>Make an annotated diagram of a brain showing the location and main functions of these areas.</p> <p>View video recordings showing the principles of brain scanning techniques.</p>	
<p><b>27</b></p>	<p>how imbalances in certain naturally-occurring brain chemicals can contribute to ill health, including dopamine in Parkinson's disease and serotonin in depression, and to the development of new drugs</p> <p>how drugs can be produced using genetically modified organisms (plants, animals and microorganisms)</p> <p>how recombinant DNA can be produced, including the roles of restriction endonucleases and DNA ligase</p>	<p>Research the causes of Parkinson's disease and the link between serotonin and depression.</p> <p>Make a table to show pharmaceutical products derived from genetically modified organisms.</p> <p>View an animation to show the production of recombinant DNA.</p>	

<p><b>28</b></p>	<p>how recombinant DNA can be inserted into other cells</p> <p>how microarrays can be used to identify active genes</p> <p>what is meant by the term <i>bioinformatics</i></p> <p>the risks and benefits associated with the use of genetically modified organisms</p>	<p>View animations showing ways in which recombinant DNA is inserted into cells and how microarrays are used to show gene expression.</p> <p>Add a definition of the term <i>bioinformatics</i> to a glossary.</p> <p>Research some of the risks and benefits associated with the use of genetically modified organisms and make a table to summarise the information.</p>	<p><b>Assertive communication</b></p> <p>Chair a debate, allowing representations and directing the discussions to a conclusion.</p> <p>Chairing a discussion on specific issues in biology, such as genetic screening, the use of animals in research, or the risks and benefits of genetically modified organisms.</p>
<p><b>29-33</b></p>	<p><b>REVISION</b></p>		