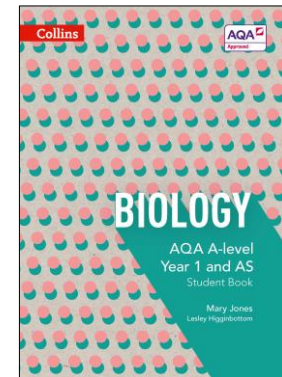


# AQA A-level Biology Year 1 and AS Scheme of Work



## Scheme of Work

### AQA A-level Biology Year 1 and AS

This course covers the requirements of the first year of the AQA AS and A-level Biology specification. These schemes of work are designed to accompany the use of Collins' AQA A-level Biology Year 1 and AS Student Book, and references to sections in that book are given for each lesson.

We have assumed that 120 one-hour lessons are taught during the year. Each lesson is matched to the Specification Content. Learning outcomes for each lesson are listed, as are the key Mathematical Skills, Practical Skills, and Apparatus and Techniques Skills that the lesson provides opportunities to practise. It is suggested in which lessons the six Required Practicals may be carried out, to help you plan for these and the sourcing of necessary equipment.

The schemes suggested are of course flexible, and editable, to correspond with your timetabling and to enable you to plan your own route through the course.

#### **KEY**

The codes in the 'skills covered' column refer to the skills in the AQA specification.

MS - Mathematical Skills

PS - Practical Skills

AT- Apparatus and Techniques Skills

Scheme of Work  
AQA A-level Biology Year 1 and AS (120 hours)

One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 1 – Water and Carbohydrates (11 Hours)					
<p>1 Biological Molecules</p> <p>Students can write on a sticky note a definition of an atom and a molecule to elicit discussion. Revisit previous learning using Molymods to show the difference between atoms and molecules. It may be useful to introduce concepts of relative scale and units of measurement at this point.</p>	<ul style="list-style-type: none"> <li>Revisit and consolidate previous learning</li> </ul>	<p>Ensure students are clear this is not examined content.</p>		1.1	
<p>2 Biological Molecules</p> <p>Students to recall the definitions of monomers and polymers. Students could be asked to define these terms using less than 15 words. Students could clarify new ideas using interconnecting bricks or similar and to model monomers and polymers. Students to name the monomers found in living organisms and the polymers they build.</p>	<ul style="list-style-type: none"> <li>Recall the definition for a monomer and polymer</li> <li>Describe the Biological Molecules as polymers and recall their monomers</li> </ul>	<p>3.1.1 Monomers and Polymers.</p> <p>Monomers are the smaller units from which larger molecules are made.</p> <p>Polymers are molecules made from a large number of monomers joined together.</p> <p>Monosaccharides, amino acids and nucleotides are examples of monomers.</p>		1.1	

<p>3 Biological Molecules</p> <p>Carry out a practical such as making 'Poly-ethene' or 'Slime' to show how polymerisation alters properties.</p>	<ul style="list-style-type: none"> <li>Describe the reactions used to form and break down polymers</li> <li>Recognise that water molecules are involved in the formation and breakdown of polymers through condensation and hydrolysis reactions.</li> </ul>	<p>3.1.1 Monomers and Polymers</p> <p>A condensation reaction joins two molecules together with the formation of a chemical bond and involves the elimination of a molecule of water.</p> <p>A hydrolysis reaction breaks a chemical bond between two molecules and involves the use of a water molecule.</p>		1.2	
<p>4 Biological Molecules</p> <p>Students are able to recognise that polymers like proteins and carbohydrates are universal and found in all living cells. Students to name some Proteins, Carbohydrates and Lipids and briefly outline where they are found in the cell and their uses. Students could independently research this to produce posters or presentations.</p>	<ul style="list-style-type: none"> <li>Explain that the biochemical basis of life is similar for all organisms and provides evidence for evolution.</li> </ul>	<p>3.1.1 Monomers and Polymers.</p> <p>The variety of life, both past and present, is extensive, but the biochemical basis of life is similar for all living things.</p>		1.1	
<p>5 Water</p> <p>Students could model the structure of water using Molymods or similar. Students to label a water molecule including bonds and dipoles.</p>	<ul style="list-style-type: none"> <li>Recall the structure of a water molecule including the bonding found within and between molecules and its dipole nature</li> <li>Students should recognise that water makes up the majority of cells and is vital for life</li> </ul>	<p>3.1.7 Water</p> <p>Water is a major component of cells. It has several properties that are important in biology.</p>		1.2	

<p>6 Water</p> <p>Students should recall the unique properties of water which make it an essential Biological molecule. You may wish to provide a circus task of activities to illustrate these properties including prompt questions e.g.  Metabolite – students could use Interconnecting bricks or similar to show polymerisation  Solvent – dissolve sugar or salt in a beaker of water  Heat Capacity – place ice cubes and hot water into large beakers of room temperature water and measure temperature changes.  Latent Heat – place a damp paper towel on the back of their hands  Cohesion – use pipettes or straws to draw up water</p>	<ul style="list-style-type: none"> <li>Describe the properties of water which make it important as a biological molecule</li> </ul>	<p>3.1.7 Water</p> <p>Water is a major component of cells. It has several properties that are important in biology. In particular, water:</p> <ul style="list-style-type: none"> <li>is a metabolite in many metabolic reactions</li> <li>is an important solvent</li> <li>has a relatively high heat capacity</li> <li>has a relatively large latent heat of vaporisation</li> <li>has strong cohesion between water molecules</li> </ul>		1.2	
<p>7 Water</p> <p>Students should be able to explain how the structure and bonding within and between water molecules provide its unique properties and how this is important to living cells. This is a good opportunity to practice exam technique by providing Students with a standardised sentence structure e.g. Water is/has _____ due to _____ which provides cells with/allows cells to _____.</p>	<ul style="list-style-type: none"> <li>Explain the function of water molecules within living organisms in relation to its structure and function</li> </ul>	<p>3.1.7 Water</p> <p>Water is a major component of cells. It has several properties that are important in biology. In particular, water:</p> <ul style="list-style-type: none"> <li>is a metabolite in many metabolic reactions, including condensation and hydrolysis reactions</li> <li>is an important solvent in which metabolic reactions occur</li> </ul>		1.2	

		<ul style="list-style-type: none"> <li>• has a relatively high heat capacity, buffering changes in temperature</li> <li>• has a relatively large latent heat of vaporisation, providing a cooling effect with little loss of water through evaporation</li> <li>• has strong cohesion between water molecules; this supports columns of water in the tube-like transport cells of plants and produces surface tension where water meets air.</li> </ul>			
<p>8 Carbohydrates</p> <p>Students should recognise the basic formula of carbohydrates. They should recall the monosaccharides Glucose, Fructose and Galactose recognising they are isomers with the same formula and giving their properties. A memory game, like sage and scribe, can be used whereby students could recreate the structure of monosaccharides from shown images. Students should describe the formation of the disaccharides maltose, sucrose and lactose through condensation reactions. Students to draw and label these reactions and the formation of glycosidic bonds and maybe able to synthesise diagrams of the hydrolysis of these molecules. Molymods can be used to show</p>	<ul style="list-style-type: none"> <li>• Recall the definition of a mono, di and polysaccharides including named examples</li> <li>• Describe, draw and label the condensation reactions which form maltose, sucrose and lactose</li> </ul>	<p>3.1.2 Carbohydrates</p> <p>Monosaccharides are the monomers from which larger carbohydrates are made. Glucose, galactose and fructose are common monosaccharides.</p> <p>A condensation reaction between two monosaccharides forms a glycosidic bond.</p> <p>Disaccharides are formed by the condensation of two monosaccharides:</p> <ul style="list-style-type: none"> <li>• maltose is a disaccharide formed by condensation of two glucose molecules</li> <li>• sucrose is a disaccharide formed by condensation of a glucose molecule and a fructose molecule</li> </ul>		1.3	

<p>the formation and structure of disaccharides.</p>		<ul style="list-style-type: none"> <li>Lactose is a disaccharide formed by condensation of a glucose molecule and a galactose molecule.</li> </ul>			
<p>9 Carbohydrates</p> <p>Students can perform chromatography and undertake Assignment 1: Using Calibration Curves.</p>	<ul style="list-style-type: none"> <li>Use practical techniques to identify monosaccharides and glucose concentration</li> </ul>		<p><i>MS 1.3, MS1.11, MS3.1, MS 3.2, PS3.1, PS 3.2, PS 3.3</i></p> <p>AT g Students could use chromatography, with known standard solutions, to separate a mixture of monosaccharides and identify their components.</p> <p>AT c Students could produce a dilution series of glucose solution and use colorimetric techniques to produce a calibration curve with which to identify the concentration of glucose in an unknown solution.</p>		
<p>10 Carbohydrates.</p> <p>Students may complete Assignment 2: Understanding Lactose Tolerance. Students should be able to describe and draw the polysaccharides Cellulose, Starch and Glycogen and relate their structure to their functions within cells. A Venn diagram could be used to compare the polysaccharides.</p>	<ul style="list-style-type: none"> <li>Recall the two monomers of Glucose</li> <li>Relate the structure of Glycogen, Starch and Cellulose to their function in animal and plant cells</li> </ul>	<p>3.1.2 Carbohydrates.</p> <p>Glucose has two isomers, <math>\alpha</math>-glucose and <math>\beta</math>-glucose.</p> <p>Polysaccharides are formed by the condensation of many glucose units.</p> <ul style="list-style-type: none"> <li>Glycogen and starch are formed by the condensation of <math>\alpha</math>-glucose.</li> </ul>	<p><i>PS1.1 MS0.1 MS1.1 MS1.11 MS 2.2 MS2.3 MS3.3 MS3.5 PS3.1 PS3.2 PS3.3</i></p>	<p>1.3</p>	

		<ul style="list-style-type: none"> <li>Cellulose is formed by the condensation of <math>\beta</math>-glucose.</li> </ul> <p>The basic structure and functions of glycogen, starch and cellulose. The relationship of structure to function of these substances in animal cells and plant cells.</p>			
<p>11 Carbohydrates</p> <p>Students should perform the tests for reducing and non-reducing sugars, be able to describe the method and results for the Biochemical tests and use them to correctly identify unknown substances. They can complete Assignment 3: Identifying Carbohydrates from Biochemical Tests.</p>	<ul style="list-style-type: none"> <li>Describe the Biochemical tests used to identify carbohydrates.</li> </ul>	<p>3.1.2 Carbohydrates</p> <p>Biochemical tests using Benedict's solution for reducing sugars and non-reducing sugars and iodine/potassium iodide for starch.</p>	<p><i>PS1.2 PS4.1</i></p> <p>AT f Students could use, and interpret the results of, qualitative tests for reducing sugars, non-reducing sugars and starch.</p>	1.3	



One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 2 – Lipids and Proteins (9 hours)					
<p>1 Lipids - Triglycerides</p> <p>Students should recall that lipids are biological molecules containing C, H and O. They should recognise Triglycerides as a group of lipid formed by condensation reactions between glycerol and fatty acid chains and be able to draw and label this reaction and the formation of ester bonds. They may be able to synthesise diagrams of the hydrolysis reactions which break these molecules down. Students should recognise saturated, unsaturated and polyunsaturated fatty acids and describe the presence or absence of double bonds within them. Molymods can be used to make glycerol, saturated and unsaturated fatty acids and triglycerides.</p>	<ul style="list-style-type: none"> <li>Describe the structure of a triglyceride</li> <li>Describe, draw and label the condensation reactions required to form these molecules</li> <li>Describe how R-group of a fatty acid maybe saturated or unsaturated</li> </ul>	<p>3.3.1 Lipids</p> <p>Triglycerides and phospholipids are two groups of lipid.</p> <p>Triglycerides are formed by the condensation of one molecule of glycerol and three molecules of fatty acid.</p> <p>A condensation reaction between glycerol and a fatty acid (RCOOH) forms an ester bond.</p> <p>The R-group of a fatty acid may be saturated or unsaturated.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>recognise, from diagrams, saturated and unsaturated fatty acids.</li> </ul>		2.1	
<p>2 Lipids – Phospholipids</p> <p>Students should recognise that in a Phospholipid one of the fatty acid chains in a triglyceride is substituted for a phosphate group and be able to draw and label the molecule. They should be able to draw and label this reaction and the formation of ester bonds.</p>	<ul style="list-style-type: none"> <li>Describe the structure of a phospholipid</li> <li>Describe, draw and label the condensation reactions required to form these molecules</li> </ul>	<p>3.3.1 Lipids</p> <p>Triglycerides and phospholipids are two groups of lipid.</p> <p>In phospholipids, one of the fatty acids of a triglyceride is substituted by a phosphate-containing group.</p>	AT f Students could use, and interpret the results of the emulsion test for lipids.	2.1	

They may be able to synthesise diagrams of the hydrolysis reactions which break these molecules down. Students could complete the Emulsion test.	<ul style="list-style-type: none"> <li>Describe the method and results of the Emulsion test</li> </ul>				
<p>3 Lipids - Structure and Function.</p> <p>Students could complete Assignment 1: Investigating the insulation properties of blubber. Student could try and elicit the functions of lipids from pictures. They should describe the functions of Triglycerides and where they may be found. They should be able to relate the behaviour of a phospholipid in water to its structure.</p>	<ul style="list-style-type: none"> <li>Explain the properties of triglycerides and phospholipids in relation to their structure.</li> </ul>	<p>3.3.1 Lipids</p> <p>The different properties of triglycerides and phospholipids related to their different structures</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>explain the different properties of triglycerides and phospholipids</li> </ul>	<p><i>MS 1.7 MS1.9 PS 2.1 PS2.4 PS3.1PS3.2</i></p>	2.1	
<p>4 Proteins</p> <p>Students should recognise that proteins make up many structures within cells and organisms. Functions of proteins can be shown using images, e.g., image of hair, glands to show hormones, etc. You could reiterate the idea that DNA provides the instructions for building these proteins. They could perform the biuret test.</p>	<ul style="list-style-type: none"> <li>Describe the biuret test</li> </ul>	<p>3.1.4.1 General Properties of Proteins</p> <p>The biuret test for proteins. Students should be able to relate the structure of proteins to properties of proteins named throughout the specification.</p>	<p>AT f</p> <p>Students could use, and interpret the results of, a biuret test for proteins.</p>	2.2	
<p>5 Protein Structure</p> <p>Students should recall that amino acids are monomer units joined by a condensation reaction to form di/polypeptides with peptide</p>	<ul style="list-style-type: none"> <li>Recall the structure of an amino acid molecule</li> </ul>	<p>3.1.4.1 General Properties of Proteins</p> <p>Amino acids are the monomers from which proteins are made.</p>		2.2	

<p>bonds. They may be able to synthesis the hydrolysis reaction that breaks down these polymers. Students should be able to draw and label a standard amino acid and describe the primary, secondary, tertiary and quaternary structure of proteins. Molymods can be used to make amino acids, dipeptides and polypeptides.</p>	<ul style="list-style-type: none"> <li>• Draw and label the condensation reaction between two amino acids</li> <li>• Describe the primary, secondary, tertiary and quaternary structure of polypeptides</li> </ul>	<p>The general structure of an amino acid.</p> <p>The twenty amino acids that are common in all organisms differ only in their side group.</p> <p>A condensation reaction between two amino acids forms a peptide bond.</p> <ul style="list-style-type: none"> <li>• Dipeptides are formed by the condensation of two amino acids.</li> <li>• Polypeptides are formed by the condensation of many amino acids.</li> </ul>			
<p>6 Specific Shape of Proteins</p> <p>Students could complete Assignment 2: Identifying Amino Acids using Chromatography. Students should recognise how changing R groups influence protein shape through the role of hydrogen, ionic and disulfide bridge bonding.</p>	<ul style="list-style-type: none"> <li>• Explain how changing R groups contribute to the structure of a protein by altering bonding within the molecule</li> </ul>	<p>3.1.4.1 General Properties of Proteins</p> <p>Amino acids are the monomers from which proteins are made. The general structure of an amino acid.</p> <p>The twenty amino acids that are common in all organisms differ only in their side group.</p> <p>The role of hydrogen bonds, ionic bonds and disulfide bridges in the structure of proteins.</p>	<p><i>MS 0.3 MS2.4 PS2.3 PS3.3</i></p> <p>AT g</p> <p>Students could use chromatography with known standard solutions, to separate a mixture of amino acids and identify their components</p>	<p>2.2</p>	
<p>7 Protein Function</p> <p>Students should describe the structure and function of Fibrous and Globular proteins. You could</p>	<ul style="list-style-type: none"> <li>• Describe the structure and function of proteins.</li> </ul>	<p>3.1.4.1 General Properties of Proteins</p> <p>A functional protein may contain one or more polypeptides.</p>		<p>2.2</p>	

<p>introduce some named examples i.e. Haemoglobin. Students could use modelling clay to make a model of a fibrous protein like collagen and a globular protein like haemoglobin.</p>		<p>Proteins have a variety of functions within all living organisms. The relationship between primary, secondary, tertiary and quaternary structure, and protein function.</p>			
<p>8 Consolidating learning</p> <p>Students can spend a lesson consolidating learning from the previous two chapters. They could play games like Taboo to cement learning of Key terms and produce revision resources such as cue cards and quick quizzes. They can complete the practice questions and peer mark with the mark scheme before correcting their work in order to develop exam technique. Mind maps can be produced to draw together all the concepts taught so far. Venn diagrams can be used to compare carbohydrates, lipids and proteins.</p>	<ul style="list-style-type: none"> <li>• Revisit and consolidate learning from Chapters 1 and 2</li> <li>• Identify areas of weakness which require further study</li> <li>• Compare progress to MTG</li> </ul>				
<p>9 Test/past papers</p> <p>Following on from the above, this lesson can be spent completing an AFL test consisting of past paper questions. This can be marked to assess progress and identify opportunities to improve exam performance and possible intervention opportunities.</p>	<ul style="list-style-type: none"> <li>• Revisit and consolidate learning from Chapters 1 and 2</li> <li>• Identify areas of weakness which require further study</li> <li>• Compare progress to MTG</li> </ul>				

One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 3 - Enzymes (10 hours)					
<p>1 Enzymes are Biological Catalysts</p> <p>In pairs students can create a poster of their current understanding of enzymes. This poster can be revisited and amended throughout the following lessons. Students should recognise that Enzymes are globular proteins which catalyse essential reactions within cells and for whole organisms by providing an alternative pathway with lower activation energy thereby increasing rate of reaction. They should be able to draw and annotate a graph to show this.</p>	<ul style="list-style-type: none"> <li>Describe, using labelled diagrams, how enzymes catalyse reactions</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <p>Each enzyme lowers the activation energy of the reaction it catalyses</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>appreciate that enzymes catalyse a wide range of intracellular and extracellular reactions that determine structures and functions from cellular to whole-organism level.</li> </ul>		<p>3.1</p> <p>3.2</p>	
<p>2 How Enzymes Work</p> <p>Students should be able to describe the role of the active site in enzyme function. They should recognise that the complex 3D tertiary structure of the enzyme provides it with a specific shape allowing the formation of enzyme-substrate complexes.</p>	<ul style="list-style-type: none"> <li>Using labelled diagrams describe how enzymes work</li> <li>Explain the specificity of enzymes</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <p>The properties of an enzyme relate to the tertiary structure of its active site and its ability to combine with complementary substrate(s) to form an enzyme-substrate complex.</p> <ul style="list-style-type: none"> <li>The specificity of enzymes</li> </ul>		3.3	
<p>3 How enzymes work</p>	<ul style="list-style-type: none"> <li>Describe the induced fit model of enzyme action</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p>		3.3	

<p>Students should move on from the 'lock and key' model they worked with at GCSE and be able to describe the 'induced fit' model. There are several animations available on the internet to illustrate this concept. Students can make clay models to illustrate the lock and key and induced fit models.</p>		<p>The induced-fit model of enzyme action.</p> <p>The properties of an enzyme relate to the tertiary structure of its active site and its ability to combine with complementary substrate(s) to form an enzyme-substrate complex.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• appreciate how models of enzyme action have changed over time</li> </ul>			
<p>4 Factors effecting Enzyme function</p> <p>Focusing on enzyme and substrate concentration. Students could complete a set of simple practical activities to illustrate such as oxygen produced from catalase (from potatoes) and different hydrogen peroxide concentrations.</p>	<ul style="list-style-type: none"> <li>• Describe the effects of concentration on enzyme activity</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <ul style="list-style-type: none"> <li>• The effects of the following factors on the rate of enzyme controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.</li> </ul>		3.4	
<p>5 Factors effecting Enzyme function</p> <p>Focusing on temperature in preparation for required practical. You could show a piece of liver (catalase) catalysing the breakdown of hydrogen peroxide and then heat the liver in a Bunsen flame and repeat. Students can complete Assignment 1: Investigating</p>	<ul style="list-style-type: none"> <li>• Describe the effects of temperature on the activity of enzymes</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <ul style="list-style-type: none"> <li>• The effects of the following factors on the rate of enzyme controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.</li> </ul>	PS1.2 PS2.1 PS2.4	3.4	

Biological Washing Powders this can also be adapted as a practical task.					
6 Required Practical  Students should carry out Required Practical 1 and investigate enzyme-controlled reactions, using a range of different apparatus.	<ul style="list-style-type: none"> <li>Use appropriate apparatus to record a range of quantitative measurements</li> <li>Use laboratory glassware apparatus for a variety of experimental techniques.</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <ul style="list-style-type: none"> <li>The effects of the following factors on the rate of enzyme controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.</li> </ul>	<p><i>MS1.3 MS3.2 MS3.5 MS3.6 PS2.1 PS2.4 PS3.1 PS3.2 PS3.3 PS4.1 Ata ATb ATc ATf ATl</i></p> <p>PS 2.4 Students could identify the variables that must be controlled in their investigation into rate of reaction.</p> <p>PS 3.3 Students could calculate the uncertainty of their measurements of the rate of reaction.</p> <p>MS 3.2 Students could select an appropriate format for the graphical presentation of the results of their investigation into the rate of enzyme controlled reactions.</p> <p>MS 3.6 Students could use a tangent to find the initial rate of an enzyme-controlled reaction.</p>	3.4	Required practical 1: Investigation into the effect of a named variable on the rate of an enzyme-controlled reaction.
7 Factors effecting Enzyme function	<ul style="list-style-type: none"> <li>Describe the effect of pH on enzyme action</li> </ul>	3.1.4.2 Many Proteins are Enzymes	<i>MS1.3 MS3.1 MS3.2 PS1.2 PS3.1</i>	3.4	

<p>Focusing on pH. Students may complete Assignment 2: Investigating the effect of pH on Enzymes. Students may perform a practical investigating the effect of pH on Pepsin.</p>		<ul style="list-style-type: none"> <li>The effects of the following factors on the rate of enzyme controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.</li> </ul>	<p>MS 0.5 Students could be given the hydrogen ion concentration of a solution in order to calculate its pH, using the formula: <math>pH = -\log_{10}[H^+]</math></p>		
<p>8 Factors effecting Enzyme function</p> <p>Focusing on competitive and non-competitive inhibition. Students could investigate how lead inhibits catechol oxidase.</p>	<ul style="list-style-type: none"> <li>Describe the effect of competitive and non-competitive inhibition on enzyme action</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <ul style="list-style-type: none"> <li>The effects of the following factors on the rate of enzyme controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.</li> </ul>		3.4	
<p>9 Factors effecting enzyme function</p> <p>Students can complete Assignment 3: Investigating enzymes for the future and research enzyme use further with access to the internet.</p>	<ul style="list-style-type: none"> <li>Describe the factors which affect the rate of enzyme action</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <ul style="list-style-type: none"> <li>The effects of the following factors on the rate of enzyme controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.</li> </ul>	<p><i>MS0.1 MS0.3 PS1.1 PS1.2</i></p>	3.4	
<p>10 Factors effecting enzyme function</p> <p>Students can complete Assignment 4: Measuring the</p>	<ul style="list-style-type: none"> <li>Describe the factors which affect the rate of enzyme action</li> </ul>	<p>3.1.4.2 Many Proteins are Enzymes</p> <ul style="list-style-type: none"> <li>The effects of the following factors on the rate of enzyme controlled reactions – enzyme</li> </ul>	<p><i>MS1.3 MS3.2 MS4.1 PS1.1 PS2.3 PS3.1 PS3.2</i></p>	3.4	



activity of amylase. This can also be adapted as a practical task.

concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and temperature.

One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 4 - Nucleotides (10 hours)					
<p>1 Structure of DNA</p> <p>Students should be able to recall the properties of DNA. Students must draw and label a nucleotide and describe the condensation reactions and bonding that produce a polynucleotide. The should describe how two polynucleotide chains run in antiparallel and form hydrogen bonds to produce the DNA double helix. It may help students to build some models of DNA. A practical to extract DNA from an onion or kiwi can be carried out as an introductory lesson.</p>	<ul style="list-style-type: none"> <li>Recall the structure of a nucleotide</li> <li>Describe the formation of a polynucleotide and DNA double helix</li> </ul>	<p>3.1.5.1 Structure of DNA and RNA</p> <ul style="list-style-type: none"> <li>The components of a DNA nucleotide are deoxyribose, a phosphate group and one of the organic bases adenine, cytosine, guanine or thymine.</li> <li>A condensation reaction between two nucleotides forms a phosphodiester bond.</li> </ul> <p>A DNA molecule is a double helix with two polynucleotide chains held together by hydrogen bonds between specific complementary base pairs.</p>	<p>MS0.3 PS1.2</p> <p>MS 0.3</p> <p>Students could use incomplete information about the frequency of bases on DNA strands to find the frequency of other bases.</p>	4.1	
<p>2 Base pairing, how DNA hold information</p> <p>Students could complete Assignment 2: Understanding Base Pairing. Students should recall the full names of the four bases and how they are paired. It may help students understand the concepts to discuss Purines and Pyrimidines and the number of hydrogen bonds formed but detailed knowledge will not be required for the examination.</p>	<ul style="list-style-type: none"> <li>Use knowledge of base pairing to complete partial data on the number of bases present in various organisms</li> </ul>	<p>3.1.5.1 Structure of DNA and RNA</p> <p>A DNA molecule is a double helix with two polynucleotide chains held together by hydrogen bonds between specific complementary base pairs</p>	MS0.3 PS1.2	4.1	

<p>3 The Discovery of DNA</p> <p>Students can complete Assignment 1: Discovering the structure of DNA. You may also wish to have them watch one of the many excellent documentaries available on Watson and Crick or the 1987 dramatization 'Life Story'. You could also provide the opportunity for independent working by asking Students to work in pairs to research and produce a presentation on one of the Scientist involved in the discovery of DNA.</p>	<ul style="list-style-type: none"> <li>• Develop an understanding of the sequence of events that lead to our current understanding of the structure of DNA.</li> </ul>	<p>3.1.5.1 Structure of DNA and RNA</p> <p>Students should be able to appreciate that the relative simplicity of DNA led many scientists to doubt that it carried the genetic code.</p>	<p>PS1.2</p>	<p>4.1</p>	
<p>4 The structure of RNA</p> <p>Students should recall the structure of RNA and describe its function in cells. A table can be completed to compare the similarities and differences between DNA and RNA. Students may benefit from building a model of RNA.</p>	<ul style="list-style-type: none"> <li>• Describe the structure of RNA</li> <li>• Compare RNA and DNA</li> </ul>	<p>3.1.5.1 Structure of DNA and RNA</p> <p>Students should recognise that DNA and RNA are nucleic acids. Students should be able to describe the differences and similarities between them.</p> <p>An RNA molecule is a relatively short polynucleotide chain</p> <ul style="list-style-type: none"> <li>• The components of an RNA nucleotide are ribose, a phosphate group and one of the organic bases adenine, cytosine, guanine or uracil.</li> </ul> <p>Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are important information-carrying molecules. In all living cells, DNA holds genetic information and</p>		<p>4.1</p>	

		<p>RNA transfers genetic information from DNA to the ribosomes.</p> <p>Ribosomes are formed from RNA and proteins.</p> <p>Both DNA and RNA are polymers of nucleotides. Each nucleotide is formed from a pentose, a nitrogen-containing organic base and a phosphate group.</p>			
<p>5 DNA Replication</p> <p>Give students some of the functions of DNA and in pairs they have to come up with structural features that aid this. Students should recognise the features that make DNA adapted of copying and passing on genetic information and describe the process of semi-conservative replication including the role of DNA Helicase and DNA Polymerase. It may help the learning process to produce a flow diagram detailing each stage.</p>	<ul style="list-style-type: none"> <li>• Describe the process of DNA replication</li> <li>• Explain the role of enzymes in replication</li> <li>• Explain how DNA is adapted to enable copying</li> </ul>	<p>3.1.5.2 DNA Replication</p> <p>The semi-conservative replication of DNA ensures genetic continuity between generations of cells.</p> <p>The process of semi-conservative replication of DNA in terms of:</p> <ul style="list-style-type: none"> <li>• unwinding of the double helix</li> <li>• breakage of hydrogen bonds between complementary bases in the polynucleotide strands</li> <li>• the role of DNA helicase in unwinding DNA and breaking its hydrogen bonds</li> <li>• attraction of new DNA nucleotides to exposed bases on template strands and base pairing</li> <li>• the role of DNA polymerase in the condensation reaction that joins nucleotides.</li> </ul>		4.2	

<p>6 Evidence for semi-conservative replication</p> <p>Students should be able to interpret Meselson and Stahl's data and predict outcomes of further generations. Students frequently find this experimental data challenging. You may wish to extend the 'sweetie DNA' model task frequently used at GCSE to help their understanding. Students may use different colours of sherbet rope type sweets or pipe cleaners to represent heavy and light nitrogen. Students could work in groups to predict what the results of the experiment would have been had DNA replicated through conservative or dispersive replication.</p>	<ul style="list-style-type: none"> <li>Describe how Meselson and Stahl found evidence which support semi-conservative replication</li> <li>Predict the outcome of future generations for this experiment</li> </ul>	<p>3.1.5.2 DNA Replication</p> <p>Students should be able to evaluate the work of scientists in validating the Watson–Crick model of DNA replication.</p>		4.2	
<p>7 ATP</p> <p>Students should recognise the universal importance of ATP and describe its role within the cell. They should draw ATP and describe its synthesis and hydrolysis including the role of enzymes ATPHydrolase and ATP Synthase. Molymods can be used to make ATP.</p>	<ul style="list-style-type: none"> <li>Recall the structure of ATP</li> <li>Describe the hydrolysis of ATP</li> <li>Explain why ATP is essential to cells</li> </ul>	<p>3.1.6 ATP</p> <p>A single molecule of adenosine triphosphate (ATP) is a nucleotide derivative and is formed from a molecule of ribose, a molecule of adenine and three phosphate groups.</p> <p>Hydrolysis of ATP to adenosine diphosphate (ADP) and an inorganic phosphate group (Pi) is catalysed by the enzyme ATPHydrolase.</p>	MS0.2 MS1.1 MS4.1	4.3	

		<ul style="list-style-type: none"> <li>• The hydrolysis of ATP can be coupled to energy-requiring reactions within cells.</li> <li>• The inorganic phosphate released during the hydrolysis of ATP can be used to phosphorylate other compounds, often making them more reactive.</li> </ul> <p>ATP is re-synthesised by the condensation of ADP and Pi. This reaction is catalysed by the enzyme ATP synthase during photosynthesis, or during respiration.</p>			
<p>8-10 Consolidating/revision</p> <p>In the first lesson Students can spend a lesson consolidating learning from the previous two chapters. They could play games like Taboo to cement learning of Key terms and produce revision resources such as cue cards and quick quizzes. They can complete the practice questions and peer mark with the mark scheme before correcting their work in order to develop exam technique.</p> <p>The second lesson can be spent completing an AFL test consisting of past paper questions. This can be marked to assess progress and identify opportunities to improve exam performance and possible intervention opportunities.</p>	<ul style="list-style-type: none"> <li>• Revisit and consolidate learning from Chapters 9 and 10</li> <li>• Identify areas of weakness which require further study</li> <li>• Compare progress to MTG</li> </ul>				

In the third lesson the test can be reviewed and Students can correct their work and redraft answers. They should set their own targets for improvement; these can reference content or exam technique.

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One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 5 – Cells (14 hours)					
<p>1 Cells and Living Organisms</p> <p>Students could recall prior knowledge and list examples of cells, tissues, organs, etc. Taboo could be used as an introductory game using key words or Pictionary. Students should recognise that all life on earth is dependent on cells. They should describe the adaptation of specialised cells and how they are organised in multicellular organisms.</p>	<ul style="list-style-type: none"> <li>Recall how specialised cells are organised into tissues, organs and organ systems</li> <li>Describe how specialised cells are adapted for their functions</li> </ul>	<p>3.2.1.1 Structure of Eukaryotic Cells</p> <p>In complex multicellular organisms, eukaryotic cells become specialised for specific functions. Specialised cells are organised into tissues, tissues into organs and organs into systems.</p>		5.1	
<p>2 Cells and Living Organisms</p> <p>Students should revisit the use of optical microscopes to prepare them for the required practical.</p>	<ul style="list-style-type: none"> <li>Correctly and safely use an Optical microscope</li> <li>Recall, use and rearrange the magnification formula</li> </ul>	<p>3.2.1.1 Structure of Eukaryotic Cells</p> <p>Use of the formula: magnification = size of image /size of real object</p>	MS0.1 MS0.2 MS1.2 MS1.8 MS2.2 MS2.3 MS2.5 MS4.1	5.4	
<p>3 Structure of Eukaryotic cells – Animal cells</p> <p>Students should be able to label the required features in Eukaryotic Animal cells. They should be able to give the function of each of the organelles. Students may draw the diagrams or produce a ‘junk model’ with labels to help cement learning. Back to the board can be used to</p>	<ul style="list-style-type: none"> <li>Recall labels for organelles found Eukaryotic cells (Animal)</li> <li>Describe the function of each of the organelles</li> </ul>	<p>3.2.1.1 Structure of Eukaryotic Cells</p> <p>The structure of eukaryotic cells, restricted to the structure and function of:</p> <ul style="list-style-type: none"> <li>nucleus</li> <li>mitochondria</li> <li>cell-surface membrane</li> </ul>		5.2	



<p>introduce the structure of some of the key organelles whereby ne student describes what they can see for another student to draw.</p>		<ul style="list-style-type: none"> <li>• Golgi apparatus and Golgi vesicles</li> <li>• lysosomes (a type of Golgi vesicle that releases lysozymes)</li> <li>• ribosomes</li> <li>• rough endoplasmic reticulum and smooth endoplasmic reticulum</li> </ul> <p>Students should be able to apply their knowledge of these features in explaining adaptations of eukaryotic cells.</p>			
<p>4 Structure of Eukaryotic cells – Plant cells</p> <p>Students should be able to label the required features in Eukaryotic Plant cells. They should be able to give the function of each of the organelles. Students may draw the diagrams or produce a 'junk model' with labels to help cement learning.</p>	<ul style="list-style-type: none"> <li>• Recall labels for organelles found Eukaryotic cells (Plants)</li> <li>• Describe the function of each of the organelles</li> </ul>	<p>3.2.1.1 Structure of Eukaryotic Cells</p> <p>The structure of eukaryotic cells, restricted to the structure and function of:</p> <ul style="list-style-type: none"> <li>▪ nucleus</li> <li>▪ mitochondria</li> <li>▪ chloroplasts</li> <li>• cell-surface membrane</li> <li>• Golgi apparatus and Golgi vesicles</li> <li>• lysosomes (a type of Golgi vesicle that releases lysozymes)</li> </ul>		5.2	

		<ul style="list-style-type: none"> <li>• ribosomes</li> <li>• rough endoplasmic reticulum and smooth endoplasmic reticulum</li> <li>• cell wall (in plants, algae and fungi)</li> <li>• cell vacuole (in plants).</li> </ul>			
<p>5 Ultrastructure of Organelles</p> <p>Students need to be able to describe the ultrastructure of the main organelles and their functions. Students may draw the diagrams or produce a 'junk model' with labels to help cement learning. Clay models of these organelles can be made.</p>	<ul style="list-style-type: none"> <li>• Recall the ultrastructure of the nucleus, mitochondria and chloroplasts</li> <li>• Give their functions</li> <li>• Describe how they are adapted to their functions</li> </ul>	<p>3.2.1.1 Structure of Eukaryotic Cells</p> <p>The structure of eukaryotic cells, restricted to the structure and function of:</p> <ul style="list-style-type: none"> <li>• nucleus (containing chromosomes, consisting of protein-bound, linear DNA, and one or more nucleoli)</li> <li>• mitochondria</li> <li>• chloroplasts (in plants and algae)</li> </ul>		5.2	
<p>6 Comparing Eukaryotic Cells</p> <p>Students should be able to state the similarities and differences between the Eukaryotic cells types and how they are adapted to their functions. A Venn diagram or table can be used to structure the comparison. This is an opportunity to develop exam technique by</p>	<ul style="list-style-type: none"> <li>• Compare the organelles found in animal and plant cells</li> </ul>	<p>3.2.1.1 Structure of Eukaryotic Cells</p> <p>Students should be able to apply their knowledge of these features in explaining adaptations of eukaryotic cells.</p>		5.2	

<p>examining the same content using different command words.</p>					
<p>7 Prokaryotic Cells and Viruses</p> <p>Students should recognise that not all cells are Eukaryotic. They should be able to recall the structure and function of the features of a prokaryotic cell. A clay model of a prokaryotic cell can be made. Students should be able to compare Eukaryotic and Prokaryotic cells, this can be done in a table.</p>	<ul style="list-style-type: none"> <li>• Recall the features and functions of a Prokaryotic cell</li> <li>• Compare Eukaryotic and Prokaryotic cells</li> <li>• Explain why Viruses are described as 'acellular' and 'non-living'</li> </ul>	<p>3.2.1.2 Structure of Prokaryotic cells and viruses</p> <p>Prokaryotic cells are much smaller than eukaryotic cells. They also differ from eukaryotic cells in having:</p> <ul style="list-style-type: none"> <li>• cytoplasm that lacks membrane-bound organelles</li> <li>• smaller ribosomes</li> <li>• no nucleus; instead they have a single circular DNA molecule that is free in the cytoplasm and is not associated with proteins</li> <li>• a cell wall that contains murein, a glycoprotein.</li> </ul> <p>In addition, many prokaryotic cells have:</p> <ul style="list-style-type: none"> <li>• one or more plasmids</li> <li>• a capsule surrounding the cell</li> <li>• one or more flagella.</li> </ul> <p>Details of these structural differences are not required.</p> <p>Viruses are acellular and non-living. The structure of virus particles to include genetic</p>		<p>5.3</p>	

		material, capsid and attachment protein.			
<p>8 Methods of Studying Cells</p> <p>Students should be able to compare optical, electron and scanning electron microscopes. Students could complete a table with information about each device, its benefits and limitations. Students could use an optical microscope to view cells. Images of micrographs can be given and students have to calculate the actual size from the image and magnification.</p>	<ul style="list-style-type: none"> <li>Compare optical and electron microscopes giving their advantages and limitations.</li> </ul>	<p>3.2.1.3 Methods of Studying Cells</p> <p>The principles and limitations of optical microscopes, transmission electron microscopes and scanning electron microscopes.</p> <p>Measuring the size of an object viewed with an optical microscope.</p> <p>The difference between magnification and resolution.</p> <p>Use of the formula: magnification = size of image/size of real object</p> <p>Principles of cell fractionation and ultracentrifugation as used to separate cell components.</p> <p>Students should be able to appreciate that there was a considerable period of time during which the scientific community distinguished between artefacts and cell organelles.</p>	<p>MS0.1 MS0.2 MS1.2 MS1.8 MS2.2 MS2.3 MS2.5 MS4.1</p>	5.4	
<p>9 Methods of Studying Cells</p> <p>Students can complete a practical task using iodide to stain starch cells and using their observations in the magnification formula.</p>	<ul style="list-style-type: none"> <li>Explain what is meant by magnification and resolution</li> <li>Use the magnification formula correctly</li> </ul>	<p>3.2.1.3 Methods of Studying Cells</p> <p>Measuring the size of an object viewed with an optical microscope.</p> <p>The difference between magnification and resolution.</p>	<p>AT d, e and f</p> <p>Students could use iodine in potassium iodide solution to identify starch grains in plant cells.</p> <p>MS 1.8</p>	5.4	

		Use of the formula: magnification = size of image/size of real object			
<p>10 Methods of Studying Cells</p> <p>Students should be able to describe the steps in ultracentrifugation, the principle behind the process and how it allow us to study cells. If you have access to an ultracentrifuge Students could use it to extract the largest organelles. The analogy of a spinning ride with occupants of different sizes and masses can be used to illustrate the concept.</p>	<ul style="list-style-type: none"> <li>Explain the stages in cell fractionation and ultracentrifugation and how it allows us to study organelles</li> </ul>	<p>3.2.1.3 Methods of Studying Cells</p> <p>Principles of cell fractionation and ultracentrifugation as used to separate cell components.</p> <p>Students should be able to appreciate that there was a considerable period of time during which the scientific community distinguished between artefacts and cell organelles.</p>		5.4	
<p>11 Making New Cells</p> <p>Students could complete Assignment 1: Controlling the Cell Cycle. Students should appreciate the role of Stem cells and how cell division leads to growth and repair. Students should recognise uncontrolled mitosis leads to the development of tumours and cancer.</p>	<ul style="list-style-type: none"> <li>Recall the stages of cell cycle</li> <li>Explain how uncontrolled Mitosis can cause disease</li> </ul>	<p>3.2.2 All cells arrive from other cells</p> <p>Within multicellular organisms, not all cells retain the ability to divide. Eukaryotic cells that do retain the ability to divide show a cell cycle.</p> <ul style="list-style-type: none"> <li>DNA replication occurs during the interphase of the cell cycle. Mitosis is a controlled process. Uncontrolled cell division can lead to the formation of tumours and of cancers. Many cancer treatments are directed at controlling the rate of cell division.</li> </ul>	MS0.1 MS0.5 MS1.3 MS2.5 PS1.2 PS2.4 PS3.1	5.5	
<p>12 Making New Cells – Mitosis</p>	<ul style="list-style-type: none"> <li>Describe the key features in each stage of Mitosis</li> </ul>	<p>3.2.2 All cells arrive from other cells</p>		5.5	

<p>Students should recall the cell cycle and describe the stages of mitosis. Students could create a cartoon strip to show mitosis. They should be able to identify the stages as shown in diagrams and electro micrographs. Activities such as back to back drawing or Taboo can be used to cement knowledge.</p>		<ul style="list-style-type: none"> <li>• Mitosis is the part of the cell cycle in which a eukaryotic cell divides to produce two daughter cells, each with the identical copies of DNA produced by the parent cell during DNA replication.</li> </ul> <p>The behaviour of chromosomes during interphase, prophase, metaphase, anaphase and telophase of mitosis. The role of spindle fibres attached to centromeres in the separation of chromatids.</p> <p>Division of the cytoplasm (cytokinesis) usually occurs, producing two new cells. Meiosis is covered in section 3.4.3</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• recognise the stages of the cell cycle: interphase, prophase, metaphase, anaphase and telophase (including cytokinesis)</li> <li>• explain the appearance of cells in each stage of mitosis.</li> </ul>			
<p>13 Making New Cells - Cell division in Prokaryotes</p> <p>Students should describe Prokaryotic cellular division. They should compare the process of cell division in Eukaryotic and Prokaryotic cells.</p>	<ul style="list-style-type: none"> <li>• Describe cell division in Prokaryotes</li> <li>• Compare cell division in Eukaryotic and Prokaryotic cells</li> </ul>	<p>3.2.2 All cells arrive from other cells</p> <p>Binary fission in prokaryotic cells involves:</p> <ul style="list-style-type: none"> <li>• replication of the circular DNA and of plasmids</li> </ul>	<p>MS0.1 MS0.5 MS1.3 MS2.5</p>	<p>5.5</p>	

<p>Students can use the worked example as a guide and complete a practical investigation into bacterial growth rates.</p>		<ul style="list-style-type: none"> <li>• division of the cytoplasm to produce two daughter cells, each with a single copy of the circular DNA and a variable number of copies of plasmids.</li> </ul> <p>Being non-living, viruses do not undergo cell division. Following injection of their nucleic acid, the infected host cell replicates the virus particles.</p>			
<p>14 Required Practical 2: Root Tip Squashes.</p> <p>Students must complete the required practical and calculate the mitotic index of root tip squashes.</p>	<ul style="list-style-type: none"> <li>• Safely and correctly complete the practical</li> <li>• Use results to calculate mitotic index</li> <li>• Use magnification formula to calculate actual size of the cells</li> </ul>	<p>3.2.2 All cells arise from other cells</p>	<p>AT d and e MS 0.3 Calculation of a mitotic index. MS 1.8</p>	<p>5.5</p>	<p>Required practical 2: Preparation of stained squashes of cells from plant root tips; set-up and use of an optical microscope to identify the stages of mitosis in these stained squashes and calculation of a mitotic index</p>

One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 6 - Cell Membranes (11 hours)					
<p>1 The structure of cell membranes</p> <p>Students can draw diagram of the cell membrane and correctly identify its components. They can interpret electron micrographs of the cell membrane and calculate the thickness of the membrane. Ensure Students recognise that the same arrangement makes up the cell surface membrane and the membrane which bind the organelles in Eukaryotes.</p>	<ul style="list-style-type: none"> <li>Describe the structure of the cell membrane</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>The basic structure of all cell membranes, including cell-surface membranes and the membranes around the cell organelles of eukaryotes, is the same.</p>	<p>MS 0.1 Recognise and make use of appropriate units in calculations</p> <p>MS 0.2 Recognise and use expressions in decimal and standard form</p> <p>MS 0.4 Estimate results</p> <p>MS 1.8 Make order of magnitude calculations</p>	6.1	
<p>2 The function of cell membranes</p> <p>Students can create models of the cell membrane. They can know the membrane as the 'fluid mosaic model' and explain why it has this name. They can annotate their diagrams from previous lesson to describe the function of each part of the membrane.</p>	<ul style="list-style-type: none"> <li>Explain the role of molecules within the cell membrane</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>The arrangement and any movement of phospholipids, proteins, glycoproteins and glycolipids in the fluid-mosaic model of membrane structure. Cholesterol may also be present in cell membranes where it restricts the movement of other molecules making up the membrane.</p>		6.1	
<p>3 The function of cell membranes</p> <p>Students can list the features that make the cell membrane adapted to its function. They can recall how</p>	<ul style="list-style-type: none"> <li>Describe how cell membranes are adapted to their function</li> </ul>	<p>3.2.3 Transport across cell membranes</p>		6.2	



<p>some specialised cells are adapted to increase the rate of transport. Give students pictures of specialised cells and in pairs they should come up with some of the features.</p>	<ul style="list-style-type: none"> <li>Explain how specialised cells are adapted to increase the rate of transport</li> </ul>	<p>Cells may be adapted for rapid transport across their internal or external membranes by an increase in surface area of, or by an increase in the number of protein channels and carrier molecules in, their membranes.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>explain the adaptation of specialised cells in relation to the rate of transport across their internal and external membranes.</li> </ul>			
<p>4 The function of cell membranes</p> <p>Students should be able to list the factors affecting the rate of transport prior to learning about them in detail. It may help them to watch some animations. A poster of the cell membrane can be created to draw together all the concepts together on the cell membrane.</p>	<ul style="list-style-type: none"> <li>Recall the factors affecting the rate of transport across cell membranes</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>explain how surface area, number of channel or carrier proteins and differences in gradients of concentration or water potential affect the rate of movement across cell membranes.</li> </ul>		6.2	
<p>5 Movement across the cell membrane: diffusion</p> <p>Diffusion can be demonstrated using tea bags or spraying perfume. Students define diffusion and give examples of molecules that would move across the cell membrane this way. Factors affecting the rate of movement</p>	<ul style="list-style-type: none"> <li>Define and describe the passive method of diffusion across the cell membrane</li> <li>Explain the factors that can affect the rate of transport across the cell membrane</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Movement across membranes occurs by:</p> <ul style="list-style-type: none"> <li>simple diffusion (involving limitations imposed by the nature of the phospholipid bilayer)</li> </ul>	<p>MS 1.2 Find arithmetic means</p> <p>MS 1.3 Construct and interpret frequency tables and diagrams, bar charts and histograms</p> <p>MS 2.3 Substitute numerical values into</p>	6.2	

<p>should be identified; this is an opportunity for students to practice calculating surface area. Students could draw and explain graphs showing diffusion with concentration of substance on the x-axis and rate of diffusion on the y-axis.</p>	<ul style="list-style-type: none"> <li>• Illustrate graphically movement across a cell membrane by diffusion</li> </ul>		<p>algebraic equations using appropriate units for physical quantities</p> <p>MS 3.1 Translate information between graphical, numerical and algebraic forms</p> <p>MS 4.1 Calculate the circumferences, surface areas and volumes of regular shapes</p> <p>PS 3.1 Plot and interpret graphs</p>		
<p>6 Movement across the cell membrane: facilitated diffusion</p> <p>Students define facilitated diffusion and give examples of molecules that would move across the cell membrane this way. They should be able to draw annotated diagrams showing the process. Factors affecting the rate of movement should be identified. Ensure Students recognise both diffusion and facilitated diffusion are passive processes dependent on concentration gradients. Students could draw and explain graphs showing facilitated diffusion with concentration of substance on the x-axis and rate of diffusion on the y-axis.</p>	<ul style="list-style-type: none"> <li>• Define and describe the passive facilitated diffusion across the cell membrane</li> <li>• Explain the factors that can affect the rate of transport across the cell membrane</li> <li>• Illustrate graphically movement across a cell membrane by facilitated diffusion</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Movement across membranes occurs by:</p> <ul style="list-style-type: none"> <li>• facilitated diffusion (involving the roles of carrier proteins and channel proteins).</li> </ul>		<p>6.2</p>	

<p>7 Movement across the cell membrane: osmosis</p> <p>Osmosis can be demonstrated by putting a jelly baby in water. Students can recall prior knowledge of water and osmosis and add to this by defining osmosis in terms of water potential. Students can predict the movement of water between cells based on given values for water potential. In small groups students can predict the consequences to animal and plant cells when placed in solutions with differing water potentials. Venn diagrams can be completed to compare diffusion, facilitated diffusion and osmosis.</p>	<ul style="list-style-type: none"> <li>Define osmosis in terms of water potential and explain what an aquaporin is</li> <li>Give the units for water potential and identify what happens to water potential when solute concentration changes</li> <li>Predict the net direction of the movement of water using water potential and explain the consequences for cells</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Movement across membranes occurs by:</p> <ul style="list-style-type: none"> <li>osmosis (explained in terms of water potential)</li> </ul>		6.3	
<p>8 Practical: movement across the cell membrane by osmosis</p> <p>Students can produce a serial dilution of a solute to produce a calibration curve with which to identify the water potential of a plant tissue. Data collected can be plotted in an appropriate format and students could determine the water potential of plant tissues using the intercept of a graph of, e.g. water potential of solution against gain/loss of mass.</p>	<p>Objectives can be chosen depending on the emphasis of the practical lesson:</p> <ul style="list-style-type: none"> <li>Select and use laboratory equipment accurately to collect experimental data</li> <li>Calculate and prepare a serial dilution</li> <li>Calculate a percentage change in mass</li> <li>Present data collected in a graph</li> <li>Interpret data collected to draw a conclusion</li> <li>Explain the steps in the scientific method</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Movement across membranes occurs by:</p> <ul style="list-style-type: none"> <li>osmosis (explained in terms of water potential)</li> </ul>	<p>MS 0.3 Use ratios, fractions and percentages</p> <p>MS 3.2 Plot two variables from experimental or other data</p> <p>MS 3.4 Determine the intercept of a graph</p> <p>PS 2.2 Present data in appropriate ways</p> <p>PS 3.1 Plot and interpret graphs</p> <p>PS 3.2 Process and analyse data using appropriate mathematical skills as</p>	6.3	<p>Required practical 3: Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue.</p>

			<p>exemplified in the mathematical appendix for each science</p> <p>PS 4.1 Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification</p> <p>AT c Use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions</p> <p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p> <p>AT I Use ICT such as computer modelling, or data logger to collect data, or use software to process data</p>	
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<p>9 Practical: factors affecting rate of movement across a cell membrane</p> <p>Students plan an investigation into the effect of a named variable on the permeability of cell-surface membranes. Data collected can be plotted in a graph in the appropriate format.</p>	<p>Objectives can be chosen depending on the emphasis of the practical lesson:</p> <ul style="list-style-type: none"> <li>• Select and use laboratory equipment to record a range of quantitative measurements</li> <li>• Describe what a colorimeter is used for</li> <li>• Identify investigative variables</li> <li>• Display experimental data in tabular form</li> <li>• Plot data graphically</li> <li>• Describe and explain any pattern observed in the data</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• explain how surface area, number of channel or carrier proteins and differences in gradients of concentration or water potential affect the rate of movement across cell membranes</li> </ul>	<p>MS 3.2 Plot two variables from experimental or other data</p> <p>PS 4.1 Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification</p> <p>AT a Use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH)</p> <p>AT b Use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer</p> <p>AT c Use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions</p> <p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p>	<p>6.3</p>	<p>Required practical 4: Investigation into the effect of a named variable on the permeability of cell-surface membranes.</p>
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			AT   Use ICT such as computer modelling, or data logger to collect data, or use software to process data		
<p>10 Movement across the cell membrane by active transport</p> <p>Students can describe the process of active transport and recognise the importance of ATP. They may list adaptations of cells which undergo large amounts of active transport. Active transport could be plotted graphically with concentration of substance on the x-axis and rate of uptake on the y-axis and compared to the graphs of diffusion and facilitated diffusion.</p>	<ul style="list-style-type: none"> <li>Define the terms active transport</li> <li>Give examples of active transport</li> <li>Illustrate graphically active transport</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Movement across membranes occurs by:</p> <ul style="list-style-type: none"> <li>active transport (involving the role of carrier proteins and the importance of the hydrolysis of ATP)</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>explain the adaptation of specialised cells in relation to the rate of transport across their internal and external membranes</li> <li>explain how surface area, number of channel or carrier proteins and differences in gradients of concentration or water potential affect the rate of movement across cell membranes</li> </ul>	<p>MS 1.3 Construct and interpret frequency tables and diagrams, bar charts and histograms</p> <p>MS 3.1 Translate information between graphical, numerical and algebraic forms</p> <p>PS 3.1 Plot and interpret graphs</p>	6.4	

<p>11 Movement across the cell membrane by co-transport</p> <p>Using exercise, the epithelial cell and blood capillary as a case study, students describe in context the role of co-transport. Adaptations of the epithelial cell as a specialised cell could be identified.</p>	<ul style="list-style-type: none"> <li>• Define the term co transport</li> <li>• Give examples of co transport</li> </ul>	<p>3.2.3 Transport across cell membranes</p> <p>Movement across membranes occurs by:</p> <ul style="list-style-type: none"> <li>• co-transport (illustrated by the absorption of sodium ions and glucose by cells lining the mammalian ileum)</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• explain the adaptation of specialised cells in relation to the rate of transport across their internal and external membranes</li> <li>• explain how surface area, number of channel or carrier proteins and differences in gradients of concentration or water potential affect the rate of movement across cell membranes</li> </ul>	<p>6.4</p>	
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One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 7 - The Immune System (9 hours)					
<p>1 Cell surface antigens</p> <p>Prior knowledge of immunity can be assessed by asking students to write down a fact on sticky notes on immunity or by creating a mind map in pairs or small groups. Students can begin to create a glossary of key words which can be added to throughout the topic.</p>	<ul style="list-style-type: none"> <li>Define key terms including cell surface antigens, immune response and phagocytes</li> <li>Identify how foreign antigens end up inside the body</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p> <p>Each type of cell has specific molecules on its surface that identify it. These molecules include proteins and enable the immune system to identify:</p> <ul style="list-style-type: none"> <li>pathogens</li> <li>cells from other organisms of the same species</li> <li>abnormal body cells</li> <li>toxins</li> </ul> <p>Definition of antigen. The effect of antigen variability on disease and disease prevention.</p> <p>Phagocytosis of pathogens. The subsequent destruction of ingested pathogens by lysozymes.</p>		7.1	
<p>2 Phagocytosis</p> <p>Students can create a cartoon strip to illustrate what happens in the process of phagocytosis. There are animations and real time videos of the process which can be watched.</p>	<ul style="list-style-type: none"> <li>Describe the process of phagocytosis</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p> <p>Phagocytosis of pathogens. The subsequent destruction of ingested pathogens by lysozymes.</p>		7.2	
<p>3 The immune response</p>	<ul style="list-style-type: none"> <li>Define key terms including neutrophils, macrophages,</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p>		7.3	



<p>Students match key terms and definitions using a card sort. This can be revisited at the end of the lesson or assessed through a game of taboo. A model of an antibody can be made using modelling clay.</p>	<p>antigen presenting cell, clonal selection, cytotoxic T cell, helper T cell, cytokines, memory cells, plasma cells , agglutination and immunoglobulin</p> <ul style="list-style-type: none"> <li>Identify different types of lymphocytes</li> </ul>	<ul style="list-style-type: none"> <li>Definition of antibody</li> <li>Antibody structure</li> <li>The formation of an antigen-antibody complex, leading to the destruction of the antigen, limited to agglutination and phagocytosis of bacterial cells.</li> </ul>			
<p>4 The immune response</p> <p>Students could select key information from written passages of the immune response to create a flow chart of both the cellular and humoral immune response.</p>	<ul style="list-style-type: none"> <li>Describe the cellular and humoral immune response</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p> <p>The roles of plasma cells and of memory cells in producing primary and secondary immune responses</p> <p>The response of T lymphocytes to a foreign antigen (the cellular response)</p> <ul style="list-style-type: none"> <li>The role of antigen-presenting cells in the cellular response</li> <li>The role of helper T cells (TH cells) in stimulating cytotoxic T cells (TC cells), B cells and phagocytes. The role of other T cells is not required</li> </ul> <p>The response of B lymphocytes to a foreign antigen, clonal selection and the release of monoclonal antibodies (the humoral response).</p>		7.3	
<p>5 Immunity</p> <p>Primary and secondary response as well as passive and active immunity can be compared in tabular form. Using a case study of</p>	<ul style="list-style-type: none"> <li>Describe and compare the primary and secondary immune response</li> <li>Identify the difference between passive and active immunity</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p> <p>The roles of plasma cells and of memory cells in producing primary and secondary immune responses.</p>	MS 1.3 Construct and interpret frequency tables and diagrams, bar charts and histograms	7.3	

<p>MMR the success of herd immunity can be discussed. Assignment 1 and question 10 can be used to structure interpretation of graphical data on the immune response.</p>	<ul style="list-style-type: none"> <li>• Explain the term herd immunity and interpret graphs illustrating the immune response</li> </ul>	<p>The use of vaccines to provide protection for individuals and populations against disease.</p> <p>The concept of herd immunity.</p> <p>The differences between active and passive immunity.</p>	<p>MS 3.1 Translate information between graphical, numerical and algebraic forms</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p>		
<p>6 HIV and the immune system</p> <p>Using a card sort students could recall previous lessons and put together a flow chart of the cellular and humoral immune response. Students recall prior knowledge of the structure of a virus and relate it to the structure of HIV. Working in pairs or independently students could research and create a poster/presentation to meet the lesson objectives on HIV.</p>	<ul style="list-style-type: none"> <li>• Recall the cellular and humoral immune response</li> <li>• Describe the structure of HIV</li> <li>• Explain how HIV replicates and how it can be treated</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p> <p>Structure of the human immunodeficiency virus (HIV) and its replication in helper T cells.</p> <p>How HIV causes the symptoms of AIDS. Why antibiotics are ineffective against viruses.</p>		<p>7.3</p> <p>7.4</p>	
<p>7 Monoclonal antibodies</p> <p>Students could try and define a monoclonal antibody in less than 20 words. A flow chart can be created or modelled to describe how monoclonal antibodies are used in ELISA tests. Assignment 4 can be used to frame discussion surrounding the ethics of using antibiotics.</p>	<ul style="list-style-type: none"> <li>• Define the term monoclonal antibody</li> <li>• Explain how monoclonal antibodies can be used in diagnostic testing</li> <li>• Discuss the ethics surrounding vaccination programmes, the use of monoclonal antibodies in diagnostic testing and use of antibiotics</li> </ul>	<p>3.2.4 Cell recognition and the immune system</p> <p>The use of monoclonal antibodies in:</p> <ul style="list-style-type: none"> <li>• targeting medication to specific cell types by attaching a therapeutic drug to an antibody</li> <li>• medical diagnosis.</li> </ul> <p>Details of the production of monoclonal antibodies is not required.</p>	<p>MS 3.1 Translate information between graphical, numerical and algebraic forms</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 2.1 Comment on experimental design and evaluate scientific methods</p>	<p>7.5</p>	

		<p>Ethical issues associated with the use of vaccines and monoclonal antibodies. The use of antibodies in the ELISA test.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• discuss ethical issues associated with the use of vaccines and monoclonal antibodies</li> <li>• evaluate methodology, evidence and data relating to the use of vaccines and monoclonal antibodies</li> </ul>	<p>PS 2.2 Present data in appropriate ways</p> <p>PS 2.3 Evaluate results and draw conclusions with reference to measurement uncertainties and errors</p> <p>PS 3.1 Plot and interpret graphs</p> <p>PS 3.3 Consider margins of error, accuracy and precision of data</p>		
<p>8 Consolidation: the immune response</p> <p>Students can create a mind map to link together the various concepts within immunity. Knowledge of key terminology can be assessed using card sorts or games like taboo. Application of knowledge can be attempted through practice questions at the end of the chapter and the worked maths example. Students could be given data on the prevalence of particular diseases or of inheritance of diseases, for example, and asked to calculate probabilities.</p>	<ul style="list-style-type: none"> <li>• Make connections between different concepts in the immune response</li> <li>• Apply scientific knowledge to exam style questions</li> <li>• Calculate probability and draw conclusions based on probability</li> </ul>	3.2.4 Cell recognition and the immune system	<p>MS 0.3 Use ratios, fractions and percentages</p> <p>MS 1.1 Use an appropriate number of significant figures</p> <p>MS 1.4 Understand simple probability</p>	<p>7.1</p> <p>7.2</p> <p>7.3</p> <p>7.4</p> <p>7.5</p>	
<p>9 Past Paper Questions</p> <p>Students to sit a test of past paper question based on the content</p>	<ul style="list-style-type: none"> <li>• Complete a test to assess progress</li> </ul>				

from Chapters 5, 6 and 7 to assess progress, identify areas of weakness and inform the planning of intervention. The BBC produced an excellent documentary 'Secret Universe: Hidden Life of a Cell' in 2012 in conjunction with The Wellcome Trust. This may be a useful revision tool and has accompanying internet resources.

One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 8 - Exchange with the Environment (11 hours)					
<p>1 Surface area to volume ratio</p> <p>Students could be given the dimensions of simple cells with different shapes from which to calculate the surface area to volume ratios of these cells, this can be extended using assignment 1. Surface area to volume ratio can be investigated using agar blocks containing indicator to determine the effect of surface area to volume ratio and concentration gradient on the diffusion of an acid or alkali.</p>	<ul style="list-style-type: none"> <li>Calculate surface area to volume ratio</li> <li>Describe the effects of surface area to volume ratio on the rate of exchange for an organism</li> <li>Identify features that help exchange in large organisms</li> </ul>	<p>3.3.1 Surface area to volume ratio</p> <p>The relationship between the size of an organism or structure and its surface area to volume ratio.</p> <p>Changes to body shape and the development of systems in larger organisms as adaptations that facilitate exchange as this ratio reduces.</p> <p>Students should be able to appreciate the relationship between surface area to volume ratio and metabolic rate.</p>	<p>MS 0.3 Use ratios, fractions and percentages</p> <p>MS 2.1 Understand and use the symbols: =, &lt;, &lt;&lt;, &gt;&gt;, &gt;, <math>\alpha</math>, ~</p> <p>MS 2.2 Change the subject of an equation</p> <p>MS 2.3 Substitute numerical values into algebraic equations using appropriate units for physical quantities</p> <p>MS 2.4 Solve algebraic equations</p> <p>MS 4.1 Calculate the circumferences, surface areas and volumes of regular shapes</p> <p>PS 1.1 Solve problems set in practical contexts</p> <p>PS 3.2 Process and analyse data using appropriate mathematical skills as exemplified in the mathematical appendix for each science</p>	8.1	

<p>2 Gas exchange in unicellular organisms and insects</p> <p>Students should be able to identify the gas exchange surface of a single celled amoeba and explain why that surface is sufficient. The tracheae in an insect's gas exchange system can be observed as small, silvery tubes in the dissection of a locust. Optical microscopes can be used to show prepared slides of spiracles or the tracheal system. Assignment 2 can be used to further investigate gas exchange in insects and interpret graphical data.</p>	<ul style="list-style-type: none"> <li>Describe how gas exchange occurs in a unicellular organism and in an insect</li> <li>Define ventilation and explain how this occurs in an insect</li> <li>Identify problems that terrestrial animals have with gas exchange and how an insect can overcome these</li> </ul>	<p>3.3.2 Gas exchange</p> <p>Adaptations of gas exchange surfaces, shown by gas exchange:</p> <ul style="list-style-type: none"> <li>across the body surface of a single-celled organism</li> <li>in the tracheal system of an insect (tracheae, tracheoles and spiracles)</li> </ul> <p>Structural and functional compromises between the opposing needs for efficient gas exchange and the limitation of water loss shown by terrestrial insects and xerophytic plants.</p>	<p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 3.1 Plot and interpret graphs</p> <p>AT d use of light microscope at high power and low power, including use of a graticule</p> <p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p>	<p>8.2</p>	
<p>3 Gas exchange in fish</p> <p>Students can work in pairs to come up with differences in air and water as a gas exchange medium and any associated problems. The structure of the gills can be visualised through the dissection of a fish head and prepared slides using an optical microscope to see the lamella. Provide data for students to plot a graph showing oxygen saturation against distance along the gill lamella to aid explanation of the counter-current mechanism.</p>	<ul style="list-style-type: none"> <li>Identify difficulties associated with water as a gas exchange medium</li> <li>Describe the structure of the gills</li> </ul>	<p>3.3.2 Gas exchange</p> <p>Adaptations of gas exchange surfaces, shown by gas exchange:</p> <ul style="list-style-type: none"> <li>across the gills of fish (gill lamellae and filaments including the counter-current principle)</li> </ul>	<p>AT d Use of light microscope at high power and low power, including use of a graticule</p> <p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p>	<p>8.2</p>	
<p>4 Gas exchange in fish</p> <p>Provide data for students to plot a graph showing oxygen saturation</p>	<ul style="list-style-type: none"> <li>Define the counter-current mechanism and explain the benefits of this mechanism</li> </ul>	<p>3.3.2 Gas exchange</p> <p>Adaptations of gas exchange surfaces, shown by gas exchange:</p>	<p>PS 3.1 Plot and interpret graphs</p>	<p>8.2</p>	

<p>against distance along the gill lamella to aid explanation of the counter-current mechanism.</p>		<ul style="list-style-type: none"> <li>• across the gills of fish (gill lamellae and filaments including the counter-current principle)</li> </ul>			
<p>5 Gas exchange in plants</p> <p>A transverse section of a dicotyledonous leaf can be examined using a light optical microscope. Students can draw their observation and label the features. This can be compared to a leaf section of a xerophyte like marram grass. The problem of water loss and adaptations shown by a plant to prevent this can be compared to that of an insect. A Venn diagram can be completed to compare gas exchange in plants, insects and fish.</p>	<ul style="list-style-type: none"> <li>• Identify the tissue layers, specialised cells and features of a transverse section of a leaf</li> <li>• Describe features of the leaf that allow for efficient gas exchange</li> <li>• Identify problems that terrestrial plants have with gas exchange and explain the adaptations to overcome these</li> </ul>	<p>3.3.2 Gas exchange</p> <p>Adaptations of gas exchange surfaces, shown by gas exchange:</p> <ul style="list-style-type: none"> <li>• by the leaves of dicotyledonous plants (mesophyll and stomata)</li> </ul> <p>Structural and functional compromises between the opposing needs for efficient gas exchange and the limitation of water loss shown by terrestrial insects and xerophytic plants.</p>	<p>AT d Use of light microscope at high power and low power, including use of a graticule</p> <p>AT e Produce scientific drawing from observation with annotations</p> <p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p>	<p>8.2</p>	
<p>6 Gas exchange in humans</p> <p>Prior knowledge can be first assessed in pairs as students can identify the gas exchange surface of a human and describe how they think gas exchange and ventilation takes place. Students can label a diagram of the gas exchange system and inspiration and expiration can be compared in a table. A bell jar can be used to show ventilation and pressure changes. Similarities and difference in ventilation between fish and humans can be identified. Students could be given values of pulmonary ventilation rate (PVR)</p>	<ul style="list-style-type: none"> <li>• Label the gas exchange system of a mammal</li> <li>• Identify ways that alveoli are adapted to their function</li> <li>• Describe how the lungs are ventilated and compare with ventilation in a fish</li> </ul>	<p>3.3.2 Gas exchange</p> <p>The gross structure of the human gas exchange system limited to the alveoli, bronchioles, bronchi, trachea and lungs.</p> <p>The essential features of the alveolar epithelium as a surface over which gas exchange takes place.</p> <p>Ventilation and the exchange of gases in the lungs. The mechanism of breathing to include the role of the diaphragm and the antagonistic interaction between the external and internal</p>	<p>MS 2.2 Change the subject of an equation</p> <p>AT b Use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer</p>	<p>8.3</p>	

<p>and one other measure, requiring them to change the subject of the equation. Alternatively students could use three-way taps, manometers and simple respirometers to measure volumes of air involved in gas exchange.</p>		<p>intercostal muscles in bringing about pressure changes in the thoracic cavity.</p>			
<p>7 Gas exchange in humans</p> <p>Students may work in pairs to dissect a pair of mammalian lungs to illustrate the material covered in the previous lesson</p>	<ul style="list-style-type: none"> <li>• Complete a lung dissection</li> </ul>	<p>3.3.2 Gas exchange</p> <p>The gross structure of the human gas exchange system limited to the alveoli, bronchioles, bronchi, trachea and lungs.</p>	<p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p>	<p>8.3</p>	
<p>8 Correlation and causation</p> <p>Using a light optical microscope students could observe the difference between a slide showing alveoli from a healthy lung and from one with emphysema. Assignment 4 can be used as a framework for discussing correlation and causation. A data set can be taken from the internet linking air quality and rates of asthma. Students work in small groups to present two contrasting arguments that can be taken from the data. Following this they should evaluate how data can be interpreted, identifying limitations of correlations and discuss how risk factors can be identified.</p>	<ul style="list-style-type: none"> <li>• Describe the difference between the terms correlation and causation</li> <li>• Define the term risk factor</li> <li>• Identify patterns in data presented graphically</li> <li>• Evaluate data presented graphically</li> </ul>	<p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• interpret information relating to the effects of lung disease on gas exchange and/or ventilation</li> <li>• interpret data relating to the effects of pollution and smoking on the incidence of lung disease</li> <li>• analyse and interpret data associated with specific risk factors and the incidence of lung disease</li> <li>• evaluate the way in which experimental data led to statutory restrictions on the sources of risk factors</li> <li>• recognise correlations and causal relationships.</li> </ul>	<p>MS 1.3 Construct and interpret frequency tables and diagrams, bar charts and histograms</p> <p>MS 1.7 Use a scatter diagram to identify a correlation between two variables</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 2.1 Comment on experimental design and evaluate scientific methods</p> <p>PS 2.3 Evaluate results and draw conclusions with reference to measurement uncertainties and errors</p>	<p>8.3</p>	



			PS 3.1 Plot and interpret graphs		
<p>9 Digestion</p> <p>Students can make a model of the human digestive system using modelling clay and identify the different parts. Definitions of key terms can be covered using a card sort and revisited through a game of taboo. Chemical digestion of carbohydrates, lipids and proteins can be summarised in turn and recorded in the form of a table. Various animations and video clips are available on YouTube to illustrate chemical digestion.</p>	<ul style="list-style-type: none"> <li>Identify the organs in the human digestive system</li> <li>Describe the functions of the alimentary canal</li> <li>Identify the enzymes involved in chemical digestion</li> <li>Describe the role and location of each enzyme</li> </ul>	<p>3.3.3 Digestion and absorption</p> <p>During digestion, large biological molecules are hydrolysed to smaller molecules that can be absorbed across cell membranes.</p> <p>Digestion in mammals of:</p> <ul style="list-style-type: none"> <li>carbohydrates by amylases and membrane-bound disaccharidases</li> <li>lipids by lipase, including the action of bile salts</li> <li>proteins by endopeptidases, exopeptidases and membrane-bound dipeptidases</li> </ul>		8.4	
<p>10 Practical: Investigating chemical digestion</p> <p>Students could design and carry out investigations into the effect of a pH or bile salts on the rate of reaction catalysed by a digestive enzyme. Give students a list of equipment available to use and the title of the investigation. Templates can be used to help structure the design of the investigation for weaker students.</p>	<p>Objectives can be chosen depending on the emphasis of the practical lesson:</p> <ul style="list-style-type: none"> <li>Identify independent, dependent and control variables</li> <li>Design an investigation on the rate of a reaction catalysed by a digestive enzyme</li> <li>Apply knowledge on chemical digestion to form a hypothesis and conclusion</li> <li>Present data collected accurately in tabular form</li> </ul>	<p>3.3.3 Digestion and absorption</p>	<p>PS 1.1 Solve problems set in practical contexts</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 2.2 Present data in appropriate ways</p> <p>PS 2.4 Identify variables including those that must be controlled</p>	8.4	

<p>11 Absorption</p> <p>Products of digestion could be recalled from the previous lesson. Methods of transport from chapter 6 could also be revisited. Absorption of monosaccharides, amino acids and fatty acids could be described in turn. Students can create a mind map to bring the ideas of digestion and absorption together. Practice questions at the end of the chapter can be used for students to apply their understanding.</p>	<ul style="list-style-type: none"> <li>• Identify adaptations of the alimentary canal for efficient absorption</li> <li>• Explain how products of digestion are absorbed from the lumen of the alimentary canal and into the epithelial cell</li> <li>• Explain how products of digestion leave the epithelial cell.</li> </ul>	<p>3.3.3 Digestion and absorption</p> <p>Mechanisms for the absorption of the products of digestion by cells lining the ileum of mammals, to include:</p> <ul style="list-style-type: none"> <li>• co-transport mechanisms for the absorption of amino acids and of monosaccharides</li> <li>• the role of micelles in the absorption of lipids.</li> </ul>		<p>8.4</p>	
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One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 9 - Mass Transport (10 hours)					
<p>1 Oxygen transport in mammals</p> <p>Clarification of key terminology is required including the terms affinity, association, dissociation, saturation and partial pressure. Students can recall the structure of haemoglobin from chapter 2. The oxygen dissociation curve should be drawn and annotated for human haemoglobin, to show the Bohr effect, for fetal haemoglobin and for at least one other animal such as the Llama or Tubifex worm. Application of knowledge should be tested through exam style questions.</p>	<ul style="list-style-type: none"> <li>Define the terms mass transport and mass flow</li> <li>Describe the structure and function of haemoglobin</li> <li>Interpret the oxygen dissociation curve</li> <li>Explain the effect of carbon dioxide on the transport of oxygen</li> <li>Explain, using examples, why haemoglobin comes in many different forms</li> </ul>	<p>3.3.4.1 Mass transport in animals</p> <p>The haemoglobins are a group of chemically similar molecules found in many different organisms. Haemoglobin is a protein with a quaternary structure.</p> <p>The role of haemoglobin and red blood cells in the transport of oxygen. The loading, transport and unloading of oxygen in relation to the oxyhaemoglobin dissociation curve. The cooperative nature of oxygen binding to show that the change in shape of haemoglobin caused by binding of the first oxygen makes the binding of further oxygen easier. The effects of carbon dioxide concentration on the dissociation of oxyhaemoglobin (the Bohr effect).</p> <p>Many animals are adapted to their environment by possessing different types of haemoglobin with different oxygen transport properties.</p>		<p>9.1 9.2</p>	
<p>2 Structure of the heart and circulatory system</p>	<ul style="list-style-type: none"> <li>Define a double circulatory system identifying names of some of the main vessels</li> </ul>	<p>3.3.4.1 Mass transport in animals</p> <p>The general pattern of blood circulation in a mammal. Names</p>		<p>9.3</p>	

<p>The double circulatory system can be modelled in the classroom as students move between 3 different locations: the heart, the lungs and the body, collecting or dropping off red (oxygen) balloons or blue (carbon dioxide) balloons. Students could recall a diagram labelling the structure of the heart. A simple description of the flow of blood during the cardiac cycle should be given.</p>	<ul style="list-style-type: none"> <li>• Label the structure of the heart</li> <li>• Describe the flow of blood through the heart</li> </ul>	<p>are required only of the coronary arteries and of the blood vessels entering and leaving the heart, lungs and kidneys.</p> <p>The gross structure of the human heart.</p>			
<p>3 Pressure changes in the heart and cardiac output</p> <p>Students could recall from the previous lesson a simple description of the cardiac cycle. Give students a graph showing pressure changes in the heart during a cardiac cycle. See if they can add given labels and annotations first. Highlight how volume changes alongside pressure changes in the heart. Students could calculate the number of heartbeats in one minute from the graph. Students could be given values of cardiac output (CO) and one other measure, requiring them to change the subject of the equation <math>\text{cardiac output} = \text{stroke volume} \times \text{heart rate}</math>. Assignment 1 can be used as a framework to practice calculating cardiac output and stroke volume.</p>	<ul style="list-style-type: none"> <li>• Describe how pressure changes in the heart during the cardiac cycle</li> <li>• Interpret a graph illustrating pressure changes in the heart identifying any associated valve movements</li> <li>• Define and calculate cardiac output and stroke volume</li> </ul>	<p>3.3.4.1 Mass transport in animals</p> <p>Pressure and volume changes and associated valve movements during the cardiac cycle that maintain a unidirectional flow of blood.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• analyse and interpret data relating to pressure and volume changes during the cardiac cycle.</li> </ul>	<p>MS 0.1 Recognise and make use of appropriate units in calculations</p> <p>MS 2.2 Change the subject of an equation</p> <p>MS 2.3 Substitute numerical values into algebraic equations using appropriate units for physical quantities</p> <p>MS 2.4 Solve algebraic equations</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 3.2 Process and analyse data using appropriate mathematical skills as exemplified in the mathematical appendix for each science</p>	<p>9.3</p>	

<p>4 Heart dissection and investigating heart rate</p> <p>Templates can be given for students to either independently or in pairs complete a heart dissection and following this plan an investigation into the effect of a named variable (for example exercise, caffeine) on human pulse rate or heart rate of Daphnia. This can be used as a planning activity only or it can be carried out as a full investigation using an additional lesson (9.5)</p>	<ul style="list-style-type: none"> <li>• Safely use instruments for dissection of an animal organ</li> <li>• Identify structural features of the heart</li> <li>• Design an investigation into the effect of exercise on human pulse rate or the effect of caffeine on the heart rate of an invertebrate, such as Daphnia</li> </ul>	<p>3.3.4.1 Mass transport in animals</p> <p>The gross structure of the human heart</p>	<p>PS 1.1 Solve problems set in practical contexts</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 2.4 Identify variables including those that must be controlled</p> <p>PS 4.1 Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification</p> <p>AT j Safely use instruments for dissection of an animal organ, or plant organ</p>	<p>9.3</p> <p>9.4</p>	<p>Required practical 5: Dissection of animal or plant gas exchange system or mass transport system or of organ within such a system.</p>
<p>5 Investigating heart rate</p> <p>Use of Daphnia should promote a good ethical attitude towards them. Templates can be used to structure the planning process.</p>	<p>Objectives can be chosen depending on the emphasis of the practical lesson:</p> <ul style="list-style-type: none"> <li>• Design an investigation into the effect of a named variable on the heart rate of an invertebrate, such as Daphnia</li> <li>• Identify investigative variables including</li> </ul>	<p>3.3.4.1 Mass transport in animals</p>	<p>MS 1.3 Construct and interpret frequency tables and diagrams, bar charts and histograms</p> <p>MS 3.2 Plot two variables from experimental or other data</p> <p>PS 1.1 Solve problems set in practical contexts</p>	<p>9.3</p>	

	<p>independent, dependent and control variables</p> <ul style="list-style-type: none"> <li>• Consider the ethical use of organisms in scientific investigations</li> <li>• Present data collected in tabular form</li> <li>• Present data collected graphically</li> <li>• Draw a conclusion using scientific understanding</li> </ul>		<p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 2.2 Present data in appropriate ways</p> <p>PS 2.4 Identify variables including those that must be controlled</p> <p>PS 3.1 Plot and interpret graphs</p> <p>PS 4.1 Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification</p> <p>AT h Safely and ethically use organisms to measure:</p> <ul style="list-style-type: none"> <li>• plant or animal responses</li> <li>• physiological functions</li> </ul>		
<p>6 Blood vessels</p> <p>Models can be made of the various blood vessels. Transverse sections of an artery and a vein can be observed using a light optical microscope. Students can make scientific drawings of their observations. Students could</p>	<ul style="list-style-type: none"> <li>• Describe the structure of blood vessels</li> <li>• Relate the structure of blood vessels to their function</li> <li>• Describe and explain how blood pressure changes through the various vessels</li> </ul>	<p>3.3.4.1 Mass transport in animals</p> <p>The structure of arteries, arterioles and veins in relation to their function.</p> <p>The structure of capillaries and the importance of capillary beds as exchange surfaces</p>	<p>AT d Use of light microscope at high power and low power, including use of a graticule</p> <p>AT e Produce scientific drawing from observation with annotations</p>	9.4	

<p>interpret a graph showing how pressure, cross sectional area and speed of blood flow changes through the various vessels.</p>					
<p>7 Formation of tissue fluid and cardiovascular disease</p> <p>Give students key phrases and terms to explain the formation of tissue fluid. Composition of tissue fluid and plasma could be compared. Students understanding of the formation of tissue fluid can be extended using the example of kwashiorkor and the accumulation of fluid with protein deficiency. Students could be given a data set to evaluate the incidence of cardiovascular disease and associated risk factors. Alternatively students can research using the internet what are the named risk factors for cardiovascular disease, to evaluate how much evidence there is for a causal relationship and to present their findings.</p>	<ul style="list-style-type: none"> <li>• Describe the difference between tissue fluid and plasma</li> <li>• Explain how tissue fluid is formed at the capillary bed</li> <li>• Evaluate the evidence associating risk factors with cardiovascular disease</li> </ul>	<p>3.3.4.1 Mass transport in animals</p> <p>The structure of capillaries and the importance of capillary beds as exchange surfaces. The formation of tissue fluid and its return to the circulatory system.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• analyse and interpret data associated with specific risk factors and the incidence of cardiovascular disease</li> <li>• evaluate conflicting evidence associated with risk factors affecting cardiovascular disease</li> <li>• recognise correlations and causal relationships</li> </ul>		9.4	
<p>8 Transpiration</p> <p>Students could recall water potential from chapter 6 and properties of water from chapter 1. Transpiration could be modelled in the classroom using students as water molecules or demonstrated using celery in dyed water. Various animations can be found to</p>	<ul style="list-style-type: none"> <li>• Define the term transpiration</li> <li>• Explain the factors that affect the rate of transpiration</li> <li>• Describe the structure of the xylem vessel</li> <li>• Explain the cohesion-tension mechanism of water moving up the xylem</li> </ul>	<p>3.3.4.2 Mass transport in plants</p> <p>Xylem as the tissue that transports water in the stem and leaves of plants. The cohesion-tension theory of water transport in the xylem</p>		9.5	

<p>illustrate transpiration. Diagrams can be annotated by students and the factors affecting transpiration rate compared in tabular form.</p>					
<p>9 Practical: Investigating transpiration</p> <p>Introduce a potometer and the various features of the equipment including how it should be set up. Students could set up and use a potometer to investigate the effect of a named environmental variable on the rate of transpiration. Alternatively if potometers are not available, a computer simulation of a potometer could be used. Ask students to evaluate the results, highlighting uncertainties and errors in data collection. Correlation and causation can be revisited when looking at the data as numerous factors influence transpiration rate.</p>	<p>Objectives can be chosen depending on the emphasis of the practical lesson:</p> <ul style="list-style-type: none"> <li>• Describe the equipment that can be used to measure transpiration rate</li> <li>• Use laboratory equipment to accurately collect quantitative data</li> <li>• Identify investigative variables</li> <li>• Present data collected in graphical format</li> <li>• Apply scientific understanding to draw a conclusion from the data collected</li> <li>• Evaluate results identifying any uncertainties and errors in the scientific method</li> </ul>	<p>3.3.4.2 Mass transport in plants</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• recognise correlations and causal relationships.</li> </ul>	<p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 2.3 Evaluate results and draw conclusions with reference to measurement uncertainties and errors</p> <p>PS 2.4 Identify variables including those that must be controlled</p> <p>AT b Use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer</p> <p>AT I Use ICT such as computer modelling, or data logger to collect data, or use software to process data</p>	<p>9.5</p>	
<p>10 Translocation</p> <p>Models of the phloem tissue can be made using modelling clay. Students can construct a table to compare phloem tissue with xylem tissue. Annotated diagrams can be made to describe how translocation occurs. Students can work in groups to review</p>	<ul style="list-style-type: none"> <li>• Describe the structure of the phloem tissue</li> <li>• Define the term translocation</li> <li>• Describe and evaluate the experimental evidence for mass flow in the phloem</li> </ul>	<p>3.3.4.2 Mass transport in plants</p> <p>Phloem as the tissue that transports organic substances in plants. The mass flow hypothesis for the mechanism of translocation in plants. The use of tracers and ringing experiments to investigate transport in plants.</p>	<p>MS 1.6 Understand the terms mean, median and mode</p> <p>MS 3.1 Translate information between graphical, numerical and algebraic forms</p>	<p>9.6</p>	



<p>information given on ringing and tracer experiments to describe what they illustrate and provide evidence for and identify the limitations of these experiments. Assignment 6 can be used as a framework to explain the use of tracers.</p>		<p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• interpret evidence from tracer and ringing experiments and to evaluate the evidence for and against the mass flow hypothesis</li> </ul>	<p>MS 3.5 Calculate rate of change from a graph showing a linear relationship</p> <p>PS 1.2 Apply scientific knowledge to practical contexts</p> <p>PS 3.1 Plot and interpret graphs</p> <p>PS 3.2 Process and analyse data using appropriate mathematical skills as exemplified in the mathematical appendix for each science</p>		
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One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 10 – DNA and Protein Synthesis (9 hours)					
<p>1 Genes, chromosomes and the genetic code</p> <p>Students could recall their understanding from chapter 4 on DNA structure and be able to draw a DNA nucleotide. Furthermore they could recall the difference between eukaryotic and prokaryotic cells from chapter 5.</p> <p>DNA in eukaryotic and prokaryotic cells can be compared by constructing a table. Key terminology can be reviewed using a card sort, creating a glossary and through a game of taboo.</p>	<ul style="list-style-type: none"> <li>Define key terminology including gene, chromosome, histone, locus, genome, allele, sense strand, degenerate, exons and introns</li> <li>Explain what is meant by the term ‘the genetic code’</li> </ul>	<p>3.4.1 DNA, genes and chromosomes</p> <p>In prokaryotic cells, DNA molecules are short, circular and not associated with proteins.</p> <p>In the nucleus of eukaryotic cells, DNA molecules are very long, linear and associated with proteins, called histones. Together a DNA molecule and its associated proteins form a chromosome.</p> <p>The mitochondria and chloroplasts of eukaryotic cells also contain DNA which, like the DNA of prokaryotes, is short, circular and not associated with protein.</p> <p>A gene is a base sequence of DNA that codes for:</p> <ul style="list-style-type: none"> <li>the amino acid sequence of a polypeptide</li> <li>a functional RNA (including ribosomal RNA and tRNAs)</li> </ul> <p>A gene occupies a fixed position, called a locus, on a particular DNA molecule.</p> <p>A sequence of three DNA bases, called a triplet, codes for a specific</p>	<p>PS 1.2 Apply scientific knowledge to practical contexts</p>	<p>10.1 10.2</p>	

		<p>amino acid. The genetic code is universal, non-overlapping and degenerate.</p> <p>In eukaryotes, much of the nuclear DNA does not code for polypeptides. There are, for example, non-coding multiple repeats of base sequences between genes. Even within a gene only some sequences, called exons, code for amino acid sequences. Within the gene, these exons are separated by one or more non-coding sequences, called introns.</p>			
<p>2 Genes, chromosomes and the genetic code</p> <p>Give students a list of key words and phrases to include in a written description of the genetic code. Students could determine the sequence of amino acids from a sequence of nucleotide bases. Assignment 1 can be used to draw together student's current understanding of DNA.</p>	<ul style="list-style-type: none"> <li>Compare how DNA is organised in eukaryotic and prokaryotic cells</li> </ul>	<p>3.4.1 DNA, genes and chromosomes</p> <p>In prokaryotic cells, DNA molecules are short, circular and not associated with proteins.</p> <p>In the nucleus of eukaryotic cells, DNA molecules are very long, linear and associated with proteins, called histones. Together a DNA molecule and its associated proteins form a chromosome.</p> <p>The mitochondria and chloroplasts of eukaryotic cells also contain DNA which, like the DNA of prokaryotes, is short, circular and not associated with protein.</p> <p>A gene is a base sequence of DNA that codes for:</p>	<p>PS 1.2 Apply scientific knowledge to practical contexts</p>	<p>10.1 10.2</p>	

		<ul style="list-style-type: none"> <li>• the amino acid sequence of a polypeptide</li> <li>• a functional RNA (including ribosomal RNA and tRNAs)</li> </ul> <p>A gene occupies a fixed position, called a locus, on a particular DNA molecule.</p> <p>A sequence of three DNA bases, called a triplet, codes for a specific amino acid. The genetic code is universal, non-overlapping and degenerate.</p> <p>In eukaryotes, much of the nuclear DNA does not code for polypeptides. There are, for example, non-coding multiple repeats of base sequences between genes. Even within a gene only some sequences, called exons, code for amino acid sequences. Within the gene, these exons are separated by one or more non-coding sequences, called introns.</p>			
<p>3 Transcription</p> <p>The genetic code can be reviewed briefly from the previous lesson. Key terminology including proteome, transcription and mRNA should be defined. There are numerous video clips that can be found on YouTube to illustrate transcription. The process of</p>	<ul style="list-style-type: none"> <li>• Define the terms proteome, codon and transcription</li> <li>• Describe the role of mRNA</li> <li>• Explain how mRNA is produced in transcription</li> </ul>	<p>3.4.2 DNA and protein synthesis</p> <p>The concept of the genome as the complete set of genes in a cell and of the proteome as the full range of proteins that a cell is able to produce.</p> <p>Transcription as the production of mRNA from DNA. The role of RNA</p>		10.3	

transcription can be written as a flow chart. Students can determine the sequence of bases on mRNA from a given DNA molecule. Modelling clay can be used to construct a model showing the process of splicing. Differences between DNA and mRNA can be listed.		polymerase in joining mRNA nucleotides.  Students should be able to:  • relate the base sequence of nucleic acids to the amino acid sequence of polypeptides, when provided with suitable data about the genetic code  Students will not be required to recall in written papers specific codons and the amino acids for which they code.			
4 Transcription  Students can determine the sequence of bases on mRNA from a given DNA molecule. Modelling clay can be used to construct a model showing the process of splicing. Differences between DNA and mRNA can be listed.	<ul style="list-style-type: none"> <li>Describe the difference between pre mRNA and mature mRNA</li> </ul>	3.4.2 DNA and protein synthesis  • In prokaryotes, transcription results directly in the production of mRNA from DNA.  • In eukaryotes, transcription results in the production of pre-mRNA; this is then spliced to form mRNA.		10.3	
5 Transcription  Students may draw and annotate diagrams of mRNA and tRNA. They could also make models	<ul style="list-style-type: none"> <li>Recall the structure of mRNA and tRNA</li> </ul>	3.4.2 DNA and protein synthesis  The structure of molecules of messenger RNA (mRNA) and of transfer RNA (tRNA).		10.3	
6 Translation  Students can draw a cartoon strip to illustrate the process of translation. Construct a table to compare transcription and translation, as an extension DNA	<ul style="list-style-type: none"> <li>Describe the structure and role of tRNA and a ribosome</li> <li>Describe how a polypeptide is produced during translation</li> </ul>	3.4.2 DNA and protein synthesis  Translation as the production of polypeptides from the sequence of codons carried by mRNA. The roles of ribosomes, tRNA and ATP.	PS 1.1 Solve problems set in practical contexts  PS 1.2 Apply scientific knowledge to practical contexts	10.3	

<p>replication from chapter 4 can also be compared. Similarities and differences between tRNA and mRNA can be listed. Practice questions at the end of the chapter can be completed for students to apply their understanding. Assignment 2 can be used as an extension looking at the role of polyribosomes.</p>	<ul style="list-style-type: none"> <li>• Compare the processes of transcription and translation</li> </ul>	<p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• relate the base sequence of nucleic acids to the amino acid sequence of polypeptides, when provided with suitable data about the genetic code</li> <li>• interpret data from experimental work investigating the role of nucleic acids</li> </ul> <p>Students will not be required to recall in written papers specific codons and the amino acids for which they code.</p>			
<p>7-9 Consolidating/revision</p> <p>In the first lesson students can spend a lesson consolidating learning from the previous two chapters. They could play games like Taboo to cement learning of Key concepts and produce revision resources such as cue cards and quick quizzes. They can complete the practice questions and peer mark with the mark scheme before correcting their work in order to develop exam technique.</p> <p>The second lesson can be spent completing an AFL test consisting of past paper questions. This can be marked to assess progress and identify opportunities to improve exam performance and possible intervention opportunities.</p> <p>In the third lesson the test can be reviewed and students can correct their work and redraft answers.</p>	<ul style="list-style-type: none"> <li>• Revisit and consolidate learning from Chapters 9 and 10</li> <li>• Identify areas of weakness which require further study</li> <li>• Compare progress to MTG</li> </ul>				

They should set their own targets for improvement, these can reference content or exam technique.

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One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 11 – Genetic Diversity (9 hours)					
<p>1 Mutations</p> <p>Ask students to define a mutation and suggest causes to elicit discussion. The severity of different types of gene mutation can be demonstrated using sentence analogies where changes to letters represent changes to bases</p>	<ul style="list-style-type: none"> <li>Identify causes of mutation</li> <li>Define the different types of gene mutation</li> </ul>	<p>3.4.3 Genetic diversity can arise as a result of mutation or during meiosis</p> <p>Gene mutations involve a change in the base sequence of chromosomes. They can arise spontaneously during DNA replication and include base deletion and base substitution. Due to the degenerate nature of the genetic code, not all base substitutions cause a change in the sequence of encoded amino acids. Mutagenic agents can increase the rate of gene mutation.</p>		11.1	
<p>2 Mutations</p> <p>Students could research and produce case studies of mutations can be used such as sickle cell anaemia, albinism, cancer and Down’s syndrome. Possible beneficial mutations can be discussed for example sickle cell anaemia and resistance to malaria. Students could identify mutations when given data on the genetic code.</p>	<ul style="list-style-type: none"> <li>Describe a type of chromosome mutation</li> <li>Explain the consequences of a gene mutation</li> </ul>	<p>3.4.3 Genetic diversity can arise as a result of mutation or during meiosis</p> <p>Mutations in the number of chromosomes can arise spontaneously by chromosome non-disjunction during meiosis.</p>		11.1	



<p>3 Meiosis</p> <p>Students could recall as many points about mitosis as they can from chapter 5. Students could begin to learn the new key word definitions using a game such as ‘who am I?’ Diagrams showing the 2 divisions in meiosis can be drawn and annotated.</p> <p>Students could examine meiosis in prepared slides of suitable plant or animal tissue and identify any differences with mitosis they might see. Using this and new information on meiosis a table can be constructed to compare the main differences between the 2 processes. Students should be able to synthesis ideas about when meiosis may occur in non-mammal life cycles.</p>	<ul style="list-style-type: none"> <li>• Define key terms including homologous chromosomes, haploid, diploid and bivalent</li> <li>• Describe the role of meiosis</li> <li>• Compare meiosis with mitosis</li> <li>• Identify where meiosis may happen in a variety of life cycles.</li> </ul>	<p>3.4.3 Genetic diversity can arise as a result of mutation or during meiosis</p> <p>Meiosis produces daughter cells that are genetically different from each other.</p> <p>The process of meiosis only in sufficient detail to show how:</p> <ul style="list-style-type: none"> <li>• two nuclear divisions result usually in the formation of four haploid daughter cells from a single diploid parent cell</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• complete diagrams showing the chromosome content of cells after the first and second meiotic division, when given the chromosome content of the parent cell</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• explain the different outcome of mitosis and meiosis</li> <li>• recognise where meiosis occurs when given information about an unfamiliar life cycle</li> </ul>	<p>AT d Use of light microscope at high power and low power, including use of a graticule</p>	<p>11.2</p>	
<p>4 Sources of genetic variation</p> <p>Using different colour pipe cleaners independent assortment and crossing over can be modelled</p>	<ul style="list-style-type: none"> <li>• Name 3 sources of genetic variation</li> <li>• Describe the 3 sources of genetic variation</li> </ul>	<p>3.4.3 Genetic diversity can arise as a result of mutation or during meiosis</p>	<p>MS 0.5 Use calculators to find and use power, exponential and logarithmic functions</p>	<p>11.2</p>	

<p>to explain the sources of genetic variation. There are many animations available to illustrate this process. New terminology should be reviewed again at the end of the lesson, including terms such as bivalent and chiasmata.</p>		<p>The process of meiosis only in sufficient detail to show how:</p> <ul style="list-style-type: none"> <li>• genetically different daughter cells result from the independent segregation of homologous chromosomes</li> <li>• crossing over between homologous chromosomes results in further genetic variation among daughter cells.</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• explain how random fertilisation of haploid gametes further increases genetic variation within a species</li> </ul>			
<p>5 Sources of genetic variation</p> <p>Students could use the expression <math>2n</math> to calculate the possible number of different combinations of chromosomes following meiosis, without crossing over. This could be extended by asking students to try and derive a formula from this to calculate the possible number of different combinations of chromosomes following random fertilisation of two gametes, where <math>n</math> is the number of homologous chromosomes pairs.</p>	<ul style="list-style-type: none"> <li>• Use mathematical formula to calculate genetic variation</li> </ul>	<p>3.4.3 Genetic diversity can arise as a result of mutation or during meiosis.</p> <p>The process of meiosis only in sufficient detail to show how:</p> <ul style="list-style-type: none"> <li>• genetically different daughter cells result from the independent segregation of homologous chromosomes</li> <li>• crossing over between homologous chromosomes results in further genetic variation among daughter cells.</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• explain how random fertilisation of haploid gametes further</li> </ul>	<p>MS 0.5 Use calculators to find and use power, exponential and logarithmic functions</p>	<p>11.2</p>	

		increases genetic variation within a species			
<p>6 Natural Selection</p> <p>Students can be provided with scenarios which describe the variation within a population and a selection pressure. In pairs students could then predict what they think will happen in future generations. A flow chart could be created to explain the steps involved in natural selection. There are numerous YouTube clips to illustrate natural selection. Direction and stabilising selection can be illustrated in the form of a graph and described using examples to visualise the selection.</p>	<ul style="list-style-type: none"> <li>• Define genetic diversity</li> <li>• Explain the advantages of genetic diversity</li> <li>• Describe the steps in the theory of natural selection</li> <li>• Explain the difference between directional and stabilising selection</li> </ul>	<p>3.4.4 Genetic diversity and adaptation</p> <p>Genetic diversity as the number of different alleles of genes in a population.</p> <p>Genetic diversity is a factor enabling natural selection to occur.</p> <p>The principles of natural selection in the evolution of populations.</p> <ul style="list-style-type: none"> <li>• Random mutation can result in new alleles of a gene. <ul style="list-style-type: none"> <li>• Many mutations are harmful but, in certain environments, the new allele of a gene might benefit its possessor, leading to increased reproductive success.</li> <li>• The advantageous allele is inherited by members of the next generation.</li> <li>• As a result, over many generations, the new allele increases in frequency in the population.</li> </ul> </li> </ul> <p>Directional selection, exemplified by antibiotic resistance in bacteria, and stabilising selection, exemplified by human birth weights.</p> <p>Natural selection results in species that are better adapted to their</p>	11.3		

		environment. These adaptations may be anatomical, physiological or behavioural			
<p>7 Evidence for natural selection and the chi squared test</p> <p>Recall the steps of natural selection from the previous lesson by using a card sort whereby students need to rearrange the steps. The peppered moth is used as an example of evidence for natural selection. Question 8, 9 and 10 can be used as a framework to evaluate the evidence. Chi squared can be introduced by asking students to toss a coin and predict how many heads and tails from tossing the coin 50 times. Provide data linked to natural selection for students to complete further calculations on chi squared.</p>	<ul style="list-style-type: none"> <li>Describe evidence for natural selection</li> <li>Use mathematical formula to calculate chi squared</li> <li>Describe when to use a chi squared test</li> <li>Interpret the results of a chi squared test</li> </ul>	<p>3.4.4 Genetic diversity and adaptation</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>use unfamiliar information to explain how selection produces changes within a population of a species</li> <li>interpret data relating to the effect of selection in producing change within populations</li> <li>show understanding that adaptation and selection are major factors in evolution and contribute to the diversity of living organisms.</li> </ul>	<p>MS 1.9 Select and use a statistical test</p> <p>PS 3.2 Process and analyse data using appropriate mathematical skills as exemplified in the mathematical appendix for each science</p>	11.3	
<p>8-9 Practical: Investigating microbial growth</p> <p>Use of aseptic techniques to investigate the effect of antimicrobial substances on microbial growth. More than 1 lesson can be spent learning and practicing aseptic technique, making serial dilutions and producing lawn or streak plates. Students can assess each other carrying out an aseptic technique and provide feedback to each</p>	<p>Objectives can be chosen depending on the emphasis of the practical lesson:</p> <ul style="list-style-type: none"> <li>Describe how to make a serial dilution</li> <li>Use laboratory equipment to carry out a serial dilution</li> <li>Describe the steps involved in aseptic technique</li> <li>Describe the necessity for aseptic technique</li> </ul>	<p>3.4.4 Genetic diversity and adaptation</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>interpret data relating to the effect of selection in producing change within populations.</li> </ul>	<p>MS 2.5 Use logarithms in relation to quantities that range over several orders of magnitude</p> <p>PS 4.1 Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification</p>	11.3	Required practical 6: Use of aseptic techniques to investigate the effect of antimicrobial substances on microbial growth.

<p>other. Cultures should be incubated and looked at the following lesson for conclusions, calculations and consolidation. The presence or absence of microbial growth can be linked back to the development of antibiotic resistance through natural selection.</p>	<ul style="list-style-type: none"> <li>• Carry out an aseptic technique safely</li> <li>• Describe the difference between a lawn plate and a streak plate</li> <li>• Use scientific understanding to form a hypothesis</li> <li>• Calculate an estimate of bacterial population size</li> </ul>		<p>AT c Use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions</p> <p>AT i Use microbiological aseptic techniques, including the use of agar plates and broth</p>		
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One hour lessons	Learning Outcomes	Specification Content	Skills Covered	Student Book Section	Required Practicals
CHAPTER 12 – Taxonomy and biodiversity (7 hours)					
<p>1 The Species Concept</p> <p>Students should recall the definition of ‘Species’. Give students a variety of pictures of different organisms and they have to try and classify, put the organisms into groups, they must be able to justify their reason for doing so. This should elicit why classifying species is sometimes difficult. Students should be able to define the Phylogenetic classification as a hierarchy of groups within groups without overlap. They should recall the taxa and the binomial system used to identify species. Students should be able to explain how courtship behaviours, immunology and genome sequencing provide evidence for evolutionary relationships.</p>	<ul style="list-style-type: none"> <li>Recall what is meant by a Species and the order of taxa of Phylogenetic classification</li> <li>Explain why it may be difficult to identify new species</li> <li>Utilise the binomial system of naming species</li> <li>Explain techniques which provide evidence to clarify evolutionary relationships</li> </ul>	<p>3.4.5 Species and Taxonomy</p> <p>Two organisms belong to the same species if they are able to produce fertile offspring. Courtship behaviour as a necessary precursor to successful mating. The role of courtship in species recognition.</p> <p>A phylogenetic classification system attempts to arrange species into groups based on their evolutionary origins and relationships. It uses a hierarchy in which smaller groups are placed within larger groups, with no overlap between groups. Each group is called a taxon (plural taxa). One hierarchy comprises the taxa: domain, kingdom, phylum, class, order, family, genus and species.</p> <p>Each species is universally identified by a binomial consisting of the name of its genus and species, e.g., <i>Homo sapiens</i>.</p> <p>Recall of different taxonomic systems, such as the three domain or five kingdom systems, will not be required.</p>		12.1	

		Students should be able to appreciate that advances in immunology and genome sequencing help to clarify evolutionary relationships between organisms.			
<p>2 Biodiversity</p> <p>Student could complete Assignment 1: Investigating the effect of hedges on crop yield. Students should recall what is meant by Biodiversity and why it is an important measure of a habitats fitness. Students should be able to use the index of diversity to compare habitats. Students should be able to discuss the impacts of farming on biodiversity and how to balance productivity and conservation.</p>	<ul style="list-style-type: none"> <li>• Explain what is meant by Biodiversity</li> <li>• Use the index of diversity to compare habitats</li> <li>• Discuss how farming impacts biodiversity and how to minimise this</li> </ul>	<p>3.4.6 Biodiversity within a community</p> <p>Biodiversity can relate to a range of habitats, from a small local habitat to the Earth. Species richness is a measure of the number of different species in a community.</p> <p>An index of diversity describes the relationship between the number of species in a community and the number of individuals in each species.</p> <p>Calculation of an index of diversity (<math>d</math>) from the formula</p> $d = \frac{N(N - 1)}{\sum n(n - 1)}$ <p>where <math>N</math> = total number of organisms of all species and <math>n</math> = total number of organisms of each species.</p> <p>Farming techniques reduce biodiversity. The balance between conservation and farming.</p>	<p>MS3.1 PS1.2 PS3.2</p> <p>MS 2.3</p> <p>Students could be given data from which to calculate an index of diversity and interpret the significance of the calculated value of the index.</p>	12.2	

<p>3 Investigating diversity</p> <p>Students may complete Assignment 2: Analysing Amino acid sequences, Assignment 3: Analysing variation on Lundy Island and Assignment 4: Analysing diversity of Apricot trees. They should appreciate that improvement in gene technology have allowed us to develop and understanding of the relationships within and between species. They should be able to utilise genome data provided to establish these relationships.</p>	<ul style="list-style-type: none"> <li>Recall the ways of assessing genetic diversity within or between species</li> <li>Use genetic data to establish genetic diversity</li> <li>Explain how gene technology has contributed to our understanding of genetic diversity</li> </ul>	<p>3.4.7 Investigating Diversity</p> <p>Genetic diversity within, or between species, can be made by comparing:</p> <ul style="list-style-type: none"> <li>the frequency of measurable or observable characteristics</li> <li>the base sequence of DNA</li> <li>the base sequence of mRNA</li> <li>the amino acid sequence of the proteins encoded by DNA and mRNA.</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>interpret data relating to similarities and differences in the base sequences of DNA and in the amino acid sequences of proteins to suggest relationships between different organisms within a species and between species</li> <li>appreciate that gene technology has caused a change in the methods of investigating genetic diversity; inferring DNA differences from measurable or observable characteristics has been replaced by direct investigation of DNA sequences.</li> </ul> <p>Knowledge of gene technologies will not be tested.</p>	<p>MS1.2 MS1.3 MS1.5 MS1.6 MS1.10 MS3.2 PS1.2 PS2.2 PS3.1 PS3.2</p>	<p>12.3</p>	
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<p>4 Investigating diversity</p> <p>Students should also collect their own data and calculate means and standard deviation demonstrating an understanding of what this shows. Use this as an opportunity to develop an understanding of experimental design and sampling techniques. Data such as leaf size from different trees or number of spines on Holly leaves are ideal but data must be gathered from within the same Species. Data can be collected on each other, e.g. height, hand span, foot length etc.</p>	<ul style="list-style-type: none"> <li>• Collect your own data and calculate standard deviation</li> </ul>	<p>3.4.7 Investigating Diversity</p> <p>Quantitative investigations of variation within a species involve:</p> <ul style="list-style-type: none"> <li>• collecting data from random samples</li> <li>• calculating a mean value of the collected data and the standard deviation of that mean</li> <li>• interpreting mean values and their standard deviations. Students will not be required to calculate standard deviations in written papers.</li> </ul>	<p>AT k</p> <p>Students could:</p> <ul style="list-style-type: none"> <li>• design appropriate methods to ensure random sampling</li> <li>• carry out random sampling within a single population</li> <li>• use random samples to investigate the effect of position on the growth of leaves.</li> </ul> <p>MS 1.2 Students could use standard scientific calculators to calculate the mean values of data they have collected or have been given.</p> <p>MS 1.10 Students could calculate, and interpret the values of the standard deviations of their mean values.</p>		
<p>5-7 Consolidating/revision</p> <p>In the first lesson Students can spend a lesson consolidating learning from the previous two chapters. They could play games like Taboo to cement learning of Key concepts and produce revision resources such as cue cards and</p>	<ul style="list-style-type: none"> <li>• Revisit and consolidate learning from Chapters 9 and 10</li> <li>• Identify areas of weakness which require further study</li> <li>• Compare progress to MTG</li> </ul>				

<p>quick quizzes. They can complete the practice questions and peer mark with the mark scheme before correcting their work in order to develop exam technique. The second lesson can be spent completing an AFL test consisting of past paper questions. This can be marked to assess progress and identify opportunities to improve exam performance and possible intervention opportunities. In the third lesson the test can be reviewed and Students can correct their work and redraft answers. They should set their own targets for improvement, these can reference content or exam technique.</p>					
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