Year 12 Biology Scheme of Learning (edited from AQA 7401 Scheme of Work available at <u>https://www.aqa.org.uk/subjects/biology/as-level/biology-7401/teaching-</u><u>resources?secondaryResourceType=Schemes+of+work</u>)</u>

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what a monomer and polymer are. Identify some biological polymers and the monomer from which they are made. Explain the concept of condensation and hydrolysis reactions in forming/breaking down polymers. 	 Learning activities: GCSE baseline assessment present pictures of biological molecules and ask for identification of monomer repeating units introduce biological polymers and their monomers, including hydrolysis and condensation word equations to summarise. Skills developed by learning activities: AO1 – Demonstration of knowledge of scientific ideas. 		 Rich questions: During which process/group of processes are polymers hydrolysed in the body into monomers? What catalyses hydrolysis in the body?

3.1 Biological molecules

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Identify common monosaccharides. Describe the monosaccharides from which lactose, maltose and sucrose are made. Explain what is meant by a glycosidic bond and how they form through condensation. Describe how polymerisation of α- glucose can form starch or glycogen. 	 Learning activities: introduce monosaccharides, with examples molymod modelling from structural formulas link models to model condensation introduce disaccharides and polysaccharides. Skills developed by learning activities: AO1 – Demonstration of knowledge of scientific ideas. 	Past exam paper materials: BIOL1 Jan 2013 Q3a Exampro: BYB1 Jan 2007 Q1 BYA1 Jan 2004 Q1 BYB1 Jan 2005 Q2 BYA1 Jun 2008 Q1	 Rich questions: If a glucose and a fructose (both with the formula C6H12O6) joined together in a condensation reaction, what would be the disaccharide which formed and what would its molecular formula be? Provide the structures of two monosaccharides and ask students to draw the structure of the disaccharide which would result from condensation.

3.1.2 Carbohydrates

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the tests for starch, a reducing and non- reducing sugar in detail. Explain what is meant by qualitative testing. 	 Learning activities: introduce biochemical test procedures and the concept of reducing and non-reducing sugars hazcard risk assessment exam question. Skills developed by learning activities: AT f – interpret the results of qualitative tests 8.4.2.1 and 8.4.2.2 (practical competency) – interpret experimental techniques for biochemical tests independently 8.4.2.3 – risk assessment of dangers and appropriate control measures, using hazcards AO1 – demonstration of knowledge of techniques AO3 – interpret evidence to make judgements and reach conclusions from Benedict's test. 	Past exam paper materials: BIOL1 – June 2011 Q1a and 1b Exampro: BYB1 Jan 2004 Q4	cleapss.org.uk mrothery.co.uk/module 1/Mod%201%20technig ues.htm

r	
Could also link to required practical 3 and introduce calibration curves and colorimetry and discuss the usefulness of calibration curves or standards:	
 discuss what is meant by quantitative data and how the Benedict's test can be adapted to provide quantitative data 	
 students to modify Benedict's method to provide a quantitative value for an unknown concentration 	
 practical: produce dilution series and produce calibration curves from known concentrations to work out 	
unknown concentration. This could be done via colorimetry, mass of precipitate or colour matching	
 BIO3T ISA Q = 2014. Skills developed by learning activities: 	
• AT b and c /8.4.2.3 – production of a dilution series from a stock glucose concentration. Use colorimetric techniques to	
 AT b and c /8.4.2.3 – production of a dilution series from a stock glucose concentration. Use colorimetric techniques to produce a calibration curve 	

 MS 0.2 – convert concentrations between standard and ordinary form PS 4.1 – use calibration curves PS 3.1 and MS 1.3/3.2 – plot a calibration curve and read off an unknown concentration from the graph 8.4.2.1, 8.4.2.2, 8.4.2.3 and 8.4.2.4 AO2 – application of knowledge in a practical context. 	
Provide three unknown samples for students to test and identify eg soluble starch, glucose, sucrose.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Represent the structure of α - glucose and β – glucose diagrammatically. Explain that glycosidic bonds between α–glucose form starch or glycogen and how this relates to their function and properties. Explain that glycosidic bonds between β–glucose form cellulose and how this relates to their stanch or glycosidic bonds between β–glucose form cellulose and how this relates to its function and properties. 	 Learning activities: molymods: challenge students to produce structural isomers of glucose introduce α-glucose and β-glucose jigsaw learning: one student from each group of three researches glycogen, starch and cellulose (structure and properties) feedback exam questions/quiz. Skills developed by learning activities: AO1 – Demonstration of knowledge of scientific ideas. 	Specimen assessment material: A-level Paper 1 (set 1) – Q4 Past exam paper material: BIOL2 Jan 2013 – Q1 BIOL2 Jan 2013 – Q3 BIOL2 Jan 2011 – Q1b –1c; BIOL2 June 2010 – Q1	Rich question: Why does the structure of starch, cellulose and glycogen mean that starch and glycogen are good molecules for storage, whilst cellulose is a good structural molecule in cell walls?

3.1.3 Lipids

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the stages of the emulsion test. Interpret the results of the emulsion test. 	 Learning activities: introduce what a lipid is and the emulsion test for lipids practical: use of the emulsion test to test samples for the presence of lipids. Skills developed by learning 	Past exam paper material: BIOL1 Jan 2012 – Q1a	<u>cleapss.org.uk</u> <u>brilliantbiologystudent.w</u> <u>eebly.com/ethanol-</u> <u>emulsion-test-for-</u> <u>lipids.html</u> Rich questions: • Describe how you
	 activities: AT f – interpret the results of the emulsion test for lipids 8.4.2.1/8.4.2.2 – independently follow instructions for the emulsion test to test samples for lipids AO1 – demonstration of knowledge of scientific technique AO3 – make judgements as to the presence of lipids. 		 would conduct an emulsion test for lipids. Is the emulsion test quantitative or qualitative? Explain your answer.

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of triglycerides. Explain how triglycerides form. Recognise, from diagrams, saturated and unsaturated fatty acids. 	 Learning activities: teacher explanation of two lipid groups teacher explanation of triglyceride structure and saturation/ unsaturation of fatty acid R groups exam questions. Skills developed by learning activities: AO1 – demonstration of knowledge of scientific idea.	Past exam paper material: BIOL1 Jan 2011 – Q4 Exampro: BYB1 June 2004 – Q2	 Rich questions: Are triglycerides (and phospholipids) polymers? Explain your answer. Why is the degree of saturation of the fatty acid chains important?

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of phospholipids. Explain the properties of phospholipids related to their structure. Contrast the different properties of triglycerides and phospholipids. 	 Learning activities: highlighting exercise, showing the differences between triglycerides and phospholipids teacher explanation of phospholipids and the concepts of hydrophilic and hydrophobic head/tail (NB these terms are not required specification knowledge) exam questions. Skills developed by learning activities: AO1 – Demonstration of knowledge of scientific idea.	Specimen assessment material: AS Paper 1 (Set 1) – Q7 Past exam paper material: BIOL1 Jan 2012 – Q1b	Rich question: Where might the hydrophobic nature of lipids be useful within a cell and why?

3.1.4 Proteins

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the general structure of an amino acid. Describe the biuret test and how it can be interpreted. Explain the variety of functions that proteins have and why they are so important to the body. 	 Learning activities: teacher explanation of the biuret test students do biuret test to test labelled samples (can be mock samples) of things within the body eg amylase, bile. Arrive at a list of roles played by proteins provide diagrams of 20 amino acids and ask students to generate 'Golden Rules' about structure exam questions. Skills developed by learning activities: AT f – use and interpret the results of a biuret test for proteins 8.4.2.1/8.4.2.2 – independently follow instructions for the biuret test AO1 – demonstration of knowledge of scientific idea/technique 	Past exam paper material: BIOL1 Jan 2010 – Q1b–Q1c Exampro: BYA1 June 2004 – Q1	cleapss.org.uk Rich questions: • describe the biuret test • a student took a sample of 100% pure starch and added the enzyme amylase to it. After 1 hour, they tested the solution using the Benedict's, iodine, emulsion and biuret tests. Which tests would be positive and why?

	AO3 – Interpret evidence to make judgements and reach conclusions from Biuret test.		
 Explain the principle of chromatography. Identify amino acids in a mixture. Interpret chromatograms. 	 Learning activities: teacher explanation of chromatography and Rf values students conduct chromatography on a mixture of amino acids or on leaf pigments calculation of Rf values and comparison against published values. Skills developed by learning activities: AT g – use chromatography with known standard solutions, to separate a mixture of amino acids and identify their components MS 2.3/MS 2.4 – calculation of Rf values and comparison against published data 	Past exam paper questions: HBIO1 – Jan 2009 – Q3	<u>cleapss.org.uk</u> <u>biotopics.co.uk/as/amin</u> <u>o acid chromatograph</u> <u>y.html</u> Rich question: Explain the basis by which chromatography is able to separate different amino acids.
	• 0.4.2.1, 0.4.2.2 and 0.4.2.3 and 8.4.2.4		

 AO1 – demonstration of knowledge of scientific idea/technique. 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain how dipeptides and polypeptides form. Explain the hierarchical organisation of protein structure. Describe the types of bond involved in protein structure and the weakness of hydrogen bonds. Relate the structure of proteins to properties of proteins (this is required for proteins named throughout the specification). 	 Learning activities: use molymods to make glycine molecules and then join them together to model condensation teacher explanation of properties of globular and fibrous proteins and of primary, secondary, tertiary and quaternary structure (using videos and animations) modelling of protein structure using Tangle toys. Ask students to apply knowledge of protein structure to the model and present to class exam questions. Skills developed by learning activities: AT I – use RASMOL (ICT) to computer model protein structure 	Specimen assessment material: A-level Paper 1 (Set 1) – Q11.2	bcconline.com/biol10rs/ <u>Pearson-</u> <u>Animations/protein_stru</u> <u>cture.swf</u> <u>rasmol.org</u> <u>amazon.co.uk/Tangle-</u> <u>Original-Jr-</u> <u>Toy/dp/B0012GQU2I</u> <u>Rich question:</u> • show some bonds between functional groups covered so far and ask students to identify them as ester, peptide or glycosidic • provide the structures of two amino acids and ask students to

AO1 and AO2 – demonstration and application of knowledge of scientific idea extended exam/essay	draw the structure of the dipeptide which would result from condensation
answers.	
Student research into proteins eg haemoglobin, collagen, relating structure to function. RASMOL could be used to research structure and apply knowledge.	

3.1.4.2 Many proteins are enzymes

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Interpret energy level diagrams and identify the activation energy. Explain the induced-fit model of enzyme action. Apply knowledge of tertiary structure to explain enzyme specificity and the formation of enzyme-substrate complexes. 	 Learning activities: practical demonstration of how long it takes to decompose hydrogen peroxide using manganese(IV) oxide in one tube, liver or potato in another and no catalyst in a third teacher explanation of activation energy and induced-fit model, using animations or videos exam questions. Skills developed by learning activities: MS 1.3 – interpret graphs of energy changes during reactions, to identify activation energy AO1 and AO2 – demonstration and application of knowledge of scientific idea AO3 – interpret scientific information and ideas to make judgements in the context of 	Past exam paper material: BIOL1 June 2009 – Q3a and 3b BIOL1 Jan 2011 – Q2b BIOL1 June 2010 – Q5	Rich questions: • what aspects of enzyme catalysis cannot be explained using lock and key? • why is induced-fit a more refined model of enzyme catalysis than lock and key? Students could also extend their learning by researching why the specificity of enzymes in catalysing reactions makes them useful in industrial processes and biosensors.

activation energy and the strength of enzyme catalysis models.	
 Student modelling of each model using plasticine. Student evaluation of which model is stronger and why. 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain how temperature, pH, substrate concentration, enzyme concentration and the presence of inhibitors affect enzyme catalysis. Describe and explain trends within graphs, relating this back to the tertiary structure of active sites and the effect of these variables. Calculate rate of reaction from graphs and raw data and explain the advantage of using initial rate. Interpret graphs of enzyme-controlled reactions and apply knowledge to explain them. 	 Learning activities: conduct group investigations relating to each variable (leave one to be conducted as full investigation in next section) get students to calculate rate and produce graphs for each practical teacher explanation of trends within graphs for each factor exam questions. Skills developed by learning activities: AT a/AT I – use apparatus, including data loggers, to record measurements eg pH, temperature MS 0.1 – work out and use appropriate units for rate MS 0.5 – calculate pH from data about hydrogen ion concentration, using the formula: pH = -log10 [H+] AO2/AO3 and PS1.2 – apply knowledge to practical contexts 	Specimen assessment material: A-level Paper 1 (Set 1) – Q11.3 AS Paper 1 (Set 1) – Q2 Past exam paper material: BIOL1 Jan 2012 – Q7a–7c BIOL1 Jan 2011 – Q2b BIOL1 June 2011 – Q3 BIOL1 Jan 2010 – Q3 BIOL1 Jan 2010 – Q3	cleapss.org.uk nuffieldfoundation.org/p ractical- biology/investigating- enzyme-controlled- reaction-catalase-and- hydrogen-peroxide- concentrat nuffieldfoundation.org/p ractical- biology/investigating- effect-ph-amylase- activity nuffieldfoundation.org/p ractical- biology/investigating- effect-ph-amylase- activity nuffieldfoundation.org/p ractical- biology/investigating- effect-concentration- activity-trypsin saps.org.uk/attachment s/article/95/SAPS%20- %20Inhibitors%20on%2 0enzyme%20beta- galactosidase%20- %20Scottish%20Higher s.pdf

 MS 3.2/3.3 – plot two variables on graphs. Sketch the shape of a graph with a linear relationship using the formula y = mx +c eg the effect of substrate concentration in the presence of excess enzyme 	
 8.4.2.1, 8.4.2.2 and 8.4.2.2. 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the features of good experimental design. Process data to calculate rates. Represent raw and processed data clearly using tables and graphs. Apply knowledge to draw and explain conclusions. Evaluate the results and conclusions. 	 Learning activities: students design an experiment to investigate the effect of a named variable on the rate of an enzyme-controlled reaction. This should include: risk assessment (hazcards) carrying out (subject to teacher approval) processing and presentation of data evaluation and explanation findings. 	Students could undertake investigations/ questions from the following Biology and Human Biology ISAs: BIO3T P10 BIO3T P11 BIO3T P13 BIO3T Q12 HBI3T P11 HBI3T Q09.	<u>cleapss.org.uk</u> <u>nuffieldfoundation.org/p</u> <u>ractical-</u> <u>biology/investigating-</u> <u>enzyme-controlled-</u> <u>reaction-catalase-and-</u> <u>hydrogen-peroxide-</u> <u>concentrat</u> <u>nuffieldfoundation.org/p</u> <u>ractical-</u> <u>biology/investigating-</u> <u>effect-ph-amylase-</u> <u>activity</u> <u>nuffieldfoundation.org/p</u> <u>ractical-</u>
	activities:		biology/investigating-

 AT a/AT I – use appropriate apparatus, including data loggers, to record quantitative measurements such as temperature and pH PS 1.1 – design an experiment, based on research, to test a hypothesis PS 2.4 – identify key variables which influence enzyme- 	effect-concentration- activity-trypsin nuffieldfoundation.org/p ractical- biology/quantitative- food-test-protein- content-powdered-milk
 controlled reactions PS 2.2/MS 1.3/MS 3.1/MS 3.2 	Rich question: Evaluate the
 controlled reactions PS 2.2/MS 1.3/MS 3.1/MS 3.2 present experimental data using tables and graphs PS 3.2/MS 2.4/MS 3.6 – calculate/work out initial rates of reaction from data and from slopes of a tangent PS 2.3 and PS3.3 – evaluate results for errors MS 0.1/MS 0.2 – use and convert units for concentration MS 1.9 – select (and use) an appropriate statistical test. Students could select and use an appropriate statistical test to find the significance of differences in the rates of reaction following use of a 	Evaluate the statements: • "temperature denatures enzymes" • "acidic and alkaline pHs denature enzymes".
temperature, enzyme concentration or substrate concentration) or of a	

 discontinuous variable (eg presence and absence of an enzyme inhibitor) 8.4.2.1, 8.4.2.2 and 8.4.2.4 and 8.4.2.5 AO1/AO2 – application of knowledge to explain trends AO3 – develop and refine proctical design 	
practical design.	

3.1.5 Nucleic acids are important information-carrying molecules

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the significance of DNA to organisms. Describe the structure of DNA and identify structural components from diagrams. Apply knowledge of complementary base pairing rules to work out the frequency of certain bases, when provided with information about the frequency the other bases. Explain why many scientists initially doubted that DNA was the genetic code. 	 Learning activities: extract DNA from frozen peas as a stimulus show data from Chargaff's experiments. Students generate 'Golden rules' and questions it raises teacher explanation of nucleotide structure and how this assembles to a double helix structure (using animations, videos and diagrams) questioning about how structure relates to function and ask students to suggest why many scientists did not believe DNA to be the genetic code exam questions. Skills developed by learning activities: MS 0.3 – use incomplete information about the 	Past exam paper material: BIOL2 June 2012 – Q5a BIOL2 June 2009 – Q2	yourgenome.org/teache rs/yummy.shtml yourgenome.org/teache rs/origami.shtml yourgenome.org/teache rs/zoom.shtml <u>cell-cell-cell.com/wp- content/uploads/CCC</u> <u>Activity ModellingTheH</u> <u>elix v01.doc</u> <u>genetics.thetech.org/onl</u> <u>ine-exhibits/zooming- dna</u>

 frequency of bases on DNA strands to find the frequency of other bases AO1 – knowledge and understanding of scientific ideas AO2/AO3 – analysing data on base frequency and applying knowledge of base pairing, to work out frequency of other bases. 	
Modelling DNA structure using molymod DNA kit, jelly babies or paper model.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the role of RNA in transferring genetic information and as a component of ribosome Describe the structure of RNA and identify structural components of an RNA nucleotide from diagrams. Compare and contrast the similarities and differences between DNA and RNA. 	 Learning activities: teacher explanation of types of RNA and their roles, with focus on ribosomal and messenger RNA comprehension on RNA structure. Students highlight differences to DNA teacher explanation of single-stranded RNA structure related to function provide DNA sequence and ask students to produce the complementary mRNA sequence exam questions. Skills developed by learning activities:	Exampro: BYA3 – Jan 2003 Q1a BYB2 – June 2009 Q3a–3c	 Rich questions: why can we not work out the frequency of bases in RNA when provided with data about the frequency of some of the other bases? how does the short, single-stranded structure of RNA suit its role in transferring genetic information to the ribosomes?
	 AO1 – development of knowledge and understanding AO2/AO3 – interpreting DNA sequence and applying knowledge to work out complementary mRNA code. 		

3.1.5.2 DNA replication

Knowledge, understanding and s kills	Implementation	Evaluation and assessment	Additional resources
 Describe the process of DNA replication. Explain the significance of DNA replication. Evaluate the work of scientists in validating the Watson-Crick model of DNA replication. Apply your knowledge to explain experimental results from the work of these scientists. 	 Learning activities: DARTS task – students convert comprehension on DNA replication into a diagrammatic representation and then present to group evaluation of presentations teacher explanation, focussed on remaining weaknesses, using videos and animations exam questions teacher explanation of Meselson–Stahl experiment application of knowledge to predict band patterns for subsequent generations. Skills developed by learning activities: AO1 – development of knowledge PS 1.2/AO2 – apply knowledge of semi- conservative DNA replication to the results of Meselson and 	Past exam paper material: BIOL2 Jan 2013 – Q8a BIOL2 June 2013 – 4a–4b	sumanasinc.com/webc ontent/animations/content/animations/content/animations/content nt/meselson.html Rich questions: • describe the process of semi- conservative DNA replication, including the role of key enzymes • why did the Meselson–Stahl experiment prove the mechanism of DNA replication? • what would the Meselson–Stahl experiment results have looked like if conservative replication was the mechanism for DNA replication?

• AO3 – Interpret and explain the results of the Meselson– Stahl experiment.		 Stahl, to explain how this experiment proved semi-conservative replication over other theories eg conservative or dispersive replication AO3 – interpret and explain the results of the Meselson–Stahl experiment. 		
--	--	---	--	--

3.1.6 ATP

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of ATP. Explain the role of enzymes in hydrolysing and synthesising ATP. Explain the significance of ATP in numerous processes within organisms, as a supplier of energy or phosphate. 	 Learning activities: teacher explanation of the structure and significance of ATP and the enzymes required to hydrolyse/synthesis ATP exam questions. Skills developed by learning activities: AO1 – development of knowledge and understanding of scientific ideas and processes extended exam answers 	Past exam paper material: BIOL4 Jan 2012 – Q8a BIOL4 June 2011 – Q1b–1c	 Rich questions: explain why ATP is such an important molecule evaluate the statement "when ATP is hydrolysed, it makes energy for cellular processes to occur".

 Students circulate round information posters containing simplified descriptions of ATP driven processes within Biology (that they will come across later in the course) eg active transport, muscle contraction. Provide question sheets for students to find the answers to Collate findings Produce a concept map grouped around whether the ATP is providing energy and/or phosphorylating compounds to increase 	
and/or phosphorylating compounds to increase reactivity.	

3.1.7 Water

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the properties that are important in water. Explain the properties of water linked to the polar nature of the molecule. Explain the significance of these properties to living organisms and processes. 	 Learning activities: teacher explanation of the polar nature of water molecules practical investigation activity circus to include: surface tension – count how many drops of water that can balance on a penny. Repeat with soapy water and oil cohesion – capillary tubing with dyed water solvent – add salt to water and oil and compare the relative amounts of how much can dissolve specific heat capacity – compare the temperature rise of water and vegetable oil put on hot plates for the same time latent heat of vaporisation – model the effect of sweating on heat loss from boiling tubes (using 	Past exam paper material: BYB1 – June 2008 Q4	nanosense.sri.com/acti vities/finefilters/science ofwater/FF Lesson2Te acher.pdf filestore.aqa.org.uk/Add itional resources/biology/AQA- 7401-7402- WATER.PPTX filestore.aqa.org.uk/Add itional resources/biology/AQA- 7401-7402-TN- WATER.PDF

 boiling tubes wrapped in wet and dry paper towels) teacher explanation of the significance of water to all life on Earth in each of the categories stated in the learning objectives/ specification. 	
 Skills developed by learning activities: MS 2.4 – calculation of specific heat capacity of water from data AO1 and AO2 – development and application of knowledge and understanding about properties of water related to their significance to life AO3 – interpreting activity circus and drawing conclusions. 	

3.1.8 Inorganic ions

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by the term inorganic ions and where they occur in the body. Explain the specific role of hydrogen ions, iron ions, sodium ions and phosphate ions. Relate the role of each of these ions to their properties. 	 Learning activities: provide information stations about each type of ion in the specification topics (hydrogen, sodium, iron and phosphate), in different four areas of the room. This could include comprehension material, internet pages, videos etc get students to work in groups of four and to send one person to each station to become an expert on that type of ion get group members to feedback to each other to complete a summary table assess knowledge and understanding using AfL techniques reinforce through teacher explanation, if required. Skills developed by learning activities: 		Rich questions: • explain the role of: • hydrogen ions • iron ions • sodium ions • phosphate ions • using GCSE knowledge, explain how we gain and lose inorganic ions and why homeostatic control of inorganic ions in the body is so important. filestore.aqa.org.uk/Add <u>itional</u> resources/biology/AQA- <u>7401-7402-</u> <u>INORGANIC-</u> <u>IONS.PPTX</u> filestore.aqa.org.uk/Add <u>itional</u> resources/biology/AQA- <u>7401-7402-</u>

AO1 and AO2 – development and application of knowledge and understanding about inorganic ions, their properties and their roles.	<u>INORGANIC-</u> IONS.PDF

3.2 Cells

3.2.1 Cell structure

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by a eukaryotic cell and the defining characteristics of a eukaryotic cell. Explain the roles of different components and organelles within eukaryotic cells. Interpret pictures, diagrams and electron micrographs to identify cell organelles. 	 Learning activities: student exploration of parts of the cell using animations/ virtual cell tour. teacher explanation of eukaryotic cells students circulate round information posters containing information about the components and organelles within eukaryotic cells. Link to an activity/question sheet collate findings teacher explanation of areas of weakness or misconception (using videos, diagrams and animations) get students to develop analogies of the cell and its organelles eg analogy to a country 	Past exam paper material: BIOL1 Jan 2013 – Q2 Exampro: BYB1 June 2006 – Q1a	<u>cell-cell-</u> <u>cell.com/Additional</u> <u>resources/activities</u> <u>learn.genetics.utah.edu</u> <u>/content/cells/insideacel</u> <u>l</u> <u>vcell.ndsu.nodak.edu/a</u> <u>nimations/flythrough/mo</u> <u>vie-flash.htm</u> <u>bigpictureeducation.co</u> <u>m/cell</u> Rich question: Evaluate the statement "Mitochondria produce energy during respiration".

 identification of cell components in light and electron micrographs teacher explanation of standard form and how to convert different units set students the task of arranging organelles in order, with dimensions being given in different units. Ask them to represent the final, converted dimensions in standard form 	
 exam questions. Skills developed by learning activities: MS 0.1 – convert between units on mm and um 	
 MS 0.2 – understand standard form when applied to the size of organelles AO1 – development of knowledge of cell structure AO2 – application of knowledge to micrographs. 	
Students could also produce models of cell components.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Identify examples of specialised eukaryotic cells. Explain common adaptations that cells have to particular functions. Apply knowledge of eukaryotic cells features in suggesting the role of cells based on their adaptations. 	 Learning activities: introduce how to set up and use a microscope microscopy and drawing of pre-prepared microscope slides showing eukaryotic cells eg palisade mesophyll cells ask students to link knowledge from GCSE/last lesson to explain adaptations jigsaw task: students work in teams of six, with each investigating one specialised cell from information or the internet. They then feedback to each other students come up with 'Golden Rules' for looking at common adaptations and the role they play within the cell eg large surface area for exchange provide diagrams of unknown cells and ask them to suggest adaptations and potential roles exam questions. 	Past exam paper material: BIOL1 Jan 2012 – Q3 BIOL2 June 2011 – Q1 BIOL2 Jan 2010 – Q1	bigpictureeducation.co m/annotated-cells- images cellsalive.com/gallery.ht m biologymad.com Rich question: Provide students with new cells that they have not encountered, eg B lymphocytes and ask them to identify their adaptations and suggest a role, eg large numbers of mitochondria and rough E.R. indicative of large amounts of protein synthesis to produce antibodies.

Skills developed by learning activities:
AT d/AT e – use optical microscopes to observe and draw pre-prepared microscope slides of specialised eukaryotic cells.

3.2.1.2 Structure of prokaryotic cells and of viruses

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structural differences between prokaryotic and eukaryotic cells. Explain the role of plasmids, capsules and flagella. 	 Learning activities: teacher introduction to prokaryotic cells and explanation about the differences in size and structure for eukaryotic and prokaryotic cells (using videos and animations) students could convert information about the size of prokaryotic cells and organelles into standard form or different units students work in groups to produce a guide to the prokaryotic cells and how they differ from eukaryotic ones identification of cell components in light and electron micrographs exam questions. Skills developed by learning activities: extended exam answers. 	Past exam paper material: BIOL1 Jan 2009 Q7a. Exampro: BYB1 June 2006 Q1b.	cellsalive.com/cells/bac tcell.htm Rich question: Compare and contrast prokaryotic and eukaryotic cells.

 MS 0.1 – convert between units eg mm and µm MS 0.2 – understand standard form when applied to the size of bacteria AO1 – development of knowledge of prokaryotes AO2 – application of knowledge to micrographs. 		
--	--	--

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of virus particles. Describe the role of the capsid and attachment protein. Relate the structure of a virus to its replication within cells. 	 Learning activities: teacher introduction to virus particles and their structure get students to relate the cell components found in prokaryotic and eukaryotic cells that viruses do not have, to the processes that viruses would be unable to do. Relate this to a brief description of virus replication students could convert information about the size of viruses eg from nm to µm. Ask them to work out how many viruses could fit in the 		Rich question: Why are viruses described as particles rather than cells?
same length as one bacterial cell • exam questions from Exampro.			
--	--		
Skills developed by learning activities:			
 MS 0.1 – convert between units eg µm and nm MS 0.2 – understand standard form when applied to the size of viruses 			
 AO1 – development of knowledge of virus structure. 			

Knowledge, understanding and \$ ills	Implementation	Evaluation and assessment	Additional resources
 Describe how an optical microscope and an electron microscope work. Explain the concepts of magnification and resolution and how they differ. Compare and contrast optical and electron microscopes. Explain why, for a considerable period of time, the scientific community distinguished between artefacts and cell organelles. 	 Learning activities: teacher explanation of difference between resolution and magnification. This could be illustrated by showing pictures magnified by the same amount but taken with a 2 mega pixel vs a 10 mega pixel camera introduce light and electron microscopy students circulate around research stations containing videos, comprehensions, internet sites, teacher explanation etc to investigate light and electron microscopes accept feedback, assess understanding and then tackle areas of weakness through teacher explanation students could write an essay comparing and contrasting light and electron microscopes or do exam questions. 	Past exam paper material: BIOL1 June 2012 – Q1 BIOL 1 Jan 2009 – Q7b	bigpictureeducation.co m/video-electron- microscopy bigpictureeducation.co m/video-light- microscopy learn.genetics.utah.edu /content/cells/scale biologymad.com Rich question: Optical microscopes were invented hundreds of years ago, whilst electron microscopes were invented in the 1930s. Suggest why some parts of the cell like rough endoplasmic reticulum were not discovered until the 1940s and 1950s, whilst others like mitochondria were

3.2.1.3 Methods of studying cells

Skills developed by lea activities:	arning discovered much earlier.
 extended exam ansi MS 0.2 – understand convert numbers fr standard to ordinary when applied to magni MS 0.5 – use calculat find and use the po functions when looki magnification MS 1.9 – students of select and use an appr statistical test to find significance of differen numbers of a partic organelle (eg mitochor chloroplasts) in differer of cells AO1 – developmer knowledge and unders of microscopy techni 	wers d and rom form ification tors to ower ing at could ropriate d the timean cular ndria or nt types to form ing at

Knowledge, understanding andskills	Implementation	Evaluation and assessment	Additional resources
 Explain the use of an eyepiece graticule. Calculate the actual size of cells based on measured size and magnification. 	 Learning activities: introduce students to the concept of magnification in greater detail and the concept of how to use a graticule alongside a stage micrometer students could prepare a slide and use an optical microscope to identify stained starch grains in plant cells and measure them teacher explanation of how to use and manipulate the magnification formula, including conversion of units if required in groups, provide electron micrographs of organelles with data about the size of the organelles. Ask students to identify the organelle and work out the magnification. exam questions. 	Specimen assessment material: A-level Paper 3 (set 1) – Q2 Past exam paper material: BIOL1 Jan 2011 Q1 BIOL2 Jan 2012 – Q1	snabonline.com/Conten t/SkillsSupport/Practical Support/P0_09S.pdf
	 Skills developed by learning activities: MS 0.1 – convert between units eg mm and µm 		

Knowledge, understanding andskills	Implementation	Evaluation and assessment	Additional resources
 Describe the processes of cell fractionation and ultracentrifugation. Explain why the separation of cell components is important in studying cells and their components. Explain the use of low temperatures and buffers during cell fractionation. Explain the principles of separation by ultracentrifugation. 	 Learning activities: think, pair, share: what are the difficulties that need to be overcome in investigating the function cell components and organelles? a simple demonstration can be carried out by centrifuging orange juice with pulp to produce a pellet and supernatant teacher explanation of cell fractionation and ultracentrifugation in obtaining fractions for investigation. Use animations and videos to support explanation provide students with information on organelles and ask them to suggest what order they would sediment at exam questions. Skills developed by learning activities: PS 1.2 – apply knowledge of organelles and their size to interpret results of what organelles would be in the 	Specimen assessment material: AS Paper 1 (set 1) – Q1 Past exam paper material: BIOL1 June 2009 – Q1 BIOL1 June 2010 – Q3 BIOL1 Jan 2013 – Q2 Exampro BYB1 June 06 Q1c BYB1 – June 2005 Q3	sumanasinc.com/webc ontent/animations/content/animations/content/animations/content nt/cellfractionation.html accessexcellence.org/R C/VL/GG/cellBreak1.ph p homepages.gac.edu/~c ellab/chpts/chpt8/ex8- 1.html Rich question: • put the cell organelles in order of sedimentation as the speed of the centrifuge is increased • why are fractionated cells kept in a solution that is ice cold, buffered and the same water potential?

 pellet and supernatant after centrifugation AO1 – development of knowledge and understanding of cell fractionation procedures and the reasoning behind stages AO2 – application of cell structure to suggest or explain the sedimentation at different centrifuge speeds. 	
The extraction of chloroplasts from spinach leaves could be undertaken if the centre has the appropriate equipment and time.	

3.2.2 All cells arise from other cells

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what the cell cycle is and why it does not occur in some cells from multicellular organisms. Describe the stages of the cell cycle. 	 Learning activities: provide card sort statements for students and ask them to arrange in a logical order eg DNA replication, DNA polymerase made, ATP stores increase teacher explanation of the cell. Be clear on the difference between the cell cycle and mitosis students could calculate the number or percentage of cells in each stage of the cell cycle, based on the number of hours each stage takes and the number of cells exam questions. 	Specimen assessment material: A-level Paper 1 (set 1) – Q8 AS Paper 1 (set 1) – Q4 Past exam paper material: BIOL2 Jan 2011 – Q7	cellsalive.com/cell cycle.htmhighered.mheducation.com/sites/0072495855/student view0/chapter2/animation how the cell_cycle_works.htmlRich questions:Why would scientistsinvestigating mitosischoose to study bonemarrow cells overneurones?
	 Skills developed by learning activities: MS 0.3 – students could use data about the number of hours spent in each stage, to predict the ratio or % of cells in each stage of mitosis 		

	 AO1 – development of knowledge and understanding of the cell cycle AO3 – analysis of data relating to the length of time at each stage. 	
Describe the events which occur during G1, S and G2 phase of interphase and the outcomes of mitosis.	Teacher explanation of the events at each stage of interphase.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Recognise the stages of the cell cycle: interphase, prophase, metaphase, anaphase and telophase (including cytokinesis). 	 Learning activities: teacher explanation of the role of mitosis teacher explanation of the stages of mitosis, reinforced with videos and/or animations of the process 	Specimen assessment material: A-level Paper 1 (set 1) – Q10.1 and 10.2 Past exam paper material:	bigpictureeducation.c om/cell-division- images cellsalive.com/mitosis. <u>htm</u>

Knowledge, understanding andskills	Implementation	Evaluation and assessment	Additional resources
 Apply knowledge of mitosis and the cell cycle, to identify cells in different stages of mitosis. Use measured values to calculate the actual size of cells. Explain what the mitotic index is and calculate the mitotic index from observed values. 	 Learning activities: preparation and observation of squashes of root tip cells eg from allium, garlic or hyacinth observation and drawing of cells in various stages of mitosis, under a microscope calculation of actual size of cells and the mitotic index exam questions. 	Past exam paper material: Students could undertake the HBI3T ISA P from 2013 Specimen assessment material: AS Paper 2 (set 1) – Q1 Exampro:	nuffieldfoundation.org/ practical- biology/investigating- mitosis-allium-root-tip- squash cleapss.org.uk
	 activities: AO1 – knowledge and understanding the techniques and procedures for staining chromosomes and using microscopes AO2 – application of knowledge to use these techniques and identify stages of mitosis in tissue being observed AT d and e – students prepare, observe and draw squashes of root tip cells eg from allium, garlic or hyacinth 	BYA2 Jan 05 Q1 BYA2 Jun 05 Q4	

 MS 0.3 – calculation of mitotic index MS 1.8 – calculation of the actual size of cells MS 1.9 – students could select and use an appropriate statistical test to find the significance of differences in the number of cells undergoing mitosis at two close, but different, distances from the root tip PS 1.2 – apply scientific knowledge to practical contexts 	
• 8.4.2.1, 8.4.2.2 and 8.4.2.3.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the events involved in the formation of tumours and cancers and why this is damaging to the body. Identify the processes within the cell cycle which are disrupted and which lead to cancer. State that cancer treatments often work to inhibit stages of the cell cycle. Interpret data relating to cancer treatments and their effects on the rate of cell division. 	 Learning activities: NB this section should be approached sensitively teacher explanation what cancer is and how tumours can form. Link in to the brief outline of proto-oncogenes and tumour suppressor genes and how the cell cycle is affected when they mutate. Use animations to help discuss cancer treatments and link to data on the reduction in cancer cells after each treatment. Link drugs back to their effects eg in inhibiting spindle formation exam questions. Skills developed by learning activities: MS 1.3 – interpret graphical data showing the effect of cancer treatments on the number of cancerous cells AO1 – knowledge and understanding of cancer and 	Assessment Past exam paper material: BIOL1 Jan 2013 – Q5 BIOL2 Jan 2013 – Q8b BIOL2 June 2013 – Q4c BIOL2 June 2013 – Q4	yourgenome.org/teac hers/roguecells.shtml insidecancer.org

 AO2/AO3 – interpretation of exam question data and application of knowledge of the impact of some treatments on mitosis and the cell cycle. 	

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Explain what binary fission is and the organisms which carry out binary fission. Describe the process of binary fission. 	 Learning activities: show an agar plate with bacterial colonies. Ask students to suggest why these are visible given that bacteria are microscopic teacher led description of the process of binary fission in prokaryotes ask students to evaluate how it differs from the process in eukaryotic cells students could calculate the exponential growth of bacteria from one cell, each hour for 8 hours, under ideal conditions exam questions from Exampro (especially relating to data). 		classzone.com/books/ hs/ca/sc/bio 07/anima ted biology/bio ch05 0149 ab fission.htm <u>l</u> Rich question: Binary fission can happen every 20 minutes for some species, under ideal conditions. Suggest one example where this trait would be useful to humans.

Skills developed by learning activities:
 MS 0.5 – estimate the exponential growth of bacteria after 8 hours with the assumption of binary fission occurring once every 20 minutes AO1 – knowledge and understanding of binary fission.

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain why viruses are not classified as being living organisms. Describe the sequence of events by which viruses replicate. Explain why viruses are so difficult to treat and develop medicines against. 	 Learning activities: questioning to recall the structure of a virus teacher led explanation of the replication of viruses. Link virus structure to their mode of replication and to the work done in Unit 1 on nucleic acids exam questions from specimen material and from Exampro. Skills developed by learning activities: AO1 – Knowledge and understanding of viral replication. 	Specimen assessment material: AS Paper 1 (set 1) – Q9	 sites.fas.harvard.edu/ biotext/animations/lytic iccycle.html Rich question: why do scientists disagree about whether viruses should be classified as living? why do viruses make you ill?

3.2.3 Transport across cell membranes

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the arrangement of proteins, glycoproteins, glycolipids, phospholipids and cholesterol in the fluid mosaic model of membrane. Explain the roles/importance of the constituent parts of the membrane. Relate the structure of the membrane to its role around/inside cells. 	 Learning activities: questioning to recap the structure and properties of phospholipids (from section 3.1.3) rainstorm the roles played by the plasma membrane eg selectively permeable, cell signalling etc teacher led explanation of the role of the plasma membrane, including cholesterol and the role of extrinsic and intrinsic proteins. A 3D model or animation can be used here reinforce concept by modelling the fluid and 3-D nature of membranes by half filling a tray with water, adding in marshmallows (representing phosphate heads of phospholipids) and coloured polystyrene chunks (representing the other components, eg proteins and glycoproteins, which float) 	Specimen assessment material: AS Paper 1 (set 1) – Q7.5–7.7 Exampro: BYB1 – June 2006 Q2 BYB1 – Jan 2006 Q7a BYB1 – Jan 2005 Q4a– b BYB1 – June 2004 Q3a BYB9 – Jan 2004 Q2a	glencoe.mheducation. com/olcweb/cgi/plugin pop.cgi?it=swf::550::4 00::/sites/dl/free/0078 802849/383931/Plas ma_Membrane_The_ Fluid Mosaic Model.s wf::The%20Fluid%20 Mosaic%20Model teach.genetics.utah.e du/content/begin/cells/ print/BuildAMembrane .pdf Rich questions: Explain how the structure of the membrane relates to its role as being partially permeable.

exam questions.	
Skills developed by learning activities:	
 PS 1.2 – apply knowledge about the role of cholesterol to practical data about membrane fluidity AO1/AO2 – application of knowledge and understanding from Section 3.1.3 to understand the structure and function of plasma membranes. 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Identify key variables which affect membrane permeability. Represent raw and processed data clearly using tables and graphs. Apply knowledge of the fluid mosaic model to suggest how temperature/ alcohol affects membrane permeability. Evaluate the quality of results and reliability of conclusions. 	 Learning activities: students design an experiment to investigate the effect of a named variable eg temperature or alcohol concentration on membrane permeability. This could include: working through key aspects of experimental design eg key variables carrying out (subject to teacher approval) processing and presentation of data. Skills developed by learning activities: AT b – use a colorimeter to record quantitative measurements PS 1.1 – design an experiment, based on research, to test a hypothesis PS 1.2 – apply scientific knowledge to practical contexts 	Students could undertake the BIO3T ISA Q from 2010	cleapss.org.uk nuffieldfoundation.org/ practical- biology/investigating- effect-temperature- plant-cell-membranes

 PS 2.4 – identify key variables which affect membrane permeability PS 2.2/PS 3.1/MS 3.2/MS 1.3 – plot the experimental data in an appropriate format PS 2.3 – evaluate data for errors and uncertainties PS 4.1 – understand how a colorimeter works and how to interpret results from colorimetry MS 0.1/MS 0.2 – use and convert units for concentration MS 1.9 – select (and use) an appropriate statistical test. 8.4.2.1, 8.4.2.2, 8.4.2.3 and 8.4.2.4 AO1/AO2 – application of knowledge to explain trends and to understand the 	
 AO1/AO2 – application of knowledge to explain trends and to understand the technique of colorimetry AO3 – develop and refine practical design. 	

Knowledge, understanding and \$ ills	Implementation	Evaluation and assessment	Additional resources
 Define osmosis in terms of water potential. Explain the movement of water due to osmosis into or out of cells. Explain the effect of osmosis on plant and animal cells. 	 Learning activities: teacher explanation of osmosis and water potential to arrive at an A-level definition jigsaw learning: working in teams of three, one student goes to each information station to discover about the effect of placing plant and animal cells in solutions with different water potentials (the terms hypotonic, hypertonic and isotonic are not specification terms) students feedback to one another teacher assessment and explanation to address areas of weakness exam questions. 	Past exam paper material: HBI3T 2014 EMPA Students could undertake the BIO3T ISA P from 2012	nuffieldfoundation.org/ practical- biology/observing- osmosis-plasmolysis- and-turgor-plant-cells cleapss.org.uk highered.mheducation .com/sites/007249585 5/student view0/chapt er2/animation how osmosis works.html Rich question: Present diagrammatic representation of cells with numerical water potentials and ask students to represent the net movement of water with arrows between cells.
	Skills developed by learning activities:		
	 AT d/AT e – use an optical microscope to examine and draw onion cells 		

 AO1 – development of knowledge of osmosis and water potential AO2 – application of knowledge and understanding of osmosis 8.4.2.2 and 8.4.2.4 	
Microscopy to observe and draw plasmolysis and turgor (terms no required) in onion cells. Red onion or rhubarb petiole give clear results. Ask students to explain using GCSE knowledge.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what a dilution series is and produce one from stock solutions. Apply knowledge to explain how the water potential of a plant tissue can be experimentally determined. Represent raw and processed data clearly using tables and graphs. Process data to calculate percentage gain/loss. Apply knowledge to explain trends in graphs in relation to osmosis, water potential and mass change. Explain the usefulness of calibration curves or standards. 	 Learning activities: Students conduct an experiment to identify the water potential of plant tissue. This should include: research into methods carrying out processing and presentation of data evaluation and explanation findings a past ISA paper (relevant to practical). Skills developed by learning activities: AT c – use glassware to produce serial dilutions MS 0.1/0.2 – use and convert concentrations between standard and ordinary form MS 0.3 – calculate percentage change in mass PS 1.1 – design an experiment, based on research, to test a hypothesis PS 2.2/MS 3.1/MS 3.2/MS 1.3 – plot the experimental data in an appropriate format (tables and graphs) 	Students could undertake the investigations/ questions from the following ISAs: BIO3T P14 BIO3T Q09 HBI3T P10 HBI3T P12 Specimen assessment material: AS Paper 1 (set 1) – Q8 Past exam paper material: BIOL1 Jan 2009 – Q3 BIOL1 Jan 2011 – Q5 BIOL1 Jan 2010 – Q5	<u>cleapss.org.uk</u> <u>nuffieldfoundation.org/p</u> <u>ractical-</u> <u>biology/investigating-</u> <u>effect-concentration-</u> <u>blackcurrant-squash-</u> <u>osmosis-chipped-</u> <u>potatoes</u>

٠	Evaluate the results	 PS 4.1 – use calibration 	
	and conclusions.	curves	
		 MS 1.9 – select (and use) an 	
		appropriate statistical test	
		 MS 3.4 – determine the water 	
		potential of plant tissues using	
		the intercept of a graph of	
		water potential of solution	
		against gain/loss of mass	
		• 8.4.2.1, 8.4.2.2. 8.4.2.3 and	
		8.4.2.4	
		 AO1/AO2 – application of 	
		knowledge to explain trends	
		and to understand serial	
		dilutions	
		 AO3 – develop and refine 	
		practical design and analyse	
		data to draw conclusions.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Define what is meant by diffusion and facilitated diffusion. Explain the process of facilitated diffusion. Identify which substances rely on facilitated diffusion and why they cannot enter/leave cells by diffusion. Interpret data to identify when a substance is moving by facilitated diffusion or diffusion. 	 Learning activities: students observe diffusion using agar cubes containing phenolphthalein. Place in dilute NaOH solution for 5–10 minutes and cut the cubes open to show where NaOH has diffused to. This could be conducted with different concentrations to highlight diffusion gradients teacher explanation of factors which affect the rate of diffusion teacher explanation of why water-soluble molecules cannot pass across the phospholipid bilayer by diffusion. Introduce facilitated diffusion and the role of channel and carrier proteins. Use animations and video clips to support discuss some data showing data on facilitated diffusion and ask students to explain trends. Model an answer. 	Exampro: BYA1 – Jan 2005 Q5 BYA1 – June 2004 Q6	highered.mheducation. com/sites/9834092339/ student view0/chapter5 /how facilitated diffusio n_works.html cleapss.org.uk Rich question: Show students a list of substances and ask them to categorise those which can diffuse by simple diffusion and those that cannot.

	Skills developed by learning activities:	
	 AO1 – development of knowledge and understanding of facilitated diffusion MS 1.3/AO3 – interpret data from a variety of tables and graphs AO2/AO3/PS 1.2 – apply knowledge of diffusion to explain trends in experimentally derived data on the movement of molecules and ions. 	
Describe Fick's law.	Teacher explanation of Fick's law and the factors which affect the rate of diffusion.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Define what is meant by active transport. Explain the process of active transport. Compare and contrast active transport and facilitated diffusion. Interpret data to identify when a substance is being actively transported. 	 Learning activities: teacher explanation of active transport, using animations and video clips to support discuss some data showing data on active transport and ask students to explain trends. Model an answer. exam questions. Skills developed by learning activities: AO1 – development of knowledge and understanding 	Specimen assessment material: A-level Paper 1 (set 1) – Q5 AS Paper 2 (set 1) – Q2 Past exam paper material: BIOL1 June 2013 – Q5 BIOL1 June 2012 – Q4 BIOL1 June 2011 – Q5	nuffieldfoundation.org/p ractical- biology/tracking-active- uptake-minerals-plant- rootshighered.mheducation. com/sites/9834092339/ student view0/chapter5 /primary active transp ort.htmlcleapss.org.uk
	 AO3/MS 1.3 – interpret data about active transport from a variety of tables and graphs AO2/PS 1.2 – apply knowledge of active transport to explain trends in experimentally derived data on the movement of molecules and ions. 	Exampro: BYB1 – Jan 2006 Q7b	 Rich questions: Why do poisons that inhibit respiration, result in active transport stopping? Suggest why overwatering of plants can kill the plants.

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Explain the adaptations of specialised cells maximising the rate of transport across their internal and external membranes (could be linked to Fick's law). 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 membrane. 	 Learning activities: questioning to assess understanding of adaptations to increase rate of diffusion calculate surface area: volume ratio of cells with folds, when supplied with appropriate data. (Could address with section 3.3.1) exam questions. Skills developed by learning activities: AT d – use optical microscopes to observe cells that are adapted for rapid exchange eg root hair cells, epithelial cells of the small intestine MS 0.3/MS 4.1 – calculate surface area: volume ratios of cells extended exam answers. 	Past exam paper material: BIOL1 June 2011 Q8b	 Rich questions: what does Fick's law state? what common adaptations do cells of exchange surfaces have?

 Microscopy of cells that have adaptations for exchange. Ask pupils to identify and explain these adaptations. Teacher led explanation based on feedback. 		
---	--	--

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the adaptations of small intestine epithelial cells for absorption. Define what is meant by cotransport. Explain the process of co-transport in the context of absorption of glucose (and amino acids). 	 Learning activities: DARTS task – students convert comprehension on co- transport into a diagrammatic representation of the process and then present to group peer evaluation of presentation teacher explanation to address weak areas of presentations provide data showing a range of different transport processes and ask pupils to identify the transport process from the data to summarise this section of the specification 	Questions from Section B of the 2014 BIO3T Q14 ISA Past exam paper material: BIOL1 Jan 2013 – Q9a BIOL1 June 2010 – Q7a BIOL1 Jan 2010 – Q4	 Rich questions: describe the process of co-transport. how does co-transport differ from direct active transport?

exam questions.	
Skills developed by learning activities:	
 AO1 – development of knowledge and understanding of co-transport AO2/PS 1.2 – apply knowledge of transport processes to explain data and identify the transport process being used extended exam answers. 	

3.2.4 Cell recognition and the immune system

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by an antigen and the types of molecules which can act as antigens. Explain why antigen recognition is important for the immune system. Identify cells which the immune system would launch an immune response against. 	 Learning activities: assess GCSE recall and understanding define an antigen and explain which types of molecules usually act as antigens explain importance of antigens in identification by the immune system discuss with students that abnormal cells of the body can produce antigens which would initiate an immune response eg cancer cells exam question. 	Specimen assessment material: A-level Paper 3 (set 1) – Q4 Exampro: BYA3 – June 2006 Q1a	 Rich questions: efine what an antigen is. xplain why the surface molecules of some cells act as antigens.
	Skills developed by learning activities:		
	AO1 – Development of knowledge and understanding of antigens and their importance.		

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Describe the process of phagocytosis. Explain the role of lysozymes in the destruction of pathogens. Explain the role of antigen presentation following destruction. 	 Learning activities: teacher introduction to the concept of non-specific and specific immune responses and phagocytosis exam questions. Skills developed by learning activities: AO1 – development of knowledge and understanding of phagocytosis extended exam answers. 	Past exam paper material: BIOL1 June 2011 Q8a BIOL1 June 2012 Q5a and 5b; BIOL1 Jan 2009 Q5a	dnatube.com/video/116 /Neutrophil-attacts-on- bacteria highered.mheducation. com/sites/0072495855/ student view0/chapter2 /animation phagocyto sis.html Rich questions: • Describe the process of phagocytosis from start to finish. • Evaluate the statement "Phagocytes eat the pathogen".
	 Get students to visit information stations showing videos, animations, textbook pages and comprehensions on phagocytosis. Students then combine collective learning to produce a narrated video of the 		

process using flip cameras (or equivalent) and plasticine.	
 Peer assess quality of explanations. 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by the specific immune response. Explain the cell-mediated (cellular) immune response. Explain the roles played by helper T cells. 	 Learning activities: define the circumstances under which the cell mediated immune response is used teacher explanation of the cell mediated immune response in detail (linked to antigen presentation and the role of TH and TC cells), use videos and animations to support get students to write an essay on the cell mediated response. Skills developed by learning activities: 		highered.mheducation. com/sites/0072507470/ student_view0/chapter2 2/animation_the_imm une_response.html sbs.utexas.edu/psaxen a/MicrobiologyAnimatio ns/Animations/Cell- MediatedImmunity/micr o_cell-mediated.swf highered.mheducation. com/sites/0072495855/ student_view0/chapter2 4/animation_the_imm une_response.html
	AO1 – development of knowledge and understanding of the cell mediated response.		Rich questions: Why is the cell- mediated response able to destroy body

	cells that have turned cancerous?
--	-----------------------------------

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Relating previous knowledge of protein structure, describe the structure of antibodies. Explain the specificity of an antibody to a particular antigen. Explain how antibodies lead to the destruction of pathogens. 	 Learning activities: questioning about protein structure and the roles of proteins teacher definition of an antibody highlighting exercise about how antibodies bind to and lead to the destruction of pathogens that have complementary antigens (specification only requires agglutination and destruction by phagocytosis). Students can also generate their own questions that they would like answered show students antibody structure and explain variable and constant regions and how the antigen binding site means specificity for one antigen exam questions. 	Past exam paper material: BIOL1 Jan 2012 – Q6 HBIO1 – June 12 Q4a Exampro: Specimen paper Unit 1 Q2	 Rich questions: Define what an antibody is. Explain the importance of the variable region of antibodies. Explain the structure of antibodies in terms of the hierarchy of protein structure.

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the humoral (antibody-mediated) immune response. Explain what is meant by a monoclonal antibody. Explain the roles of plasma cells in producing a primary response and memory cells in producing a secondary response. 	 Learning activities: teacher explanation of the humoral immune response in detail (linked to antigen presentation and the roles of B lymphocytes and of TH cells), Use videos and animations to support card sort – provide statements which students categorise as humoral, cell mediated or both provide data on the antibody concentrations in the blood after a primary and secondary response. Ask students to explain and ask for improvements to statements such as "the body knows how to fight it off in the secondary response" exam questions. Skills developed by learning activities: AO1 – development of knowledge and understanding of the humoral response 	Past exam paper material: HBIO1 – June 2012 Q4b	highered.mheducation. com/sites/0072507470/ student view0/chapter2 2/animation the imm une_response.html sbs.utexas.edu/psaxen a/MicrobiologyAnimatio ns/Animations/Humorall mmunity/micro humora I.swf Rich questions: • Would the humoral response be used during a viral infection? Explain your answer. • Why does the secondary immune response mean that pathogens are destroyed before they are able to make you ill?
--			

Knowledge, understanding and s kills	Implementation	Evaluation and assessment	Additional resources
 Explain that antigen variability can lead to some diseases being caught more than once. Explain how mutations can cause antigen variability and how this can cause new strains of pathogen. Explain the consequences of antigen variability on the incidence of disease and the development of therapies against that disease. 	 Learning activities: teacher led introduction to antigenic variability through gene mutation students examine information about past epidemics/ pandemics eg influenza outbreaks over the last century and why periodically some are so serious students could research the modern focus on disease prevention using internet materials and why recent outbreaks eg avian and swine flu, have attracted such media focus teacher summary could bring together their findings and 	Exampro: BYB7 June 2004 Q6 HBIO1 – June 2012 Q2	newscientist.com/topic/ bird-flu bigpictureeducation.co m/epidemics bigpictureeducation.co m/influenza-special- issue Rich questions: • Suggest why we can suffer from some diseases multiple times, but we get others only once and are then immune. • Why is it so difficult to develop a

 discuss the consequences of antigen variability of disease prevention and treatments. Skills developed by learning activities: MS 0.3 – calculate and understand the use of exercise environments. 	 vaccine against the common cold or HIV? Why have many animal flu viruses eg bird flu, made the news so often in recent years? During recent flu outbreaks the
 percentages of values per 100 000 when looking at data within populations AO1 – development of knowledge and understanding of antigen variability and its consequences AO2 – application of knowledge of antigen variability to the context of recent outbreaks of influenza (and other diseases). 	government invested in Tamiflu drugs to protect the population in the event of a pandemic. Was this a wise decision?

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Compare and contrast active and passive immunity and apply knowledge to given examples. Describe how antigens can be used to produce a vaccine. Explain why vaccination is able to protect against diseases caused by particular pathogens. Explain what is meant by herd immunity and why it is able to protect unvaccinated individuals in a population Discuss ethical issues associated with the use of vaccines Evaluate methodology, evidence and data 	 Learning activities: teacher introduction to active and passive immunity. Get students to categorise rich question statements teacher explanation of concept of vaccination and the types of vaccines which are used/in development debate the ethical issues of the use of vaccines with students given different viewpoints to discuss provide structured questions for students to analyse the data against. Skills developed by learning activities: MS 0.3 – understand the use of, percentages or values per 100,000 when looking at disease data AO1 – development of knowledge of vaccines AO3 – evaluate scientific evidence. 	Specimen assessment material: AS Paper 2 (set 1) – Q10.1 and 10.2 Past exam paper material: BIOL1 June 2013 – Q7 BIOL1 Jan 2012 – Q8a BIOL1 Jan 2011 – Q6 BIOL1 June 2009 – Q4 BIOL1 June 2010 – Q4	 bigpictureeducation.co m/herd-mentality Rich questions: Provide statements and ask students to identify them as relating to active immunity, passive immunity or both, eg: antibodies rapidly produced on re- infection by same pathogen an antibody reacts with an antigen antibodies received in breast milk attenuated microorganisms in a vaccine.

relating to the use of vaccines.		
Evaluate methodology, evidence and data relating to the use of vaccines.	 Get students to research or provide data from the MMR and autism research of Andrew Wakefield and Hideo Honda (and data on the impact on vaccination rates in the UK). PS 2.1 – Evaluate the scientific methods and experimental design of Andrew Wakefield. 8.4.2.5 – Carry out research into the MMR link to autism. 	thelancet.com/journals/l ancet/article/PIIS0140- 6736(05)75696- 8/fulltext nature.com/ni/journal/v 9/n12/full/ni1208- 1317.html newscientist.com/article /dn7076-autism-rises- despite-mmr-ban-in- japan.html#.U7kjL5hO WUk
		Rich questions:
		Evaluate the relative data and methodology of Wakefield and Honda in their studies of MMR and autism. Which is the most convincing study and why?

on and Additional resources
m paper rial:wellcome.ac.uk/Educati on-Additional resources/Education- and-learning/Additional resources/Animation/W TDV026676.htmn 2009 Q8TDV026676.htm hhmi.org/biointeractive/ hiv-life-cyclednadarwin.org/casestud ies/7/highered.mheducation. com/sites/0072495855/ student view0/chapter2 4/animation_hiv_replic ation.htmlRich questions: • Why are so few anti-viral drugs licensed for human use compared with the number against other types of pathogen? • What is the

 100 000 when looking at data within populations AO1 – development of knowledge of HIV and AIDS and the replication of HIV AO2/AO3 – interpret scientific data (graphs) and apply knowledge to explain them. 	being HIV positive and having AIDS?
---	--

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
• Explain how the specificity of monoclonal antibodies can be used in medical diagnosis and	 Learning activities: introduce what is meant by monoclonal antibodies and the usefulness of their specificity for a particular antigen 	Specimen assessment material: A-level Paper 1 (set 1) – Q7 AS Paper 2 (set 1) –	sumanasinc.com/webc ontent/animations/conte nt/ELISA.html Rich question:
targeting of medication at particular cell types. Explain the use of monoclonal	 teacher explanation of ELISA using animations exam questions showing monoclonal antibody uses in different contexts. 	Past exam paper material:	What property of monoclonal antibodies makes them so useful in diagnostic testing?
 ELISA technique. Interpret information to explain the accuracy and results of tests 	Skills developed by learning activities: • AO1 – development of	BIOL1 Jan 2010 – Q6	
which use the ELISA technique.	knowledge of monoclonal antibodies and their uses		

 Discuss ethical issues associated with the use of monoclonal antibodies Evaluate methodology, evidence and data relating to the use of monoclonal antibodies. 	 AO2 – application of knowledge of monoclonal antibodies to the contexts given in exam questions. 	
	Students undertake internet research into applications of monoclonal antibodies eg ADEPT, ELISA, magic bullets.	
	8.4.2.5 – research and reference some applications of monoclonal antibodies using the internet eg ADEPT technique and magic bullets in cancer treatment.	

3.3 Organisms exchange substances with their environment

3.3.1 Surface area to volume ratio

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain how the size of an organism affects its surface area to volume ratio and why this is important. Apply your knowledge of surface area to volume ratio, to explain adaptations to body shape or the development of exchange systems. Describe and explain the relationship between surface area to volume ratio and metabolic rate. Calculate surface area to volume ratios when 	 Learning activities: get students to make multilink block cubes, increasing in size and investigate the effect on SA:vol ratio get students to calculate the surface area and volume of the cubes and work out the ratios. Ask them to draw conclusions linking SA:vol ratio to diffusion question about the consequences for larger organisms teacher led explanation as to how this has led to the development of exchange surfaces and mass transport systems, or a change to body shape in larger organisms think, pair, share: do animals with a larger SA:vol ratio have a higher or lower rate of 	Students could undertake the HBI3T ISA Q from 2012 Past exam paper material: BIOL2 June 2012 Q1a BIO3X 2013 EMPA	<u>aqa.org.uk</u>

supplied with cell/organism dimensions.	metabolism? Question and discuss to arrive at the correct answer • exam questions.	
	Skills developed by learning activities:	
	 PS 1.1 – use 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 MS 0.3/MS 4.1 – calculate the surface area to volume ratios of different shaped object/cells/organisms when supplied with their dimensions 8.4.2.1, 8.4.2.2 and 8.4.2.4 AO1 – development of knowledge of why larger organisms have specialised surfaces and mass transport systems, or particular body shapes. 	

 eg flatten and re-calculate. Students use multilink blocks to produce shapes with larger SA:vol ratios to model the changes to body shape. Practical investigation of whether size affects the rate 	 Model 1 cm3 'animals' in plasticine in various shapes eg sphere, cube, cylinder. Calculate SA:vol ratio. Squash into a different shape 	nuffieldfoundation.org/p ractical-biology/effect- size-uptake-diffusion
	 Squash into a different shape eg flatten and re-calculate. Students use multilink blocks to produce shapes with larger SA:vol ratios to model the changes to body shape. Practical investigation of whether size affects the rate 	<u>cleapss.org.uk</u>

3.3.2 Gas exchange

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the internal structure of a leaf. Explain how the structure is an adaptation allowing efficient gas exchange. Explain what a xerophytic plant is Explain the adaptations that xerophytic plants have and how these balance the needs for gas exchange whilst minimising water loss. 	 Learning activities: microscopy of vertical sections through dicotyledonous plant leaf microscopy of nail varnish painted on underside of the leaf to see stomata teacher explanation of how the structure of a leaf is adapted for gas exchange highlighting exercise on xerophytic plants, in which students highlight any adaptations the plants have to water conservation exam questions. 	Past exam paper material: BIOL2 June 2012 Q1b BIOL2 Jan 2010 Q5 Exampro: BYB3 June 2006 Q1 BYB3 Jan 2006 Q2	 Rich questions: explain the ways in which the structure of a leaf is adapted for gas exchange explain the adaptations present in xerophytic plants that reduce water loss.
	 Skills developed by learning activities: AT d/ AT e – use an optical microscope to examine and 		

	draw vertical sections through	
	a dicotyledonous plant	
	 MS 1.9 – students could 	
	select and use an appropriate	
	statistical test to find the	
	significance of differences in	
	the number of stomata on the	
	upper and lower surfaces of	
	leaves of a single plant	
	species or on the lower	
	surfaces of leaves of different	
	plant species	
	 AO1 – development of 	
	knowledge of leaf structure	
	and the adaptations present in	
	xerophytes	
	 AO2 – application of earlier 	
	learning on features that	
	increase the rate of exchange,	
	to explain features that reduce	
	water loss in xerophytic	
	plants.	
1		

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Explain the adaptations of single-celled organisms for efficient gas exchange. Describe the structure of insect tracheal systems. Explain how the tracheal system is adapted to allow efficient gas exchange. Explain how tracheal systems balance the needs for gas exchange whilst minimising water loss. Describe the structure of fish gills. Explain how fish gills are adapted to maximise gas exchange, including counter current flow. 	 Learning activities: teacher led explanation about the gas exchange systems within fish and insects and how they are adapted exam questions. Skills developed by learning activities: AT j – dissect the gas exchange system of a bony fish and/or an insect AT d/AT e – use an optical microscope to examine and draw prepared mounts of the gas exchange surface of fish or insects, or temporary mounts of gills 8.4.2.1 and 8.4.2.3. 	Past exam paper material: BIOL2 June 2013 – Q8b–8g BIOL2 June 2009 – Q8a BIOL2 Jan 2012 – Q9b- 9f BIOL2 Jan 2010 – Q8	nuffieldfoundation.org/p ractical- biology/dissection- ventilation-system- locust cleapss.org.uk pskf.ca/sd/ s-cool.co.uk/a- level/biology/gas- exchange/revise-it/gas- exchange/revise-it/gas- exchange-in-fish kscience.co.uk/animatio ns/anim 3.htm Rich question: Explain the adaptations present in fish gills and insect tracheal systems.

 Dissection of fish gills and locust to investigate filament and tracheal systems. View locust mounts and prepared gill mounts under microscope. Observe breathing movements of a stick insect held in a boiling tube. 		
---	--	--

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of the human gas exchange system. Explain the roles of cartilage in the trachea and bronchi. 	 Learning activities: GCSE baseline activities dissection of lungs with emphasis on identification of key parts teacher explanation of key aspects of lungs eg C-shaped rings of cartilage. Skills developed by learning activities: AT j – dissect mammalian lungs. 	Past exam paper material: BIOL1 – Jan 2013 Q1a	nuffieldfoundation.org/p ractical- biology/dissecting-lungs cleapss.org.uk Rich questions: • Compare and contrast the human gas exchange system with that of an insect or a fish. • The trachea and bronchi have C- shaped rings of cartilage, but the bronchioles do not.

	Suggest the advantages of this.

Knowledge, understanding andskills	Implementation	Evaluation and assessment	Additional resources
 Explain the role of ventilation in terms of maintaining diffusion gradients. Explain the mechanism of breathing in terms of the action of the diaphragm muscle and the antagonistic action of the external and internal intercostal muscles and the pressure changes which they cause in the thoracic cavity. 	 Learning activities: use balloon lungs in a jar, or get students to construct a lung model, to show breathing is due to changes in pressure due to changes in thoracic volume teacher explanation of the mechanism of breathing exam questions on the mechanism of breathing students given data relating to pulmonary ventilation rate and one other measure exam questions. 	Students could undertake the HBI3T ISA Q from 2010 Specimen assessment material: AS Paper 2 (set 1) – Q4.1–4.2 Past exam paper material: BIOL1 Jan 2013 – Q1 BIOL1 Jan 2012 – Q2 BIOL1 June 2010 – Q2	nuffieldfoundation.org/p ractical- biology/modelling- human-ventilation- system nuffieldfoundation.org/p ractical-biology/using- spirometer-investigate- human-lung-function cleapss.org.uk nuffieldfoundation.org/p ractical- biology/measuring-rate- metabolism
	 Skills developed by learning activities: MS 2.2 – students could be given values of pulmonary ventilation rate and one other 	BIOL4 June 2012 – Q6 BIOL 4 Jan 2011 – Q6a and 6b	

measure, requiring them to change the subject of the equation: PVR = tidal volume × breathing rate	
 AT b/ AT h – students could use three-way taps, manometers and simple respirometers to measure volumes of air involved in gas exchange AO1 – development of knowledge of mechanism of breathing and associated measurements and the techniques associated with spirometers and respirometers PS 3.1/AO3/AO2 – interpret graphs showing spirometer traces. 	
 Students conduct a practical to measure volume of air being breathed in eg spirometers or respirometers with manometer tube, scale and three-way tap. They could plot their data and then discuss how to interpret 	

the spirometer traces to identify tidal volumes.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the process of gas exchange, related to blood circulation and ventilation. Describe the features of the squamous epithelium. Explain how the squamous epithelium is adapted to maximising gas exchange. 	 Learning activities: teacher led explanation of the process of gas exchange linked to ventilation and circulation relate the maintenance of a diffusion gradient to circulation and ventilation exam questions. Skills developed by learning activities: AT d – use an optical microscope to examine prepared mounts of the gas exchange surface of a mammal extended exam answers. 	Past exam paper material: BIOL1 June 2013– Q3 BIOL1 June 2012 – Q3 BIOL1 June 2009 – Q6 BIOL1 June 2010 – Q7b BIOL1 Jan 2010 – Q2	highered.mheducation. com/sites/0072495855/ student_view0/chapter2 5/animation_gas_exch ange_during_respiratio n.html
	Microscopy of squamous epithelial cells to look for		

further adaptations related to Fick's law.	
• Collate feedback and emphasise key points about the features of the alveolar epithelium.	

Knowledge, understanding and s kills	Implementation	Evaluation and assessment	Additional resources
 Interpret information relating to the effects of lung disease on gas exchange and/or ventilation. Interpret data relating to the effects of pollution and smoking on the incidence of lung disease. Analyse and interpret data associated with specific risk factors and the incidence of lung disease. Recognise correlations and 	 Learning activities: teacher explanation of how to critically analyse and evaluate data showing correlations. Emphasise the concept of risk and that correlation does not mean causation use a past exam question to model the analysis and evaluation process teacher explanation of how to critically analyse and evaluate data showing correlations exam questions on evaluating data about lung disease and risk factors. 	Specimen assessment material: A-level Paper 1 (set 1) -Q2 AS Paper 2 (set 1) $-Q4.1 - 4.2$ Past exam paper material: BIOL1 June 2011 - Q4 BIOL1 Jan 2012 - Q4 BIOL1 Jan 2009 - Q4 BIOL1 - Jan 2011 - Q7 BIOL2 Jan 2013 - Q9	 Rich questions: What is risk? Why does correlation not prove causation?

causal relationships. NB the specification does not require knowledge of specific lung diseases or risk factors.	 PS 3.1/ MS 1.3/MS 1.7 – interpret graphs showing correlations between lung diseases and associated risk factors MS 0.3 – calculate and understand the use of percentages or values per 100 000 when looking at data within populations MS 1.9 – students could select and use an appropriate statistical test to find the significance of a correlation between data about an environmental variable and data about the incidence of a particular lung disease AO3 – analyse, interpret and evaluate scientific information and evidence to assess the validity of conclusions and the strength of correlations. 	
	Information treasure hunt on lung diseases eg TB, cancer, emphysema, asthma, fibrosis (symptoms, causes/risk factors, long term consequences, treatments). Students circulate around information posters and find answers to a question sheet.	

3.3.3 Digestion and absorption

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the general roles of organs within the digestive system and where key events in digestion happen. Explain the purpose of digestion. Explain the role of different enzymes in the digestive process and relate the specificity of enzymes back to protein structure. Explain how endopeptidases and exopeptidases increase protein digestion. Explain the role of bile salts. 	 Learning activities: baseline questioning students about the purpose of digestion and where key events happen in the digestive system jigsaw task: In groups of three, each person goes to a different information station (text, videos etc.), to learn about the digestion of starch, protein or lipids. They then feedback to other group members to gain a complete picture of other two exam questions. Skills developed by learning activities: PS 1.1 – use Visking tubule models to investigate the absorption of the products of digestion 	Specimen assessment material: A-level Paper 1 (set 1) – Q11.3 A-level Paper 3 (set 1) – Q3 AS Paper 2 (set 1) – Q5 Past exam paper material: A-level BIOL1 June 2009 – Q7 BIOL1 June 2012 – Q7 BIOL1 June 2012 – Q7 BIOL1 June 2012 – Q3 BIOL1 June 2012 Q6 BIO3X 2010 EMPA HBI3X 2011 EMPA HBI3X 2012 EMPA	nuffieldfoundation.org/p ractical- biology/evaluating- visking-tubing-model- gut cleapss.org.uk bigpictureeducation.co m/anatomy-digestive- system-images filestore.aqa.org.uk/Add itional resources/biology/AQA- 7401-7402-PROTEIN- DIGEST.PPTX filestore.aqa.org.uk/Add itional resources/biology/AQA- 7401-7402-TN- PROTEIN- DIGEST.PDF
	Knowledge and understanding of digestion		

	 AO2/AO3 – application of knowledge to explain exam 		Why do vitamins and
	 questions/data showing the reduction in pH when lipase and bile are added to milk extended exam answers. 		minerals not require digestion?
	Model gut activity (eg using starch and amylase, or triglycerides, bile and lipase). Ask them to relate this to digestion.		
 Explain the features of good experimental design. Evaluate risk. Research and adapt methodology as the basis for designing an experiment. Process data to calculate rates. Represent raw and processed data clearly using tables and graphs. Apply knowledge to draw and explain conclusions. Evaluate the quality of results and 	Learning activities: Students design an experiment to investigate the whether the concentration of bile salts affects the rate of triglyceride digestion. This should include the stages of: • questioning about what features a well-designed investigation has • research to develop method • risk assessment (Hazcards) • processing and presenting data • drawing conclusions and evaluating findings • past ISA paper (if appropriate).	Students could undertake the BIO3T ISA P 2010	nuffieldfoundation.org/p ractical- biology/investigating- effect-temperature- activity-lipase shsbiology.pbworks.co m/f/Breaking+Down+Fa t+Digestion+CH+29+La b.pdf cleapss.org.uk

reliability of conclusions.	Skills developed by learning activities:	
	 AT a/At I – use apparatus, including dataloggers, to measure time and pH PS 1.1/PS 2.4 – design an experiment, based on research, to test a hypothesis PS 2.2/3.1/MS 1.3 – present and interpret data using tables and graphs PS 2.3 – evaluate results for errors PS 3.2 – process data to calculate rates MS 1.9 – select (and use) an appropriate statistical test 8.4.2.1, 8.4.2.2. 8.4.2.3, 8.4.2.4 and 8.4.2.5 AO2 – apply knowledge in a practical context AO3 – analyse, interpret and evaluate scientific information and evidence to make judgements, reach conclusions and develop/refine practical data and practical data and practical data and practical context 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Recall the adaptations of intestinal epithelial cells to exchange. Explain the absorption of amino acids and glucose against a concentration gradient by cotransport. Explain the role of micelles in the absorption of lipids. 	 Learning activities: card sort recapping the adaptations that cells have to increase exchange (section 3.2.3) ask students to label the adaptations of a small intestine epithelial cell DARTS tasks – students use a comprehension about how glucose, amino acids and lipids are absorbed and recreate this in diagrammatic form presentation of diagrams to the group and peer evaluation to address remaining weaknesses using videos and animations exam questions. 	Past exam paper material: BIOL1 June 2009 – Q7b BIOL1 June 2011 – Q8b BIOL1 June 2009 – Q7b	Rich question: Explain the mechanisms by which each of the products of digestion is absorbed.
	 Skills developed by learning activities: extended exam answers AO1 – development of knowledge and understanding of absorption 		

AO2 – application of earlier learning from section 3.2.3 AO3 – evaluation of scientific	;
information in other people's presentations.	

3.3.4 Mass transport

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of the circulatory system, with particular reference to the blood vessels entering/leaving the heart, lungs and kidneys. Link the structure of the circulatory system to its role in exchanging and transporting materials. 	 Learning activities: teacher explanation of the advantage of mass transport systems in large organisms teacher explanation of the double circulatory system, using animations and videos students complete labelled diagram of organs and blood vessels, based on their learning exam questions from Exampro. Skills developed by learning activities: AO1 – development of knowledge 	Past exam paper material: BIOL2 – June 2009 Q1a–1b	 kscience.co.uk/animatio ns/blood_system.swf Rich questions: Why do humans need a double circulatory system? Describe the journey of a red blood cell around one circuit of the body, naming the main blood vessels and the chambers of the heart.
	and understanding or circulation and the key blood vessels entering and leaving the kidneys, lungs and heart.		

Student modelling of the double circulatory system – mark out the classroom to have a double circulation with the heart in the centre and desks for other organs. Students have to pick up oxygen, carbon dioxide, glucose and urea cards at key points and drop them at the correct points	
where they leave the blood.	

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Relate knowledge of protein structure to the structure of haemoglobin. Explain what is meant by the term "partial pressure". Explain how the binding of one oxygen molecule changes the shape of haemoglobin and how this affects the binding of further oxygen molecules. Relate knowledge to explain the shape of an oxyhaemoglobin dissociation curve. Explain the effect of carbon dioxide concentration on oxygen dissociation. Relate this knowledge to explain oxygen loading and 	 Learning activities: use RASMOL/information sheets to investigate the structure of haemoglobin. Ask students to relate this back to protein structure from 3.1.4 teacher introduction to the dual role of loading in the lungs and unloading in the respiring tissues (using animations) teacher explanation of the oxyhaemoglobin dissociation curve, the concept of partial pressure and the Bohr effect (using animations) get students to generate "Golden Rules" about what a shift to the left or right on the oxyhaemoglobin dissociation curve means exam questions. Skills developed by learning activities: AT I – use ICT to model the structure of haemoglobin (using RASMOL) 	Past exam paper material: BIOL2 June 2013 – Q6 BIOL2 Jan 2012 – Q9a BIOL2 June 2010 – Q7a BIOL2 June 2010 – Q9 (except 9c)	rasmol.org johnwiley.net.au/higher ed/interactions/media/R espiration/content/Resp iration/resp3a/screen0. <u>swf</u> Rich questions: • Why does haemoglobin have a quaternary structure? • What effect does the first oxygen binding have on the structure of haemoglobin? • What are haemoglobin's two seemingly conflicting roles (in the lungs and respiring tissues)? • How are both roles achieved? • Explain the S shape of the

unloading in	 AO1 – development of 	oxyhaemoglobin
different tissues.	knowledge on oxygen loading,	dissociation curve.
	transport and unloading	
	 AO2 – application of 	
	knowledge to explain the Bohr	
	effect on an oxyhaemoglobin	
	dissociation curve	
	 MS 1.3/AO3 – interpret data 	
	from graphs showing	
	oxyhaemoglobin dissociation	
	curves	
	 MS 3.1 – translate data 	
	between a number of different	
	formats eg graphical and	
	tabular forms.	
		1

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain differences between the oxyhaemoglobin dissociation curves of different species. Relate these differences to the environment in which the organisms with to explain how these adaptations allow organisms to survive. 	 Learning activities: questioning used to recap and assess understanding of the Bohr effect and oxygen dissociation think, pair, share: show oxyhaemoglobin dissociation curves comparing human and bird haemoglobin and ask students to suggest the advantage to birds of having a curve to the right provide environmental information about other organisms eg lugworms and ask students to suggest what challenges they face and what their oxyhaemoglobin dissociation curve would be like in comparison to human haemoglobin. They can present with explanation accept feedback and use as a prompt for discussion exam questions. 	Past exam paper material: BIOL 2 Jan 2011 - Q2 BIOL 2 June 2009 - Q8b-c BIOL 2 June 2011 - Q6a BIOL 2 June 2010 - Q7b BIOL 2 Jan 2010 - Q4	Rich questions: Provide examples of organisms and the conditions in which they live eg birds. Then show oxyhaemoglobin dissociation curves and ask students to relate them to the environmental conditions.

 PS 1.2 – apply knowledge of oxygen dissociation and adaptations of organisms, to experimental data showing oxygen dissociation at different partial pressures AO3/MS 1.3 – interpret data from graphs showing oxyhaemoglobin dissociation curves MS 3.1 – translate data between a number of different formats eg graphical and tabular forms AO1 – development of knowledge on oxygen loading, transport and unloading AO2 – application of knowledge to suggest how organisms have haemoglobin 		
knowledge to suggest how organisms have haemoglobin with different transport properties.		
	 PS 1.2 – apply knowledge of oxygen dissociation and adaptations of organisms, to experimental data showing oxygen dissociation at different partial pressures AO3/MS 1.3 – interpret data from graphs showing oxyhaemoglobin dissociation curves MS 3.1 – translate data between a number of different formats eg graphical and tabular forms AO1 – development of knowledge on oxygen loading, transport and unloading AO2 – application of knowledge to suggest how organisms have haemoglobin with different transport properties. 	 PS 1.2 – apply knowledge of oxygen dissociation and adaptations of organisms, to experimental data showing oxygen dissociation at different partial pressures AO3/MS 1.3 – interpret data from graphs showing oxyhaemoglobin dissociation curves MS 3.1 – translate data between a number of different formats eg graphical and tabular forms AO1 – development of knowledge on oxygen loading, transport and unloading AO2 – application of knowledge to suggest how organisms have haemoglobin with different transport properties.

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Describe and label the structure of the heart. Explain differences in the thickness of cardiac muscle between the atria and ventricles and between different sides of the heart. Explain the role of the atrio-ventricular and semilunar valves. Explain the role of the coronary artery. 	 Learning activities: introduce students to the external structure of the heart and discuss the key features eg role of the coronary artery teacher explanation of the gross internal structure of the heart, building on GCSE knowledge. Link the structure back to the double circulatory system students to perform a dissection, using instruction sheet students identify key internal structures/chambers. 	Exampro: BYB3 – Jan 2006 Q1a BYA1 – June 2005 Q2	nuffieldfoundation.org/p ractical-biology/looking- heart cleapss.org.uk
	 Skills developed by learning activities: AT j – dissect mammalian heart 8.4.2.1 and 8.4.2.3 AO1 – development of knowledge on the structure of the heart. 		

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Explain the cardiac cycle. Explain the opening and closing of AV and semi-lunar valves in terms of differences in pressure at different stages of the cardiac cycle. Analyse and interpret data relating to pressure and volume changes during the cardiac cycle. 	 Learning activities: introduce the concept of the heart beating at a certain rate teacher explanation of the events within a heartbeat using animation. Emphasise the pressure and volume changes and how this causes the opening and closing of particular valves to maintain unidirectional flow show students data of the volume and pressure changes on a graph. Ask them to discuss in pairs and interpret the changes. Finally ask them to justify which valves will be opening and closing at which positions exam questions. 	Past exam paper material: BIOL1 June 2013 – Q8b BIOL1 Jan 2011 – Q3 (except 3c) BIOL1 June 2011 – Q6 BIOL1 Jan 2012 – Q5	<u>nhlbi.nih.gov/health/hea</u> <u>lth-</u> <u>topics/topics/hhw/contr</u> <u>action.html</u>
	Skills developed by learning activities:		
	 MS 2.2/ MS 2.4 – students could be given values of cardiac output (CO) and one other measure, requiring them 		

to change the sul equation	oject of the n:
CO = stroke volu rate	me × heart
 AO1 – develop knowledge of th cycle, the press volume changes v how this causes open and c AO2/AO3/MS 1.3 data from graph showing pressur changes within th cycle and apply kr explain the extended exam 	prenent of e cardiac sure and within it and valves to close - interpret hs/tables re/volume he cardiac howledge to data answers

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Describe the structure of arteries, arterioles, veins and capillaries. Relate the structure of arteries, arterioles, veins and capillaries to their functions. Compare and contrast the structure and function of different blood vessels. Explain what tissue fluid is and which substances it contains. Explain the formation of tissue fluid in terms of hydrostatic pressure. Explain the reabsorption of some tissue fluid back into the capillaries, in terms of hydrostatic 	 Learning activities: introduce the relationships between the different types of blood vessels jigsaw task: Groups of 4. One from each group goes to an information station containing materials about the structure linked to the function of one of the blood vessels students feedback to each other and complete a summary table teacher assessment and explanation of weaker areas teacher explanation of the formation of tissue fluid and its return to the circulatory system exam questions. Skills developed by learning activities: ATd /AT e – use an optical microscope to examine and draw prepared slides of sections through blood vessels 	Specimen assessment material: AS Paper 1 (set 1) – Q6 Past exam paper material: BIOL2 Jan 2013 – Q2 BIOL2 June 2012 – Q8b-8c BIOL2 Jan 2011 – Q8c BIOL2 June 2009 – Q1 BIOL2 June 2009 – Q1 BIOL2 June 2010 – Q2 BIOL2 Jan 2010 – Q2	nuffieldfoundation.org/p ractical-biology/elastic- recoil-arteries-and- veins cleapss.org.uk

pressure and water potential • Explain the role of the lymph system.	 MS 1.8 – use and manipulate the magnification formula AO1 – development of knowledge of the structure and function of different blood vessels AO2 – application of knowledge of structure to the function of each blood vessels. 		
	 Hang masses from an artery and vein and show that artery has more elasticity. Microscopy and drawing of prepared slide of sections through different blood vessels. 		
 Explain the features of good experimental design. Process data to calculate rates. Represent raw and processed data clearly using tables and graphs. Apply knowledge of circulation to draw and explain conclusions. 	Learning activities: Students design an experiment to investigate the effect of exercise on human pulse. This should include the stages of: • research to develop method. • risk assessment • carrying out (subject to teacher approval) • processing and presenting data • drawing conclusions and evaluating findings	Students could undertake the HBI3T ISA P from 2009. Past exam paper material: BIOL1 Jan 2013 – Q7 BIO3X 2012 EMPA	nuffieldfoundation.org/p ractical- biology/observing- effects-exercise- human-body cleapss.org.uk

•	Evaluate the quality of results and reliability of conclusions.	 past ISA paper (if appropriate). 	
		Skills developed by learning activities:	
		 AT h – students could design and carry out an investigation into the effect of a named variable on human pulse rate PS 3.1 – plot and interpret graphs showing the effect of a named variable on pulse rate PS 3.2 – process data to calculate rates MS 0.1 – make use of units appropriate in calculations MS 1.9 – select (and use) an appropriate statistical test 8.4.2.1, 8.4.2.2, 8.4.2.3 and 8.4.2.4 AO2 – apply knowledge in a practical context AO3 – analyse, interpret and evaluate scientific information and evidence to make judgements and reach conclusions and design/refine practical design and 	
		procedureo.	
Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
---	--	--	--
 Analyse and interpret data associated with specific risk factors and the incidence of cardiovascular disease. Recognise correlations and causal relationships. NB the specification does not require knowledge of specific CVD or risk factors but students should be able to use their knowledge of heart function to predict what would or could happen when given information. 	 Learning activities: jigsaw task: Students research one cardiovascular disease eg stroke, heart disease and then feedback to others in their group to build up collective picture of cardiovascular disease and associated risk factors teacher explanation of how to analyse critically and evaluate data showing correlations use a past exam question to model the analysis and evaluation process exam questions. Skills developed by learning activities: PS 3.1 – interpret graphs showing correlations between CVD and associated risk factors MS 0.3 – calculate and understand the use of, percentages or values per 100,000 when looking at data within populations 	Past exam paper material: BIOL1 June 2013 – Q6 BIOL1 June 2010 – Q6 BIOL1 June 2012 – Q2 BIOL1 June 2012 – Q8b BIOL1 Jan 2012 Q7c and 7d	 Rich questions: What are the risk factors associated with CVD? Explain why a strong correlation is not proof that a factor causes CVD.

MS 1.3 – interpret data from	
graphs relating to factors	
which influence the risk of	
CVD	
 MS 1.7 – interpret scatter 	
graphs showing correlations	
 MS 1.9 – students could 	
select and use an appropriate	
statistical test to find the	
significance of a correlation	
between data about an	
environmental variable and	
data about the incidence of a	
particular cardiovascular	
disease	
 AO3 – analyse, interpret and 	
evaluate scientific information	
and evidence to assess the	
validity of conclusions and the	
strength of correlations.	
-	

3.3.4.2 Mass transport in plants

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the role of the xylem in plants. Explain how water transport in the xylem is linked to transpiration in the leaves. Explain the cohesion-tension theory of water transport. Explain the factors which affect transpiration. 	 Learning activities: questioning on leaf structure (3.3.2) and GCSE knowledge on xylem teacher led explanation of movement of water against gravity due to cohesion-tension theory (using animation) interpret results from potometer experiments exam questions. Skills developed by learning activities: AO1 – development of understanding of cohesion-tension theory and water movement MS 1.3/AO3 – plot graphs and interpret data from graphs relating to water transport 8.4.2.1, 8.4.2.2, 8.4.2.3 and 8.4.2.4 	Past exam paper material: BIOL2 Jan 2013 – Q5 BIOL2 June 2013 – Q8a BIOL2 Jan 2011 – Q8b BIOL2 Jan 2012 – Q8b BIOL2 June 2010 – Q4	filestore.aqa.org.uk/Add itional resources/biology/AQA- <u>7401-7402-TN-</u> <u>TOC.PPTX</u> filestore.aqa.org.uk/Add itional resources/biology/AQA- <u>7401-7402-TN-</u> <u>TOC.PDF</u> nuffieldfoundation.org/p <u>ractical-</u> biology/measuring-rate- water-uptake-plant- shoot-using-potometer saps.org.uk/secondary/t <u>eaching-Additional</u> <u>resources/1274</u> saps.org.uk/secondary/t <u>eaching-Additional</u> <u>resources/770-</u> <u>microscopy-looking-at-</u> xylem-and-specialised- <u>cells</u>

		saps.org.uk/secondary/t eaching-Additional resources/115- potometer-measuring- transpiration-rates cleapss.org.uk
		Rich question:
		How are big trees, like giant redwood trees, able to move water against gravity to the leaves at the top?
 Practical investigation to use potometers to measure how uptake of water is affected by a named environmental variable eg wind speed or light intensity. Microscopy of xylem vessels within carnations/pre-prepared xylem/vascular bundle slides. AT b – record quantitative data eg use a potometer to investigate the effect of a named environmental variable on the rate of transpiration. PS 3.2/MS 3.5/MS 3.6 – process data to calculate 	BIOL2 – Jun 2010 Q4	

rates and calculate rates from
 the slope of a tangent. MS 1.1 – calculate data to an appropriate number of significant figures. MS 1.9 – select (and use) an appropriate statistical test. AO1/PS 4.1 – understand the principles of using and reading values from a potometer.

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the role of the phloem in plants. Explain what is meant by translocation. Explain the mass flow hypothesis as a mechanism for translocation. Recognise correlations and causal relationships. Interpret evidence from tracer and ringing experiments and evaluate the evidence for and against the mass flow hypothesis. 	 Learning activities: provide information about the methodology and the results from ringing and tracer experiments. Ask students to formulate a hypothesis teacher led explanation of translocation of sugars by mass flow ask them to evaluate earlier explanations and reform their explanations of the experimental results, in light of their new learning exam questions. Skills developed by learning activities: AO1 – development of knowledge and understanding of translocation by mass flow PS 1.2/AO2 – apply knowledge of translocation to traces and ringing experiments MS 1.3/AO3 – interpret data from graphs relating to translocation 	Specimen assessment material: A-level Paper 1 (set 1) – Q9 AS Paper 2 (set 1) – Q9	highered.mheducation. com/sites/9834092339/ student_view0/chapter3 8/animation - phloem_loading.html saps.org.uk/secondary/t eaching-Additional resources/1274 Rich questions: • Explain how ringing and tracer experiments prove the mass flow hypothesis through the phloem. • What causes translocation by mass flow?

 AO3 – evaluate scientific evidence in supporting scientific ideas 	
Scientine lueas.	

3.4 Genetic information, variation and relationships between organisms.

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by the terms chromosome and gene. Compare and contrast DNA in eukaryotes with that in prokaryotes, mitochondria and chloroplasts. Explain what a gene could code for. 	 Learning activities: questioning from GCSE about the meaning of key terms like gene, chromosome and allele use animation to show scale of chromosomes in eukaryotic cells and how chromosomes are made of DNA and histones. Introduce the concept of a gene teacher explanation about the difference between the arrangement of DNA in prokaryotic cells and eukaryotic cells students generate a summary table comparing and contrasting prokaryotic and eukaryotic DNA. Skills developed by learning activities: 		yourgenome.org/teache rs/zoom.shtml Rich question: A textbook stated that "The bacterial chromosome is found in the cytoplasm of the cell". Evaluate this statement.

3.4.1 DNA, genes and chromosomes.

 MS 0.2 – students can be introduced to base pairs/kilobase pairs as a measuring of length when discussing the loci of a gene on a chromosome and convert this from standard to ordinary form AO1 – development of knowledge and understanding of the arrangement of DNA in eukaryotes and prokaryotes and the relationship between DNA, genes and chromosomes. 	
Ask students to compare the structure of prokaryotic cells with mitochondria and chloroplasts, identify similarities and suggest a theory.	

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Explain how the DNA base sequence is able to code for the primary structure of a polypeptide. Explain the terms degenerate, universal and non- overlapping. Explain why much of eukaryotic DNA can be considered as non-coding. Explain what is meant by an intron and an exon. 	 Learning activities: remind students that there are 20 amino acids and only 4 bases. Ask how many bases would have to code for an amino acid to give sufficient combinations teacher explanation of the triplet code and the fact that there is degeneracy (as well as the fact it is universal and non-overlapping) ask the rich question: how many bases code for a polypeptide of 24 amino acids explain why the answer might in fact be more than 72 as there are introns in the gene. Introduce the idea of introns and also non-coding regions between genes exam questions. 	Past exam paper material: BIOL2 June 12 Q5b BIOL2 June 2011 – Q3a BIOL2 Jan 2010 – Q3	 yourgenome.org/teache rs/dnaprotein.shtml Rich questions: What is meant by the terms: degenerate? non-overlapping? universal? A polypeptide is made of 24 amino acids. What is the minimum number of bases that the gene coding for it must have had?
	 Skills developed by learning activities: MS 0.3 – students could calculate the percentage of human DNA which does code 		

for polypentides when	
supplied with data about the	
Supplied with data about the	
number of coding bases and	
the total number of bases	
• MS 0.5 – students could work	
out the possible number of	
combinations that a triplet	
code can have (ie 43) to	
highlight the idea of	
degeneracy	
 AO1 – development of 	
knowledge and understanding	
of the triplet code and non-	
coding sections of it.	
-	

3.4.2 Protein synthesis.

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Explain what the terms genome and proteome mean. Describe the structure of mRNA and how it is related to its function (link to 3.1.5.1). Explain the process of transcription in prokaryotes. Explain the process of transcription and splicing in eukaryotes, linking this to knowledge of introns. Interpret data from experimental work investigating the role of nucleic acids. 	 Learning activities: questioning to recap knowledge about the role of DNA and RNA from section 3.1.5 provide students with data from experimental work investigating the role of nucleic acids eg the Hershey- Chase experiment and ask them to interpret this introduce concept of genome and proteome teacher explanation of the process of transcription and how the structure of mRNA relates to its function of transferring the code to the ribosomes. Use animation to support this. Skills developed by learning activities: PS 1.2 - apply knowledge of transcription and puoloin acide 	Past exam paper material: BIOL5 June 2010 – Q2 BIOL5 June 2011 – Q1.	 yourgenome.org/teache rs/dnaprotein.shtml Rich questions: What are the advantages of mRNA being used to carry the genetic code to the ribosomes, rather than DNA? Explain how mRNA is adapted to its function. What is the difference between mRNA and pre- mRNA? Provide students with a DNA code, identify the sense strand and ask students to transcribe it

to explain experimental data	(assuming there are
from investigations into the	no introns).
role of nucleic acids	
 AO1 – development of 	
knowledge around	
transcription and the structure	
and role of mRNA	
AO2 – application of	
knowledge to transcribe a	
DNA sequence into mRNA.	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the process of translation. Explain the specific roles of ribosomes, ATP and tRNA in translation. Describe the structure of tRNA and how it is related to its function. Relate the base sequence of nucleic acids to the amino acid sequence of polypeptides, when provided with suitable data about the genetic code. 	 Learning activities: questioning to recap knowledge about transcription, the role of ribosomes from section 3.2.1 and ATP from section 3.1.6 teacher explanation of the process of translation and how the structure of tRNA relates to its function in delivering the specific amino acid. Use animation to support this exam questions. Skills developed by learning activities: AO1 – development of knowledge around translation and the structure and role of tRNA AO2 – application of knowledge to translate a mRNA sequence into a sequence of amino acids. 	Specimen assessment material: A-level Paper 1 (set 1) – Q11.1 Past exam paper material: BIOL5 June 2012 – Q1 (except Q1cii and 1d)	 yourgenome.org/teache rs/dnaprotein.shtml Rich questions: Evaluate the statement "DNA is a triplet code which instructs the ribosomes how to make amino acids". Explain how the structure of tRNA is adapted for its function. Provide students with an mRNA code and ask them to translate it into an amino acid sequence (when provided with appropriate information).

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what a gene mutation is and how it arises. Explain what is meant by a deletion and substitution mutation and the 	 Learning activities: teacher led explanation of how gene mutations arise and mutagenic agents which can increase the risk students work through the 	Specimen assessment material: AS Paper 2 (set 2) – Q3	<u>cell-cell-cell.com/wp-</u> <u>content/uploads/CCC</u> <u>Activity_CrackTheCodo</u> <u>n_v01.doc</u> Rich questions:
 potential potential consequences of each (linked to primary protein structure). Interpret base sequences to identify gene mutations and their impact. Describe what a mutagenic agent is and identify some possible mutagenic agents. 	transcription and translation activity (linked in Additional resources). Then ask them to repeat the activity twice more but this time putting in a substitution mutation for one and a deletion mutation for another. Compare effects of the two mutations to the original amino acid sequence. Ask students to relate these effects to their knowledge of protein structure • teacher explanation of the effects of substitution and deletion mutations and also the possible neutral effects of substitution due to degeneracy. • exam questions.	Past exam paper material: BIOL2 Jan 2013 – Q6a–6 BIOL2 June 2013 – Q7b–7c BIOL2 Jan 2012 – Q4 BIOL2 June 2011 – Q3b BIOL2 June 2010 – Q3	 Evaluate this statement: "Sunbathing exposes your body to UV light which causes mutations to occur". Which type of gene mutation is likely to be the most damaging and why? A student wrote that UV light increased the likelihood of mutations in the protein that the cell made. Why is this not correct?

3.4.3 Genetic diversity can arise as a result of mutation or during meiosis

Skills developed by learning activities:	
 AO1 – development of knowledge around gene mutations and their possible consequences AO2 – application of knowledge of mutation to a model of protein synthesis model to suggest possible effects of gene mutation on the structure of the protein 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the different outcome of mitosis and meiosis. Explain how meiosis results in variation. Complete diagrams showing the chromosome content of cells after the first and second meiotic division, when given the chromosome content of the parent cell. Recognise where meiosis occurs when given information about an unfamiliar life cycle. Explain how 	 Learning activities: introduce the convention of 2n and n. Students then calculate the number of possible chromosome combinations (without crossing over) think, pair, share: there is more variation possible than our calculated number – where does the extra variation come from? teacher explanation of the process of meiosis, supported by animations and videos students compare and contrast mitosis and meiosis students interpret information about unfamiliar life cycles to identify where meiosis and mitosis are occurring. 	Specimen assessment material: A-level Paper 1 (set 1) – Q10; AS Paper 1 (set 1) – Q3. Past exam paper material: BIOL2 June 2013 – Q1; BIOL2 June 2010 – Q5.	nuffieldfoundation.org/p ractical- biology/preparing- anther-squash cleapss.org.uk highered.mheducation. com/sites/0072495855/ student_view0/chapter3 /animation_how_meio sis_works.html highered.mheducation. com/sites/0072495855/ student_view0/chapter2 /animation_compariso n_of_meiosis_and_mito sis_quiz_1html sumanasinc.com/webc ontent/animations/conte nt/meiosis.html
random fertilisation of haploid gametes further increases genetic variation within a species.	activities: • MS 0.5 – use the expression 2n to calculate the possible number of different combinations of chromosomes		Compare and contrast the similarities and differences between mitosis and meiosis.

 MS 0.5 – derive a formula from this to calculate the possible number of different combinations of chromosomes following random fertilisation 8.4.2.1 and 8.4.2.2 AO1 – development of knowledge of meiosis AO2 – application of knowledge to unknown life cycles. 	
Observe meiosis in prepared or produced slides of suitable plant or animal tissue and produce suitable drawing.	

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Explain what a non- disjunction event is and how it occurs. Compare and contrast gene and chromosomal mutations. 	 Learning activities: questioning to recall the principles and events of meiosis teacher explanation of non-disjunction as a mechanism of chromosomal mutations (supported by animation) and how these differ from gene mutations provide data about the likelihood of non-disjunction and how it increases with age. They could draw conclusions and work out the percentage of cells which do not undergo meiosis correctly exam questions. 		sumanasinc.com/webc ontent/animations/conte nt/mistakesmeiosis/mist akesmeiosis.swf
	 Skills developed by learning activities: MS 0.3 – students could calculate the fraction or percentage of cells in which non-disjunction occurs for different ages, when supplied with appropriate data 		

	AO1 – development of knowledge and understanding of non-disjunction events during meiosis leading to	
Explain the possible consequences of a non-disjunction event in animals and plants.	Students could use the internet/ highlighting sheets to briefly research non-disjunction events in humans eg Down's syndrome, Turner's syndrome, (Not required knowledge but adds context to the specification content).	

3.4.4 Genetic diversity and adaptation

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by genetic diversity and allele frequency. Explain the concept of reproductive success. Explain the principles of natural selection and how selection and adaptation are major factors in evolution and contributing to species diversity. Apply knowledge to unfamiliar information to explain how selection produces changes within a population of a species. 	 Learning activities: teacher explanation of the concept of allele frequency and reproductive success students model natural selection using one of the activities/models (see Additional resources) eg different paperclips to pick up seeds representing Darwin's finches and natural selection on different islands ask students what each part of the model represented and relate to real life context eg Darwin's finches extend teacher explanation to explore how adaptation and natural selectors in evolution and also ensure a diversity of species generate a model answer as a class exam questions. 	Past exam paper material: BIOL2 Jan 2011 – Q4 BIOL2 Jan 2011 – Q9a – 9d BIOL2 June 2011 – Q2	Rich question: How would selective breeding of animals and plants by humans affect genetic diversity? bbsrc.ac.uk/web/FILES/ Additional resources/natural_selec tion_teachers.pdf nuffieldfoundation.org/p ractical-biology/model- natural-selection- %E2%80%93- spaghetti-worms nuffieldfoundation.org/p ractical-biology/simple- model-natural- selection#node-3217

Skills developed by learning activities:	
 AO1 – development of knowledge around natural selection and adaptation, the principles involved in selection and how this is linked to evolution AO2 – application of knowledge to explain the evolution of a species in an unknown context (using the information provided). 	

Knowledge, understanding and s ills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by directional and stabilising selection. Identify types of selection from distribution curves. Interpret data relating to the effect of selection in producing change within populations. Apply knowledge of types of selection to explain antibiotic resistance and human birth weights. 	 Learning activities: ask rich question as a stimulus and gauge student responses introduce the concept of directional and stabilising selection with examples. Link this to the distribution curves for populations subjected each card sort – give further examples (eg Australian snakes with big heads being able to eat the poisonous Cane toad, resulting in death of those with large heads; fossilised ferns showing little difference to modern day ferns) and ask them whether each indicates stabilising or directional selection revisit rich question to reassess responses exam questions. 	Past exam paper material: BIOL2 June 2012 Q2 BIOL2 Jan 2011 – Q6 BIOL2 June 2009 – Q3 (except 3b) BIOL2 Jan 2012 – Q5 (except 5c)	Rich question: Fossils indicate that crocodiles and sharks have remained relatively unchanged for millions of years. Does this indicate that they are no longer subject to natural selection?

 AO3/MS 1.3 – interpret data from graphs showing selection AO1 – development of knowledge around and understanding of directional and stabilising selection AO2 – application of knowledge to explain changes/lack of changes in the distribution curves/features of a population. 	
---	--

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Explain the basis of working aseptically and the standard techniques for doing so. Apply knowledge of types of selection to explain antibiotic resistance. 	 Learning activities: train students in aseptic techniques and standard procedures eg aseptic transfer and producing a bacterial lawn carry out the method to investigate the effect of antimicrobial substances measure zones of clearing/measure turbidity of broth interpret data and draw conclusions. Skills developed by learning activities: AT c – use laboratory glassware apparatus to perform serial dilutions of bacteria to perform a count 	Students could undertake the HBI6T ISA P from 2012. Past exam paper material: BIOL2 June 2013 – Q5 (except 5aii) BIOL2 June 2010 – Q8	nuffieldfoundation.org/p ractical- biology/investigating- anti-microbial-action nuffieldfoundation.org/p ractical-biology/aseptic- techniques nuffieldfoundation.org/p ractical-biology/making- spread-or- %E2%80%98lawn%E2 %80%99-plate nuffieldfoundation.org/p ractical-biology/making- pour-plate nuffieldfoundation.org/s ites/default/files/files/eff ects-of-antiseptics-on- microbes-87(1).pdf
	 AT I – use microbiological aseptic techniques, including the use of agar plates or broth MS 2.5 – students could use a logarithmic scale when dealing with data relating to 		<u>pactena/apout</u> <u>cleapss.org.uk</u>

 large numbers of bacteria in a culture MS 1.3 – present data in tables and graphs MS 1.9 – students could select and use an appropriate statistical test to find the significance of differences in the effect of different antimicrobial substances on microbial PS 4.1/AO1 – understand the reasons for working aseptically AO3 – make judgements and reach conclusions 8.4.2.1, 8.4.2.2, 8.4.2.3 and 8.4.2.4 	
Carry out HBI6T ISA P12 exam paper (even if spices have not been used as the antimicrobial substance).	

3.4.5 Species and taxonomy.

Knowledge, understanding and s tills	Implementation	Evaluation and assessment	Additional resources
 Explain what a species is. Appreciate the difficulties in defining the term species. Explain the role of courtship and why it is necessary. Interpret information and data relating to courtship displays. 	 Learning activities: tacher explanation defining what a species is show videos from the internet showing different animal courtship behaviour eg Wilson's bird of paradise teacher explanation of the roles that courtship displays can play, with particular emphasis on species recognition ask students to come up with a list of potential courtship behaviours, in pairs discuss the principle of behaviour patterns and work through some examples eg the Mallard duck provide students with exam questions on courtship and ask them to work through them, applying their knowledge and interpreting data. 	Past exam paper material: BIOL2 June 2009 – Q7 BIOL2 June 2012 – Q6b BIOL2 June 2013 – Q9 BIOL2 Jan 2010 – Q10 (except 10f) BIOL2 Specimen paper Q8	 Rich questions: Define what a species is. What is the difficulty in applying this definition to species such as bacteria? If a mutation were to affect the ability of a group of individuals to perform elements of a courtship display correctly, suggest what this would mean for them and why it might be significant in terms of speciation?

Skills developed by learning activities:	
 AO1 – development of knowledge and understanding of what a species is and the importance of courtship behaviours AO2/AO3 – application of knowledge to interpret information and data about courtship behaviours. 	

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain the hierarchical taxonomic ranks used in the classification of species. Interpret phylogenetic trees. Apply knowledge to identify different taxonomic ranks from information provided. Appreciate the difficulties in constructing valid 	Learning activities: • provide students with some pictures eg CD covers and ask them to group them into groups, becoming ever smaller until they reach CD level. Each group is likely to classify in a different way, underlining the difficulty of constructing a valid phylogenetic classification. This could also be done using a selection of nails, screws, paperclips, hair pins, drawing pins etc	Specimen assessment material: A-level Paper 1 (set 1) – Q6 AS Paper 1 (set 1) – Q5 Past exam paper material: BIOL2 June 2009 – Q6a–6c BIOL2 Jan 2012 – Q3 BIOL2 Jan 2010 – Q2	Rich questions: Provide information about the classification of different organisms and ask students to fill in the gaps eg determining the genus from the binomial name.

	1		
phylogenetic classifications.	 introduce hierarchical system used for classification of organisms. Relate to their CD classification students develop mnemonics to remember hierarchical taxonomic ranks provide pictures of organisms and ask them to repeat classification exercise discuss difficulties in constructing phylogenetic classifications based on external features eg fish and dolphins are very different, why anatomical and physiological features are better to use and why modern day classification is still being refined 	Exampro BYA4 June 2005 – Q5	
	 exam questions. Skills developed by learning activities: AO1 – development of knowledge and understanding of classification AO2 – application of knowledge to the context of particular species, based on binomial name, to identify genus and species. 		

Students could research and investigate comparative anatomy and embryology.		
---	--	--

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain how the results of genetic sequencing and immunological analysis can help us to update our understanding of evolutionary relationships. NB details of methods for sequencing are not required. Interpret results from genetic and immunological analysis, to draw valid conclusions as to evolutionary relationships between organisms. 	 Learning activities: show students a phylogenetic tree and ask them questions requiring them to interpret relationships and discuss common ancestors explain how changes in evolutionary features must have been mirrored by changes in proteins and therefore in DNA explain how DNA sequencing and immunological analysis can be used to determine how closely related organisms are. Link to the idea that this is refining our idea on classification and leading to reclassification of some species provide data from these experiments and ask students to interpret them. 	Past exam paper material: BIOL2 Jan 2012 – Q6 BIOL2 June 2011 – Q7	 Rich questions: Explain why determining the similarity of DNA sequences for common genes is a valid way of determining evolutionary relationships. Explain why immunological comparisons are a valid way of determining evolutionary relationships. Explain why these techniques allow us to classify more accurately than comparing

Skills developed by learning activities:	anatomical features.
 AO1 – development of knowledge and understanding of how the results genomic sequencing and immunological techniques can be used to refine our understanding of evolutionary relationships AO2/AO3 – application of knowledge to interpret data and draw conclusions on evolutionary relationships. 	

3.4.6 Biodiversity within a community

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain what is meant by the terms biodiversity, species richness and index of diversity. Calculate the index of diversity when supplied with relevant information. Interpret information and draw conclusions from the index of diversity for different habitats. Explain how farming techniques impact on biodiversity and the reason why these techniques are used Evaluate conservation techniques and why these must be 	 Learning activities: teacher led explanation of the concepts of biodiversity, species richness and the index of diversity worked examples of how to calculate the index of diversity students could then research farming methods and suggest what the impact of these methods is teacher led discussion of examples of conservation where a balance has been struck exam questions. Skills developed by learning activities: MS 1.5/MS 2.3 – students could be given data from random sampling, from which to calculate an index of diversity and interpret the 	Specimen assessment material: A-level Paper 1 (set 1) – Q3 AS Paper 2 (set 1) – Q6 AS Paper 2 (set 1) – Q7 Past exam paper material: BIOL2 Jan 2013 – Q7 BIOL2 June 2012 – Q7 BIOL2 June 2012 – Q7 BIOL2 June 2011 – Q5 BIOL2 June 2011 – Q8 BIOL2 June 2011 – Q8	 Rich questions: Define what we mean by the terms: biodiversity; species richness; and index of diversity. Why is the index of diversity a more useful measure than counting the number of species in an area? Explain some of the ways in which farming causes a reduction in biodiversity. Biological Sciences Review, November 2007. Tropical rainforests: conservation or preservation.

balanced with farming.	 significance of the calculated value of the index AO1 – development of knowledge and understanding of biodiversity and the impact of farming AO2 – application of knowledge to the context of question to calculate correctly the index of diversity. 	

3.4.7 Investigating diversity

Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
 Explain how the results of DNA hybridisation and biochemical analysis can be used to suggest relationships between different organisms within/between species. Interpret data obtained from DNA hybridisation or biochemical analysis. Explain how gene technology has changed the way in which relationships 	 Learning activities: teacher explanation about the methods for assessing genetic diversity and how this can be applied to allow revision of the classification system and how some organisms relate to each other work through some data analysis exercises together to assess genetic diversity and the relationships between organisms exam questions. Skills developed by learning activities:	Past exam paper material: BIOL2 Jan 2013 – Q3 BIOL2 June 2012 – Q6 (except 6c) BIOL2 Jan 2011 – Q3 BIOL2 June 2013 – Q1 BIOL2 June 2009 – Q8d BIOL2 June 2011 – Q7 BIOL2 June 2010 – Q6 BIOL2 Jan 2010 – Q10f	hhmi.org/biointeractive/ creating-phylogenetic- trees-dna-sequences
 between organisms are worked out. Evaluate direct DNA/protein sequencing against methods of measuring the 	MS 1.3 – Interpret tabular data relating to amino acid sequences or DNA hybridisation of different organisms and draw conclusions about the evolutionary relationships between the organisms.		

frequency of characteristics.			
NB Details of methods of, for example, DNA hybridisation, are not required.			
Knowledge, understanding and skills	Implementation	Evaluation and assessment	Additional resources
--	---	---	--
 Understanding and \$kills Explain how random samples can be obtained. Explain what standard deviation is and how it is calculated. Represent raw and processed data clearly using tables and graphs. Interpret data in terms of means and the overlap of standard deviation bars. Apply knowledge of, to draw and explain conclusions. Evaluate the quality of results and reliability of conclusions. 	Implementation Learning activities: Students conduct a quantitative investigation into variation eg the effect of light intensity on leaf size. This should include: • research into methods • designing a practical • carrying out (subject to teacher approval) • processing and presentation of data • evaluation and explanation findings • 2011 ISA Paper BIO3T Q. Skills developed by learning activities: • AT k: • design methods to ensure random sampling • carry out sampling at	assessment BIO3T ISA Q11 Past exam paper material: BIOL2 Jan 2013 – Q4 BIOL2 Jan 2012 – Q7 BIOL4 June 2010 – Q7a	Additional resources <u>cleapss.org.uk</u> <u>nuffieldfoundation.org/p</u> <u>ractical-</u> <u>biology/recording-</u> <u>variation-ivy-leaves</u>
	random within a single population		

 use sampling at random to investigate the effect of aspect on leaf growth. PS 4.1 – understand how to use sampling techniques PS3.2, MS 1.2, MS 1.6, M.S 1.10 – calculate and interpret mean values and the standard deviation around the mean 8.4.2.1, 8.4.2.2 and 8.4.2.4 AO2 – apply knowledge in a practical context 	
AO3 – analyse, interpret and evaluate scientific information and evidence to make judgements and reach conclusions and design/refine practical design and procedures.	