Scheme of Work 2020-2021
Subject: Biology

Year Group: 12 Autumn term 1
Specification: AQA

Lesson No	Topic & Objectives	Big Question – What will students learn?	Key Activities & Specialist Terminology (Do Now Task / Starter/Tasks/Plenary	Planned Assessment	Homework or flipped learning resources DODDLE resources	Lit Num SMSC Codes
1	**3.1.1 Biological molecules** Monomers are the smaller units from which larger molecules are made. Polymers are molecules made from a large number of monomers joined together. Monosaccharides, amino acids and nucleotides are	• 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.	Summary questions	**Rich questions:** • During which process/group of processes are polymers hydrolysed in the body into monomers? • What catalyses hydrolysis in the body? **Flipped learning activity** Complete the blendspace prep notes on proteins https://www.blendspace.com/lessons/ei7PHtqvo8ZTig/ama-aqa-biology-year-1-1-6-proteins And section 1.5 of your revision homework booklet.	C1, Sp3,C3

	examples of monomers. A condensation reaction joins two molecules together with the formation of a chemical bond and involves the elimination of a molecule of water. A hydrolysis reaction breaks a chemical bond between two molecules and involves the use of a water molecule					
2	Monosaccharides, including glucose, galactose and fructose, are monomers	• Identify common monosaccharides. • Describe the monosaccharides from which lactose, maltose and sucrose are made. • Explain what is meant by a glycosidic bond	**Learning activities:** • introduce monosaccharides, with examples • molymod modelling from structural formulas • link models to model condensation • introduce disaccharides and polysaccharides.	**Past exam paper materials:** BIOL1 Jan 2013 Q3a **Exampro:**	<u>Flipped learning opportunities</u> **Rich questions:** • If a glucose and a fructose (both with the formula C6H12O6) joined	C1, Sp3,C3

	from which larger carbohydrates are made. Condensation reactions produce disaccharides through the formation of glycosidic bonds. These include maltose, sucrose and lactose. Glycogen and starch are polysaccharides formed by condensation of α-glucose.	and how they form through condensation. • Describe how polymerisation of α-glucose can form starch or glycogen.	**Skills developed by learning activities:** AO1 **–** Demonstration of knowledge of scientific ideas.	BYB1 Jan 2007 Q1 BYA1 Jan 2004 Q1 BYB1 Jan 2005 Q2 BYA1 Jun 2008 Q1	together in a condensation reaction, what would be the disaccharide which formed and what would its molecular formula be? Students to draw the structure of the disaccharide PiXL Independence: Biology – Student Booklet KS5 - Biological molecules	
3	Identify the biochemical tests for reducing sugars, non-reducing sugars and starch.	• 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	**Past exam paper materials:** BIOL1 – June 2011 Q1a and 1b **Exampro:** BYB1 Jan 2004 Q4	cleapss.org.uk mrothery.co.uk/module1/Mod%201%20techniques.htm Students to plan investigation to test a named food for reducing sugar and non-reducing sugar.	Sp7,Sp2

			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. 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 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.			
4	Glucose has two isomers, α-glucose and β–glucose. Polysaccharides are formed by the condensation of many glucose units. • Glycogen and starch are formed by the condensation of α-glucose. • Cellulose is formed by the condensation of β-glucose.	• 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 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 Jun 2012 – 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?	C1, Sp3,C3
5	The emulsion test for lipids.	• 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.	**Past exam paper material:** BIOL1 Jan 2012 – Q1a	cleapss.org.uk brilliantbiologystudent.weebly.com/ethanol-emulsion-test-for-lipids.html	So5,Sp2 M2

			Skills developed by learning 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		**Rich questions:** • Describe how you would conduct an emulsion test for lipids. Is the emulsion test quantitative or qualitative? Explain your answer	
6	Triglycerides and phospholipids are two groups of lipid. Triglycerides are formed by the condensation of one molecule of glycerol and three molecules of fatty acid (RCOOH) through the formation of ester bonds/three ester bonds. The R-group of a fatty acid may be saturated or	• 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?	C1, Sp3,C3

	unsaturated .					
7	The structure of phospholipids and how this structure relates to their properties.	• 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	C1, Sp3,C3
8	The general structure of amino acids and how the only difference between amino acids is their side group. The roles played by proteins. The biuret test for proteins.	• 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	C1, Sp3,C3

			AO3 – interpret evidence to make judgements and reach conclusions from Biuret test			
9	Separating biological compounds using thin layer/paper chromatography.	• 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 • 8.4.2.1, 8.4.2.2 and 8.4.2.3 and 8.4.2.4 AO1 – demonstration of knowledge of scientific idea/technique.	**Past exam paper questions:** HBIO1 – Jan 2009 – Q3	cleapss.org.uk biotopics.co.uk/as/amino_acid_chromatography.html **Rich question:** Explain the basis by which chromatography is able to separate different amino acids.	So5,Sp2 M2
10	The formation of dipeptides and polypeptides through condensation of amino acids. The relationship between primary, secondary, tertiary and	• 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	**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.	**Specimen assessment material:** A-level Paper 1 (Set 1) – Q11.2	bcconline.com/biol10rs/Pearson-Animations/protein_structure.swf rasmol.org amazon.co.uk/Tangle-Original-Jr-Toy/dp/B0012GQU2I **Rich question:** • show some bonds between functional groups covered so	C1, Sp3,C3

	quaternary structure and protein function. The role of hydrogen bonds, ionic bonds and disulfide bridges in the structure of proteins	throughout the specification).	**Skills developed by learning activities:** • AT l – use RASMOL (ICT) to computer model protein structure • AO1 and AO2 – demonstration and application of knowledge of scientific idea extended exam/essay answers.		far and ask students to identify them as ester, peptide or glycosidic provide the structures of two amino acids and ask students to draw the structure of the dipeptide which would result from condensation.	
11	Enzyme catalysis and activation energy. The induced-fit model of enzyme action. Enzyme specificity linked to active site structure.	• 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 activation energy and the strength of enzyme catalysis models.	**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. **Flipped learning activity** Make prep notes on enzymes 1.7 – 1.9	So5,Sp2 M2

					https://www.blendspace.com/lessons/YPYvIwhPLfUIPQ/ama-aqa-biology-year-1-1-7-1-9-enzymes	
12	The properties of an enzyme relate to the tertiary structure of its active site in the formation of an enzyme-substrate complex. The effects of the following factors on the rate of enzyme-controlled reactions – enzyme concentration, substrate concentration, concentration of competitive and of non-competitive inhibitors, pH and	• 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 l – 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 • 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	**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 BIO3X 2011 EMPA	Students should use the websites provided to research on how the properties of enzymes relate to their functions. cleapss.org.uk nuffieldfoundation.org/practical-biology/investigating-enzyme-controlled-reaction-catalase-and-hydrogen-peroxide-concentrat nuffieldfoundation.org/practical-biology/investigating-effect-ph-amylase-activity nuffieldfoundation.org/practical-biology/investigating-effect-concentration-activity-trypsin saps.org.uk/attachments/article/95/SAPS%20-%20Inhibitors%20on%20enzyme%20beta-galactosidase%20-	C1, Sp3,C3

	temperature. Calculate rate. NB Whilst covering the theory of all variables which affect enzyme-controlled reactions, conduct one of the suggested practicals or ISAs as a full investigation in the next section.				%20Scottish%20Highers.pdf	

13	**Required practical 1 –**
	Investigation into the effect of a named variable on the rate of an enzyme-controlled reaction.
	Could include:
	• design a valid experim
		• 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.
			
			Skills developed by learning activities:
			• AT a/AT l – 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
				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
					cleapss.org.uk
					
					nuffieldfoundation.org/practical-biology/investigating-enzyme-controlled-reaction-catalase-and-hydrogen-peroxide-concentrat
					
					nuffieldfoundation.org/practical-biology/investigating-effect-ph-amylase-activity
					
					nuffieldfoundation.org/practical-
						Sp7,Sp2

	ent, using the work of others as a starting point, to investigate and solve a problem in a scientific context • identify variables including those that must be controlled • calculate initial rate • plot and interpret graphs evaluate findings to draw meaningful conclusions		• PS 2.4 – identify key variables which influence enzyme-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 continuous variable (eg pH, 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 practical design.		biology/investigating-effect-concentration-activity-trypsin nuffieldfoundation.org/practical-biology/quantitative-food-test-protein-content-powdered-milk **Rich question:** Evaluate the statements: • "temperature denatures enzymes" "acidic and alkaline pHs denature enzymes".	
14	Deoxyribonucleic acid is important in all living	• Explain the significance of DNA to organisms. • Describe the structure of DNA and identify	**Learning activities:** • extract DNA from frozen peas as a stimulus	**Past exam paper material:**	Use the resources provided to research on the topic before the lesson.	C1, Sp3,C3

3.1.5 Nucleic acids are important information-carrying molecules	cells, as it carries genetic information. DNA is a polymer of nucleotides formed by condensation, with phosphodiester bonds between nucleotides. Each nucleotide is formed from a deoxyribose, a nitrogen-containing organic base and a phosphate group. DNA is a double helix with two polynucleotide chains, held together by hydrogen bonds between complementary bases.	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.	• 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 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.	BIOL2 June 2012 – Q5a BIOL2 June 2009 – Q2	yourgenome.org/teachers/yummy.shtml yourgenome.org/teachers/origami.shtml yourgenome.org/teachers/zoom.shtml cell-cell-cell.com/wp-content/uploads/CCC_Activity_ModellingTheHelix_v01.doc	

15	Ribonucleic acid is important in all living cells, as it transfers genetic information from DNA to ribosomes. RNA is a polymer of nucleotides formed by condensation, with phosphodiester bonds between nucleotides. Each nucleotide is formed from a ribose, a nitrogen-containing organic base and a phosphate group. An RNA molecule is a relatively short polynucleotide chain.	• 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:** • AO1 – development of knowledge and understanding AO2/AO3 – interpreting DNA sequence and applying knowledge to work out complementary mRNA code.	**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?	C1, Sp3,C3

	Ribosomes are made of RNA and proteins.					
16	The semi-conservative replication of DNA ensures genetic continuity between generations of cells. The process of semi-conservative replication of DNA, including the role of helicase and DNA polymerase	• 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 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.	**Past exam paper material:** BIOL2 Jan 2013 – Q8a BIOL2 June 2013 – 4a–4b	sumanasinc.com/webcontent/animations/content/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?	C1, Sp3,C3
17	A single molecule of ATP is a nucleotide derivative, formed from a molecule	• Describe the structure of ATP. • Explain the role of enzymes in hydrolysing and synthesising ATP. Explain the significance of ATP in numerous	**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:**	**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	C1, Sp3,C3

	of ribose, a molecule of adenine and three phosphate groups. Hydrolysis of ATP to ADP and P_i is catalysed by the enzyme ATP hydrolase and can be used to phosphorylate compounds often making them more reactive, or provide energy to energy-requiring cellular reactions. ATP is resynthesised from ADP and P_i by the enzyme ATP synthase, during photosynthe	processes within organisms, as a supplier of energy or phosphate	• AO1 – development of knowledge and understanding of scientific ideas and processes extended exam answers. • 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 reactivity.		makes energy for cellular processes to occur".	

	sis or respiration.					

18	Water is a major component of cells. It has several properties that are important in biology. In particular, water:
	• is a metabolite
	• is a solvent
	• has a high heat capacity
	• has a large latent heat of vaporisation
	has strong cohesion between molecules
		• 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 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
				Past exam paper material:
				BYB1 – June 2008 Q4
					Use the resources provided to research on the topic before the lesson.
					nanosense.sri.com/activities/finefilters/scienceofwater/FF_Lesson2Teacher.pdf
					
					filestore.aqa.org.uk/resources/biology/AQA-7401-7402-WATER.PPTX
					
					filestore.aqa.org.uk/resources/biology/AQA-7401-7402-TN-WATER.PDF
						C1, Sp3,C3

			understanding about properties of water related to their significance to life AO3 – interpreting activity circus and drawing conclusions.			

19	Inorganic ions occur in solution in the cytoplasm and body fluids of organisms, some in high concentrations and others in very low concentrations.
	
	Each type of ion has a specific role, depending on its properties.
	
	Students should be able to recognise the role of ions in the following topics: hydrogen ions and pH; iron ions as a
		• 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 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:
			AO1 and AO2 **–** development and application of knowledge and understanding about inorganic ions, their properties and their roles.
					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/resources/biology/AQA-7401-7402-INORGANIC-IONS.PPTX
					filestore.aqa.org.uk/resources/biology/AQA-7401-7402-TN-INORGANIC-IONS.PDF
						C1, Sp3,C3

	component of haemoglobin; sodium ions in the co-transport of glucose and amino acids; and phosphate ions as components of DNA and of ATP					
20 **3.2.1 Cell structure**	The structure of eukaryotic cells	• 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 • 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	**Summary questions**	**Flipped learning opportunities** Cells checklist cell-cell-cell.com/resources/activities learn.genetics.utah.edu/content/cells/insideacell vcell.ndsu.nodak.edu/animations/flythrough/movie-flash.htm bigpictureeducation.com/cell **Rich question:** Evaluate the statement “Mitochondria produce	C1, Sp3,C3

			to represent the final, converted dimensions in standard form • exam questions. **Skills developed by learning activities:** • MS 0.1 – convert between units eg mm and µm • 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		energy during respiration". **Flipped learning opportunity** PiXL Independence: Biology – Student Booklet KS5 - Cells	
21	Eukaryotic cells have adaptations to their function	• 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. **Skills developed by learning activities:**	**Past exam paper material:** BIOL1 Jan 2012 – Q3 BIOL2 June 2011 – Q1 BIOL2 Jan 2010 – Q1	bigpictureeducation.com/annotated-cells-images cellsalive.com/gallery.htm 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.	C1, Sp3,C3

			AT d/AT e – use optical microscopes to observe and draw pre-prepared microscope slides of specialised eukaryotic cells.			
12	The structure of prokaryotic cells, including the differences between prokaryotic and eukaryotic cells and the additional features of the cell which may be present.	• 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. • 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	**Past exam paper material:** BIOL1 Jan 2009 Q7a. **Exampro:** BYB1 June 2006 Q1b	cellsalive.com/cells/bactcell.htm **Rich question:** Compare and contrast prokaryotic and eukaryotic cells.	C1, Sp3,C3
23	The structure of virus particles to include	• Describe the structure of virus particles. • Describe the role of the capsid and attachment protein.	**Learning activities:** • teacher introduction to virus particles and their structure	Summary questions	**Rich question:** Why are viruses described as particles rather than cells?	So5,Sp2 M2

	genetic material, capsid and attachment protein	Relate the structure of a virus to its replication within cells.	• 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 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			
24	The principles and limitations of optical microscopes, transmission electron microscopes and scanning electron microscopes. The difference between magnificatio	• 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	**Past exam paper material:** BIOL1 June 2012 – Q1 BIOL 1 Jan 2009 – Q7b	bigpictureeducation.com/video-electron-microscopy bigpictureeducation.com/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	C1, Sp3,C3

	n and resolution.		• students could write an essay comparing and contrasting light and electron microscopes or do exam questions. **Skills developed by learning activities:** • extended exam answers • MS 0.2 – understand and convert numbers from standard to ordinary form when applied to magnification • MS 0.5 – use calculators to find and use the power functions when looking at magnification • MS 1.9 – students could select and use an appropriate statistical test to find the significance of different mean numbers of a particular organelle (eg mitochondria or chloroplasts) in different types of cells AO1 – development of knowledge and understanding of microscopy techniques.		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 discovered much earlier.	
25	Measuring the size of an object viewed with an optical microscope and calculation of magnification	• 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	Use the resourc3s provided to explain the use of an eyepiece graticule. Calculate the actual size of cells based on measured size and magnification snabonline.com/Content/SkillsSupport/PracticalSupport/P0_09S.pdf	So5,Sp2 M2

			Skills developed by learning activities: • MS 0.1 – convert between units eg mm and µm • MS 1.8/MS 2.2 – use and manipulate the magnification formula • AT d, e and f – use iodine in potassium iodide solution to identify starch grains in plant cells under a microscope • AO1 – knowledge of the procedure of using a micrometer and graticule AO2 – application of knowledge to data given to calculate magnification, object size or image size.			
26	Principles of cell fractionation and ultracentrifugation as used to separate cell components	• 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 pellet and supernatant after centrifugation	**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/webcontent/animations/content/cellfractionation.html accessexcellence.org/RC/VL/GG/cellBreak1.php homepages.gac.edu/~cellab/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?	Sp7,Sp2

			• 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			
27	Not all cells in multicellular organisms retain the ability to divide. The cell cycle involves DNA replication followed by mitosis.	• 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. **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.	**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.htm highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation__how_the_cell_cycle_works.html **Rich questions:** Why would scientists investigating mitosis choose to study bone marrow cells over neurones?	C1, Sp3,C3
28	The behaviour of chromosom	• Recognise the stages of the cell cycle:	**Learning activities:** • teacher explanation of the role of mitosis	A-level Paper 1 (set 1) – Q10.1 and 10.2	cellsalive.com/mitosis.htm	So5,Sp2 M2

	es during interphase and the stages of mitosis. The role of spindle fibres.	interphase, prophase, metaphase, anaphase and telophase (including cytokinesis). • Explain the appearance of cells in each stage of mitosis	• teacher explanation of the stages of mitosis, reinforced with videos and/or animations of the process • card sort using actual pictures of cells at different stages. Ask students to put them in order, name the stage and then explain why it is that stage • get students to interpret the amount of DNA in a cell and link these to different stages of the cell cycle • exam questions. **Skills developed by learning activities:** • AO1 – Knowledge and understanding of stages of mitosis. • AO2/AO3 – Interpretation of images of cells in mitosis and identification of stages. A03 – Application of knowledge to explain scientific data about the amount of DNA within a cell. Students could produce a video podcast summarising mitosis and its role within the larger cell cycle	**Past exam paper material:** BIOL2 June 12 Q4 BIOL2 Jan 2012 – Q2 BIOL2 June 2011 – Q4 **Exampro:** BYA2 Jan 06 Q2	**Rich question:** • Evaluate the statement "Mitosis consists of Interphase, Prophase, Metaphase, Anaphase and Telophase". Provide students with pictures of each stage of mitosis and ask them to describe what the chromosomes are doing and which stage of mitosis the cell is at.	
29	**Required practical 2:** Preparation of stained squashes of cells from plant root tips; set-up and use of an optical microscope to identify the stages of mitosis in these	• 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. **Skills developed by learning activities:**	**Past exam paper material:** Students could undertake the HBI3T ISA P from 2013 **Specimen assessment material:** AS Paper 2 (set 1) – Q1	Research on an investigation to prepare a stained squashes of cells from plant root tips; set-up and use of an optical microscope to identify the stages of mitosis in these stained squashes and calculation of a mitotic index.	Sp7,Sp2

	stained squashes and calculation of a mitotic index. Measurement of cells and calculation of their actual size.		• 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 • 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	**Exampro:** BYA2 Jan 05 Q1 BYA2 Jun 05 Q4	Measurement of cells and calculation of their actual size nuffieldfoundation.org/practical-biology/investigating-mitosis-allium-root-tip-squash cleapss.org.uk	
30	Uncontrolled cell division can lead to the formation of tumours and of cancers. Many cancer treatments are directed at controlling the rate of cell division.	• 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.	**Past exam paper material:** BIOL1 Jan 2013 – Q5 BIOL2 Jan 2013 – Q8b BIOL2 June 2013 – Q4c BIOL2 June 2013 – Q4	yourgenome.org/teachers/roguecells.shtml insidecancer.org	C1, Sp3,C3

			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 its treatment AO2/AO3 – interpretation of exam question data and application of knowledge of the impact of some treatments on mitosis and the cell cycle			
31	Binary fission in prokaryotic cells.	• 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). **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		classzone.com/books/hs/ca/sc/bio_07/animated_biology/bio_ch05_0149_ab_fission.html **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.	C1, Sp3,C3
32	Viruses do not undergo cell division.	• Explain why viruses are not classified as being living organisms.	**Learning activities:** • questioning to recall the structure of a virus	**Specimen assessment material:**	sites.fas.harvard.edu/~biotext/animations/lyticcycle.html	C1, Sp3,C3

	Following injection of their nucleic acid, the infected host cell replicates the virus particles.	• Describe the sequence of events by which viruses replicate. • Explain why viruses are so difficult to treat and develop medicines against. •	• 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	AS Paper 1 (set 1) – Q9	**Rich question:** • why do scientists disagree about whether viruses should be classified as living? why do viruses make you ill?	