The City School

Curriculum Distribution Chart

Class: 9 Sept. ’14 – May ’15

Cambridge O-Level Biology (5090)

Unit 1: Cells and cell processes

Recommended prior knowledge
Since this is a logical place to begin the course, no prior knowledge is essential. Nevertheless, it would be helpful if learners were already familiar with the use of a microscope and with standard, safe laboratory technique. They might also know the basic principles of diagram drawing – sharp HB pencil, drawings as large as can be fitted into the available space (with room for labels, in upper case, in pencil with ruled label lines). A simple understanding of chemical molecules and chemical reactions, the kinetic theory, solutions and pH would also be helpful.

Context
Cells are the building blocks of living organisms and basic physiological processes in which they are involved have relevance throughout the syllabus.

Outline
Structural features common to and different in plant and animal cells are considered. Specific examples show how the basic cell structure may be modified for different functions. The involvement of cells in the processes of diffusion, osmosis and active transport is explained as is the importance and mode of action of enzymes.

Learning objectives		Suggested teaching activities	Learning resources	Week
			5090 past question papers are available at: http://teachers.cie.org.uk	1
1(a)	**Candidates should be able to:** Examine under the microscope an animal cell (e.g. from fresh liver) and a plant cell (e.g. from Elodea, moss, onion epidermis, or any suitable, locally available material), using an appropriate temporary staining technique, such as iodine or methylene blue	Use pre-prepared microscope slides to examine, compare and identify structures in (i) epidermal cells peeled from the inner surface of an onion bulb and stained with iodine solution; (ii) locally available plants with leaves which display mesophyll cells adhering to the peeled-off epidermis in order to show the presence of chloroplasts; (iii) freshwater filamentous algae, Elodea or moss that can be mounted in a drop of water on a slide and viewed under a microscope. A more **challenging** activity is for learners to prepare their own slides of the type described above and to prepare slides of fresh liver cells or human cheek cells stained with methylene blue. Ask learners to compare the structures seen in each of the slides they have prepared.	PowerPoint presentation: Cells and tissues www.biology-resources.com/ Plant and animal cell structure diagrams and explanations: www.s-cool.co.uk/gcse/biology/ Illustrations of cells: www.cellsalive.com/ Cell structure: www.exploratorium.edu/	
1(b)	Draw diagrams to represent observations of the plant and animal cells examined above		Video clip – cell structure: www.bbc.co.uk/learningzone/	
1(c)	Identify from fresh preparations or on diagrams or photomicrographs, the cell membrane, nucleus and cytoplasm in an animal cell	Use slides prepared during practical work above to identify the structures visible. Present learners with diagrams and photomicrographs of a range of cell types to allow them to identify the named structures. A more **challenging** activity is to use diagrams and photomicrographs	**Textbooks:** Jones, M – Unit 1 Cell structure Burton, I J – Topic 1 Cell structure and organisation	

Learning objectives		Suggested teaching activities	Learning resources	Week
		showing these structures within different types of cells with which learners are unfamiliar.	Jones, G & Jones, M – 1 Cells	
1(d)	Identify from diagrams or photomicrographs, the cellulose cell wall, cell membrane, sap vacuole, cytoplasm, nucleus and chloroplasts in a plant cell	Use slides prepared during practical work above to identify the structures visible. Present learners with diagrams and photomicrographs of a range of cell types to allow them to identify the same structures (and those previously not visible). A more **challenging** activity is to use diagrams and photomicrographs showing these structures within different types of cells with which learners are unfamiliar.		2
1(e)	Compare the visible differences in structure of the animal and the plant cells examined	Use the slides prepared and diagrams presented above to construct a table of the similarities and differences between plant and animal cell structure. A more **challenging** activity is for learners to make models of a plant cell and/or an animal cell to gain an idea of the orientation of the main structures. Extend the task by asking learners to consider the limitations of their models in comparison to actual cellular components.		
1(f)	State the function of the cell membrane in controlling the passage of substances into and out of the cell	Explain why the passage of substances must be controlled. Extend the discussion by inviting learners to suggest chemicals that might pass in either direction through the membrane (and some that may not pass through). Extend further by asking learners to suggest reasons why such substances may/may not enter the cell – i.e. reasons that they are needed within the cell or because they might harm the cell.	**5090 5090 past paper question:** Jun 2011 Paper 21 Q8	
1(h)	State, in simple terms, the relationship between cell function and cell structure for the following: absorption – root hair cells conduction and support – xylem vessels transport of oxygen – red blood cells	Provide good diagrams of a root hair cell and of a red blood cell (in surface view and in longitudinal section) for learners to label. Alternatively learners may draw and label one of the specialised cells on A3 paper and present their findings to other learners. A more **challenging** activity is for learners to research a greater range of specialised cells and their functions. Explain the importance of surface area to volume ratios and relate this to the maximum rate and amount of uptake in cells marked*. Understand that xylem vessels are dead and should not be called 'cells'. Their walls are strengthened for support. Since they have no cytoplasm, they are hollow tubes for the conduction of water and mineral ions. Red blood cells are	Adaptations of specialised cells: www.bbc.co.uk/ Red blood cell diagram: www.s-cool.co.uk/assets/ Root hair cell diagram: www.bbc.co.uk/schools/	3

Learning objectives		Suggested teaching activities	Learning resources	Week
		biconcave discs to provide a large surface area for gas exchange and to make the cell flexible enough to pass through small capillaries.		4
1(i)	Identify these cells from preserved material under the microscope, from diagrams and from photomicrographs	Observe prepared slides of root hair cells, xylem vessels and red blood cells under the microscope. Extend this practical work by asking learners to make annotated drawings of a root hair cell and of red blood cells as seen under the microscope. A more **challenging** practical task is for learners to germinate their own seeds (part-fill a specimen tube or glass jar with water and trap a seed between the walls of the tube/jar and a piece of filter paper) and observe the root hairs.	Seed germination apparatus: http://fromdirttodinner.files.wordpress.com/	
1(j)	Differentiate cell, tissue, organ and organ system as illustrated by examples covered in syllabus sections 1–12, 15 and 16	Explain the hierarchy of these structures and invite learners to supply both animal and plant examples of each. Learners can draw a flow diagram from cells to a named organ system to gain an understanding of the complexity of the human body. An outline of the human body can be used to draw in the main organs and organ systems of the body. A more **challenging** activity is to prepare a set of cards - each with the name and/or a diagram of one example of a cell, tissue, organ or system. Learners may classify each card by placing them into groups and then place the groups of cards in order of organisation level.	Hierarchy or organisation: http://lgfl.skoool.co.uk/	

Learning objectives		Suggested teaching activities	Learning resources	Week
2(a)	Define diffusion as the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient	Refer to chemical molecules always being in a state of random motion. Explain the concept of concentration in gases and in liquids and the tendency for molecules to move from where they are more concentrated to where they are less concentrated. Illustrate diffusion with an air freshener placed on one side of the laboratory, with potassium manganate IV solution dropped with a pipette into a large beaker of still water and with ammonia/hydrochloric acid placed at opposite ends of a long glass tube lined with damp indicator paper. Explain that netting drawn across the room would not prevent the diffusion of the molecules of air freshener since the mesh is too large to inhibit their passage. Relate this analogy to the passage of molecules through the cell walls of plants. A more **challenging** practical task is for learners to investigate the effect of surface area/volume ratio on the rate of diffusion by measuring the time taken for alkali agar cubes of different dimension coloured with phenolphthalein indicator to turn colourless when placed in dilute hydrochloric acid.	PowerPoint presentation: Diffusion www.biology-resources.com/biology-CD.html Diffusion animation and explanation: www.bbc.co.uk/schools/ Diffusion practical activities: www.iit.edu/ Agar cube practical instructions: www.practicalbiology.org/ Agar cube practical video: www.youtube.com/ **Textbooks:** Burton, I J – Topic 3 Diffusion and Osmosis (active transport also covered) Jones, G & Jones, M – 2 Diffusion, Osmosis and Active transport Jones, M – Unit 2 Diffusion, Osmosis and Active Transport. **5090 5090 past paper questions:** Nov 2011 Paper 22 Q1 Nov 2010 Paper 22 Q8	5

Learning objectives		Suggested teaching activities	Learning resources	Week
2(b)	Define osmosis as the passage of water molecules from a region of their higher concentration to a region of their lower concentration through a partially permeable membrane	Osmosis should be explained as a special case of diffusion, in which only water molecules are able to move from one side of a partially permeable membrane to another. Ensure that learners understand what a solution is in terms of particles, so that they are able to imagine the water molecules and solute particles behaving independently of each other. Use Visking tubing to demonstrate that it allows water molecules to pass but not sugar (sucrose) molecules. Set up a Visking 'sausage' containing a concentrated sucrose solution, attached to a length of glass tubing at one end and submerged in a beaker of water at the other. Note the rise in the level of sucrose solution. Extend the demonstration by asking learners to draw the distribution of molecules before, during and after and to explain their movement during the demonstration.	**5090 5090 past paper question:** Jun 2011 Paper 61 Q1 Visking tubing demonstration: www.hyss.sg/ Osmosis animation and explanations: www.bbc.co.uk/ www.s-cool.co.uk/	
2(c)	Describe the importance of water potential gradient in the uptake of water by plants and the effects of osmosis on plant and animal tissues	Relate uptake of water into cells with an increase in their volume and, as a consequence of the cell wall, also of pressure within the cell. Explain the importance of turgidity in the process of support. In the absence of a cell wall animal cells will burst. Stress that during osmosis water molecules ONLY move across a water potential gradient. Discuss differences in the effects of water uptake and loss on animal cells that lack a cellulose cell wall and plant cells that have a cellulose cell wall. Learners may observe the effect of osmosis on plant cells using onion epidermis mounted in pure water and in concentrated sugar solution and viewed under a microscope. Extend this activity by asking learners to make annotated diagrams of the observed cells/tissue. A more **challenging** task is for learners to demonstrate the effect of osmosis on plant tissue using measured lengths of raw potato chips or dried raisins immersed in water and in sugar solution of different concentrations. Extend this activity by asking learners to graph their results in terms of sugar concentration vs change in mass of potato and to explain the pattern of their results using osmosis theory. Relate water uptake by osmosis to the structure of root hair cells covered earlier in this unit.	Video clips of osmosis in onion epidermal cells: www.youtube.com/ www.youtube.com/	6
2(d)	Define active transport as the movement of	Explain the need for uptake of ions even when their concentration may	Data task: active uptake	

Learning objectives		Suggested teaching activities	Learning resources	Week
	ions into or out of a cell through the cell membrane, from a region of their lower concentration to a region of their higher concentration against a concentration gradient, using energy released during respiration	already be greater inside a cell or organism. Energy from respiration must be used to counteract the effect of passive diffusion. No detail of the molecular mechanism of active transport is required. Explain the importance of active transport in the specific context of the root hair cell and the intestinal villi. A **challenging** practical task is for learners to set up bean seedlings in dilute fertiliser solution and to measure the nitrate concentration in the water (using commercially available reagent strips) to show the effect of active transport on the uptake of ions into the roots. A **challenging** data analysis activity is for learners to undertake the active uptake data task detailed in the online resources column.	www.practicalbiology.org/	
2(e)	Discuss the importance of active transport as an energy-consuming process by which substances are transported against a concentration gradient, as in ion uptake by root hairs and glucose uptake by cells in the villi			
3(a)	Define catalyst as a substance that speeds up a chemical reaction and is not changed by the reaction	Revise the meaning of the term catalyst and relate to the use of the term in chemistry. Explain the function of a catalyst in terms of altering the rate of a chemical reaction without itself being used up during the reaction.	Enzymes and their action: www.bbc.co.uk/schools/ www.s-cool.co.uk/ www.abpischools.org.uk/ http://highered.mcgraw-hill.com/ **Textbooks:** Jones, G & Jones, M – 3 Enzymes Jones, M – Unit 3 Enzymes Burton I J – Topic 4 Enzymes – Topic 5 Nutrition (for food tests) **5090 past paper question:** Nov 2011 Paper 62 Q1 Enzyme action and effect of temperature animation: www.biotopics.co.uk/ Enzyme action and graphs showing effect of changing temperature and pH: www.bbc.co.uk/schools/	7
3(b)	Define enzymes as proteins that function as biological catalysts			
3(c)	Explain enzyme action in terms of the ‘lock and key’ hypothesis	Introduce the terms *substrate, product* and *active site.* Use the online resources to illustrate the nature of these structures. The analogy of the ‘lock and key’ is useful when explaining the mechanism of enzyme action. Learners may produce and use 3D models of enzyme and substrate molecules using clay to illustrate the hypothesis.		
3(d)	Investigate and describe the effect of temperature and pH on enzyme activity	Explain in terms of heat and pH the effect of changing the shape of the active site of an enzyme – permanently in the case of extreme heat. Reference to the difference between raw and cooked egg white may be made. State that the rate of enzyme-controlled reactions increases to an optimum as increased heat supplies kinetic energy to increase the speed of movement of both substrate and enzyme molecules. Enzymes are then denatured or destroyed - but NOT killed. Extend learner’s understanding by asking them to consider why some enzymes may have a different optimum temperature to those found in humans and to research specific examples. Explain graphs of rate of enzyme reaction at different temperatures and at different pHs. Provide learners with graphs and ask them to annotate sections of the graph to explain the change in rate at each stage (e.g. increase, optimum and decrease)		8

Learning objectives		Suggested teaching activities	Learning resources	Week
		Explain the use of the iodine test for starch and Benedict's test for reducing sugars. Learners should carry out the iodine test for starch and Benedict's test for reducing sugars on prepared solutions of starch and glucose before undertaking enzyme experiments. Simple experiments using the enzyme catalase are appropriate as a basic introduction, such as: i) the breakdown of hydrogen peroxide by catalase (e.g. in yeast or potato) This may be followed by experiments to show: i) the effect of amylase on starch solution or lipase on lipids at different temperatures and also to show the effect of boiling enzymes before use ii) the effect of pH on the same reaction at a constant temperature	Catalase in potato tissue: www.ngfl-cymru.org.uk/ www.nuffieldfoundation.org/ Effect of temperature on lipase: www.nuffieldfoundation.org/ Effect of pH on amylase: www.nuffieldfoundation.org/	

Unit 3: Animal nutrition

Recommended prior knowledge
Learners need to know of the existence of chemical elements, particularly of carbon, oxygen, hydrogen and nitrogen, also that chemical energy is contained within the larger organic molecules. Knowledge of enzymes and enzyme action is necessary (Unit 1) as well as a very simple understanding of the circulatory system. Otherwise, this unit could be used as a starting point for the course with the above requirements being dealt with as they arise in the learning objectives.

Context
This unit provides the underlying biochemical knowledge essential for studying almost all of the other units in the course.

Outline
The unit begins with a study of the three major classes of organic nutrients and their food tests. Diet and its importance are considered, as well as the processing of dietary intake within the body. The action of specific enzymes is considered and the unit ends with a link to Unit 5 with a consideration of the role of the liver.

Learning objectives		Suggested teaching activities	Learning resources	Week
			5090 past question papers are available at: http://teachers.cie.org.uk	
5(a)	**Candidates should be able to:** List the chemical elements that make up carbohydrates, fats and proteins	That carbohydrates and fats contain carbon, hydrogen and oxygen only (but in different proportions) and that proteins contain the same three elements plus nitrogen can be illustrated using a collection of four different shapes cut from paper or thin card and moved around on an OHP under food-group headings. Explain that 'hydrate' relates to water and carbohydrates always contain H and O in the same ratio as in water.	Nutrition and food groups: www.s-cool.co.uk/ http://purchon.com/ **Textbooks:** Burton, I J – Topic 5 Nutrition Jones, G & Jones, M – 4 How Animals Feed Jones, M – Unit 5 Animal Nutrition – Diet	9
5(b)	Describe tests for starch (iodine in potassium iodide solution), reducing sugars (Benedict's solution), protein (biuret test) and fats (ethanol emulsion test)	Learners perform the tests on prepared solutions of starch, glucose and egg albumen and cooking oil. They should carry out a test in each case on pure water as a control. Observations and conclusions to be recorded in a table. A more **challenging** activity is for learners to identify the components of an unknown mixture of food molecules. Extend the practical to test common foodstuffs – making predictions about the presence or absence of components	Food tests practical procedure: www.biotopics.co.uk/ Food tests practical animation: http://lgfl.skoool.co.uk/ **5090 past paper questions:**	10

Learning objectives		Suggested teaching activities	Learning resources	Week
		prior to testing.	Nov 2011 Paper 31 Q2 Nov 2011 Paper 32 Q2	
5(c)	List the principal sources of, and describe the dietary importance of, carbohydrates, fats, proteins, vitamins (C and D only), mineral salts (calcium and iron only), fibre (roughage) and water	Consider the importance of the different chemical constituents of a diet before considering their sources. Use the online resources listed to research the components and to compare how the principal sources of each differ in different areas of the world. Learners may present this information in the form of a three column table showing components, sources and dietary sources. Food packets provide a useful source of stimulus material. Learners may be asked to bring in a range of food packaging and to discuss the significance of the data displayed regarding their nutritional content.	Vitamins: http://kidshealth.org/ http://kidshealth.org/ Minerals: http://kidshealth.org/ http://kidshealth.org/teen/food_fitness/	
5(d)	Name the diseases and describe the symptoms resulting from deficiencies of vitamin C (scurvy), vitamin D (rickets), mineral salts, calcium (rickets) and iron (anaemia)	Descriptions of the deficiency diseases resulting from a lack of vitamins C and D should be supported if possible with pictures. The need for calcium in the development of strong bones and teeth should be mentioned. The role of iron in the manufacture of haemoglobin for oxygen transport should also be included. Learners may research information on the vitamins and minerals listed and present their findings either in a table or in the form of an illustrated poster.	Deficiency diseases: http://lgfl.skoool.co.uk/ Scurvy and Rickets: www.nhs.uk/conditions/ www.nhs.uk/conditions/Scurvy/	11
5(e)	Understand the concept of a balanced diet	Stress the importance of a diet containing the correct proportions of each constituent to satisfy the body's needs. Too little or too much of any one or more constituents can be harmful - see 5(e), (f) and (g). A possible introduction to the topic is to show learners pictures of people whose diet is unbalanced (including obese and starving people) and to ask them what the people have in common. The online resources and video clips may then be used to explain the concept of a balanced diet.	Dietary food groups activity: www.footprints-science.co.uk/ Balanced diet video clips: www.bbc.co.uk/ www.bbc.co.uk/learningzone/	
5(f)	Explain why diet, especially energy intake, should be related to age, sex and activity of an individual	Present and analyse data showing the energy requirements for sedentary and physical life styles together with those of people of different ages. Consider how diet, other than energy, may differ at different stages of a person's life. Cross reference 16(y) in Unit 8. Learners should be aware of the main sources of each type of nutrient in their own country, but also be prepared to consider how diets differ in other parts of the world. The 'science across the world' online resource may be used to facilitate this appreciation. Learners may keep a record of the food they eat during a short period of time	Energy requirement data table: www.nhlbi.nih.gov/ Interactive balanced diet: www.abpischools.org.uk/ Science Across the World: www.nationalstemcentre.org.uk/ National nutrient database: http://www.nal.usda.gov/	

Learning objectives		Suggested teaching activities	Learning resources	Week
		and then consider whether they are obtaining the nutrients they need. Their diet could be analysed using printed food tables or the 'national nutrient database' online resource. A more **challenging** activity is for learners to practically investigate and compare the amount of energy in a variety of foods. Learners' basic mathematical and skills will be utilised in this activity. Extend the practical work by asking learners to present their numerical data in a variety of formats including tables and suitable graphs.	Practical Biology - Energy in food: www.practicalbiology.org/ **5090 past paper question:** Jun 2011 Paper 22 Q2	
5(g)	State the effects of malnutrition in relation to starvation, heart disease, constipation and obesity	Link to work on the causes of famine in 5(h) but also use this objective to illustrate that eating too much of a food group over a prolonged period is also a form of malnutrition. Discuss the growing problem in developed countries of obesity leading to heart disease.	World Health Org. obesity website: www.who.int/topics/obesity/en/	
5(h)	Discuss the problems that contribute to famine (unequal distribution of food, drought and flooding, increasing population)	Use a stimulus picture to initiate a group 'brainstorm' where learners list all the factors they can think of which contribute to famine. These can then be collected, compared and discussed further. Extend learners' research skills by asking them to collect information on famine and the problems contributing to its cause from newspaper and/or television sources prior to teaching this topic. Extend learners' thinking by asking them to consider whether new technologies, such as the development of genetically modified varieties of crops, are likely to improve the situation or exacerbate it. The concept of 'food miles' may also be considered.	Famine stimulus picture: http://i207.photobucket.com/ The problems of feeding the world's growing population with links to many sites: www.nationalacademies.org/webextra/crops/	12
5(i)	Identify the main regions of the alimentary canal and the associated organs: mouth (buccal) cavity, salivary glands, oesophagus, stomach, duodenum, pancreas, gall bladder, liver, ileum, colon, rectum and anus	Provide a labelled diagram of the appropriate components of the alimentary canal. Avoid providing more labels than the syllabus requires. Write a flow chart to show the order in which food travels through the labelled regions and list separately the associated organs through which food does not travel. The suggested online resources provide good source material in the form of diagrams and animations to support these activities.	Regions of the digestive system: www.bbc.co.uk/schools/ Digestive system and digestion – relevant to several learning objectives. www.abpischools.org.uk/ **Textbooks:** Jones, M – Unit 6 Animal Nutrition – Digestion Burton, I J – Topic 7 Animal Nutrition	
5(j)	Describe the main functions of these	The terms ingestion and absorption are usually easily understood. Stress that	See suggested resources above.	

Learning objectives		Suggested teaching activities	Learning resources	Week
	parts in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate	only certain large molecules are digested (in order to be absorbed). Assimilation is less easily understood and should be described as the incorporation of absorbed chemicals into the structure of an organism. Egestion and excretion are often confused by learners, so careful explanation will be required. Add annotations to the labelled diagram provided in 5(i) to show which function(s) occur(s) in each region labelled. The need for digestion to take place before absorption occurs may be shown by using Visking tubing (to represent the alimentary canal) containing a mixture of glucose, starch and water. This is placed in a beaker of water (to represent blood). Ask learners to make predictions about the results of tests for starch and glucose performed on the contents of the tube and of the beaker before and after leaving for a period of time to allow the glucose to diffuse across the tubing	Visking tubing model gut demo: www.nuffieldfoundation.org/	
5(k)	Identify the different types of human teeth and describe their structure and functions	Include reference to milk and wisdom teeth. 'Cutting' and 'grinding' (as appropriate) should be used in place of 'chewing'. Use a model tooth to show internal structure. Provide learners with diagrams of a tooth in longitudinal section (LS) and of a dental arcade. Learners should label the structures shown on a longitudinal section (LS) of a tooth and name and label the functions of the different teeth in a lower or upper jaw.	Types of teeth: www.crickweb.co.uk/ Internal tooth anatomy: www.enchantedlearning.com/	13
5(l)	State the causes of dental decay and describe the proper care of teeth	Stress that sugar left on teeth, particularly whilst asleep, attracts bacteria and that it is the acid excreted by these bacteria as they feed on the sugar which dissolves the enamel. Use commercially available 'disclosing' tablets to reveal the plaque layer on learners' teeth. Discuss the alkaline nature of toothpaste, and of saliva released when chewing sugar free gum, in neutralising the acid produced. Use the tooth decay animation to illustrate the process to learners and then ask them to produce a written account of the process and how it may be prevented.	Tooth decay animation: www.mchoralhealth.org/	
5(m)	Describe peristalsis	A bead in a length of rubber tubing illustrates the action. Reference should be made to food being pushed along **the entire length of the gut** by waves of contraction of circular muscles and of the antagonistic effect of the longitudinal muscles.	Digestion, including peristalsis diagram and animation: www.passmyexams.co.uk/ Endoscopic peristalsis video:	

Learning objectives		Suggested teaching activities	Learning resources	Week
		Use the online resource suggested to show learners a video clip of peristalsis occurring in a patient. Learners should describe the muscular action involved in peristalsis and explain its importance.	www.youtube.com/	
5(n)	Explain why most foods must be digested	Also see 5(j). Only small molecules can pass through the membranes of the cells lining the gut to be absorbed into the body. Until then, even when in the gut, they are still outside the body. Starch, proteins and fats are too large to be absorbed and must be broken down into the smallest constituent parts. Shapes cut from thin card and projected on a PowerPoint slide or overhead projector can illustrate effectively how starch is constructed from a string of monosaccharide units, proteins from amino acids and fats from fatty acids and glycerol.	Macromolecules and end prods: www.passmyexams.co.uk/	
5(o)	Describe digestion in the alimentary canal and the functions of a typical amylase, protease and lipase, listing the substrates and end products	Where each molecule is dismantled may be related to a specific region of the alimentary canal and to a specific enzyme (and optimum pH). When food arrives in the ileum, only the end products of digestion are present (together with those chemicals that are not broken down, either because they are already small enough for absorption or because no enzymes are present for their breakdown). The role of bile in emulsifying fats should be included. The effect of bile as an emulsifier may be demonstrated by adding washing up detergent (to represent bile) to cooking oil (to represent lipids consumed) added to water and stirred. Learners may then draw diagrams to represent the process of bile emulsifying the fat droplets to increase their surface area over which lipase may act. Refer back to the diagram provided in 5(i) and explain how each region and organ achieves the breakdown demonstrated in 5(n). A more **challenging** activity is for learners to answer a question such as ‘describe fully the digestion of a potato fried in oil’ to test their understanding and sequencing of the important facts relating to the digestion of multiple food chemicals.	Digestion diagrams and explanations: www.bbc.co.uk/schools/ www.bbc.co.uk/schools/digestion3.shtml www.s-cool.co.uk/ Digestion animated video: www.bbc.co.uk/ Digestion video clips: www.bbc.co.uk/ www.bbc.co.uk/ **5090 past paper questions:** Jun 2011 Paper 21 Q5 Jun 2010 Paper 22 Q8	14
5(p)	Describe the structure of a villus, including the roles of capillaries and lacteals	All food substances entering the body are absorbed by villi. Refer to the large surface area of each villus and of villi collectively. Display a large annotated diagram to show villus structure in LS. All absorbed substances pass into the blood capillaries, with the exception of the digested fats which pass into the lacteals.	Photomicrograph of villi: http://missinglink.ucsf.edu/ Labelled diagram of villus: www.bbc.co.uk/scotland/	

Learning objectives		Suggested teaching activities	Learning resources	Week
		Make a large, labelled and annotated drawing of a villus.		
5(q)	Describe the significance of villi in increasing the internal surface area	As 5(p): All food substances entering the body are absorbed by villi. Refer to the large surface area of each villus and of villi collectively. Display a large annotated diagram to show villus structure in LS. All absorbed substances pass into the blood capillaries, with the exception of the digested fats which pass into the lacteals. Make a large, labelled and annotated drawing of a villus.	As above: Photomicrograph of villi: http://missinglink.ucsf.edu/ Labelled diagram of villus: www.bbc.co.uk/scotland/	
5(r)	State the function of the hepatic portal vein as the route taken by most of the food absorbed from the small intestine	Explain that lacteals unite to join the lymph system, which feeds into the circulatory system and by-passes the liver. Blood capillaries link directly with the liver via the hepatic portal vein.		
5(s)	State: that large molecules are synthesised from smaller basic units - glycogen from glucose, proteins from amino acids, lipids (fats and oils) from glycerol and fatty acids the role of the liver in metabolism of glucose and amino acids the role of fat as a storage substance that the formation of urea and the breakdown of alcohol occur in the liver	The breakdown of large molecules to small ones has already been considered. The reverse of this is a part of the process of assimilation. Stress that glucose in animals is built up into glycogen rather than starch. Simple modelling kits can be used to illustrate the concept of small molecules joining together to make larger ones. Conversion of glucose into glycogen and its storage occur in the liver. Refer to 11(j) and (k) in Unit 5 for details. Fat is a high-energy, insulating storage substance. It is stored in the dermis and round kidneys. It is not considered to be ‘stored’ around the heart. The breakdown of excess amino acids into a carbohydrate (stored as glycogen) and the excretory product urea in the liver should be mentioned. As a part of its role in removing poisons the liver also breaks down alcohol. An **extension** activity to highlight the importance of the liver is to ask learners to research and present information on the causes and effects of liver failure.	**5090 past paper question:** Jun 2011 Paper 21 Q6a	

SECOND TERM

Unit 2: Plant nutrition and transport

Recommended prior knowledge
Unit 1 will supply learners with valuable knowledge on the structure of plant cells as well as on diffusion, osmosis, and transport in the xylem. The basic structure of the starch and sugar molecules should be understood. Energy will have been mentioned with reference to active transport, but learners should be aware that there are different forms of energy and that it can be transformed from one form to another.

Context
This unit concentrates on the botanical relevance of topics covered in Unit 1 and forms a natural link with topics to be visited in several other units, notably Units 3 and 7.

Outline
Photosynthesis, as the process responsible for the production of food for all living organisms, is explained. The basic biochemistry of the process as well as the conditions necessary for the process to occur, are considered. The structure and adaptation of a leaf and of leaf cells for photosynthesis are considered in some detail and reference is made to carbohydrate as the starting point for protein synthesis. A knowledge of leaf structure allows learners to investigate the process of transpiration. The unit generates many opportunities for practical work, but for centres operating in areas which experience marked seasonal change, some thought may have to be given to the best time for studying the unit.

Learning objectives		Suggested teaching activities	Learning resources	Week
			5090 past question papers are available at: http://teachers.cie.org.uk	
4(a)	**Candidates should be able to:** Understand that photosynthesis is the fundamental process by which plants manufacture carbohydrates from raw materials	Explain that photosynthesis is a plant's method of nutrition. Only small molecules can be absorbed (by diffusion and osmosis) and these are used by the plant to build larger molecules. Explain that energy is required to construct the larger molecules and is obtained as light energy. Some of this energy remains locked away (as chemical energy) in the molecules of carbohydrate produced.	Photosynthesis diagrams and explanations covering several learning objectives in this unit: www.bbc.co.uk/schools/ www.s-cool.co.uk/ **Textbooks:** Jones, G & Jones, M – 5 How Green Plants Feed Jones, M – Unit 4 Photosynthesis Burton, I J – Topic 6 Plant Nutrition	1

Learning objectives		Suggested teaching activities	Learning resources	Week
4(b)	Investigate the necessity of chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls	- For chlorophyll, learners should use a plant with variegated leaves e.g. variegated *Pelargonium*. Any locally available variegated leaf will suffice, however trial the experiment first to check that it stores starch, not sugar (common in monocot plants). - For light, use aluminium foil or black paper held either side of a leaf using paperclips. - For CO_2, place the plant under a bell jar, or similar, containing a beaker of concentrated sodium hydroxide solution to absorb CO_2. This may be more suited to a whole-class demonstration. Include in all cases the importance of starting with a de-starched plant. Explain the importance of controls in scientific practice and invite learners to list the variables which must be controlled during the above investigations. Stress the importance of keeping all variables constant other than the one being investigated. It is advisable to demonstrate the steps of the starch test on a leaf before allowing learners to carry it out. If a naked flame is used for heating, stress the danger of using flammable liquid and the need for safety precautions. Learners may summarise their practical work in the form of a flow chart illustrating the steps involved and the scientific reasons for each step.	Practical to investigate the factors affecting photosynthesis: www.practicalbiology.org/ Animation showing starch test procedure: www.footprints-science.co.uk/ **5090 past paper question:** Nov 2011 Paper 31	
4(c)	State the equation (in words or symbols) for photosynthesis	An equation in words is adequate, however if given, an equation in symbols, it must balance. In both cases, 'light energy' rather than just 'energy' should be specified.		
4(d)	Investigate and state the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis (e.g. in submerged aquatic plants)	Learners may first be shown a water plant evolving bubbles of oxygen as it photosynthesises in bright light. Then invite learners to suggest how they might investigate the effect of varying light intensity, temperature or carbon dioxide. A **challenging** activity for learners is for them to plan their own investigation into the effect of one of these factors. Different groups of learners may investigate a different factor – allowing for collaborative discussion following the practical work. If available the aquatic plant *Cabomba* is a reliable alternative to the commonly used *Elodea*. Extend the practical work by providing learners with a microscope to view a leaf from the plant in order to show the presence of chloroplasts.	Practical to investigate the effect of light on photosynthesis in an aquatic plant: www.practicalbiology.org/ *Elodea* investigation apparatus and effect of factors: www.nuffieldfoundation.org/ Interactive activity: www.kscience.co.uk/	2

Learning objectives		Suggested teaching activities	Learning resources	Week
		All experiments here are modifications of that in which a water plant is submerged in a container of water. The rate of photosynthesis is determined by measuring volumes or counting bubbles of O_2 released as the plant is exposed to one altered variable. The concentration of CO_2 may be altered by adding varying amounts of sodium hydrogen carbonate to the water. An **extension** practical activity is for learners to investigate the floating behaviour of leaf discs due to the evolution of O_2 gas during photosynthesis in different conditions.	Investigating the behaviour of leaf discs: www.saps.org.uk/ **5090 past paper question:** Nov 2010 Paper 61 Q1	
4(e)	Understand the concept of limiting factors in photosynthesis	The required factor which is in the shortest supply limits the rate at which a plant will photosynthesise. Show by a simple graph that the rate of photosynthesis levels off with increased availability of CO_2 or light. Extend learner's thinking by inviting them to suggest an explanation for this and asking them to predict what might happen if the availability of the limiting factor is increased. A more **challenging** activity is for learners to plot the results of the previous experiment from 4(d) to show how light acts as a limiting factor. Plot rate of reaction (bubbles of O_2 released per minute) against light intensity (equal to $1/d^2$ where d is the distance from the light source to the plant). Extend learners' thinking by asking them to present verbal and written explanations of their data to other learners.	See online resources listed against 4(a). **5090 past paper question:** Nov 2010 Paper 21 Q8a	3
4(f)	Describe the intake of carbon dioxide and water by plants	Carbon dioxide from the atmosphere and water from the soil are small molecules which are used to construct the larger glucose molecules formed during photosynthesis. Explain the entry of carbon dioxide through pores (stomata) in the leaf surface by diffusion and its subsequent diffusion through spaces between mesophyll cells. CO_2 then dissolves before entering the cells and diffusing into chloroplasts.	See 4(i) below for resources to demonstrate action of guard cells and stomata. Resources to demonstrate diffusion are referenced in Unit 1.	
4(g)	Understand that chlorophyll traps light energy and converts it to chemical energy for the formation of carbohydrates and their subsequent storage	Chlorophyll absorbs the light energy and thus photosynthesis occurs where chlorophyll is located – in the chloroplasts. No details of light-dependent and independent reactions are required. Glucose manufactured by photosynthesis may be converted to starch and stored in the chloroplasts and/or converted to sucrose to be conducted to other organs (via phloem) for storage as sucrose or as starch. Invite	Uses of glucose made in photosynthesis: http://lgfl.skoool.co.uk/	

Learning objectives		Suggested teaching activities	Learning resources	Week
		learners to suggest examples of such storage organs. Learners may prepare a temporary microscope slide using a thin scraping of potato tissue stained with iodine solution to show the presence of starch grains. Explain the storage of carbohydrate in the form of insoluble starch in terms of the osmotic balance of cells.	Photomicrograph of starch grains: www.microscopy-uk.org.uk/	
4(h)	Explain why most forms of life are completely dependent on photosynthesis	A **challenging** activity is to present learners with the learning objective and to ask them to collaborate with other learners to suggest explanations for why this is so. Explain that the carbohydrates (and the proteins subsequently produced – see 4(j)) are important components of their own diets manufactured by plants. Fats and oils are also manufactured by plants. Learners may be able to name common examples. Explain that humans require O_2 to respire and that they breathe out CO_2 – the exact reverse of photosynthesis.		4
4(i)	Identify and label the cuticle, cellular and tissue structure of a dicotyledonous leaf, as seen in a cross-section under a microscope, and describe the significance of these features in terms of function, i.e. distribution of chloroplasts – photosynthesis stomata and mesophyll cells – gas exchange vascular bundles – transport	Using a projected photomicrograph or TS diagram of a leaf and identify the main tissues - explaining the role of each part in photosynthesis. A basic activity is to supply learners with a large, clear, unlabelled drawing of a leaf TS and, using the above resource, ask them to label their diagrams. Include labels for xylem and phloem (see Unit 3) as well as for vascular bundle and describe the functions of the two separate tissues. A more **challenging** activity is for learners to draw a TS of the leaf from their observation of a microscope slide and to annotate this with details of the component structures. Extend learners' practical work using the 'measuring stomatal density' activity from the online resources list. Explain the control of stoma size by water pressure within guard cells. Demonstrate the opening and closing of stomata by using two balloons to represent guard cells. Affixing a band of adhesive tape along one edge of each balloon prior to their inflation models the change in cell shape on becoming turgid.	Photomicrograph of leaf TS: http://images.botany.org/ Leaf TS diagram (labelled): www.bbc.co.uk/ Leaf TS diagram (unlabelled) www.ellenjmchenry.com/ Measuring stomatal density: www.saps.org.uk/ Video clip of guard cells opening and closing stomata: www.youtube.com/ ***BIOSCOP*E (2004) CD** TS leaves of *Erica* and privet **5090 past paper question:** Nov 2011 Paper 22 Q6	

Learning objectives		Suggested teaching activities	Learning resources	Week
4(j)	Understand the effect of a lack of nitrate and magnesium ions on plant growth	Carbohydrate manufactured by photosynthesis is the molecule which acts as the starting point for building other organic molecules. Plants must absorb ions from the soil in order to make these molecules. Magnesium is necessary for chlorophyll manufacture and nitrates for protein manufacture. Without magnesium a plant cannot photosynthesise and without proteins it cannot grow. A basic activity is to use photographs to demonstrate plants grown under these deficiencies alongside a control which does not lack the ions. Ask learners to identify and account for the visible differences between the plants shown. A more **challenging** activity is for learners to grow plants in culture solutions lacking magnesium or nitrates and to compare their growth after several weeks against a plant grown in a control culture medium.	Uses of glucose made in photosynthesis: http://lrrpublic.cli.det.nsw.edu.au/ Magnesium deficiency: www.gardenersworld.com/	
6(a)	Relate structure and functions of root hair cells to their surface area and to water and ion uptake	The importance of surface area, in particular of root hair cells for the uptake of water and ions, has been covered in Unit 1. Learning objectives 4(f) and 4(j) above have also referred to their uptake. This learning objective provides an opportunity for these facts previously taught to be consolidated.	Root hair diagrams and photographs: http://www.biologie.uni-hamburg.de/ Uptake by root hairs: http://lgfl.skoool.co.uk/ **Textbooks:** Jones, M – Unit 7 Transport in Flowering Plants Jones, G & Jones, M – 7 Transport Burton, I J – Topic 8 Transport in Flowering Plants	5
6(b)	State that transpiration is the evaporation of water at the surface of the mesophyll cells followed by the loss of water vapour from the leaves through the stomata	Ensure that learners understand that evaporation has occurred first from moist surfaces of mesophyll cells within the leaf prior to water vapour then diffusing through the leaf spaces and out into the atmosphere down a concentration gradient. Ensure also that there is no confusion between guard cell and stoma(ta).	Basic transpiration animation: http://extension.oregonstate.edu/ Detailed transpiration animation: www.kscience.co.uk/	
6(c)	Describe: how water vapour loss is related to cell surfaces, air spaces and stomata	Explain that those conditions which speed up or slow down the evaporation of water also speed up or slow down the rate of transpiration. Increased light intensity speeds up transpiration by virtue of the fact that it opens up the stomata to their fullest extent.		

Learning objectives		Suggested teaching activities	Learning resources	Week
	the effects of air currents (wind), and the variation of temperature, humidity and light intensity on transpiration rate how wilting occurs	Learners may be provided with a diagram of a potometer set up to investigate the rate of water loss/uptake. A basic activity is to ask learners how the potometer may be used to investigate the loss/uptake of water. A more **challenging** activity is for learners to write a step-by step plan of a controlled investigation into how altering one condition affects the rate of water loss/uptake. Practical use of a potometer provides good visual support to this section; however difficulty may be experienced in altering any of the variables required. Graphs may be either provided to learners, or as a more **challenging** activity they may draw their own from data provided, to show the effect of each factor on the rate of water loss/uptake. Explain that water lost from a plant must be replaced from the soil. If the rate of water loss exceeds its rate of uptake the plant will wilt (not 'wither'). Invite learners to describe and explain the appearance of a wilted plant.	Use of a potometer: www.biologydaily.com/ Potometer interactive activity: www.sycd.co.uk/ Using a potometer to compare transpiration rates: www.saps.org.uk/ **Past papers questions:** Jun 2011 Paper 21 Q 2 Nov 2010 Paper 62 Q1	6
6(d)	Investigate, using a suitable stain, the pathway of water in a cut stem	Learners will know that water travels in the xylem. This learning activity will demonstrate the distribution of xylem tissue in a chosen stem. Though not a stem, a 'stick' of celery is a suitable material for this demonstration, however any plant with a relatively colourless and fleshy stem is likely to be satisfactory. Learners should cut the stem cleanly and place the cut end in a solution of a suitable stain (food dye is inexpensive and works well). Results can often be seen in 10 to 15 minutes when a further section is taken from the stem at a position just above the level of the solution. Learners may then make a labelled drawing of their observations. The activity may be extended to compare and explain the rate of movement in a leafy and non-leafy stem.	Movement of dye through xylem of celery activity: www.york.ac.uk/ **5090 past paper question:** Jun 2011 Paper 22 Q6	7
6(e)	Explain the movement of water through the stem in terms of transpiration pull	Explain that the evaporation of water from mesophyll cells increases the concentration in the sap vacuole of those cells. Osmosis then draws more water up the xylem to replace the water lost. Dissolved in that water are ions which have been absorbed by the root hairs.	Resources for illustrating the movement of water during the transpiration stream: Basic transpiration animation: http://extension.oregonstate.edu/ Detailed transpiration animation: www.kscience.co.uk/	
6(f)	Identify the positions of xylem and phloem tissues as seen in transverse sections (TS)	Use projected photomicrographs then diagrams to demonstrate the position and appearance of xylem and phloem in roots and stems (leaves	***BIOSCOPE* (2004) CD**: TS and LS of *Ranunculus* stem and root	

Learning objectives		Suggested teaching activities	Learning resources	Week
	of unthickened, herbaceous, dicotyledonous roots, stems and leaves	have already been considered in 4(i) above). Use a transparency to project labelled diagrams of the position of the xylem and phloem in roots and stems. Supply learners with blank copies of the diagrams to label. A more **challenging** activity is for learners to draw and label their own diagrams from observations of TS microscope slides of dicotyledonous roots, stems and leaves. An **extension** activity in which learners consider the effects of 'ringing' a tree can help to bring together knowledge of stem structure and function. Small mammals gnaw the bark and destroy the phloem that is in the inner bark region. If the ring is cut below the leaves, then all the cells beneath the ring are deprived of products of photosynthesis from the leaves, and eventually die.		
6(g)	State the functions of xylem and phloem	Annotate the diagrams from 6(f) above to indicate that phloem conducts SUCROSE (not glucose) and amino acids in solution and the xylem carries water and ions (dissolved salts).		

Unit 4: Human transport and respiration

Recommended prior knowledge
The first part of this unit stands very much alone and can be studied in isolation, although knowledge of the substances absorbed into the blood from the small intestine would be useful. The respiration section of the unit would certainly benefit from a prior knowledge of chemical molecules and of energy (see Units 2 and 3) and of active transport (Unit 1).

Context
Since all characteristics of living organisms are heavily dependent on the energy released during respiration, this unit provides essential knowledge for the understanding of most of the other units.

Outline
The structure and function of the heart and the circulatory system are considered together with coronary disease. The structure and function of blood and its component parts are also studied. Aerobic and anaerobic respiration are covered as well as the organs and structures involved in gaseous exchange. The unit generates a varied assortment of practical investigations.

Learning objectives		Suggested teaching activities	Learning resources	Week
			5090 past question papers are available at http://:teachers.cie.org.uk	
7(a)	**Candidates should be able to:** Describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood	The name of the pump (the heart) and of the three different types of blood vessel should be mentioned. It is possible to demonstrate the one-way action of valves in the vein running along the back of the wrist or fore-arm by performing a similar procedure to the English scientist William Harvey in 1628.	William Harvey's experiment: www.princeton.edu/ Heart and circulation: www.abpischools.org.uk/ Video clips: www.bbc.co.uk/human-circulation **Textbooks:** Burton, I J – Topic 9 Transport in Human Beings Jones, G & Jones, M – 7 Transport Jones, M – Unit 8 Transport in Humans	8
7(b)	Describe the double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and	Explain that blood leaves the heart in arteries, returns in veins, and that arteries are joined to veins by capillaries. Since the lungs are close to the heart, and at the same level as the heart, the pressure needed to send blood to them is lower. Label and shade (to show oxygenated and	Double circulation animations: www.bbc.co.uk/circulatorysys	

Learning objectives		Suggested teaching activities	Learning resources	Week
	relate these differences to the different functions of the two circuits	deoxygenated blood) diagrams of the double circulation.		
7(c)	Name the main blood vessels to and from the heart, lungs, liver and kidneys	A simplified, labelled, demonstration diagram of only those blood vessels specified may be explained to learners and then a similar but unlabelled diagram provided for learners to label.	Simplified vessel diagram: www.ringwoodbiology.co.uk/	
7(d)	Describe the structure and function of the heart in terms of muscular contraction and the working of valves	A labelled demonstration diagram may be used to provide the correct terminology for the structures of the heart and to explain the heart cycle and the action of valves. Stress that both atria contract together, followed by both ventricles – rather than the right side contracting first to send blood to the lungs, followed by the left side to send blood to rest of the body. As above, an unlabelled diagram should be provided for learners to label. A demonstration dissection of a heart may be carried out, although be alert to the possible sensibilities of individual learners.	Circulatory system animations: http://apan.net/ Heart structure diagrams: www.bbc.co.uk/circulatorysys2 Practical Biology – Heart dissection: www.practicalbiology.org/	9
7(e)	Compare the structure and function of arteries, veins and capillaries	Transverse section (TS) drawings of all three vessels should be supplied – together with a longitudinal section (LS) of a vein to show semi-lunar valves. Annotations on the diagrams can be used to link structure with function. Compare the nature of blood flow in each. Learners may complete a table to compare the structure and function of the three types of blood vessel. Ask learners to use their knowledge to identify the type of blood vessel labelled A and B in the online resource and to write a paragraph to explain how their structure and functions can be compared. Use the blood vessel animation online resource to show the flow of blood through vessels under a range of conditions. Note the action of valves in veins.	Blood vessel structure and function: www.s-cool.co.uk/bloodvessels Artery and vein (TS): www.bioclix.org/ Blood vessel animations: www.medmovie.com/ ***BIOSCOPE* CD (2004)** TS of artery and of vein **5090 past paper question:** Nov 2011 Paper 22 Q7	10
7(f)	Investigate and state the effect of physical activity on pulse rate	Learners should locate an artery (e.g. at their wrist or at the side of the neck) and count and record the rate of the pulse at rest. The number of beats per 15 sec should be recorded and multiplied by four to give beats per minute. Learners should work in pairs – one as the researcher and one as the subject, who takes two minutes brisk exercise. Immediately afterwards, the researcher takes the pulse rate for 15 sec every minute until the rate returns to normal.	Practical Biology – Control of heart rate: www.practicalbiology.org/	

Learning objectives		Suggested teaching activities	Learning resources	Week
		Graphs may be drawn of rate (beats per minute) against time. Data for the whole class may be pooled and compared if they all perform exactly the same exercise and the investigation extended as an opportunity to discuss control of variables.		
7(g)	Describe coronary heart disease in terms of the occlusion of coronary arteries and state the possible causes (diet, stress and smoking) and preventive measures	This objective links with Unit 3. Saturated fats and cholesterol should be mentioned as being constituents of atheroma. The need for exercise should be stressed – as well as other precautions, especially if there is a family history of heart disease Learners may write a commentary to the suggested online resource to list the steps in development of atheroma. A list of the possible causes and preventative measures, in the form of a table, may accompany the diagram.	CHD website including animation: http://hcd2.bupa.co.uk/heart_disease	11
7(h)	Identify red and white blood cells as seen under the light microscope on prepared slides, and in diagrams and photomicrographs	A basic activity is for learners to be shown diagrams and photomicrographs of blood cells. Learners should note the paler colour of red blood cells towards their centres, the different comparative sizes and numbers of red and white cells, and that there are different types of white cell (their different names are not required). Note that the colours of the cells are as seen after staining and are not their natural colours. A more **challenging** activity is for learners to use microscopes to view prepared slides of blood at high power. Learners may be asked to draw the cells observed and to annotate their diagrams to describe the structure and basic functions of the cells drawn.	Blood cell photomicrograph: http://t0.gstatic.com/ Images of blood cells: www.exploratorium.edu/= ***BIOSCOPE* CD (2004)** Human Blood	
7(i)	List the components of blood as red blood cells, white blood cells, platelets and plasma		Constituents of blood: www.pennmedicine.org/	12
7(j)	State the functions of blood: red blood cells – haemoglobin and oxygen transport white blood cells – phagocytosis, antibody formation and tissue rejection platelets – fibrinogen to fibrin, causing clotting plasma – transport of blood cells,	Learners may prepare a table to show the name and functions of each type of blood cell. The table may be extended to show a diagram of cells seen in 7(h) above. The ability of haemoglobin to absorb and to release oxygen should be mentioned. Link to 5(d) Unit 3 - anaemia. Learners may write a commentary to the online resource animations. A more **challenging** activity is to invite learners to suggest why transplants are likely to be more successful between closely related people. Fibrinogen should be introduced as a plasma protein. The role of the clotting process and formation of a scab in preventing entry of pathogens	Action of white blood cells: www.bbc.co.uk/schools/ Phagocytosis animation: www.edumedia-sciences.com/ Blood clotting animation: www.footprints-science.co.uk/ **5090 past paper question:** Jun 2010 Paper 22 Q8	

Learning objectives		Suggested teaching activities	Learning resources	Week
	ions, soluble food substances, hormones, carbon dioxide, urea, vitamins and plasma proteins.	should be included. Link to 5(d) in Unit 3 - calcium. Learners may watch the suggested online animation and write an accompanying commentary. As an **extension** activity learners may research the disease haemophilia.		
7(k)	Describe the transfer of materials between capillaries and tissue fluid	Capillaries may be thought of as 'leaky', but their walls will not allow large molecules to pass. Plasma proteins are too large to do so, as are blood cells with the exception of some white blood cells which are able to change shape to squeeze through and reach a site of infection. This description will allow learners to differentiate between plasma and tissue fluid. Stress the two-way movement of materials – with metabolic products able to pass from cells into capillaries. Cross-reference 5(p) in Unit 3 and 8(k) in Unit 4.		**13**
8(a)	Define respiration as the release of energy from food substances in all living cells	It is essential at this stage to differentiate between breathing and respiration. It should be made clear that respiration is a chemical reaction occurring in all living cells with the sole purpose of releasing energy. Also stress that energy is not 'needed' for respiration and that respiration does NOT 'create' or 'produce' energy. Note that the definition allows for respiratory substrates other than glucose, although glucose is the only one required by the syllabus. Respiration may be compared with combustion – the equation is the same, but respiration occurs in a series of small reactions that do not suddenly release large amounts of heat energy. Link to 3(d) in Unit 1 – enzymes. If not already carried out in Unit 3, learners may practically investigate and compare the amount of energy in a variety of foods. Learners' basic mathematical and skills will be utilised in this activity. Extend the practical work by asking learners to present their numerical data in a variety of formats including tables and suitable graphs. The activity may be extended by considering how use of a calorimeter provides a more accurate method of determining energy content. An **extension** activity is to demonstrate the release of heat energy by germinating seeds. See online resource.	Aerobic and anaerobic respiration: www.s-cool.co.uk/summary **Note:** this resource is relevant to many of the subsequent learning objectives in this unit. Introduction to respiration: www.biotopics.co.uk/ **Textbooks:** Jones, M – Unit 9 Respiration Ian J. Burton – Topic 10 Respiration Jones, G & Jones, M – 6 Respiration **5090 past paper question:** Nov 2011 Paper 32 Q2(c)	

Learning objectives		Suggested teaching activities	Learning resources	Week
8(b)	Define aerobic respiration as the release of a relatively large amount of energy by the breakdown of food substances in the presence of oxygen	Learners should realise that during this process the glucose is completely broken down to its constituent molecules, releasing all of the energy absorbed in building the molecule. An **extension** activity is to use a respirometer to demonstrate the uptake of oxygen by living tissue. See online resource.	Introduction to respiration: www.biotopics.co.uk/humans/respro.html	
8(c)	State the equation (in words or symbols) for aerobic respiration	In Unit 2 learners have learnt the equation for photosynthesis and that the process is the reverse of respiration. Again, a word equation is acceptable, but if symbols are used the equation must balance (it is acceptable to add '+ energy released' on the right hand side).		**14**
8(d)	Name and state the uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature	This objective allows for the introduction of the concept of energy being required to build large molecules other than glucose or starch. Two further types of energy are also introduced – heat energy and electrical energy, to add to light and chemical energy so far considered in Unit 2. Learners may produce a 'spider diagram' to state the uses of energy and may illustrate their diagram with hand-drawn or printed pictures and/or further annotations.		
8(e)	Define anaerobic respiration as the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen	This is likely to be a new concept for learners. It may be explained that in the absence of oxygen, the respiratory substrate is not completely broken down into its constituent molecules. Some chemical energy therefore remains in the molecules produced in the reaction, leaving less to be released than in aerobic respiration. Anaerobic respiration can be demonstrated using a suspension of yeast in boiled (to remove dissolved O_2) water. The CO_2 released can be detected by being bubbled through lime water in a test tube using a delivery tube. This activity may alternatively be carried out when delivering learning objective 14(c) in Unit 6.		
8(f)	State the equation (in words or symbols) for anaerobic respiration in humans and in yeast	Two forms of anaerobic respiration are relevant to the syllabus. Both should be given with a clear explanation that one form is encountered in fermentation (Unit 6) and the other in muscle action. Word equations are likely to be more easily accessible to learners at this level.		
8(g)	Describe the effect of lactic acid production in muscles during exercise	Ask learners to raise their arm and to open and close their fist in quick succession for as long as possible. The resulting discomfort is a result of lactic acid build up in the muscles. Whilst discussing the concept with learners, sufficient time will elapse for the discomfort to subside – a result of	Marathon runner stimulus photo: http://gobblegreen.com/	

Learning objectives		Suggested teaching activities	Learning resources	Week
		the lactic acid being broken down into harmful carbon dioxide and water. Use the stimulus photo of a runner with muscle cramp to elucidate ideas. This can be related to the build-up of lactic acid during exercise. Cramp often strikes after exercise has finished - a result of the circulation not being able to remove the lactic acid quickly enough from the muscles - refer to 7(k).		
8(h)	Know the percentages of gases in atmospheric air and investigate and state the differences between inspired and expired air	A table of differences – with approximate percentages – should be given. Learners may use this data to plot pie charts of gas composition and to produce written explanations for the similarities and differences apparent. The table above should be supported by a practical investigation of the comparative amounts of CO_2 and water vapour in air, and of differences in temperature. Learners may breathe out through limewater indicator to show presence of CO_2 in exhaled air. The demonstration may be extended to the 'huff-puff' apparatus to show more CO_2 is present in exhaled than inhaled air. Breathing into a test-tube of water at laboratory temperature for several minutes (to demonstrate temperature of expired air) and onto dried cobalt chloride paper (to show presence of moisture) may be suitable investigations depending on ambient temperature and humidity.	Composition of air table: www.yteach.co.uk/ Huff-puff apparatus: www.chemistrydaily.com/	15
8(i)	Investigate and state the effect of physical activity on rate and depth of breathing	Learners will be aware that they breathe more deeply after exercise. This knowledge should be supported with an illustrative graph (which would also show the change in rate of breathing). A spirometer, if available, may be used to generate such a graph both before and after exercise. Working in pairs, with one learner as the subject, breathing rates before and after exercise may be measured (using the 'count for 15 sec then multiply by 4' method – repeated for 10 minutes after the exercise). Graphs may be drawn of the results and compared with those obtained in 7(f) above. Extend learners' practical skills by asking them to plan their own controlled investigation to compare activities such as walking, skipping, running or hopping with definite constant variables of time/distance. A more **challenging** activity is for learners to explain the results of their investigation using their knowledge of aerobic and anaerobic respiration.	Using a spirometer: www.nuffieldfoundation.org/ Spirometer trace before and after exercise: www.brianmac.co.uk/	

Learning objectives		Suggested teaching activities	Learning resources	Week
8(j)	Identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries	A labelled transparency or diagram of the contents of the thorax could be shown and described to the learners. Include only the labels specified (plus the diaphragm, ribs and intercostals muscles covered later). Supply learners with an unlabelled version for them to label.	Thorax labelled diagram: www.homebusinessandfamilylife.com/	
8(k)	State the characteristics of, and describe the role of, the exchange surface of the alveoli in gas exchange	Draw attention to the small size, large number and large surface area of the alveoli. The thinness of the alveoli walls, their moist coating and the short distance between the air and the extensive networks of capillaries should also be included. Provide learners with an unlabelled diagram showing the alveolar wall surrounded by a blood capillary. Ask learners to add labels to show the direction that gases move by diffusion during gas exchange. Learners may then annotate the diagram to describe the characteristics of the exchange surface. Learners may watch the animation from the online resource and then write a commentary to describe the process of gas exchange.	Gas exchange animation: www.bbc.co.uk/respiratorysys3 ***BIOSCOPE* CD (2004)** Lung (showing alveoli)	16
8(l)	Describe the role of cilia, diaphragm, ribs and intercostal muscles (external and internal) in breathing	Ensure that learners do not believe cilia to be hairs that filter the passing air. Consider the mechanism by which these components result in altering the volume and pressure in the thorax. A basic activity is to show learners balloons attached to a glass tube in an air-tight bell jar with a rubber sheet stretched across its base to demonstrate the principles involved. Ask learners to list ways in which the demonstration does not accurately reflect the process of breathing. A more **challenging** activity is for learners to construct similar models – see online resource. Learners may use the method described in the online resource to simply measure their own lung capacity.	Inhalation and exhalation: www.bbc.co.uk/respiratorysys1 Learner-constructed model: www.nuffieldfoundation.org/ Measuring lung capacity: www.biologycorner.com/	