Scheme of Work

Cambridge O Level Biology

5090

For examination from 2016

CAMBRIDGE International Examinations

Contents

Introduction

This scheme of work provides ideas about how to construct and deliver a course. The syllabus for Cambridge O Level Biology has been broken down into teaching units with suggested teaching activities and learning resources to use in the classroom. This scheme of work is meant to be a guideline, offering advice, tips and ideas. It can never provide everything a teacher needs but hopefully provides teachers with a basis to plan their lessons. It covers the minimum required for the Cambridge O Level course but also adds enhancement and development ideas on topics. It does not take into account that different schools take different amounts of time to cover the Cambridge O Level course.

Recommended prior knowledge

This syllabus involves a consideration of its topics, very largely from first principles, so little prior knowledge is required.

Outline

The units within this scheme of work are:

Unit	Topic	Content (syllabus reference)	Teaching time (%)
Unit 1	Cells and cell processes	1 Cell structure and organisation 2 Diffusion and osmosis 3 Enzymes	15 %
Unit 2	Plant nutrition and transport	4 Plant nutrition 6 Transport in flowering plants	15 %
Unit 3	Animal nutrition	5 Animal nutrition	15 %
Unit 4	Human transport and respiration	7 Transport in humans 8 Respiration	11 %
Unit 5	Coordination, response, movement and homeostasis	9 Excretion 10 Homeostasis 11 Coordination and response 12 Support, movement and locomotion	11 %
Unit 6	Drugs, microorganisms and biotechnology	13 The use and abuse of drugs 14 Microorganisms and biotechnology	8 %

Unit	Topic	Content (syllabus reference)	Teaching time (%)
Unit 7	Organisms and the environment	15 Relationships of organisms with one another and with the environment	8 %
Unit 8	Reproduction	16 Development of organisms and continuity of life	9 %
Unit 9	Inheritance and evolution	17 Inheritance	8 %

Teaching order

The units may be taught in order, 1 to 9. This is not essential, but the following recommendations apply.
(a) It is recommended that Unit 1 is taught as the first unit of the course.
(b) Other units that are suitable for teaching early in the course include Units 2, 3 and 4. Some of the ideas met in earlier units are revisited in later units.
(c) It is recommended that the teaching of some skills and concepts are ongoing across all units.

Suggested teaching activities

Further guidance and suggested teaching activities are provided in the scheme of work for each learning objective. These are indicated as being either whole-class teaching points or activities **(W)**, paired **(P)**, group **(G)** or individual **(I)** activities. These indications are for guidance only and there is often more than one way in which a learning objective may be successfully delivered. In the case of practical activities the availability of equipment will be an important consideration.

Opportunities for differentiation are indicated as **challenging** and **extension** activities. There is the potential for differentiation by resource, length, grouping, expected level of outcome, and degree of support by teacher, throughout the scheme of work. Timings for activities and feedback are left to the judgment of the teacher, according to the level of the learners and size of the class. Length of time allocated to a task is another possible area for differentiation.

Teacher support

Teacher Support **https://teachers.cie.org.uk** is a secure online resource bank and community forum for Cambridge teachers, where you can download specimen and past question papers, mark schemes and other resources. We also offer online and face-to-face training; details of forthcoming training opportunities are posted online. This scheme of work is available as PDF and an editable version in Microsoft Word format; both are available on Teacher Support at **https://teachers.cie.org.uk** If you are unable to use Microsoft Word you can download Open Office free of charge from **www.openoffice.org**

Resource list

The up-to-date resource list for this syllabus, including textbooks endorsed by Cambridge, is listed at **www.cie.org.uk**
Endorsed textbooks have been written to be closely aligned to the syllabus they support, and have been through a detailed quality assurance process. As such, all textbooks endorsed by Cambridge for this syllabus are the ideal resource to be used alongside this scheme of work as they cover each learning objective.

Textbooks

The textbooks referenced have been written to accommodate this Cambridge O Level Biology syllabus (though it is advisable to check textbook content with the syllabus before each unit, since the text may also contain some material relevant to other Cambridge International Examinations syllabuses).

The textbooks referenced in this scheme of work include:
Biology for IGCSE and O Level International Edition Jones, G and Jones, M (Cambridge University Press, 2002)
O Level Biology Jones, M (Oxford University Press, 2010)
Teaching and Assessing Practical Skills in Science Hayward, D (Cambridge University Press, 2003) 'Professional Development for Teachers' series.
The Cambridge Revision Guide GCE O Level Biology Burton, I J (Cambridge University Press, 2000)

Websites

The suggested references are intended to provide support for learners and teachers following the course. Some resources directly support the suggested teaching activities whilst others provide more general reference, background and extension material. All resources have been checked to ensure their relevance and academic level is suitable for the Cambridge O Level Biology syllabus. All references are to specific web pages rather than to the general site URL and may be followed directly from the electronic scheme of work or typed directly into the address bar of any web browser. A number of animation and video resources rely on the correct plug-in software being installed on the user's computer (e.g. QuickTime and Flash) – all of which are freely available for download via the internet.

Cambridge International Examinations is not responsible for the accuracy or content of information contained in the listed websites. The inclusion of a link to an external website should not be understood to be an endorsement of that website or the site's owners (or their products/services).

The website pages referenced in this scheme of work were selected when the scheme of work was produced. Other aspects of the sites were not checked and only the particular resources are recommended.

CD-ROM

BIOSCOPE (2004) – A CD of prepared microscope slides produced by Cambridge International Examinations, Cambridge-Hitachi, UK

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 – a 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 the 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
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
1(a)	Examine under the microscope an animal cell (e.g. from fresh liver) and a plant cell (e.g. from Elodea, a 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 • epidermal cells peeled from the inner surface of an onion bulb and stained with iodine solution • locally available plants with leaves which display mesophyll cells adhering to the peeled-off epidermis in order to show the presence of chloroplasts • freshwater filamentous algae, Elodea or a moss that can be mounted in a drop of water on a slide and viewed under a microscope. **(I) or (G)** 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. **(I)**	**Online:** PowerPoint presentation: Cells and Tissues: www.biology-resources.com/biology-CD.html Plant and animal cell structure diagrams and explanations: www.s-cool.co.uk/gcse/biology/cells/plant-and-animal-cells.html Illustrations of cells: www.cellsalive.com/
1(b)	Draw diagrams to represent		

Learning objectives		Suggested teaching activities	Learning resources
	observations of the plant and animal cells examined above		Cell structure: www.exploratorium.edu/imaging_station/activities/classroom/elodea_explorations/ca_elodea_explorations.php Video clip – cell structure: www.bbc.co.uk/learningzone/clips/plant-and-animal-cell-structures/4188.html **Textbooks:** *O Level Biology* – Unit 1 Cell structure *The Cambridge Revision Guide GCE O Level Biology* – Topic 1 Cell structure and organisation *Biology for IGCSE and O Level* – 1 Cells
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. **(I)** A more **challenging** activity is to use diagrams and photomicrographs showing these structures within different types of cells with which learners are unfamiliar. **(I), (P) or (G)**	
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). **(I)** A more **challenging** activity is to use diagrams and photomicrographs showing these structures within different types of cells with which learners are unfamiliar. **(I) or (G)**	
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. **(I)** 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. **(I) or (P)**	
1(f)	State the function of the cell membrane in controlling the	Explain why the passage of substances must be controlled. Extend the discussion by inviting learners to suggest chemicals that might pass in	**5090 past paper question:** Jun 2011 Paper 21 Q8

Learning objectives		Suggested teaching activities	Learning resources
	passage of substances into and out of the cell	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. **(W)**	
1(g)	State the function of the cell wall in maintaining turgor (turgidity) within the cell		
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. **(I)** A more **challenging** activity is for learners to research a greater range of specialised cells and their functions. **(I)** 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 biconcave discs to provide a large surface area for gas exchange and to make the cell flexible enough to pass through small capillaries. **(W)**	**Online:** Adaptations of specialised cells: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/cells/cells2.shtml Red blood cell diagram: www.s-cool.co.uk/assets/red_blood_cells.jpg Root hair cell diagram: www.bbc.co.uk/bitesize/ks3/science/images/plant_root_cell.gif **5090 past paper question:** Nov 2013 Paper 22 Q3
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. **(I)** 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. **(I) or (P)**	

Learning objectives		Suggested teaching activities	Learning resources
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. **(I)** Learners can draw a flow diagram from cells to a named organ system to gain an understanding of the complexity of the human body. **(I)** An outline of the human body can be used to draw in the main organs and organ systems of the body. **(W)** 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. **(P)**	**Online:** Hierarchy or organisation: http://lgfl.skoool.co.uk/content/keystage3/biology/pc/learningsteps/OLTLC/launch.html

Learning objectives		Suggested teaching activities	Learning resources
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. **(W)** 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. **(W)** 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. **(W)** 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. **(P) or (G)**	**Online:** PowerPoint presentation: Diffusion: www.biology-resources.com/biology-CD.html Diffusion animation and explanation: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/cells/cells3.shtml Diffusion practical activities: www.iit.edu/~smile/bi9508.html Agar cube practical instructions: www.practicalbiology.org/areas/advanced/exchange-of-materials/diffusion/effect-of-size-on-uptake-by-diffusion,37,EXP.html Agar cube practical video: www.youtube.com/watch?v=xuG4ZZ1GbzI **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 3 Diffusion and Osmosis (active transport also covered) *Biology for IGCSE and O Level* – 2 Diffusion, Osmosis and Active transport *O Level Biology* – Unit 2 Diffusion, Osmosis and Active Transport.

Learning objectives		Suggested teaching activities	Learning resources
			5090 past paper questions: Nov 2010 Paper 22 Q8 Nov 2011 Paper 22 Q1
2(b)	Define osmosis as the passage of water molecules from a region of higher water potential to a region of their lower water potential 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. **(W)** 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. **(W)** 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. **(W)**	**Online:** Visking tubing demonstration: http://en.wikibooks.org/wiki/School_Science/Apparatus_for_demonstrating_osmosis Osmosis animation and explanations: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/cells/osmosisact.shtml www.s-cool.co.uk/gcse/biology/cells/revise-it/moving-molecules **5090 past paper question:** Jun 2011 Paper 61 Q1
2(c)	Describe the importance of a 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 plant 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. **(W)** 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. **(W)** 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. **(I), (P) or (G)**	**Online:** Video clips of osmosis in onion epidermal cells: www.youtube.com/watch?v=gWkcFU-hHUk&feature=related www.youtube.com/watch?v=nHWUAdkYq4Q&feature=related **5090 past paper question:** Jun 2013 Paper 62 Q1

Learning objectives		Suggested teaching activities	Learning resources
		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. **(P) or (G)** Relate water uptake by osmosis to the structure of root hair cells covered earlier in this unit. **(W)**	
2(d)	Define active transport as the movement of 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	Explain the need for uptake of ions even when their concentration may 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. **(W)** Explain the importance of active transport in the specific context of the root hair cell and the intestinal villi. **(W)** 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. **(P) or (G)** A **challenging** data analysis activity is for learners to undertake the active uptake data task detailed in the online resources column. **(I)**	**Online:** Data task: active uptake: www.practicalbiology.org/areas/intermediate/exchange-of-materials/active-uptake/tracking-active-uptake-of-minerals-by-plant-roots,130,EXP.html **5090 past paper question:** Nov 2013 Paper 21 Q7a
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. **(W)** Explain the function of a catalyst in terms of altering the rate of a chemical reaction without itself being used up during the reaction. **(W)**	**Online:** Enzymes and their action: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/enzymes/enzymes1.shtml www.s-cool.co.uk/gcse/biology/enzymes/enzymes.html
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	

Learning objectives		Suggested teaching activities	Learning resources
		'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. **(I) or (P)**	www.abpischools.org.uk/page/modules/enzymes/enzymes1.cfm http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_enzymes_work.html Enzyme action and effect of temperature animation: www.biotopics.co.uk/other/enzyme.html Enzyme action and graphs showing effect of changing temp and pH: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/enzymes/enzymes1.shtml Catalase in potato tissue: http://practicalbio.blogspot.co.uk/2012/03/easy-enzyme-experiment-potato-catalase.html www.nuffieldfoundation.org/practical-biology/investigating-enzyme-controlled-reaction-catalase-and-hydrogen-peroxide-concentrat Effect of temperature on lipase: www.nuffieldfoundation.org/practical-biology/investigating-effect-temperature-activity-lipase Effect of pH on amylase: www.nuffieldfoundation.org/practical-biology/investigating-effect-ph-amylase-activity
3(d)	Investigate and describe the effects 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. **(W)** 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. **(I)** 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. **(P)** 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	

Learning objectives		Suggested teaching activities	Learning resources
		temperature **(P) or (G)**	**Textbooks:** *Biology for IGCSE and O Level* – 3 Enzymes *O Level Biology* – Unit 3 Enzymes *The Cambridge Revision Guide GCE O Level Biology* – Topic 4 Enzymes – Topic 5 **5090 past paper questions:** Nov 2011 Paper 62 Q1 Jun 2012 Paper 22 Q5 Nov 2012 Paper 32 Q1 Nov 2012 Paper 22 Q8

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
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
4(a)	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. **(W)**	**Online:** Photosynthesis diagrams and explanations covering several learning outcomes in this unit: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/plants/plants1.shtml www.s-cool.co.uk/gcse/biology/photosynthesis/revise-it/photosynthesis **Textbooks:** *Biology for IGCSE and O Level* – 5 How Green Plants Feed

Learning objectives		Suggested teaching activities	Learning resources
			O Level Biology – Unit 4 Photosynthesis *The Cambridge Revision Guide GCE O Level Biology* – Topic 6 Plant Nutrition
4(b)	Investigate the necessity for chlorophyll, light and carbon dioxide (CO_2) 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). **(P) or (G)** - For light, use aluminium foil or black paper held either side of a leaf using paperclips. **(P) or (G)** - 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. **(W)** 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. **(W)** 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. **(W)**	**Online:** Practical to investigate the factors affecting photosynthesis: www.practicalbiology.org/areas/introductory/energy/photosynthesis/identifying-the-conditions-needed-for-photosynthesis,74,EXP.html Animation showing starch test procedure: www.footprints-science.co.uk/index.php?module=1&type=Starch%20in%20leaf%20test&section=Section1&info=4 **5090 past paper question:** Nov 2011 Paper 31 Q1
4(c)	State the equation (in words or	An equation in words is adequate, however if given as an equation in	

Learning objectives		Suggested teaching activities	Learning resources
	symbols) for photosynthesis	symbols, it must balance. In both cases, 'light energy' rather than just 'energy' should be specified. **(W)**	
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 (CO_2). **(W)** 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*. **(G)** 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. **(I)** 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 hydrogencarbonate 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. **(P) or (G)**	**Online:** Practical to investigate the effect of light on photosynthesis in an aquatic plant: www.practicalbiology.org/areas/intermediate/energy/photosynthesis/investigating-factors-affecting-the-rate-of-photosynthesis,45,EXP.html *Elodea* investigation apparatus and effect of factors: www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-rate-photosynthesis Interactive activity: www.kscience.co.uk/animations/photolab.htm Investigating the behaviour of leaf discs: www.saps.org.uk/secondary/teaching-resources/284-investigating-the-behaviour-of-leaf-discs- **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. **(W)**	See **online** resources listed against 4(a). **5090 past paper question:** Nov 2010 Paper 21 Q8a

Learning objectives		Suggested teaching activities	Learning resources
		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. **(I)**	
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. **(W)** Explain the entry of CO_2 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. **(W)**	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. **(W)** 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 learners to suggest examples of such storage organs. **(W)** 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. **(I) or (P)**	**Online:** Uses of glucose made in photosynthesis: http://lgfl.skoool.co.uk/content/keystage3/biology/pc/learningsteps/USGLC/launch.html Photomicrograph of starch grains: www.microscopy-uk.org.uk/mag/imgoct09/Fig5.jpg
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. **(P) or (G)** 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	

Learning objectives		Suggested teaching activities	Learning resources
		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. **(W)**	
4(i)	Identify and label the cuticle, cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section under the 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 transverse section (TS) diagram of a leaf and identify the main tissues - explaining the role of each part in photosynthesis. **(W)** A basic activity is to supply learners with a large, clear, unlabelled drawing of a leaf transverse section (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. **(I)** A more **challenging** activity is for learners to draw a transverse section (TS) of the leaf from their observation of a microscope slide and to annotate this with details of the component structures. **(I)** Extend learners' practical work using the 'measuring stomatal density' activity from the online resources list. **(P)** 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. **(W)**	**Online:** Photomicrograph of leaf TS: http://images.botany.org/set-13/13-063v.jpg Leaf TS diagram (labelled): www.bbc.co.uk/schools/gcsebitesize/science/images/bi05004.gif Leaf TS diagram (unlabelled): www.ellenjmchenry.com/downloads/LeafCrossSectionColoringPage.pdf Measuring stomatal density: www.saps.org.uk/secondary/teaching-resources/299-measuring-stomatal-density- Video clip of guard cells opening and closing stomata: www.youtube.com/watch?v=cFX4JrsPaUs ***BIOSCOP*E (2004) CD** TS leaves of *Erica* and privet **5090 past paper question:** Nov 2011 Paper 22 Q6 Jun 2012 Paper 62 Q1
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	**Online:** Uses of glucose made in photosynthesis:

Learning objectives		Suggested teaching activities	Learning resources
		manufacture. Without magnesium a plant cannot photosynthesise and without proteins it cannot grow. **(W)** 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. **(W)** 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. **(G)**	http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/skoool/bio/step/glucose_uses/index.html Magnesium deficiency: www.gardenersworld.com/how-to/problems/flowers/magnesium-deficiency/433.html
6(a)	Relate the 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. **(W)**	**Online:** Root hair diagrams and photographs: www.biologie.uni-hamburg.de/b-online/e05/05b.htm Uptake by root hairs: http://lgfl.skoool.co.uk/viewdetails_ks3.aspx?id=572 **Textbooks:** *O Level Biology* – Unit 7 Transport in Flowering Plants *Biology for IGCSE and O Level* – 7 Transport *The Cambridge Revision Guide GCE O Level Biology* – Topic 8 Transport in Flowering Plants
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). **(W)**	**Online:** Transpiration animation: www.kscience.co.uk/animations/transpiration.swf

Learning objectives		Suggested teaching activities	Learning resources
6(c)	Describe: • how water vapour loss is related to cell surfaces, air spaces and stomata • the effects of air currents (wind), and the variation of temperature, humidity and light intensity on transpiration rate • how wilting occurs.	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. **(W)** 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. **(W)** 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. **(I)** 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. **(I)** 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. **(W)**	**Online:** Use of a potometer: http://en.wikibooks.org/wiki/School_Science/Potometer Potometer interactive activity: www.mhhe.com/biosci/genbio/virtual_labs/BL_10/BL_10.html **5090 past papers questions:** Jun 2011 Paper 21 Q2 Nov 2010 Paper 62 Q1
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. **(W)** 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. **(I) or (P)**	**Online:** Movement of dye through xylem of celery activity: www.york.ac.uk/res/sots/activities/celery.htm **5090 past paper question:** Jun 2011 Paper 22 Q6 Nov 2013 Paper 31 Q2

Learning objectives		Suggested teaching activities	Learning resources
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. **(W)**	**Online:** Resources for illustrating the movement of water during the transpiration stream: Transpiration animation: www.kscience.co.uk/animations/transpiration.swf
6(f)	Identify the positions of xylem and phloem tissues as seen in transverse sections (TS) of unthickened, herbaceous, dicotyledonous roots, stems and leaves	Use projected photomicrographs then diagrams to demonstrate the position and appearance of xylem and phloem in roots and stems (leaves have already been considered in 4(i) above). **(W)** 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. **(W) (I)** A more **challenging** activity is for learners to draw and label their own diagrams from observations of transverse section microscope slides of dicotyledonous roots, stems and leaves. **(I)** 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. **(I) or (P)**	***BIOSCOPE* (2004) CD**: TS and LS of *Ranunculus* stem and root
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). **(W)**	

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
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
5(a)	List the chemical elements that make up: • carbohydrates • fats • 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. **(W)**	**Online:** Nutrition and food groups: www.s-cool.co.uk/gcse/biology/nutrition/revise-it/nutrition www.abpischools.org.uk/res/coResourceImport/resources04/digestion/digest3.cfm **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 5 Nutrition *Biology for IGCSE and O Level* – 4 How Animals Feed

Learning objectives		Suggested teaching activities	Learning resources
			O Level Biology – Unit 5 Animal Nutrition – Diet
5(b)	Describe tests for: • starch (iodine in potassium iodide solution) • reducing sugars (Benedict's solution) protein (biuret test) • 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. **(I) or (P)** 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 prior to testing. **(I) or (P)**	**Online:** Food tests practical procedure: www.biotopics.co.uk/nutrition/footes.html Food tests practical animation: http://lgfl.skoool.co.uk/content/keystage3/biology/pc/learningsteps/FOTLC/launch.html **5090 past paper questions:** Nov 2011 Paper 31 Q2 Nov 2011 Paper 32 Q2 Jun 2013 Paper 62 Q2c
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. **(W)** Learners may present this information in the form of a three column table showing components, sources and dietary sources. **(I)** 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. **(I) (P)**	**Online:** Vitamins: http://kidshealth.org/teen/misc/vitamin_chart.html http://kidshealth.org/teen/food_fitness/nutrition/vitamind.html Minerals: http://kidshealth.org/teen/misc/mineral_chart.html http://kidshealth.org/teen/food_fitness/nutrition/calcium.html
5(d)	Name the diseases and describe the symptoms resulting from deficiencies of vitamin C (scurvy), vitamin D (rickets), 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	**Online:** Deficiency diseases: http://lgfl.skoool.co.uk/content/keystage3/biology/pc/learningsteps/MALLC/launch.html

Learning objectives		Suggested teaching activities	Learning resources
		the vitamins and minerals listed and present their findings either in a table or in the form of an illustrated poster. **(I)**	Scurvy and rickets: www.nhs.uk/conditions/rickets/pages/introduction.aspx www.nhs.uk/conditions/Scurvy/Pages/Introduction.aspx
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), 5(f) and 5(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. **(W)**	**Online:** Dietary food groups activity: www.footprints-science.co.uk/index.php?module=1&type=Food%20groups&section=Section1&info=2 Balanced diet video clips: www.bbc.co.uk/learningzone/clips/a-balanced-diet/10609.html **5090 past paper question:** Jun 2013 Paper 22 Q7a
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. **(W) (I) or (P)** 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. **(W) (I) or (P)** Learners may keep a record of the food they eat during a short period of time 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. **(I)** A more **challenging** activity is for learners to practically investigate and	**Online:** Energy requirements data table: www.nhlbi.nih.gov/health/public/heart/obesity/wecan/images/chart2_87.gif Interactive balanced diet: www.abpischools.org.uk/page/modules/balanceddiet/index.cfm Science Across the World: www.nationalstemcentre.org.uk/elibrary/resource/1727/talking-about-food-food-nutrition-and-health

Learning objectives		Suggested teaching activities	Learning resources
		compare the amount of energy in a variety of foods. Learners' basic mathematical 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. **(P)**	National nutrient database: www.nal.usda.gov/fnic/foodcomp/search/ Practical Biology - Energy in food: www.practicalbiology.org/areas/introductory/energy/energy-in-food/how-much-energy-is-there-in-food,42,EXP.html **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. **(W)**	**Online:** World Health Org. obesity site: 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. **(I) (G) (W)** 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. **(I)** 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. **(W)**	**Online:** Famine stimulus picture: http://i207.photobucket.com/albums/bb125/Cheeriotown/starvation.jpg Food Security - The problems of feeding the world's growing population with links to many articles: www.theguardian.com/global-development/food-security
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 regions of the alimentary canal. Avoid providing more labels than the syllabus requires. **(I)** 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. **(I)** The suggested online resources provide good source material in the form	**Online:** Regions of the digestive system: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/enzymes/enzymes_and_digestion1.shtml

Learning objectives		Suggested teaching activities	Learning resources
		of diagrams and animations to support these activities. **(W) (I)**	Digestive system and digestion – relevant to several learning outcomes. www.abpischools.org.uk/res/coResourceImport/resources04/digestion/index.cfm **Textbooks:** *O Level Biology* – Unit 6 Animal Nutrition – Digestion *The Cambridge Revision Guide GCE O Level Biology* – Topic 7 Animal Nutrition
5(j)	Describe the main functions of these parts in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate	The terms ingestion and absorption are usually easily understood. Stress that 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. **(W)** Add annotations to the labelled diagram provided in 5(i) to show which function(s) occur(s) in each region labelled. **(I)** 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. **(W) (I)**	See suggested resources above. **Online:** Visking tubing model gut demo: www.nuffieldfoundation.org/practical-biology/evaluating-visking-tubing-model-gut
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. **(W)**	**Online:** Types of teeth: www.crickweb.co.uk/assets/resources/flash.php?&file=teeth

Learning objectives		Suggested teaching activities	Learning resources
		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. **(I)**	Internal tooth anatomy: www.enchantedlearning.com/subjects/anatomy/teeth/toothanatomy.shtml **5090 past paper questions:** Nov 2013 Paper 31 Q3 Jun 2012 Paper 21 Q5a
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. **(W)** 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. **(I)** 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. **(W) (I)**	**Online:** Tooth decay animation: www.mchoralhealth.org/OpenWide/media/flash/decay_flash.htm **5090 past paper question:** Jun 2012 Paper 21 Q5b
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. **(W)** Use the online resource to show learners a video clip of peristalsis occurring in a patient. **(W)** Learners should describe the muscular action involved in peristalsis and explain its importance. **(I)**	**Online:** Digestion, including peristalsis diagram and animation: www.passmyexams.co.uk/GCSE/biology/digestive_system.html www.bbc.co.uk/schools/gcsebitesize/science/add_edexcel/common_systems/digestionrev2.shtml Endoscopic peristalsis video: www.youtube.com/watch?v=o18UycWRsaA&feature=player_embedded

Learning objectives		Suggested teaching activities	Learning resources
5(n)	Explain why most foods must be digested	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. **(W)** 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. **(W)**	**Online:** Macromolecules and end products of digestion: www.passmyexams.co.uk/GCSE/biology/images/enzymes_digestion.jpg
5(o)	Describe: • digestion in the alimentary canal • 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. **(W)** 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), adding the mixture to water and stirring. 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. **(W)** Refer back to the diagram provided in 5(i) and explain how each region and organ achieves the breakdown demonstrated in 5(n). **(W)** 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. **(I)**	**Online:** Digestion diagrams and explanations: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/enzymes/enzymes_and_digestion2.shtml www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/enzymes/enzymes_and_digestion3.shtml www.s-cool.co.uk/gcse/biology/nutrition/revise-it/digestion Digestion video clips: www.bbc.co.uk/learningzone/clips/the-digestive-system/4180.html **5090 past paper questions:** Jun 2011 Paper 21 Q5 Jun 2010 Paper 22 Q8

Learning objectives		Suggested teaching activities	Learning resources
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. **(W)** Make a large, labelled and annotated drawing of a villus. **(I)**	**Online:** Photomicrograph of villi: http://missinglink.ucsf.edu/lm/IDS_101_histo_resource/images/246x10-cell_structure_labelled.jpg Labelled diagram of villus: www.bbc.co.uk/schools/gcsebitesize/science/add_edexcel/common_systems/digestionrev5.shtml
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. **(W)** Make a large, labelled and annotated drawing of a villus. **(I)**	**Online:** Photomicrograph of villi: http://missinglink.ucsf.edu/lm/IDS_101_histo_resource/images/246x10-cell_structure_labelled.jpg Labelled diagram of villus: www.bbc.co.uk/schools/gcsebitesize/science/add_edexcel/common_systems/digestionrev5.shtml
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. **(W)**	**5090 past paper question:** Jun 2013 Paper 21 Q8a
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 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. **(W)** Simple modelling kits can be used to illustrate the concept of small molecules joining together to make larger ones. **(I) or (P)** Conversion of glucose into glycogen and its storage occur in the liver. Refer to 11(j) and (k) in Unit 5 for details.	**5090 past paper questions:** Jun 2011 Paper 21 Q6a Jun 2013 Paper 21 Q8b

Learning objectives		Suggested teaching activities	Learning resources
	• the role of fat as a storage substance • that the formation of urea and the breakdown of alcohol occur in the liver.	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. **(W)** 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. **(W)** 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. **(I)**	

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 is 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
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
7(a)	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. **(W)**	**Online:** William Harvey's experiment: www.princeton.edu/~his291/Harvey.html Heart and circulation: www.abpischools.org.uk/res/coResourceImport/resources04/heart/index.cfm Video clips: www.bbc.co.uk/learningzone/clips/human-circulation/12223.html www.bbc.co.uk/learningzone/clips/breathing-and-circulation/10607.html

Learning objectives		Suggested teaching activities	Learning resources
			5090 past paper question: Nov 2013 Paper 22 Q1 **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 9 Transport in Human Beings *Biology for IGCSE and O Level* – 7 Transport *O Level Biology* – Unit 8 Transport in Humans
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 relate these differences to the different functions of the two circuits	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 deoxygenated blood) diagrams of the double circulation. **(W)**	**Online:** Double circulation animations: www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/0_anatomy_circulatorysys_rev1.shtml **5090 past paper question:** Nov 2012 Paper 21 Q8a
7(c)	Name the main blood vessels that carry blood 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. **(I)**	**Online:** Simplified vessel diagram: www.ringwoodbiology.co.uk/rotheryimages/dblcirc.gif
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. **(I)** A demonstration dissection of a heart may be carried out, although be alert to the possible sensibilities of individual learners. **(W), (P) or (G)**	**Online:** Circulatory system animations: http://apan.net/meetings/busan03/materials/ws/education/demo-los/blood-rlo/circulatorysystem.swf Heart structure diagrams: www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/0_anatomy_circulatorysys_rev2.shtml

Learning objectives		Suggested teaching activities	Learning resources
			Practical Biology – Heart dissection: www.practicalbiology.org/areas/intermediate/cells-to-systems/structure-of-a-heart/looking-at-a-heart,76,EXP.html
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. **(I)** Learners may complete a table to compare the structure and function of the three types of blood vessel. **(I)** 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. **(I)** 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. **(W)**	**Online:** Blood vessel structure and function: www.s-cool.co.uk/gcse/biology/heart-and-circulation/revise-it/blood-vessels Blood vessel animations: www.medmovie.com/mmdatabase/MediaPlayer.aspx?ClientID=65&TopicID=771 ***BIOSCOPE* CD (2004)** TS of artery and of vein **5090 past paper questions:** Nov 2011 Paper 22 Q7 Jun 2013 Paper 22 Q9a
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 seconds 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 seconds every minute until the rate returns to normal. **(I)** 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. **(I) (W)**	**Online:** Practical Biology – Control of heart rate: www.practicalbiology.org/areas/intermediate/control-and-communication/control-of-heart-rate/observing-the-effects-of-exercise-on-the-human-body,75,EXP.html

Learning objectives		Suggested teaching activities	Learning resources
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. **(W)** 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. **(I)**	**Online:** CHD website including animation: http://hcd2.bupa.co.uk/fact_sheets/html/coronary_heart_disease.html
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. **(W)** 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. **(I)**	**Online:** Blood cell photomicrograph: http://t0.gstatic.com/images?q=tbn:ANd9GcQiS4CttgznwdI14O53cgxgCOItWJ6gzfPy078BX38FsAE5waH6_M_flvAt Images of blood cells: www.exploratorium.edu/imaging_station/gallery.php?Category=Blood%20Cells&Section= ***BIOSCOPE* CD (2004)** Human Blood
7(i)	List the components of blood as red blood cells, white blood cells, platelets and plasma		**Online:** Constituents of blood: www.pennmedicine.org/health_info/bloodless/000209.html
7(j)	State the functions of blood: • red blood cells – haemoglobin and oxygen transport • white blood cells – phagocytosis, antibody formation and tissue rejection	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. **(I)** The ability of haemoglobin to absorb and to release oxygen should be mentioned. Link to 5(d) Unit 3 – anaemia. **(W)** Learners may write a commentary to the online resource animations. A	**Online:** Action of white blood cells: www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/human/defendingagainstinfectionrev4.shtml Phagocytosis animation: www.edumedia-

Learning objectives		Suggested teaching activities	Learning resources
	• platelets – fibrinogen to fibrin, causing clotting • plasma – transport of blood cells, ions, soluble food substances, hormones, carbon dioxide, urea, vitamins and plasma proteins.	more **challenging** activity is to invite learners to suggest why transplants are likely to be more successful between closely related people. **(I)** Fibrinogen should be introduced as a plasma protein. The role of the clotting process and formation of a scab in preventing entry of pathogens should be included. Link to 5(d) in Unit 3 - calcium. **(W)** Learners may watch the suggested online animation and write an accompanying commentary. As an **extension** activity learners may research the disease haemophilia. **(I)**	sciences.com/en/a82-phagocytosis Blood clotting animation: www.footprints-science.co.uk/index.php?module=1&type=Blood%20clotting&section=Section1&info=1 **5090 past paper questions:** Jun 2013 Paper 22 Q9b Nov 2012 Paper 21 Q8b
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. **(W)** 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. **(W)**	
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. **(W)** 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. **(W)** 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 skills will be utilised in this activity. Extend the practical work by asking learners to present their numerical data in a variety of formats	**Online:** Aerobic and anaerobic respiration: www.s-cool.co.uk/gcse/biology/respiration/remember-it/s-cool-revision-summary **Note:** this resource is relevant to many of the subsequent learning objectives in this unit. Introduction to respiration: www.biotopics.co.uk/ **Textbooks:** *O Level Biology* – Unit 9 Respiration

Learning objectives		Suggested teaching activities	Learning resources
		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. **(P) (I)** An **extension** activity is to demonstrate the release of heat energy by germinating seeds. See online resource. **(G) or (W)**	*The Cambridge Revision Guide GCE O Level Biology* – Topic 10 Respiration *Biology for IGCSE and O Level* – 6 Respiration **5090 past paper question:** Nov 2011 Paper 32 Q2(c)
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. **(W)** An **extension** activity is to use a respirometer to demonstrate the uptake of oxygen by living tissue. See online resource. **(G) or (W)**	**Online:** 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). **(W)**	
8(d)	State the uses of energy in the human body: 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. **(W)** 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. **(I)**	
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. **(I)**	

Learning objectives		Suggested teaching activities	Learning resources
		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. **(W)**	
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. **(W)**	
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 the lactic acid being broken down into CO_2 and water. Use the stimulus photo of a runner with muscle cramp to elucidate ideas. **(I)** 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). **(W)**	**Online:** Marathon runner stimulus photo: http://therunningbug.co.uk/cfs-file.ashx/__key/communityserver-blogs-components-weblogfiles/00-00-00-00-34/1805.running_2D00_cramp.jpg
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. **(I)** 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. **(W)** Learners may breathe out through limewater 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. **(W)** Breathing into a test-tube of water at laboratory temperature for several minutes (to demonstrate the temperature of expired air) and onto dried	**Online:** Composition of air table: www.yteach.co.uk/page.php/resources/view_all?id=diaphragm_expiration_hemoglobin_inspiration_pleura_respiratory_system_lungs_t_page_22 **Online:** Huff-puff apparatus: http://upload.wikimedia.org/wikipedia/commons/6/68/Huff_'n'puff_equipment.png

Learning objectives		Suggested teaching activities	Learning resources
		cobalt chloride paper (to show presence of moisture) may be suitable investigations depending on ambient temperature and humidity. **(W)**	
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. **(W)** Working in pairs, with one learner as the subject, breathing rates before and after exercise may be measured (using the 'count for 15 seconds 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. **(P) (I)** 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. **(I)** A more **challenging** activity is for learners to explain the results of their investigation using their knowledge of aerobic and anaerobic respiration. **(I)**	**Online:** Using a spirometer: www.nuffieldfoundation.org/practical-biology/using-spirometer-investigate-human-lung-function
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. **(W) (I)**	**Online:** Thorax labelled diagram: www.homebusinessandfamilylife.com/images/respiratory_system.gif
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. **(W)** 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. **(W) (I)**	**Online:** Gas exchange animation: www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev3.shtml ***BIOSCOPE* CD (2004)** Lung (showing alveoli)

Learning objectives		Suggested teaching activities	Learning resources
		Learners may watch the animation from the online resource and then write a commentary to describe the process of gas exchange. **(I)**	
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. **(W)** Consider the mechanism by which these components result in altering the volume and pressure in the thorax. **(W)** 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. **(W)** A more **challenging** activity is for learners to construct similar models – see online resource. **(I) or (P)** Learners may use the method described in the online resource to simply measure their own lung capacity. **(I)**	**Online:** Inhalation and exhalation: www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev1.shtml Pupil-constructed model: www.nuffieldfoundation.org/practical-biology/modelling-human-ventilation-system Measuring lung capacity: www.biologycorner.com/worksheets/lungcapacity.html

Unit 5: Coordination, response, movement and homeostasis

Recommended prior knowledge
Some knowledge of cells, blood and the circulatory system, osmosis and enzymes (particularly the effect of temperature on enzyme activity) would be helpful. A basic understanding of the behaviour of light rays as they pass through lenses would be useful, though not essential.

Context
This unit builds on the idea that all units so far studied do not describe activities which operate in isolation within the body. All processes are interlinked to maximise the survival and success of the organism.

Outline
Waste products from metabolism must not be allowed to accumulate within a body. Their removal is linked to the maintenance of a constant internal environment. In the unit, the removal of carbon dioxide is considered as well as a simple treatment of the structure of the excretory system. The function of the kidney and of the artificial kidney is given basic coverage and the homeostasis theme is continued with skin structure, temperature regulation and control by negative feedback. Nervous and hormonal control is studied in relation to co-ordination, with reflex actions being amplified by a wider consideration of eye structure and the antagonistic arrangement of muscles in the arm.

Learning objectives		Suggested teaching activities	Learning resources
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
9(a)	Define excretion as the removal of toxic materials and the waste products of metabolism from organisms	Teachers should be aware that many learners hold an inaccurate belief that excretion is the correct term for defecation. **(W)**	**Textbooks:** *Biology for IGCSE and O Level* – 10 Homeostasis and Excretion *O Level Biology* – Unit 10 Excretion *The Cambridge Revision Guide GCE O Level Biology* – Topic 12 Excretion
9(b)	Describe the removal of carbon dioxide from the lungs	This objective links excretion with respiration considered in Unit 4 and will already have been described when considering gaseous exchange and exhalation.	**5090 past paper question:** Nov 2013 Paper 22 Q7a

Learning objectives		Suggested teaching activities	Learning resources
9(c)	Identify on diagrams and name the kidneys, ureters, bladder, urethra, and state the function of each (the function of the kidney should be described simply as removing urea and excess salts and water from the blood. Details of kidney structure and nephron are **not** required)	Note that 'ureter' and 'urethra' **must** be spelt correctly. Stress that it is **excess** water which is removed and refer to this helping to maintain the blood at a constant concentration. **(W)** A diagram identifying the structures may be shown to learners who may then label their own copy. **(I)** Learners may add annotations to their diagram to describe the function of each labelled component. **(I)**	**Online:** Labelled urinary tract diagram: www.enchantedlearning.com/subjects/anatomy/urinary/label/answers.GIF Unlabelled urinary tract diagram: www.enchantedlearning.com/subjects/anatomy/urinary/label/label.GIF **5090 past paper questions:** Nov 2011 Paper 21 Q8 Nov 2013 Paper 22 Q7b
9(d)	Describe dialysis in kidney machines as the diffusion of waste products and salts (small molecules) through a membrane; large molecules (e.g. protein) remain in the blood	A simple labelled diagram of a kidney dialysis machine should be provided. **(I)** Use the suggested online animation to demonstrate the movement of substances across the dialysis membrane and to show that the content and concentration of the dialysis fluid controls which substances leave the blood. Learners may then write a summary of how the structure of the dialysis machine is related to its function. **(W) (I)** Submerge lengths of Visking tubing, tightly tied at both ends, in distilled water. One tube should contain a solution of egg albumen (use dried albumen to make the solution) and the other a solution of glucose. After 30 minutes test the distilled water for the presence of protein and reducing sugar. **(W)** As learners will have met Visking tubing as a partially permeable membrane associated with osmosis in Unit 1 it will be necessary to explain that water molecules are not the only ones able to pass through (Note: Visking tubing is available with different-sized 'pores'). **(W)**	**Online:** Dialysis machine diagram: www.goldiesroom.org/Multimedia/Bio_Images/13%20Human%20Other/13%20Kidney%20Dialysis.jpg Dialysis membrane animation: http://healthsciences.merlot.org/images/18loop.gif Revision – kidney failure: www.s-cool.co.uk/gcse/biology/homeostasis/revise-it/dealing-with-kidney-failure **5090 past paper questions:** Jun 2011 Paper 22 Q7 Nov 2012 Paper 22 Q7

Learning objectives		Suggested teaching activities	Learning resources
10(a)	Define homeostasis as the maintenance of a constant internal environment	'Internal environment' may be explained as 'conditions within the body'. **(W)** 'Homeostasis' may be split into 'homeo' (meaning 'the same') and 'stasis' (meaning 'staying' or 'standing'). **(W)** Learners may watch the suggested animated videos following which a class 'brainstorm' can be used to list the body functions controlled by homeostasis and the organs involved. **(W)**	**Online:** Homeostasis animated videos: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/homeo/homeosts.shtml www.phys.unsw.edu.au/biosnippets/biosnippets_container2.swf Homeostasis introduction: www.s-cool.co.uk/gcse/biology/homeostasis/revise-it/what-is-homeostasis **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 13 Homeostasis *O Level Biology* – Unit 11 Homeostasis *Biology for IGCSE and O Level* – 10 Homeostasis and Excretion
10(b)	Explain the concept of control by negative feedback	The operation of a thermostat illustrates the concept well, but it should be explained that temperature is not the only variable that can be controlled. An introduction relating to temperature control leads comfortably on to learning objective 10(d). **(W)** Use the negative feedback cycle diagram to explain the steps involved in controlling a constant room temperature and then diversify to explain the control of homeostatic functions in the body listed when studying 10(a) above. **(W)**	**Online:** Negative feedback cycle: www.bbc.co.uk/bitesize/higher/biology/images/01stages_negativefdback.gif

Learning objectives		Suggested teaching activities	Learning resources
10(c)	Identify, on a diagram of the skin, hairs, sweat glands, temperature receptors, blood vessels and fatty tissue	Provide learners with a labelled diagram of the skin to show the features required. The suggested online resource may be printed for this purpose and learners asked to add temperature receptors to the diagram. **(I)**	**Online:** Skin (no temp. receptor shown): www.ewart.org.uk/biology/pics/skin.gif
10(d)	Describe the maintenance of a constant body temperature in humans in terms of insulation and the role of temperature receptors in the skin, sweating, shivering, blood vessels near the skin surface and the coordinating role of the brain	The functions of the labelled structures are important here. Stress that capillaries **do not move** nearer or further away from the skin surface and that they **do not** constrict or dilate (as they are not muscular). **(W)** Learners may use the online interactive activity, following which two bullet-point lists can be made to outline the ways in which the body responds to cause an increase or decrease in its internal temperature. **(I)** A more **challenging** activity is for learners to complete the sweating data analysis task from the online resources. **(I)** Describe the role of the brain in monitoring the temperature of blood flowing through it and the control, via nerves, of the action effectors in the skin to bring about the changes previously listed. **(W)**	**Online:** Temperature regulation by skin: www.abpischools.org.uk/page/modules/skin/skin3.cfm Sweating data analysis task: www.practicalbiology.org/areas/intermediate/control-and-communication/homeostasis/interpreting-information-about-sweating-and-temperature,125,EXP.html **5090 past paper questions:** Jun 2010 Paper 22 Q4 Nov 2011 Paper 21 Q3 Nov 2013 Paper 21 Q1
11(a)	State that the nervous system (brain, spinal cord and nerves) serves to coordinate and regulate bodily functions	Provide a simple diagram showing the three main parts and explain that all parts of the body are served by the nervous system. **(I)** An activity to emphasise the importance of the nervous system is for learners to investigate the speed of their reaction time using the online resources. **(I)** A more **challenging** activity is for learners to deduce the pathway taken by nervous impulses from the time a stimulus appears to their response. Ask learners to discuss this after their investigation and to construct a flow diagram. **(I)**	**Online:** Nervous system basic diagram: http://medicalimages.allrefer.com/large/nervous-system-1.jpg Testing reaction time: www.bbc.co.uk/science/humanbody/sleep/sheep/ www.humanbenchmark.com/tests/reactiontime/index.php **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 14 Coordination and Response

Learning objectives		Suggested teaching activities	Learning resources
			Biology for IGCSE and O Level – 9 Coordination and Response *O Level Biology* – Unit 12 Coordination
11(b)	Identify, on diagrams of the central nervous system, the cerebrum, cerebellum, pituitary gland and hypothalamus, medulla, spinal cord and nerves	Provide a labelled diagram of the brain showing the required features - avoid any further labels not required by the syllabus. **(I)**	**Online:** Labelled diagram of brain: www.epilepsy.org.au/sites/all/themes/epilepsy/images/brain_regions.jpg
11(c)	Describe the principal functions of the above structures in terms of coordinating and regulating bodily functions	Learners may use the suggested online resource to add annotations to the diagram from 11(b) (or to produce a separate table) outlining the major functions of each named structure. **(I)** A more **challenging** activity is for learners to consider the problems that would be associated with damage to different areas of the brain. **(I) or (G)**	**Online:** Brain structure and function: http://kidshealth.org/en/kids/nsmovie.html?WT.ac=en-k-htbw-main-page-f **5090 past paper questions:** Jun 2010 Paper 21 Q7 Jun 2013 Paper 21 Q2b
11(d)	Describe the gross structure of the eye as seen in front view and in horizontal section	The front view of the eye may be studied by learners using hand-mirrors and a list of the structures observed collated. Learners may draw and label the front view of one of their eyes using a mirror. **(I)** A demonstration dissection of an eye is a possible **extension** activity; however learners often find it difficult to relate eye structure as seen in this way to structure as represented diagrammatically. **(W)** Invite learners to demonstrate their blind spots by drawing two small circles about 9 cm apart and moving them towards and away from one eye with the other closed. The second spot disappears at a distance of about 30 cm. **(I)** Learners may use the suggested online resources to label a diagram of the eye in horizontal section following which their understanding may be	**Online:** Eye anatomy: www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway_pre_2011/ourselves/3_keeping_in_touch2.shtml Eye and vision, for learning objectives 11(d) to 11(f): www.s-cool.co.uk/gcse/biology/nerves-and-hormones/revise-it/the-eye

Learning objectives		Suggested teaching activities	Learning resources
		assessed by providing a large diagram of the eye and laminated cards on which important labels are written. Learners then place cards on the diagram to label the components. **(P) (I)**	Eye labelling activities: www.kscience.co.uk/animations/eye_drag.htm www.kscience.co.uk/animations/eye_function_drag.htm ***BIOSCOPE* CD (2004)** Rat eye
11(e)	State the principal functions of component parts of the eye in producing a focused image of near and distant objects on the retina	Explain that refraction of light occurs at both the cornea and the lens (which fine-tunes the focus depending on the distance away of the object). Explain the action of the ciliary muscles in **reducing** tension on the suspensory ligaments as they contract (note that the ligaments themselves do not contract). Details of rod and cone cells are not required. **(W)** Learners may draw simple ray diagrams of light from both near and distant objects being focused on the fovea and showing the different shapes of the lens in each case. **(I)** Accommodation may be demonstrated by reading and then looking outside to a distant object. **(I)**	See suggested resources listed above. **5090 past paper question:** Jun 2012 Paper 22 Q1
11(f)	Describe the pupil reflex in response to bright and dim light	Working in pairs, learners may observe on one another the effect of turning on a bench lamp or torch (with a bulb of low rating) held about a metre from the eye. Learners may draw labelled diagrams of the pupil and iris in each instance and add annotations to explain their observations. **(P)** Stress the distinction between ciliary muscles and those present in the iris. The antagonistic action of the iris muscles (circular and longitudinal) should be mentioned together with the reasons for this reflex. **(W)**	**Online:** Iris muscle action in pupil reflex: www.apsu.edu/thompsonj/anatomy%20&%20physiology/2010/2010%20exam%20reviews/exam%204%20review/15-09_Pupil.JPG **5090 past paper question:** Jun 2012 Paper 21 Q4
11(g)	Outline the functions of sensory neurones, relay neurones and motor neurones	Learners may draw diagrams of the three types of neurone and specify the function of each – possibly following study of 11(h) below. **(I)** Stress that neurones carry ‘electrical impulses’ (**not** ‘messages’ or ‘signals’).	**5090 past paper question:** Jun 2011 Paper 21 Q9

Learning objectives		Suggested teaching activities	Learning resources
11(h)	Discuss the function of the brain and spinal cord in producing a coordinated response as a result of a specific stimulus (reflex action)	All learners will be familiar with the rapid withdrawal of their hand when it accidentally comes into contact with a hot object. This reflex may be used to introduce the steps and structures involved in a reflex arc. Cross-reference this example of a 'spinal reflex' with the pupil reflex studied in 11(f) as an example of a 'cranial reflex' centred on the brain. A labelled diagram may also include structural details of the arm bones, joints and antagonistic muscle arrangement required in 12(a), 12(b) and 12(c) below. **(W) (I)** Learners may demonstrate the 'knee jerk' response by striking below their kneecap with their hand whilst their legs are loosely crossed. Learners may then write an account, in the form of numbered steps, to explain each step involved in the reflex arc. **(P) (I)** Learners may be invited to identify the stimuli, receptors and effectors in two other reflex actions – including one where the effector is a gland (e.g. salivation upon smelling food cooking). **(I)**	**Online:** Reflex arc animation (withdrawal): www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/brain_mind/reflexactionsrev1.shtml Reflex arc diagram (knee jerk): http://classroom.sdmesa.edu/eschmid/F10.04.L.150.jpg **5090 past paper question:** Nov 2010 Paper 21 Q7
11(i)	Define hormone as a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver	Unit 3 considered substances passing between tissue fluid and blood capillaries. Here we identify a useful substance passing from cells into the circulatory system, performing a particular function, then being destroyed. Cross reference 9(a) in this unit as hormones are removed from the body as waste products of metabolism. **(W)**	**5090 past paper question:** Nov 2010 Paper 22 Q6
11(j)	State the role of the hormone adrenaline in boosting the blood glucose concentration and give examples of situations in which this may occur	Ask learners to 'brainstorm' specific 'fight or flight' situations. Invite learners to offer suggestions for the value of increased blood glucose in these situations. **(I) (W)** A more **challenging** activity is to ask learners to list and explain other areas of their biological knowledge that this learning objective relates to (which include links with 5(s) in Unit 3 and 8(d) in Unit 4). **(I) (W)**	
11(k)	state the role of the hormone insulin in controlling blood glucose concentration	Learners may interact with the animations in the suggested online resources and may then write an account, in the form of numbered steps, to outline the events that take place to achieve control of blood glucose concentration. **(I)**	**Online:** Control of blood glucose: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/homeo/homeostasis2.shtml

Learning objectives		Suggested teaching activities	Learning resources
			Blood glucose control animation: www.abpischools.org.uk/res/coResourceImport/modules/hormones/en-flash/bloodsugar_b.cfm
11(l)	Describe the signs (increased blood glucose concentration and glucose in urine) and treatment (administration of insulin) of diabetes mellitus	It may be possible to invite a diabetic into the classroom to offer further information. **(W)** Learners may use the suggested online resource to research the signs and treatment of diabetes and to summarise their findings in the form of a brief talk or presentation. **(I)**	**Online:** Diabetes information sites: www.diabetes-explained.co.uk/ www.abpischools.org.uk/page/modules/diabetes/index.cfm
12(a)	Identify and describe, from diagrams, photographs and real specimens, the main bones of the forelimb (humerus, radius, ulna and scapula) of a mammal	Examine the bones (or photographs or drawings of the bones) of a small mammal. Learners should learn to identify each bone, how they fit together and the type of joint formed in each case. **(P) or (G)** Learners may prepare labelled diagrams of their observations. Where actual specimens and photographs are difficult to obtain, X-ray photographs may be used to illustrate both the bones and the joints. **(I)** An **extension** activity is for learners to use paper drinking straws to investigate a model of how 'bone' strength changes with length and bone pairing. Clamp either one or two paper drinking straws of varying length between two retort stands. Hang an increasing mass on the straws and record how much mass it takes for the straws to buckle. Learners should deduce that shorter straws arranged in pairs provide the strongest arrangement. Ask learners to relate their findings to the arrangement of bones in the forelimb. **(P) (I)**	**Online:** Skeleton: www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/2_anatomy_skeleton_rev1.shtml Elbow joint anatomy: www.nyboneandjoint.com/wp-content/uploads/2013/10/Anatomy-of-the-Elbow1-385x256.jpg **Textbooks:** *Biology for IGCSE and O Level* – 11 Support and Movement *The Cambridge Revision Guide GCE O Level Biology* – Topic 11 Support, Movement and Locomotion *O Level Biology* – Unit 13 Support, Movement and Locomotion **5090 past paper question:** Jun 2010 Paper 61 Q3

Learning objectives		Suggested teaching activities	Learning resources
12(b)	Describe the type of movement permitted by the ball and socket joint and the hinge joint of the forelimb	Learners may locate the prescribed joints on a diagram of the human skeleton and annotate the diagram to show the type of joint and the type of movement permitted in each case. **(I)** Ask learners to identify other examples of ball and socket and hinge joints in the body and to add labels to their diagrams to show their location. **(I)**	
12(c)	Describe the action of the antagonistic muscles at the hinge joint	These muscles show similarities to those already described in the iris in 11(f). Muscles work only when they contract - they can pull but never push. Note that inelastic tendons transmit force to the bones. **(W)** Use the suggested online resource to review the action of muscles at the hinge joint. Learners may be provided with two copies of a similar diagram and annotate each to indicate the role of muscles and tendons when the arm is raised and lowered. **(I)**	Hinge joint animation: www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/life_processes/revision/8/ **5090 past paper question:** Nov 2013 Paper 21 Q2

Unit 6: Drugs, microorganisms and biotechnology

Recommended prior knowledge
It would be helpful, but not essential, to have a basic understanding of the respiratory system and of the structure of the circulatory system as well as of respiration and enzymes.

Context
Although the use and abuse of drugs does not sit entirely comfortably with the other topics in the unit, references to bacteria run from antibiotics, through to microorganisms and biotechnology. The section on drugs picks up on knowledge gained in 5(s) in Unit 3 and 8(j) to 8(l) in Unit 4. Biotechnology re-visits anaerobic respiration covered in 8(e) and 8(f) in Unit 4.

Outline
Drugs are considered from both the helpful and the harmful angle. Included in the abuse of drugs is an appraisal of the harmful effects of alcohol and of smoking. Benefits of microorganisms and their use in various forms of biotechnology are then considered.

Learning objectives		Suggested teaching activities	Learning resources
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
13(a)	Define a drug as any externally administered substance that modifies or affects chemical reactions in the body	Stress that drugs have side effects, must be taken only in the correct dosage, only by the person for whom they are prescribed and only when required. **(W)**	**Textbooks:** *Biology for IGCSE and O Level* – 13 Health, Disease and Medicine *The Cambridge Revision Guide GCE O Level Biology* – Topic 15 The Use and Abuse of Drugs *O Level Biology* – Unit 14 The Use and Abuse of Drugs

Learning objectives		Suggested teaching activities	Learning resources
13(b)	Describe the medicinal use of antibiotics for the treatment of bacterial infection	Explain that certain antibiotics are more effective against certain types of bacteria. Also explain that the more resistant bacteria are the last to be killed and if the course is not completed the resistant bacteria survive, spread, and are then much less effectively treated by the same antibiotic. **(W)** Learners may watch the suggested online video clip and write a commentary to help them to understand issues surrounding the development of antibiotic resistant bacteria. **(I)**	**Online:** Antibiotics: http://hcd2.bupa.co.uk/fact_sheets/html/antibiotics.html Antibiotic resistance video clip: www.sumanasinc.com/scienceinfocus/antibiotics/antibiotics_fla.html Antibiotic resistance information: www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/disease/antibioticsdrugtestingrev2.shtml
13(c)	Describe the effects of the abuse of heroin: a powerful depressant, problems of addiction, severe withdrawal symptoms and associated problems such as crime and infection, e.g. AIDS	Learners should be aware that heroin has a valuable use as an effective reliever of severe pain. A side effect is to slow down brain functions and give a feeling of intense well-being, but when addicted, progressively greater amounts are taken to achieve the same level of euphoria. **(W)** Withdrawal from drugs like heroin is extremely uncomfortable, but not dangerous unless they are mixed with other drugs. Heroin withdrawal on its own does not produce seizures, heart attacks, strokes, or delirium. **(W)** Crime is used to fund the habit. If heroin is injected with used needles, diseases such as AIDS may be spread. **(W)** Learners may research the biological and social effects of heroin using the suggested online resources and produce a 'spider diagram', written summary or class presentation to summarise the findings of their research. **(I)**	**Online:** Heroin facts: http://faculty.washington.edu/chudler/hero.html www.talktofrank.com/drugs.aspx?id=186 **5090 past paper question:** Jun 2011 Paper 22 Q8
13(d)	Describe the effects of excessive consumption of alcohol: reduced self-control, depressant, effect on reaction times, damage to liver and social implications	Note that excessive alcohol consumption is being considered. Social implications include being a danger to others (e.g. slowed reaction times when driving) as well as crime committed, both when under the influence and to fund the habit. Liver damage results from excessive long-term alcohol use – cross reference with 5(s) in Unit 3. **(W)** Learners may produce a two column table listing the biological and social	**Online:** Effects of alcohol: www.drinkaware.co.uk/check-the-facts/health-effects-of-alcohol

Learning objectives		Suggested teaching activities	Learning resources
		effects of excessive alcohol consumption. **(I)**	Alcohol addiction including links to other useful sites: www.nhs.uk/live-well/addiction/alcohol-addiction **5090 past paper question:** Jun 2013 Paper 21 Q7b
13(e)	Describe the effects of tobacco smoke and its major toxic components (nicotine, tar and carbon monoxide) on health: strong association with bronchitis, emphysema, lung cancer and heart disease, and the association between smoking during pregnancy and reduced birth weight of the baby	Apart from a description of the listed effects, learners should be referred to their knowledge of lung structure from Unit 4, 8(j), 8(k) and 8(l) for an explanation of tar coating the walls of the alveoli, for the destruction of cilia and the consequent build-up of mucus, and for the effect of emphysema. **(W)** A variety of research (book and internet) and presentation styles (e.g. written summaries, class presentations and annotated diagrams) may be used to appropriately challenge and assess learners' understanding of this theoretical component of the course. **(I), (P), or (G)** Using a filter pump to draw smoke from a lighted cigarette through a cotton-wool filter provides a graphic and effective demonstration of the tar deposit from one cigarette. Addition of universal indicator shows production of an acidic gas. **(W)**	**Online:** Tar, nicotine and CO: www.tree.com/health/smoking-tar.aspx http://info.cancerresearchuk.org/healthyliving/smokingandtobacco/howdoweknow/tobacco-smoking-and-cancer-the-evidence Smoking and pregnancy: www.bupa.co.uk/health_information/html/healthy_living/lifestyle/smoking/smoking_pregnancy.html Smoking machine demo: www.practicalbiology.org/areas/intermediate/health-and-disease/health-choices/whats-in-cigarette-smoke,67,EXP.html
13(f)	Recognise the fact that many people regard smoking as no longer socially acceptable	Refer to research on the link between lung cancer and 'passive' smoking, as well as to the effect on the eyes and clothes of those in the presence of a smoker. **(W)** Teachers may wish to use data from the 'smoking statistics' online resource to provide more **challenging** data-handling exercises for learners to consider. **(I)** Extend learners' research skills and provide a global perspective on the topic	**Online:** Passive smoking article: www.guardian.co.uk/society/2010/nov/26/passive-smoking-deaths-who-report

Learning objectives		Suggested teaching activities	Learning resources
		by asking learners to research and discuss recent changes in the law in some countries to restrict the sale of tobacco and/or smoking in public places. Use the online resources to discuss whether the scope of these laws should be extended further. followed by discussion. **(I), (P) or (G)**	International smoking statistics: www.theguardian.com/news/datablog/2012/mar/23/tobacco-industry-atlas-smoking
14(a)	List the main characteristics of the following groups: viruses, bacteria and fungi	Present learners with labelled diagrams of the external features of each type of organism. Learners may use the suggested online resource to produce a supporting table comparing these organisms. **(I)**	**Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 16 The Diversity of Organisms *O Level Biology* – Unit 15 Micro-organisms and Biotechnology *Biology for IGCSE and O Level* – 14 Making Use of Microorganisms **5090 past paper question:** Jun 2012 Paper 21 Q2a
14(b)	Outline the role of microorganisms in decomposition	Explain that the ions, originally absorbed by plants, (cross reference 4(j) in Unit 2), are released again when bacteria decompose dead plants and animals in a reverse of the process which attached them to organic molecules within the plant. Microorganisms release enough energy (as heat) as they respire during this process that compost/manure heaps steam, smoke and may even catch fire. **(W)** Produce a table or 'spider diagram' listing how a range of factors affect the rate of decomposition. **(I)** A basic activity is to use the stimulus photo showing a steaming compost heap and/or a video of fruit decaying – asking learners to discuss and/or write a description of the processes occurring. **(W) (I) or (P)** A more **challenging** activity is for learners to extend their discussion and written work to include details of the process occurring to bring about the changes observed. **(P)**	**Online:** Compost heap stimulus photo: http://hotdogjam.files.wordpress.com/2008/11/compost_heap.jpg Time-lapse decay video: www.bbc.co.uk/schools/gcsebitesize/design/foodtech/acidoxitempre v2.shtml Factors affecting decomposition: www.bbc.co.uk/schools/gcsebitesize/science/add_gateway_pre_2011/greenworld/decayrev1.shtml

Learning objectives		Suggested teaching activities	Learning resources
14(c)	Explain the role of yeast in the production of bread and alcohol	In 8(e) and 8(f) in Unit 4 learners learnt that a form of anaerobic respiration (fermentation) turns sugar into alcohol and CO_2. Explain that the CO_2 is used in bread making to make the dough rise and the CO_2 provides sparkle to alcoholic drinks in which fruit or other plant sugars are used as the substrate. Yeast provides a collection of enzymes during anaerobic respiration to catalyse this process. **(W)** Learners may use the suggested online resources to research and present information explaining the science behind the production of these foods. **(I)** A more **challenging** activity is for learners to use yeast in a glucose solution to: • demonstrate the anaerobic evolution of CO_2. The rate may be measured at different temperatures using a water bath and counting the number of bubbles released from a narrow delivery tube in unit time • make dough with flour placed in a measuring cylinder. The rate of CO_2 release can be measured as the dough rises up the cylinder. Different temperatures could be investigated. Measurements could be recorded and graphs of the rate of respiration (distance risen in unit time) against temperature could be drawn. **(G)** Learners may use data collected from their practical work and use these to construct tables, draw graphs and write conclusions relating their results to the supporting theory. Link with work on enzymes from Unit 1. **(I)**	Bread making: www.guardian.co.uk/science/blog/2009/nov/26/science-breadmaking Demo CO_2 production by yeast: http://image.tutorvista.com/content/respiration/alcoholic-fermentation-demonstration.jpeg Time-lapse dough rising video: www.youtube.com/watch?v=Sgr9gery9dY **5090 past paper question:** Nov 2013 Paper 32 Q1
14(d)	Outline the role of bacteria in yoghurt and cheese production	The production of lactic acid is now relevant as this is the agent that sours the milk. Learners may read and discuss the suggested online resource and produce a written summary of: • how bacteria are used to produce yoghurt from milk • how production of yoghurt allows milk to be preserved. **(I) (P)** Learners may watch the video of cheese production and produce a flow chart to summarise and explain each of the steps in the production process. **(I)**	**Online:** Lactic acid producing bacteria: www.eufic.org/article/en/page/FTARCHIVE/artid/lactic-acid-bacteria/ Cheese production video: www.foodafactoflife.org.uk/VideoActivity.aspx?contentId=163&sectionId=63&siteId=14&titleId=171

Learning objectives		Suggested teaching activities	Learning resources
			5090 past paper question: Jun 2010 Paper 62 Q3
14(e)	Describe the use of fermenters for large-scale production of antibiotics and single cell protein	Provide learners with a copy of a labelled diagram of an industrial fermenter to which they may add annotations to explain the significance of each feature labelled. **(I)** The general principles of controlling amount of substrate and temperature, sterilisation of utensils, production of large yields in a small space and purification of product should be covered. **(W)** Even though the substrates are often waste products from other industries (e.g. molasses from sugar refining), expense can often be a disadvantage. **(W)**	**Online:** Fermenter diagram: www.biotopics.co.uk/microbes/penici.html **5090 past paper questions:** Nov 2011 Paper 21 Q6 Jun 2013 Paper 22 Q5
14(f)	Describe the role of the fungus *Penicillium* in the production of penicillin	Understand the nature of penicillin as a secondary metabolite and the conditions required for its production. **(W)** A more **challenging** activity is for learners to watch the online video summarising the discovery of penicillin and to write an outline describing how the methods used in penicillin's early production are in contrast to the large commercial production of the drug today. **(I)**	**Online:** Discovery of penicillin video: http://videos.howstuffworks.com/science-channel/29783-100-greatest-discoveries-penicillin-video.htm

Unit 7: Organisms and the environment

Recommended prior knowledge
Learners should have knowledge of the different forms of energy, of plant nutrition, respiration and transpiration. Knowledge of the great diversity of life and habitats would be helpful.

Context
This unit, whilst considering some of the fundamental topics of biology, also takes a broader view of the subject and investigates some of the ethical issues raised by human interference with the environment.

Outline
Energy flow is traced through biological systems and the carbon and nitrogen cycles are considered in some detail. There is a reference to parasitism in the shape of the transmission and control of malaria, but control measures employed lead into a consideration of the human effect on the ecosystem in a wider sense – deforestation, pollution and damage to habitats leading to a need for conservation.

Learning objectives		Suggested teaching activities	Learning resources
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
15(a)	State that the Sun is the principal source of energy input into biological systems	Stress that it is **light** energy from the Sun which is important in photosynthesis, but enzymes controlling all metabolic reactions rely also on its heat energy to provide a suitable temperature for their operation. **(W)**	**Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 17 The Relationship between Organisms and the Environment *O Level Biology* – Unit 16 Organisms and Environment *Biology for IGCSE and O Level* – 15 Living organisms and their environment
15(b)	Describe the non-cyclical nature of energy flow	Once energy is released by organisms it is lost and can be replaced only by further input, directly or indirectly, from the Sun. **(W)**	
15(c)	Define the following terms and establish the relationship of	Learners may be able to suggest food chains in various different habitats.	**Online:** Food chains and terminology:

Learning objectives		Suggested teaching activities	Learning resources
	each in food webs: producer, consumer, herbivore, carnivore, decomposer, food chain	Learners may be provided with a food chain of at least three organisms, starting with a producer, and write each of the specified words underneath the appropriate component of the food chain provided. **(I)** If learners have the opportunity to visit a habitat, even if only in the school grounds, they may construct a food chain based on their observations. **(W)**	www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/foodchains/foodchains1.shtml **5090 past paper question:** Jun 2010 Paper 22 Q7(a)
15(d)	Describe energy losses between trophic levels and infer the advantages of short food chains	In 8(d) in Unit 4 learners considered the use of energy for different processes in a body, thus there is always less energy available to each successive level in a food chain or web. **(W)** Use the suggested online resource called 'energy transfer' to review the ways in which energy may be lost between trophic levels. Learners may make a bullet-point list of these and explain why food chains are commonly limited in length. **(I)** The efficiency of food production in terms of placing humans as primary consumers and of reducing energy losses through factory farming may be discussed with reference to named examples (including chickens and pigs) generated by learners. The video clips may be used to introduce and to reinforce this learning objective. **(W)**	**Online:** Energy transfer: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/foodchains/foodchains2.shtml **5090 past paper question:** Jun 2010 Paper 21 Q1
15(e)	Describe and interpret pyramids of numbers and of biomass	It should be explained why pyramids of biomass (which are of typical pyramid shape) provide a more accurate representation of energy relationships between organisms in a food chain or food web than pyramids of numbers (many of which are not the typical pyramid shape). **(W)** Learners may draw and explain pyramids of number and biomass for food chains introduced earlier in the unit. They may link the shape of biomass pyramids to the knowledge gained in 15(d). Extend learners' understanding to include food chains which are atypical (e.g. where there is a single large producer or where the top consumer is a parasite). **(I)** A more **challenging** activity is for learners to draw pyramids to scale using graph paper if numbers and/or biomasses are given. **(I)**	**Online:** Video clip – pyramid of numbers: www.bbc.co.uk/learningzone/clips/food-chains-pyramid-of-numbers/201.html Pyramids of biomass: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/foodchains/foodchains3.shtml **5090 past paper questions:** Nov 2012 Paper 22 Q9 Nov 2013 Paper 21 Q9a

Learning objectives		Suggested teaching activities	Learning resources
		An **extension** opportunity is for learners to collect leaf litter or to collect invertebrates from grassland (using sweep nets) or trees (by shaking branches) and to construct a pyramid of numbers or biomass based on classification of the organisms found. **(G) (I)**	
15(f)	Describe and state the importance of the carbon cycle	This objective stresses the fact that life is carbon-based and is an opportunity to consolidate topics covered in Units 2, Unit 3 and Unit 4. Learners may list and then arrange into a sequence all the processes they have studied which involve carbon compounds. The cyclical nature of these processes should become apparent. **(I)** Learners may be given cards showing stages of the carbon cycle and asked to arrange them into a complete cycle. An **extension** activity is for the objective of this task to be presented in the form of a poster or classroom display. **(P) (I)** A more **challenging** way of covering this learning objective is to ask learners to describe, as fully as possible, the fate of an atom of carbon after it has entered a plant in a CO_2 molecule during photosynthesis, thus building up their own carbon cycles. These may then be combined to provide (perhaps with a few additions/adjustments) the definitive version for distribution. **(I) (G) (W)** The suggested online resources may be used to provide additional stimuli and assistance during or following the above activities. **(W)** **Extension** activities may include learners considering what is meant by the term 'carbon neutral' **(W)**, or using the suggested online resource to investigate the effect of microbes in the decay of cellulose. **(I)**	**Online:** The carbon cycle info and diag.: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/foodchains/foodchains5.shtml Carbon cycle animated video: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/foodchains/foodchainact.shtml Practical Biology – Carbon Cycle: www.practicalbiology.org/areas/intermediate/environment/carbon-cycle/microbes-ate-my-homework-investigating-how-microbes-help-us-to-break-down-cellulose-and-recycle-plant-material,72,EXP.html **5090 past paper question:** Jun 2011 Paper 21 Q7(a)

Learning objectives		Suggested teaching activities	Learning resources
15(g)	Describe the nitrogen cycle in making available nitrogen for plant and animal protein, including the role of bacteria in nitrogen fixation, decomposition and nitrification (details of denitrification and the names of individual bacteria are **not** required)	Learners may attempt to brainstorm the nitrogen cycle in a similar way to the carbon cycle. Cross reference with decomposition considered in 14(b) in Unit 6. **(I) or (P)** Learners tend to find this cycle difficult to understand and remember. It is therefore wise to avoid unnecessary detail. The suggested online resources present the topic at an appropriate level. Learners may use the talking explanation of the nitrogen cycle to write a set of bullet-point notes to explain each step – underlining the different types of bacteria involved. **(I)** Distinguish carefully between the terms 'nitrogen fixation' and 'nitrification'. Reference should be made to bacteria in the root nodules of leguminous plants as well as to those which are free-living. The photograph of root nodules may be used to aid explanation of the role of leguminous plants. **(W)** Learners may be given cards or statements describing aspects of the nitrogen cycle and arrange them into a complete cycle. The video clip may be used to consolidate this task. **(I) or (P)**	**Online:** Simple nitrogen cycle diagrams: www.s-cool.co.uk/gcse/biology/environment/revise-it/cycling-through-nature Talking explanation and animation of the nitrogen cycle: http://bcs.whfreeman.com/thelifewire/content/chp58/5802004.html Photograph of root nodules: http://blog.lib.umn.edu/denis036/thisweekinevolution/AlfalfaNodules5.jpg Video clip – nutrient recycling: www.bbc.co.uk/learningzone/clips/recycling-nutrients/4172.html
15(h)	Understand the role of the mosquito as a vector of disease	Indicate how the lifestyle of the mosquito makes it a successful vector of a wide variety of diseases. Stress that the mosquito is the carrier (vector) of the pathogen but does not itself **cause** malaria. Ways in which control of the mosquito vector is achieved should be considered here. **(W)** Learners may use the suggested online resources to research the lifestyle and control of the mosquito vector and present their findings in the form of a poster, fact sheet or brief presentation to the class. **(I) (W)** It is possible for some learners to research and summarise 15(h) whilst others do so for 15(i). Learners may subsequently share their findings. **(I) (G)**	**Online:** Mosquito vector and control: www.cdc.gov/malaria/about/biology/mosquitoes/index.html World Health Organization malaria fact sheet: www.who.int/mediacentre/factsheets/fs094/en/index.html **Textbook:** *Biology for IGCSE and O Level* – 13 Health, disease and medicine
15(i)	Describe the malaria pathogen as an example of a parasite and	Control of the pathogen both before and after it has entered the body should be considered here.	See suggested resources listed above.

Learning objectives		Suggested teaching activities	Learning resources
	describe the transmission and control of the malarial pathogen (details of the life cycle of the pathogen are **not** required)	As above, learners may use the suggested online resources to research the lifestyle and control of the mosquito vector and present their findings in the form of a poster, fact sheet or brief presentation to the class. **(I) (W)**	**5090 past paper question:** Jun 2013 Paper 21 Q9
15(j)	Describe the effects of humans on the ecosystem with emphasis on examples of international importance (tropical rain forests, oceans and important rivers)	Action which affects large areas in one part of the world may have consequences in another (e.g. global warming, scarcity or contamination of fish supplies). Loss of habitats leads to extinction of species and to loss of possible benefits from those species (e.g. drugs). Action taken in one region near a river can cause flooding and devastation hundreds of miles away. **(W)** The effects of deforestation and other effects of humans could be discussed using newspaper/media articles. These may be either provided by the teacher or a more **challenging** activity is for learners to provide these. **(W) or (I)** Learners may be divided into three groups with each group studying in depth, using the suggested online resources, one example of the effects of humans on the ecosystem. Learners may present their findings in the form of a report or presentation to exchange with others. **(G) (W)**	**Online:** Tropical rain forests: http://environment.nationalgeographic.com/environment/habitats/rainforest-threats/ www.bbc.co.uk/learningzone/clips/rainforest-destruction-kalimantan-indonesia-and-costa-rica/3096.html www.bbc.co.uk/learningzone/clips/sustainable-forestry-using-animal-power/11966.html www.bbc.co.uk/learningzone/clips/natural-balance-threats-to-the-rainforest/4712.html Oceans: www.protectplanetocean.org/introduction/introduction.html Rivers: www.internationalrivers.org/ www.bbc.co.uk/learningzone/clips/why-have-fish-stocks-decreased-in-the-north-sea-pt-1-2/4687.html **Textbooks:** *O Level Biology* – Unit 17 Human effects on ecosystems

Learning objectives		Suggested teaching activities	Learning resources
			The Cambridge Revision Guide GCE O Level Biology – Topic 18 The Effects of Human Activity on the Ecosystem *Biology for IGCSE and O Level* – 16 Humans and the Environment
15(k)	Describe the consequences of deforestation in terms of its effects on soil stability, climate and local human populations	The removal of trees removes the binding effect their roots have on the soil as well as the protection their canopies provide from sun, wind and rain. The humus their dead leaves provide is also lost. Local populations may lose homes and livelihoods. Climate changes are usually experienced at greater distances from the site of deforestation. **(W)** Learners may use the list of points outlined above and the suggested online resource to produce a 'spider diagram' showing the consequences of deforestation. **(I)**	**Online:** Deforestation: www.bbc.co.uk/dna/h2g2/A3556848 www.the-organic-mind.com/spider-diagrams.html
15(l)	Evaluate the effects of: water pollution by sewage, by inorganic waste and by nitrogen containing fertilisers air pollution by greenhouse gases (carbon dioxide and methane), contributing to global warming air pollution by acidic gases (sulfur dioxide and oxides of nitrogen), contributing to acid rain pollution due to insecticides	Learners should be made aware of the damage being caused to the planet by the stated forms of pollution and that it is when the materials mentioned are used or released in excess that problems occur. **(W)** Eutrophication should be considered as an effect of water pollution by sewage and N_2 fertilisers, as should the build up along food chains of insecticides which cannot be metabolised. An opportunity exists here to consolidate earlier work on the nitrogen cycle. **(W)** Ensure that there is a clear distinction in learners' minds between the use of fertilisers and the use of insecticides. **(W)** Learners may produce a set of flow charts to list the steps involved in the processes of eutrophication, global warming and the production of acid rain. **(I)** Learners may produce a poster or information leaflet describing the effects of the stated forms of pollution. **(I)** The distinction between 'causes' and 'consequences' may be clearly	**Online:** Water pollution: www.water-pollution.org.uk/ Combustion products: www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/atmosphere/chemicalreactionsrev2.shtml Greenhouse effect animation: http://earthguide.ucsd.edu/earthguide/diagrams/greenhouse/ Acid rain: www.supergreenme.com/go-green-environment-eco:Acid-Rain www.nationalstemcentre.org.uk/elibrary/resource/1728/acid-rain

Learning objectives		Suggested teaching activities	Learning resources
		made by asking learners to list these in two columns of a table for each form of pollution. **(I)**	
15(m)	Discuss reasons for conservation of species with reference to maintenance of biodiversity, management of fisheries and management of timber production	Many of the points relevant here will have been considered in 15(j) and 15(k) above. The concept of sustainable management of fish (via 'quotas') and timber supplies should be promoted. Learners may research specific examples of species or ecosystems which are actively being conserved, the methods by which this is being achieved and the reasons why their conservation is important. Learners may present their findings in a variety of formats. **(I)**	**Online:** Conserving Biodiversity: www.nationalstemcentre.org.uk/elibrary/resource/1738/biodiversity-around-us Video clips - conservation: www.bbc.co.uk/learningzone/clips/biodiversity-and-the-human-implications/5505.html **5090 past paper question:** Jun 2010 Paper 22 Q7(b)
15(n)	Discuss reasons for recycling materials, with reference to named examples	Depletion of the planet's resources is of concern. Deforestation for paper production may be reduced by paper recycling and energy may be saved by recycling glass. Recycling metal (from cans to cars) saves both energy and reduces the need to mine the ore. **(W)** The suggested online resource may be used by learners to research the topic further. Learners may produce a poster or information leaflet, for use in their school or community, to promote the benefits of recycling. **(I)**	**Online:** Metal, paper, plastic and glass recycling: www.thriftyfun.com/tf42552953.tip.html **5090 past paper question:** Jun 2012 Paper 21 Q8b

Unit 8: Reproduction

Recommended prior knowledge
The major part of this unit stands alone. Helpful, but not essential, would be a knowledge of cell structure, enzymes, nutrition and excretion and bacteria.

Context
The general thread of reproduction runs throughout the unit.

Outline
First, reproduction is considered in general terms, and then sexual reproduction in both plants and animals is addressed. Sexually transmitted diseases are studied together with their control.

Learning objectives		Suggested teaching activities	Learning resources
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
16(a)	Define mitosis as cell division giving rise to genetically identical cells in which the chromosome number is maintained and state the role of mitosis in growth, repair of damaged tissues, replacement of worn-out cells and asexual reproduction	The nucleus of a cell contains a number of chromosomes and that number is fixed and constant for each species (46 in the human being). A new body cell must be an exact copy of the cell producing it. (Details of the stages in mitosis are **not** required). **(W)** Use the suggested online resource to guide learners through the basic steps of the procedure and ask them to consider the genetic significance of each. **(W) (I)**	**Online:** Mitosis: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/celldivision/celldivision2.shtml Practical Biology – Cloning: www.practicalbiology.org/areas/intermediate/genetics/introducing-gene-technologies/cloning-a-living-organism,43,EXP.html **Textbooks:** *Biology for IGCSE and O Level* – 8 Reproduction *O Level Biology* – Unit 18 Reproduction in Plants
16(b)	Define asexual reproduction as the process resulting in the production of genetically identical offspring from one parent and describe **one named**, commercially important application of asexual reproduction in plants	For the chosen commercial application (e.g. a potato tuber) learners should understand the benefits and the disadvantages of this method of reproduction. **(W)** Learners may produce a table comparing the benefits and disadvantages together with an outline of how the technique is used in a named commercially important application. **(I)** An **extension** practical activity is for learners to use the suggested online resource in order to make clones by taking cuttings. **(I)**	

Learning objectives		Suggested teaching activities	Learning resources
			The Cambridge Revision Guide GCE O Level Biology – Topic 20 Reproduction **5090 past paper question:** Jun 2010 Paper 21 Q8
16(c)	Define meiosis as a reduction division in which the chromosome number is halved from diploid to haploid	Details of meiotic division are not required other than its role in halving of the chromosome number. The terms gamete, diploid and haploid should be explained. **(W)** Use the suggested online resource to guide learners through the basic steps of the procedure and ask them to consider the genetic significance of each. Compare the objective and process with that of mitosis from 16(a). **(W) (I)**	**Online:** Meiosis: www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/celldivision/celldivision4.shtml **5090 past paper questions:** Nov 2012 Paper 21 Q7a Jun 2012 Paper 62 Q4
16(d)	State that gametes are the result of meiosis (reduction division)	Link this learning objective with coverage of 16(c) above.	
16(e)	Define sexual reproduction as the process involving the fusion of haploid nuclei to form a diploid zygote and the production of genetically dissimilar offspring	Learners should appreciate that each parent therefore makes an equal contribution to the diploid cell from which an offspring will develop. **(W)** Learners may draw a flow chart showing gametes, zygote and embryo onto which they may annotate each stage to show the chromosome number (n or 2n) and type of cell division (mitosis or meiosis) involved. **(I)**	
16(f)	Identify and draw, using a hand lens if necessary, the sepals, petals, stamens and carpels of **one**, locally available, **named**, insect-pollinated dicotyledonous flower, and examine the pollen grains under a light microscope	If possible a large, brightly-coloured, scented flower with visible nectar should be chosen. Ensure that learners produce large drawings, with a sharp HB pencil, draw clean lines and give the magnification of their drawing (e.g. x3). **(I)** Use the suggested online resources to assist learners in their identification of the listed components. **(I)** Learners may make posters or classroom displays showing flower structure using the suggested online resources and/or their own	**Online:** Components of flowering plant: www.bbc.co.uk/schools/ks2bitesize/science/living_things/plant_life_cycles/read1.shtml Flower structure: www.biology-resources.com/plants-flowers.html

Learning objectives		Suggested teaching activities	Learning resources
		observations. **(P) or (I)** The interactive flower activities provide an opportunity for learner self-assessment once the learning objective has been covered. **(I)**	Flower structure: www.saps.org.uk/secondary/teaching-resources/547-the-structure-of-flowers Interactive flower activities: www.bbc.co.uk/schools/scienceclips/ages/9_10/life_cycles.shtml www2.bgfl.org/bgfl2/custom/resources_ftp/client_ftp/ks2/science/plants_pt2/parts.htm **5090 past paper question:** Jun 2013 Paper 31 Q3
16(g)	State the functions of the sepals, petals, anthers and carpels	It will be necessary to explain that carpels are made up of component parts – stigma, style, ovary and ovules. Also ensure that learners are clear that pollen (grains) are not gametes but that they **contain** the gametes. **(I)** Learners may use information from a text book or from the suggested online resources to annotate their diagrams from 16(f) to show the functions of the components labelled. Further suggested activities relevant to this learning objective are listed against 16(f) above. **(I)** An **extension** activity is for learners to research the nature and function of 'nectar guides' on the petals of some plant species. These are visible only under UV light as shown in the suggested online resource. **(I)**	See suggested resources listed above. **Online:** Nectar guides: www.dailymail.co.uk/sciencetech/article-473897/A-bees-eye-view-How-insects-flowers-differently-us.html
16(h)	Use a hands lens to identify and describe the anthers and stigmas of **one**, locally available, **named**, wind- pollinated flower, and examine the pollen grains under a light microscope	Note that a drawing is not required. Learners may list any noticeable differences from the features seen in the insect-pollinated flower and attempt to account for each of the differences observed. **(I)** Learners may use their own observations and the suggested online resource to note differences in the amount and structure of pollen produced by insect and wind pollinated flowers and attempt to account for	**Online:** Types of pollen: www.sciencephoto.com/features/1132-Pollen.pdf

Learning objectives		Suggested teaching activities	Learning resources
		any differences. **(I)**	
16(i)	Outline the process of pollination and distinguish between self-pollination and cross-pollination	Learners may draw and annotate summary diagrams to outline the transfer of pollen between named flower parts in the two processes. **(I)** Learners may describe the differences between the two processes and produce a list of the advantages and disadvantages of each method. **(I)**	**5090 past paper question:** Jun 2013 Paper 21 Q3
16(j)	Compare, using fresh specimens, an insect-pollinated and a wind-pollinated flower	See learning objectives 16(f) to 16(h) above.	
16(k)	Describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (production of endosperm and details of development are **not** required)	Use a diagram to show the path taken by the pollen tube. **(W)** Learners may use the suggested online animation to add annotations to a labelled diagram. Note, the level of detail in the animation is quite advanced yet provides a good link back to the nature of haploid and diploid cells. **(I)** A more advanced **extension** activity is for learners to attempt to grow pollen tubes using the practical technique outlined in the suggested online resource. **(P)**	**Online:** Pollen tube growth practical: www.saps.org.uk/secondary/teaching-resources/222-student-sheet-4-pollen-tube-growth **5090 past paper question:** Jun 2012 Paper 61 Q3
16(l)	Investigate and describe the structure of a non-endospermic seed in terms of the embryo (radicle, plumule and cotyledons) and testa, protected by the pericarp (fruit wall)	Learners may dissect pea or large bean seeds, soaked for 24 hours before use, and make labelled drawings of the components identified using online and textbook references as a source of information. **(I)**	See PowerPoint resource listed in 16(f). **5090 past paper question:** Jun 2013 Paper 62 Q2ab
16(m)	State that seed and fruit dispersal by wind and by animals provides a means of colonising new areas	The class may ‘brainstorm’ advantages of the ability of plants to colonise new areas. **(W)**	**5090 past paper question:** Nov 2013 Paper 21 Q8b
16(n)	Describe the external features of **one**, locally available, **named** example of a wind-dispersed	Stress that fruit and seed dispersal by wind or animals can happen only after pollination (by wind or insects) and the two very different processes must not be confused. **(W)**	**Online:** Websites for seed dispersal mechanisms:

Learning objectives		Suggested teaching activities	Learning resources
	fruit or seed and of **one named** example of an animal-dispersed fruit or seed	Although there are adaptations for different methods of animal dispersal, only one need be considered in detail. Learners may each (or in small groups) consider a different method and then present their findings to other learners in a variety of formats. The activity may then be extended by asking learners to compare the likely effectiveness of the different animal seed-dispersal mechanisms. **(I) or (G)** Learners may research and produce large, annotated diagrams of each seed to explain how their features enable seed-dispersal by the relevant method. **(I)**	www.britannica.com/EBchecked/media/145426/Seeds-and-their-dispersal-mechanisms www2.bgfl.org/bgfl2/custom/resources_ftp/client_ftp/ks2/science/plants_pt2/dispersal.htm www.mbgnet.net/bioplants/seed.html Wind dispersal mechanisms: http://waynesword.palomar.edu/plfeb99.htm
16(o)	Investigate and state the environmental conditions that affect germination of seeds: suitable temperature, water and oxygen	Note that 'warmth' is scientifically vague and that seeds surrounded by 'moisture' rather than 'water' do not germinate. Containers of seeds may be set up, one lacking only a suitable temperature (placed in fridge at approx 4^{o}C), one lacking only water and one lacking only oxygen (sealed and containing alkaline pyrogallol). A control, with seeds exposed to all three conditions, should also be included. A hypothesis may be made for each set of seeds, following which the germination progress of each set should be noted following a period of time. The results may be compared and explanations for any differences noticed may be suggested. **(W) (G) or(I)** A more **challenging** activity is to ask learners to aid the planning of this investigation by considering experimental design including variables to alter, measure and control. **(I)** For reasons of safety and expense, the pyrogallol container might take the form of a teacher demonstration. **(W)**	See PowerPoint resource listed in 16(f) for diagrams showing this experimental design.
16(p)	Describe the uses of enzymes in the germination of seeds	Cross reference with learning objective 5(o) of Unit 3. The need to convert insoluble storage compounds into soluble ones which can be transported should be stressed. **(W)** Learners may use the appropriate section of the suggested online	See PowerPoint resource listed in 16(f) for animated content.

Learning objectives		Suggested teaching activities	Learning resources
		PowerPoint resource to gain an understanding of the process, following which they may produce a written or flow-chart summary of the key events. **(I)**	**Online:** Video clip – germination: www.bbc.co.uk/learningzone/clips/an-introduction-to-seed-germination-and-growth/63.html
16(q)	Identify on diagrams of the male reproductive system and give the functions of the testes, scrotum, sperm ducts, prostate gland, urethra and penis	Learners may use the suggested online or textbook resources to label a diagram of the components required. Learners should be able to interpret both front and side views. **(I)**	**Online:** Male reproductive anatomy: www.passmyexams.co.uk/GCSE/biology/images/reproductive_system_male.jpg **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 21 Sexual Reproduction in Human Beings *O Level Biology* – Unit 19 Reproduction in Humans
16(r)	Identify on diagrams of the female reproductive system and give the functions of the ovaries, oviducts, uterus, cervix and vagina	Learners may use the suggested online or textbook resources to label a diagram of the components required. Learners should be able to interpret both front and side views. **(I)**	**Online:** Female reproductive anatomy: www.passmyexams.co.uk/GCSE/biology/images/reproductive_system_female.jpg
16(s)	Compare male and female gametes in terms of size, numbers and mobility	Comparisons should be supported by reasons for the differences and may be presented in the form of a table. **(I)** Use the stimulus photo to introduce difference in size. **(W)**	**Online:** Fertilisation stimulus photo: http://image3.examiner.com/images/blog/wysiwyg/image/Sperm-egg(1).jpg
16(t)	Describe the menstrual cycle, with reference to the alternation of menstruation and ovulation, the natural variation in its length and the fertile and infertile phases of the cycle	Annotated diagrams showing the cycle divided into days and showing the build-up and breakdown of the uterus lining are helpful. **(W)** Learners may use the suggested online resource to produce a timeline of the events comprising the menstrual cycle. **(I)**	**Online:** Events of the menstrual cycle: http://lgfl.skoool.co.uk/content/keystage3/biology/pc/learningsteps/MENLC/launch.html

Learning objectives		Suggested teaching activities	Learning resources
			Hormones in the menstrual cycle: www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/human/hormonesrev3.shtml
16(u)	Explain the role of hormones in controlling the menstrual cycle (including follicle-stimulating hormone (FSH), luteinizing hormone (LH), progesterone and oestrogen)	Learners may use the suggested online resource to understand the role of these hormones. This may be followed by learners preparing a bullet-point list for each hormone to summarise their respective roles. **(I)** A more **challenging extension** activity is for learners to then add information regarding the level of each hormone to the timeline produced in 16(t) above. **(I)**	**Online:** Menstrual cycle hormones: www.abpischools.org.uk/res/coResourceImport/modules/hormones/en-flash/menstrualCycle.cfm **5090 past paper question:** Jun 2013 Paper 21 Q6a
16(v)	Describe fertilisation and early development of the zygote simply in terms of the formation of a ball of cells that becomes implanted in the wall of the uterus	The location of fertilisation should be clearly described. Division of the zygote by mitosis prior to implantation should be referred to. **(W)** Learners may watch the video accompanying the suggested online resource, following which they may produce a written commentary of the key events. **(I)**	**Online:** Fusion of gametes: www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/evolution/reproductionrev2.shtml
16(w)	State the function of the amniotic sac and the amniotic fluid	Ways in which the embryo is protected by the fluid (contained by the sac) should be listed by learners. **(I)**	**Online:** Amniotic fluid and sac: www.babiesonline.com/articles/health/amnioticfluid.asp
16(x)	Describe the function of the placenta and umbilical cord in relation to exchange of dissolved nutrients, gases and excretory products (**no** structural details are required)	Stress that maternal and fetal bloods do not mix. **(W)** The content of this learning objective may be linked to those covering diffusion and excretion in previous units. Learners may produce a list of the substances which cross the placenta and indicate the direction of movement of each. **(I)**	**5090 past paper question:** Jun 2013 Paper 21 Q6b
16(y)	Describe the special dietary needs of pregnant women	Learners may use the suggested online or textbook resources to produce a two-column table listing the dietary needs and the importance of each.**(I)**	

Learning objectives		Suggested teaching activities	Learning resources
		Cross reference may be made with Unit 3.	
16(z)	Describe the advantages of breast milk compared with bottle milk	The advantages may be presented by learners in the form of a bullet point list. **(I)**	**Online:** Breast and bottle feeding: http://kidshealth.org/parent/growth/feeding/breast_bottle_feeding.html# **5090 past paper question:** Nov 2011 Paper 21 Q7b
16(aa)	Describe the following methods of birth control -natural, chemical (spermicides), mechanical, hormonal and surgical	Family planning clinics are often helpful in supplying information and exhibits. Learners may be shown examples of different types of contraceptive if available. **(W)** A simple description of the biological basis of the different types of birth control is required. Learners should also understand the relative effectiveness of each. Discussion may be extended to include the ways in which religious or cultural beliefs can affect their use. The advantages of condoms in reducing the risk of transmitting sexually transmitted infections. **(G) (W)** Learners may use the suggested online resource to research information on specific examples and present their findings in a variety of formats. Note that abortion is not considered to be a method of birth control. **(I)**	**Online:** Birth-control methods: www.clearblue.com/uk/contraception.php www.avert.org/teens-condoms.htm **5090 past paper question:** Jun 2012 Paper 21 Q7b
16(bb)	Explain that syphilis is caused by a bacterium that is transmitted during sexual intercourse	The potentially severe nature of syphilis should be mentioned, together with concern that AIDS has diverted attention away from other STDs. The need for early treatment should be stressed. **(W)**	
16(cc)	Describe the symptoms, signs, effects and treatment of syphilis	Learners may research the specified aspects of the disease and present their findings in the form of a ‘spider-diagram’. **(I)**	**Online:** Syphilis: http://herpes-coldsores.com/std/syphilis.htm

Learning objectives		Suggested teaching activities	Learning resources
16(dd)	Discuss the spread of human immunodeficiency virus (HIV) and methods by which it may be controlled	Ensure that learners are aware that no cure is yet available yet with care the spread of HIV may be restricted. **(W)** Learners construct a table showing the ways in which HIV is spread and, for each, the methods by which its spread may be controlled. **(I)** A more **challenging** activity is for learners to extend their understanding to include the socioeconomic, religious and cultural factors that influence the effectiveness of the control methods in different parts of the world. **(I)** An **extension** activity is for learners to research some of the most up-to-date medical advances in the drug-related control of HIV. **(I)**	**Online:** HIV/AIDS: www.abpischools.org.uk/page/modules/diseases/diseases3.cfm How HIV is spread: www.sfaf.org/aids101/transmission.html#transmitted Control of HIV: www.avert.org/aids-hiv-prevention.htm **5090 past paper question:** Nov 2013 Paper 22 Q9a

Unit 9: Inheritance and evolution

Recommended prior knowledge
The major part of this unit stands alone. Helpful, but not essential, would be a knowledge of cell structure, enzymes, nutrition and excretion and bacteria.

Context
The general thread of reproduction continues to run through this unit from Unit 8. Genetic inheritance leading on to variation and finally to evolution is considered.

Outline
The importance of DNA is considered along with simple inheritance. A study of variation leads to an explanation of evolution. The unit ends with DNA function and genetic engineering.

Learning objectives		Suggested teaching activities	Learning resources
Syllabus ref	**Candidates should be able to:**		5090 past question papers are available at: http://teachers.cie.org.uk
17(a)	Describe the difference between continuous and discontinuous variation and give examples of each	Body weight and height are standard examples of continuous variation, as are blood groups and sex of discontinuous variation. Learners may collect data concerning these characteristics amongst their peers and draw graphs to compare the distributions. Graphs should be drawn of the distributions shown by the two types of variation. Non-human variation may be investigated by measuring the diameter of a selection of leaves taken from the same tree. **(G) (I)** Graphs may be annotated to indicate the influence of genes and/or environment on each type of variation. **(I)**	**Online:** Types of variation: www.bbc.co.uk/schools/ks3bitesize/science/organisms_behaviour_health/variation_classification/revise3.shtml Causes of variation: www.bbc.co.uk/schools/ks3bitesize/science/organisms_behaviour_health/variation_classification/revise4.shtml Investigating variation in humans: www.practicalbiology.org/areas/introductory/genetics/inheritance/introducing-ideas-about-inheritance,155,EXP.html **Textbooks:** *The Cambridge Revision Guide GCE O Level Biology* – Topic 22 Inheritance

Learning objectives		Suggested teaching activities	Learning resources
			Biology for IGCSE and O Level – 12 Inheritance and evolution *O Level Biology* – Unit 20 Inheritance
17(b)	State that a chromosome includes a long molecule of DNA	Detail of DNA structure is **not** required beyond a description as two long strands cross-linked by a succession of paired molecules called bases. Learners may use the suggested online activity on genome structure, following which they may write a written summary of the levels of organisation found in the genome. **(I)**	**Online:** Chromosome structure: www.johnkyrk.com/chromosomestructure.html Genetic terminology: www.siskiyous.edu/class/bio1/genetics/genetic_terms_v2.html Genes and inheritance: www.abpischools.org.uk/page/modules/genome/index.cfm
17(c)	State that DNA is divided up into sections called genes	Explain that, as a consequence, each gene comprises its own particular sequence of linked bases. **(W)** Learners may include this concept in their response to the suggested activity in 17(b) and may use the suggested online resource covering genetic terminology as consolidation. **(I)**	
17(d)	Explain that genes may be copied and passed on to the next generation	Explain that when a cell divides its nucleus first makes an exact copy of each strand of DNA (and therefore also of each gene). The original passes into the nucleus of one cell and its copy passes into the other. In this way, the same genes are passed from generation to generation. **(W)** Cross reference with resources and activities used in 16(a) and 16(c) in Unit 8.	See suggested online resources for learning objectives 16(a) and (c) of Unit 8.
17(e)	Define a gene as a unit of inheritance and distinguish clearly between the terms gene and allele	Each gene is a length of DNA that may be passed from parent to offspring. Alleles are alternate forms of the same gene. Many genes have many different alleles. **(W)**	**Online:** Alleles and complete dominance: www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/genetics/genesi

Learning objectives		Suggested teaching activities	Learning resources
		A possible link to 17(q) may be made at this time.	nheritencerev5.shtml Video clips – inheritance: www.bbc.co.uk/learningzone/clips/dominant-and-recessive-characteristics/4197.html
17(f)	Describe complete dominance using the terms dominant, recessive, phenotype and genotype	These terms follow naturally from a consideration of genes and alleles above and are better explained alongside their use in 17(i) when genetic crosses are presented. **(W)**	
17(g)	Describe mutation as a change in the structure of a gene (sickle cell anaemia) or in the chromosome number (e.g. 47 in Down's syndrome instead of 46)	Genes are subject to mutations leading to a change in phenotype. Whilst most changes are very small and barely noticeable, others have a more marked effect. **(W)** Learners should link this change in gene structure to 17(d) and 17(q) and to the subsequent phenotypic objective. Learners may be shown the Down's karyotype and asked to identify how this is different from that expected. An extension activity is to ask learners to suggest mechanisms, based on their knowledge of meiosis, for how the mutation may arise. **(W) (I)**	**Online:** Down's syndrome: http://kidshealth.org/parent/medical/genetic/down_syndrome.html# Down's karyotype: http://anthro.palomar.edu/abnormal/images/Down_Syndrome_Karyotype.jpg
17(h)	Name radiation and chemicals as factors that may increase the rate of mutation	Mutagens can have the effect of altering the molecular structure of a gene and thus altering the way in which the gene works. This may be linked to 17(g) and in turn to 17(d) and 17(q). **(W)** Learners may produce a 'spider diagram' to show radiation and chemicals as mutagens and extend this to show examples of each and how they may be encountered in the environment. **(I)** An **extension** activity is for learners to research the impact of the Chernobyl nuclear reactor incident that occurred in 1986, causing mutations in hundreds of people and unborn babies or of mustard gas used in the First World War. **(I)**	
17(i)	Predict the results of simple	Learners should be encouraged to draw full genetic diagrams to show	**Online:**

Learning objectives		Suggested teaching activities	Learning resources
	crosses with expected ratios of 3:1 and 1:1, using the terms homozygous, heterozygous, F_1 generation and F_2 generation	these crosses. The diagrams should be annotated and include reference to parents and gametes. Such diagrams demonstrate that the same phenotype may have different genotypes. **(I)** Learners may use the suggested online learning activity to understand the terminology and process of a monohybrid genetics cross. This may be followed by attempting a series of teacher-set and assessed problems covering similar scenarios. **(I)** It is good practice, and avoids confusion between gametes and genotypes, if a circle is drawn around each gamete. Use of Punnett square diagrams to illustrate the possible objectives of a genetic cross is advised to aid clarity. It may be beneficial to give learners practice at representing probability in different formats (e.g. as a ratio, percentage or frequency). **(I)** Cross reference should be made to the terminology introduced in 17(e) and 17(f).	Monohybrid inheritance animation and activity: www.siskiyous.edu/class/bio1/genetics/monohybrid_v2.html **5090 past paper questions:** Nov 2011 Paper 21 Q5 Jun 2012 Paper 21 Q3
17(j)	Explain why observed ratios often differ from expected ratios, especially when there are small numbers of progeny	Learners should understand that the objective of a genetic cross is a probability and does not refer to the genotype/phenotype of four offspring produced. **(W)** It should be stressed that the ratios predicted in 17(i) are statistical and are obtained only from large samples. Learners may use the suggested online resource to view observed and statistical data from Mendel's experiments. **(I)** A more **challenging** activity is for learners to produce a verbal or written description of any differences observed. **(I)**	**Online:** Observed and expected ratios in Mendel's experiments: www.siskiyous.edu/class/bio1/genetics/three_to_one_ratio.html
17(k)	Explain codominance by reference to the inheritance of the ABO blood group phenotypes (A, B, AB, O,	Learners will observe that there can be more than two alleles of the same gene. It is helpful to write down a list of the possible genotypes for blood groups	**5090 past paper questions:** Nov 2010 Paper 21 Q4 Nov 2012 Paper 21 Q7b

Learning objectives		Suggested teaching activities	Learning resources
	gene alleles I^A I^B and I^O)	and the resulting phenotypes before attempting to draw the genetics diagram. A full genetics diagram may then be provided as a worked example, following which learners may attempt similar problems to assess their understanding. **(I)**	
17(l)	Describe the determination of sex in humans (XX and XY chromosomes)	It will be necessary to point out that the inheritance of sex is the result of the inheritance of chromosomes, not of genes. **(W)** Learners may use the suggested online or text book resources, following which they may draw a full genetics diagram to show the inheritance of sex. **(I)** A more **challenging extension** activity is for learners to produce a full written explanation, using correct terminology, of why the probability of male:female is 1:1 and for them to explain which parent determines a child's sex. **(I)**	**Online:** Inheritance of sex: www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/genetics/genesinheritencerev3.shtml
17(m)	Describe variation and state that competition leads to differential survival of organisms, and reproduction by those organisms best fitted to the environment	Variation is a random process which happens to leave some members at a survival advantage over other organisms in a particular environment. It does not occur 'in order to adapt to the environment' as learners often believe. Organisms which survive then reproduce and at least some of their offspring inherit this advantage. **(W)** Learners may use the suggested online and textbook resources to write a numbered list of 'generic' points outlining the process of natural selection. Learners may then be presented with previously unseen specific examples of where the process occurs and asked to apply their list of generic points. **(I)** Learners may use the suggested online activity to demonstrate natural selection in the classic example of the peppered moth. **(I)** More **challenging** activities that may be used to illustrate the process of natural selection are outlined in the 'modelling natural selection' online resource. **(I)**	**Online:** Natural selection process: http://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_25 **Online:** Peppered moth simulation: www.techapps.net/interactives/pepperMoths.swf Modelling natural selection: www.nuffieldfoundation.org/practical-

Learning objectives		Suggested teaching activities	Learning resources
		An **extension** activity is for learners to participate in the natural selection game outlined in the online resource. **(P)**	biology/modelling-natural-selection Natural selection game: www.biology4all.com/resources_library/source/200.doc
17(n)	Assess the importance of natural selection as a possible mechanism for evolution	Survival of the better-adapted organisms, each showing variations, some of which are advantageous, generation after generation, leads to evolutionary change in the species. Learners may cross-reference this principle to the evolution of antibiotic resistant bacteria from 13(b) in Unit 6. **(W)**	**Online:** Example of antibiotic resistant bacteria: www.windows2universe.org/cool_stuff/tour_evolution_9.html Antibiotic resistance information and animation: www.abpischools.org.uk/page/modules/infectiousdiseases_medicines/medicines3.cfm?coSiteNavigation_allTopic=1 **5090 past paper questions:** Nov 2011 Paper 21 Q4 Nov 2013 Paper 22 Q5
17(o)	Describe the role of artificial selection in the production of economically important plants and animals	When humans select organisms with characteristics that are commercially desirable and breed from them, variation can again enhance the selected characteristic – especially when repeated over many generations. **(W)** Examples may include: • wheat that has high-yield seed and shorter stems. • rice that has roots tolerant to lactic acid. • maize bred to adapt to low carbon dioxideconcentrations. Learners may use the suggested online resource to select one example of where this principle is used to research in further detail – including details of the feature(s) selected for and the commercial reasons for doing so. **(I)**	**Online:** Artificial selection: www.s-cool.co.uk/gcse/biology/genetic-crosses/revise-it/selective-breeding-crosses
17(p)	Explain that DNA controls the production of proteins	The linking of amino acids to form a protein in the cells of a body is determined by DNA. The exact amino acids and their particular sequence	

Learning objectives		Suggested teaching activities	Learning resources
		in each different protein are controlled by one specific gene. Cross reference should be made to 17(e) and 17(g) in this unit and to 5(s) in Unit 3.	
17(q)	State that each gene controls the production of one protein	Each gene is a length of DNA that codes for the production of a particular protein and may be passed from parent to offspring. Refer back to learning objective 17(e). **(W)**	
17(r)	Explain that genes may be transferred between cells (reference should be made to transfer between organisms of the same or different species)	The following transfers may be included: • Human to human in the case of treatment for cystic fibrosis. • Human to bacterium (insulin production). • Transfer to plant species (in the production of genetically modified crops). Learners may be divided into groups and each asked to research one specific example of gene transfer. Learners may share the results of their research in a variety of formats. Each example would include the gene origin, gene destination, method of transfer and the nature of the benefit(s) gained. **(I)** An **extension** activity is for learners to use the 'GM crop issues' online resource to assist them in considering the biological, social and economical issues surrounding growing GM crops in different countries. **(I)**	**Online:** Cystic fibrosis gene therapy: www.telegraph.co.uk/health/healthnews/4639764/Cystic-fibrosis-sufferers-offered-hope-by-gene-therapy-treatment.html Information and animation of Genetic engineering: www.abpischools.org.uk/page/modules/geneng/index.cfm GM crop production animation: www.cfs.gov.hk/english/programme/programme_gmf/programme_gmf_er_res2.html# Exploring GM crop issues: www.nationalstemcentre.org.uk/elibrary/resource/1750/talking-about-genetics
17(s)	Explain that the gene that controls the production of human insulin can be inserted into bacterial DNA	The insulin gene can be identified and, with the aid of enzymes, isolated from the strand of DNA in the nucleus of a cell from a healthy person. Enzymes are again used to attach it to the DNA of a bacterium. This example will form one aspect included in the task set in 17(r) above. **(W)**	**Online:** Production of human insulin: www.abpischools.org.uk/res/coResourceImport/modules/hormones/en-flash/geneticeng.cfm
17(t)	Understand that such genetically engineered bacteria can be used to produce human insulin	Culture and extraction of the insulin commercially produced should be explained similarly to that for single cell protein and penicillin in 14(e) of Unit 6. **(W)**	

Learning objectives		Suggested teaching activities	Learning resources
	on a commercial scale		
17(u)	Discuss potential advantages and dangers of genetic engineering	Learners may use the suggested online resource to prepare one side of the argument in readiness for class debate arguing the pros and cons of genetically engineered food. **(I) (W)** The need for development of an overall balanced argument may be stressed by asking each learner, following the class debate, to write for the argument opposing their original position. **(I) (W)**	**Online:** Balanced arguments for and against GM foods: www.csa.com/discoveryguides/gmfood/overview.php

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