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Scheme of work – Cambridge IGCSE® Biology (0610)

Unit 1: Cells and cell processes

Recommended prior knowledge
Students can come to this unit with very little prior knowledge. In order to understand diffusion and osmosis, they will need some understanding of particle theory. Some knowledge of catalysts will also be helpful, and they should know a little about simple chemical reactions and how to represent these by word equations. The concept of pH should also be understood at a simple level.

Context
This unit covers some fundamental topics that will be drawn on in all the units that follow, and therefore the majority of it is covered by both Core and Supplement (Extended).

Outline
The unit first considers the special features that make living things different from non-living objects, and then looks at the structure and functions of animal and plant cells, which leads into the organisation of cells into tissues. Some particular examples of specialised cells are considered, which introduces the idea of structural adaptations for particular functions. Movement of substances within living organisms by diffusion, osmosis and active transport (the latter for the supplement only) is considered. A simple treatment of enzyme function and some applications completes the unit.
Note that Unit 1.2, 1.3 and 1.4 (dealing with classification and keys) are included in this unit, but some teachers may prefer to cover these topics at the beginning of Unit 9 Organisms and environment.

(Please note: **(S)** in **bold** denotes material in the Supplement (Extended syllabus) only)

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
I 1	1.1 Characteristics of living organisms • List and describe the characteristics of living organisms • Define the terms: – *nutrition* as taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them – *excretion* as removal from	Section 1 of this unit can provide an introduction to the Biology course. The seven characteristics of living things form a basis from which the themes underlying many biological concepts can be developed. Activities can include: 1. The comparison of the characteristics of living organisms with those of non-living things – for example, what are the characteristic of life shown by a petrol engine. The comparison is clear when written in a table. 2. The mnemonic, MRS GREN is useful to remember the seven characteristics.	*Biology for IGCSE*, Williams et al. Nelson Thornes, 2009 p2–3 Student activity – Characteristics of Living things: www.exploratorium.edu/imaging_station/activities/classroom/characteristics/ca_characteristics.php Including video clips and student

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	organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements – *respiration* as the chemical reactions that break down nutrient molecules in living cells to release energy – *sensitivity* as the ability to detect or sense changes in the environment (stimuli) and to make responses – *reproduction* as the processes that make more of the same kind of organism – *growth* as a permanent increase in size and dry mass by an increase in cell number or cell size or both – *movement* as an action by an organism or part of an organism causing a change of position or place	3. Students should understand that single-celled organisms, plants and animals all have these characteristics. 4. The characteristic of nutrition could be extended to include autotrophic and heterotrophic nutrition and the terms parasite and saprophyte. 5. If models or specimens are available, students could discuss the importance of having a large surface area in relation to volume for diffusion. The importance of diffusion of gases in respiration will be understood more easily when Unit 4 is studied. 6. Growth could also be explained as an increase in size due to cell division. There might be a change in shape with growth. 7. Examples to explain the need for energy to carry out each of the characteristics should be discussed. Students will appreciate that energy is required for movement and this can be extended to show that energy is needed for growth, nutrition and sensitivity. Extension – students could perform a search of the characteristics of life. Do all scientists use the same list? How do we classify viruses? Student progress could be assessed using: May/June 2011 Paper 0610/22 question 1 May/June 2008 Paper 0610/02 question 1	worksheet. Revision – Cells and Life Processes: www.lgfl.skoool.co.uk/content/keystage4/biology/pc/lessons/uk_ks4_cells_life_processes/h-frame-ie.htm Revision – Characteristics of Life: www.s-cool.co.uk/gcse/biology/cells/revise-it/characteristics-of-life
I 2.1	1.2 Concept and use of a classificatory system • Define and describe the *binomial system* of naming species in which the scientific name of an organism is made up of two parts showing the genus and species	Students may know some binomials, such as *Homo sapiens*. Use this as an introduction of the Latin names for classification of all organisms. Carl Linnaeus can be mentioned and his work discussed. Emphasise the format of binomial names: Genus with a capital letter and species with a lower case letter and the possible use of *italics* or underlining.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p4–13 Students can visit a variety of living organisms to appreciate the variety amongst living things: Local zoo Game park Natural history museum Online specimen collections www.nhm.ac.uk/index.html

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	• List the main features of the following vertebrates: – bony fish – amphibians – reptiles – birds – mammals	The use of the internet, photographs or specimens of the five groups of vertebrates can be used to draw up a table or produce a poster to include the main characteristics of each class. Students should understand the specific features that differentiate each class: e.g. Birds have feathers, beaks, front limbs modified into wings and lay hard-shelled eggs. Student progress could be assessed using: May/June 2010 Paper 0610/21 question 2 May/June 2009 Paper 0610/31 question 1 Oct/Nov 2010 Paper 0610/21 question 1 Oct/Nov 2010 Paper 0610/22 question 2 Oct/Nov 2008 Paper 0610/02 question 1	The four species of crow can serve to explain the importance of classification. *Corvus coroner*: carrion *Corvus corax:* raven *Corvus frugilus*: rook *Corvus monedula*: jackdaw www.rspb.org.uk/wildlife/birdguide/name/c/carrioncrow/index.aspx Bird images: www.allaboutbirds.org/Page.aspx?pid=1189 Species diversity: www.seaworld.org/animal-info/info-books/bio-diversity/index.htm An exploration of Biodiversity
I 2.1 (S)	**1.2** • **Know that there are other classification systems e.g. cladistics (based on RNA/DNA sequencing data)** • **List the main features used in the classification of the following groups:** – **viruses** – **bacteria** – **fungi** **and their adaptation to the environment, as appropriate**	Viruses and bacteria should be studied from photomicrographs or diagrams but their relevance can be mentioned in nutrition and disease ref: Unit 2 and Unit 7.1. Mucor as a fungus can be grown and the gross structure studied under a light microscope. Emphasise the role of spores in dispersal. Positive applications of viruses and bacteria can be mentioned in Unit 2.2 and 8.6. Student progress could be assessed using: Oct/Nov 2009 Paper 0610/31 question 1.	Cladistics: www.evolution.berkeley.edu/evolibrary/article/phylogenetics_01 *Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p10–11 The virtual virus experience: www.library.thinkquest.org/13373/intro/intro.htm Infectious diseases – Pathogens: www.abpischools.org.uk/page/modules/infectiousdiseases_pathogens/index.cfm

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I 2.2	1.3 Adaptations of organisms to their environment (to be illustrated by examples wherever possible) • List the main features used in the classification of the following groups: – flowering plants: monocotyledons and eudicotyledons (dicotyledons) – arthropods: insects crustaceans arachnids myriapods – annelids – nematodes – molluscs	This section focuses on the adaptations of animals and plants to their environment. Specimens from each group can be viewed under the microscope and the main features noted. Emphasis should be given to drawing clear diagrams in pencil. Students can draw a chart to list and then compare the distinguishing features of each group. Reference should be made to the organism's habitat and reference later in Units 3.6, 9.2 and 10.5. Extension – students could be asked to search the ARKive database and compile a presentation of the listed groups of organisms.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p4–13 & p94–95 A comparison of monocots and dicots: www.csdl.tamu.edu/FLORA/201Manhart/mono.vs.di/monosvsdi.html Preserved specimens if available, are excellent for explaining external features. An excellent source for images and video clips of animals and plants is ARKive: www.arkive.org/
I 3	1.4 Simple keys • Use simple dichotomous keys based on easily identifiable features	Many students have difficulty in constructing dichotomous keys. The concept can be introduced with coins or nails/ screws with different shaped heads or even with postage stamps. The students can then classify a selection of leaves from the school grounds or from a selection of small pictures of different arthropods. Extension – more complex keys could be used to identify local flora or fauna. Student progress could be assessed using: May/June 2011 Paper 0610/21 question 1 May/June 2010 Paper 0610/22 question 1 May/June 2009 Paper 0610/02 question 1 Oct/Nov 2010 Paper 0610/33 question 1a	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p14–15

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II 1	1.5 Cell structure and organisation • State that living organisms are made of cells • Identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell) as seen under a light microscope • Describe the differences in structure between typical animal and plant cells	Palisade cells can be seen using prepared slides or transparencies of leaf sections. Students can make their own slides of freshwater filamentous algae, Elodea or moss that can be mounted in a drop of water on a slide and viewed with a microscope. Liver cells are difficult to observe, but it may be possible to make temporary mounts of wrist cells. Wash the inside of the wrist and place a piece of scotch tape onto this part of the wrist. Pull off the scotch tape and view the cells under the microscope. Extension – Students can also make models of a plant cell and / or an animal cell to gain an idea of the orientation of the main structures of each type of cell. Show video clip – cell structure: www.bbc.co.uk/learningzone/clips/parts-of-plant-and-animal-cells/10602.html Student progress could be assessed using: May/June 2010 Paper 0610/21 question 1 Oct/Nov 2009 Paper 0610/02 question 2	PowerPoint presentation – Cells and Tissues: www.biology-resources.com/biology-CD.html Illustrations of cells: www.cellsalive.com/ *An Atlas of Histology,* Freeman and Bracegirdle. An excellent reference book for teachers. Cell structure: www.exploratorium.edu/imaging_station/activities/classroom/elodea_explorations/ca_elodea_explorations.php Revision – Cell structure: www.s-cool.co.uk/gcse/biology/cells/revise-it/plant-and-animal-cells
II 1 (S)	**1.5** • **Relate the structures seen under the light microscope in the plant cell and the animal cell to their functions**	Candidates studying the supplement should consider functions of features that are common to plant and animal cells, and those that are found in plant cells only. They should understand how the differences between animal and plant cells relate to their different methods of obtaining nutrients. Examine a temporary mount of epidermal tissue peeled from the inner surface of an onion bulb. Students could review cell structure ("cell structure and function" or "organelles"): www.exploratorium.edu/imaging_station/gallery.php	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p19 Inside animal and plant cells: learn.genetics.utah.edu/content/begin/cells/insideacell/ Video clip – Cell structure: www.bbc.co.uk/learningzone/clips/plant-and-animal-cell-structures/4188.html

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II 2	1.6 Levels of organisation • Relate the structure of the following to their functions: – ciliated cells – in respiratory tract – root hair cells – absorption – xylem vessels – conduction and support – muscle cells – contraction – red blood cells – transport • Define: – *tissue* as a group of cells with similar structures, working together to perform a shared function – *organ* as a structure made up of a group of tissues, working together to perform specific functions – *organ system* as a group of organs with related functions, working together to perform body functions using examples covered in Sections II and III	The coverage of these examples of cells and of organs and organ systems could come later when they can be dealt with in context but it may help to introduce the students to cells with different functions at this stage using an overhead or on a PowerPoint presentation. Students can select their own specialised cell, draw and label it on A3 paper. Flash cards are an interactive way of learning about specialised cells. Students can draw a flow diagram from cells to the particular organ system to begin to understand the complexity of the human body. An outline of the human body can be used to draw in the main organ systems of the body. Extension – students could research a greater range of specialised cells. This could link to stem cells and their uses. Student progress could be assessed using May/June 2009 Paper 0610/02 question 5.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p20–23 Examples of differentiated cells: www.rothamsted.ac.uk/notebook/organ.htm
II 3	1.7 Size of specimens • Calculate the magnification and size of biological specimens using millimetres as units	Use the temporary mount of epidermal tissue peeled from the inner surface of an onion bulb or rhubarb stem and to use an appropriate scale to determine the size of cells. Students can magnify a piece of hair to understand that magnification is $\frac{\text{size of image}}{\text{size of object}}$ Student progress could be assessed using: May/June 2009 Paper 0610/31 question 2b	Microscope magnification specifications & field of view: www.microscope-microscope.org/advanced/magnification-1.htm Student activity – Specimen size: www.exploratorium.edu/imaging_station/activities/classroom/size/ca_size.php Relative sizes of cells: www.cellsalive.com/howbig.htm

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
			Scale: learn.genetics.utah.edu/content/begin/cells/scale/
II 4.1	1.8 Diffusion • Define *diffusion* as the net movement of molecules from a region of their higher concentration to a region of their lower concentration down a concentration gradient as a result of their random movement • Describe the importance of gaseous and solute diffusion and of water as a solvent	Use a simple demonstration of diffusion, for example a potassium manganate VII crystal in a gas jar of water or a drop of methylene dye on gelatine solidified in a test tube (diffusion of a solute), or ammonia and hydrochloric acid placed at opposite ends of a long glass tube, or simply a perfume container opened in one corner of the room. Bromine in a gas jar (carried out in a fume cupboard) can quickly show diffusion (gaseous diffusion). Teachers should be aware that these experiments are often carried out by the Chemists at the beginning of the Cambridge IGCSE course and collaboration is important. Emphasise the random motion of particles. Variables of temperature, pressure, distance moved, concentration and size of particles. Consider the relevance of diffusion to living organisms – for example, the diffusion of oxygen and carbon dioxide into and out of a plant leaf or across the surface of the alveoli in the human lungs. Emphasise that water is an important solvent and most cells contain about 75% water. Water transports substances and allows many chemical reactions to take place. Extension – students could investigate the effects of surface area/volume ratio on rates of diffusion. Student progress could be assessed using: May/June 2011 Paper 0610/22 question 6 Oct/Nov 2009 Paper 0610/02 question 9	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p26–27 PowerPoint presentation – Diffusion: www.biology-resources.com/biology-CD.html Experiments in biology – Diffusion: www.biology-resources.com/biology-experiments2.html Practical Biology – Diffusion: www.nuffieldfoundation.org/practical-biology/diffusion Diffusion and animation and text: www.bbc.co.uk/schools/gcsebitesize/science/add_gateway/living/diffusionrev1.shtml

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II 4.2 (S)	**1.9 Active Transport** • **Define *active transport* as movement of ions in or out of a cell through a cell membrane, from a region of their lower concentration to a region of their higher concentration against their concentration gradient, using energy released during respiration** • **Discuss the importance of active transport as an energy-consuming process by which substances are transported against a concentration gradient e.g. ion uptake by root hair cells and the uptake of glucose by epithelial cells of villi**	A simple explanation is climbing uphill. No detail of the molecular mechanism of active transport needs to be considered. Students should understand that energy for this process is provided by respiration. Students will understand the importance of the movement of particles by active transport after having studied Units 2, 3 and 5.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p32–33 Practical Biology – Active uptake: www.nuffieldfoundation.org/practical-biology/active-uptake
II 4.3	1.10 Osmosis • Define *osmosis* as the diffusion of water molecules from a region of their higher concentration to a region of their lower concentration, through a partially permeable membrane • Describe the importance of osmosis in the uptake of water by plants and its effects on plant and animal tissues	Osmosis should be treated as a special case of diffusion, in which only *water* molecules are able to move from one side of a partially permeable membrane to another. Ensure that students understand what a *solution* is in terms of particles, so that they are able to imagine the water molecules and solute particles behaving independently of each other. Use visking tubing to demonstrate osmosis. Investigation of changes in mass or length of potato chips or of dried raisins placed in a range of different concentrations of sugar solution provides good opportunity for quantitative treatment of results, as well as enhancing understanding of osmosis. 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. Turgor as an important mechanism of support in plants could be discussed (Unit 3.4 & 3.5).	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p28–31 PowerPoint presentation – Osmosis: www.biology-resources.com/biology-CD.html Experiments in biology – Osmosis: www.biology-resources.com/biology-experiments2.html Practical Biology – Osmosis: www.nuffieldfoundation.org/practical-biology/osmosis Osmosis animation and text: www.bbc.co.uk/schools/gcsebitesize/science/add_gateway/greenwo

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
		Relate water uptake by osmosis to the structure of root hair cells covered earlier in this unit. Student progress could be assessed using: Oct/Nov 2008 Paper 0610/02 question 9	rld/waterrev1.shtml Interactive osmosis (advanced for IGCSE): www.physioweb.uvm.edu/bodyfluids/osmosis.htm Revision – Osmosis: www.s-cool.co.uk/gcse/biology/cells/revise-it/moving-molecules
II 4.3 (S)	**1.10** • **Describe and explain the importance of a water potential gradient in the uptake of water by plants**	Explain water potential as the tendency for water to leave a solution. The more water (that is then a more dilute the solution) the higher the water potential. Water moves from a high water potential to a low water potential – that is, down a water potential gradient. Do not introduce the idea of negative water potentials at this level. Relate to intake of water by root hairs.	
II 5	1.11 Enzymes • Define the term *catalyst* as a substance that speeds up a chemical reaction and is not changed by the reaction • Define *enzymes* as proteins which function as biological catalysts • Investigate and describe the effect of changes in temperature and pH on enzyme activity	Simple experiments with catalase are an excellent introduction to enzymes. Revise the meaning of the term 'catalyst'. Ensure that students understand that enzymes are simple (protein) molecules, not living organisms. They cannot, therefore, be 'killed'. Investigate the effect of temperature on the effect of enzyme activity, for example using starch and amylase, or pepsin and milk powder. Explain the rise in activity with temperature, in terms of kinetic theory, and the fall as temperature rises above the optimum in terms of denaturation of the enzyme molecules. Consider the different optimum temperatures of different enzymes, not only those in humans. Extension – students could investigate the effectiveness of enzyme based washing powders.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p36–39 Experiments in biology – Enzymes: www.biology-resources.com/biology-experiments2.html Practical Biology – Enzymes: www.nuffieldfoundation.org/practical-biology/investigating-enzymes-used-laundry-detergents Simple account of how enzymes work: www.abpischools.org.uk/page/modules/enzymes/enzymes1.cfm

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		Use the kscience animation on an interactive whiteboard to demonstrate enzyme actions. Student progress could be assessed using: Oct/Nov 2010 Paper 0610/22 question 1 May/June 2008 Paper 0610/02 question 3	Interactive model of enzyme action: www.kscience.co.uk/aanimations/model.swf Revision – Enzyme experiments: http://lgfl.skoool.co.uk/content/keystage4/biology/pc/modules/digestion/digestion_experiments/index.html Revision – Enzymes: www.lgfl.skoool.co.uk/content/keystage4/biology/pc/modules/digestion/digestion_part_3/index.html Revision – Enzymes: www.s-cool.co.uk/gcse/biology/enzymes/revise-it/enzymes
II 5 (S)	**1.11** • **Explain enzyme action in terms of the 'lock and key' model** • **Explain the effect of changes in temperature and pH on enzyme activity** • **Describe the role of enzymes in the germination of seeds and their uses in biological washing products and in the food industry (including pectinase and fruit juice)** • **Outline the use of microorganisms and fermenters to manufacture the antibiotic penicillin and enzymes for use in biological washing products** • **Describe the role of the fungus**	Power point demonstrations and graphs to show the trends of increasing temperature and of different pH solutions provide useful means of interpreting data. The role of amylase in the breakdown of starch to maltose in seeds provides an example of enzymes in plants. Germinating barley seeds, dipped into a sterilising solution to destroy any micro-organisms on their surfaces, can be placed on sterile starch agar in a Petri dish, which can later be tested for starch with iodine solution. Extension: proteases, lipases and amylases, often with high optimum temperatures, are all used in biological washing products. Investigations can be carried out into the effectiveness of these in removing different types of stains. Simple experiments on the effect of pectinase on the yield of juice from crushed apples or tinned apple purée can be carried out.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009, p36–41 Downloadable booklets with practical investigations using a variety of enzymes: www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/pracbiotech.html www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/juice.html

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	Penicillium **in the production of antibiotic penicillin**	Student progress could be assessed using: May/June 2009 Paper 0610/31 question 3 Oct/Nov 2010 Paper 0610/33 question 3 May/June 2008 Paper 0610/31 question 3	