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.

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 section I, parts 2 and 3, are studied in this unit, but some teachers may prefer to cover these topics at the beginning of Unit 9.

	Learning Outcomes	Suggested Teaching Activities	Resources
I 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 organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements	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. The comparison is clear when written in a table. 2. The mnemonic, MRS GREN is useful to remember the seven characteristics. 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.	Students can visit any one of: Local zoo, Game park Natural history museum to appreciate the variety amongst living things.

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	- *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.	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.	
I. **2.1**	Classification and diversification of living organisms Concept and use of 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 • List the main features of the following vertebrates - bony fish - amphibians - reptiles - birds - mammals	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. The use of the internet, photographs or specimens of the five groups of vertebrates can be used to draw up a table to include the main characteristics of each class. Students should understand the specific features that differentiate each class: Birds have beaks and lay hard-shelled eggs	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 Species diversity http://www.seaworld.org/infobooks/Biodiversity/speciesbio.html Photographs and descriptions of a range of mammals, reptiles, amphibians and fish.

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	Supplement • 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 2.5 and Unit 4 7.2.3. 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.	http://www.everythingbio.com/glos/definition.php?word=cladistics The virtual virus experience: http://library.thinkquest.org/13373/intro/intro.htm
II 2.2	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 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 animal's habitat and reference later in Units 9 IV 2 and 10 IV 5.3.	http://www.britannica.com/EBchecked/topic/35798/dicotyledon A comparison of monocots and dicots: http://www.csdl.tamu.edu/FLORA/201Manhart/mono.vs.di/monosvsdi.html An introduction to annelida: http://www.ucmp.berkeley.edu/annelida/annelida.html Preserved specimens if available, are interesting for explaining external features. http://www.theseashore.org.uk/theseashore/speciesPages/Dog%20whelks.html
II.3	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	

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		arthropods.	Past examination paper 2 are a valuable source for this section.
II 1	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. It is not advisable to make temporary slides of cheek cells. 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.	Illustrations of cells http://www.cellsalive.com/ The Atlas of Histology by Freeman and Bracegirdle: 0435-60317-5 published by Heinemann is an excellent reference book for teachers. http://click4biology.info/c4b/2/cell2.4.htm#structure
II 1	Supplement • 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. Ref: Units 2 and 3 and 9 considering trophic levels. Examine a temporary mount of epidermal tissue peeled from the inner surface of an onion bulb	
II 2	Levels of organisation. • Relate the structure of the following to their functions: - ciliated cells – in respiratory tract - root hair cells – absorption	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	Examples of differentiated cells: http://www.iacr.bbsrc.ac.uk/notebook/courses/guide/organ.htm

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	- 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	overhead or on a power point 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.	
II 3	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 $\frac{\text{size of image}}{\text{size of object}}$	Microscope magnification specifications & field of view http://www.microscope-microscope.org/advanced/magnification-1.htm Paper 6 June 2001, question 2 would provide a question to work on .
II 4.1	Movement in and out of cells • 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)	Diffusion and osmosis animation and text: http://www.bbc.co.uk/scotland/revision/biology/investigating_cells/cells_and_diffusion_rev.shtml#diffusion Diffusion and osmosis interactive animations: http://physioweb.med.uvm.edu/bodyfluids/osmosis.htm

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		Teachers should be aware that these experiments are often carried out by the Chemists at the beginning of the 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.	
II 4.2	Supplement 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 and 3	
II 4.3	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.	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.	Visking tubing experiment, an interactive source: http://www.mhhe.com/biosci/esp/2001_gbio/folder_structure/ce/m3/s3/cem3s3_3.htm

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	• Describe the importance of osmosis in the uptake of water by plants and its effects on plant and animal tissues.	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, Unit 3. 7.1. as an important mechanism of support in plants could be discussed. Relate water uptake by osmosis to the structure of root hair cells covered earlier in this Unit.	
II 4.3	Supplement • 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	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.	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'.	Simple account of how enzymes work: http://www.activescience-gsk.com/miniweb/content/enzymes/how_do.htm http://www.kscience.co.uk/aanimations/model.swf

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	• Investigate and describe the effect of changes in temperature and pH on enzyme activity.	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. This will be covered in Units 2 and 9.	
II 5	Supplement • 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 powders. • Describe the role of the fungus *Penicillium* in the production of antibiotic penicillin.	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. Proteases, lipases and amylases, often with high optimum temperatures, are all used in biological washing powders. 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.	Downloadable booklet 'Practical Biotechnology', with practical investigations using a variety of enzymes http://www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/pracbiotech.html