

O Level Biology (5090)

Unit 1: Cells and Cell Processes

Recommended Prior Knowledge

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

Context

Cells are the building blocks of living organisms and basic physiological processes in which they are involved have a 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.

AO	Learning outcomes	Suggested activities and further guidance	Online resources	Other resources
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 microscopes to examine, compare and identify structures in epidermal cells peeled from a fleshy leaf of an onion bulb and stained with iodine solution. Check on locally available plants for leaves which display mesophyll cells adhering to the peeled-off epidermis in order to show the presence of chloroplasts. Prepare and observe fresh liver cells or human cheek cells stained with methylene blue.	Plant and animal cell structure diagrams and explanations: http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/cells/cells1.shtml http://www.s-cool.co.uk/gcse/biology/cells/plant-and-animal-cells.html	Textbooks Mary Jones – Unit 1 Cell structure: Ian J. Burton – Topic 1 Cell structure and organisation M. & G. Jones – 1 Cells
1(b)	Draw diagrams to represent observations of the plant and animal cells examined above.	Use this learning outcome to reinforce the basic principles of biological diagram drawing – sharp HB pencil, drawings as large as can be fitted into the available space (with room for labels, in upper case, in pencil with ruled label lines).		

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 students with diagrams and photomicrographs of a range of cell types to allow them to identify the same structures within different contexts.		
1(d)	Identify from diagrams or photomicrographs, the 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 students with diagrams and photomicrographs of a range of cell types to allow them to identify the same structures (and those previously not visible) within different contexts.		
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.		
1(f)	State the function of the cell membrane in controlling the passage of substances into and out of the cell.	Explain why the passage of substances must be controlled and invite suggestions for chemicals which might pass in either direction through the membrane (and some which may not pass through – either because they are needed within the cell or because they might harm the cell).		
1(g)	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 students to label. 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.	Adaptations of specialised cells: http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/cells/cells2.shtml Red blood cell diagram: http://www.s-cool.co.uk/assets/red_blood_cell_s.jpg Root hair cell diagram: http://www.bbc.co.uk/schools/ks3bitesize/science/images/plant_root_cell.gif	

1(h)	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. Students may 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. Students should make drawings of a root hair cell and of red blood cells as seen under the microscope.	Seed germination apparatus: http://fromdirttodinner.files.wordpress.com/2009/02/seed-jar-sprouted_02-06-09.jpg	
1(i)	Differentiate cell, tissue, organ and organ system as illustrated by examples covered in syllabus sections 1 to 12, 15 and 16.	Explain the hierarchy of these structures and invite students to supply both animal and plant examples of each. Prepare a set of cards each with the name and/or a diagram of one example of a cell, tissue, organ or system. Students may classify each card by placing them into groups and then place the groups of cards in order.	Hierarchy or organisation: http://lgfl.skool.co.uk/content/keystage3/biology/pc/learningsteps/OLTLC/launch.html	
2(a)	Define diffusion as the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient.	Refer to chemical molecules always being in a state of random motion. Explain the concept of concentration in gases and in liquids and the tendency for molecules to move from where they are more concentrated to where they are less concentrated. Illustrate with an air freshener placed on one side of the laboratory and with potassium manganate IV solution dropped with a pipette into a large beaker of still water. 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.	Diffusion animation and explanation: http://www.bbc.co.uk/schools/gcsebitesize/science/add_gateway/living/diffusionrev1.shtml Diffusion practical activities: http://www.iit.edu/~smile/bi9508.html	Textbooks Ian J. Burton – Topic 3 Diffusion and Osmosis (active transport also covered) M. & G. Jones – 2 Diffusion, Osmosis and Active transport Mary Jones – Unit 2 Diffusion, Osmosis and Active Transport.
2(b)	Define osmosis as the passage of water molecules from a region of their higher concentration to a region of their lower concentration through a partially permeable membrane.	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.	Visking tubing demonstration: http://www.hyss.sg/ebioscience3/getdetails.asp?checkid=78	

2(c)	Describe the importance of water potential gradient in the uptake of water by plants and the effects of osmosis on plant and animal tissues.	<p>Relate uptake of water into cells with an increase in their volume and, as a consequence of the cell wall, also of pressure within the cell. Explain the importance of turgidity in the process of support. In the absence of a cell wall animal cells will burst. Stress that during osmosis water molecules ONLY move across a water potential gradient.</p> <p>Students should observe the effect of osmosis</p> <ul style="list-style-type: none"> i) on plant cells using onion epidermis mounted in pure water and in concentrated sugar solution and viewed under a microscope and ii) on tissue using measured lengths of raw potato chips immersed in water and in concentrated sugar solution. 	<p>Osmosis animation and explanations: http://www.bbc.co.uk/schools/gcsebitesize/science/add_gateway/greenworld/waterrev1.shtml</p> <p>Video clips of osmosis in onion epidermal cells: http://www.youtube.com/watch?v=gWkcFU-hHUK&feature=related http://www.youtube.com/watch?v=nHWUAdkYq4Q&feature=related</p>	
2(d)	Define active transport and discuss its importance 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.	<p>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.</p> <p>Students may set up bean seedlings in dilute fertiliser solution and 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>		
3(a)	Define enzymes as proteins that function as biological catalysts.	Explain the function of a catalyst in terms of altering the rate of a chemical reaction without itself being used up during the reaction.	<p>Enzymes video animation: http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/enzymes/acidsbasesact.shtml</p>	<p>Textbooks M. & G. Jones – 3 Enzymes Mary Jones - Unit 3 Enzymes Ian J. Burton – Topic 4 Enzymes – Topic 5 Nutrition (for food tests)</p>

3(b)	Explain enzyme action in terms of the 'lock and key' hypothesis.	Introduce the terms <i>substrate</i> , <i>product</i> and <i>active site</i> . Use the video animation to show the nature of these structures. The analogy of the 'lock and key' is useful when explaining the mechanism of enzyme action.	Enzymes and their action: http://www.s-cool.co.uk/gcse/biology/enzymes/enzymes.html	
3(c)	Investigate and describe the effect of temperature and pH on enzyme activity.	<p>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.</p> <p>Explain graphs of rate of enzyme reaction at different temperatures and at different pHs.</p> <p>Explain the use of the iodine test for starch and Benedict's test for reducing sugars. Students 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> <p>Students should perform experiments to show;</p> <ol style="list-style-type: none"> i) the effect of amylase on starch solution at different temperatures and also to show the effect of boiling amylase before use, ii) the effect of pH on the same reaction at a constant temperature, and iii) the breakdown of hydrogen peroxide by catalase (e.g. in yeast or potato). 	<p>Enzyme action and effect of temperature animation: http://www.biotopics.co.uk/other/enzyme.html</p> <p>Enzyme action and graphs showing effect of changing temp and pH: http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/enzymes/enzymes1.shtml</p> <p>Experiments to demonstrate the effect of external conditions on enzyme action: http://www.biotopics.co.uk/nutrition/enzfac.html</p>	