

UNIT 2 Regulation and control

Recommended Prior Knowledge Students should have a good understanding of cell structure. They should understand the concept of water potential, and how active transport takes place. They should also know the structure of a cell surface membrane.

Context This unit could either precede or follow Units 1 and 2. If students are going to study Option 1, Mammalian Physiology, you might like to bring forward some of the material in Sections 4 and 5 of that Option as it follows closely from some of the topics in this Unit. Similarly, if students will later be studying Option 3, the topics on plant growth regulators relate closely to some of the material in Section 5 of that Option.

Outline The need for communication systems in multicellular organisms is discussed, and the roles of the nervous system and endocrine system are described. The control of water content and of blood glucose concentration illustrate the concept of homeostasis. Excretion of nitrogenous wastes by the kidneys is also dealt with.

Reinforcement and formative assessment It is recommended that, towards the end of the time allocated to the unit, time be taken to permit reinforcement of the learning that has occurred. There are many ways in which this might be done, ranging from revision lessons, through overview homework, through research project and into preparation of essays, presentations, posters or other material.

- This topic, with so much attractive visual material, is very well suited to highly visual presentations. Small groups of two or three students should be encouraged to work together for an hour or two of lesson time, plus homework for a week or two. They should prepare a visual presentation of a topic to their peers. This could be in the form of a poster, a video, a PowerPoint presentation, an OHP illustrated talk, a short video clip or whatever seems appropriate. Some students will wish to draw their own diagrams, and others to download them from the net, and others to photocopy them from paper sources – all these approaches should be encouraged.
- Formative assessment could take the form of student self-marked minitests, taking just 10 or 15 minutes for students to do and then mark for themselves, perhaps using questions from the Learn CIE Test Centre – discussing the correct answers as a whole class.
- At the end of the unit, there should be a much larger formative assessment test, using appropriate past-examination and similar style questions, taking a lesson to do, and a lesson to provide feedback after marking by the teacher.

Sequence of teaching and learning There are four main topics in this unit, nervous coordination, chemical coordination, excretion and plant communication.

- Some teachers prefer to teach it in the order it is presented, on the basis that the nervous system is more familiar and can act as a basis for the more detailed consideration of the nerve transmission. Also practical work on reflex reactions makes the unit interesting to many candidates, and therefore easier to understand first.
- Obviously the plant communication could be taught separately but the receptor, communication method and effector concept may be easier for candidates to understand in humans, before thinking of the same concept in plants.

Please evaluate these various approaches, and choose the sequence of topics that seems most appropriate for your students.

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
N(e)	<p>outline the need for communication systems within mammals to respond to changes in the internal and external environment</p> <p>Learning Activity Pupils should participate in: Brainstorm of prior knowledge given terms such as organisation of multicellular organisms, internal changes, changes in external environment, endocrine, nervous system, reflexes. Presentation of ideas by groups. Whole class discussion / oral question and answer leading to table showing internal changes, which organs/systems affected/receptors, communication method and effector/s and response. A similar table could be used to consider the external changes in environment and the receptors, communication method and effectors involved.</p>	<p>Discuss with the class the need for communication between different organs in a multicellular organism. Students should already be familiar with the endocrine and nervous systems, so use question and answer to remind them of what they know.</p>	<p>http://smccd.net/accounts/ka pp/130/note/130t4.htm Section 1 importance of internal communication.</p>	<p><i>Biology A2 Biozone</i>, outlines the ways of detecting change on page 215. Model answers to questions are provided in a separate student book and on CD.</p>
N(g)	<p>describe the structure of a sensory neurone and a motor neurone and outline their functions in a reflex arc.</p> <p>Learning Activity Pupils should participate in: -review of own knowledge of structure and function of sensory and motor neurons and reflex arcs, followed by pair work to compare knowledge then group work to correct any misunderstandings. -drawing labelled, annotated diagrams of the structure of sensory and motor neurons and compare these to electron micrographs.</p>	<p>Students will probably be familiar with reflex arcs and the neurones involved in them. Raise their level of understanding by asking them to interpret electron micrographs of neurones. Point out that many reflex actions (e.g. the pupil reflex) involve the brain rather than the spinal cord. Students could look at slides of cross sections of the spinal cord to see motor neurone cell bodies.</p> <p>Practical work can be carried out into reflex actions and reaction times.</p>	<p>http://www.gen.umn.edu/courses/1135/lab/reflexlab/reflexlab.html Notes, accessible to A level students, on reflexes and reflex arcs, including descriptions of how to elicit several reflexes. http://www.sumanasinc.com/webcontent/anisamples/neurobiology/reflexarcs.html Animation of reflex actions http://www.meddean.luc.edu/lumen/MedEd/Histo/frames/frame6.html</p>	<p><i>Practical Advanced Biology</i>, King et al, has descriptions of experiments investigating human reflexes, and also reaction times.</p> <p><i>Biology A2 Biozone</i>, give a clear account on pages 242 and 243. Model answers to questions are provided in a separate student book and on CD.</p>

	<p>-draw reflex arcs and annotate to show the function of the neurons; example of reflex using spinal cord and one using the brain.</p> <p>-carrying out experiments on reflex actions and reaction times.</p> <p>-tabulating as a group the difference/s between a neurone and a nerve.</p> <p><i>-candidates could make models of the two different neurones or a section through an axon with myelin sheath.</i></p>	<p>Ensure that students understand the difference between a neurone and a nerve.</p>	<p>Pictures of histology of nervous tissue with good notes.</p> <p>http://educ.queensu.ca/~science/main/concept/biol/b06/B06LACW1.htm</p> <p>Procedures for investigating human reflexes</p>	
N(f)	<p>outline the role of sensory receptors in mammals in converting different forms of energy into nerve impulses</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <p>-review of different forms of energy by brainstorming and producing a list.</p> <p>-discuss in the group a definition of the term 'receptor' and make sure they have written a clear definition.</p> <p>-making a list of the sensory receptors in humans, matching these to the reception of an energy form and what form this energy is converted into by the receptor.</p> <p>-carrying out experiments to investigate touch, temperature and pain receptors in the skin.</p>	<p>Explain to students the meaning of the term 'receptor' and ask them for examples of sensory receptors in humans. Build up a list of these. Help them to name the types of energy involved in each of our senses.</p> <p>Practical work can be carried out to investigate touch, temperature and pain receptors in the skin.</p>	<p>http://faculty.washington.edu/chudler/twopt.html</p> <p>Investigates touch, temperature and pain.</p>	<p><i>Practical Advanced Biology</i>, King et al, has an experiment investigating receptors in the skin.</p> <p><i>Biology A2 Biozone, covers sensory perception and vision and hearing on pages 248 - 252. Model answers to questions are provided in a separate student book and on CD.</i></p>
N(h)	<p>describe and explain the transmission of an action potential in a myelinated neurone (the importance of sodium and potassium ions in the impulse transmission should be emphasised)</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <p>- revision of terms - partially permeable, impermeable, permeable, active transport, protein channels, ATP, ion pumps, diffusion, potential</p>	<p>Students often find this topic difficult. It is important to take it steadily and not to risk confusing students by giving them more detail and complexity than is needed.</p> <p>Students should understand how a resting potential is maintained in a neurone and how depolarisation generates an action potential. Help them to relate these events to the different areas of a graph showing an action potential and explain how the</p>	<p>http://www.biology4all.com/resources_library/details.asp?ResourceID=40</p> <p>A nerve impulse animation.</p>	<p><i>Biology</i> gives a good guide to the level of treatment required.</p> <p><i>Biology A2 Biozone, gives outline on page 244. Model answers to questions are provided in a separate student book and on CD.</i></p>

<p>difference.</p> <ul style="list-style-type: none"> - model the maintenance of the resting potential in a neurone by drawing a simple cylinder to show the outside and inside of the neurone and with cards for Na^+ and K^+ ions and terms needed to explain their movement e.g. active transport, diffusion, permeable, relatively impermeable, relatively permeable and resting potential and that this is described as polarised. - draw a diagram of the resting potential maintained by sodium and potassium active transport. - defining an impulse in terms of the reversal of the electrical potential - modelling the transmission of an impulse using the drawing of the neurone with cards on in resting potential and change as depolarised. Cards as above plus cards with sodium gates, sodium pumps, changing permeability of membrane to sodium ions, action potential, arrow to show direction of impulse. Move the action potential along the neurone as it is propagated because sodium ions entering the axon creates a positive charge and a flow of current is set up in a local circuit between this and the negatively charged resting potential in the area ahead. Current flow changes membrane permeability to the sodium ions and so the action potential is self-propagated. As current flow moves the membrane returns to the resting potential. -draw the diagram to show the impulse and depolarisation of the neurone. -model the return to the resting potential showing movement of K^+ by 	<p>resting potential is eventually restored. Students also need to understand how an action potential sweeps along an axon. Explain the concept of a refractory period, and help students to see why this means that the action potential passes in only one direction.</p>		
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	<p>diffusion. Explain that time taken for return to resting potential is called the refractory period, at the beginning of the refractory period is the absolute refractory period when the neurone cannot be stimulated to depolarise, followed by the relative refractory period when only a high intensity stimulus can lead to further depolarisations.</p> <p>-drawing a graph showing the passage of the depolarisation, refractory period and repolarisation.</p> <p>-link this idea to the refractory period to the passage of the action potential in one direction only.</p>			
N(i)	<p>explain the importance of the myelin sheath (saltatory conduction) and the refractory period in determining the speed of nerve impulse transmission</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <ul style="list-style-type: none"> -research into non-myelinated axons and conduction speeds and examples of animals. - draw a diagram to show the local circuits are very close together in non-myelinated. - compare electron micrographs of myelinated axons with own observations using light microscopes -draw a diagram to show Schwann cells and nodes of Ranvier - draw diagram to show local circuit between nodes of Ranvier so action potential 'jumps' from one node to the next called saltatory conduction so increasing speed of conduction. 	<p>Ask candidates to interpret diagrams and electron micrographs of an axon with a myelin sheath. They should know about Schwann cells and nodes of Ranvier, and be able to explain how saltatory conduction is brought about and the very great effect that this has on speed of transmission of action potentials.</p> <p>Students could use prepared microscope slides to make drawings of a transverse section of nerve; this will not only help their microscopy skills, but also helps them to understand the difference between a nerve and a neurone and that not all axons are myelinated.</p>	<p>http://cats.med.uvm.edu/cats_teachingmod/histology/lectures_online/ems/cell/cell.html</p> <p>Shows several electron micrographs building from light micrograph showing lots of cells to electron micrographs showing details of Schwann cells.</p>	<p><i>Practical Advanced Biology</i>, King et al, and <i>Comprehensive Practical Biology</i>, Siddiqui, both contain a practical exercise recording and interpreting micrographs of nerve tissue.</p> <p><i>Biology A2 Biozone</i>, gives outline on page 244. Model answers to questions are provided in a separate student book and on CD.</p>

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
N(j)	<p>describe the structure of a cholinergic synapse and explain how it functions (reference should be made to the role of calcium ions)</p> <p>Learning Activity Pupils should participate in:</p> <ul style="list-style-type: none"> -observe electron micrographs of synapses and compare them with diagrams of a synapse. -research and produce a presentation to show the transmission of the impulse across the synapse e.g. a set of posters or slides on powerpoint or a drama with people showing what happens in presynaptic knob by playing the roles of synaptic vesicles, mitochondria, calcium ions, transmitter substances and channels, hydrolytic enzymes and how the neurotransmitter crosses the synapse and triggers the depolarisation in the post-synaptic membrane -draw own set of diagrams to illustrate transmission. -discuss effects of drugs on the transmission across the synapse 	<p>Show students electron micrographs of synapses. Help them to understand the structure and function of a synapse.</p>	<p>http://www.tvdsb.on.ca/westmin/science/sbioac/homeo/synapse.htm A simple line animation of synaptic transmission.</p> <p>http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/D/Drugs.html <u>Information about the effects of drugs of abuse on the nervous system</u></p>	<p>An annotated diagram in <i>Biology</i> describes the structure and function of a cholinergic synapse. This text also gives brief descriptions of the actions of some drugs and toxins at synapses, which may interest students.</p> <p><i>Biology A2 Biozone, gives clear detail on page 245. Model answers to questions are provided in a separate student book and on CD.</i></p>
N(k)	<p>outline the roles of synapses in the nervous system in determining the direction of nerve impulse transmission and in allowing the interconnection of nerve pathways</p> <p>Learning Activity Pupils should participate in:</p> <ul style="list-style-type: none"> - discussion of one way transmission of the impulse and link this to reflex arcs. - bullet point main points on one way transmission. - research and discuss other roles of synapses. -produce a list of other roles. 	<p>Refer back to the reflex arc, and ask students to suggest why impulses can only pass in one direction along it. Discuss other roles of synapses, including the fact that one neurone can have many synapses relating to it, thus allowing interconnection of numerous nerve pathways; this increases the range of responses which can take place to a particular stimulus. If time allows, students could carry out some simple investigations into learning, which involves synapses.</p>	<p>http://www.skool.ie/skool/examcentre_sc.asp?id=2879 Provides a summary in bullet points but detail needs discussion.</p>	<p><i>Practical Advanced Biology, King et al, has ideas for investigations into learning in small mammals and in humans.</i></p> <p><i>Biofactsheet 20: Nerves and synapses</i> <i>Biofactsheet 58: Reflex action</i></p> <p><i>Biology A2 Biozone, covers summation on page 246. Model answers to questions</i></p>

				are provided in a separate student book and on CD.
N(l)	<p>explain what is meant by the term <i>endocrine gland</i></p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <ul style="list-style-type: none"> - discussing what a gland is. - writing clear definitions of a gland, secretion, endocrine (ductless) gland, ducted glands with examples. - discussion of the endocrine glands as effectors. 	<p>Ask students to name some glands in the human body. Ask them: what do all these glands have in common? Help them to understand that a gland is an organ (or tissue) which secretes something. Ensure they understand the meaning of 'secretion'. Explain to them the difference between ductless and other glands (e.g. the salivary glands).</p>		<p><i>Biology A2 Biozone</i>, gives details of the main endocrine glands on page 220. Model answers to questions are provided in a separate student book and on CD.</p>
N(m)	<p>describe the cellular structure of an islet of Langerhans from the pancreas and outline the role of the pancreas as an endocrine gland</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <ul style="list-style-type: none"> - identifying where the pancreas is in the human body relative to other organs -research the role/s of the pancreas - explain how the pancreas acts as both an endocrine and a ducted(exocrine) gland. -drawing prepared slides and annotating them to show the functions. 	<p>Show students a diagram or a model showing the main organs in the body, and ask them: where is the pancreas? What does it do? Draw out from them its dual role as a ducted gland which secretes pancreatic juice into the pancreatic duct and then into the duodenum; and as an endocrine gland which secretes insulin and glucagon Students can make their own annotated drawings from prepared slides.</p>	<p>http://www.udel.edu/Biology/Wags/histopage/colorpage/cp/cp.htm</p> <p><u>This has images showing the cellular structure of the pancreas.</u></p>	<p><i>Practical Advanced Biology</i>, King et al, and <i>Comprehensive Practical Biology</i>, Siddiqui, both contain a practical exercise looking at the microscopic structure of the pancreas.</p> <p>The CD-ROM: <i>Images of Biology for Advanced Level</i> published by Stanley Thornes has suitable images that are useful here</p> <p><i>Biology A2 Biozone</i>, gives a brief outline on page 223. Model answers to questions are provided in a separate student book and on CD.</p>
N(n)	<p>explain how the blood glucose concentration is regulated by negative feedback control mechanisms, with reference to insulin and glucagons</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <ul style="list-style-type: none"> -summarising the change in glucose concentration in the blood as the stimulus, receptors, method of communication, effectors, response 	<p>Students will already know something about the role of insulin in reducing blood glucose levels. Raise their knowledge to A level by helping them to understand how insulin acts on liver and muscle cells. Take care that they understand that it is the pancreas itself which monitors the concentration of glucose in the blood (not the hypothalamus - a very common error). Also point out the potential confusion</p>		<p><i>Biology A2 Biozone</i>, gives a clear explanation on page 222. Model answers to questions are provided in a separate student book and on CD.</p>

	<ul style="list-style-type: none"> - discuss the effect of insulin on liver and muscle cells -draw diagrams of a liver cell and a muscle cell and annotate to show the effect of insulin -possibly research the effect of diabetes on the control of blood glucose concentration 	<p>between glucagon and glycogen - spelling must be accurate here.</p> <p>Students may also be interested in knowing about diabetes which links in with the use of genetic engineering to produce insulin (Unit 3).</p>		
N(a)	<p>discuss the importance of homeostasis in mammals and explain the principles of homeostasis in terms of receptors, effectors and negative feedback</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <ul style="list-style-type: none"> - reviewing knowledge of internal changes and idea of homeostasis as maintaining internal environment so the body's cells can function. - brainstorm ideas on why it is important to keep blood glucose concentration relatively constant? Link to problems of diabetics when it is not controlled. -bullet point the main reasons for the importance of keeping blood glucose constant. -drawing own flow charts to show how secretion of insulin and glucagon controls the blood glucose concentration by negative feedback. Shade in different colours the stimulus, receptor, communication method, effector and response. -research receptors and effectors involved in control of body temperature. Draw a flow chart to summarise control and how negative feedback is involved. 	<p>Ask students: why is it important for blood glucose levels to be kept relatively constant? Use question and answer to draw on their knowledge of osmosis and respiration to predict what might happen if blood glucose rises too high or falls too low. Ask: what else should be controlled? Students should be able to suggest water balance and temperature. Ensure that they know and can use the term homeostasis.</p> <p>Ask them to draw their own flow diagrams summarising the way in which the secretion of insulin and glucagon is controlled. Help them understand that this is a negative feedback control mechanism. Discuss with them how they can define 'negative feedback' and how every example of negative feedback involves a receptor and effector. Ask them: what are the receptors and effectors involved in control of body temperature? Which organ is responsible for the control of blood water content?</p>	<p>http://www.biologymad.com/master.html?http://www.biologymad.com/Homeostasis/Homeostasis.htm</p> <p>A good summary with diagram.</p>	<p><i>Biofactsheet 28: Feedback control mechanisms</i></p> <p><i>Biology A2 Biozone, clearly explains this section on pages 214 – 219. Model answers to questions are provided in a separate student book and on CD.</i></p>

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
N(b)	<p>define the term <i>excretion</i> and explain the importance of removing nitrogenous waste products and carbon dioxide from the body</p> <p>Learning Activity Pupils should participate in:</p> <ul style="list-style-type: none"> -write a definition of excretion and explain how this is different from egestion. - reviewing their understanding of nitrogen-containing waste producing a table of nitrogen- containing waste and its sources and the consequences if it was not excreted. Carbon dioxide with a brief summary of where and how this is made (revise respiration in cells)and the consequences if it was not excreted. 	<p>Provide students with a definition of excretion, and ensure that they can distinguish between excretion and egestion. Help them to understand where nitrogenous wastes come from (but note that they do not need to know details of deamination in this part of the syllabus).</p>		
N(c)	<p>describe the gross structure of the kidney and the detailed structure of the nephron with the associated blood vessels (candidates are expected to be able to interpret the histology of the kidney, as seen in sections using the light microscope)</p> <p>Learning Activity Pupils should participate in:</p> <ul style="list-style-type: none"> -making annotated drawings of the external appearance of a kidney, a section through the kidney and using prepared slides the histology of the cortex and medulla (using reference books to help). -using a diagram of a nephron to annotate it with the processes that occur in each region. -producing a glossary of the processes 	<p>Provide students with a whole kidney (e.g. from a sheep) and prepared slides of cortex and medulla in transverse and longitudinal section . Guide them to make annotated diagrams of gross and microscopic structure, using reference books to help them to interpret what they can see. Show them, on a whole kidney, what is meant by 'transverse' and 'longitudinal' sections.</p> <p>Provide them with a diagram of nephron structure, including the associated blood vessels and ask them to annotate with the processes that occur in each region.</p>	<p>http://faculty.washington.edu/kepeter/119/images/kidney_sections.htm</p> <p><u>Sections of the kidney to support a dissection of a kidney and a study of microscope slides of the cortex and medulla.</u></p>	<p><i>Practical Advanced Biology</i>, King et al, contains an exercise looking at kidney structure, both macroscopic and microscopic, as does <i>Comprehensive Practical Biology</i>, Siddiqui.</p> <p>The CD-ROM: <i>Images of Biology for Advanced Level</i> published by Stanley Thornes has suitable images that are useful here</p> <p><i>Biology A2 Biozone</i>, gives clear simple coverage on pages 232 and 233. Model answers to questions are provided in a separate student book and on CD.</p>

N(d)	<p>Explain the functioning of the kidney in the control of water and metabolic wastes, using water potential terminology</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <ul style="list-style-type: none"> -reviewing the meaning of the terms osmosis, diffusion, active transport, water potential. -research how ultrafiltration takes place linked to the structure of the Bowman's capsule and glomerulus. Draw annotated diagrams to explain ultrafiltration. - discuss as a group the reabsorption of molecules and the processes involved e.g. osmosis, diffusion and active transport. - discuss how a low water potential is produced in loop of Henle in the medulla and its effect on the control of water in the blood -interpreting data showing the concentrations of various molecules within the nephron and explaining what would happen to them. -discussing why it is important to control the water content of blood. -using the control of blood glucose flow chart, produce their own flow chart to show the negative feedback control of water in the blood. 	<p>Help students to understand how ultrafiltration and reabsorption take place, relating the structure of the nephron to its functions. They should understand the way in which the loop of Henle produces a low water potential in the medulla, and how this allows water to move down a water potential gradient from the inside of the collecting duct into the tissue fluid and capillaries in the medulla. Provide them with data relating to concentrations of different substances in each part of the nephron and ask them to interpret these.</p> <p>Ask students: why is it important to control the water content of the blood? Use question and answer to draw out their ideas, using what they know about osmosis. They should know the roles of the pituitary gland and the hypothalamus in this control mechanism, and how ADH acts on the cell membranes of the cells lining the collecting duct, increasing the reabsorption of water from the fluid in the nephron. Ask students to draw their own flow diagrams, using the insulin/glucagon one as a model, to show the negative feedback process which controls blood water content.</p>	<p>www.biologyinmotion.com/nephron/index.html</p> <p>A rather simplistic animation, which may nevertheless be helpful to some students, showing how the loop of Henle produces a high concentration of salts, and how this draws water from the collecting duct.</p>	<p><i>Biofactsheet 1: The kidney: excretion and osmoregulation</i></p> <p><i>Biology A2 Biozone, gives clear simple coverage on pages 232 – 234. Model answers to questions are provided in a separate student book and on CD.</i></p>
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	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
N(o)	<p>outline the need for, and the nature of, communication systems within flowering plants to respond to changes in the internal and external environment</p> <p>Learning Activity Pupils should participate in: -working as a group draw a large diagram of a plant and label its communication systems, answering the question 'As a multicellular organism like a human what are the internal and external changes that the plant needs to respond to? And what are the plant's receptors, communication method and effectors? -research plant growth regulators and write a comparison with animal hormones.</p>	Remind students of the need for a receptor, communication method and effector to allow organisms to respond to changes in their environment. Ask students: how does this happen in plants? Introduce the concept of plant growth regulators, and draw parallels with animal hormones.	<p>http://www-saps.plantsci.cam.ac.uk/worksheets/activ/prac4.htm</p> <p>A protocol for an investigation into the effect of IAA on root growth in seedlings</p>	<p><i>Biofactsheet 111: Plant Growth Substances</i></p> <p><i>Biology A2 Biozone, provides a clear useful section on plant responses on page 259. Model answers to questions are provided in a separate student book and on CD.</i></p>
N(p)	<p>describe the roles of auxins in apical dominance</p> <p>Learning Activity Pupils should participate in: -carrying out experiments or studying data from removing the apical bud from growing shoots and comparing with those with intact apical buds -researching the role of auxin to explain the results and summarising either in diagrams, table or writing. Highlighting the receptor, communication method and effector perhaps using different colours.</p>	Use plants with growing points removed and others with them intact to show students how the presence of an apical bud prevents the growth of lateral buds, and explain the role of auxin in this inhibition.	<p>http://www-saps.plantsci.cam.ac.uk/worksheets/ssheets/ssheet6.htm</p> <p>A protocol for an investigation which includes the effect of IAA on growth of lateral buds.</p>	<p><i>Biology A2 Biozone, gives a brief account on page 260. Model answers to questions are provided in a separate student book and on CD.</i></p>
N(q)	<p>describe the roles of gibberellins in stem elongation and in the germination of wheat or barley</p> <p>Learning Activity Pupils should participate in: -review knowledge on where mitosis occurs in plants and how cell elongation</p>	Students can carry out practical work to investigate the effect of gibberellic acid on hypocotyl elongation and on seed germination.	<p>http://www.biology-online.org/3/6_gibberellin.htm</p> <p>Useful notes on gibberellins with links to growth at apical meristems.</p>	<p><i>Practical Advanced Biology, King et al, has protocols for an investigation into the effect of gibberellic acid on pea seedlings, and on the germination of cereal grains.</i></p>

	<p>gives rise to growth.</p> <p>-carry out experiments on the effect of gibberellic acid on stem elongation and on the germination of barley.</p> <p>-summarise the effects of gibberellins on stem elongation and on seed germination using annotated diagrams.</p> <p>-discuss how the gibberellin affects mitosis and cell elongation.</p>			<p><i>Biofactsheet 118: Germination</i></p> <p><i>Biology A2 Biozone, gives a brief account on page 260.</i></p>
N(r)	<p>describe the role of abscisic acid in the closure of stomata</p> <p>Learning Activity</p> <p>Pupils should participate in:</p> <p>-review knowledge or research how stomata open and close, draw annotated diagrams of stomata to explain the mechanism and processes involved – different colours could be used for processes.</p> <p>-research how abscisic acid is involved in the closure of stomata and under what conditions.</p> <p>-discuss the differences and similarities between the animals and plants in their responses to changes in internal and external conditions.</p>	<p>Remind students of the mechanism by which stomata open and close (or cover this topic here if it was not dealt with in Unit 1) and explain the role of abscisic acid as a 'stress hormone' in helping plants to survive difficult environmental conditions.</p>	<p>http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/A/ABA.html</p> <p><u>Information on different roles of abscisic acid.</u></p>	<p><i>Biology A2 Biozone, gives a brief account on page 260. Model answers to questions are provided in a separate student book and on CD.</i></p>