STAWA DEPTH and BREADTH of CONTENT: Teacher Support Documents

Senior Secondary Science WACE 2015 – 2016: Biology - Unit 2

The STAWA Depth & Breadth of Content documents have been developed through the collaboration of teachers working in Department of Education, Catholic Education and Independent Schools.

Purpose

The STAWA Depth & Breadth of Content documents are intended to promote a shared understanding of the course content that improves moderation across schools, regions and systems/sectors.

Caution

The Depth and Breadth points of elaboration are interpretations. The ATAR syllabus content statements are the only parts of these documents that are mandated. Examiners are required to address the mandated statements only.

The STAWA Depth & Breadth of Content documents are a great example of teachers helping teachers for the benefit of all students.

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Leadership in Science Education

BIOLOGY

ATAR Year 11

Unit 2 – From single cells to multicellular organisms

Unit description

The cell is the basic unit of life. Although cell structure and function are very diverse, all cells possess some common features: all prokaryotic and eukaryotic cells need to exchange materials with their immediate external environment in order to maintain the chemical processes vital for cell functioning. In this unit, students examine inputs and outputs of cells to develop an understanding of the chemical nature of cellular systems, both structurally and functionally, and the processes required for cell survival. Students investigate the ways in which matter moves and energy is transformed and transferred in the processes of photosynthesis and respiration, and the role of enzymes in controlling biochemical systems.

Multicellular organisms typically consist of a number of interdependent systems of cells organised into tissues, organs and organ systems. Students examine the structure and function of plant and animal systems at cell and tissue levels in order to describe how they facilitate the efficient provision or removal of materials to and from all cells of the organism.

Through the investigation of appropriate contexts, students explore how international collaboration, evidence from multiple disciplines and the use of ICT and other technologies have contributed to developing understanding of the structure and function of cells and multicellular organisms. They investigate how scientific knowledge is used to offer valid explanations and reliable predictions, and the ways in which scientific knowledge interacts with economic and ethical factors.

Students use science inquiry skills to explore the relationship between structure and function by conducting real or virtual dissections and carrying out microscopic examination of cells and tissues. Students consider the ethical considerations that apply to the use of living organisms in research. They develop skills in constructing and using models to describe and interpret data about the functions of cells and organisms.

Learning outcomes

By the end of this unit, students:

- understand that the structure and function of cells and their components are related to the need to exchange matter and energy with their immediate environment
- understand that multicellular organisms consist of multiple interdependent and hierarchically-organised systems that enable exchange of matter and energy with their immediate environment

- understand how theories and models have developed, based on evidence from multiple disciplines; and the uses and limitations of biological knowledge in a range of contexts
- use science inquiry skills to design, conduct, evaluate and communicate investigations into the structure and function of cells and multicellular organisms
- evaluate, with reference to empirical evidence, claims about cellular processes and the structure and function of multicellular organisms
- communicate biological understanding using qualitative and quantitative representations in appropriate modes and genres.

Unit content

This unit includes the knowledge, understandings and skills described below.

Science Inquiry Skills

1. identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
2. design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
3. conduct investigations**, including microscopy techniques, real or virtual dissections and chemical analysis**, safely, competently, ethically and methodically for the collection of valid and reliable data
4. represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error, and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
5. interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
6. select, construct and use appropriate representations, **including diagrams of structures and processes, and images from different imaging techniques**, to communicate conceptual understanding, solve problems and make predictions
7. communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports

Green: specific content related to Unit 2. The rest of the statements are the same generic ones across the units.

Unit 2 Summary

Cells as the basis unit of life

SU 1, 2, 4: basic cell structures and functions; prokaryotic and eukaryotic cells

SU 5, 6, 7, 8: model of the cell membrane and movement of materials across the membrane

SU 3, 9, 10, 13, 14, 15, 16: metabolism and biochemical processes including photosynthesis and respiration

SU 11, 12: enzymes and factor affecting their function

SHE 1: the cell membrane model has been continually reconceptualised and revised since the mid-nineteenth century and the currently accepted model, based on the evidence from improved technologies, is the fluid mosaic model

SHE 2: developments in microscopy and associated preparation techniques have contributed to more sophisticated models of cell structure and function

SHE 3: the use of probes technologies and computer analysis for understanding cell function

SHE 4: current research for the production of food, beverages and biofuels, and the breakdown of rubbish, involves the control of cellular respiration and photosynthesis

SIS 3: conduct investigations, including microscopy techniques and chemical analysis

SIS 6: select, construct and use diagrams of structures and processes, and images from different imaging techniques

Multicellular organisms

SU 17: hierarchical organisation within organisms

SU 18, 21: gas exchange in animals and plants

SU 19: acquisition of nutrients - animals only

SU 20, 22: transport in animals and plants

SU 23: adaptations of Australian plants to minimise water loss in arid environments

SHE 5 - ethical treatment of animals

SIS 3: investigations: real or virtual dissections

Unit Content	Elaboration	Activities	Assessment opportunities
Cells as the basis of life			
1. cells require energy inputs, including light energy or chemical energy in complex molecules, and matter, including gases, simple nutrients and ions, and removal of wastes, to survive	• cells - inputs and outputs • differences between cells of autotrophs and heterotrophs • differences between cells of autotrophs at different times of the day • range of nutrients requires and their uses in cells ○ amino acids, monosaccharides, fatty acids, glycerol, minerals, vitamins, water • wastes - water excess materials, metabolic wastes - nitrogenous wastes • chemosynthesis - when energy from light is not available energy from the breakdown of hydrogen sulphide is used - many in ocean depths around volcanic vents		
2. prokaryotic and eukaryotic cells have many features in common, which is a reflection of their common evolutionary past, but prokaryotes lack internal membrane-bound organelles, do not have a nucleus, are significantly smaller than eukaryotes, usually have a single circular chromosome, and exist as single cells	• features of prokaryotes • features of eukaryotes - form multicellular organisms • evolutionary appearance of each cell type in geological time • specialisation of eukaryote cells	microscopy - comparing plant and animal cells, create wet mounts, use pre-prepared slides. Measuring diameter of field of view, calculating sizes of cells QSP Act 2.1 Cells–units of life. Cell structure and function. Prokaryotic and eukaryotic cells http://www.diffen.com/difference/Eukaryotic_Cell_vs_Prokaryotic_Cell OR http://www.biologymad.com/resources/AS%20Cells.pdf	

SHE 2: developments in microscopy and associated preparation techniques have contributed to more sophisticated models of cell structure and function Timeline of the development of the microscope http://www.nobelprize.org/educational/physics/microscopes/timeline/ History of the microscope http://www.microscope.com/education-center/microscopes-101/history-of-microscopes/ An Introduction to Specimen Preparation http://www.leicabiosystems.com/pathologyleaders/an-introduction-to-specimen-preparation/			

3. metabolism describes the sum total of the physical and chemical processes by which cell components transform matter and energy needed to sustain life	• physical processes
	  ○ movement of materials
	  ○ cell division
	• chemical processes
	  ○ anabolism
	  ○ catabolism
	• metabolic rate can be measured by use of oxygen as respiration is the only reaction in cells that uses oxygen and it is the only reaction to release useable energy for the cell
		Cellular metabolism
		http://www.hartnell.edu/faculty/nwheat/4.%20Cellular%20Metabolism.ppt
		Metabolism interactive
		http://www.brainpop.com/science/cellularlifeandgenetics/metabolism/preview.weml	

4. eukaryotic cells carry out specific cellular functions in specialised structures and organelles, including i. cell membrane ii. cell wall iii. chloroplasts iv. endoplasmic reticulum (rough and smooth) v. Golgi apparatus vi. lysosomes vii. mitochondria viii. nucleus ix. ribosomes x. vacuoles	• link the functions of cellular structures to life processes • the structure/contents of organelles is suited to its function • variations in the contents of cells is related to cell specialisation • plant and animal cells are distinguished by differences in cellular content/structure • importance of membranes ○ differentiate internal and external environments ○ location of enzymes in specialised organelles ○ separation and control cellular contents eg lysosomes and nucleus	identify diagrams and electron micrographs of cells Cells and organelles http://umanitoba.ca/Biology/BIOL1020/lab3/biolab3_2.html#Examine Looking at the Structure of Cells in the Microscope http://www.ncbi.nlm.nih.gov/books/NBK26880/	
5. the currently accepted model of the cell membrane is the fluid mosaic model	• fluid mosaic model ○ phospholipid bilayer with carrier proteins, protein channels, receptors and identifying chemicals (eg marker proteins) ○ provides flexibility for endo- and exo-cytosis	STAWA HB ATAR Yr 11 workbook Act 5: Properties of the Cell Membrane	

SHE 1: the cell membrane model has been continually reconceptualised and revised since the mid-nineteenth century and the currently accepted model, based on the evidence from improved technologies, is the fluid mosaic model

Theoretical models: the cell membrane
http://www.nuffieldfoundation.org/teaching-about-science/lesson-b-cell-membranes

SIS 6

- select, construct and use appropriate representations, including diagrams of structures and processes, and images from different imaging techniques, to communicate conceptual understanding, solve problems and make predictions

Medical imaging technology - activity and reflection questions

http://kilby.sac.on.ca/departments/science/snc2d/CourseDocs/sb_pdf/is10_unit_a3-1.pdf

Webinar: Techniques and methods in live-cell imaging

http://webinar.sciencemag.org/webinar/archive/techniques-and-methods-live-cell-imaging Cellular and molecular imaging - with links https://www.dana.org/Publications/ReportDetails.aspx?id=44359 Diagnostic imaging techniques http://vetmed.oregonstate.edu/hospital/diagnostic-imaging-techniques Seeing is believing: imaging techniques to monitor plant health http://users.telenet.be/laury.chaerle/StressImaging/WWW/BBA/Lacha_BBA.pdf Plant cell biology in the new millennium: new tools and new insights http://www.amjbot.org/content/87/11/1547.full.pdf+html			
6. the cell membrane separates the cell from its surroundings and controls the exchange of materials, including gases, nutrients and wastes, between the cell and its environment	• cell composition needs to remain within narrow limits when faced with changing external conditions therefore needs to control inputs and outputs	Membranes and enzymes https://njctl.org/courses/science/biology/membranes-and-enzymes/	
7. movement of materials across membranes occurs via i. passive processes, including diffusion, facilitated diffusion, osmosis ii. active processes, including active transport, endocytosis and exocytosis	• passive processes do not require energy use by the cell: includes ○ diffusion ○ facilitated diffusion ○ osmosis • presences of semi-permeable membranes will affect movement of materials • active processes require the input of energy from ATP: includes ○ active transport ○ endocytosis ○ exocytosis	QSP Act 2.2 That's about the size and shape of it. Relationship between shape, size and diffusion rate Size and shape diffusion simulation http://www1.union.edu/rices/size_shape.html	

8. factors that affect exchange of materials across membranes include i. the surface area to volume ratio of the cell ii. concentration gradients iii. the physical and chemical nature of the materials being exchanged	• materials diffuse at a set rate (eg. oxygen through cellular fluids at about 16 cm per minute) • SA: Vol gives faster diffusion efficiency as greater SA is available for particles to transfer across • contents of cell as close to a surface for efficient supply or removal of materials • differences in concentration across the membrane will determine the direction and rate of movement of materials • size, solubility and electrical charge of particles will affect their movement across membranes eg small and lipid soluble molecules diffuse across membrane easily; charged and large molecules require carrier proteins or special channel proteins (eg for glucose)	STAWA HB ATAR Yr 11 workbook Act 3: Diffusion: How fast and Which Way. Act 4: EGGSperimenting with Osmosis Act 5: Properties of the Cell Membrane	
9. biological molecules are synthesised from monomers to produce complex structures, including carbohydrates, proteins and lipids	• carbohydrates are polymers of monosaccharides • proteins are polymers of amino acids • lipids are polymers of fatty acids and glycerol • DNA is a polymers of nucleotides The big 4 macromolecules http://www.mpsaz.org/mesa/staff/segrant/bio/files/lipid_proteins_carbohydrates_1.ppt.		
10. biochemical processes in the cell are controlled by factors, including the nature and arrangement of internal membranes, and the presence of specific enzymes	• internal membranes including endoplasmic reticulum, chloroplasts and mitochondria has specific enzymes attached providing locations within the cell for specific reactions • internal membranes provide large SA:Vol for efficient rates of reactions • enzymes are proteins that function as biological catalysts for essential cell reactions, by reducing required activation energy • enzyme function depends on the 3D structure of the molecule to catalyse a specific reaction		

11. enzymes have specific functions which can be affected by factors, including i. temperature ii. pH iii. presence of inhibitors iv. concentrations of reactants and products	• temperature affects the kinetic energy of the molecules taking part in in the reaction: this will affect the achievement of activation energy for the reaction to proceed and the rate of the reaction • high temperatures denature enzymes reducing their function • pH affects the 3D structure of the enzyme producing problems of specific fit to the substrate • action of inhibitors prevent binding of substrate to enzyme either by binding preferentially or changing shape of active site so no longer fits reactants slowing or preventing the reaction • concept of limiting factors: increased concentration of reactants may leads to faster reaction rate; increased concentration of products leads to decreased reaction rate • cofactors/coenzymes may activate enzyme or may be required to complete the shape of the enzyme to fit the substrate	Nelson Biology 1&2 Act 2.2 Effect of temperature on enzyme activity QSP Act 2.4 The facilitators: enzymes and factors affecting enzyme activity NoB 2 Act 2.5 Enzymes in action	

12. two models that are used to explain enzyme action are the lock and key model and the induced fit model	• lock-and-key model
	  ○ the substrate and enzyme complement each other
	  ○ therefore, they can fit together, like a lock and key
	  ○ different molecules do not complement the enzyme's active site
	• induced fit model
	  ○ before binding, the substrate and enzyme do not exactly fit each other
	  ○ binding of the substrate to the enzyme changes the configuration of both so that they fit together
	  ○ different molecules cannot induce a fit with the enzyme
		Models of enzyme function
		http://www.chem.wisc.edu/deptfiles/genchem/netorial/modules/biomolecules/modules/enzymes/enzyme3.htm
		
		http://leavingbio.net/enzymes.htm
		http://www.kscience.co.uk/animations/anim_2.htm	

13. photosynthesis is a biochemical process that uses light energy to	• light dependent - energy from light is absorbed by chlorophyll and is used to split water (H_2O) to produce ATP and H+ ions takes place in the grana membranes in the chloroplast	The Floating Leaf Disk Assay for Investigating Photosynthesis this is one of the best activities for photosynthesis and it can be done in a lesson	

synthesise organic compounds; light dependent and light independent reactions occur at different sites in the chloroplast; and make up separate parts of the overall process that can be represented as a balanced chemical equation	• light independent - energy from ATP is used to drive the series of reactions between CO_2 and H+ ions to produce glucose - - takes place in the fluid (stroma) of the chloroplast • $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$ is the overall balanced equation for photosynthesis	http://www.elbiology.com/labtools/Leafdisk.html NoB 2 Act 2.3 Finding out about photosynthesis QSP Act 2.6 Green or variegated? relationship between chlorophyll and starch production	
14. the rate of photosynthesis can be affected by the availability of light and carbon dioxide, and temperature	• the rate of photosynthesis can be measured by ○ oxygen production ○ iodine for starch production ○ pH of solution for CO_2 levels • light wavelengths used for photosynthesis - link to colour of chlorophyll • CO_2 - could be a limiting factor in the reaction if in low concentrations	Nelson Biology 1&2 Act 4.1 Compensation point: pond weed and oxygen production	
15. cellular respiration is a biochemical process that occurs in different locations in the cytosol and mitochondria, and metabolises organic compounds, aerobically or anaerobically, to release useable energy in the form of ATP; products of anaerobic respiration vary between organisms (plants, yeast, bacteria, animals); the overall process of aerobic	• aerobic - with oxygen ○ full breakdown of glucose ○ balanced chemical equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 38$ ATP ○ occurs in cytosol and mitochondria ○ same in plants and animals • anaerobic - without oxygen ○ partial breakdown of glucose - first part of aerobic respiration ○ produces 2ATP ○ occurs only in cytosol ○ in animals - produces lactic acid ○ in plants - produces alcohol	Nelson Biology 1&2 Act 2.3 Respiration in Yeast (requires data loggers with oxygen probe) NoB 2 Act 2.2 Respiration involving oxygen - aerobic respiration Oxygen: Balance of photosynthesis & respiration in ecosystems - look at Lesson Resources Worksheet: Dissolved Oxygen Changes for great secondhand data http://www.caryinstitute.org/educators/teaching-materials/changing-hudson-project/ecosystems-action-	

respiration can be represented as a balanced chemical equation		cycling-matter-energy/oxyge-0	

SHE 4: current research for the production of food, beverages and biofuels, and the breakdown of rubbish, involves the control of cellular respiration and photosynthesis

Why study photosynthesis?
http://bioenergy.asu.edu/photosyn/study.html
Artificial photosynthesis: saving energy for a rainy day
http://www.osa-opn.org/home/articles/volume_24/february_2013/features/artificial_photosynthesis_saving_solar_energy_for/#.U56ULfmSzTo
Solar fuels and artificial photosynthesis
http://www.rsc.org/images/Solar-fuels_tcm18-221433.pdf
Exploring Anaerobic Bacteria for Industrial Biotechnology
http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=4146454&fileOId=4146455
Aerobic and Anaerobic Digestion and types of Decomposition
http://water.me.vccs.edu/courses/ENV149/lesson4b.htm

16. the rate of respiration can be affected by the availability of oxygen and glucose, and temperature	• rate of respiration can be measured by ○ use of oxygen ○ change in the amount of glucose ○ temperature differences - known amounts of glucose release known amounts of energy in respiration • oxygen and glucose can be limiting reagents • temperature affects the amount of kinetic energy of molecules and therefore the probability of reaching the activation energy required for the reaction to proceed	QSP Act 2.5 Useful yeasts: factors affecting respiration Aerobic respiration investigation - scroll down to the last few screens for activity - good diagrams in this presentation http://hansonbiology.weebly.com/uploads/1/7/7/8/17781999/sg_bio_ic_aerobic_respiration_in_yeast.pdf	

SHE 3: the use of probes technologies and computer analysis has further advanced the understandings of vital chemical processes in cells

NIST Microanalysis Technique Makes the Most of Small Nanoparticle Samples
http://www.nist.gov/mml/acmd/tga-022413.cfm
Microanalysis technique makes the most of small nanoparticle samples
http://www.sciencedaily.com/releases/2014/02/140224110128.htm

SIS 3

- conduct investigations, including microscopy techniques, real or virtual dissections and chemical analysis, safely, competently, ethically and methodically for the collection of valid and reliable data

Food chemistry experiments
http://www.accessexcellence.org/pizza/pdf/fcbook.pdf

Chemistry/biochemistry labs based on food
http://www.math.unl.edu/~jump/Center1/BioChemLabs.html

Multicellular organisms			
17. multicellular organisms have a hierarchical structural organisation of cells, tissues, organs and systems	• hierarchy levels from sub-atomic to global incorporate these levels • similar to hierarchy for classification	Hierarchy of living things http://understandingthescienceoflife.blogspot.com.au/2011/08/hierarchy-of-living-things.html	
18. in animals, the exchange of gases between the internal and external environments of the organism is facilitated by the structure of the exchange surface(s), including spiracles, gills, alveoli and skin	• characteristics of effective exchange surfaces: ○ large SA:Vol ○ thin ○ moist ○ concentration gradient maintained across the membranes • exchange by diffusion • rate of supply is dependent upon the metabolic rate • CO_2 is more toxic and therefore more important to remove than having a low oxygen content • different organisms have successfully addressed the requirements of gas exchange using different systems related to their environment but all have the same features for exchange surfaces ○ lungs and spiracles/trachea for terrestrial ○ gills, skin and mantles for aquatic	QSP Act 2.12 An inspirational effort. Gas exchange in animals. Act 2.11 Leaves the losers. Plant leaf structure and functioning NoB 1&2 Act 6.3: Grasshoppers, fish and rats– how do they obtain oxygen QSP Act 2.10: Respiring seeds and rodents. Oxygen consumption by seeds and animals Dissection of a locust - ventilation system http://www.nuffieldfoundation.org/practical-biology/dissection-ventilation-system-locust	
19. in animals, the acquisition	• function of digestive system is to provide cells with	Compare different digestive systems, relating structure to function	

and processing of nutrients is facilitated by the structure of the digestive system; animals may have a gastro vascular cavity with one opening or a specialised alimentary canal with two openings; specialisation of alimentary canals is related to diet, for example, herbivores and carnivores	nutrients in a form that can be absorbed and used by the cells
	• digestion changes nutrients
	  ○ large to small
	  ○ insoluble to soluble
	• the structure of digestive systems depends on the rate of supply required and the form of the nutrient intake/diet
	• the sequence of events for digestion is reflected in the structure of the digestive system
	• enzymes and micro-organisms have roles in digestion
	• different organisms require different nutrients
		Look at digestive system of rat in dissection - virtual dissection URLs listed below
		
		QSP
		Act 2.9 Food tubes. Comparison of animal digestive systems.
		Act 2.33 Fellow travellers. Study of ectoparasites.
		Act 2.34 Life on the inside. Study of endoparasites.	

20. in animals, the transport of materials within the internal environment for exchange with cells is facilitated by the structure of open and closed circulatory systems according to the different metabolic requirements of organisms and differing environments	• reasons why multi-cellular organisms require transport systems
	• separation of blood and body fluids
	• materials transported around the body - origin and destination of these materials
	• structure of systems is related to requirements of metabolism
	  ○ no specialised system in some animals
	  ○ open circulatory systems
	  ○ closed circulatory systems
	  ▪ number of chambers in heart and separation of oxygenated and deoxygenated blood
	  ▪ different blood contents
	Discuss how different organisms on land vs water, and ectotherms vs endotherms have different requirements & different solutions for gaining sufficient O_2. Relate structure of system to needs of organisms eg compare insect (open circulation; O_2 through spiracles) to fish (closed system to move gases, but ectotherm so slow single system sufficient), and to mammal (high energy needs so need fast efficient double closed system).
		Heart dissection: see double circulation and key vessels to and from heart
		
		Observing blood circulation in *Asellus* (small crustacean)
		http://www.nuffieldfoundation.org/practical-biology/circulation-animals
		Virtual dissections - links listed below	

SHE 5: ethical treatment of animals, including the three strategies of replacement, reduction and refinement, forms the basis of many international guidelines in			

animal research Links to animal ethics sites www.nhmrc.gov.au/guidelines/publications/ea28 www.slp.wa.gov.au www.dlg.wa.gov.au www.det.wa.edu.au/curriculumsupport/animalethics/detcms/portal/ (use this one to information on SAEC proposal submission) **SIS 3** • conduct investigations, including microscopy techniques, real or virtual dissections and chemical analysis, safely, competently, ethically and methodically for the collection of valid and reliable data Virtual dissections: http://www.whitman.edu/academics/courses-of-study/biology/virtual-pig/ pig foetus dissection http://www.froguts.com/ frog dissection http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html frog dissection http://www.ent.iastate.edu/ref/anatomy/ihop/ grasshopper dissection http://www.brainbeau.com/index.php/en/virtual-dissection-resources links to virtual dissections of many different organisms			
21. in vascular plants, gases are exchanged via stomata and the plant surface and does not involve the plant transport system	• gas exchange is related to photosynthesis and respiration and environmental conditions ○ rate can be measured by use/production of gases ○ rate of photosynthesis and respiration influences overall gas exchange • CO_2 and O_2 are exchanged independently of one another • leaf structure allows for the movement of gases without a transport system • variations in leaf structure addresses requirements of environmental differences and metabolism	structure of guard cells, stoma, - diagrams and microscopy of leaf XS QSP Act 2.13 An uplifting experience. Plant structure and transport. NoB 1&2 Act 6.4: Transport systems in plants–plant pipelines.	
22. in vascular plants, transport of water and mineral nutrients from the roots occurs via xylem	• structure of the vascular tissue includes ○ xylem - water ○ cambium - growth tissue ○ phloem - products of photosynthesis • vascular tissue has different distribution in different	Observing water moving through plants http://www.nuffieldfoundation.org/practical-biology/observing-water-moving-through-plants	

through root pressure, capillary action (adhesion and cohesion of water molecules), transpiration; transport of the products of photosynthesis and some mineral nutrients occurs by translocation in the phloem	plant types
	• root hairs and root structures aid the uptake of water
	• movement of water from roots to leaves is influenced by
	  ○ root pressure
	  ○ transpiration pull
	  ○ adhesion/cohesion forces in capillary action
	• translocation - evidence from use of radioisotopes and sap-sucking insects (aphids)
	• transpiration measurement from different plants varies with environmental conditions
	• role of stomata in control of transpiration - glucose and osmotic pressure changes in guard cells
	• mass flow mechanism in phloem
		QSP
		Act 2.8: Life's necessities. Elements needed for plant growth
		
		Transpiration
		http://water.me.vccs.edu/courses/SCT112/lecture3_print.htm	

23. terrestrial Australian plants are adapted to minimise water loss in an arid environment	• arid environment - low water availability and extremes of temperatures
	• structural adaptations
	  ○ overall shape of plant
	  ○ shape of leaves
	  ○ leaf coverings and colour
	• physiological adaptations
	  ○ leaf rolling or angle to the sun
	  ○ stomatal opening times
	• impact on metabolism and growth rates
		examples of adaptations: reduced surface area in thin leaves or phyllodes, grey colour, hairs, thick epidermis
		
		Plant adaptations
		http://www.mbgnet.net/bioplants/adapt.html
		AUSTRALIA'S DESERTS, DESERT WILDLIFE OF AUSTRALIA
		http://www.abs.gov.au/ausstats/abs@.nsf/previousproducts/1301.0feature%20article42006?opendocument
		Desert Plant Adaptations Walk
		http://www.opbg.com.au/pdfs/selfguided%20walks/Desert%20Plant%20Adaptations%20walk.pdf
		What is a desert
		http://www.nma.gov.au/__data/assets/pdf_file/0017/19421/Extremes_desert_science.pdf	

		Xerophytes www.mrothery.co.uk/PowerPoints/**xerophytes**.ppt Xerophytes and their adaptations http://www.scribd.com/doc/77014949/Xerophytic-Plants-and-Their-Adaptations	

Resources used in Activities Column

STAWA HB ATAR Yr 11 workbook
QSP
Queensland Science Project: Biology A contextual approach student activity manual
NoB 1&2
Nature of Biology Book 1 activity manual (3rd edition)
Nelson Biology 1
Nelson Biology VCE Units 1 & 2 Student Activity Manual
Nelson Biology 2
Nelson Biology VCE Units 3&4 Student Activity Manual