BLITZING BIOLOGY 11

Sample Answers

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About Blitzing Biology 11

Blitzing Biology 11 is a student activity book, which contains activities that seek to address the content and skills outcomes for the *Biology Stage 6 Syllabus* (2017) – published by NESA (NSW Education Standards Authority).

To find out more about *Blitzing Biology 11* or to order a copy, please visit: www.blitzingbiology.com.au

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Disclaimers

These sample answers are provided as a tool to assist teachers and students.

These answers are designed as a guide only. Please note that many of the activities in *Blitzing Biology* have more than one possible correct answer.

Every effort has been made to provide error-free answers. However, no one is perfect. Please email the author if you would like to advise of any correction(s) needed for future editions: katrina@blitzingbiology.com.au

Revisions to these answers are regularly made. The latest version of these answers is available on the Blitzing Biology website: www.blitzingbiology.com.au

Module 1: Cells as the basis of life

Chapter 1

Section	*Activity*	*Sample answers*
1.1	1	1:3, 2:1, 3:2, 4:6, 5:5, 6:4, 7:7
	2	a) Proteins b) Cytoplasm c) DNA d) Genes e) Cells f) Cell membrane (or membrane) g) Deoxyribonucleic acid
	3	a) The cytoplasm is mainly water, with a variety of chemical substances dissolved in it, including salts, sugars, enzymes, amino acids and wastes. b) The genetic material provides the 'recipe' or 'code' for making proteins. The ribosomes use this 'code' to make proteins. c) 1. It is a barrier between the cell's contents and external environment. 2. It regulates what substances enter and leave the cell. (It also allows many chemical reactions to take place).
	4	*Clockwise from bottom left:* cell membrane, ribosome, genetic material, cytoplasm
1.2	1	Prokaryotic: Bacteria, Archaea Eukaryotic: Plants, Animals, Fungi
	2	1. Before nucleus; proper nucleus 2. Small; larger 3. Less complex; more complex 4. Within cytoplasm; inside nucleus 5. No; Yes 6. Yes; Yes 7. No; Yes 8. 0.1–5.0 µm; 10–100 µm
1.3	1	1:2, 2:1, 3:4, 4:3
1.4	2	a) Prokaryotic b) Unicellular c) A flagellum d) Lux operon e) Luciferase f) Marine fish and squid g) Over 1000 bacteria/mL h) Recombinant DNA
	3	a) As toxin exposure increases, the amount of light produced decreases. b) Stress from toxin exposures reduces light production by bioluminescent bacteria due to reduced energy availability. c) These bacteria are unlikely to undergo bioluminescence as high concentration is essential for bioluminescence and this seawater sample only has a low concentration.

Chapter 1 [continued]

Section	*Activity*	*Sample answers*
1.5	1	For sample answers to functions, see Activity 3: Mix & Match. All organelles listed are in both plant and animal cells, except *chloroplasts* and *cell wall*, which are only in plant cells.
	3	1:1, 2:4, 3:2, 4:5, 5:3, 6:8, 7:6, 8:7
	5	<u>*Across*</u>: 1. Ribosomes 4. Cell wall 6. Chloroplast 7. Lysosome 8. DNA 10. Mitochondria 11. Cell membrane 12. Cytoplasm 13. Genes 14. Vacuole 15. Nucleus 16. Organelle <u>*Down*</u>: 1. Rough ER 2. Eukaryotic 3. Electron microscope 5. Organelle 9. Smooth ER 12. Cells
1.6	1	Key evidence includes that the mitochondria and chloroplasts: • look similar to specific bacterial species • have their own DNA and have double membranes • reproduce in a similar way to bacteria
	2	Student flow-chart should be very similar to the diagram shown in Link 1.6.
1.7	1	Brainstorm may include some of these ideas: growth, movement, reproduction, taking in nutrients, removing wastes, responding to stimuli, using energy, and made of cells.
	2	1. Cell theory states all living things are made of cells. This theory is based on the vast amount of available evidence. Should new evidence come to light, the theory would be modified. 2. a) Microscopes allowed scientists to see cells and gather the necessary data to develop the cell theory. Without being able to see cells, it was difficult to understand what living things were made of. b) They enabled scientists to see the microscopic structures involved in reproduction. For example, they were able to see fly eggs hatch to see where maggots came from. 3. a) There is no 'correct' answer, as scientists still debate this question. Students must justify their opinion with suitable reasoning. b) Although viruses display some signs of living things, they are non-cellular. So if viruses were classified as living, the cell theory would no longer be accurate. However, if viruses are classified as not living, then the cell theory remains accurate.

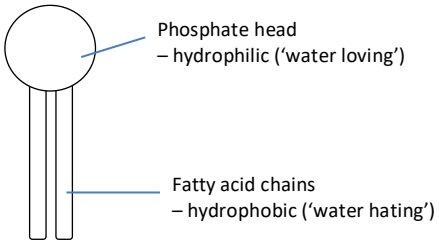
Chapter 2

Section	*Activity*	*Sample answers*
2.1	2	• pencil • structures • label • ruler • 1/3 • magnification • name • cells
2.2	B. I.	1. Leaves 2. Food storage 3. No chloroplasts would be present. Chloroplasts use light to make food by photosynthesis, which occurs in the leaves. There is no light underground and so chloroplasts are not present in onion bulb cells. 4. The sugars made in photosynthesis are stored as starch in onion bulb cells, and iodine changes colour when it binds to these starch molecules. 5. Nucleus
	Method	• tweezers • slide • drop • cover • light • diagram • iodine • blue
	Review	1. Constant, Independent, Constant, Dependent, Constant, Constant 2. Qualitative 3. Nucleus, cell wall 4. a) Yes b) One type – as they were similar in size and shape. Also, they were taken from a single tissue sample and all cells stored starch. 5. When iodine was used, some parts of the specimen turned a blue-black colour. This suggests starch was present.
2.3	1	1. x100, x100, x400, x50, x10, x10 2. a) 1000 µm ÷ 5 cells = 200 µm b) 350 µm ÷ 200 µm = 1.75 cells c) 200 µm *(as the real cell size does not change size with magnification)* 3. a) 1.2 mm ÷ 20 = 0.06 mm b) 1.2 mm ÷ 4 = 0.3 mm c) 0.3 mm ÷ 0.06 mm = 5 cells 4. a) Approximately 23 cells x 8 µm = 184 µm b) Using answer from (a): 184 µm ÷ (300/1000) = 184 µm ÷ 0.3 = 613 µm
2.4	2	These answers will depend on the brand of microscopes being used and the specific slides observed.
	3	Brainstorm may include some of the following ideas: size, structure, presence of organelles, shape, colour, ease of being seen under a light microscope, etc.
	4	Various answers possible, depending on cell chosen for this activity.
2.5	1	• one • functions • unicellular • multicellular • specialise • DNA • organelles • structures
	2	1:3, 2:4, 3:2, 4:1, 5:5, 6:7, 7:6
	3	Left column: root hair cell, intestinal epithelial cell, palisade mesophyll cell Right column: neutrophil, red blood cell, nerve cell, sperm cell

Chapter 2 [continued]

<table>
<tr><th>Section</th><th>Activity</th><th>Sample answers</th></tr>
<tr><td>2.5</td><td>4</td><td>1. a) chloroplasts
b) Root hair cells are underground, so do not carry out photosynthesis.
2. The microvilli have a large surface area to increase the rate of absorption of nutrients from the digestive tract.
3. They would probably have more mitochondria compared to other cells.
4. a) The enzymes they contain can destroy foreign bodies.
b) Neutrophils need to destroy foreign particles such as bacteria.
5. Similarities: both eukaryotic cells, with a membrane and a nucleus.
Unique to palisade mesophyll plant cell: cell wall and many chloroplasts, as well as being more angular in shape and having a large vacuole.
Unique to intestinal epithelial cell: has microvilli and rounder shape.</td></tr>
<tr><td rowspan="3">2.6</td><td>2</td><td>1. b
2. d
3. c
4. b
5. a
6. a
7. a
8. d
9. b
10. c</td></tr>
<tr><td>3</td><td>LM
• 0.2
• x1000
• light
• low
• low
• yes
• 1600s
EM
• 0.0001
• x300,000
• electrons
• high
• high
• no
• mid 1900s</td></tr>
<tr><td>4</td><td>• structure • function • biochemistry • processes • quickly • mass • evidence • respiration • microscope</td></tr>
</table>

Chapter 3

Section	*Activity*	*Sample answers*
3.1	1	Nutrients (e.g. oxygen, glucose) move into cells, while wastes (e.g. carbon dioxide, urea) move out of cells. Many substances move both in and out of cells, such as water, salts, proteins and gases.
	2	a) eukaryotic b) around organelles e.g. nucleus, mitochondria, chloroplasts, lysosomes, etc c) It allows some substances to pass in/out of the cell, while blocking others.
	4	• bilayer • two • phospholipids • across • transport • down • concentration • membrane • oxygen • dioxide • glucose • protein • diffusion • move • high • energy • active • pump
3.2	1	
	2	1:2, 2:3, 3:7, 4:5, 5:1, 6:4, 7:6
3.3	1	a) Two layers form due to the hydrophobic and hydrophilic properties of phospholipids. The hydrophilic heads face outwards into the watery cytoplasm and extracellular environment, while the tails face inwards. b) Polar molecules have unevenly distributed electrons, giving them slight charges at either end of the molecule. Non-polar molecules have evenly distributed electrons and no charge as a molecule. c) These proteins aid transport and communication. d) *Mosaic* – this refers to the pattern that is formed by the phospholipids and proteins in the membrane (as viewed under a microscope). *Fluid* – this refers to the ability of the molecules involved in membranes to move around. e) Cholesterol helps keep the molecules involved in the membrane maintain the correct distance between each other at different temperatures (not too close and not too far apart).
3.5	1	1. a) yes b) relatively slowly c) the water in the beaker 2. a) yes b) quite quickly c) the air in the room 3. Diffusion is aided by the random movement of molecules in a substance. Molecules move more rapidly in gases compared to in liquids. Hence diffusion occurs more quickly in gases compared to in liquids.

Chapter 3 [continued]

3.5	2	• concentration • low • gradient • movement • energy • passive • lungs • osmosis • dilute
	3	Solute X diffuses across the semi-permeable membrane from a region of high concentration to low concentration, until its concentration is even. Solute X and Y are initially on separate sides of the membrane. Over time, both solutes diffuse from where their concentration is high to where their concentration is low until they are evenly concentrated throughout the fluid.
3.6	B. I.	1. An egg with its eggshell removed. 2. Vinegar is an acid and it reacts with the calcium carbonate of the eggshell, breaking it down into a soluble salt, carbon dioxide and water. 3. Osmosis is the diffusion of water (from an area of low solute concentration to an area of high solute concentration). 4. LEFT: Hypotonic (arrow to show water moves into cytoplasm). MIDDLE: isotonic (n arrow needed, as no water movement). RIGHT: hypertonic (arrow to show water moves out of cytoplasm).
	Method	• beakers • hours • gently • mass • hypertonic • watch • syrup • three • egg • record
	Review	1. Constant, dependent, independent, constant, constant, constant 2. Qualitative observations may be quicker to take and avoid risking damaging the eggs during mass measurements. However, qualitative observations will not provide exact data and can be subjective. 3. Hypotonic and hypertonic solutions cause osmosis to occur. In a hypotonic solution, water moves by osmosis into the egg/cell, while in a hypertonic solution, water moves by osmosis out of the egg/cell. Isotonic solutions do not cause a significant amount of osmosis to occur.
3.7	2	a) The starch bag turned blue-black and expanded in size. The water level in the beaker decreased. b) No c) Yes d) Yes e) Size affects the ability to diffuse, with smaller molecules better able to diffuse (e.g. iodine, water) than larger molecules (e.g. starch).
	4	• Osmosis – water moved out of the fruit into the sugar • Osmosis – water moved into the dry food • Diffusion – the scent spread through the air • Osmosis – water moved into the apricot • Osmosis – water moved out of the food • Diffusion – oxygen moved into the cells • Diffusion – CO_2 moved out of the blood (into the air in the lungs)

Chapter 3 [continued]

Section	*Activity*	*Sample answers*
3.8	1	The swollen red blood cell (RBC) was in a hypotonic solution that caused water to move in by osmosis. The normal RBC was in an isotonic solution. The shrivelled RBC was in a hypertonic solution that caused water to move out by osmosis.
	2	Giving a patient pure water would cause their blood to become hypotonic. This could cause the patient's cells to swell and burst.
	3	Drinking sports drinks helps replenish both the salts and water lost via sweat. This would help to ensure the fluids in the body remain isotonic. However, these drinks also contain sugar, which may not be required in such large amounts and could increase the risk of obesity and diabetes. Similarly, the colour and flavourings may not be good for one's general health.
3.9	1	a) Active uses energy, while passive does not use energy b) Some substances cannot diffuse in or out of cells without active transport, as they are too big or polar or are moving against the concentration gradient.
	3	a) Cell membranes b) Yes c) Active d) Out e) In
3.10	1	a) Membranes b) Cell membrane, ER and Golgi apparatus c) Transport in/out of cells d) Out e) In f) Active
	2	1:2, 2:3, 3:1, 4:4
	3	1. A 2. D 3. B 4. D 5. C 6. C

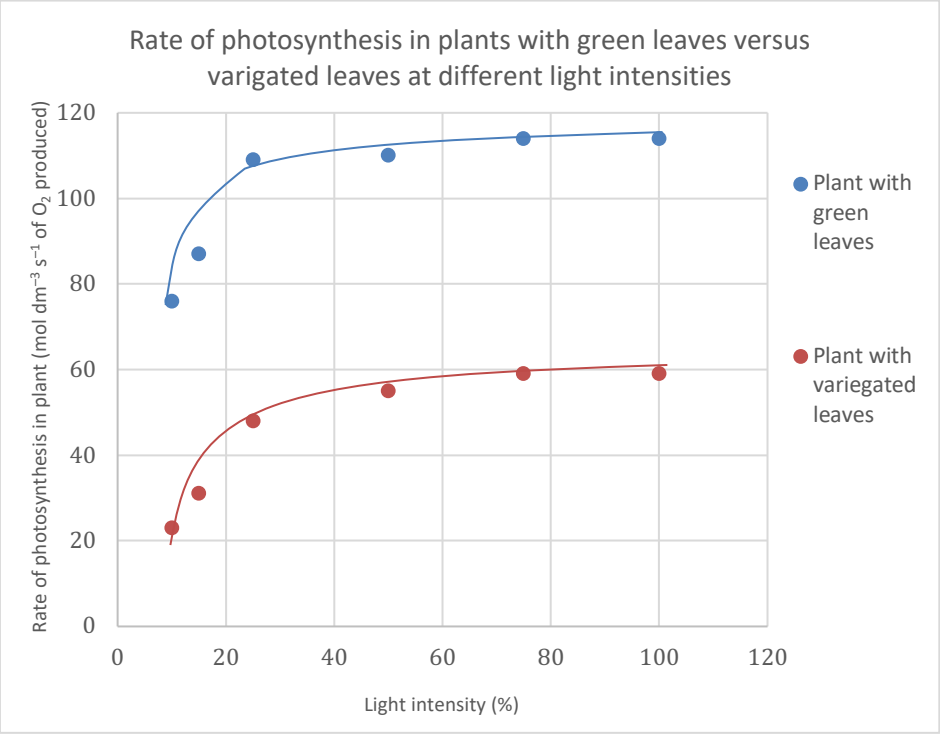
Chapter 3 [continued]

Section	*Activity*	*Sample answers*
3.11	D.Q.	1. a) Amount of tablet added to each test tube, amount of water added to each test tube, size of test tube, source of water, etc b) This question has many possible answers. One possible answer is: The timers were not started at exactly the same time. Having one person in charge of each timer may reduce errors in timing. 2. Crushing increased the surface area of the tablet, allowing it to dissolve into water more readily. Once dissolved, the reaction could take place. 3. Students' answers will depend on their own results.
3.12	B.I.	1. Basic 2. Pink 3. Colourless 4. Acids and bases can irritate the skin. 5. Acids and bases can irritate the eyes.
3.12	Method	• measure • jelly • three • acid • stopwatch • diffuses • time
	D.Q.	1. The smallest cube 2. The largest cube 3. The smallest cube 4. The largest cube 5. It is better to have a larger SA:V ratio. 6. Smaller cells 7. Size of jelly cube 8. Time taken for cube to become colourless 9. Constant variables include: type of jelly used, concentration of acid used, the size and type of beaker used, and the stopwatch (timing device) used. 10. Quantitative
3.13	1	• osmosis • volume • surface • outside • in • small • compared • substances
	2	a) As length of side of cube increases, SA:V ratio decreases b) The same trend would be observed in cells. Even though most cells do not have the exact same shape as a cube, the cube provides a suitable model of what occurs to SA:V as cell size increases. Smaller cells have a higher SA:V ratio, while larger cells have a lower SA:V ratio.
	3	a) Prokaryotic cells would have a higher SA:V ratio than eukaryotic cells. This means that prokaryotic cells would be better able to passively diffuse substances in and out. b) Some eukaryotic organelles have the role of transporting substances in and out of the cell. This allows eukaryotic cells to still have efficient transport, despite being larger with a smaller SA:V. c) Eukaryotic cells can engulf small particles by endocytosis. Bacteria are around one-tenth the size of eukaryotic cells. So vesicular transport may have occurred, allowing endosymbiosis to occur.

Chapter 3 [continued]

Section	*Activity*	*Sample answers*
3.14	1	*Active/passive – Substances – Description transport method* • passive – many – particles move down the concentration gradient • passive – water – water particles move to dilute solutes • passive – many, e.g. salts – membrane proteins aid diffusion process • active – many, e.g. sodium and potassium – membrane proteins use energy to aid the transport of molecules, often against the concentration gradient • active – large particles or bacteria – membrane extends outwards to engulf substance and bring it into the cell • active – water or small molecules – membrane folds back on itself to trap substance and bring it into the cell • active – specific substances that match receptor – receptors bind substances before the membrane encloses them to bring into the cell • active – many – vesicles fuse with the cell membrane to expel substances from the cell

Chapter 4

Section	*Activity*	*Sample answers*
4.1	1	a) Plants, algae and some bacteria b) Light energy from the Sun c) Carbon dioxide and water d) Glucose and oxygen e) Chloroplast f) Chlorophyll g) Carbon-fixation h) To convert light energy into chemical energy (glucose) for the plant to use.
	2	a) They are necessary for the reaction but do not actually react themselves b) Plants absorb carbon dioxide during photosynthesis and oxygen is released. So this helps to 'clean the air' as carbon dioxide is a pollutant that contributes to climate change.
	3	a) Palisade mesophyll b) They conduct photosynthesis. c) Stoma d) It would stop the gas flow. e) i) They would expand to close. ii) It decreases the rate of photosynthesis (as CO_2 cannot enter closed stomata). f) The vacuole in a swollen, open guard cell contains relatively more fluid than the vacuole in a shrunken, closed guard cell. This changes the shape of the vacuole, and so results in opening and closing the stomata.
4.2	1	

Chapter 4 [continued]

<table>
<tr><th>Section</th><th>Activity</th><th>Sample answers</th></tr>
<tr><td>4.2</td><td>2</td><td>a) As light intensity increases, the rate of photosynthesis increases initially and then reaches a plateau.
b) The rate of photosynthesis is higher in plants with green leaves compared to plants with variegated leaves.
c) Photosynthesis requires the green pigment chlorophyll. The variegated plant has a lower rate of photosynthesis as it has less chlorophyll.
d) Carbon dioxide concentration and temperature.
e) As the carbon dioxide concentration increases, the rate of photosynthesis increases initially and then reaches a plateau.
f) As the temperature increases, the rate of photosynthesis increases to an optimal point. The rate then decreases beyond this optimal temperature.</td></tr>
<tr><td rowspan="3">4.3</td><td>2</td><td>Photosynthesis stage 1
• Light-dependent reactions
• Yes
• Thylakoid membrane
• Oxygen

Photosynthesis stage 2
• Light-independent reactions
• No
• Stroma
• Glucose</td></tr>
<tr><td>3</td><td>a) Inorganic molecules readily occur in nature without being made by an organism. Organic molecules are chemicals produced by organisms.
b) Carbon-fixation changes inorganic carbon dioxide into organic sugars that combine to form glucose.
c) Carbon fixation occurs in plants during photosynthesis. It occurs during the light-independent reactions in the stroma of chloroplasts.</td></tr>
<tr><td>4</td><td>a) The light energy of the Sun is transformed by plants through the process of photosynthesis into the chemical energy stored in a glucose molecule.
b) Carnivorous plants do still conduct photosynthesis. This provides ‘food’ in the form of glucose. The reason for carnivorous plants ‘eating’ insects is to provide other nutrients that most plants gain through the soil. This behaviour is an adaptation to allow growth in poor soils.</td></tr>
<tr><td rowspan="2">4.4</td><td>B.I.</td><td>a) Plants convert the glucose produced by photosynthesis into starch. Hence if starch is present, photosynthesis has occurred to produce the original glucose that has been converted into the starch.
b) Iodine can easily stain clothing and skin, so use with care and wear gloves. Ethanol is flammable and dangerous for eyes. It must be kept away from flames and safety glasses should be worn.
c) Plants can be de-starched by leaving them in a dark place for 48 hours.</td></tr>
<tr><td>Hypo-theses</td><td>1. present, absent
2. present, absent</td></tr>
</table>

Chapter 4 [continued]

Section	*Activity*	*Sample answers*
4.4	D.Q.	1. a) *Expected result*: yes b) *Expected result*: Iodine remained brown on leaves from Plants A & B c) To act as a control 2. a) The green regions b) *Expected result*: the green regions c) Chlorophyll in the green regions is necessary for photosynthesis to occur. 3. a) *Expected result*: the parts exposed to sunlight b) Sunlight is necessary for photosynthesis to occur.
4.5	1	a) glucose and oxygen b) carbon dioxide, water and energy (ATP) c) energy (ATP) d) mitochondrion (plural: mitochondria) e) adenosine tri-phosphate f) by eating food g) by breathing air h) from photosynthesis
4.7	2	a) carbon dioxide b) Aerobic respiration requires oxygen and produces water, while anaerobic respiration does not require oxygen and produces ethanol. Both types of respiration use glucose to produce energy and carbon dioxide. c) No. While the bread is rising, alcohol is produced by anaerobic respiration. However, this is usually removed by baking.
4.8	1	1:4, 2:1, 3:2, 4:3
	2	a) Glucose b) Carbon dioxide c) Bacteria d) Carbon dioxide and light e) Organic compounds

Chapter 5

Section	*Activity*	*Sample answers*
5.2	1	1:1, 1:3, 2:1, 2:4, 3:2, 3:5
	2	1. IV – Time of day DV – Amount of oxygen produced by plant (during photosynthesis) CV – Probe used, type of plant used, air plants are exposed to, etc 2. IV – Distance of an artificial light source from the plant DV – Number of oxygen bubbles produced by the pondweed (during photosynthesis) CV – Amount/type of water, age/depth of plants, source of light, etc
	2	3. IV – Temperature DV – Time for the cellulose bag to turn black CV – Amount/concentration of starch solution, amount/concentration of iodine, type of cellulose bag, equipment set-up for each bag, etc 4. IV – Concentration of iodine solution DV – Time taken for cellulose bag to turn black CV – Amount/concentration of starch solution, amount of iodine, type of cellulose bag, temperature, equipment set-up for each bag, etc 5. IV – Extent to which the microscope's diaphragm is open DV – Ability to visualise the onion cells CV – Microscope used, onion cells / slide used, lighting in the room, etc 6. IV – Plant slides observed (rainforest species vs sunny species) DV – Cellular structures in the leaves observed CV – Microscope used, person observing slides, part of leaf observed, etc.
5.3	1	a) 3rd aim b) It specified the dependent variable and clarified how this would be measured (daily height for 3 weeks).
	2	1. To determine whether the time of day affects the amount of oxygen produced by a plant during photosynthesis. 2. To determine whether the distance to an artificial light source affects the number of oxygen bubbles produced by pondweed during photosynthesis. 3. To determine the effect of temperature on the time taken for the contents of the cellulose bag to turn black when surrounded by iodine solution. 4. To determine the effect of iodine concentration on the time taken for the contents of the cellulose bag to turn black when surrounded by iodine solution. 5. To determine the effect of changing the position of a microscope's diaphragm on the ability to visualise onion cells. 6. To determine whether the cellular leaf structures of a rainforest plant species are different to those of a plant found in a sunny environment.

Chapter 5 [continued]

Section	*Activity*	*Sample answers*
5.4	2	[Note: The hypotheses below are only samples. There are many possible ways to correctly phrase an hypothesis. A good hypothesis should clearly state the expected relationship between the independent and dependent variables.] 1. If the time of day is closer to midday, then the amount of oxygen produced by a plant will be higher. 2. If the light source is closer to the pondweed, then the pondweed will produce a greater number of oxygen bubbles. 3. If the temperature increases, then the time taken for a cellulose bag of starch surrounded by iodine solution to turn black will decrease. 4. If the concentration of iodine increases, then the time taken for a cellulose bag of starch surrounded by iodine solution to turn black will decrease.
	2	5. If the microscope's diaphragm is more open, then it will be easier to visualise the onion cells. 6. Rainforest plant species have more stomata and more chloroplasts than plant species living in sunny areas.
5.5	1	Background research helps to ensure that: • your experimental design actually fulfils your aim • you have sufficient knowledge about the variables in the experiment to understand what is occurring • you can interpret your results
	2	F, T, F, F, T, T
5.6	1	a) This is only a single source of information, with social media making it difficult to know how up-to-date the information is, or where the information came from. This means it has limited reliability. b) Steve should find at least three alternative sources of information on this topic written relatively recently by a person/organisation with scientific expertise. He can then use these to fact-check the Facebook post.
5.8	1	1. Does it test the stated hypothesis? Are the variables constant? Is there a suitable control? 2. Repetition needs to also achieve consistent results to indicate reliability. Inconsistent results in repeats suggest it is an unreliable experiment. 3. By using more precise tools, e.g. using a measuring cylinder instead of a beaker. 4. No. Some experiments may come to valid conclusions using only qualitative observations or basic measuring tools. The required level of accuracy in measuring devices will depend on the experiment.

Chapter 5 [continued]

Section	*Activity*	*Sample answers*
5.8	2	a) The pots without fertiliser. b) Amount of sun, amount of water, type of soil, same age of basil plants, etc c) Tayla's experiment does not truly test her hypothesis. It only uses one type of commercial fertiliser, which may not be representative of all commercial fertilisers. Likewise, her home fertiliser may not be representative of home fertilisers as a whole. d) She has excluded Pot 3 from the average calculation, as this had a very inconsistent (outlier) result compared to her other repetitions. e) Tayla's results are only moderately reliable. There is significant variation in one of her repetitions for commercial fertiliser, suggesting another variable interfered with her results. Her repetitions for other experimental conditions had more consistency and so are more reliable.

Chapter 6

Section	*Activity*	*Sample answers*
6.1	2	a) Rapid production of bubbles, fizzing sound, test tube felt hot (test tube B) … whereas the control (test tube A) had no changes. b) Production of bubbles (in test tube C), whereas the control (test tube A) had no changes. c) The black powder remained in the test tube (it did not 'disappear' or seem to react).
	3	No – the detergent just makes the foam and the dye adds colour.
6.2	1	• speeds • match • slow • rusting • reaction • after • biological • enzymes • quickly • photosynthesis
	2	a) Substrate b) Active site c) Enzyme-substrate complex d) The right diagram above e) The left diagram above
	3	a) Sucrose b) Glucose and fructose c) Catabolic d) They have matching shapes. e) Sucrase helps to release glucose from the sucrose in foods we consume. This glucose is very important for cellular respiration to occur to produce energy. f) No. The active site of the enzyme lactase has the wrong shape for binding sucrose molecules. Sucrose sugars need the enzyme sucrase to break them down.
	4	1. A lock will only work with the matching key. Similarly, substrate molecule(s) can only bind with the active site of the correct enzyme(s). 2. It would stop the enzyme being able to form the enzyme-substrate complex. 3. Machines on a factory assembly line can be reused, as can enzymes. These machines do specific jobs. In the same way, enzymes have specific reactions that they speed up. 4. Enzymes do not take part in reactions, they simply help the reactions occur. In the same way, Mitch does not take part in the fight, but his jeering encourages the fight to occur.
	6	1. a) ribosomes b) the nucleus 2. They ensure energy is produced quickly enough for the organism's needs. 3. To aid digestion and to destroy foreign bodies.
	7	1. b is the correct answer 2. Enzymes lower the amount of activation energy required for a reaction to take place.

Chapter 6 [continued]

Section	*Activity*	*Sample answers*
6.2	8	a) Pepsin and lipase b) Cellulase c) Pepsin and peptidase d) Catabolic
	9	• key • bind • catalyse • protein • site • shape • induced • active • bonds • original
6.3	B.I.	1. Milk 2. Curds and whey 3. Heat is a form of energy that aids chemical reactions in reaching their activation energy. Cold temperatures reduce the available heat energy. 4. Rennin helps to clot milk in the stomachs of calves to increase the digestion of nutrients. Humans also use rennin to clot milk to make dairy-based products, such as cheese, yoghurt, junket.
	D.Q.	a) *Expected result*: 35°C will be most effective. b) There is insufficient energy for the reaction to reach activation energy, even with the enzyme present. c) At high temperatures, rennin is denatured and so its shape has changed. Hence it can no longer bind to the substrate, and so cannot function. d) The rennin was most effective at 35°C, which of the temperatures used was closest to 38°C. (*assuming expected results were achieved*) e) Answer depends on results achieved by students. f) Using test tubes B as a control showed that when the milk clotted, it was due to the rennin enzyme and not the temperature change. Variables were kept constant (e.g. equal volumes of milk, equal amounts of rennin in test tubes A, and using the same technique to determine if milk had clotted) to ensure the results were due to the independent variable.
6.4	B.I.	1. Hydrogen peroxide 2. Hydrogen peroxide $\xrightarrow{catalase}$ oxygen + water 3. Catalase helps break down hydrogen peroxide, which is a toxic substance produced in the cells of most living things. 4. Left to right: strongly acidic, weakly acidic, neutral (pH = 7), weakly basic, strongly basic
	D.Q.	a) Observations of foaming b) Height of foaming c) Either answer can be correct, so long as it is appropriately justified. d) A, B, C, D, E e) Based on expected results: Test tube C reacted most quickly as it was neutral, which is similar to the natural conditions in which the catalase enzyme occurs. As the pH became more acidic or more basic, the reaction was slower as these test tubes had a pH that is less optimal for catalase. f) Various answers are possible. Ideas for validity should relate to improving how variables are kept constant or adding in an experiment control. Ideas for reliability should focus on achieving consistent results in repetitions. g) Blood might contain the enzyme catalase.

Chapter 6 [continued]

Section	*Activity*	*Sample answers*
6.5	1	a) They would have the same optimal temperature (37°C). The optimal pH would be near pH 2 for stomach enzymes and near pH 6 for intestinal enzymes. b) This would reduce the efficacy of enzymes in the blood as they would no longer be at their optimal temperature. c) Any variation from 37°C reduces the efficacy of enzymes in humans. This causes important biological reactions to occur at either a slower rate than the optimal or not at all, and so interferes with normal metabolism in the body.
	2	a) As enzyme concentration increases, the rate of reaction also increases. b) As substrate concentration increases, the rate of reaction increases until the point of saturation. After this point, the rate of reaction plateaus. c) All enzyme active sites are occupied by substrate, so there are no free active sites for additional substrate to bind to.
	3	Some inhibitors block the substrate from binding at the active site, while other inhibitors cause a shape change to the active site that stops the substrate being able to bind.
	4	a) Inorganic b) Organic c) Magnesium (or iron) d) Vitamins e) By eating food f) No g) Yes
	5	Cofactor involved in: (a), (b) and (d) Coenzyme involved in: (c)

Module 2: Organisation of living things

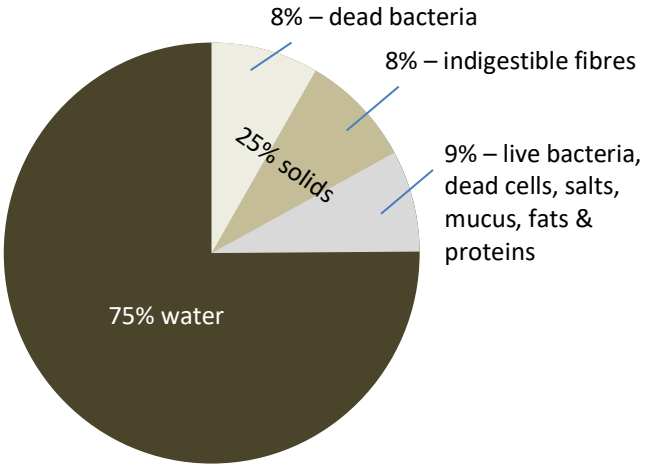
Chapter 7

Section	*Activity*	*Sample answers*
7.1	1	a) Unicellular b) Pseudopods (= pseudopodia) c) Heterotrophic
	2	• A slime mould can grow through a maze towards a stimulus of food. • The mould first explores all possible paths. • It leaves a chemical trail behind it to assist it in knowing places it has already been – this acts a bit like memory. • Once the slime mould finds the shortest route to the food, it retracts all parts of it that have been extended into 'dead ends' or inefficient routes.
	3	a) Multicellular b) Using chemical signals c) Food becoming scarce d) A slug forms from congregated amoebas and can move as a single entity. It eventually stops and some cells form a stalk, while other cells form a fruiting body. It reproduces via spores released from the fruiting body.
	4	• one • multiple • moulds • multicellular • congregate • individual • colonial • joined • single
7.2	3	1:1, 2:3, 3:4, 4:2
	4	Students can argue either way, so long as they justify their opinion.
	5	Urinating is not the recommended first aid treatment. According to the Ambulance Service of NSW, any tentacles stuck to the skin should be removed with tweezers or a gloved hand, then the sting area should be washed with seawater and/or immersed in warm to hot water (but not hot enough to burn the person). They recommend against using vinegar. A similar treatment is also recommended by the Royal Australian College of General Practitioners.
7.3	1	• single • wastes • reproducing • small • volume • diffusion • organelles • transport • larger • specialised • organs • alive
	2	1:5, 2:4, 3:1, 4:6, 5:2, 6:3
	3	a) It acts as a protective barrier for our bodies. b) Skin cells are programmed to die when they reach the outer most layer of skin. Here the dead cells form a thin, scaly mesh that is water-proof and acts as a barrier to microbes from entering the body.
	4	a) Around 3.8 billion years ago (*bya*) b) More than 30 times c) It allows increased organism size; internal parts have protection from outer cells – including reproductive cells; parts of the organism can die while the rest of the organism survives. d) To fulfil specific functions that suit their position relative to the other cells e.g. outside cells tend to have a role as a protective barrier.

Chapter 8

Section	*Activity*	*Sample answers*
8.1	1	<u>*Across*</u>*:* 1. Light 4. Leaf 6. ATP 10. Respiration 12. Glucose 13. Chlorophyll 14. Water 15. Anaerobic 17. Starch 18. Oxygen 19. Carbon dioxide 20. Carbon dioxide <u>*Down*</u>*:* 2. Heterotroph 3. Water 5. Autotroph 7. Plant 8. Chloroplast 9. Mitochondria 11. Photosynthesis 16. Oxygen
8.3	1	• Salts – Inorganic – Na^+ – Help nerves to function • Carbohydrates – Organic – Sugars, pastas – Used for energy • Lipids – Organic – Fats, oils – Energy storage, cell membranes, insulation • Proteins – Organic – Meats, eggs – Growth and repair • Vitamins – Organic – B group – Help enzymes function, regulate cell activities, assist metabolism and growth
	2	Sugar is very important for having energy as an organism. However, many other substances are derived from foods that are not sugars and are essential for the healthy functioning of an organism. For example, fats in food are useful for energy storage and vitamins are needed to allow enzymes to function correctly.
8.4	1	a) Our digestive system from the mouth to the anus is like a donut hole, as food passing through it is not part of the body, just as something in a donut hole is not inside the donut itself. b) Water, mucous, and the enzyme amylase. c) Help churn the food. d) Hydrochloric acid creates an acid environment to allow pepsin to start breaking down proteins. e) Bile salts surround lipids to assist in breaking them down. f) They help break down different substances in food. g) Nutrients move by diffusion and active transport into the cells and capillaries of the intestinal lining. h) Water is absorbed from waste and bacteria here help to release vitamins from the food. i) In herbivores, the appendix helps to break down cellulose. However, in humans, who eat much less cellulose in their diet, the appendix is not involved in digesting cellulose.

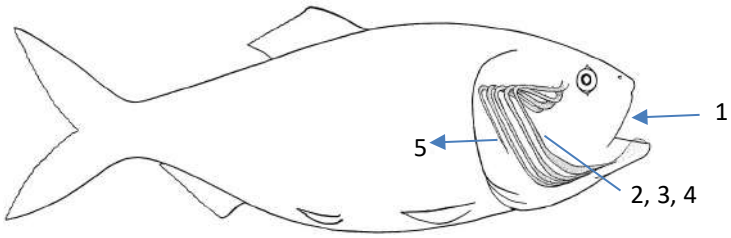
Chapter 8 [continued]

Section	*Activity*	*Sample answers*
8.4	2	*Clockwise from bottom left:* • appendix • large intestine • gall bladder • liver • stomach • pancreas • small intestine • rectum
	3	*Mouth*: • Chemical: releases saliva containing enzymes, e.g. amylase • Physical: teeth cut/grind food, which increases its surface area *Stomach*: • Chemical: releases acid and enzymes such as pepsin • Physical: muscles churn food *Small intestine:* • Chemical: contains many different enzymes to break down food
8.5	1	a) Faeces b) It is eliminated as faeces. c) Rectum d) 8%
	2	<u>Poop pie chart</u> 
	3	a) To 'transfuse' microbes from a healthy person to someone with a condition that has reduced their natural microflora. This increases the diversity of microbes in their intestines, which is associated with better health. b) The bilirubin from broken down red blood cells is processed by bacteria in the intestines, turning it into a brown colour. This gives poo its colour. c) Sewage is screened and skimmed to remove large objects / rubbish. Oil and grease is allowed to separate, then removed. Solid sewage remnants are broken down by microbes. Water is extracted and purified.
8.6	1	• down • plant • mammals • cows • low • walls • nectar • easily • meat • energy

Chapter 8 [continued]

Section	*Activity*	*Sample answers*
8.6	2	a) Rumen, abomasum, omasum, reticulum b) Ruminants have a diet high in cellulose and these microbes help to break down this cellulose. c) *Labels may include some of the following:* Mouth – chews food twice (before/after regurgitation) Reticulum & rumen – contain microbes to break down cellulose Omasum – water is removed Abomasum – digestive enzymes help break down food Small intestine – nutrients are absorbed
	3	a) • nectar-feeding herbivore • carnivore • omnivore • grazing herbivore b) A carnivore's digestive system would be shorter than that of a grazing herbivore, as the carnivore has a diet that is more easily digested. Grazing herbivores consume a lot of cellulose, which is difficult to break down. c) You should have circled the organ labelled 'caecum' on each diagram. d) A grazing herbivore e) The human appendix is not involved in the digestion of cellulose or any other substances in the human diet, so it is not needed for digestion in humans.
8.7	1	*You should have added the following labels to the diagram:* • trachea •bronchus • bronchiole • alveolus (surrounded by capillaries) • diaphragm muscle • lungs • ribs • rib muscles
	2	a) The internal balloons inflated when the bottom balloon was pulled down and deflated when the bottom balloon was pushed upwards. b) The diaphragm is a muscle that acts like the bottom balloon in the model. When it moves downwards, the chest cavity expands. When it pushes upwards, the chest cavity contracts.
	3	Inhaled air has more oxygen and less carbon dioxide than exhaled air. The concentration of other gases remains constant.
	4	a) The concentration of CO_2 is higher in the blood than the lungs, so CO_2 diffuses into the lungs. The concentration of O_2 is higher in the lungs than the blood, so O_2 diffuses into the blood. b) Smaller objects tend to have a greater SA:V ratio. An increased SA:V ratio improves the rate of diffusion. Hence the small alveoli in the lungs increase the SA:V ratio and so improve the rate of diffusion.
	5	a) The respiratory system brings in oxygen, a reactant for cellular respiration and removes carbon dioxide, a waste product from cellular respiration. b) There are many possible answers – e.g. breathing system, gas exchange system, etc.

Chapter 8 [continued]

<table>
<tr><th>Section</th><th>Activity</th><th>Sample answers</th></tr>
<tr><td rowspan="4">8.8</td><td>1</td><td>• gas • respiration • lungs • similar • flow • muscles
• mouth • skin • gills • water • air • exchange</td></tr>
<tr><td>4</td><td>a) The fine branches have a high SA:V ratio, which increases the rate of diffusion of oxygen.
b) The movement and flow of water normally keeps the gill filaments open and separate from each other.
c) 
</td></tr>
<tr><td>5</td><td>a) As water temperature increases, the number of times a gold fish opens its mouth per minute increase.
b) Cold water has more oxygen – as the fish opens its mouth less for taking in water (its source of oxygen) when in cold water.
c) The use of three repetitions to form an average improves the reliability. However, without seeing how consistent the results from the three trials are, it is difficult to assess the degree of reliability. Human error in observations may have led to poor consistency between trials.</td></tr>
<tr><td>6</td><td>a) F
b) T
c) F
d) T
e) T
f) F
g) T</td></tr>
<tr><td rowspan="2">8.9</td><td>1</td><td>a) Blood
b) Heart
c) Lungs
d) Small intestines
e) To carry out cellular respiration (to get energy)
f) From the breaking down of proteins
g) From cellular respiration</td></tr>
<tr><td>2</td><td>a) LEFT DIAGRAM: Closed. RIGHT DIAGRAM: Open
b) Closed
c) Examples include: Insects, spiders, crabs, snails, clams, scallops, slugs, etc
d) • closed • open • open • closed
• closed • open • closed • closed
Note: all molluscs have open circulatory systems except those in the cephalopod class (e.g. squid, octopus, cuttlefish)</td></tr>
</table>

Chapter 8 [continued]

Section	*Activity*	*Sample answers*
8.9	3	a) The network of vessels through which the transport medium travels. If this network is a complete circuit, it is said to be 'closed'. b) • haemolymph / • blood • short / • long • slow / • fast • low / • high • low / • high • arthropods / • mammals c) A closed system allows larger, more active animals to have more efficient transport to ensure they can produce energy in large amounts. It allows materials to be transported quickly and to reach farther distances.
8.10	1	a) *Post-2023 Q: Account for the circulation in these organisms being referred to as a 'double-loop'.* In these organisms, blood is pumped around two major loops – one loop (pulmonary) is between the heart and lungs, while the other loop (systemic) is between the heart and the rest of the body. *Old print runs: Explain why there are two beats.* The heart's valves need to open and close to control blood flow through the heart. The valves closing and changes in blood flow create an audible 'lub dub' heart sound. b) *Post-2023 Q: Which side of a mammalian heart would you expect to have thicker muscle? Justify your choice.* The left side of the heart, as it pumps to the entire body (systemic loop), while the right side only pumps to the lungs (pulmonary loop). *Old print runs: When you measure your pulse on your wrist or neck, you only feel one beat. Explain why.* These parts of the body are part of the systemic loop – which only have blood pumped to them from the left ventricle of the heart. c) Both fish and humans have closed circulation using a heart and blood vessels. However, fish have a single-loop circulatory system, while humans have a double-loop. Fish have gills, whereas humans have lungs to oxygenate the blood. Fish hearts have less chambers than human hearts. d) Most reptiles have a three-chambered heart, while human hearts have four chambers. Most reptiles have some mixing of oxygenated and deoxygenated blood in the ventricles, but humans do not.

Chapter 8 [continued]

<table>
<tr><th>Section</th><th>Activity</th><th>Sample answers</th></tr>
<tr><td>8.11</td><td>1</td><td>
<table>
<tr><td>Row 1</td><td>… from the heart</td><td></td><td>… to the heart</td></tr>
<tr><td>Row 2</td><td>< 18 mm</td><td>5 µm</td><td>< 30 mm</td></tr>
<tr><td>Row 3</td><td>Relatively thick</td><td>Very thin (one cell)</td><td>Moderately thick</td></tr>
<tr><td>Row 4</td><td>Connective, smooth muscle, elastic fibres, epithelial</td><td>Epithelial</td><td>connective, smooth muscle, elastic fibres, epithelial</td></tr>
<tr><td>Row 5</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>Row 6</td><td>Yes</td><td>Sometimes</td><td>No</td></tr>
<tr><td>Row 7</td><td>Pumping of the heart</td><td>Blood pressure</td><td>Blood pressure; the skeletal muscles assist; valves prevent backflow</td></tr>
</table>
</td></tr>
<tr><td rowspan="3">8.12</td><td>1</td><td>IN TABLE:
Description
RBC red colour and donut-like; they carry oxygen
WBC white coloured; help fight disease
Platelets flat and able to stick together; help blood to clot and form scabs
Plasma a yellow fluid; transports the components of the blood

TOP LEFT DIAGRAM (top to bottom): plasma, WBC and platelets, RBC
TOP RIGHT DIAGRAM (top to bottom): WBC, RBC
BOTTOM DIAGRAM (top to bottom): platelet, WBC, RBC</td></tr>
<tr><td>2</td><td>a) Determine the size of the field of view using a minigrid slide, then divide the diameter by the number of cells that would fit across the diameter.
b) Students own calculations based on obversations
c) Diameter of RBC: 6-8 µm. Diameter of WBC: 12-17 µm
d) Student answer will depend on how close their calculations of cell sizes were to the accepted size ranges.</td></tr>
<tr><td>3</td><td>a) An RBC is small: approximately 7.5 µm in diameter, and 2.5 µm in height. It is biconcave, contains no nucleus and only a few organelles. It contains many haemoglobin molecules.
b) Over 200 million
c) Oxygen is bound to the iron in each heme group in haemoglobin (thus forming oxyhaemoglobin). Hence iron is required to bind oxygen, thus enabling its transport by a red blood cell.</td></tr>
</table>

Chapter 8 [continued]

Section	*Activity*	*Sample answers*
8.13	1	a) Skeletal b) Cardiac c) Smooth d) Cardiac e) Smooth f) Smooth and cardiac g) Skeletal h) Smooth i) Cardiac and skeletal j) Cardiac k) Skeletal
8.14	1	a) Glucose + oxygen $\rightarrow$ carbon dioxide + water + energy (ATP) b) Glucose and oxygen c) Carbon dioxide
	2	1:2, 2:5, 3:7, 4:3, 5:6, 6:4, 7:1
	3	Diagrams should summarise the changes described in Activity 2: Mix & Match.

Chapter 9

Section	*Activity*	*Sample answers*
9.1	1	a) Carbon dioxide + water $\xrightarrow{sunlight\ \&\ chlorophyll}$ oxygen + glucose b) Glucose + oxygen $\rightarrow$ carbon dioxide + water + energy (ATP) c) Plants need to exchange both CO_2 and O_2 between their cells and the environment to allow photosynthesis and respiration to occur.
	2	1:2, 2:1, 3:4, 4:3, 5:7, 6:6, 7:5
	3	*Labels (top to bottom) should be:* • Upper epidermis – structural support and allows light to pass through • Palisade mesophyll –primary site of photosynthesis • Spongy mesophyll – allow gases to diffuse through and secondary site of photosynthesis • Lower epidermis – aids structural support
	4	*Labels clockwise, starting from the top left tip of the leaf:* • tip • midrib • margin • veins • petiole • lamina
9.2	1	a) There are many possible reasons, e.g. • the different plant species live in different environments • they have different water availability in their natural habitat • these differences have evolved in the species to conserve water, etc.
9.3	1	a) (1) By photosynthesis. (2) By absorption from the soil. b) (1) Self-feeding. (2) An organism that can use inorganic carbon sources, such as carbon dioxide. c) (1) Other-feeding. (2) An organism that requires an organic carbon source.
	2	a) T b) F c) F d) T e) T
	3	*Autotrophs* • Any plant • Yes • Yes • CO_2 and O_2 • CO_2 and O_2 • CO_2 • Photosynthesis and uptake from the soil *Heterotrophs* • Any animal • No • Yes • O_2 • CO_2 • Glucose • Eating food
	4	a) To compensate for poor nutrient levels in their soil, e.g. when living in a swamp where water washes nutrients away. b) Yes. An autotroph is a plant that uses inorganic carbon sources, such as carbon dioxide. Carnivorous plants still do this via photosynthesis. The consumption of insects gives them nutrition that most other plants can gain from the soil.

Chapter 9 [continued]

Section	*Activity*	*Sample answers*
9.4	1	• organ • anchoring • mineral • soil • starch • vegetables • beetroots • two • main • roots
	2	a) To transport water and mineral nutrients (from the soil to other parts of the plant) and sugars (from the leaves to the root). b) Root 'hairs' are long and thin, which gives a high SA:V ratio. This increases the available surface area for substances to be absorbed into the plant.
9.5	1	a) Water and mineral nutrients b) Sugars c) Plants with vascular tissue (xylem and phloem) for transport. d) They absorb water by osmosis from their environment as they do not have xylem or phloem. e) Moss f) Stomata open so oxygen and carbon dioxide can move in and out of the plant – but water can also escape. g) To open and close the stomata. h) They have thin leaves to reduce the surface area and hence reduce water loss. OR Some desert plants only open their stomata at night when it is cooler and then have ways to store gases. i) They have broad leaves to increase surface area to access more sunlight. j) They supplement their soil nutrient intake by trapping and breaking down insects.
9.6	1	*Xylem* • Water and mineral nutrients • Up • Dead cells stiffened by lignin • Dead *Phloem* • Sugars (in a solution of water) • Up and down • Companion cells and cells separated by sieve plates • Living
	2	a) Roots b) Leaves c) Xylem d) Photosynthesis e) Leaves f) Yes g) Phloem
9.7	2	1:3, 2:1, 3:2, 4:4
	3	a) Soil → roots → stem → leaves b) It is made of dead cells, joined together with their ends removed to create a hollow tube. The walls are thickened and strengthened by lignin. c) Water is pulled up the xylem due to negative pressure created by water loss in transpiration, cohesion of water molecules and adhesion between xylem and water molecules (transpiration-cohesion-tension theory). d) There is negative pressure at the leaves, which pulls water up the plant.

Chapter 9 [continued]

Section	*Activity*	*Sample answers*
9.8	1	a) *Expected results*: coloured water can be seen to have travelled up the stems (in the xylem) resulting in colour in the petals. b) Water moved upwards through a plant.
	2	c) Adhesion d) Cohesion
	3	a) The thinnest b) The widest c) As width of diameter in a tube (or straw) decreases, the height that water will move up doe to cohesive/adhesive forces increases.
	4	a) *Expected result*: water stays within the lower part of the straw b) *Expected result*: water drops out of the straw c) Water moves up the straw due to cohesive and adhesive forces, as occurs in xylem vessels. Putting a finger over the top of the straw creates negative pressure to help hold the water in place, as occurs during the transpiration of water from leaves.
9.9	2	• auto • dioxide • glucose • photosynthesis • leaves • sunlight • oxygen • starch • energy • transport • up • respire • sucrose
	3	a) Sieve tube elements b) Companion cell c) Sieve tube plates
	4	a) Leaves and roots b) Regions that produce or store sugars c) Root tips and shoots at the top of the plant d) Places where sugar is needed e) Up and down f) Translocation g) The sugars are moving against the concentration gradient, from the source (lower concentration) into the phloem (higher concentration). h) Water moves via osmosis into the phloem to dilute the high concentration of sugars.
	5	*From top to bottom*: 5, 1, 2, 4, 3, 6

Chapter 9 [continued]

<table>
<tr><th>Section</th><th>Activity</th><th colspan="2">Sample answers</th></tr>
<tr><td rowspan="2">9.10</td><td>5</td><td>Xylem
• Water and minerals
• Up from the roots
• Roots
• Stems and leaves
• A hollow tube of dead cells strengthened by lignin
• Passive
• Transpiration creates negative pressure to pull water up the plant, aided by adhesion and cohesion forces.</td><td>Phloem
• Sugars (as a water solution)
• Up and down stems and away from leaves
• Sugar sources, e.g. leaves / roots
• Sugar sinks, e.g. all cells in plant
• Sieve tube elements and plates, and companion cells
• Active and passive
• Sugars are actively loaded into the phloem from sugar sources. Pressure helps to transport the sugars to sugar sinks.</td></tr>
<tr><td>6</td><td colspan="2">Examples of labels that students may had added include:
• Leaves – water removed from the xylem
• Leaves – sugars added to the phloem
• Roots – water and nutrients added to the xylem
• Roots – sugars added from stores, e.g. root vegetables
• Shoots / root tips – sugars removed from phloem to aid growth
• Any cell – sugars removed from phloem for cellular respiration</td></tr>
<tr><td>9.11</td><td>1</td><td>Animals
• Yes
• No
• Oxygen
• Carbon dioxide
• Lungs
• Glucose (chemical energy)
• Glucose (organic source)
• Eating food (animal and/or plant materials)
• Digestive system processes nutrients for absorption into the body
• Arteries, capillaries, veins
• In blood (or in haemolymph)
• In blood (or in haemolymph)
• In blood (or in haemolymph)</td><td>Plants
• Yes
• Yes
• Oxygen and carbon dioxide
• Oxygen and carbon dioxide
• Leaves
• Sunlight (light energy)
• Carbon dioxide (inorganic source)
• Sugars from photosynthesis and mineral nutrients dissolved in water from the soil
• Photosynthesis creates sugars; and in carnivorous plants, nutrients are also obtained by consuming insects.
• Xylem, phloem
• In xylem
• Sugars in phloem, mineral nutrients in xylem
• Gases move directly from the environment into tissues and then diffuse from cell to cell</td></tr>
</table>

Chapter 10

Section	*Activity*	*Sample answers*
10.1	1	Photosynthesis allows plants to use light energy to convert carbon dioxide into organic nutrients (sugars) for the plant, as well as for consumers and secondary consumers. Photosynthesis is also important because of the oxygen it produces, as all living things need oxygen to survive. Hence plants increase the nutrients being cycled.
	2	a) Photosynthesis b) Respiration c) Output d) As light intensity increases, the uptake of carbon dioxide also increases. After a specific light intensity, the rate of carbon dioxide uptake levels off (or plateaus).
10.3	1	a) Mineral nutrients in the soil b) Water c) The soil (water and mineral nutrients) and the air (carbon dioxide and oxygen). d) Quantitative e) Van Helmont's work helped disprove the ancient Greeks' idea that plants gained mass by taking in mineral nutrients from the soil. Van Helmont's work highlighted the role of water in plants gaining mass, using quantitative results to support his idea. He was not entirely correct. However, his ideas helped scientists to realise that water was essential for plants, and later on, to understand the role of water in photosynthesis.
10.4	1	a) The candle requires oxygen for combustion to occur. Once it uses up the oxygen in the jar, it can no longer combust. *Alternative answer*: The candle is using up the O_2 in the jar and is also producing CO_2. Lack of O_2 and excess CO_2 cause flames to extinguish. b) The mint sprig is a plant. Hence it was using up the carbon dioxide in the jar as it photosynthesised and released oxygen as an output. c) The mouse alone uses O_2 for respiration until there is insufficient left, causing it to die. The plant alone photosynthesises at a higher rate than it respires, causing it to eventually use up all the CO_2 and no longer be able to survive. Together, the mouse and plant respire and photosynthesise at rates that allow O_2 and CO_2 levels to remain viable for both to survive.
10.5	1	a) ^{18}O has two more neutrons than ^{16}O, giving it a higher atomic mass. b) Water labelled with high levels of ^{18}O leads to oxygen with high levels of ^{18}O. Hence water is the source of the oxygen produced in photosynthesis. c) CO_2 labelled with high levels of ^{18}O does <u>not</u> cause oxygen to have high levels of ^{18}O. Hence CO_2 is <u>not</u> the source of the O_2 produced in photosynthesis. d) Water

Chapter 10 [continued]

Section	*Activity*	*Sample answers*
10.6	1	a) ^{14}C has two more neutrons than ^{12}C, giving it a higher atomic mass. ^{14}C is radioactive and releases radiation as it decays, while ^{12}C is not radioactive. b) ^{14}C (as CO_2 is the carbon source for producing sugars, e.g. glucose, in photosynthesis) c) Exposure to CO_2 containing ^{14}C causes plants to produce various organic compounds during photosynthesis that contain ^{14}C. Autoradiography can detect the radioactive emissions from these compounds and show that their location is in the phloem vessels.
	2	a) Geiger counter b) Using photographic film sensitive to radioactivity. c) The radiation emitted by the ^{14}C radioisotope allowed monitoring of the chemical reactions and the intermediate products formed during photosynthesis.

Module 3: Biological diversity

Chapter 11

Section	*Activity*	*Sample answers*
11.1	1	a) A community of organisms living in proximity to one another. b) *Many possible answers*, e.g. • rainforest • human intestines • sand dunes • alpine area • desert •freshwater lake, etc. c) Ecosystems can be different sizes. Some smaller ecosystems, such as an animal's intestines, are also part of a larger ecosystem, e.g. a rainforest.
	2	• Genetic diversity – the variety of genes found within a species • Species diversity – the variety of species found within a habitat or region • Ecosystem diversity – the variety of ecosystems found within a given area
11.2	1	• pressures • variation • termites • source • decrease • reproduce • corals • fur • living • competition
	2	1:5, 2:1, 3:6, 4:3, 5:2, 6:4
	3	a) Biotic b) Biotic c) Abiotic d) Abiotic e) Abiotic f) Biotic g) Biotic h) Abiotic i) Abiotic j) Abiotic k) Biotic l) Abiotic m) Abiotic n) Abiotic o) Biotic p) Abiotic q) Abiotic r) Abiotic
	4	1. (a) 2. (d) 3. (c)
11.3	1	a) Abiotic b) Abiotic c) Biotic d) Biotic e) Biotic f) Abiotic g) Biotic h) Abiotic i) Biotic
	2	a) Loss of habitat (from the trees in the forest being culled) b) Biotic (as culling of the forest removes some of their tree habitats) c) This is likely to act as a slightly negative selection pressure. The effects will likely be only mild as the owl population has options to migrate elsewhere or to find new habitat within the agricultural land (e.g. inside barns).
	3	a) Toxic chemicals (pesticides) b) Abiotic c) Only the black cutworms with the genetic variation that allows them to survive exposure to pesticides will live. This may reduce the moth population size in the short term. Over time, this variation may become more common.

Chapter 11 [continued]

Section	*Activity*	*Sample answers*
11.3	4	a) Limited food supplies being available in their island habitats b) Biotic c) It has evolved to be able to climb coconut trees and to have claws suited to opening coconuts, in order to use coconuts as a food source.
	5	a) A lack of light for fig saplings on the forest floor b) Abiotic c) A weak selection pressure – as they are acting on a number of different species and are not targeting just the one species.
	6	a) Divers and robots ('COTS-bots') use a one-shot injection method that contains bile salts. These dissolve fats and damage the cell membranes of the COTS, leading to death. This is being done in popular tourist areas. b) These pressures should have a negative impact on the population numbers of COTS in tourist areas. However, such regions are only a small part of the GBR, so the reduction may not be very significant. c) High nutrient run-off from agricultural areas d) The giant triton snail is the main predator of COTS. So, overfishing of these snails (reducing their numbers) has been a positive biotic selection pressure on the COTS, as it has reduced the level of predation by these snails. e) COTS are predators of corals. Hence high numbers of COTS act as a significant negative biotic selection pressure on coral populations. COTS are currently wiping our large regions of corals in the GBR.
11.4	1	a) Frog abundance = 428 frogs/100 km^2 = 4.28 frogs per km^2 b) Possum abundance = 2600 possums/10 km^2 = 260 possums/km^2 c) Salmon abundance = 374 salmon/1000 L = 0.374 salmon/L d) Total number of swans = abundance *x* size of area = 0.1/m^2 × 5400 m^2 = 540 swans e) Total number of kangaroos = (14% × 58) + 58 = 66.12 kangaroos Kangaroo abundance = 66.12 kangaroos/10 km^2 = 6.6 kangaroos/km^2

Chapter 12

<table>
<tr><th>Section</th><th>Activity</th><th colspan="3">Sample answers</th></tr>
<tr><td rowspan="3">12.1</td><td>2</td><td colspan="3">1:3, 2:2, 3:4, 4:5, 5:6, 6:7, 7:1</td></tr>
<tr><td>3</td><td colspan="3">a) Interspecific competition
b) Intraspecific competition
c) Adaptations
d) Habitat space, food, water and mates, etc.</td></tr>
<tr><td>4</td><td colspan="3">a) These two species of lizard have very different niches. The niche of A. poncensis is sunny, dry, low lying vegetation, whereas the niche of A. roosevelti is shady, moist, high canopy vegetation.
b) Having different ecological niches reduces interspecific competition between these two species of lizards. This is an example of resource partitioning, because occupying different niches to one another reduces direct competition between them.</td></tr>
<tr><td rowspan="2">12.2</td><td>1</td><td colspan="3">Elephant adaptations
• Excess (or baggy) and wrinkled skin – increases surface area for heat loss.
• Rolling in muddy water leaves wet mud on their skin. As the mud dries, evaporation of the water cools the elephant.
• They can flap their thin ears, which have many blood vessels that radiate out heat when it is hot (the high SA:V ratio also increases heat loss).
Penguin adaptations (any three):
• Huddling in large groups to insulate each other.
• Densely packed, overlapping and waterproof feathers can trap air to insulate them.
• Fat lining their feet provides insulation
• Rocking on heels of their small feet reduces contact with the cold ground.</td></tr>
<tr><td>2</td><td>Type of adaptation
• Structural
• Physiological
• Behavioural</td><td>Description
Relates to the size and shape of an organism and its body parts
Relates to how an organism’s body functions
Relates to an organism’s behaviours</td><td>Example
Kangaroos have powerful leg muscles
Humans sweat to assist heat loss
Penguins huddle to stay warm</td></tr>
</table>

Chapter 12 [continued]

Section	*Activity*	*Sample answers*
12.2	3	a) Structural b) Behavioural c) Structural d) Physiological e) Behavioural f) Structural g) Physiological h) Physiological i) Behavioural j) Physiological k) Structural l) Structural m) Structural
	4	a) Being tall to access sunlight more easily. Hooked spines to help attach to trees when climbing upwards. White coloured flowers that help to attract pollinators. b) Climbing up taller trees to access sunlight.* Opening flowers at night to concentrate scent.* c) Producing a strong scent in flowers.
	5	a) Behavioural* b) Physiological c) Structural d) Structural e) Physiological (salt accumulation) and behavioural (dropping leaves off)

*Note:
The categorisation of adaptations as structural, physiological or behavioural is designed by humans, not nature. As such, these classifications are somewhat arbitrary and do not always perfectly align with reality. A given behaviour in an organism cannot occur without physiological mechanisms underpinning the action. For each of these 'behavioural' adaptations of plants, one could make the argument that they are physiological adaptations. In fact, some scientists debate whether the 'behavioural' adaptation category should be omitted altogether for plants.

Chapter 13

Section	*Activity*	*Sample answers*
13.1	2	• pressures • niche • selection • vary • limited • growth • survive • live • advantageous • next • inheritance • change • common • adapted
	3	*From top to bottom*: 3, 4, 1, 2
	4	a) Variation, heritability and reproductive advantage. b) Evolutionary change requires differences between individuals in a given species (=variation) that offspring can inherit via DNA (=heritability). For evolution to favour a variant, it must make the individual more likely to reproduce e.g. due to better survival (=reproductive advantage).
	5	a) Charles Darwin and Alfred Wallace b) No c) Travelling the world on the *HMS Beagle* d) Galapagos Islands and Australia e) 1858 f) *The Origin of the Species* g) 1859
13.2	2	a) *Biston betularia* b) Predatory birds c) Soot pollution that darkened forest trees d) 87 regions e) 22,000 bases f) A jumping gene g) The *cortex* gene h) 105/110 = 95% i) 0%
	3	a) TEs (or 'jumping genes') can mobilise and insert themselves into new places within an organism's DNA. This can disrupt or interfere with the correct functioning of important genes. b) The TE was found in 95% of the dark moths and 0% of the light moths. A large sample size of 393 moths achieved fairly consistent results, suggesting good reliabilty. Another factor may explain the 5 anomalies.
13.3	1	The sandy background colour increased the frequency of light coloured fur in the rock pocket mice and decreased the frequency of dark coloured fur. The black rock background did the opposite (increased dark fur and decreased light fur among the mice population).
	2	*From top to bottom*: 3, 2, 1, 4
13.4	2	1:4, 2:1, 3:2, 4:3, 5:6, 6:5
	3	a) Ability to build cell walls b) Fungi and bacteria c) Healthy microflora d) Asexual reproduction e) Mutations

Chapter 13 [continued]

Section	*Activity*	*Sample answers*
13.4	5	1. *Variation*: Random mutations can give some bacteria resistance to a specific antibiotic 2. *Selection pressure*: Antibiotics act as a negative selection pressure on bacteria 3. *Inheritance*: Bacteria reproduce asexually, giving their resistance to all their offspring. They also can share their DNA. [Note: DNA sharing occurs through either 'naked uptake' or 'conjugation'.] 4. *Gradual change in population*: Over time, non-resistant bacteria die out and resistant bacteria become the norm within the population.
13.5	1	• selection • survival • variation • inherit • natural • pressure • reproduce • mating • objects • bower • dance • fight • antlers • males • attract • increase • likely • change
	2	a) Male peacock spiders vary in their colourfulness and ability to wave and vibrate their legs. Those deemed more attractive by the females are more likely to reproduce and less likely to be attacked and/or eaten by the female. The offspring of more attractive mates inherit their traits. Overtime, the 'attractive' traits have become more pronounced in the males of the population. b) There is variation in the size and shine of male frigate birds' throat sacs. Those with larger, shinier sacs are more likely to be chosen as a mating partner. Their offspring then inherit genes associated with large, shiny throat sacs. Over time, the size and shininess of throat sacs in the males of the population have become more common. c) Male lions vary in their strength and fighting ability. Better, stronger fighters are more likely to reproduce, allowing offspring to inherit these favourable traits. Over time, the lion population will have higher numbers of big, strong, fighting males.
13.6	2	a) Darwin and Wallace b) Professor Rick Shine c) The early 1980s d) They have become longer e) About 10 km per annum f) Over 50 km per annum g) Queensland h) Queensland, Northern Territory and NSW i) Northern Territory (or near Darwin) j) North-West k) Spatial sorting l) Longer legs and higher endurance (leading to the ability to travel further) m) Beetles damaging sugar cane crops

Section	*Activity*	*Sample answers*
13.6	3	a) Spatial sorting and natural selection are both ways in which evolution can occur. Both rely on variation in the population, inheritance of traits and time. However, natural selection involves a selection pressure driving the survival of advantageous traits. Spatial sorting instead involves traits leading to geographical dispersal, with impacts on mating partner options. b) Cane toads are a dispersing population with a high reproduction rate. Toads with particular traits (long legs and high endurance) are more likely to be located at the front of the invasion front. Here they reproduce with other toads with the same traits, causing longer legs and higher endurance to become more common in the toads at the frontline. c) Over time, cane toad speed has increased (measured by rate of expansion of territory per annum).
	4	a) IV: location of habitat (Queensland versus NSW) DV: various traits in red-bellied black snakes, e.g. wariness of the toads, amount of immunity to toad poison, head-to-body ratio. b) He should have used repetition by examining a large number of snakes and ensured that there was a high level of consistency in his results (e.g. the NSW snakes consistently had a particular trait). c) There was variation in several traits in Queensland red-bellied snakes, with some individuals being better suited to co-existing with cane toads. Those individuals were more likely to survive when exposed to cane toads. Their offspring inherited these favourable traits. Over time, the population of red-bellied snakes became better suited to co-existing with cane toads. d) Red-bellied blacksnakes show that genetic variation within a species can allow survival in spite of exposure to cane toads. Instead of the species dying out and reducing species biodiversity, the toads acted as a selection pressure for particular traits, and the genes that cause these traits. Hence the toads may alter genetic biodiversity rather than species biodiversity.

Chapter 14

Section	*Activity*	*Sample answers*
14.1	1	a) Convergent b) Convergent c) Divergent d) Divergent e) Convergent f) Convergent g) Divergent h) Convergent
14.2	1	• changes • time • formation • one • example • two • of • isolation • islands • members • pressures • niches • resources
	2	1:2, 2:3, 3:4, 4:1
	3	Speciation is the process by which one species diverges into two or more closely related species. It is more likely to occur if two populations of a species cannot interbreed due to geographical isolation or reproductive isolation. This can expose them to different selection pressures, which are separately inherited. Similarly, the use of different ecological niches by the two groups can expose them to differing selection pressures. Over time, the accumulation of microevolutionary changes can create two distinct species.
14.3	2	a) *A. porcatus* b) *A. lineatopus* c) *A. grahami* d) *A. equestris* e) Large body, large toe pads f) *A. porcatus* and *A. grahami* g) (i) *A. sagrei* and *A. lineatopus* (ii) Cuba and Jamaica (iii) Convergent
	3	Dewlap colour is used to attract a mate. Different dewlap colours have created reproductive isolation. This isolation in combination with different ecological niches aided the process of speciation, where one original species became two or more separate species.
	4	The ancestral species had genetic variations. As isolated populations were exposed to differing selection pressures, some traits were selected for and others were selected against. Individuals with advantageous traits survived and reproduced and their offspring inherited these traits. Over time, the various populations of anole lizards became so different to each other that they became different species.
	5	*A. equistris* and *A. garmani* both had variation in their populations. They lived in a similar niche with similar selection pressures. Both species evolved similarly to have larger bodies and larger toe pads to suit their environment. These lizards survived and reproduced and their offspring inherited these favourable traits. Over time, the populations of each species having these traits became more common.

Chapter 15

Section	*Activity*	*Sample answers*
15.1	1	a) *G. fortis* and *G. scandens* b) No correct answer – as your answer is opinion based. *Options include*: • song sound • spectrogram of song • general appearance • beak shape c) Many correct answers are possible – student must explain their choice of trait in (b). d) It is part of the Galapagos island group, off the coast of Ecuador. It is one of the smallest islands in this group and has no human inhabitants. e) The cactus finch has a longer, more pointed beak. This allows it to probe and open cactus fruits and to extract nectar and pollen from flowers. The medium ground finch has a shorter, blunter beak for cracking open seeds.
15.2	2	• Rosemary • finch • Daphne • annually • length • size • births • 40 • drought • diet • larger • open • population • analysis • average • survivors • beak
	3	a) Drought OR Scarcity of small seeds to eat b) Larger beak size c) There was variation in the beak size of medium ground finches. A drought acted as a selection pressure in which larger beaks were a survival advantage. Birds with larger beaks survived to reproduce, with offspring inheriting this favourable trait. Over time, the average population beak size increased.
	4	Comics may vary between students, while still being correct. *Four suitable captions might be*: 1. Medium ground finches had variations in beak size 2. High rainfall made small seeds available, favouring a smaller beak size 3. Finches with smaller beaks lived to reproduce, with offspring inheriting this trait. 4. Over time, the average beak size in the population decreased.
15.3	1	a) Beak size b) Shape of beak c) Beaks in Darwin's finches vary significantly in size, ranging from small to large. They also vary significantly in shape, ranging from blunt to pointed. d) Yes [*the heavier finches appear to have a more blunt beak*] e) Yes [*the heavier finches appear to have a larger beak size*] f) As the mass of finch increases, the size of the beak also appears to increase, e.g. warbler finch is 9 g with a small beak, while large ground finch is 35 g with a larger beak.

Chapter 15 [continued]

Section	*Activity*	*Sample answers*
15.3	2	a) 20 b) 10 c) 25 d) 8.8 cm e) Reading from graph: 9.1 cm f) 10 g) Reading from graph: 9.5 cm h) Average beak size of survivors is larger than the pre-drought population. This suggests that having a larger beak increased their chance of survival. i) Average beak size of drought-survivors and of 1978 offspring is the same. This suggests having a larger beak was a trait inherited by offspring.
15.4	1	a) T b) F c) F d) F e) T f) F g) T h) F
	2	The phylogenetic tree shows that the 13 species of finches are more closely related to one another than they are to a mainland species, such as the grassquit finch. This supports the idea that a single ancestral mainland species of finch migrated to the Galapagos islands and underwent speciation.
	3	a) Ground finch common names (small, medium, large) are consistent with their relative masses. b) *Any TWO of these finches*: • warbler finch • woodpecker finch • large tree • medium tree • small tree c) Beak types specifically suit the diet of each finch, e.g. a pointed, grasping beak helps woodpecker finches get insects out of cracks, while a blunt, crushing beak helps ground finches break and eat ground seeds. d) There is less variation in beak type within a single genus than across several genuses of finches, e.g. there are two beak types in the single genus *Geospiza*, but six beak types across the four genuses in the table.
15.5	1	*References will vary between students.* *Signs of reliability include*: • source was written recently by an organisation or individual who have authority/expertise on the topic. • source is an original publication and/or provides information that is consistent with other reliable sources.
	3	The route drawn on the map should go from England south-west to Brazil before looping around South America and back up towards the Galapagos islands off the coast of Ecuador. Route continues west past New Zealand and on to Sydney. Route loops to lower parts of Australia, stopping in Tasmania and Western Australia, then up to the Cocos Islands, before continuing west past the southern tip of Africa, and back up to England.

Chapter 15 [continued]

Section	*Activity*	*Sample answers*
15.5	4	a) T b) T c) F d) F e) T f) F g) T h) T i) T
	5	Darwin collected many biological samples during his travels on the HMS Beagle, including a number of finch specimens. These were examined back in England and found to consist of a number of unique species that differed from other known finches. Darwin observed that they had adaptations suited to their specific ecological niches and so used them to help formulate his ideas about natural selection. Hence others have subsequently nicknamed this group of finches 'Darwin's finches'.
15.6	2	*Many approaches can be used by students to appropriately address this extended response.* *Suggested marking criteria include:* • Students' responses use biological terms correctly and demonstrate an understanding of the key words in the question (microevolution, natural selection, speciation) • Students' responses use specific examples to support their points • Students' explain how their examples support their points
15.7	1	a) The fossil record b) Niles Eldredge and Stephen Jay Gould c) The gradualism model d) The punctuated equilibrium model
	2	a) Punctuated equilibrium – because they are strong selection pressures that drastically alter the genetic diversity in a population towards whatever trait allows survival. Such events are more likely to result in rapid, rather than gradual change. b) Punctuated equilibrium – an asteroid/comet would have suddenly caused many extinctions, and the survivors would have had strong selection pressures applied to their gene pools. This would explain why over 50% of marine species became extinct and surviving organisms changed.

Chapter 16

Section	*Activity*	*Sample answers*
16.1	3	1:2, 2:1, 3:5, 4:3, 5:6, 6:4
	4	• evidence • widely • patterns • mechanism • best • fossils • common • structure • analysis • DNA
16.2	2	a) Snakes cannot walk, so do not need pelvic bones. They are an inherited structure from their walking ancestors, but are no longer needed. Hence they are a vestigial structure. b) Both the tail in human embryos and tailbone in humans are vestigial structures as they exist due to inheritance from tailed ancestors, but are no longer needed in humans. c) Convergent evolution can cause two unrelated species to have similar structures develop from different DNA sequences to better suit similar ecological niches and/or to respond to similar selection pressures. d) Most vestigial structures have no functional role. If a vestigial structure caused harm, it would be selected against by natural selection. For a vestigial structure to continue to exist in a species, it must not affect the ability of an organism to survive and reproduce.
16.3	1	This image shows that the forelimbs of bats, mice, whales and humans all have a basic pentadactyl (five-digit) structure. This similarity in anatomy suggests that they all share a common ancestor that had a pentadactyl limb.
	2	This image shows some different stages of embryonic development for a number of organisms, including a fish, chicken and a human. In the earlier stages, the embryos are extraordinarily similar. The similarities are too great to have arisen by chance. This suggests that these organisms have descended from a common ancestor.
16.4	1	• genetic • double • sugar • bond • specific • bases • heat • single
	2	*From top to bottom*: 4, 2, 3, 1
	3	a) Greater heat is required to separate the hybrid DNA of closely related species than to separate the hybrid DNA of less closely related species. [Note: This is because there are more bonds in the hybrid DNA from closely related species than from less closely related species. So more heat is needed to break these bonds apart.] b) DNA-DNA hybridisation allows biochemical analysis to be conducted to determine how genetically similar DNA samples are when from two different species. It can be used to infer how closely related different species are and so determine their evolutionary relationship.

Chapter 16 [continued]

Section	*Activity*	*Sample answers*
16.5	2	a) Sedimentary b) The bottom layer c) The top layer d) Yes e) Relative dating f) Radiometric dating
	3	a) Relative dating determines a fossil's age compared to the age of other known fossils, e.g. as younger or older. So it is less precise than radiometric dating using carbon-14, which uses the ratio of carbon-14 to nitrogen-14 to get the numerical age of a fossil. b) Index fossils are found in widespread locations, but only occurred for a brief time. Hence rock strata with the same index fossils in them are the same age. c) Volcanic rocks can be found above or below layers of sedimentary rock. Hence the dating of such volcanic rocks can provide an estimated age of these sedimentary layers and any fossils within them.
16.6	1	a) *Any TWO of the following:* • larger body • more pronounced manes • larger ears • feet changed from toes to a hoof b) It changed from denser foliage to open grasslands.
	2	a) Earlier horses had three toes, while more recent horses have a single hoof. b) • skull became larger and longer • eye socket moved further back on the skull • shape of lower jaw changed

Chapter 17

Section	*Activity*	*Sample answers*
17.1	1	• years • extreme • high • lightning • activity • cells • Theory • meteorites • million • rose • autotrophs • fossils • have
	2	a) 4600 million years ago b) There was no ozone layer c) No d) The Chemosynthetic Theory e) The Theory of Panspermia f) Prokaryotic g) Atmospheric oxygen levels increased h) Banded iron formations i) 3500 million years ago j) 2200 million years ago k) Unicellular
	3	a) It shows: • volcanic activity • hot lava flows • asteroids entering the atmosphere • storm clouds. b) The asteroids shown in the image may have brought organic molecules to Earth from elsewhere in the Universe and thus 'seeded' life on Earth.
	4	a) High radiation, high heat, low oxygen availability, frequent storms, volcanic lava and volcanic gases. b) These organisms were using up organic carbon sources without replenishing them. So eventually they would have depleted all available organic carbon sources. c) Autotrophic prokaryotes produced oxygen, which was a major change in the atmosphere of early Earth and allowed organisms to evolve that could undertake aerobic respiration. Autotrophs also changed atmospheric carbon into organic carbon sources during photosynthesis, thus recycling carbon sources for heterotrophs.
17.2	1	a) Archaean eon b) Cenozoic era c) 1.5 billion years d) 2.7 billion years e) 0.5 billion years ago f) In water, e.g. the oceans
	2	a) Animal cells are eukaryotic. Hence eukaryotic cells had to develop prior to animals being able to develop. b) Colonial organisms would have probably developed in-between single-celled eukaryotes and multicellular eukaryotes. This places their development at around 1.75 million years ago. c) Plants are multicellular eukaryotes, so they could not have developed prior to 1.5 billion years ago. Most plants are terrestrial, but some are aquatic. Hence they probably developed between 0.5–1.5 billion years ago.

Chapter 17 [continued]

Section	*Activity*	*Sample answers*
17.3	1	a) Bacteria and archaea b) Eukarya c) Animals d) rRNA e) Classification systems are revised and updated over time as new data becomes available or to interpret old data in a new way. The old textbook probably had a less recent tree of life. f) *Either answer can be given, so long as it is justified. For example:* • Bacteria – as bacteria have their own domain with many different kingdoms. This suggests a high level of variation in these organisms. Whereas animals are only one kingdom, suggesting less variations in this kingdom. • Animals – all bacteria are unicellular and so lack tissues and organs, whereas animals are multicellular organisms with many different tissues and organs. Hence animals have more diversity in their structure.
17.4	2	*Many approaches can be used by students to appropriately address this extended response.* *Suggested marking criteria include:* • Students' responses use biological terms correctly and demonstrate understanding of these terms (e.g. prokaryotic, eukaryotic, evolution, biodiversity) • Students' responses use specific examples to support their points • Students' explain how their examples support their points

Module 4: Ecosystem dynamics

Chapter 18

Section	*Activity*	*Sample answers*
18.1	3	a) When there is a high animal density in an area with limited resources and this is causing environmental degradation or the animals are starving. b) Lethal control methods involve culling them, e.g. shooting. Non-lethal control methods include capturing to sterilise the kangaroos [Note: This involves using tranquillising darts to capture them.]
18.2	1	• living • non-living • factors • interactions • resources • source • relationship • one
	4	a) Mutualism b) Parasitism c) Commensalism d) Parasitism e) Mutualism f) Allelopathy g) Allelopathy h) Commensalism i) Mutualism j) Commensalism k) Commensalism l) Mutualism
18.3	1	a) Prey b) Predator c) Prey d) Prey e) Predator f) Prey
	2	a) The predators are eating the prey at higher rates as their population increases. This causes the prey population to decrease. b) Indefinite predator population growth would lead to a decline in prey and would result in no prey being left. The predators would then starve. c) *There are many correct answers for this question, including:* • Impacts of disease • Changes in the availability of the prey's food source • Harm to either or both prey/predator from changes in environmental conditions, such as temperature, rainfall, natural disasters, etc.
	3	*As these are informed predictions, there may be variation in exact responses. Students should be able to justify their prediction if asked.* *The following trends are likely to feature in most students' predicted graphs:* a) A decline in mice at point X, followed by a subsequent decline in owls. b) From point X, wolf and deer populations will rise and fall in the pattern of a stereotypical predator-prey graph (as prey population increases, predator numbers increase due to increased food supply; then as prey decrease, predator numbers 'echo' this trend and decrease … and so on). c) At point X, the sea urchin population will increase, causing a decline in the kelp populations. Students may then show a stereotypical predator-prey graph, or they may also predict the kelp population reducing to zero, followed by the sea urchin population likewise reducing to zero. d) The sea anemone population will decline after point X, causing an 'echoing' decline in the clown fish population.

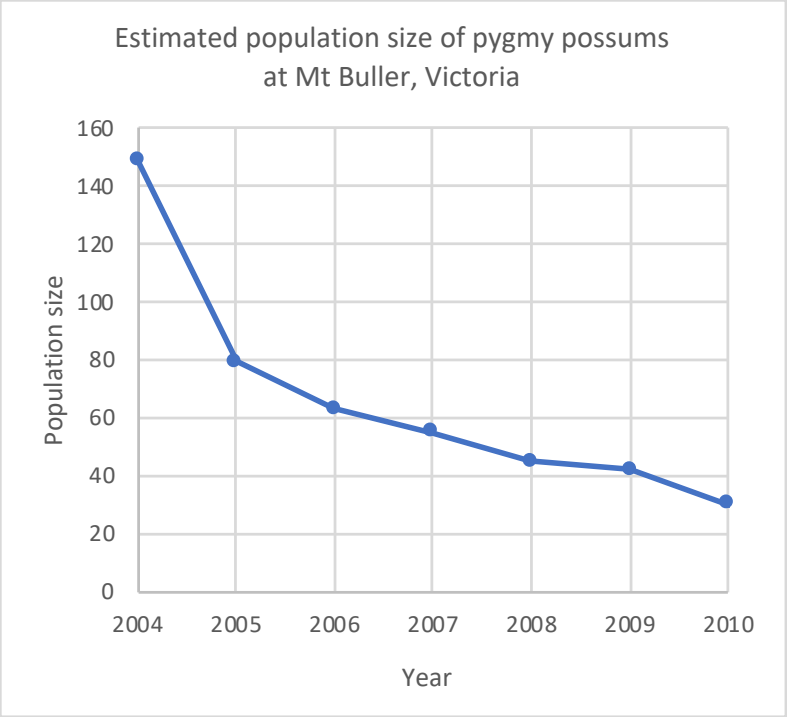
Chapter 18 [continued]

Section	*Activity*	*Sample answers*
18.4	1	a) Seagulls, fish and penguins b) Penguins and elephant seals c) Squid d) Seaweed and phytoplankton e) *Any of the following*: • zooplankton • krill • crabs f) *Any of the following*: • fish • seagulls • blue whales • leopard seals, • penguins • squid • elephant seals • killer whales g) Leopard seals, penguins and elephant seals h) Zooplankton i) Elephant seals j) *Any of the following*: • killer whale • leopard seal k) Consumers
	2	a) They are competitors for squid. Increases in the population size of penguins would reduce the available squid for elephant seals and so reduce their population size. b) Increases in the fish population would lead to increases in the population size of their predators (seagulls and leopard seals), while decreasing the population size of their prey (krill and zooplankton). c) Lowered light levels would reduce the ability of the producers to photosynthesise and so decrease the food available to first order consumers. Over time, this would lead to a reduction in all the other consumer organisms in the food web. d) Seaweed would become more abundant. However, squid would have less available food, and so their numbers would decrease. This could then lead to less penguins and elephant seals. e) The krill numbers would increase. This could lead to more fish, and so possibly to more seagulls. It would also result in a decrease in the phytoplankton, and so cause a decrease in the zooplankton numbers.
18.5	2	• Soil / rocks (used as habitat) • Water (required as a drinking source) • Altitude (sea level to alpine areas) • Temperature (broad range, including alpine) • Snow (present in some seasons in some of its habitats)
18.5	3	a) Owls and Tasmanian devils b) Feral cats and red foxes c) Eastern quolls compete with feral cats for food resources and compete with the spotted tail quoll for food resources and territory. [Note: They also compete with their predators (e.g. owls, Tasmanian devils, red foxes) for food resources, such as mice, rabbits, birds, some snakes, etc.] d) They produce olfactory and auditory signals to avoid other quolls entering their foraging area. [Note: This allows them to be mainly solitary animals.]

Chapter 18 [continued]

Section	*Activity*	*Sample answers*
18.5	3	e) Eastern quolls dart around feeding Tasmanian devils in order to steal scraps of flesh from their food. This is commensalism, as it benefits the quolls with little impact on the devils. f) Quolls have more than six babies, but only six teats for providing them with milk. So the babies in a litter have to compete for access to the teats, with only six usually surviving.
18.6	1	Some websites appear in both searches. Overall, the key words *Tasmanian tiger* resulted in more news-based sites, while the *Thylacinus cynocephalus* search brought up more reliable sites associated with scientific organisations.
	2	*Abiotic factors may include:* • Temperature (preferred nocturnal temperatures, but could survive in a range of temperatures – sometimes seen moving around in daytime) • Water availability (lived in areas with adequate rainfall) • Altitude (found in highland and lowland areas) • Light (preferred the dark) • Caves (used for shelter and nest) • Winds (as they can damage their habitat) • Fire (caused by lightning/human activity, led to death/habitat destruction) *Biotic factors may include:* • Members of the same species (e.g. their mate, offspring in the female's pouch, & other thylacines) • Their food sources (e.g. kangaroos and other marsupials, small rodents, birds including emus, sheep, poultry, and they scavenged on dead rabbits) • Predators (e.g. dingoes on the mainland and wild dogs) • Humans (who hunted thylacines as there was a bounty for killing them) • Habitat (they lived in most habitats, except dense rainforest – but preferred dry eucalypt forests, wetlands and grassland)
	3	The exact cause of extinction is not fully known. Suspected threats that may have contributed to the thylacine's extinction include competition with dingos (which were introduced), habitat loss, disease and human killings. [Note: Human killings of the thylacine in Tasmania were encouraged by there being a bounty placed on thylacines.]

Chapter 19

Section	*Activity*	*Sample answers*
19.1	1	• size • health • determine • species • counting • complete • cost • estimate • population
	2	a) Area = 11 m *x* 9 m = 99 m^2 b) Average = (11 + 7 + 4 + 8 + 12) / 5 = 42/5 = 8.4 daffodils per 1 m^2 quadrat c) Total = 99 m^2 *x* 8.4 daffodils/m^2 = 831.6 = 832 daffodils d) *Multiple correct answers are possible. Reasons may include:* • They may have sampled different quadrats with fewer daffodils • One of the people may have had errors in their calculations • Sampling techniques are never perfect – they are just estimates e) When more quadrats are used, the average number of organisms per quadrat becomes more accurate.
19.2	1	*From left to right:* • 149 • 79 • 63 • 55 • 45 • 42 • 30
	2	

Chapter 19 [continued]

Section	*Activity*	*Sample answers*
19.2	4	a) It ensured the 'marked' beads were randomly mixed with the 'population' (= the other beads in the bag). Otherwise the 'marked' beads may just sit on top of the other beads and be more likely to be 'recaptured'. b) *There are many possible correct answers. Some possible reasons are:* • The tags harmed the animals in some way causing them to die. • An environmental event caused death or injury to the animals. • The animals are very mobile or migratory and had left the area. • There was a flaw in the second set of traps that meant animals escaped or were not lured by the food. • The tagged animals had learned not to go near the traps. c) Tracking technologies provide more precise data and additional information to work out animal behaviours. However, these technologies are more invasive, sometimes requiring insertion of a transmitter/receiver, and are more difficult to attach/insert than the tags used in traditional CMR methods. These new technologies are likely to cost more for both the product and the labour involved for data analysis.
19.3	1	*Averages in order from top to bottom are:* • 0 • 14 • 42 • 11
	2	a) Distance from shoreline impacts the density of six-plated barnacles. The highest density occurs at 15 m from the shoreline, with a lower barnacle density at further and closer distances. b) The rock platform has considerable changes in abiotic factors, such as exposure to tidal water flow and salinity. This means that the barnacles are unlikely to have an even distribution. So transects are more accurate for estimating population sizes and densities than using random quadrats.
	3	a) A transect study is better as the plants might not be evenly dispersed in this type of ecosystem. This would be due to changes in abiotic factors, such as height above sea level and amount of salt spray, which can impact on the vegetation types and numbers present. b) Using transect lines would provide a better representation as coral populations tend to be unevenly distributed across a large area. This is due to abiotic factors, such as varying distance from the shore and varying depth in the water, which can affect their distribution.
19.4	1	1:2, 2:4, 3:1, 4:3
	2	a) Capture-mark-recapture b) Transect study c) Random quadrats d) Random quadrats e) Transect study f) Capture-mark-recapture

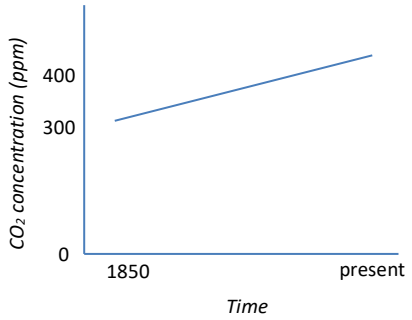
Chapter 19 [continued]

Section	*Activity*	*Sample answers*
19.4	3	a) The organism is stationary or very slow moving and the area for study has relatively similar conditions throughout, which cause the organism to be evenly distributed throughout the area. b) *There are multiple correct answers. For example:* Monitoring and measuring changes in population sizes provides information on the health of a species, or on the efficacy of conservation measures. For example, transect studies allow the numbers of coral in the Great Barrier Reef to be estimated or can be used to determine the ratio of healthy coral to diseased coral.
19.5	1	a) *There are a number of suitable sites available through web searching*. *Examples of TWO such sites* are: • Parks Victoria (2018). *Protection of Alpine National Park – Feral Horse Strategic Action Plan*. Accessed via: https://engage.vic.gov.au/alpine-national-park-feral-horse-strategic-action-plan • Australian Alps National Parks (2015). *2014 Survey of Feral Horses (Equus ferus caballus) in the Australian Alps*. Accessed via: https://theaustralianalps.files.wordpress.com/2016/05/2014-aerial-survey-feral-horses.pdf b) *Answer will depend on chosen sources. Signs of reliability include:* • source was written recently by an organisation or individual who have authority/expertise on the topic • source is an original publication and/or provides information that is consistent with other reliable sources c) Feral horses are an introduced species in alpine areas. Their hooves damage fragile vegetation and destroy habitats needed by native alpine plant and animal species. They also cause erosion and damage waterways. d) Helicopter aerial surveys of various alpine regions have been conducted to count and then monitor the abundance of feral horses. These are similar to a regular transect study, except that they can cover much larger transect lines and require highly experienced aerial observers who can distinguish the animals seen quickly and record the data.

Chapter 20

Section	*Activity*	*Sample answers*
20.1	1	a) South America, Africa, India, Antarctica and Australia b) The coastlines of the continents shown match up like pieces of a jigsaw puzzle. This supports the idea that they were once joined together in this pattern. c) The presence of *Glossopteris* fossils in each separate continent that was once a part of Gondwana implies that these continents were once joined together.
	2	a) Pangaea b) Laurasia c) Antarctica d) North-east e) The current climates in northern parts of Australia are likely to occur throughout southern parts of Australia, as it moves towards the tropics. f) Australia's climate will have changed throughout geological history due to its changing global position. The changes in temperature and rainfall associated with such movement will have acted as selection pressures for organisms in Australia. Only those organisms suited to the climate changes would have survived and reproduced.
	3	1. C 2. B
	4	A common ancestor to these birds must have existed on Gondwana before the break up of Gondwana. Australia separated from Africa and South America earlier than it separated from New Zealand. So modern species of flightless birds in Africa and South America are less closely related to emus and cassowaries. Since New Zealand and Australia separated relatively recently, their species are more closely related.
20.2	1	a) Antarctica and Greenland b) The past 800,000 years c) Seasonal differences in snow properties d) Geochemistry, electrical conductivity, layers of ash, mathematical modelling and radiometric dating are used to date older ice samples. e) Uranium-238 and uranium-234 f) Carbon dioxide and methane g) Volcanic ash particles h) Thickness of annual layers in ice cores i) Mass spectrometry j) Deuterium and oxygen-18
	2	a) A winch is used alongside a drill to pull out 1.5 metres of ice at a time. Multiple samples are taken consecutively, going deeper and deeper. b) They are samples of the atmosphere at the time the ice layer formed. The gas bubbles can be used to determine past temperatures and the concentration of greenhouse gases that were in the atmosphere.

Chapter 20 [continued]

Section	*Activity*	*Sample answers*
20.2	3	a) The increases and decreases in temperature and carbon dioxide concentration occur at almost the same time as one another. b) 3°C warmer and 9°C cooler c) Typical maximum: was 280 ppm. Typical minimum: about 180 ppm. d) No. The natural variations in CO_2 concentration did not exceed 300 ppm over the last 400,000 years – only since the 1850s. The current 400 ppm is significantly higher than the typical maximum of 280 ppm and so not part of the natural variations. e) 
20.3	1	1:2, 2:3, 3:1, 4:5, 5:4, 6:6
	2	By taking core samples of the sediment layers in an area, scientists can use the pollen grains they contain to determine what plants were growing there when each sediment layer was deposited. They can then make inferences about the past climates in the area based on the preferred climate for the plants today and so determine the changes in climate over time.
20.4	2	a) Warm and wet b) Rainforest plants c) Around 40-50 mya d) It became drier and had more fires e) Tough, with thick cuticles to allow them to maintain their shape, even in dry conditions (e.g. eucalyptus and wattle leaves) f) Increased carbon deposits g) Lightning and humans h) Eucalyptus species i) *There are many possible answers, e.g.* • lantana • prickly pear
	3	a) Overall, rainforests have become less abundant, while sclerophyll species have become more abundant relative to rainforest species. b) Fossilised pollen grains have been useful in determining changes to Australia's vegetation. Species can be identified by their pollen's unique shape and surface, aiding reliability of data. However, not all species are equally likely to produce pollen grain fossils and pollen can travel long distances. The reliability of data from pollen grains is moderately high, as it is analysed in combination with other evidence, such as the date and composition of rocks and soils, and biogeographical evidence for continental drift of Australia.

Chapter 20 [continued]

Section	*Activity*	*Sample answers*
20.5	1	a) South Australia b) A large hole is above the cave, allowing animals to accidentally fall in. Once inside, there is no exit and so they are trapped. c) *There are many possible answers, e.g.* • Marsupial lion •Tasmanian tigers d) A relatively large number of fossilised animals from different time periods have been preserved in the caves. Hence these fossils provide an excellent glimpse into the past over multiple different time periods.
20.6	1	*There are multiple correct answers. For example:* Thylacines had been observed by Aboriginal people first-hand, around 20,000 years ago. The thylacines were probably living in the Northern Territory, near to the area where the painting was done.
	2	*There are multiple correct answers. For example:* No – *Genyornis newtoni* is estimated to have become extinct thousands of years before the time that dating has estimated the rock art was done. No one then would have had first-hand memories of these birds to draw them accurately. Hence it is more likely to be of a different bird, such as the modern emu.

Chapter 21

Section	*Activity*	*Sample answers*
21.1	1	• over • extinct • record • Earth • years • dinosaurs • mammals • niches • instantly • thousands • pressures • mass • humans
	2	a) • Drastic changes in carbon dioxide levels and in temperatures • Changes in water levels and amount of ice present • Significant volcanic activity and impacts on the ozone layer • Earth was hit by a huge asteroid that created a large amount of dust that blocked sunlight b) Significant changes in carbon dioxide levels due to human activity, other pollutants, and human hunting, fishing and habitat destruction.
	3	a) 30% b) 22% c) 250 mya d) 200 mya e) End-Permian f) End-Cretaceous extinction (OR Cretaceous-Palaeogene extinction)
	4	It is thought that there were five big mass extinctions. However, it is difficult to determine the exact number of mass extinctions, as the fossil record is incomplete and also is an inconsistent record of all life over time. Statistical analysis suggests there have been around 8-11 mass extinctions.
21.2	1	a) Bees and flowers have a mutualistic relationship in which the bees gain nutrition, while the flowers get pollinated. b) The pollination of agricultural crops by bees is vital for the production of enough food for humans to eat. c) Causes of CCD include: • Pesticides (Abiotic) • Habitat loss, e.g. lack of flowers (Biotic) • Disease, e.g. parasitic mites (Biotic)
	2	The main threat to koalas is loss of habit. Eucalyptus forests continue to be cleared to make way for houses and large-scale mining. Human habitat destruction has caused the populations of koalas in some areas to become so small that they have lost genetic diversity. This lack of variation may reduce the ability of koalas to survive selection pressures such as climate change.
	3	a) A large proportion of the Tasmanian devil population has contagious facial tumours. This disease has a very high mortality rate in the wild and so it is drastically reducing Tasmanian devil populations. Tasmanian devil populations also lack genetic diversity and few devils with immunity to the facial tumour disease have been found. Devils taken into breeding programs have a degree of inbreeding, which further reduces genetic variation.

Chapter 21 [continued]

Section	*Activity*	*Sample answers*
21.2	3	b) Tasmanian devils often scavenge food from road-kill at night-time, and so often get hit themselves. The government plans to build more sealed roads into their habitat, which will increase the number of devils hit
	4	Scientists have developed methods to safely capture dugongs and conduct medical examinations of them. Data from these examinations will help to monitor the health of individual dugongs and the population, as well as helping to determine the cause of death when dugongs are found dead.
	6	a) Increases in human population and improvements in fishing technologies. b) Pelagic fish are towards the bottom of food webs. Overfishing of pelagic fish can cause starvation of organisms higher up the food web, thus resulting in multiple organisms being unable to survive. c) Breeding larger fish in farms helps to reduce the need to farm these fish from the oceans. It also helps to reduce overfishing of these species. However, in the farms, these fish are fed fishmeal, which is made from wild pelagic fish. Hence pelagic fish are still being overfished. d) In order to determine the allowable catches of fish species (without overfishing), authorities need to know the wild population size. It would be difficult and expensive to do whole population counts of fish. Instead, population estimations using transects can be used in combination with mathematical models to get an idea of the wild population size.
21.3	2	• animals • location • life cycle • stationary • algae • inside • food • colour • temperature • degrees • tissues • source • beautiful • short • die • bleaching • Barrier • water • dioxide
21.3	3	a) They help reef-building corals to build their skeletons. b) They help these organisms to build their shells. c) Pollution from human activities. d) Carbonic acid e) Carbonic acid f) Carbonate ions
	4	Climate change can alter average temperatures and is associated with an increased level of carbon dioxide gas in the atmosphere. Many species cannot withstand these selection pressures. For example, many reef-building coral species are in decline and under threat. They can no longer build their skeletons due to the impacts of increased dissolved CO_2. Furthermore, coral bleaching is killing many coral species as a result of warmer temperatures.

Chapter 21 [continued]

<table>
<tr><th>Section</th><th>Activity</th><th>Sample answers</th></tr>
<tr><td rowspan="4">21.5</td><td>2</td><td>There are multiple correct answers. For example:
Representative member of ecosystem
Sensitive to a specific environmental disturbance
It has a measurable response to varied levels of a disturbance
It has been previously studied
Its ecology is well known
It is abundant in its ecosystem
It is affordable to study</td></tr>
<tr><td>3</td><td><table>
<tr><th>Bioindicator</th><th>Data collected on this bioindicator</th><th>Data inferred from this bioindicator</th></tr>
<tr><td>Lichens/mosses</td><td>Abundance and diversity</td><td>Air pollution levels</td></tr>
<tr><td>Some microorganisms</td><td>Levels of stress proteins</td><td>Levels of particular pollutants</td></tr>
<tr><td>Some fish</td><td>Levels of certain liver enzymes</td><td>Exposure to pollutants</td></tr>
<tr><td>Earthworms</td><td>Functioning of their nervous system</td><td>Level of soil pollution</td></tr>
</table></td></tr>
<tr><td>4</td><td>The biotic data obtained from bioindicator organisms helps to create a model that predicts precise abiotic factors in an ecosystem. Bioindicators help to predict the impacts of natural changes and unnatural changes, such as pollutants. They can monitor the efficacy of management strategies. They allow cheaper and/or quicker data collection to make inferences about broader factors in ecosystems.</td></tr>
<tr><td rowspan="2">21.6</td><td>2</td><td>a) The toxins in sediment are absorbed into brown algae. This is a producer for the food web. As each consumer successively eats other organisms, the toxins are passed up the food chain.
b) Oysters are very responsive to even low concentrations of heavy metal pollution. Genetic mutations result from these metals, causing changes in proteins produced. Oysters have noticeable and different protein production in response to several different heavy metal pollutants.</td></tr>
<tr><td>3</td><td>Restoration methods revolve around transplanting healthy adult male and female crayweed into an area where the population has been decimated.
This restoration was achieved by:
removing some male and female crayweed from healthy populations out of Sydney
attaching the crayweed to a large mesh sheet, then placing these mesh sheets onto the harbour floor in a bare area without any plants
bolting the mesh with attached crayweed onto the rock surface.
The transplanted crayweed then reproduced, thus forming a patch or ‘forest’ of crayweed attached to the rock.</td></tr>
</table>

