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Student book answers

Chapter 1 Science investigation skills

Chapter review questions

1 Resolution of a microscope refers to the smallest distance between two points which can be distinguished as separate objects. The higher the resolution of a microscope, the more detail of an object can be observed; what seems to be one object may be discernable as two objects as the resolution increases. Magnification of a microscope refers to the amount an object has been amplified or enlarged for viewing. Magnifying an object by 100 times increases the size of the object but does not show you extra details.

2 One would expect that preliminary data showed that the vaccine produces an immune response and now scientists need to determine whether any harmful side effects occur following inoculation (vaccination). To start with, the research question could be: Do the test vaccines cause harmful side effects in ferrets following injection? A possible hypothesis could be: Vaccinations administered to ferrets may cause adverse side effects to the animals.

3 Independent variables are variables that are controlled in the experiment so an outcome can be observed. In this experiment, the independent variable would be the vaccine itself. The concentration, the amount of substances in the solution and the volume would need to be controlled before being administered to the ferrets. The dependent variable is the observed effects due to the administration of the vaccine, including the presence or absence of harmful side effects, such as as a fever, and the level of inflammation.

4 A control group of ferrets that are injected with an innocuous sample (a solution that does not illicit an immune response) is essential so that the experimental findings can be attributed to the vaccine alone.

5 This experiment would generate both qualitative and quantitative data. The qualitative data would include physical symptoms such as the presence of a fever, paralysis or lethargy. These symptoms would be further investigated to determine the level of inflammation and the level of immune response (antibodies), which would be quantitative data.

6 Three variables that need to be controlled in these initial experiments would be that the ferrets would need to be of the same breed, the amount of vaccine administered would need to be kept the same, and the injection schedule would need to be the same for all animals and trials.

7 Reliability of an experiment is the term given when a protocol produces similar results following consistent and repeated testing. Reliability can be achieved by repetition and replication. This includes conducting multiple trials on separate occasions, or allow the same protocol to be used by a different group. Reliability can also be improved by using a larger test sample size.

8 The validity of the experiment refers to whether the results observed are aligned to the hypothesis or intention of the experiment. For this experiment, the intention is to produce an effective vaccine with no harmful side effects. One approach that could make the data more valid is to check that variables are carefully measured and controlled so the results can be related to the aim/hypothesis of the experiment. These leaves no doubt that the data collected

result from the vaccine that was administered. Another way to make the experiment more valid is, once the results are obtained, to see what changes are needed to make the experiment aligned to the hypothesis. For example, if harmful side effects were observed, the following experiments could include changes to the dose of the vaccine given, which may change the result.

9 A histogram graph would be best to represent quantitative data. The two test groups could be compared with each other and to the control group. The different groups would be plotted on the *x* axis and as an example the levels of inflammation (dependent variable) would plotted on the *y* axis.

10 For every experiment, an assessment needs to be conducted to determine the possible risks. This includes the risks to you and other people, how likely it is there will be an injury and if there was an injury what the consequences would be. In this instance as the experiment involves the use of a highly contagious and deadly viral disease, the likelihood of harm would exist, and it could lead to catastrophic consequences, so the term or rank would be an 'extreme risk'.

11 Scientists adhere to the three Rs, which are reduction, refinement and replacement, when using animals in their experimentation. Reduction refers to minimising the number of animals to a sample size where you would obtain the same data as a larger group. Refinement refers to the modification of methods to alleviate or minimise potential pain and distress of animals. Replacement refers to using alternative models that do not involve the use of animals at all, or to replacing animals that have a nervous system with those that don't.

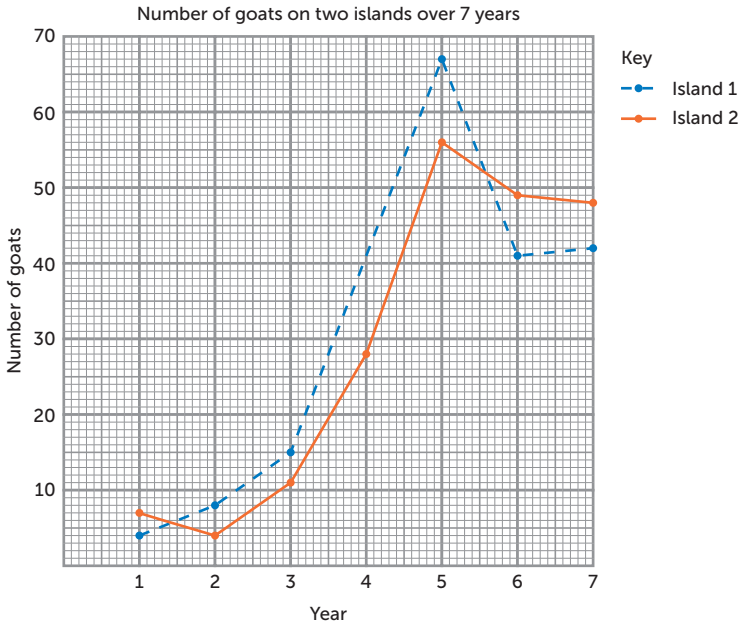
Practice exam questions

1 D

2 A

3 C

4 **a**



b i 42 (accept any answer in the range 41–43)

ii Births = 20; deaths = 38.
Population size at the end of Year 8 = (48 + 20) – 38
= 68 – 38
= 30

c i 8 ÷ 500 = 0.016 goats/ha (must show units to get the mark)

ii Island 1: 42 ÷ 500 = 0.084 goats/ha

Island 2: 48 ÷ 800 = 0.06 goats/ha

(must show units to get the mark)

5 a Dependent variable: Number of wild dogs killed/affected by baiting. This is the variable that will be affected by the experiment/measured during the experiment/that depends on the independent variable.

b Independent variable: Baiting. This is the variable that will be manipulated/altered in the experiment/upon which the results of the experiment depend.

Chapter 2 Biodiversity and classification

Question set 2.1

Remembering

1 Diversity can be considered at the levels of species, ecosystems and genetics.

2 **a** The biological species concept defines a species as a group of organisms whose members have the potential to interbreed in nature and produce viable, fertile offspring.

b The morphological species concept characterises a species by its form, or morphology.

c The phylogenetic species concept identifies a species as being the smallest group of organisms who can all trace their origins to a single common ancestor.

3 An ecosystem is made up of an interacting community of populations of organisms and the physical environment in which they live. Ecosystems are made of biotic components (living things) and abiotic components (non-living things).

Understanding

4 The biological species concept is limited for the following reasons:

- It is not possible to apply it to fossils of extinct organisms, since it is impossible to know which individuals could interbreed with another.
- It is not possible to apply it to zones where two identified species have populations that overlap. Hybrids are difficult to classify as they are the result of individuals from two different species interbreeding.

5 Biodiversity is the term used to describe the variety of life within an area; for example, Sydney Harbour supports 570 different species of fish and 3600 species of invertebrates.

6 Even though dogs vary in their morphological features, they are able to interbreed and produce fertile offspring so they are all members of the same species.

7 The greater the species diversity in an ecosystem, the more complex and more stable the ecosystem seems to be. Low species diversity equals low ecosystem diversity and high species diversity means a more biodiverse ecosystem.

Creating

8 Biodiversity has been severely reduced due to the bushfire. The following reasons outline why funding is needed and urgently.

- Biodiversity is a vital factor in the long-term survival of all life on Earth, including the societies in which we live.
- It gives educational and cultural benefits. Biodiversity provides clues about the changes in species over time and is also used in the spiritual life of some people groups such as Aboriginal and Torres Strait Islander Peoples. Biodiversity – the land, waters and all living things – form Indigenous creation and Dreamtime stories and Songlines about how they and the world around them came to be. Their traditions, food and culture are inextricably tied to the Australian landscape and its biodiversity. Recreational use such as bushwalking is beneficial for human wellbeing.

- It supports ecosystem processes essential to survival, such as: photosynthesis for converting light energy to chemical energy that can flow through food webs and providing oxygen to living things; nutrient cycling, which uses organic and inorganic matter from dead and decomposing organisms to support to new life and simultaneously cleans up wastes; population control, which involves competition and predation and maintains a balance of organisms and diversity; and pollination required by plants for the distribution of pollen by organisms such as insects, birds and mammals.
- It is vital to tourism and economics: a large amount of revenue is attributable to activities that rely on biodiversity in Australia. Tourism brings people who spend money, and this finances jobs in areas with natural attractions.
- It helps to produce food, purified water and air, fibre products such as wool and cotton, fuels, climate control and pharmaceuticals.

Question set 2.2

Remembering

1 **a** Living or growing on land

b Relating to water, fresh or salt

Understanding

2 Spatial scales consider the space or area of distribution, whereas temporal scales consider the distribution over different periods of time, such as different seasons or years.

3 Spatial scales are beneficial for describing the distribution of species, particularly for endangered species. Such information may help scientists in their planning of conservation strategies. Scientists may look for causal factors such as changes in weather patterns due to climate change. Scientists record changes in populations over time and, as a result, estimates of extinction rates can also be calculated over geological time. Patterns of biodiversity over time can allow scientists to plan for conservation strategies.

Applying

4 **a** The spatial scale was helpful because it could be compared over time to determine if population numbers increased or decreased. It can also help scientists look for patterns such as the particular sites on the property that numbats inhabited the most (e.g. where there are hollow trees, providing safety from predators).

b Temporal scales are of benefit because scientists can determine whether numbat numbers increase or decrease, and whether this occurs at a high or low rate; all of which can help them plan appropriate conservations strategies.

Question set 2.3

Remembering

1 First, the diversity of life on Earth is so enormous that classifying organisms is a way of organising information. Organisation of information about organisms allows for patterns and trends to be observed and relationships between organisms to be better understood.

Second, classification allows biologists to analyse information about organisms.

Third, classifying organisms allows biologists to communicate effectively with one another. It allows biologists to identify organisms that have already been discovered.

Applying

2 **a** This will depend on students' responses. Some examples are classifying young people as primary, secondary or tertiary students, classifying types of music and classifying types of books such as fiction or non-fiction.

b This will depend on students' responses to question **2a**. For example, classifying the type of books shows there are broad groups that indicate what the subject matter is about. It will be useful when choosing a book to read as you will already know something about the style before you read the first pages.

3 **a** Classification systems are artificial. There may be exceptions to the system and there may be new species not yet discovered that may challenge the existing classification.

b This will depend on students' responses. Most students will discuss the benefits of classification systems outweighing the limitations.

Question set 2.4

Remembering

1 Carl Linnaeus developed the binomial system of naming organisms. Before Linnaeus introduced the binomial system, organisms had descriptive Latin names, which could be very long. His system revolutionised the way that scientists describe and communicate about organisms.

2 Animalia, Plantae, Protista and Fungi

3 The taxonomic level is the classification of organisms into a series of groups that form a hierarchy or series of nested levels.

Understanding

4 Organisms within a phylum can be grouped according to similar features; these smaller groupings are called classes.

5 A binomial name consists of two parts, a generic name and a specific name. The first part (generic name) denotes the genus and is common to all organisms within that genus, and the second part is specific to the species; for example, Australia's floral emblem the golden wattle has the name *Acacia pycnantha*.

Question set 2.5

Remembering

1 Classification is based on the idea of organisms that share the same characteristics being grouped together and separated from organisms that do not share these characteristics.

Understanding

2 **a** Classification based on physical characteristics includes the examples of the presence or absence of fur, feathers and a back bone, and the number of limbs.

b Classification based on methods of reproduction includes using asexual and sexual reproduction to classify organisms. Sexual reproduction involves the union of two gametes

produced by two different individuals. Asexual reproduction does not involve gametes and reproduction is from one individual. Some organisms are able to reproduce using both processes for reproduction depending on the environment.

c Classification based on molecular sequences includes the comparison of DNA and amino acid sequences between organisms to classify species. For example, if an amino acid sequence is similar between organisms the implication is that they are more closely related than organisms with sequences showing fewer similarities.

Question set 2.6

Remembering

1

Phyla (Number Of Species)	Description of Animal Phylum
Porifera (5500) Sponges	1) Asymmetrical (no definite symmetry) 2) Body is multicellular, with few tissues and no organs 3) Cells and tissues surround a water-filled space but there is no true body cavity 4) All are sessile (as an adult, live attached to something) 5) Reproduce sexually or asexually
Cnidaria (10 000) Jellyfish, sea anemones and corals	1) Radially symmetrical (body plan is circular with structures that radiate out) 2) Gastrovascular cavity with single opening that serves as both mouth and anus 3) Reproduce sexually or asexually 4) Simple, net-like nervous system 5) Live in aquatic environments, mostly marine
Platyhelminthes (20 000) Flatworms	1) Bilaterally symmetrical (left and right halves of body are mirror images) 2) Gastrovascular cavity with single opening that serves as both mouth and anus 3) Body has three layers of tissues, with organs 4) Body without cavity 5) Body has blind gut (mouth but no anus) 6) Flattened body shape
Mollusca (100 000) Molluscs	1) Bilaterally symmetrical 2) Body without cavity 3) Body has through gut (with mouth and anus) 4) Uses muscular foot for locomotion 5) Open circulatory system with heart and aorta

Phyla (Number Of Species)	Description of Animal Phylum
Annelida (16 500) Segmented worms	1) Bilaterally symmetrical 2) Body has more than two cell layers, tissues and organs 3) Body cavity, nervous system and closed circulatory system 4) Body has through gut (with mouth and anus)
Nematoda (25 000) Roundworms	1) Bilaterally symmetrical 2) Cylindrical morphology 3) Body covered by tough cuticle (of collagen and chitin) 4) Alimentary canal (digestive system) with mouth and anus, but no circulatory system 5) Found in most aquatic habitats, soil, moist tissues of plants, and body fluids and tissues of animals
Arthropoda (1 000 000) Arthropods	1) Usually bilaterally symmetrical 2) Segmented 3) Hard exoskeleton (external skeleton) of protein and chitin 4) Most have through gut (with mouth and anus) 5) Jointed appendages (body parts attached to main trunk such as arms, legs, wings); have 3–400+ pairs of jointed legs
Echinodermata (7000) Starfish	1) Five-rayed symmetry, mostly radial, sometimes bilateral 2) Body has more than two cell layers, tissues and organs 3) Thin epidermis covering an endoskeleton; most species prickly due to skeletal bumps and spines 4) Most have short, through gut (with mouth and anus) 5) Body shape highly variable, but with no head
Chordata (57 000) Chordates	1) Ninety per cent are vertebrates (have backbones), but Chordata does include two invertebrate groups 2) Have the following features during development (possibly as embryo): • pharyngeal slits: series of openings connecting inside of throat to outside of ‘neck’; often, but not always, used as gills • dorsal nerve cord: bundle of nerve fibres running down the ‘back’; connects brain with lateral muscles and other organs • notochord: cartilaginous rod running underneath nerve cord • post-anal tail 3) Closed circulatory system with blood transported in arteries, veins and capillaries 4) Bilaterally symmetrical

Understanding

2 Echidnas are a marsupial and a mammal. All mammals are endothermic because they can generate heat using metabolic activity. This allows them to regulate their internal body temperature.

Applying

3 A bat is a mammal because it produces milk for its young from mammary glands and gives birth to live young, whereas birds lay eggs.

Question set 2.7

Remembering

1

Phylum	Three distinguishing features
Bryophytes	No true leaves, stems or roots No vascular tissue Reproduce via spores
Pteridophytes/Ferns	Leaves, roots, stems present Vascular tissue present Reproduce using spores Leaves arranged in pairs on opposite sides of stem
Gymnosperms	Leaves, roots, stems present Vascular tissue present Reproduce using seeds in cones
Angiosperms	Leaves, roots, stems present Vascular tissue present Reproduce using seeds in fruits Sex organs in flower

Understanding

2 Angiosperms, or flowering plants, are classified further into monocotyledons and dicotyledons. Features of the two groups differ from the embryo stage to the adult stage. In the embroyonic stage, monocotyledons have one cotyledon (embryonic leaf), whereas dicotyledons have two. Other differences include parallel venation of leaves in monocotyledons, whereas dicotyledons have a network of veins in their leaves. The root system also differs, with monocotyledons having a ‘tap root’ system whereas dicotyledons have a fibrous root system. Monocotyledons have petals in multiples of three, whereas dicotyledons have petals in multiples of four or five. Examples of monocotyledons include grains (wheat and corn), grasses, sugar and daffodils. Examples of dicotyledons include legumes (peas and beans), tomatoes and daisies.

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Question set 2.8

Remembering

1 Physical characteristics, reproductive methods and molecular sequences

2 Dichotomous keys are tools used to identify organisms. They involve choosing between a series of two options until an organism is identified.

Understanding

3 The more similar the amino acid sequences in a given protein are between organisms, the more closely related the organisms are. If the amino acid sequences are the same, the organisms are likely to belong to the same classification group or taxa.

Applying

4 **a** *Streptococcus pneumonia*, *Staphylococcus aureus*, *Neisseria* spp.

b *Clostridium difficile*

c *Neisseria* spp. In this case, spp. means 'members of the genus *Neisseria*'.

Question set 2.9

Remembering

1 Phylogenetic trees follow a branching pattern that shows the evolutionary history of groups of organisms (called taxa, singular taxon). The common ancestor is at the base and as populations evolve, branches form to show that the group or taxon has diversified from the original ancestor. A point where a taxon diverges from its ancestor is shown as a branch point. Taxa that are closely related have their branches closer together, whereas taxa that are not closely related have a common ancestor or branching points further away.

2 Three assumptions that are used to construct cladograms include:

a the more characteristics that are shared between organisms, the more they are closely related.

b some of the characteristics shared by a group will not be shared with more distantly related groups.

c a shared feature between taxa is more likely to have evolved from a common ancestor than independently for each taxa.

3 When a cladogram represents taxa on a branch that descended from a common ancestor, the group on that branch is referred to as a clade with the taxa referred to as monophyletic.

Understanding

4 Some taxonomists have recommended that the taxa containing birds and reptiles should be reclassified as new evidence shows that birds also evolved from dinosaurs and therefore share a common ancestor with crocodiles and alligators. Currently they are organised into separate classes as classification occurred before this evolutionary evidence was discovered.

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Chapter review questions

Remembering

1 A hybrid is a result of mating (sexual reproduction) between two individuals from different species. Hybrids are usually sterile.

2 Domain, kingdom, phylum, class, order, family, genus and species

3 A common ancestor is an organism from which two species evolved.

Understanding

4 The binomial system is the scientific method used to name species. Two names, genus and species, together form the scientific name of each species.

5 Organisms are classified into groups to organise information about them and to observe patterns and trends between them. This information can then be analysed and communicated to other scientists.

6 The biological classification system is hierarchical in that the higher taxonomic levels are larger groupings and show more diversity between individuals. Further down the hierarchy of classification, the groupings are smaller and less diverse.

7 **a** Paraphyletic

b The circle will encompass the top half of the cladogram, intersecting the line below baboons and above marmosets.

c Chimpanzees

8 More

9 When organisms inhabit similar niches in different parts of the world, they often evolve similar physical characteristics to suit their surroundings. Because of this, other characteristics are used to determine if their similarity is due to their ancestral relatedness or the environment they live in. In the case of the marsupial mole and African golden mole, their reproductive method is different enough to classify them separately.

Applying

10 Biodiversity is the variety of species that inhabit a certain ecosystem or region. Biodiversity can be broken down to three levels: all genes within a species' gene pool, all the species within an ecosystem and finally all of the ecosystems in the biosphere. Biodiversity is important for the survival of species. Populations of species are intricately balanced, and a change in one population in turn affects another population. Examples of this include interactions between populations such as competition and predation, which maintain population numbers and diversity.

11 **a** Physical characteristics, such as size and type of venomous sting; reproductive characteristics and molecular sequences

b Domain Eukarya, Kingdom Animalia, Genus Carukia

Analysing

12 a Presence of a backbone, no fur or feathers, no fins, no scales, colour of skin

b Amphibia

c There may be related species that are very similar to corroboree frogs and there may be hybrids that are not endangered. It is important to identify the members of the endangered species only so that they can be bred to produce offspring.

Evaluating

13 All cells of members of Eukarya contain DNA within a nucleus and membrane-bound organelles. All cells of Bacteria and Archaea do not contain a nucleus or membrane-bound organelles.

14 This will depend on students' response. A binomial name is useful in describing organisms for the scientific community and common names are beneficial when general populations are describing living things.

Creating

15

	Lamprey (Order Petromyzontiformes)	Shark (Class Chondrichthyes)	Lobe-Finned Fish (Class Sarcopterygii)	Ray Finned Fish (Class Actinopterygii)
Jaw	–	+	+	+
Fins attached to body on a fleshy stalk	–	–	+	–
Skeleton made of bone	–	–	+	+

Practice exam questions

1 C

2 A

3 Order Hymenoptera (1 mark)

Any of the following three (1 mark each):

- hind and front wings linked by a row of hooks
- front of abdomen narrowed to form a 'waist'
- wings and body completely covered by fine scales or hairs
- all wings membranous. May be hair or scale covered
- with two pairs of wings
- wings present.

4 Any of the following four (1 mark each):

- each species has two names
- each species has a genus name and a species name
- genus name written with first letter captialised
- italics used when typewritten
- latin is used
- species name is often descriptive
- underlined when hand written.

5 Ecosystem biodiversity – the range of different ecosystems in the biosphere (1 mark)

Any 3 marks for rationale relating to ecosystem biodiversity:

- maintains matter cycles (nitrogen, carbon, water)
- maintenance of water/food as a resource
- maintenance of climate patterns
- soil conservation (needed for farming)/ prevents wind and water erosion
- recreation and tourism.

Species diversity – the range of all the different species in an ecosystem (1 mark)

Any 2 marks for rationale relating to species biodiversity:

- food web maintenance – maintains species diversity
- new food species
- medicines
- oxygen
- not having monocultures – ensures overall biodiversity of species in an area.

Gene biodiversity – All the genes in a species (1 mark)

Any 2 marks for rationale relating to gene biodiversity:

- more likely to survive a changing environment
- more suitable genes in a changing environment
- variation.

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Chapter 3 Ecosystem classification and relationships

Question set 3.1

Remembering

1 The biosphere consists of terrestrial and aquatic biomes.

2 Bioitic factors make up the living components of the environment and include plants, animals and bacteria. Abiotic factors make up the non-living components of an environment and include the sunlight, weather conditions and pH of soil.

3 **a** A community is a group of populations of different species living in close enough proximity, in an ecosystem, to interact.

b A population is a group of individuals from the same species that inhabit the same habitat at the same time.

c Topography is the arrangement of physical features, both natural and artificial, of an area.

Understanding

4 **a** The community is the sum of all the living organisms in a habitat. A population within the community is a group of individuals belonging to the same species, living in the same habitat at the same time.

b The environment is the abiotic and biotic components of the ecosystem. The habitat is an area where an individual or species lives within an ecosystem.

c The environment is the abiotic and biotic components of the ecosystem. As well as the abiotic and biotic components, an ecosystem includes the interactions between these components.

5 Responses will vary.

Question set 3.2

Remembering

1 Environments and ecosystems are classified by their abiotic features, component species and species interactions. Ecosystems are usually named after the most dominant species in the community, along with its overall distribution.

2 A substrate is a ‘supporting surface’ on which an organism grows. The substrate may simply provide structural support, or may provide water and nutrients. A substrate may be inorganic, such as rock or soil, or it may be organic, such as wood

3 Aquatic ecosytems can be saltwater or fresh water systems, with examples including still lakes, oceans, rivers, swamps and estuaries.

Understanding

4 **a** An open ecosystem is one where some organisms enter (immigrate) and some leave (emigrate), whereas a closed ecosystem is one where there is no immigration or emigration.

b The difference between the amount of rainfall in arid deserts and tropical rainforests leads to the vast differences between the two ecosystems. The climatic condition in arid deserts are

dry whereas tropical rainforests have high humidity. Arid deserts are usually located around 30° north or south of the equator and they lack rainfall, which leads to sparse vegetation. Tropical rainforests are located near to the equator and receive large amounts of rainfall, creating a humid environment, and with their above average temperatures, they provide an environment for diverse vegetation to flourish.

c Grasslands are divided into two ecosysystems, savanna and temperate grasslands. The savanna grasslands are composed mostly of grasses with a scattering of individual trees, whereas in temperate grasslands there are no trees present. The grasses in these ecosystems have adapted to fires and drought conditions.

5 Ecosystems can be classified by their biotic features if there is one species that dominates. The hummock spinifex grasslands in the Pilbara is an example of an ecosystem that is named after a dominant species.

Creating

6 Students' own responses.

Question set 3.3a

Remembering

1 Responses will vary. One example of collaboration could be dolphins working together to herd schools of fish.

2 Disease can increase the biodiversity of a region if it reduces the number of predators. On the other hand, disease can decrease the biodiversity of an ecosystem if it kills many individuals.

Understanding

3 Interspecific relationships are those that exist between different species; for example, dolphin and fish. Intraspecific relationships are those that exist between members of the same species; for example, wolves collaborating with each other.

4 In a predator–prey relationship, one organism, the predator, kills another organism, the prey, or consumes part of it for its food.

Applying

5 Responses will vary. One example of the effect of predation on the biodiversity of an ecosystem is the release of nutrients into the soil caused by decomposing animal carcasses left behind by predators, which allows for micro-organisms to survive in the ecosystem.

Question Set 3.3b

Remembering

1 **a** Symbiosis is when there is a relationship between individuals of two or more species that interact together and in which at least one of the species benefits.

b Predation is a relationship between species in which one of them acts as a predator that captures and feeds on the other, which serves as the prey.

c Parasitism is a relationship between species in which one species benefits at the expense of the other.

d Mutualism is a relationship between species in which both species benefit and neither is harmed.

e Commensalism is a relationship between species in which one species benefits and the other neither benefits nor is harmed.

Understanding

2 Pollinators are essential for many flowering plants to reproduce, because they rely on the pollinators to transfer pollen from one plant to another. Seed dispersers are also essential to ecosystem biodiversity. These organisms eat fruits and seeds for nutrition, and when these animals defecate, they deposit seeds in a new location where the seeds germinate and grow. Seeds do not get damaged in the animal's digestive system and therefore remain viable for germination.

3

Type of symbiosis	Species 1	Species 2
Parasitism	+	–
Mutualism	+	+
Commensalism	+	0

4 Responses will vary.

Parasitism: If the presence of the parasite kills some varieties of the host, this will reduce the diversity of the ecosystem.

Mutualism: If species cannot survive by themselves because of their dependence on other species, the absence of these relationships would cause the species to become threatened or extinct. Diverse ecosystems would not be built.

Commensalism: Species that benefit from the relationship will suffer if the relationship is absent. This could cause the species to become threatened, and in the same way as in the case of changes affecting mutualism, diverse ecosystems would not be built.

Applying

5 Seed dispersers are distinct from seed predators in that the seeds do not get damaged in the animal's digestive system and therefore remain viable for germination. Seed predators use the seeds for food.

Chapter review questions

Remembering

1 Terrestrial environments are classified mainly on vegetation type, topography, soil type and climatic variation such as temperature, water, light and wind. Aquatic environments are classified on salinity, size and permanency of the body of water.

2

Abiotic factors	Terrestrial	Aquatic
Pressure	Lower	Higher, particularly at lower depths
Temperature	Wider range	Narrower range
Gas availability	Freely available	Limited availability

3 Competitors compete for the same resources whereas collaborators are species that work together to benefit each other.

Understanding

4 **a** Biosphere: the layer on Earth where the land, atmosphere and water interact in ways that sustain life. Biome: sections of the biosphere.

b Environment: the biotic and abiotic factors in an area. Ecosystem: the biotic and abiotic factors in an area, plus the interactions between them.

c Ecosystem: the biotic and abiotic factors in an area, plus the interactions between them. Habitat: area where organisms live within an ecosystem.

d Community: the sum of all the living organisms in a habitat. Population: group of individuals belonging to the same species, living in the same habitat at the same time.

e Environment: the biotic and abiotic factors in an area. Habitat: area where organisms live in the environment.

5 Biodiversity is increased when species benefit from their symbiotic relationships. It could be that they gain more food or shelter, or are distributed more widely. Any advantage to a species increases their chances of survival.

Applying

6

Relationship or interaction	Description	Example
Ecosystem	Different species living together and sharing the same resources	Forest, pool, swamp etc.
Commensalism	One organism benefits and the other neither benefits nor is harmed	Shark and remora
Intraspecific interactions (competition)	Rivalry between species for particular resources	Many throughout the text
Mutualism	Both species in the relationship benefit and neither is harmed	Pistol shrimp and the goby fish
Pollinators	Transfers pollen between flowers	Birds, insects, small mammals
Predator	An animal that kills for food	Purple sea star
Seed disperser	An organism that feeds on fruits and seeds for nutrition and, when the animal defecates, it deposits the seeds in a new location where they can germinate and grow	Cassowary

7 a, b

Relationship or interaction	Description	Example
A	Dry sclerophyll forest	Mild wet winters, hot summers, low rainfall
B	Woodland	Constantly hot, very wet and humid
C	Desert	Hot and dry, low rainfall
D	Wet sclerophyll forest	Temperate, high rainfall all year round

8 If the species introduced was a predator, it could reduce the biodiversity. If it was a species that benefited other species, the biodiversity would increase. It may also be that there is no change to the biodiversity.

Analysing

9 Mutualism: Both partners benefit and neither is harmed. The elephant obtains food and the seeds are dispersed.

10 a The dominant species is A.

b The total surface area covered by species A is 120 m^2. The percentage cover is 37%.

c The environment is classified as a eucalypt forest.

d The sample plot may not be representative of the whole area. A number of sample plots would be needed, to gain more accurate results, with the data collated (aggregated).

e Differences in light intensity, slope, availability of water due to different soil conditions, and so on. Some species may grow more rapidly than others and affect the survival of other species by competing more successfully for requirements.

11 a

Ecosystem	Temperature range (°C)	Precipitation range (mm)
Boreal forest	–17 to 15	25 to 205
Desert	3 to 31	0 to 24
Grassland	–10 to 31	0 to 78
Permanent ice	–20 to –5	0 to 125
Temperate deciduous forest	0 to 22	37 to 175
Temperate rainforest	5 to 23	198 to 263
Tropical rainforest	13 to 32	150 to 320
Tundra	–18 to 12	0 to 37

b Grassland

c Boreal forest

12 a The prey population is usually more numerous than the predator population because one predator usually depends on more than one member of the prey population for its food.

b There could be a time during a period of adverse conditions that the prey population decreases to have lower numbers than its predators. When this occurs, predators turn to alternative prey species and this allows the original prey population to grow in number

again. Alternatively, predator populations may decline due to an increase in intraspecific competition for food.

Evaluating

13 Students' own responses

Creating

14 Students' own responses.

Reflecting

15 Students' own responses.

Practice exam questions

1 A

2 B

3

Abiotic factor	Aquatic environment	Terrestrial environment
Temperature variation	Relatively smaller range and variation compared with a typical terrestrial environment.	Relatively larger range and more variable (daily and seasonal) compared with a typical aquatic environment.
Availability of gases	Limited availability. Dissolved oxygen increases with decreasing temperature and decreases with depth.	Readily available in the air. Air contains about 20% oxygen and 0.03% carbon dioxide. The availability of gases may be a limiting factor at high altitudes.
Availability of light	Less as depth increases. Animal and plant distribution is influenced by the availability of light.	More stable. Varies according to latitude. Varies according to canopy cover. The amount of light available is important for plant growth.

4 Interspecfic and intraspecific competition may include the same type of interaction between organisms for the same needed but limited resource; needed for survival or reproduction. They differ in that intraspecific is competition between members of the same species, whereas intraspecific is competition between two different species.

5 2 marks per relationship (one for relationship description and one for any correct detailed example)

Predation

A predator kills and eats an organism from another species, the prey.

Saltwater crocodiles living in mangroves are predators of prey such as birds, turtles, fish. The crocodiles hunt, attack, kill and consume their prey.

Mutualism

A relationship between two species in which both partners benefit and neither is harmed.

For example, in lichen there is a symbiotic relationship between a photosynthetic organism/ algae/bacteria and a fungus. The fungus grows around the bacterial or algal cells. The fungus benefits from the constant supply of food produced by the algae. The fungi seem to build a stable structure for the algae to grow on and in.

Parasitism

Relationship between two species in which the one species benefits (the parasite) and the other, the host, is harmed. The one receiving the benefit is harming the host.

For example, fleas (an ectoparasite) live on dogs, biting the dog's skin, sucking their blood to gain nutrients and causing the dog to itch. The host dog supplies food and a home but is harmed in the process.

Commensalism

One species benefits whilst the other is neither harmed nor benefits.

The remora fish attaches itself (using a sucker disc in its mouth) to a shark. The fish gets food and protection, and the shark receives neither benefit nor harm. (Some people argue that the shark gets cleaned of parasites and therefore this relationship can be used as an example of mutualism.)

Competition

Competition is an interaction between living things that occurs when individuals compete for a resource that limits their survival or reproduction.

This includes the struggle for food or light or mates. For example, tall trees with a canopy can outcompete shrubs for light (required for photosynthesis, which provides energy for growth and reproduction).

nelson net.

Chapter 4 Energy and matter in ecosystems

Question set 4.1

Remembering

1 The Sun

2 **a** Matter consists of atoms and is anything that takes up space and has mass. It is required to build and maintain complex structures throughout the universe.

b Biogeochemical cycling is the cycling of matter through the living components (organisms) and non-living components (such as soils, rocks, water and the atmosphere) of an ecosystem.

Understanding

3 Energy that is transformed is energy that changes from one form to another, such as light energy to heat energy or light energy to chemical energy. In contrast, energy that is transferred remains in the same form but moves from one reservoir to another.

4 There are examples of ecosystems that survive on geothermal energy rather than energy from the Sun. These include Archaea found in the Wai-O-Tapu geothermal reserves in New Zealand and tube worms found in deep sea trenches in the Pacific Ocean. In both instances these organisms live in high temperatures devoid of sunlight and use inorganic chemical compounds such as those containing sulfur as their energy source.

Question set 4.2

Remembering

1 Autotrophs such as plants and algae are able to photosynthesise. Chloroplasts are specialised organelles in the cells of autotrophs. They contain the pigment chlorophyll. This pigment is able to absorb most of the wavelengths in sunlight.

2

	Performs photosynthesis	Performs respiration	Autotropic or heterotrophic
Producer	Yes	Yes	Autotrophic
Consumer	No	Yes	Heterotrophic

Understanding

3 **a** Plants are ‘energy converters’ because they convert light energy into chemical energy.

b Producers are the autotrophs, and they provide the chemicals that other organisms in an ecosystem depend on to produce energy.

4 GPP refers to gross primary productivity and is the total amount of organic matter made in an ecosystem by producers. NPP refers to net primary productivity and is the total amount of energy available to organisms that depend on producers. NPP is less than GPP.

nelson net.

Question set 4.3

Remembering

1 Producers are vital to a community because they are the only organisms which convert the energy of sunlight into the chemical energy that maintains the ecosystem. Consumers depend on producers for energy.

2 Food chains and food webs are examples of qualitative and predictive models that allow ecologists to monitor the sustainability of an ecosystem by investigating feeding relationships.

3 **a** Producers: **iii** photosynthetic autotrophs

b Consumers: **i** herbivores, carnivores, omnivores

c Decomposers: **ii** break down organic remains and products

4 **a** Scavengers feed on the dead remains of other organisms.

b Detritivores feed on dead or decaying organic remains and wastes. They are relatively large organisms that help speed up decay by breaking down large pieces of detritus into smaller pieces, increasing the surface area for decomposers to continue their work more efficiently.

c Decomposers decompose (break down) complex organic molecules into simpler inorganic forms and returns nutrients to the soil or water.

5 Turtle

6 Detritus means pieces of dead organic matter.

7 **a** A food web consists of several food chains interlinked.

b A herbivore eats plants; a carnivore eats animals.

c A second-order consumer eats herbivores (first-order consumers) and a third-order consumer eats second-order consumers. A second-order consumer is one trophic level lower in a food chain than a third-order consumer.

8 If a member at one trophic level is eliminated it is likely that the members of a lower trophic level will increase in number and that members of a higher trophic level will decrease in number. What may also happen is that members of the higher trophic level will consume other members of the eliminated organism's trophic level.

Question set 4.4

Remembering

1 An ecological pyramid, such as a pyramid of numbers, is used to quantify species within a food chain.

2 An inverted pyramid can occur when a single very large producer supports a large number of primary consumers. It can also result when communities contain parasites.

Understanding

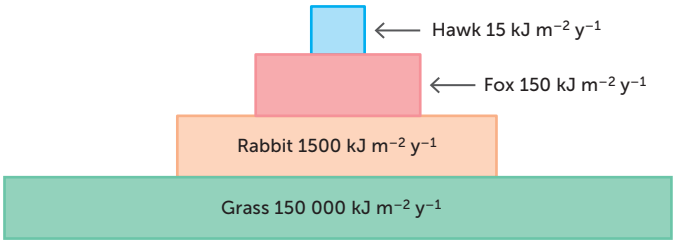
3 Data needs to be gathered over a year in a certain area. The amount of energy in each trophic level needs to be recorded.

4 Pyramids of numbers are not always pyramidal in shape; for example, one large tree can support many herbivores.

5 Pyramids of energy can never be inverted as the total amount of energy decreases with every trophic level. Only some of the energy stored in a trophic level goes to the next trophic level, giving the pyramidal shape.

Applying

6 Usually only 10% of energy is transferred between trophic levels. The following figure is not to scale.



7 The pyramid of biomass will get narrower as the food chain progresses. The grass will be on the lowest level with the greatest amount of biomass and the eagle will be at the top with the least amount of biomass.

Question set 4.5a

Remembering

1 Biogeochemical cycling is a model used to describe how chemical compounds are transformed and stored in Earth's biosphere. Total matter is a fixed resource and is cycled between biotic (biological) and abiotic (geological) processes.

2 Animals and plants are two examples of living reservoirs where matter cycles through, whereas oceans and sedimentary rock are two examples of non-living reservoirs.

3

Main Forms	Reservoirs
Carbon dioxide gas	Atmosphere
Glucose in producers	Plants
Glucose, proteins, fats in consumers	Animals
Methane	Ruminants, such as cattle, and seafloor sediment
Fossil fuels	Earth's crust – sediment, rock
Carbonic acid	Oceans

4

Process	Associated Biotic or Abiotic Component
a Photosynthesis	**iv** Producer
b Consumption	**vii** Consumer
c Cellular respiration	**i** Any living organism
d Combustion/fire	**iii** Fossil fuels, wood
e Geological activity, e.g. volcanic eruption	**ii** Volcano
f Dissolving	**v** Oceans, other water bodies
g Decomposition	**vi** Decaying organisms

Understanding

5 Photosynthesis is a process that coverts solar energy into potential chemical energy that is stored in chemical bonds. Cellular respiration is a process that breaks down organic compounds into simpler compounds, to release energy. In photosynthesis atmospheric carbon, carbon dioxide, is fixed into organic compounds such as glucose, which is used for energy by plants. In the breakdown of these organic compounds, carbon is released back into the atmosphere as carbon dioxide through the process of cellular respiration.

Applying

6 Following a bushfire a significant amount of carbon is trapped in the burnt remains, charcoal, of the forest which would become part of the soil. If the fire is large and intense, the output of carbon dioxide may be much greater. As vegetation regrows it consumes carbon through photosynthesis, taking in atmospheric carbon dioxide and storing it. These factors create a carbon sink in the area of forests that were burnt.

7 Nitrogen gas is much more abundant than carbon dioxide in the atmosphere, but needs to be fixed into a form that is usable by organisms. Nitrogen gas is fixed by prokaryotes in the soil. This usable form of nitrogen is taken up by plants. Plants are then eaten by animals and when an animal dies and decomposes, both carbon and nitrogen are released into the soil.

8 **a** If large quantities of fossil fuels continue to be consumed an imbalance in the carbon cycle would occur. Fossil fuels are a finite resource and the rate of carbon dioxide released into the atmosphere would be greater than the rate of formation of fossil fuels. Temperatures would increase and the oceans would absorb more of the atmospheric carbon, leading to the acidification (lowering of pH) of waters.

b If major deforestation occurred, an imbalance in the carbon cycle would occur. The levels of atmospheric carbon dioxide would increase as the rate of carbon dioxide that is fixed and stored is dramatically decreased, because there wouldn't be enough vegetation to remove the carbon dioxide through photosynthesis. Temperatures would increase and the oceans would absorb more of the atmospheric carbon, leading to their acidification.

Question set 4.5b

Remembering

1 Given the interdependence of biotic and abiotic components, scientists describe the cycling of matter as biogeochemical cycling. A biogeochemical cycle is a model describing how chemical elements (e.g., nitrogen, carbon) or molecules (e.g. water) are transformed and stored by both biological and geological components in Earth's biosphere. These chemicals are recycled through biological food webs and through geological processes, such as weathering, erosion and volcanic activity.

2

Form	Reservoirs
Nitrogen gas, N_2	Atmosphere
NO_2, NO_3, NH_3	Soil
Protein	Organisms, e.g. plants and animals

3

Process	Biotic or Abiotic Component Involved
a Nitrogen fixation	**iii** Microorganisms/bacteria/prokaryotes found in root nodules of legumes or lightning/volcanoes fix nitrogen
b Ammonification	**i** Bacteria and fungi convert nitrogenous substances in dead and decaying matter into ammonia in the soil
c Assimilation/ absorption	**v** Plants absorb/assimilate nitrates through their roots
d Consumption	**ii** Consumers pass nitrogen through food chains
e Denitrification	**iv** Soil bacteria convert soil nitrate into nitrogen gas

Understanding

4 **a** Volcanic emissions and the denitrification of certain bacteria both contribute to the level of nitrogen in the atmosphere.

b Nitrogen can be removed from the atmosphere by lightning and by nitrogen fixation.

Applying

5 The cycling of carbon, nitrogen and water are interconnected. For example, the movement of water is critical for the leaching of nitrogen and phosphate into rivers, lakes and oceans. The ocean is a reservoir for carbon. Mineral nutrients are cycled through the entire biosphere from one living organism to another.

6 **a** The diagram will depend on students' responses.

b Minimal or no cycling of matter would be particularly detrimental to the nitrogen cycle.

c This will depend on students' responses.

Question set 4.6

Remembering

1 The way a species functions within its environment is known as its ecological niche. The example will depend on the students' responses.

2 For example, the emperor penguin.

Feeding: They feed mainly on fish, crustaceans and squid, so are predators.

Relationships: In addition to being predators, they are prey to larger animals, such as killer whales.

Abiotic factors: They have bodies adapted to hunting in water at very low temperatures.

Habitat: open ice in Antarctica

Reproductive behaviours: Male emperor penguins keep the newly laid eggs warm by balancing them on their feet and covering them with feathered skin known as a brood pouch.

Understanding

3 Fundamental niche: the 'ideal' niche a species would occupy if there were no competitors, predators or parasites.

Realised niche: the actual niche it occupies due to its ability to exploit the resources available and cope with restrictions.

4 Gause found that when he grew each species as two separate cultures, with a constant source of food, the population numbers increased exponentially until they reached the carrying capacity of the culture. However, he found that when the two species were grown in the same culture, one had a competitive advantage and was able to obtain the food more effectively than the other, driving the less competitive species to extinction.

Applying

5 The species live at different heights and inhabit different niches within the tree. They are not competing for the same food or space. In other words, the warblers are not competing for the same resources so they are able to co-exist.

Question set 4.7

Remembering

1 A keystone species is a species of relatively low abundance that has a disproportionately large influence over lower trophic levels, determining the coexistence of these species in an area.

Understanding

2 A keystone species increases an ecosystem's biodiversity by controlling populations of other species that would otherwise dominate the community or by providing critical resources for a wide range of species.

3 A keystone species is often a species of relatively low abundance, whereas a dominant species is one that is more numerous than other species in the ecosystem.

Chapter review questions

Remembering

1 A food chain follows only one path through the food web. A food web shows all of the food chains present in an ecosystem.

2 Zooplankton

Understanding

3 At particular times of the year, the biomass of the tiny herbivorous organisms that float in lakes and oceans (zooplankton) may exceed the biomass of the tiny photosynthetic organisms (phytoplankton) on which they feed. This would result in an inverted pyramid. Another example is when a single very large producer such as the eucalypt tree supports a large number of primary consumers.

4 A mushroom (a fungi) is a saprophyte, which is the same as a detritivore, but they secrete enzymes into the decaying matter and then absorb the nutrients, whereas detritivores feed and then digest plant and animal matter.

Bacteria are decomposers, and they decompose (break down) complex organic molecules into simpler inorganic forms and returns nutrients to the soil or water.

Worms are detritivores, which feed on dead or decaying organic remains and wastes. They are

relatively large organisms that help speed up decay by breaking down large pieces of detritus into smaller pieces, increasing the surface area for decomposers to continue their work more efficiently.

Applying

5 10% of 800 kJ = 80 kJ

6 Omnivores eat both plants and animals. If there is a shortage in one type of food, an omnivore has alternatives.

7 The migration of organisms transfers energy and matter along different pathways out of the ecosystem. Organisms that depend on them will be affected and may move too.

Analysing

8 Energy is 'lost' from food chains at every link in the form of heat energy (due to cellular respiration in the tissues of organisms), detritus, organic waste, and dead plant and animal tissues.

9 A change in population of one species affects the populations of species that depend on or are affected by that species. The effect is felt along the food chains of the oceans. Monitoring is important for this reason.

10 B

11 It is most likely that the photosynthetic rate would be higher at 25°C.

Evaluating

12

Type of ecosystem	Primary productivity (kJ m^{-2} $year^{-1}$)	Energy available to primary consumers (kJ m^{-2} $year^{-1}$)	Energy available to secondary consumers (kJ m^{-2} $year^{-1}$)
Grassland	8400	840	84
Ocean	3350	335	33.5
Tropical rainforest	3800	380	38
Desert	<840	<8.4	<0.84

a GPP: total amount of biomass produced in the ecosystem. NPP: total amount of biomass available to organisms in the next link in the food chain.

b From the data in the table, the desert is the least productive ecosystem due to the low rate of productivity.

13 The weather conditions in colder climates and deserts do not favour efficient photosynthesis. In deserts, this is because of the lack of available water. In cold climates, low temperatures and less light energy reduce the rate of photosynthesis. Tropical forests and grasslands receive higher levels of sunlight and water, hence the higher production of organic matter.

14 Students' own responses. For an example, see Figure 4.22 on page 120 of the student book.

15 Food webs are interactions between species and show their particular roles in the web. Usually a population of large size will have the most impact on the dynamics of the ecosystem.

However, keystone species have a much larger effect on other species of an ecosystem even though their abundance is relatively low. This may be due to the keystone species' ability to do something critical, such as recycle nutrients. For an ecosystem to remain stable, nutrients must be recycled by specific organisms. If the keystone species disappears, this could put the survival of all of the other species in the community at great risk.

Practice exam questions

1 C

2 D

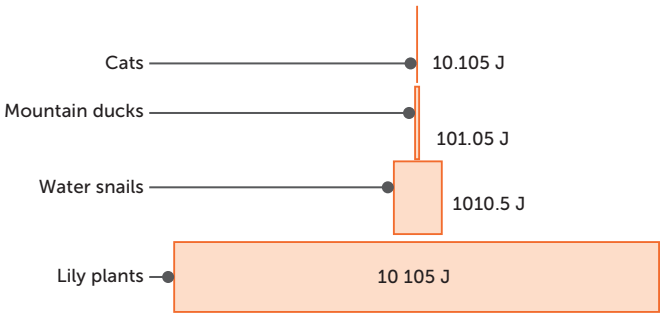
3 A

4 **a** Lily plant → water snails → mountain ducks → cats

b Correct labels (1 mark)

Approximately 90% decrease/trophic level labels close to scale in diagram (1 mark)

10 105 J (lily), 1010.5 J (water snails), 101.05 J (mountain ducks), 10.105 J (cats) (1 mark)



5 5 marks for five forms found in their correct reservoir, all labelled.

Main forms	Reservoirs
Carbon dioxide gas	Atmosphere, ocean
Glucose in producers	Plant and animal tissue
Glucose, proteins, fats in consumers	
Methane	Farm animals and atmosphere
Fossil fuels	Rocks
Carbonic acid	Ocean

5 marks for five processes mentioned in cycle and inserted correctly between reservoirs

Process	Biotic or abiotic component associated with process
Photosynthesis	Producer
Consumption (along a food chain)	Consumer
Cellular respiration	Any living organism
Combustion	Fossil fuels
Geological activity e.g. volcanic eruption	Volcano
Dissolving (in oceans)	Carbon dioxide in to oceans
Decomposition	Dead and decaying organisms

Chapter 5 Population dynamics

Question set 5.1

Remembering

1 A population is a group of individuals of one species living in one place at one time.

2 Species described as *r*-selected seize the opportunities that changes to an ecosystem bring. They will often move in after a fire or land-clearing, colonising new environments as quickly as they are able.

Understanding

3 *K*-selected species exist close to the carrying capacity of their environment. They will compete for resources, unlike *r*-selected species, which colonise an area with unlimited resources.

4 A healthy ecosystem has a variety of species. A lack of biodiversity may create vulnerability and possibly lead to extinction.

Question set 5.2

Remembering

1 Birth rate, death rate, emigration rate and immigration rate

2 Populations are distributed in three basic patterns:

- random distribution: organisms are spaced unevenly, at random
- uniform distribution: organisms are evenly spaced
- clumped (grouped) distribution: a number of groups of organisms make up the population as a whole.

3 The abundance is the number of a species in a population, whereas geographic distribution is the places in the ecosystem where individuals of the species are found.

Analysing

4 In an open ecosystem, population growth depends not only on birth and death rates but also on immigration and emigration; in a closed ecosystem, growth depends only on birth and death rates.

5 Growth rate = $(br + ir) - (dr + er)$

$= (1000 + 72) - (345 + 108)$

$= 1072 - 453$

$= 619$ in one thousand or 61.9%

Evaluating

6

Method	Brief description	Best used for
Direct observation	Counting individuals in a given area or counting individuals passing a point at a given time	Mobile organisms
Sampling: • transect	Straight line drawn through an environment	Environmental gradients (vertical and horizontal changes in environment)
Sampling: • quadrat	Several quadrats representative of an area are sampled at random. The total number can be calculated and density can be calculated: $D = \frac{\text{total numbers of individuals}}{\text{area of each quadrat}} \times \text{number of quatrats}$	Distribution, abundance and density
Sampling: • capture–mark–recapture	Total population $(N) = \frac{M \times n}{m}$ M = number marked in first sample n = total recaptured m = number of recaptured animals that are marked	Random sample of mobile species
Telemetry	Remote tracking using technology such as GPS	Predicting future needs and resource management

Applying

7 **a** Population 1: $\frac{170 \times 140}{34} = 700$, Population 2: $\frac{315 \times 295}{35} = 2655$,

Population 3: $\frac{400 \times 450}{25} = 7200$

b Population 1: $\frac{700}{290} = 2.4$ per m^2, Population 2: $\frac{2655}{1980} = 1.3$ per m^2,

Population 3: $\frac{7200}{5090} = 1.4$ per m^2. Population 1 has the highest population density.

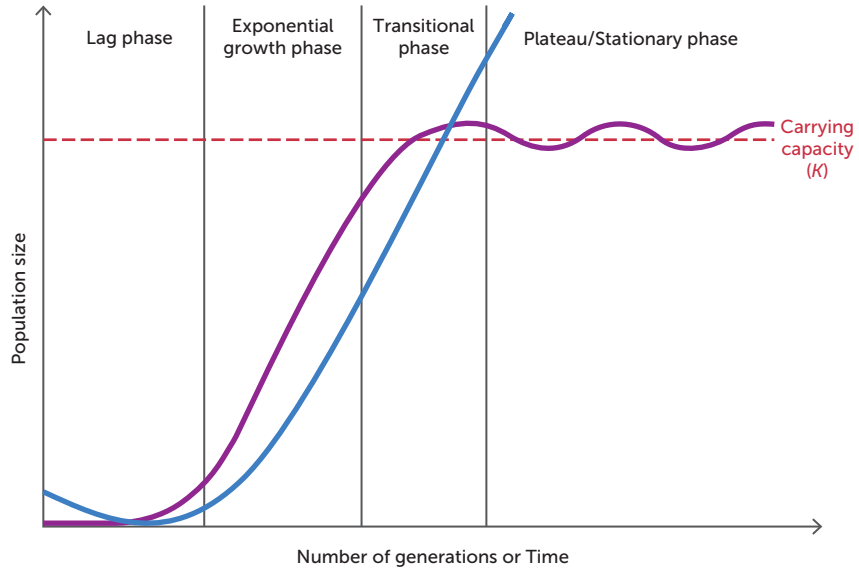
Question set 5.3

Remembering

1 Carrying capacity is the maximum size of a population that an ecosystem can support with its limited resources.

2 Competition, predation, disease caused by parasites

3



4 Exponential growth phase: population growth increasing at an increasing rate; transitional phase: population growth increasing but rate slowing down; stationary phase: population growth is zero.

Understanding

5 Lag phase: slow growth due to few reproductive individuals who are not yet widely distributed.

Exponential growth phase: rapid increase in population size as birth rate greatly exceeds death rate. Mortality is low because there are abundant resources and minimal environmental resistance.

Transitional phase: population rate decelerates. Resources eventually become limited, which leads to competition for survival. Birth rates start to fall and death rates begin to rise.

Plateau/stationary phase: overall birth rate equals death rate. The population has reached the carrying capacity (K) of the environment, with limiting factors keeping the population stable. The population size at this point will not be constant, but will fluctuate around the carrying capacity.

6 Density-dependent factors primarily regulate population growth because the size of their effect on population size or growth varies with the density of the population. They all influence the rates of births and deaths and their effect increases as the population size increases in the given area. Density-dependent factors have more impact than density-independent factors because they are mostly biotic and involve relationships such as predation and competition, which constantly affect survival; whereas density-independent factors are usually abiotic, less often have an impact and are not directly related to the survival needs of individual organisms.

Chapter review questions

Remembering

1 One contemporary technology is ‘scat drones’ and high-powered cloud computing. Scat drones are drones that spot droppings of a target species and analyse the DNA in them.

2 *K*-selection: while some individuals may not survive initially, over the long term a sustainable population can be maintained.

r-selection: opportunistic species quickly colonise an unstable ecosystem, leading to a pattern of rapid population increase and decrease (or crash), and eventual take over by competitors.

3 Density-dependent factors include competition, disease, parasites, predation and food supply. Density-independent factors include physical factors and chemical factors (e.g. bushfires, drought).

4 Resources would be distributed in a pattern that mirrors the population distribution pattern.

Understanding

5 The mark may disappear; the marked individuals may have moved away from the sample area or died.

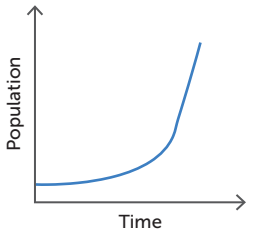
Applying

6 **a** Soil nutrients, water and amount of light

b Breeding sites and other penguins

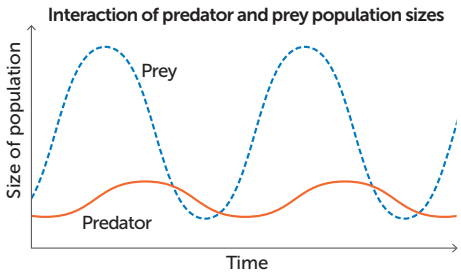
c Water, sunlight, climatic conditions

7 **a**



Exponential growth curve

b



8 A population is increasing in size when the birth rate and immigration rate are higher than the death rate and emigration rate.

9 Healthy population growth is likely from a population whose individuals are predominantly at the reproductive age. If population numbers show a gender bias or more individuals above and below the reproductive age, future growth is likely to be limited.

10 **a** Sample population density $= \dfrac{\text{total numbers of individuals in sample area}}{\text{area of quadrat} \times \text{number of quadrats sampled}}$

$$= \frac{186}{100\ \text{cm}^2 \times 10}$$

$$= 186 \text{ per } 1000\ \text{cm}^2$$

Population size (abundance) = population density × total area of study

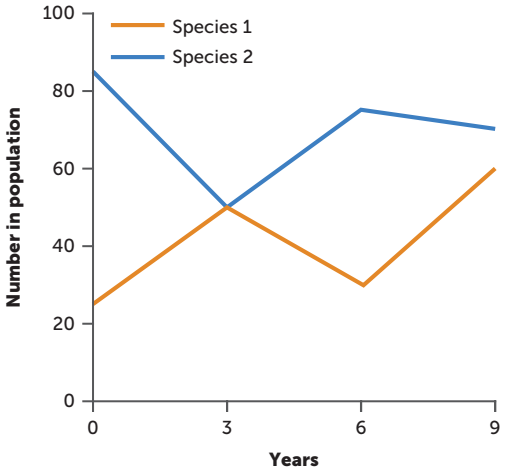
$$= (186 \text{ per } 1000 \text{ cm}^2) \times (10\,000 \text{ cm}^2)$$

$$= \frac{186 \times 1000}{1000}$$

$$= 1860$$

b Depending on terrain, a pitfall trap or Tullgren funnel could be used to obtain the count of beetles.

11 a



b Species 1 fluctuates over the 9 years. It increases then decreases and then increases again. Species 2 also fluctuates over the 9 years. It decreases then increases and then decreases slightly.

c Species 1 is likely to be the predator. The numbers of prey are normally higher than the predator numbers.

Evaluating

12 $\frac{\text{Number of individuals in first capture}}{\text{Population estimate}} = \frac{\text{Number of maked individuals in recapture}}{\text{Number of individuals in recapture}}$

$$\frac{50}{\text{Population estimate}} = \frac{10}{200}$$

$$\text{Population estimate} = \frac{50 \times 200}{10}$$

Population estimate = 1000

Creating

13 a Sampling determines the distribution and abundance of the wallabies. This can help us understand how the vulnerable wallaby species is able to survive any sort of disruption to its habitat.

b Sampling determines if the number of ducks in the population is at a sustainable level.

14 a Widespread, heavy rain and plentiful food such as grain crops

b Locusts are *r*-selected species. Their numbers rise very quickly and decline just as rapidly.

c This will depend on students' responses.

d Spray pesticides on adult locusts; spray hoppers before they start to swarm; dig up and destroy egg nests.

15 Any three of the following:

- individuals might not be randomly distributed throughout the whole study area and therefore some may be more easily captured than others
- marked animals may become wary of traps (i.e. would affect probability of recapture)
- the animal needs to be captured to be marked and this may alter its behaviour pattern (or injure it)
- part of the geographical region may be less accessible for sampling
- mark might wear off
- lizards might be weakened due to lack of food when captured and therefore it becomes easier to capture them again.
- applies only to closed systems
- traps not very specific – other animals might be trapped
- realistically, immigration and emigration do occur.

Practice exam questions

1 B

2 B

3 **a** The maximum population size an environment can sustain based on available resources. (1 mark)

b False (1 mark); a population that exceeds carrying capacity cannot be supported by the environment and will 'crash' because of lack of resources. (1 mark)

4 **a** $N = \frac{M \times n}{m}$

$= \frac{8 \times 10}{4}$

$= 20$

1 mark for each correct value for N, M, n and m.

b Any four of the following: (4 marks)

- no parrots enter or leave the population (population is closed)
- parrots do not lose bands
- parrots with bands are as likely to be caught as parrots without bands
- no parrots die
- all parrots are equally catchable (e.g. males are not more or less likely to be caught than females).

(Any other point at marker's discretion, e.g. no death of marked parrots)

5 **a** Density-dependent factors: any three of the following: (3 marks)

- availability of resources: for example, water, food, shelter; abundant resources will lead to an increase in population growth
- competition: as competition increases, population growth will decrease
- predation: as predation increases, population growth will decrease
- disease: an infectious disease will limit population growth.

Density-independent factors: any two of the following: (2 marks)

- natural disasters: for example, an intense bushfire will cause a decrease to population growth and size regardless of density
- change to abiotic factor: factors such as low water availability, or change in pH, temperature, salinity etc. affect population size regardless of density by reducing the environment's carrying capacity

- individuals have the same chance of being affected by the factor regardless of being in a high- or low-density population.

b $r = (b + i) - (d + e)$

r = population growth rate

b = birth rate

i = immigration rate

d = death rate

e = emigration rate

(2 marks for stating what letters stand for; the term 'rate' is essential.)

Population of kangaroos grew from 28 214 521 to 34 303 677 in 10 years, an increase of 6 089 156.

6 089 156 / 10 years = 608 915 kangaroos per year

(3 marks for correct calculation.)

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Chapter 6 Changes in ecosystems

Question set 6.1

Remembering

1 **a** Endemic refers to a species that occurs naturally found only in a particular region.

b As the land mass of Australia broke off from Gondwana, it was isolated from other land masses. The isolation meant that Australia evolved different species to other land masses that were still connected.

2 Changes in the climate have drastically altered the water cycle over time. These abiotic factors include lower levels of atmospheric water leading to less rainfall and creating more arid ecosystems. A drop in temperature over thousand years caused the glaciation (water freezing) over large regions of the Earth.

3 Australia became a desert a little over 15 000 years ago. Prior to this, inland Australia was covered with seas and tropical ecosystems.

Understanding

4 Low sea levels meant there were land links between Australian and other islands to the north, which made it possible for species to migrate between these locations.

Question set 6.2

Remembering

1 A climax community is the stable community present at the final stage in a succession. It is stable as long as environmental factors remain unchanged.

2 Primary succession occurs when organisms colonise bare sites that previously had no organisms inhabiting them, whereas secondary succession deals with the changes in communities that are already established. In this instance, organisms recolonise recently disturbed communities.

3 The following factors may prevent a climax community from forming:

- human events, such as forestry, cattle grazing, fires and land clearance
- natural events, such as lightning strikes, lava flows and irregular flooding.

Understanding

4 Bare rock → lichens colonise rock, secreting acids which attack the rock's surface; dust accumulates in cracks in the rock → mosses grow → organic matter produced, resulting in simple soils → grasses and small herbaceous plants start to grow → small shrubs grow → larger trees grow → climax community is established

5 The characteristic features of *r*-selected species make them successful in the early stages of succession. They generally have effective seed dispersal, rapid growth and rapid reproduction. *K*-selected species live in more stable environments and outcompete other species around them. They live longer and grow slower than *r*-selected species, making them better suited to the later stages of succession and leading to a climax community.

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Question set 6.3

Remembering

1 Three positive effects of fire on a community are: smoke acts as a germinating agent; heat acts as a germinating agent; older trees with large canopy are cleared so sunlight can enter a forest, allowing plants under the canopy to receive more light.

2 Three negative, short-term effects of fire on a community are: animals burn and suffer; animals die; endangered species may become extinct.

3 Figure 6.7 on page 184 in the student text shows a thriving biological community in the tsunami-affected area years after complete devastation by the tsunami. Another piece of evidence is seen in the regrowth of corals in areas that were damaged and destroyed by the tsunami.

Understanding

4 If burning is done too often (less than the life cycle of a plant), then plants will not have enough time to produce seeds and reproduce. This can cause some species of plants to become locally extinct.

5 The type of fire will affect succession in different ways. It can open up spaces and create a nutrient-rich seedbed, resulting in secondary succession. Fire can also stimulate regrowth in some plant species. This proliferation of new growth may attract many animal species that can move into the area.

Chapter review questions

Remembering

1

Positive effects	Negative effects
Seed germination	Loss of vegetation
Enables other species to grow	Reduction of leaf litter
Sunlight can reach below the canopy	Decrease in animal numbers
Return of some nutrients to soil	Increase in suffering of animals

Understanding

2 Comparing present biota with those in the fossil record helps us to understand changes in living components of ecosystems over time. The layers and positions of sedimentary rocks in which fossils are embedded indicate the relative ages and relationships between organisms in past ecosystems.

3 The endemic nature of Australia's biota is due to a combination of three major events:

- The extinction of the dinosaurs 65 million years ago, which opened up many new niches for rapid speciation
- The separation from Antarctica 40 million years ago, causing Australia to become an isolated, island continent
- The gradual cooling and drying of the Australian continent, which placed the existing biota under intense evolutionary pressure.

Applying

4 If dingoes had entered and spread throughout Australia before the last ice age, they would have been able to cross the land bridge that formed between Tasmania and Victoria some 10 000 years ago. They do not appear to have ever inhabited Tasmania, which implies that their dispersal throughout mainland Australia must have occurred after the last ice age (within the last 10 000 years), after the land bridge disappeared.

5 A fire regime that involves prescribed burning every 10 years would enable the correct structure and composition for the dunnart to find a sheltered habitat with more protection from feral animals. The prescribed burning will also help germination and therefore the reproduction of vegetation that dunnarts use in their niche. The desired time between burns is long enough for most plants to produce seed and fruit.

Analysing

6 It is likely that species B and C are *r*-selected and the green and purple species are *K*-selected. Reasons include the fact that *r*-selected species are typically fast growing and are first to occupy a disturbed area. They increase rapidly but also decline rapidly when competitive species move in. *K*-selected species are slow growing and live in more stable environments.

7 Traditional owners will have different ways of managing the land compared to some conservation biologists. The combined expertise will increase the effectiveness of management strategies.

8 **a** Between 1907 and 1915, the tablelands supported seven species of herbivorous mammal – the highest diversity recorded.

b Two of the three introduced mammals have successfully exploited the environmental conditions to increase, or at least maintain, population numbers. All of the native mammals have had significant declines in their populations.

c Between 1880 and 1900, land management practices and/or environmental conditions enabled most species of herbivorous mammals to increase in number. The early exception to this was eastern grey kangaroos. Their population dropped sharply as introduced sheep populations expanded. This may be due to increased competition for food resources or as a result of culling operations. The late exception is the rat kangaroo, which decreased at around the same time rabbit populations increased. Again, this may be due to competition for food resources or the introduction of new predators. From 1900 onwards, all native herbivorous mammal populations declined, including the introduced bridled nail-tail wallaby in 1905. In contrast, rabbit populations continued to increase, thereby reducing food available to other herbivorous mammals.

9 The current distribution of the Proteaceae family indicates that it is largely restricted to former Gondwana landmasses, and hence must have evolved prior to Gondwana's break-up more than 100 million years ago.

Evaluating

10

Factor	Primary	Secondary
Beginning feature	Lifeless and barren	Disturbance (natural or artificial)
Soil	No soil present	Soil present
First signs of life	Pioneer plants such as lichen	Seeds and/or roots or spores
Biomass (relative)	Low and slow to build due to low primary productivity (fewer plants)	High and increases quickly due to a higher primary productivity

11 Responses will vary.

Creating

12 Responses will vary.

13 Responses will vary.

Reflecting

14 Responses will vary.

Practice exam questions

1 D

2 C

3 B

4 The stable community present at the final stage in a succession; it is stable as long as environmental factors remain unchanged (e.g. rainforests).

5 Any 10 of the following, in appropriate order, for 1 mark each:

- starts with primary succession
- the cleared area is lifeless and barren
- pioneer plants/wild species invade the cleared land
- examples include lichen, grasses, ferns
- pioneer plants die, decompose and break down into particles that help form soil
- formation of soil makes it suitable/possible for a new wave of plant species
- seeds germinate and roots grow
- small plant species such as shrubs grow
- larger, slower-growing trees may grow
- as plant biodiversity increases, animal species migrate into area
- there is greater availability of new niches, shelter etc.
- establishment of tree species and larger animals
- climax community forms which is stable and resilient/final stage of succession.

Chapter 7 Ecosystem changes and conservation strategies for biodiversity

Question set 7.1

Remembering

1 A healthy ecosystem can sustain stress in the form of extreme conditions such as floods, droughts, invasive species, disease and overexploitation; it shows resilience.

2 Wetlands are neither aquatic nor terrestrial but exist in the meeting of these two, changing seasonally to become more or less of each type of ecosystem.

Understanding

3 Human population increased → Land cleared for housing (urbanisation) → Land cleared for agriculture → Areas of land assigned to landfill → Loss of 90% of wetlands

Question set 7.2

Remembering

1 Urbanisation is the extreme modification of an ecosystem by humans to support a human population of gradually increasing density. Urban ecosystems have reduced biodiversity and are dominated by people. There is little recycling of matter between the community (the living things present) and the non-living surroundings. Additional inputs of energy and matter are needed from other ecosystems to maintain modern standards of living. There is an increase in output of gaseous and material wastes of many kinds, and these are disposed of into our atmosphere, onto the land and into the water of other ecosystems, which in turn are also altered. Urbanisation can cause rapid changes of large magnitude to an ecosystem. Local biodiversity is reduced and, even though new species may potentially move into an urban area, the ecosystem is changed for a very long time, often permanently.

2 Habitat fragmentation happens when some of the habitat of an ecosystem is separated into isolated sections. This can be a result of habitat destruction for land clearing for agriculture, roads or urbanisation.

3 Along with many other species, the Carnaby's black cockatoo has been affected by the millions of hectares of habitat around Australia destroyed in the last 20 years. Agriculture is the main reason for the land clearing, followed by native-forest logging, urban development, and mining. The Carnaby's black cockatoo has lost thousands of hectares of habitat which has led to a great decline in the number of birds.

4 The Gondwana Link project was set up to reverse the habitat destruction and fragmentation from European colonisation. Actions to reduce the effects of habitat fragmentation include revegetation of areas previously cleared to connect various ecosystems, the eradication of introduced and feral species, and the protection of these areas to allow endemic species to repopulate of these areas.

Understanding

5 Due to human population growth, land cleared for agriculture → Deep-rooted native perennial trees replaced with shallow-rooted annual crops → Crop plant roots do not reach water table, water level starts to rise because transpiration has ceased → As water table rises, salt from surrounding soil dissolves into the water and rises with it → The salty water rises to the surface of the land → The water evaporates → Plants can't grow because of the salt concentration in the soil

6

Strategy type	Example
Genetic	As part of a risk management strategy for WA's threatened flora, certain species are stored in seed banks at the WA Seed Centre and the Threatened Flora Seed Centre. The aim of the Threatened Flora Seed Centre if to have enough genetic resources from each threatened species to be able to re-establish it in the wild if it becomes extinct. The centre stores more than 5000 collections, with priority given to seeds of species with low plant numbers, few populations and small geographic ranges, and that are genetically or taxonomically distinct and endemic (local WA plants).
Environmental	Regeneration of land and bush corridors between isolated habitats can be an effective way of returning habitat to populations and enabling subpopulations to interbreed. The Gondwana Link is an environmental strategy that has been working to reconnect bushland across the south-west of Australia since 2002.
Management	Gondwana Link has also worked on a set of restoration standards, which have been picked up for use in national standards. They provide guidance on how to design and implement revegetation for ecological restoration in such a way that the best possible ecological outcomes are achieved. The standards are particularly applicable to any project aimed at restoration of native systems.

Question set 7.3

Understanding

1 **a** When environmental conditions change and favour a rapid increase in numbers of a species at the expense of others, that species can become a pest.

b Advantage: rapid control

Disadvantages: accumulation of chemicals, perhaps non-biodegradable; species other than the target species may be affected.

2 Introduced species are species that humans have intentionally or unintentionally moved from their native location to a new ecological region, where they are without the natural predators, parasites and pathogens that would have limited their growth. Introduced species become invasive species if they manage to establish populations in new areas.

Analysing

3

Method of biological control (agents)	Examples
Virus	Myxomatosis, rabbit haemorrhagic disease virus and calicivirus have all been used to control rabbits, an agricultural pest
Specialised predators	Weevils to control water weeds Moths and flea beetles to control alligator weed Beetle to control water hyacinth etc.
Parasites	Wasps and stem-girdler moths Nematodes and *Sirex* infestations of softwood plantations
Microbial diseases	Myco-insecticides (fungal) and grubs

Evaluating

4 Cane toads outcompete native species for both food and habitat. They are toxic at all stages of their lifecycle, from eggs to tadpoles to adults. Their toxin is strong enough to kill most native animals that prey on them, such as birds, frogs, reptiles and mammals.

They are without the natural predators, parasites and pathogens that would have limited their growth.

Question set 7.4

Understanding

1 **a** If organisms such as fish are overharvested, this means they are harvested at rates that exceed the replenishment rate of the population.

2 A fishing licence is a paid certificate or statement from the state government giving you permission to fish for a specific fish species. Permission is usually seasonal to allow a period in which the fish can reproduce. Licences are one method for ensuring fishing is sustainable.

Evaluating

3 Bottom trawling involves dragging a large net across the seafloor, and is the most destructive form of fishing for our oceans. Deep-sea fish species are targeted globally by bottom trawling. Bottom trawling removes vast amounts of non-target species, including habitat-forming deep-sea corals and sponges. Therefore, bottom trawling poses a serious risk to deep-sea ecosystems.

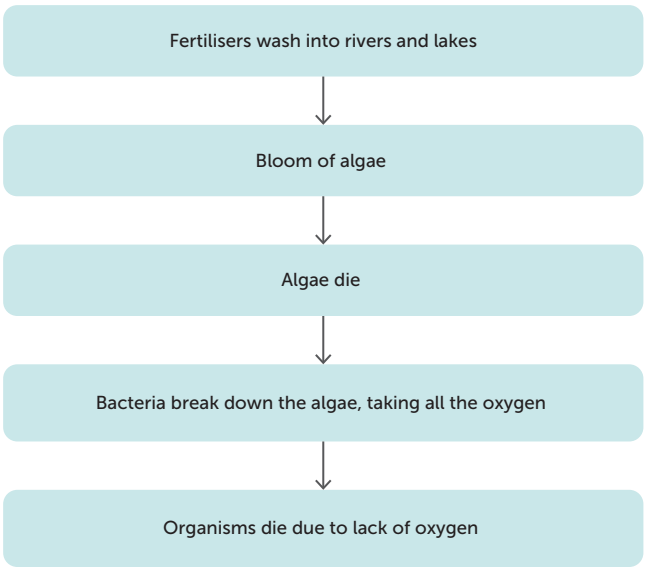
Question set 7.5

Remembering

1 Eutrophication is a process that occurs when excess nutrients, particularly nitrogen and phosphorus, enter a body of water and become highly concentrated, leading to excess growth of organisms such as algae.

Understanding

2



Evaluating

3 Students' own responses.

Question set 7.6

Remembering

1 Fossil fuels are natural energy sources, such as coal, oil and natural gas, containing hydrocarbons. Fossil fuels are formed from fossilised living things, usually in sedimentary rock, over millions of years and produce carbon dioxide when burned.

Understanding

2 Both climate and weather describe the same atmospheric factors, such as temperature, precipitation, wind and sunlight intensity. Climate is the average long-term, predictable atmospheric weather conditions at a site over a period ranging from months to many thousands of years. In contrast, weather is the atmospheric conditions in an area over a short time, usually 2–3 days. Weather forecasts or predictions can be very unreliable.

3 The climate includes abiotic factors such as temperature. Organisms are sensitive to climate factors and any change may cause organisms in the ecosystem's community to migrate to a higher altitude or another habitat, where the temperature suits them and there is plentiful shelter or food. Animals and plants will only grow and survive in places where they can fulfil their niche.

4 Global warming refers only to Earth's rising average surface temperature, while climate change includes warming and the 'side effects' of warming, such as extreme weather events, heavier rainstorms and more frequent drought.

Analysing

5 The current increases in atmospheric carbon dioxide have happened very quickly – in a matter of hundreds, rather than thousands, of years. The magnitude of the increase in the rate of atmospheric carbon dioxide is different from past rises. It took around 50 000 years for the

atmospheric carbon dioxide level to increase from its low minimum concentration to its higher maximum concentration. However, beginning only a few centuries ago, atmospheric carbon dioxide concentrations have increased beyond the historical maximum of 400 ppm.

6 Students' own diagrams – see Figure 7.28 on page 221 of the student book.

7 The greenhouse effect is the natural effect of atmospheric greenhouse gases absorbing and retaining some heat in our atmosphere. It is needed for life on Earth. The enhanced greenhouse gas is the retention of extra heat as the levels of greenhouse gases in the atmosphere rise as a result of human activity. The enhanced greenhouse effect is causing global warming and is a threat to life and biodiversity.

Chapter review questions

Remembering

1 Deforestation is the permanent removal of standing forests.

2 Cane toads have spread across the savanna in northern Australia and are a threat to our biodiversity. They compete with native species for both food and habitat. They are toxic at all stages of their lifecycle, from eggs to tadpoles to adults. Their toxin is strong enough to kill most native animals that prey on them or their eggs, such as birds, frogs, reptiles and mammals. Their toxicity means they pose a threat to pets such as dogs and cats. Their appetite means they eat large quantities of insects. They also eat native frogs, small mammals and even snakes.

3 To be a biodiversity hotspot, regions must be both rich in biodiversity that is found nowhere else in the world (having at least 1500 endemic vascular plant species) and be at a high risk of destruction and extinction (having 30% or less of its original natural vegetation).

4 Turn lights and standby lights off, open windows instead of turning on air-conditioner, use 'keep cups' instead of throw-away coffee cups (fossil fuels are used to manufacture these).

5 Species that cannot survive the changes in climate may become extinct. Currently, extinction of a species is irreversible.

6 By establishing World Heritage sites, UNESCO aims to identify, protect and preserve locations of cultural and natural heritage around the world that are considered to be of outstanding value to humanity.

7 Greenhouse gases absorb some of the long-wave radiation (heat) and trap it in Earth's atmosphere instead of allowing it all to radiate out of Earth's atmosphere and into space.

8 Carbon dioxide cycles around in matter and exists in the atmosphere as a gas. In this form it acts as a greenhouse gas. Forests are carbon sinks, because they absorb carbon dioxide gas for photosynthesis. The removal of forests (deforestation) increases the percentage of carbon dioxide in the atmosphere.

Applying

9 $0.3 \times 9.5 \times 9.5 = 27.075$ ppm

10 An algal bloom is a rapid increase in the population of algae or other micro-organisms (such as cyanobacteria), at the surface of a water body, that blocks sunlight from entering. When this happens, autotrophs that live under the surface die. Algae then die and are decomposed by bacteria. As bacteria consume the dead algae, they use large amounts of oxygen from the water, which depletes oxygen levels. The water body can become hypoxic (low in oxygen)

and possibly anoxic (completely devoid of oxygen). The low oxygen levels do not meet the respiration needs of aquatic organisms, so fish and other populations die, and eventually there is degradation of the ecosystem.

11 Farmers, manufacturers. mining companies and transportation providers (trains/buses) must make profits and their businesses currently rely on the burning of fossil fuels. To switch to an alternative energy source, they need to take some financial risks and even lose money in the short term (short-term pain). This would reduce greenhouse gases. If an alternative energy source can provide enough energy to sustain their production or service and their profit, then in the long term, the planet's ecosystems will remain healthy, biodiversity can be maintained and when fossil fuels run out, the business will continue to make money. In fact, they might increase their revenue if other companies became non-viable due to a shortage in fossil fuels.

12 Zones have been set up around migrating whales to ensure that whales are not disturbed and separated from their pod. Interaction conditions are enforced for each of these zones. In the approach zone, within 300 m from the whales, the boat must approach with caution. Only one boat is allowed in the exclusive contact zone, between 50 and 100 m of the whales and it is limited to remaining in this zone for 1 hour. Boat speed is also reduced to 8 knots. Boats are not allowed to enter the no approach zone around the whales to minimise disturbance to the whales.

Creating

13 Students' answers will vary.

14 **a** Rapid response is an advantage of spraying chemicals. The potential for the accumulation of toxic chemicals/pesticides is a disadvantage.

b Winemakers are using the *Trichogramma* wasp as a specialised predator to control the population of apple moths. This is a form of biological control.

c This will depend on students' responses.

Reflecting

15 Responses will vary.

16 Responses will vary.

17 Responses will vary.

Practice exam questions

1 A

2 D

3 **a** A species that humans have intentionally or unintentionally moved from the introduced species' native location to a new ecological region (1 mark), and that has established a population in the new area (1 mark).

b Biological control is when another organism is used to control the population of a pest species (1 mark). Risks include (two out of the following or any reasonable risk):

- the biological control becomes a pest
- the biological control becomes uncontrollable
- it doesn't target the one species
- it carries disease.

4 This is eutrophication. (1 mark)

It is caused by: (1 mark each)

- rainfall/irrigation leads to run-off from the land
- which contains excess nutrients or fertiliser, especially nitrogen and phosphorous
- which leads to increased productivity/algal growth.

5 Dryland salinity is the increase of salt in the soil.

Causes: (5 marks)

- the removal of deep-rooted trees
- replacement by shallow-rooted annual crops
- roots can't reach the water table
- reducing transpiration
- reduced transpiration causes the water table to rise
- salts from surrounding soil are dissolved and carried up as water it rises.

Effects: (4 marks)

- the water table reaches the soil surface
- water evaporates from surface
- salt concentrates at the surface
- salt makes soil infertile
- soil becomes unsuitable for farm crops.

6 Students' answers will vary.

Chapter 8 Cell requirements, microscopy, structures and functions

Question set 8.1

Remembering

1 Gases (oxygen and carbon dioxide) for use in photosynthesis and respiration; excretion of wastes to prevent toxic levels; ions for muscle and nerve cell function; water for biochemical reactions, removal of wastes and nutrient absorption; nutrients for growth and development.

Understanding

2 All parts of living things are not only made of cells but also the non-cellular products of the cells that living things produce to help them live.

3 Students' answers will vary, but could show an *Escherichia coli* bacterial cell as 1–5 µm, a human red blood cell as 7–8 µm, a typical animal cell as 10–20 µm and a typical plant cell as 10–100 µm. They may need to use a logarithmic scale.

Evaluating

4 **a** Light microscope

Advantages: living samples can be used; no treatment of samples necessary; natural colour can be seen; easy to use in many different locations, including a school room.

Disadvantages: fine structures within the cell will not be visible.

b SEM

Advantages: focuses on the sample's surface and its composition; provides three-dimensional image; accurate representation of sample; very high magnification; analysis is quick.

Disadvantages: samples are viewed in a vacuum; samples in use are required to have their surface stained with metals in order to produce images; only shows sample bit by bit; SEMs are expensive, large and must be housed in an area free of any possible electric or magnetic material or vibrations that cause interference

Calculating

5 **a** 50×

b 100×

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Question set 8.2

Remembering

1 **a** The cytoplasm is found within the plasma membrane. It is the place where chemical reactions that enable the cell to live are carried out.

b The cytosol is the fluid part of the cytoplasm. It's often described as the 'soup' of the cell because it contains many dissolved substances. Collectively, the cytoplasm is made up of cytosol together with cell organelles.

2 Plasmids are small rings of DNA found in prokaryotic cells.

Understanding

3 For example, the nuclear membrane structure includes a double membrane that has pores embedded in it. This enables it to perform its function which is to allow communication between the nucleus and the cytoplasm and for mRNA to travel out. At the same time it is holding and storing chromatin.

4 Chromosomes in prokaryotes are circular. Eukaryote chromosomes are rod-shaped when visible during cell division.

Applying

5 **a** If you look at the internal structure of the cell and see membrane-bound organelles, the cell is eukaryotic, but if the DNA is not in a membrane-bound nucleus it would be prokaryotic. Also, prokaryotic cells are far smaller than eukaryotic cells (about 1–10 µm compared to 10–100 µm).

b If the cell is from a plant, you would find:

- chloroplasts
- large, permanent vacuoles
- a cell wall.

Analysing

6 Ribosomes build up (synthesise) proteins from their building blocks, amino acids. As the skin cells don't produce as many proteins, they would need fewer ribosomes.

Evaluating

7 This cell could be prokaryotic as no membrane-bound organelles were seen. The size, however, is not typical for prokaryotic cells, which typically range from 1 to 10 µm in length. A more extensive examination of the cell is needed, particularly a search for chromosomes. If there is no clear nucleus but a darker region representing the single bacterial chromosome is observed, the cell is likely to be an abnormally large prokaryote.

8 By maximising their surface area, through the folding and stacking of internal membranes, a greater amount of chemical reactions can occur at the same time. Organelles also facilitate the synthesis of complex molecules and the entry and exit of substances. Membrane-bound organelles enable a cell to carry out hundreds of different chemical reactions simultaneously, without one reaction interfering with another. This is important when reactions are incompatible. Organelles also separate chemical reactions in time, such as when substances are stored and then later used in other reactions.

Question set 8.3

Remembering

1 Respiration, growth and repair of damaged tissue, reproduction, digestion, excretion of wastes and synthesis of new proteins

2 **a** Carbon dioxide, water, sunlight, chlorophyll

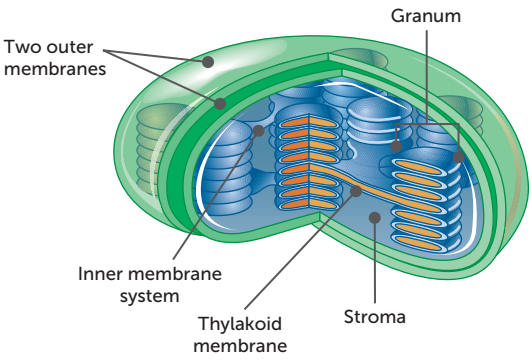
b Glucose, oxygen

Understanding

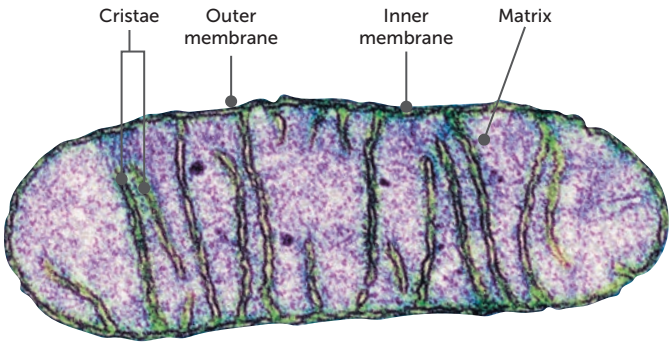
3 Autotrophs use energy from the Sun or the energy released from chemical reactions. Heterotrophs rely on autotrophs to provide their energy for them, usually when consumed.

4 Mitochondria are the organelles that allow cells to access energy. Cellular respiration takes place in these organelles (and the cytoplasm) and the energy released from this process is used to build ATP molecules. ATP stores the energy needed by a cell to carry out activities.

5 **a**



b



6 **a** Chemosynthesis is the process whereby the energy released from chemical reactions is used by cells and photosynthesis is the process whereby energy from the Sun is used by cells.

b Cellular respiration is a series of chemical reactions using glucose and oxygen and producing carbon dioxide and water, releasing energy. Photosynthesis is a series of chemical reactions using energy from the Sun to convert carbon dioxide and water into glucose and oxygen.

c Heterotrophic describes organisms that cannot synthesise their own organic compounds. They rely on other organisms for their nutrients and energy requirements. Autotrophic describes organisms that are able to produce their own food.

Applying

7 Human muscle cells use more energy when they perform their tasks of contraction and relaxation compared to the cells in your big toe. Therefore more mitochondria are needed to supply energy to build up more ATP molecules for muscle cells.

Question set 8.4

Remembering

1 The four main types of macromolecules are nucleic acids, proteins, complex carbohydrates and lipids.

2 An organic compound is a complex, carbon-containing compound.

3 Nucleic acids, proteins and complex carbohydrates are all polymers.

4 Carbohydrates can be classified by the number of monomeric units that make up the carbohydrate: monosaccharides (one monomer), disaccharides (two monomers) and polysaccharides (more than two monomers). Increasing numbers of monomers and the complexity of the linkages determine their structural and storage functions.

5 DNA is found in the nucleus of a eukaryotic cell. Some is also found in mitochondria and chloroplasts. RNA is found in both the nucleus and cytoplasm. In prokaryotic cells, DNA and RNA are found in the cytoplasm as there is no clearly defined nucleus.

Understanding

6 Because they contain three (tri-) fatty acids and one glycerol.

7 **a** Monosaccharides are composed of one sugar unit. Disaccharides are composed of two sugar units. Polysaccharides are composed of many sugar units.

b Both DNA and RNA molecules are polymers and use a triplet code. DNA is double stranded, and RNA is usually single stranded. Ribose sugar is present in both but is in a deoxygenated form in DNA. The nitrogen base thymine in DNA is replaced by uracil in RNA.

c Monomers are small molecules that can form subunits of larger molecules. When monomers are put together to form a long chain, a polymer is formed.

Applying

8 Protein diversity is made possible by arranging the 20 different amino acid monomers in various combinations or sequences that differ in length. There are many different proteins because proteins have a huge range of biological functions, including providing structure, transporting substances and acting as enzymes.

Analysing

9 Plants don't move around, and animals do; movement uses a lot of energy. Since fats have more energy per unit weight than carbohydrates, more energy can be stored in fat without increasing weight, making it better for a life requiring movement.

nelson net.

Question set 8.5

Remembering

1 Intracellular transport system: Aids the movement of substances around the cell within the channels.

Intercellular transport system: Aids the movement of substances from one cell to another.

2 Similarity: In both endocytosis and exocytosis, vesicles enclose materials to be transported.

Difference: Endocytosis is a process that moves substances into a cell and exocytosis is a process that moves substances out of a cell.

Understanding

3 The Golgi apparatus is an assembly point through which raw materials for secretion, such as enzymes, are stored before being removed from the cell. It serves as a collecting and packaging centre of the cell.

Applying

4 Smooth endoplasmic reticulum has no ribosomes attached to it, but rough endoplasmic reticulum is studded with ribosomes. If a cell has more rough ER its function is likely to be secretory. Proteins produced by the ribosomes can move directly into the ER and move about the cell. However, if some proteins are not required by the cell in which they are made then they can be exported or secreted into other cells.

5 Like a recycling station, the lysosomes are where complex chemical compounds are split into simpler ones. The lysosomes produce digestive enzymes that break down the compounds. First, a membrane forms around the unwanted structure and lysosomes discharge their contents into this 'bag'. Soluble products are absorbed into the surrounding cytoplasm, to be used as building blocks for new compounds and organelles.

Analysing

6 **a** Exocytic vesicles

b They transport large molecules and particles across the plasma membrane and out of the cell.

c Exocytosis

d Lysosomes remain within a cell. They do not transport substances.

Chapter review questions

Remembering

1 **a** iv, **b** iii, **c** vi, **d** v, **e** i, **f** ii

Understanding

2 **a** The term structure is used to refer to the form and features that make up a cell. The function is what the cell does.

b Chlorophyll is the green pigment found within the chloroplast organelle.

c Carbon-containing compounds are described as organic. Simpler carbon compounds and those that don't contain carbon are classed as inorganic.

d Rough endoplasmic reticulum has ribosomes attached, whereas smooth endoplasmic has no attached ribosomes.

3 Mitochondria and chloroplasts both contain two membranes, ribosomes and nucleic acid. Mitochondria are the site for respiration and are found in all eukaryotic cells. Chloroplasts are the site for photosynthesis and are found in photosynthetic eukaryotic cells.

Applying

4 **a** All cells have hereditary material and arise from pre-existing cells. They sense and respond to their surroundings. Cells use proteins to control chemical reactions. They enclose their contents within a plasma membrane and contain cytoplasm and ribosomes.

b **i** Prokaryotic cells have a circular chromosome and small circular plasmids within the cytoplasm.

ii Eukaryotic cells have a nucleus and other membrane-bound organelles.

5 These cells would require a lot of instant energy, for example sperm cells. Mitochondria are the cell's energy-producing organelles so the presence of large numbers of them implies a need for lots of energy.

6 Autotrophic organisms need light as their source of energy, whereas heterotrophic organisms feed off others and use their energy. They are therefore able to live without light.

7 **a** Factory: goods manufactured = proteins and other cellular products; business plans = DNA; photocopying room = nucleus; manufacturing area = cytoplasm; warehouse = endoplasmic reticulum; management offices = Golgi apparatus; assembly workers = enzymes, ribosomes; warehouse packers = Golgi apparatus; doors; hallways = smooth endoplasmic reticulum; power source = mitochondria

b Cells divide and reproduce, factories do not.

c This will depend on students' responses.

Analysing

8 **a** Eukaryote cell, because it has membrane-bound organelles.

b Electron microscope because of the level of detail.

c A cell is three-dimensional; other organelles may be present in a different area of the cell.

d (i) Chloroplast; (ii) nucleus

9 It is the job of the lysosomes to break down cells, such as bacteria. They contain digestive enzymes that split complex chemical compounds into simpler ones.

10 This will depend on students' responses. They should relate the functions of organelles to specialised cell types.

Evaluating

11 This feature is usually not observed in bacteria. It is more commonly associated with eukaryotes.

12 All cells need mitochondria. The ATP built up in mitochondria as a result of cellular respiration is the source of energy for all cellular processes. Plant cells synthesise glucose as a product of photosynthesis but the glucose cannot be used as a direct source of energy in cells. It must be broken down to release the energy to form ATP.

13 a Ribosomes, endoplasmic reticulum, Golgi apparatus, plasma membrane

b Complex proteins, enzymes, hormones, glycoproteins

Creating

14 All biomacromolecules contain carbon. There would be no life without these molecules.

Reflecting

15 Responses will vary.

Practice exam questions

1 A

2 D

3 A

4 C

5 C

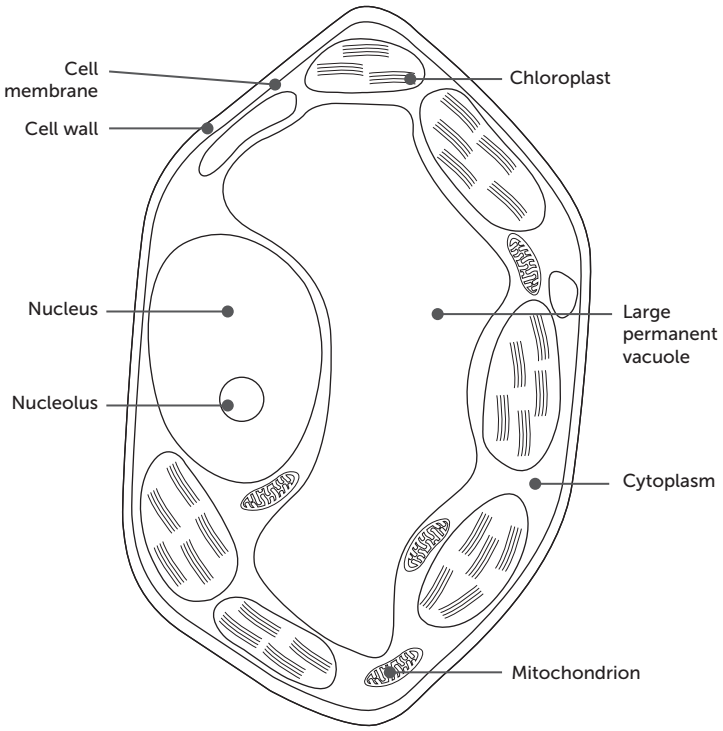
6 C

7 D

8 Autotrophs produce their own chemical energy from the Sun's light energy. (1 mark)

Heterotrophs obtain their energy and carbon sources by consuming the chemical energy stored in other organisms. (1 mark)

9 a 1 mark for any six labels



b Any two of the following: (2 marks)

chloroplast, cell wall, large vacuole

c Any two of the following: (2 marks)

- Eukaryotic cells have membrane-bound organelles but prokaryotic cells do not.
- Eukaryotic cells have a membrane-bound nucleus but prokaryotic cells do not.
- Eukaryotic cells have mitochondria and chloroplasts but prokaryotic cells do not.
- Eukaryotic cells tend to be larger than prokaryotic cells.
- Eukaryotic cells have thread-like DNA but prokaryotic cells have circular DNA.
- Greater degree of cell specialisation in eukaryotes.

10 a A: Cell membrane; B: mitochondrion; C: nucleus; D: cytoplasm

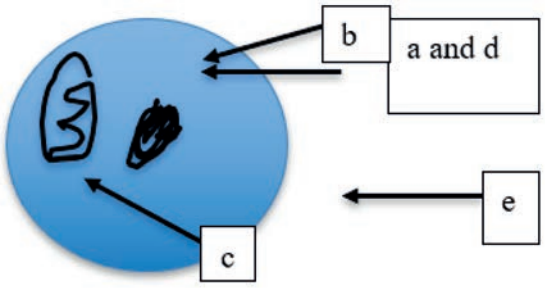
b Structure A is the cell membrane and functions as a barrier to the inner and outer environment of the cell. One role of the membrane is to regulate the movement of molecules and ions in and out of the cell. Structure C is the nucleus and contains the majority of the cell's DNA. The nucleus controls the cell's activity by regulating gene expression, that is, coding for different proteins at different times for the cell.

Chapter 9 Cell membrane and transport processes

Question set 9.1

Remembering

1 **a** cytoplasm
b plasma (cell) membrane
c an organelle membrane
d intracellular fluid
e extracellular fluid



2 The main component of cell membranes is phospholipids, which form two layers.

Understanding

3 Permeable: allows all substances through
Semipermeable: selects for only certain substances to move through
Impermeable: no substances pass through

4 **a** Sodium is an ion that is more concentrated in the extracellular environment compared to the intracellular environment. The concentration of sodium outside the cell is almost ten times greater than within the cell.
b Calcium ions are more concentrated in the intracellular environment than the extracellular environment. In this example calcium levels are approximately ten times greater within the cell than outside the cell.

Question set 9.2

Remembering

1 The fluid mosaic model describes membranes as a double layer of lipids, a lipid bilayer, with the ability to flow and change shape, like a two-dimensional fluid. Specialised protein molecules are embedded in the lipid in various patterns, like a mosaic.

2 The double-layered cell membrane is composed of two lipid membranes. Lipid membranes are composed of individual phospholipids – the phosphate group forms part of the hydrophilic portion (head) and the lipid or fatty acid chains make up the hydrophobic region (water avoiding). The hydrophobic regions of the two lipid membranes come together, forming a hydrophobic core, with the hydrophilic portions facing the internal and external environment of the cell. The structure of the bilayer allows the membrane to be flexible and able to repair itself. Proteins and other lipids, such as cholesterol, either are embedded or sit on the extracellular or intracellular surfaces of the cellular membrane.

3 **a** Receptor proteins

b Cholesterol in animal cells, phytosterol in plant and bacterial cells

c Transport proteins

4 Cholesterol interferes with interactions between the lipid tails, making the membrane more flexible. Cholesterol is important in the membrane as it helps to maintain cell membrane stability at varying temperatures.

Understanding

5 Channel proteins (ion channels): catalyse movement of specific ions (or water) down their electrochemical gradient. They help molecules move across the membrane via passive transport, a process called facilitated diffusion. An example of a protein channel is the calcium channel, which can only transport calcium in and out of the cell.

Carrier proteins (transporters): have to change shape to pass a molecule across the membrane. Many of these use energy from ATP to transport specific small molecules or ions *against* their concentration gradient. For example, the sodium–potassium pump maintains the electrochemical gradient (and the correct concentrations of sodium and potassium ions) in living cells. The sodium–potassium pump moves potassium ions into the cell while at the same time moving sodium ions out, at a ratio of three sodium ions for every two potassium ions moved in.

In addition, some carrier proteins facilitate ions or molecules along their concentration gradient, which does not require energy and is therefore passive transport.

6 The hydrophilic head of a phospholipid molecule is attracted to water, whereas the hydrophobic tails repel water.

7 Calcium is an important ion that is involved in cell signalling, and is passively transported through a protein channel, the calcium channel. No input of energy is required for calcium to diffuse into or out of a cell. However, for the transport of sodium into and out of a cell, energy is required to move ions against the concentration gradient. Sodium is actively transported across the membrane by the sodium–potassium channel. In this channel there is an exchange of the sodium and potassium ions into and out of the cells.

Question set 9.3

Remembering

1 Water is the solvent and salt is the solute.

2 The diffusion rate is increased when the concentration gradient is great, when heat is applied, when molecules are smaller and when movement occurs through a gaseous medium.

3 Many substances are too big or highly charged to pass through the plasma membrane unassisted. Facilitated diffusion is when substances, such as glucose, amino acids and various ions, bind to a protein molecule that can carry them across the plasma membrane or pass through a channel formed by a channel protein.

4 Plant cells do not burst when placed in a hypotonic solution; they become turgid. This is because the tough cell wall stretches, but does not break, when there is a net movement of water into the cell.

Understanding

5 Saline solution is isotonic to the contents of red blood cells. Hence, there is no net movement of water into or out of the red blood cell by osmosis. Therefore, the cells can be stored safely in saline solution. When red blood cells are placed in pure water, water moves into the cells and the cells rupture.

6 Plants wilt when their cells lose turgor. You can restore a plant's shape and form by soaking it in cold water until the cells take up water and become fully turgid again.

Applying

7 When sugar is sprinkled on strawberries, a higher solute concentration is created outside of the strawberry cell. This causes net movement of water out of the cells, via osmosis.

8 **a** Z

b Y

c In the hypertonic solution, the plant cell vacuoles would lose water. The cytoplasm would pull away from the cell wall, leaving a gap between the cell wall and the plasma membrane. There would be no change to the plant cell placed in the isotonic solution.

Question set 9.4

Remembering

1 Energy is required for active transport but not for passive transport.

2 **a** Oxygen, small lipids

b Water

c Sodium ions, glucose

d Potassium ions, glucose (if it is against the concentration gradient)

Understanding

3 Carrier proteins use energy from adenosine triphosphate (ATP) to move molecules or ions up their concentration gradient. As these carrier proteins work in only one direction, they effectively act as one-way valves.

Question set 9.5

Remembering

1 Cells that engulf material by the process of phagocytosis (endocytosis) are termed phagocytes. Macrophages are a type of white blood cell that engulf bacteria by phagocytosis.

2 Two examples of active transport include the absorption of glucose into the cells lining the small intestine and the secretion of harmful or nonessential substances by the cells that make up the kidneys.

3 Active transport cannot occur without an input of energy to move the substance against its concentration gradient. Simple diffusion, on the other hand, is a passive process, requiring no energy input to move the substance along its concentration gradient.

4 Substances that are secreted from cells are various but include extracellular enzymes, hormones, extracellular products (such as mucus and waxes), milk proteins and antibodies.

Understanding

5 See Figure 9.27 on page 294 of the student book. The process of pinocytosis is a type of endocytosis. The cell membrane forms a pocket around the particles ready to enter the cell. A vesicle pinches off from the plasma membrane as the ends of the membrane fuse together. The vesicle transports the particles into the intracellular environment of the cell.

See Figure 9.28 on page 294 of the student book. In the process of exocytosis, waste material or secretions are enveloped in a membrane called a vesicle, which fuses with the interior of the plasma membrane. This fusion opens the membranous envelope on the exterior of the cell, and the waste material is expelled into the extracellular space.

Question set 9.6

Remembering

1 Physical factors are size and shape. Chemical factors are charge and whether a substance is hydrophilic or hydrophobic.

2 If the concentration gradient is high, then oxygen will diffuse rapidly into the cell. As the concentration of oxygen inside and outside the cell becomes more similar, the rate of diffusion will be slower.

3 Removing the diffused substance and converting the diffused substance into something else.

Understanding

4 The shape of an object can significantly change its surface-area-to-volume ratio; for example, a sphere has the least surface area for the volume it encloses. In comparison, long, thin or flat cells have relatively more membrane for a certain volume.

5 As a cell grows larger, both its surface area and volume increase, but its volume grows faster than its surface area. Diffusion of substances into and out of cells occurs across the surface so a large surface-area-to-volume ratio in smaller cells allows for a high rate of diffusion, whereas a small surface-area-to-volume ratio in large cells reduces the rate of diffusion.

Applying

6 Responses will vary.

Cell	Radius (cm)	Surface area ($A=4\pi r^2$) (cm^2)	Volume ($4/3\ \pi r^3$) (cm^3, 1 d.p.)	S.A:Vol ratio (1 d.p.)
1	2	50.3	33.5	1.5:1
2	5	314.2	523.6	0.6:1
3	8	804.3	2144.7	0.4:1

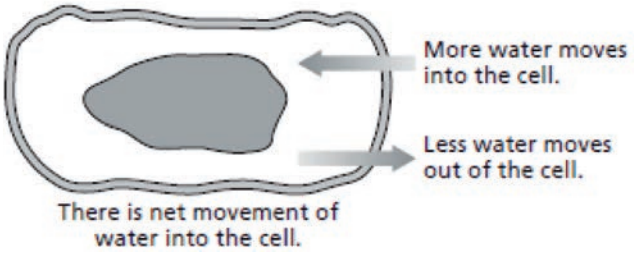
7 There is a linear relationship. As the size of a cell increases, the surface-area-to-volume ratio decreases.

Chapter review questions

Remembering

1 Plant cells may become plasmolysed during drought or when living in an aquatic environment where evaporation exceeds rainfall, causing solutes in the water to become more concentrated.

2



3 Normal saline solution has the same solute concentration as the inside of the human cheek cell. The solution is isotonic, meaning that the cell will neither gain nor lose water. As a result, the cheek cell should look the same as it does in the mouth. Tap water, however, would create a hypotonic solution, resulting in a net gain of water for the cell. This would distort the cell by making it swell and eventually result in the cell bursting.

4 The fluid mosaic model describes membranes as a double layer of lipids, a lipid bilayer, with the ability to flow and change shape, like a two-dimensional fluid. Specialised protein molecules are embedded in the lipid in various patterns like a mosaic. Some of these proteins can move laterally, and others are fixed in position.

Understanding

5 Some of the sugar from the 5% sugar solution surrounding the cell has entered the cell against a concentration gradient.

6 Carbon dioxide will move through the cell membrane into the cell via diffusion when the concentration of carbon dioxide outside of the cell is higher than it is within the cell.

7 The hypertonic salt solution has a higher concentration of salt compared to the red blood cells. This means the concentration of solvent (water) is lower in the salt solution compared to the red blood cells. Because water will move from where it is in higher concentration to a region where it is in lower concentration, it will move out of the cells into the surrounding salt solution. Hence, the red blood cells become crenated.

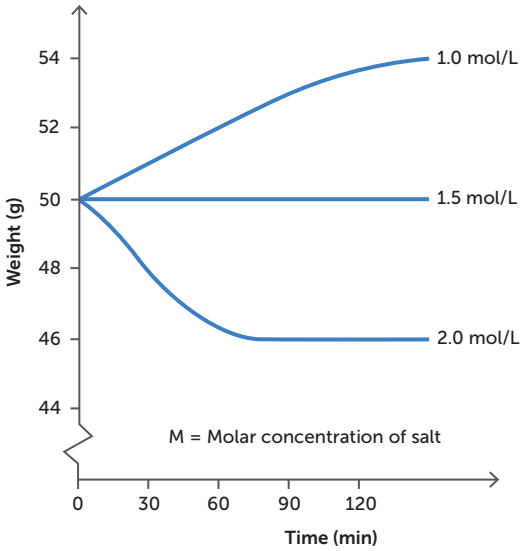
Applying

8 When plant cells do not have enough water, the vacuole shrinks, causing wilting. When watered, the vacuole fills with water and swells. This stretches the cell wall and makes the cell turgid, giving strength to the stem and causing the plant to stand straight.

Analysing

9 The size and shape of the cells may be different; larger cells have a slower rate of osmosis. Temperature is another factor; higher temperatures will speed up the rate of diffusion.

10 a



b The eggs placed in the 1.0 mol/L concentration of salt gained water because the concentration of the solution inside the cell was greater than that on the outside. In this hypotonic solution, water is able to move osmotically into the cell.

Eggs placed in the 1.5 mol/L salt concentration did not gain weight because the solution was of equal osmotic pressure to that inside the egg; therefore, there was no net movement of water into or out of the cell.

Eggs placed in the 2.0 mol/L salt concentration lost weight because the solution inside the cell was more dilute than the salt solution on the outside; therefore, there was a net movement of water out of the cell.

Evaluating

11 Both lack of available fresh water and saline soils induce water problems. Low water outside of citrus tree fruits and high saline conditions cause water to leave the roots via osmosis along the concentration gradient. However, salty soils are more disruptive. High salt levels in the cytoplasm can disrupt metabolism or slow metabolic rate. High salt can have toxic effects on the plant. Dryland salinity can lead to soil infertility and is very hard to reverse. with some irrigation, plants can survive and soil remains fertile. In contrast, with some irrigation, plants can survive even if little fresh water is available, and soil remains fertile.

12 A 2 mm round cell has a greater surface-area-to-volume ratio, compared to a 5 mm round cell, so diffusion through its plasma membrane is more efficient. This gives it a greater chance of survival, as requirements are obtained and wastes are removed more quickly.

Creating

13 Responses will vary. Issues can include high pressure, lack of sunlight and large size of cells. Adaptations to increase surface area for higher rate of absorption of nutrients as well as adaptations suited to a life of darkness, low temperature and high pressure in the deep sea. Adaptations could include structures that increase surface-area-to-volume ratio, such as flattened or elongated cells, and multiple extensions of the cell edge (fringes).

14 The formation of vesicles in endocytosis does remove parts of the plasma membrane but this is counterbalanced by exocytosis when arriving secretory vesicles fuse with the plasma membrane

to release their contents. Overall, the plasma membrane size is maintained. Students should realise that it is a very dynamic and fluid structure.

15 a The person would need to find sources of fresh water to stay alive. If there are no fresh water bodies, such as a lake or creek, the person could try to obtain fresh water from plants. They could create a humid environment, using plastic surrounding leaves, to collect the condensation that forms.

b If the person drank the sea water, cells in the digestive system would be surrounded by a hypertonic solution, causing them to lose water. Cells would become dehydrated and cease to function.

Practice exam questions

1 A

2 D

3 A

4 Diffusion is where molecules/solutes/substances move from an area of high concentration to an area of low concentration. (1 mark)

Osmosis specifically refers to the movement of water molecules from an area of high concentration to an area of low concentration through a semi- permeable membrane, or less concentrated solution to more concentrated solution. (1 mark)

5 Protein, phospholipid bilayer with heads facing outwardly and tails facing inwardly, cholesterol. (1 mark for each correctly drawn and labelled part – see Figure 9.8 on page 281 of the student book.)

6 Any two of the following: (2 marks)

- active transport
- passive transport
- receptors
- recognition
- attachment sites
- enzymes.

7 a Carbon dioxide: Diffusion; down concentration gradient; or as hydrogen carbonate ions dissolved CO_2 (2 marks)

b Glucose:

Either facilitated diffusion; glucose binds to carrier/protein; protein changes shape/carries glucose across;

Or active transport; glucose binds to carrier/protein; energy or ATP required; protein changes shape/carries glucose across; needs Na^+ to be carried at the same time (2 marks)

8 Plasmolysis is the shrinkage of the cytoplasm of a plant cell and pulling away from its cell wall and towards the centre (1 mark) because of water loss (1 mark).

Labels should include: cell wall, cytoplasm, cell membrane, water and direction of water movement during the process. (2 marks)

Diagram shows the cell wall remains intact but cell membrane pulled away. (1 mark)

9 2 marks per type of transport

Transport classification	Energy required?	Type	Mechanism
Passive transport	No	Simple diffusion	Small hydrophobic (e.g. lipids) or uncharged (e.g. carbon dioxide, oxygen gas) molecules move through the membrane unassisted, from area of high to area of low concentration
		Osmosis	Diffusion of water, through a semipermeable membrane, from an area of low solute concentration (high water content) to an area of high solute concentration (low water content). Water may move unassisted, but some membranes have proteins called 'aquaporins' which facilitate osmosis.
		Facilitated diffusion	Small hydrophilic substances (e.g. sodium ions, glycerol) move through special integral proteins, called channel proteins, from an area of high to an area of low concentration. Each type of channel protein allows only one type of molecule to diffuse.
Active transport	Yes (ATP)	Active transport	Relatively small hydrophilic or hydrophobic particles are pumped in or out of the cell by specific membrane proteins, called carrier proteins or protein pumps, up (against) the concentration gradient from areas of low to areas of high concentration.

10 Tonicity (3 marks)

- The solution on the outside of the dialysis membrane is representative of extracellular fluid of a real cell. It can be described as hypotonic to the fluid inside the dialysis membrane. In a real cell, the inside is called the intracellular fluid.

Structures and processes: any seven from the following. (7 marks)

- The dialysis membrane represents a cell membrane.
- It is semipermeable like a real plasma membrane because it lets the smaller solute pass but not the larger molecule.
- The smaller orange dots could be representing molecules that pass through the phospholipid bilayer by simple diffusion.
- For example, the red dots could be oxygen or carbon dioxide or small lipids.
- The large dots may be representing a large substance, such as wastes inside a vesicle.
- A vesicle requires the process of exocytosis to remove it from a real cell.

- The dialysis tubing is unable to demonstrate exocytosis.
- The smaller orange dots moved from an area of high concentration of solute to an area of low concentration of solute
- Movement of smaller dots occurs without the use of energy (it is passive).
- Movement of smaller dots is by a process called (simple) diffusion.
- Osmosis does not appear to have occurred.
- No net change in water movement may have occurred because there has been the same amount of osmosis into and out of the cell which leads to equilibrium.

Chapter 10 Enzymes, photosynthesis and respiration

Question set 10.1

Remembering

1 Metabolism is all of the biochemical reactions in an organism.

2 Biochemical pathways are ordered, enzyme-regulated sequences of reactions.

Understanding

3 In anabolic reactions, such as photosynthesis, simple molecules are combined into more complex molecules, whereas in catabolic reactions, such as cellular respiration, complex molecules are broken down into simpler molecules.

Applying

4 The product of one reaction becomes the reactant for the next reaction.

Question set 10.2

Remembering

1 The activation energy is the amount of initial energy required to start a chemical reaction.

2 A biological catalyst; a substance, usually a protein, that speeds up a chemical reaction and is reusable at the end of the reaction.

3 Intracellular enzymes occur inside cells, speeding up metabolic reactions. Extracellular enzymes are produced by cells, but achieve their effects outside the cell.

Understanding

4 See Figure 10.4 on page 314 of the student book.

5 A reactant is a substance that is an input in a reaction. It changes chemically into a product and is not reusable at the conclusion of the reaction. This is in contrast with an enzyme, which is present at the start of a reaction (like a reactant is) but remains unchanged and is reusable at the conclusion of the reaction.

Applying

6 Enzymes are able to destabilise existing chemical bonds in reactants. Therefore, less energy is required for bonds to break and for the reaction to start.

nelson net.

Question set 10.3

Remembering

1 Enzymes are proteins with a specific shape. Substrates bind to an enzyme's active site. As a result of these stresses on the substrate, the activation energy required to create a reaction is lowered. Enzyme activity is affected by temperature and pH.

2 As enzymes are not destroyed or altered by the reactions they catalyse, they can be used again.

Understanding

3
- They act very rapidly. The lock-and-key mechanism explains this because the enzyme–substrate complex causes the substrate to change, producing the end product.
- They are not destroyed or altered by the reactions they catalyse; they can be used again. The lock-and-key mechanism explains this because the substrate fits into the enzyme's active site, then leaves it. The active site remains intact after the substrate leaves.
- They can work in either direction. The lock-and-key mechanism explains this because the substrate molecule(s) can attach to the enzyme, and the product can also still fit the active site.
- They are affected by temperature and have an optimal range in which they operate. The lock-and-key mechanism explains this because the active site shape changes when the temperature changes.
- They are sensitive to pH. The lock-and-key mechanism explains this because the active site shape changes when the pH changes.
- They are usually specific to particular reactions. The lock-and-key mechanism explains this because each enzyme has a specific shape that fits closely with the substrate.

4 There are thousands of different reactions occurring in the human body. Each reaction requires a different enzyme, hence the need for the thousands of different types of enzymes.

Applying

5 In the induced-fit model of enzyme action, the enzyme's active site can actually change shape to ensure that the substrate is accommodated. In the lock-and-key model, the active site is a static structure into which the substrate fits.

6

Feature	Lock-and-key model	Induced-fit model
Active site	Rigid	When substrate enters active site, it causes the active site to change shape slightly. Therefore, it is less rigid
Specificity	Highly specific	Broad specificity
Shape	Perfect fit	Almost a perfect fit; active site changes shape slightly when substrate enters to accommodate the shape of the substrate
Effect on activation energy	Not applicable	The shape changes during the binding of the enzyme and the substrate places stress on the bonds in the reactant, lowering the minimum required energy to start the reaction
Action of active site after reaction	Not applicable	Active site returns to its original shape

Question set 10.4

Remembering

1 The conformation of the active site, and hence the activity of an enzyme, is sensitive to changes in pH and temperature.

2 The function of a cofactor and a coenzyme in a reaction is to allow a reaction to proceed to produce a product. An inhibitor does not allow the reaction to proceed forward and therefore no products are made.

Understanding

3 When enzymes are denatured, the active site loses its functional shape and is no longer able to accommodate the substrate.

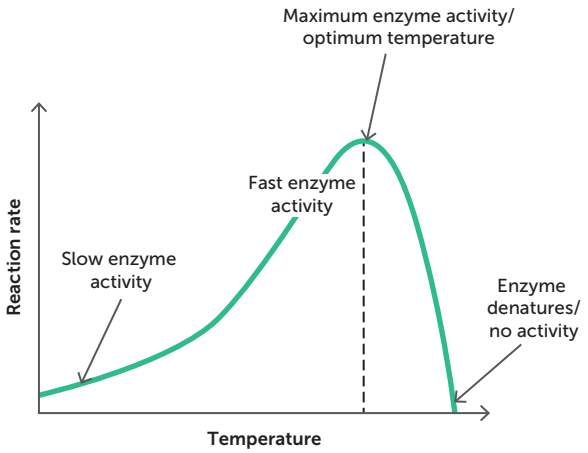
4 A build-up of product within the cell will act as an inhibitor, binding to a site on the enzyme and slowing down the reaction. If the product is removed, the reaction will speed up again.

5 Zinc and magnesium are cofactors for some enzymes. Without a sufficient supply of these ions, these enzymes would be inactive and the reactions relying on them would not be able to proceed.

Applying

6 If our body temperature increases, enzymes change shape. If they change to such an extent that they are no longer able to function, important reactions in our body may not proceed at a rate fast enough to maintain life.

7



Question set 10.5

Remembering

1 ADP is composed of an adenosine molecule with two phosphate groups attached. When another phosphate group is attached to ADP it becomes ATP. ATPase is the enzyme that speeds up the reaction of ATP breaking down to ADP + P.

Applying

2 A battery stores chemical energy that can be released as electrical energy to power various appliances. In the same way, ATP stores chemical energy in the high-energy chemical bonds

attaching the last phosphate group to ATP. This stored energy is released when the bonds are broken and a phosphate group is removed. This energy is now available to fuel a cellular reaction.

3 The coenzymes NADH and $FADH_2$ are molecules that shuttle around energy, represented by the heavy bags being carried, within the cell to couple with other biological reactions.

4 The equation shows that there is a recycling of ADP and ATP. An input of energy is required to form ATP from ADP and phosphate. However, a large amount of energy is released when a bond of phosphate is broken, producing ADP and a phosphate. These reactions are coupled to other biological reactions within the cell, and the recycling of ATP and ADP requires less energy than if the cell had to make ATP from scratch.

Question set 10.6

Remembering

1 ATP molecules and hydrogen ions are the products of light-dependent reactions used as inputs in light-independent reactions.

2 Glucose

3 Carbon dioxide + water + energy from sunlight → glucose + oxygen

$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

Understanding

4 Only living plant cells that contain chloroplasts carry out photosynthesis. Root cells, for instance, do not.

5 In the light-dependent reactions, solar energy is absorbed by pigments within the thylakoid membranes (grana) of the chloroplast. This energy is used to split water molecules into hydrogen ions and oxygen gas. In this process, molecules of ATP are produced. The light-independent reactions occur in the stroma of the chloroplast. In these reactions, carbon dioxide and hydrogen ions join to produce glucose.

Applying

6 Light and CO_2 are factors that affect the rate of photosynthesis. When a factor becomes limiting, it restricts the rate of the reaction. Although other reactants or factors may be plentiful, the reaction requires all inputs to be available for the reaction to proceed.

7 Thylakoids have a flat disc shape, with discs in piles (grana) to produce a high surface area to maximise light absorption. Stroma fluid is a medium for the essential enzymes required for photosynthesis reactions.

8 Students' own responses.

Question set 10.7

Remembering

1 $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy stored in ATP

2 The initial substrate in the glycolysis pathway is glucose and the final product is the three-carbon compound called pyruvate.

3 Glycolysis takes place in the cytosol.

4 Aerobic respiration takes place in the mitochondria, whereas fermentation takes place in the cytosol. The final products and the amount of net ATP produced are different in both pathways.

Understanding

5 In animal cells and plant cells, the final products of aerobic respiration are carbon dioxide and water. Products vary in anaerobic respiration; in animals, the final product is lactic acid and in plants, they are carbon dioxide and ethanol.

6 In aerobic cellular respiration, carbon dioxide is the by-product of a reaction that involves pyruvate and oxygen.

Applying

7 Fermentation begins to occur when oxygen is absent or not always available. Many plants (or parts of plants) can respire anaerobically for a short time, such as germinating seeds and roots living in water-logged soil, where there is little oxygen.

Evaluating

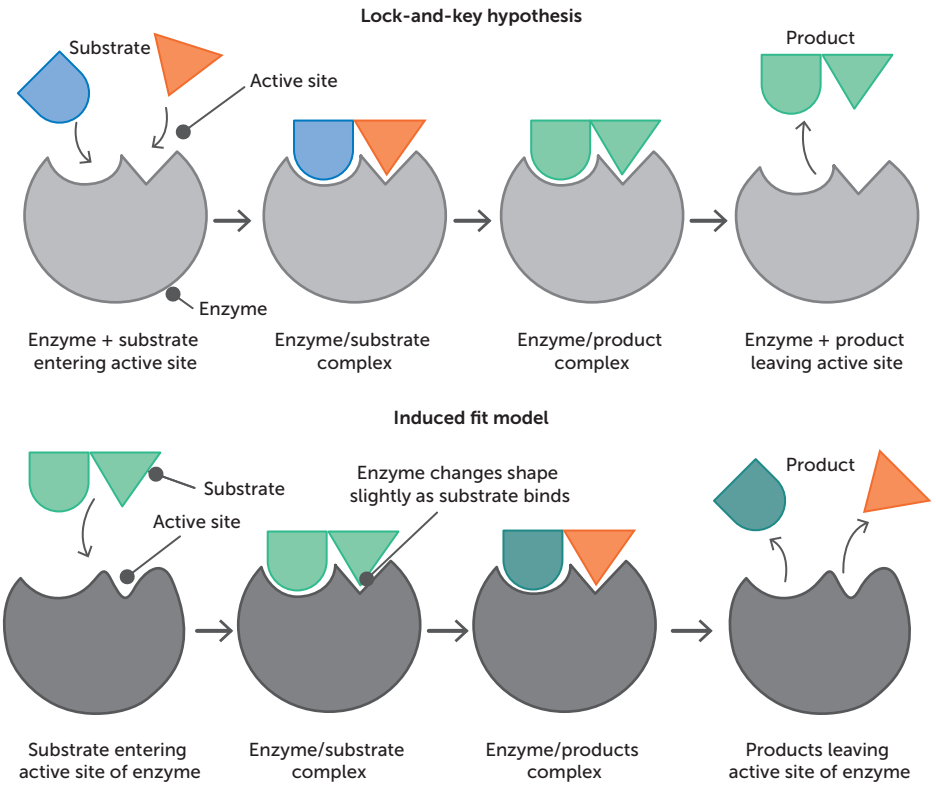
8 The fermentation process is used to make cakes and breads rise. A product of alcohol fermentation is carbon dioxide gas. The carbon dioxide bubbles pass through the dough, causing it to rise. In lactic fermentation, there is no liberation of carbon dioxide; therefore, the desired result cannot be obtained.

9 Answers will vary.

Chapter review questions

Remembering

1



2 Temperature, pH, substrate concentration, amount of enzyme, competitive and non-competitive inhibitors

Understanding

3 **a** Anabolic – builds more complex molecules

b Catabolic – produces more simple molecules

Applying

4 Body fluids are normally buffered to maintain the optimum pH for enzyme activity.

5 **a** 20 minutes

b The plant was in put in the dark; the carbon dioxide produced in cellular respiration is not being used in photosynthesis.

c The plant was put in light conditions.

d The rate of photosynthesis was at its maximum capacity. Limiting factors could be the amount of water, the amount of light, the temperature and the amount of oxygen (if the plant was in a contained environment).

e Enzymes would denature. Cellular metabolism would slow down to the stage where life could not be sustained.

f Carbon dioxide is continually produced in cellular respiration but is used in photosynthesis. The lower the carbon dioxide concentration, the greater the rate of photosynthesis.

6 When money is earned, it can be deposited into a bank. When energy is gained, it is used to add a phosphate group to an ADP molecule. The energy is then stored in the chemical bond. When money is withdrawn from the bank, it can be spent on a range of goods. When the phosphate is removed from an ATP molecule, the energy released can be 'spent' on other chemical reactions.

7 At the compensation point, all produced glucose is consumed and there is no incorporation of material into the plant. Plant growth is likely to cease.

Analysing

8 Food is produced by plants in the form of glucose. Glucose can't be directly used for cellular metabolism: it has to be converted into simpler compounds. The energy released builds up ATP molecules, which are then converted to ADP + P. The energy released can then be used for cellular activities. This process of building ATP is cellular respiration, which depends on mitochondria.

9 Alcohol fermentation is happening. To prevent this happening again, need to heat the preserved fruit to destroy bacteria.

10 **a** At a lower temperature, all chemical reactions proceed at a lower rate.

b At a higher temperature, the enzyme will become denatured.

c A lower temperature does not permanently affect the function of the enzyme's active site. At a higher temperature, the active site will not be preserved.

Evaluating

11 An increase in temperature would adversely affect the enzymes involved in sperm production.

12 Lemon juice is acidic. The change in pH will adversely affect the activity of the enzyme polyphenol oxidase and the brown colouration will not be produced.

13 Tube A would carry out rapid growth because it is capable of performing aerobic respiration. This is predicted because aerobic respiration releases much more energy than anaerobic respiration. The experimental design will depend on students' response. Tube B would have slower growth, because it is relying on the lower rate of energy release provided by anaerobic respiration.

Creating

14

	Respiration	Photosynthesis
Inputs	Oxygen, glucose	Carbon dioxide, light, water
Products	Carbon dioxide, water, energy (ATP)	Oxygen, glucose, water
Types of cells	All	Plants, some protists, bacteria
Site in cells	Cytoplasm (anaerobic) and mitochondria (aerobic)	Chloroplast
Energy source	Carbon compounds	Light
Role of ATP	Product	Carries energy from light-dependent reactions to light-independent reactions
Names of reactions	Glycolysis, fermentation, citric acid cycle, electron transport chain (oxidative phosphorylation)	Light-dependent reactions, light-independent reactions

Reflecting

15 To increase the efficiency of the photosynthesis processes of energy capture and conversion and, in addition, energy use by plants, by improving their ability to allocate resources and their tolerance to environmental challenges, which may help feed our growing human population.

Practice exam questions

1 C

2 B

3 A

4 C

5 A

6 B

7 **a** Any two of: light, water, carbon dioxide (2 marks)

b Glucose/sugar, oxygen (2 marks)

8 **a** Yes; all types of cells undergo respiration because they need a continuous source of energy (2 marks)

b Any two of: carbon dioxide, energy/ATP/heat, water (2 marks)

9 **a** Photosynthesis; $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (with chlorophyll and light energy above and below the arrow) (2 marks)

b Respiration; $C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + (ATP)$ (ATP not essential) (2 marks)

c Chloroplast (1 mark)

d Mitochondrion (1 mark)

10 Any 10 of the following: (10 marks)

- energy stored in glucose is in the bonds/stored, in the form of potential or chemical energy
- during respiration, bonds break and energy is released/ Usable form of energy is ATP
- enzyme-controlled at each step

Glycolysis:

- releases 2 ATP
- glucose bonds break to form 2 molecules of pyruvate

Citrus acid (Krebs) cycle:

- releases 2 ATP
- energy-carrying molecules receive electrons
- NADH and $FADH_2$ transport electrons (to the electron transport chain)
- occurs in the matrix

Electron transport chain (oxidative phosphorylation):

- releases 32 ATP
- oxidative phosphorylation/ $ADP + P \rightarrow ATP$
- approximately 36 ATP released
- electrons and oxygen arrive
- occurs in the cristae

Chapter 11 Cells in multicellular organisms

Question set 11.1

Remembering

1 Atom, molecule, organelle, cell

2 Prokaryotic cells do not contain membrane-bound organelles, so they do not have a defined nucleus. In contrast, eukaryotic cells do contain membrane-bound organelles and therefore they do have a well-defined nucleus with a nuclear membrane.

3 **a** Unicellular organisms

- The advantage of being unicellular is that each cell is a complete functioning organism. All the needs and functions of the organism take place within the boundary of the cell.
- The disadvantage of being unicellular is the limited number of metabolic activities that can be performed within the cell at one time.

b Multicellular organisms

- The advantage of being multicellular is that cells can perform many more processes due to their more complex structure.
- The disadvantage of being multicellular is that the cells are so specialised that they cannot exist independently of other cells.

4 The ability of cells to divide, specialise and communicate with other cells

Understanding

5 Cilia structures are found on the surface of the cell. The multiple fine structures enable it to sweep food, along with some water, into its oral groove and then into the mouth of the cell. The food travels through the cell mouth into the gullet, which is a temporary holding area for the food. When there is enough food in the gullet, the food breaks away and forms a food vacuole.

Question set 11.2

Remembering

1 **a** True: As cells differentiate, they specialise in a specific function.

b False: All cells of an individual contain the same DNA; however, not all of the genes in the DNA are 'switched on' in every cell.

c True: Stem cells are unspecialised; specialisation develops when stem cells differentiate.

2 The first difference is that stem cells are unspecialised (have not yet specialised into a particular type of cell). The second difference is that they have the potential to divide and replicate for long periods of time. The third difference is that these relatively unspecialised cells can differentiate to form different specialised cells.

Understanding

3 While the genetic information is the same in all cells of a multicellular organism, not all of this information is used in every cell. The specific genetic instructions that will be 'switched on' and expressed to make specific proteins will be dependent on the function of the specific cell.

4 The advantage is that specialisation increases efficiency and reduces duplication of effort. The disadvantage is that specialisation brings about the need for communication and coordination between cells. Specialised cells are totally dependent on activities of other cells to perform tasks that they cannot.

5 Specialised cells in multicellular organisms carry out specific functions. It is important for cells to communicate with each if they are going to act together to coordinate functions necessary for survival.

Question set 11.3

Remembering

1

Tissue type	Main function	Two area in body where found	One example of specialist cell type
Connective	Provides support, strength, elasticity; holds certain body parts together	Bone Cartilage	Blood
Epithelial	Covers many surfaces, including the surface of the body and linings of body cavities such as airways and acts as a protective layer and a barrier against infectious agents or water loss	Skin Airways	Squamous
Nervous	Provides the means of communication between all body structures and includes neurons that transmit nervous impulses	Brain Spinal cord	Neuron
Muscle	made of thin and very long thread-like cells called muscle fibres which use ATP energy to perform movements; the fibres are capable of contracting when stimulated by nerve impulses	Biceps Quadriceps	Skeletal

2 In a vascular plant, there are four main types of tissues:

- meristematic tissues, found at the tips of roots and shoots, is where growth occurs; this enables growth in length as well as width
- dermal tissue is the outermost layers, including the epidermis (the outermost of all), which is specialised to protect the plant from cuts, invasion by micro-organisms and water loss. In the roots it is also specialised for uptake of water and minerals, and in leaves it may produce a protective waxy cuticle for the prevention of water loss from leaves and other delicate tissues
- ground tissue, all the internal cells apart from vascular tissue, is specialised for storage, support and photosynthesis; examples of ground tissue include the fleshy portions of apples, pears, potatoes and carrots
- vascular tissue comprises cells specialised for the transport of water, nutrients and minerals throughout the plant.

Understanding

3 Cells make up tissues, which make up organs, which make up systems, which make up the multicellular organism.

4 Muscle tissue is made up of thin and very long thread-like cells called muscle fibres. These fibres are capable of contracting when stimulated by nerve impulses. The contraction is a type of tension force which leads to the generation of other types of forces, such as a push or a pull. Contraction and relaxation of muscle cells collectively leads to movement in organisms.

5 Responses will vary.

Chapter 11 review questions

Remembering

1

Level of organisation	Description	Examples
Organisms	The sum of all the organ **systems** working together	Animals, **plants,** fungi
Organ systems	Different types of organs working together to perform **specific** functions	Reproductive system, circulatory system, **excretory system**, respiratory system, **digestive system**
Organs	Different types of **tissues** working together to perform a specific function	Brain, heart, lung, **stomach**, **leaf**
Tissues	Different types of **cells** working together to perform a specific function	Skin tissue, epidermal tissue, muscle tissue, **connective tissue**
Cells	Building blocks of life	Blood cells, **neurons**, skin cells, bone cells, **root cells**, root hair cells
Organelles	Structures **within** the cell with a specific function	Nucleus, ribosomes, chloroplasts, **mitochondria**
Molecules	Combinations of **atoms**	Proteins, carbohydrates, nucleic acids, lipids
Atoms	Combine to make up molecules	Carbon, hydrogen, **oxygen**

2 **a** Epithelial, connective, muscle and nervous tissues

b Responses will vary. Students need only pick three from the following: the digestive system, the circulatory system, the excretory system, the immune system, the endocrine system, the muscular system, the nervous system, the reproductive system, the urinary system.

c There are many examples students can choose from.

d Students can use examples from Figure 11.13, page 365.

Understanding

3 Cells in multicellular organisms are specialised. They have specific structures and functions. They are totally dependent on other cells to perform tasks that they cannot.

4 Cells become specialised (or different) through cellular differentiation. Specialisation is when the different cells possess specific features that relate to a specific role or function.

5 Only a small portion of the genetic material is actively 'switched on' in specialised cells. The specific genes that are 'switched on' and expressed will determine the cell's structure.

Applying

6 Responses will vary.

7 **a** Meristem tissue

b Tips of roots

c Growth would be halted

Analysing

8 **a** The possession of specialised cells is advantageous to the survival of the organism because cells are able to perform many more processes due to their more complex structures.

b The possession of specialised cells is disadvantageous to the survival of the organism because cells are so specialised that they cannot exist independently of other cells, so the organism must spend energy on communication and coordination between cells.

9 In complex structures, the whole is often greater than the sum of its parts. Each of the different specialist cells in a complex multicellular organism has a specialised function, which can give rise to new abilities due to interactions among components with increasing organisation. These new abilities can be seen in multicellular organisms when individual cells cooperate to form tissues; tissues work together in organs; organs work together to form a particular function in systems; these combined systems cooperate to maintain life. The interaction and cooperation between cells, tissues, organs and systems provides multicellular organisms with abilities that are beyond the limitations of a single cell, tissue, organ or system. The interacting, interdependent parts of an organism function collectively to result in the 'whole' being more than the sum of an organism's parts.

Creating

10 Responses will vary.

Practice exam questions

1 D

2 A

3 A

4 Dermal tissue is composed of the outer cell layers of a plant. The epidermis is the outermost part of the dermal layer. In the same way as for animals, the dermal layer, made of epithelial tissue, protects the plant from cuts, invasion by micro-organisms and water loss. (2 marks)

Then any of the following: (2 marks)

- On leaves and stems, these cells usually produce a waxy cuticle. This wax is vital to the prevention of water loss from leaves and other delicate tissues.
- Epidermal cells also produce fine hairs on the surfaces of many leaves and stems. In many plants, these discourage plant eaters. Some contain harmful irritants that are released into the skin when touched.
- Epidermal root tissue produces large numbers of extremely fine extensions called root hairs. These hairs aid in the absorption of water and minerals. In woody plants, a bark layer forms when layers of specialised cells that soon die replace the epidermis.

5 Muscle tissue is a basic tissue type in animals, and is made of thin and very long thread-like cells called muscle fibres which use ATP energy to perform movements; the fibres are capable of contracting when stimulated by nerve impulses. (1 mark)

For example:

- Structure: The elongated rod-shaped cells of skeletal muscle consist of many thin fibres. (1 mark)
- Function: They are well-suited to their function of shortening during contraction, causing tension force and movement. (1 mark)

Nervous tissue is a basic tissue type in complex animals that provides the means of communication between all body structures and includes neurons that transmit nervous impulses. (1 mark)

For example:

- Structure: The elongated shape and the extensions of motor neurons (1 mark)
- Function: They are well-suited to their function of passing messages between the nervous system and other parts of the body. (1 mark)

Epithelial tissue is a basic tissue type in complex animals which covers many surfaces, including the surface of the body and linings of body cavities such as airways, and acts as a protective layer and a barrier against infectious agents or water loss. (2 marks)

For example:

- Structure: Epithelial cells are usually organised into tightly packed single or layered sheets. (1 mark)
- Function: This structural organisation increases their effectiveness as barriers that protect against mechanical injury, invasive micro-organisms and loss of fluid. (1 mark)

Chapter 12 Animal systems

Question set 12.1

Remembering

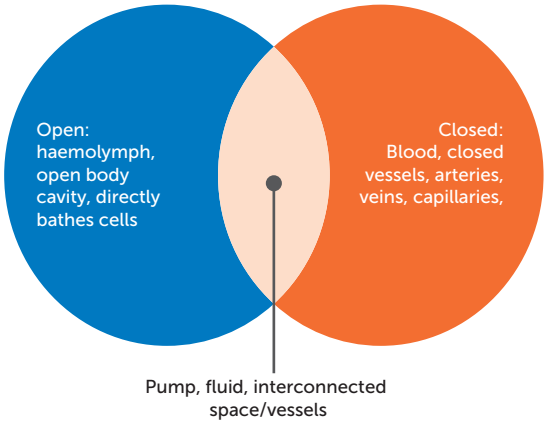
1 A fluid in which materials are transported, such as blood; a system of interconnected blood vessels or spaces throughout the body in which the fluid moves; a muscular pump, such as the heart, that pushes the fluid through the blood vessels or spaces.

2 Closed, single circulatory systems contain one circuit. They are found in bony fish and sharks. The heart pumps the blood to the gills to be re-oxygenated, after which the blood flows to the rest of the body and back to the heart. The blood loses pressure at the gills and flows around the rest of the body and back to the heart under low pressure. Fish have a two-chambered heart with one atrium and one ventricle, and oxygenated blood proceeds directly from the gills to the tissues.

Closed, double circulatory systems contain two circuits: a pulmonary circuit, which transports blood to the lungs and back to the heart, and a systemic circuit, which transports the oxygenated blood around the body and back to the heart. These circuits are found in all vertebrates other than fish; that is, birds, reptiles, amphibians and mammals. In birds and mammals, the chambers of the heart that deliver blood to each system are fully separated and there is no mixing of oxygenated and deoxygenated blood. In contrast, in amphibians and most reptiles, the heart is not completely divided, allowing for some mixing of oxygenated and deoxygenated blood.

Understanding

3



Applying

4

Feature	Similarities	Differences
Circulatory system	All have closed circulatory systems	• Fish have single circulatory system: only systemic circulation • Amphibia and mammals have double circulatory systems: pulmonary circulation as well as systemic circulation
Heart	All have a muscular heart	• Fish have one atria and one ventricle • Amphibians have two atria but only one ventricle • Mammals have two atria and two ventricles

Oxygenation of blood	Blood is oxygenated when oxygen diffuses into blood at specialised gas exchange surfaces	• In fish, oxygenated blood is sent directly from gas exchange surfaces (gills) around body • In amphibians, oxygenated blood returns to the heart to be pumped to the body, but it mixes with deoxygenated blood in the heart because there is only one ventricle • In mammals, oxygenated blood returns to the heart to be pumped to the body and is kept separate within the heart

Question set 12.2

Remembering

1 The main components of the circulatory system are the blood vessels; for example, the arteries, veins and capillaries. The main function of the circulatory system is to transport oxygen and nutrients to all cells in the body; wastes, such as carbon dioxide and urea, are also removed by the circulatory system.

2 The heart has four chambers. Blood from the body enters the right atrium via the vena cava. Contraction of cardiac muscle in the heart pushes the blood out of the atrium into the ventricle. Valves in the heart keep the blood flowing in one direction so that blood doesn't go back into the body.

3 The heart has four chambers: there are two thin-walled atria and two more muscular ventricles. Blood enters the right atrium from the general body system of blood vessels and passes into the right ventricle. When the right ventricle contracts, it pushes the blood into the arteries that lead to the lungs. At the lungs, oxygen diffuses into the blood and carbon dioxide passes out into the air in the lungs. The now oxygen-rich or oxygenated blood passes back into the heart through the left atrium and then into the left ventricle. When this ventricle contracts, the blood is forced into the aorta, the largest artery, which, through its many branches, takes blood to all parts of the body.

4 White blood cells function collectively to fight foreign substances that enter the blood. They engulf material and destroy poisons, produce antibodies, and release chemical messages and enzymes.

5 Platelets are smaller than red blood cells and are shaped like flattened discs. They release chemicals at the site of an injury in a blood vessel, causing it to contract and reduce blood loss. They also clump together to help form a clot.

Understanding

6 Haemoglobin enables blood to carry 20 mL of oxygen per 100 mL of blood, about 70 times more oxygen than it could without this red protein. It can also release oxygen easily in regions of low concentrations. Haemoglobin also carries about a quarter of the carbon dioxide in the blood.

7 Arteries take blood away from the heart; veins carry blood to the heart. Capillaries are found between these two blood vessels. The walls of the arteries are thicker than those of veins. This is because arteries have a lot more muscle and elastic fibres than veins do. The lumen of the vein is larger than that of the artery. Veins have valves in them to help keep the blood flowing to the heart. Unlike arteries and veins, capillaries have very thin walls and are very narrow. Their walls are only one cell thick, allowing nutrients and wastes to diffuse into and out of neighbouring cells.

8 Systemic circulation supplies oxygen and nutrients to all cells in the body; this form of circulation also removes wastes from the cells. Pulmonary circulation moves blood from the heart to the lungs and back to the heart, removing waste carbon dioxide and adding oxygen to the blood.

9 Both systems are responsible for circulating fluids through the body; while the circulatory system circulates blood, the lymphatic system returns excess fluid and the proteins from the tissues to the bloodstream.

10 The internal environment is all of the material contained within a cell and the external environment is all the material outside a cell. The plasma membrane is the barrier between the two environments.

Applying

11 To determine whether a blood vessel attached to the heart is an artery or a vein, the following would need to be taken into account:

- It is an artery if it is attached to a ventricle and coming out of the top of the heart.
- It is a vein if it is attached to an atrium and leading into the side of the heart.
- It is more likely to be an artery if it has a thick muscular wall.
- It is more likely to be a vein if it has a thinner, less muscular wall.

12 Students can use the diagram of the heart, Figure 12.7 on page 387 of the student book.

Question set 12.3

Remembering

1 Generally the gas exchange surface has to:

- be thin and permeable so the molecules can move across it easily and quickly
- be moist, so that the gases can dissolve in the water and diffuse from one side to the other
- be as large an area as needed by the organism, especially to provide oxygen for its varying energy needs
- have a greater supply of gas on one side than the other.

2 **a** Gills are thin filaments that are highly branched and folded, with a rich supply of capillaries.

b Spiracles are openings found along the thorax and abdomen in insects, through which respiratory gases move.

c Air destined for the lungs passes into the trachea, which branches into two bronchi, which lead to the lungs. Each bronchus continually divides into smaller tubes called bronchioles. Eventually, each bronchiole ends in a cluster of tiny air sacs called alveoli (singular alveolus). From these gases can diffuse into and out of the blood capillaries.

Understanding

3 The processes of life require the constant supply of oxygen (for cellular respiration) and the removal of carbon dioxide, a by-product of cellular respiration.

4 During inhalation the muscles lift the ribs upwards and outwards at the same time as the diaphragm contracts and moves downwards. The lungs expand because the pressure around them has decreased. During exhalation the reverse happens, with the ribs coming down and in, and the diaphragm moving up and forcing the air out.

5 Air inside the bronchioles is part of the external environment; it has not passed through the plasma membrane into cells.

6 Gills are structured so that they form a large surface area to maximise gas exchange between deoxygenated blood and water. Blood flows in the opposite direction as the flow of water. This is known as countercurrent flow and it maintains a maximum concentration gradient across the gills. The concentrations of oxygen and carbon dioxide are opposite in water and deoxygenated blood. Deoxygenated blood has a higher concentration of carbon dioxide and a low concentration of oxygen. As water passes through the gills, the carbon dioxide in the blood is released into the water and replaced by the oxygen from the water.

Analysing

7 A countercurrent exchange system enhances the diffusion of substances between two flowing vessels. For example, in the gill, blood and water flow in opposite directions to each other, which increases the efficiency of oxygen uptake from the water because it maintains a concentration gradient along the whole structure.

In contrast, if blood flowed in the same direction as water, it would have a high concentration gradient initially, but almost no concentration gradient by the end of the structure, preventing diffusion at that end. This would reduce the rate of gas exchange.

Question set 12.4

Remembering

1 The main functions of the digestive system are to ingest, digest, absorb nutrients and eliminate wastes via egestion. The digestion of macromolecules so that they can be absorbed into the internal environment of the animal occurs like this:

- carbohydrates are digested to produce glucose (a monosaccharide)
- proteins are digested to produce amino acids
- lipids are digested to produce fatty acids and triglycerides.

2 The structures through which food must pass are, in order, the mouth, teeth and tongue; epiglottis and oesophagus; stomach; small intestine (duodenum, jejunum and ileum); and the large intestine (colon and rectum).

3

Enzyme	Function
Amylase	Digestion of starch to produce glucose
Pepsin	Digestion of protein to produce peptides
Trypsin	Breaks down long-chain polypeptides to shorter-chain peptides
Lipase	Digestion of fats to produce fatty acids and triglycerides

Understanding

4 The alimentary canals of herbivores are longer because they have to provide a larger space and longer time to digest the high amount of cellulose in their diet. The alimentary canals of carnivores are shorter because they only need to provide for the faster digestion of protein.

5 Many carnivores have pointed incisors and canines, and jagged premolars and molars. The functions of these specialised teeth are to kill prey, and to cut and rip pieces of flesh during their meal.

Herbivores usually have molars with broad, ridged surfaces. The function of these specialised teeth is for grinding tough plant material. The incisors and canines may be used to bite off vegetation.

6 The purpose of chewing the cud is to break down the tough cellulose wall of the plant material in order to increase the surface area available for the action of enzyme-producing bacteria.

Analysing

7 Students can construct this using the information in the text.

8 The structure of the cow's stomach is quite different from that of the human stomach as its function is quite different. The human stomach is the site of protein digestion. Cattle do not usually consume protein; however, their consumption of low-energy plant material is high. The cow's stomach is divided into four chambers, which hold plant material at various stages of digestion.

9 The human digestive system is far more complex and contains specialized organs such as the oesophagus, stomach, and duodenum or intestines. Planaria have a simple system. The digestive system consists of a mouth, pharynx, and a gastrovascular cavity. Although both have a mouth, the human mouth is located on the head and the planarian mouth is located on its underside, around the centre of its body. Humans have an opening for input of nutrients and a separate opening for output of wastes; a mouth and an anus. In contrast, planarian worms have one opening. Humans are capable of an omnivorous diet, whereas planarians are bottom-feeders.

Question set 12.5

Remembering

1 Renal artery → Glomerulus → Proximal tubule → Loop of Henle → Distal tubule → Collecting duct

2 The final amount of water is reabsorbed from the collecting duct in the kidney.

3 The mix of water and solutes that pass from the blood in the capillaries in the glomerulus into the Bowman's capsule.

Understanding

4 Refer to Figure 12.32, page 409, and Table 12.8, pages 409–10.

5 The blood in the glomerulus is under high pressure because the arteriole coming out is narrower than that going in, so some of the blood is pushed, or filtered, out of the capillaries into the Bowman's capsule. This contains everything that was in the blood except the blood cells and large proteins such as albumin, fibrinogen and antibodies.

Analysing

6 The circulatory system and the respiratory system are interdependent because they work together to give cells a constant supply of oxygen for cellular respiration, and constant removal of carbon dioxide. The circulatory system transports the two gases from a 'pick-up' area to a 'drop-off' area, according to the needs of the organism. Oxygen enters and carbon dioxide exits across gas exchange surfaces in the respiratory system. The respiratory system supplies the oxygen and removes the carbon dioxide; the circulatory system delivers the oxygen to the cells and delivers the carbon dioxide to the exchange surface to be removed. Both systems are required, in addition to several other systems, for organisms to survive.

nelson net.

Chapter review questions

Remembering

1 **a** Heart, arteries, veins and capillaries
b Trachea and lungs comprising the bronchi, bronchioles and alveoli
c Mouth, oesophagus, stomach, liver, gallbladder, pancreas, small intestine, large intestine
d Kidneys, ureters, bladder and urethra

2 **a** Kidney
b Small intestine
c Large intestine
d Alveoli in the lungs
e Stomach
f Mouth
g Mouth

Understanding

3 **a** Respiratory system, circulatory system
b Digestive system, circulatory system
c Digestive system, circulatory system
d Circulatory system, respiratory system, excretory system

4

Section of gut	What happens
Mouth	Chewing breaks down the food into smaller pieces. Saliva mixes with food and breaks it down chemically.
Oesophagus	Food is passed into stomach by means of muscular contractions.
Stomach	Food is mixed with enzymes and acid.
Small intestine	Food is mixed with digestive enzymes from the pancreas and liver. Broken down food is absorbed into the blood.
Large intestine	Undigested food material is compacted; water and some salts are absorbed back into the body.
Anus	Faeces is released.

5 During systemic circulation, arteries carry blood from the heart and veins carry blood to the heart. The blood flow for pulmonary circulation is reversed; pulmonary arteries carry blood to the heart and pulmonary veins carry blood from the heart.

6 The fibrous nature of valves allows blood to push the flaps open, when being pushed by muscular contractions of blood vessels or the heart, but prevents blood flowing backwards.

7 Students will complete the quiz.

8 **a** The renal pelvis is the section of the kidney where urine is collected and directed to the ureter.
b The nephron is the structure of the kidney where filtration of the blood occurs.

c The loop of Henle is the portion of a nephron that connects the proximal convoluted tubule to the distal convoluted tubule.

d The collecting duct is the nephron's last region where urine is collected before leading to the kidney's central cavity.

Applying

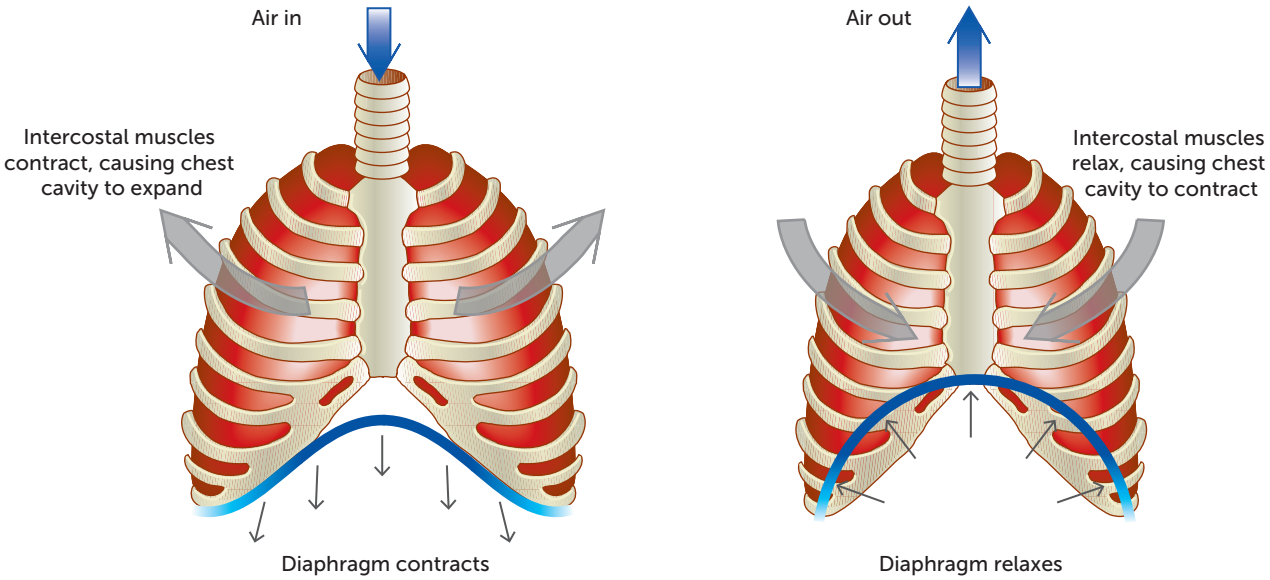
9 The fish will be mechanically digested in the mouth by the teeth with the addition of saliva. After it moves down the oesophagus into the stomach, the protein will be digested by the enzymes pepsin and trypsin in the highly acidic environment. The rest of the food will be churned until it becomes chyme, which has a thick soupy consistency. As it passes out of the stomach, the acid will be neutralised by the bicarbonate juices released by the pancreas into the top part of the small intestine. As the chyme moves down the duodenum, bile that is produced by the liver and stored in the gall bladder will enter the tract and work as a detergent on the fat globules, mechanically digesting the fat. Then lipases and proteases will enter from the pancreas and complete the digestion of the meal prior to absorption by the villi.

10 Placing a person in a thermal blanket after severe blood loss ensures that the loss of warm fluid does not have a negative impact on the person's body temperature. The fluid lost must be restored, hence the intravenous drip. This fluid may not be at body temperature, causing the body to expend further energy to maintain temperature.

Analysing

11 The food cows ingest (grass) requires a great deal of mechanical digestion. In this way, a greater surface area is exposed to the action of enzymes produced by the bacteria that populate parts of their digestive tract. As grass is very low in energy, the more that is able to be ground up ready for the action of enzymes, the better for the animal. The grinding molars allow maximum mechanical digestion of the grass.

12



Evaluating

13 When a person is suffering from diarrhoea, the matter in the large intestine moves through quickly; thus water cannot be absorbed and the waste that is eliminated is quite runny. In constipation, waste moves slowly through the large intestine; all available water is absorbed,

producing a hard, dry faecal body that is difficult to expel. In an ideal situation, at least 50 mL of water needs to be absorbed into the body via the large intestine. It is important that enough fluid remains in the waste material to allow for an easy passage out of the body but not enough to produce a runny discharge.

14 The role of the stomach is to break down food into smaller pieces so that pepsin can access more of the food. The environment in the stomach is very acidic, having a pH of 2.0 – 3.0 due to the release of hydrochloric acid by the stomach wall. The enzyme pepsin is activated by low pH and therefore is only functional in the stomach when hydrochloric acid is released. If the pH of the stomach is not low then pepsin does not function properly and digestion is not complete.

Creating

15 Answers will vary.

Practice exam questions

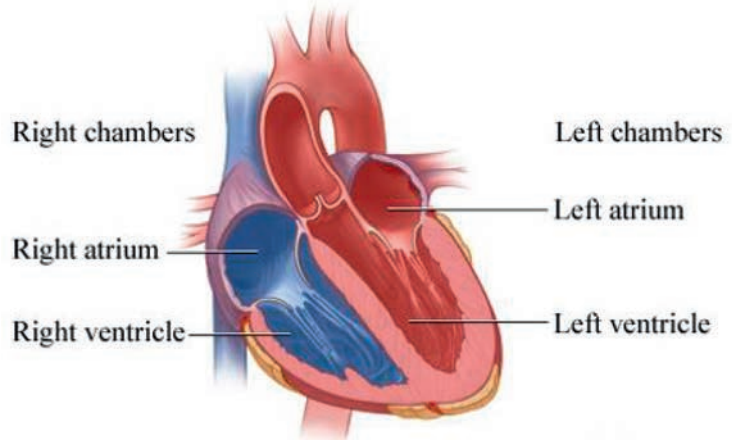
1 A

2 D

3 B

4 C

5



1 mark per label. Labels must include 'left' and 'right'.

1 mark oxygenated blood indicated as entering left atrium.

6 **a** (1 mark each, maximum 5 marks)

- Oxygen is transported from the external environment to body cells.
- Oxygen is actively pumped into the lungs by breathing/inhalation.
- Oxygen dissolves in a film of fluid coating the alveolar surface.
- Oxygen diffuses across the alveolar surface into the bloodstream.
- There is a large surface area for maximum diffusion.
- Diffusion is rapid over short distances.
- Oxygen is carried in the bloodstream around the body.
- Oxygen diffuses from the bloodstream along a diffusion gradient.
- Oxygen diffuses into intercellular fluid and then into cells.

b Carbon dioxide is transported from body cells to the external environment (1 mark each, maximum 5 marks)

- Carbon dioxide diffuses out of the cell along a diffusion gradient.
- Carbon dioxide diffuses into intercellular fluid and then into the bloodstream.
- Carbon dioxide is carried by the bloodstream to the lungs.
- When in the lungs, carbon dioxide diffuses from the bloodstream.
- Carbon dioxide diffuses into the alveoli along a diffusion gradient.
- Carbon dioxide is pumped out of the lungs by breathing out/exhalation.

7 Diffusion (1 mark); it is passive/ has no energy cost (1 mark); involves movement of a substance from an area of high concentration to an area of low concentration. (1 mark)

8 Any four of the following. The surfaces must:

- be moist, so the gases can dissolve in the water and diffuse from one side of the membrane to the other
- be thin and permeable, so the gas molecules can move across it easily and quickly
- have a large surface area in relation to the volume of the organism, so as to adequately provide the gaseous requirements
- have a greater concentration of required gas on one side of the membrane than the other, so that a concentration gradient is maintained
- be highly vascularised; this means they have a dense network of capillaries, either just beneath the surface (in the case of skin) or wrapped around each structure (in alveoli).

9 **a** Open circulatory system: insect, closed circulatory system: mammal

b Any three differences from the following.

Open circulatory system: (3 marks)

- has haemolymph
- fluid is not contained in closed vessels
- fluid is pumped by a simple/ tubular heart
- fluid moves into open ended tubes
- fluid directly bathes/in direct contact with the tissue it transports substances to and from.

Closed circulatory system: (3 marks)

- has a system that circulates blood
- blood moves through a series of connected vessels
- blood is pumped by a heart
- blood is never in direct contact with the tissues it supplies.

10 (10 marks)

Spiracles: e.g. grasshopper (1 mark)

Structures, any two of: (1 mark)

- thorax
- spiracles
- abdomen
- tracheae
- tracheoles.

Function, any three of: (3 marks)

- spiracles found along the thorax and abdomen
- spiracles are openings at the body surface that lead to tracheae
- tracheae are tubes made of chitin
- system allows oxygen to pass in by diffusion
- tracheae carry air directly to cells for gas exchange
- tracheae branch into smaller tubes known as tracheoles
- function of abdomen is to pump air
- system speeds up diffusion.

Gills, e.g. goblin shark (1 mark)

Structures, any two of: (1 mark)

- filaments
- capillaries.

Function, any three of: (3 marks)

- thin filaments are highly branched and folded
- structures enable dissolved oxygen in the water to rapidly diffuse across the gills (into bloodstream)
- long thin filaments have high surface area to volume ratio
- gas exchange surfaces are highly vascularised
- arrangement of gill filaments enables countercurrent flow
- fish constantly open their mouth and swim to allow water to pass over their gills.

Chapter 13 Plant systems

Question set 13.1

Remembering

1 **a** Xylem is responsible for the transport of water, along with mineral nutrients, from the roots to the leaves in one direction (unidirectionally).

b Phloem transports sugars, in the form of sucrose, and other products of photosynthesis from one part of a plant (usually where they are made, the leaves, or where they are stored, the roots) to where they are needed; therefore, transportation can be in two directions.

Understanding

2 The essential requirements of a large plant include carbon dioxide, water, light, oxygen and minerals. Photosynthesis and respiration are the processes that need these requirements.

3 Tubular, elongated, dead xylem cells allow the free passage of water via passive processes. This is a simple process compared to transport of substances in phloem. Phloem cells consist of sieve tube cells and companion cells. Sieve tube cells are long, thin phloem cells that have large pores through the cell walls at either end. These cells have no nuclei, mitochondria or vacuoles. The sieve tube cells are arranged end-to-end into sieve tubes. The sieve tube cells share cytoplasm. As a result, each sieve tube forms a channel through which sugars and other plant products can flow. Companion cells are phloem cells that are found alongside the sieve tubes. Companion cells have a cell nucleus and other cell organelles that are lacking in the sieve tube cells. They use energy to actively control the functioning of the sieve tube cells.

4 Root and shoot systems perform different functions for the plant. A root system anchors the plant, and penetrates the soil to absorb water and nutrients. It may store food. In contrast, a shoot system produces sugars by photosynthesis and carries out reproduction. Photosynthesis can only take place above the soil layer where the plant cells can utilise sunlight.

Question set 13.2

Remembering

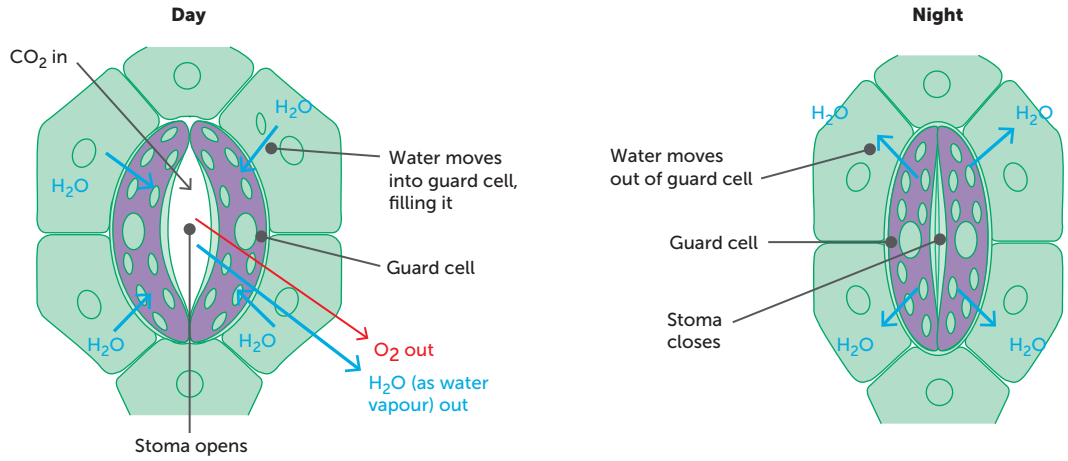
1 Stomata are small openings in leaves and some stems. The singular is stoma. Guard cells are pairs of cells surrounding and controlling the action of stomata.

2 Oxygen, carbon dioxide, water vapour

3 Gases move in and out of leaf cells by diffusion. In root cells, gases are also transferred by diffusion through the root hairs.

4 Oxygen is produced in photosynthesis and used in cellular respiration. Carbon dioxide is produced in cellular respiration and used in photosynthesis. Water vapour available in humid environments can enter the leaf via open stomata and water produced in photosynthesis can exit closed stomata as vapour during transpiration.

5 a a



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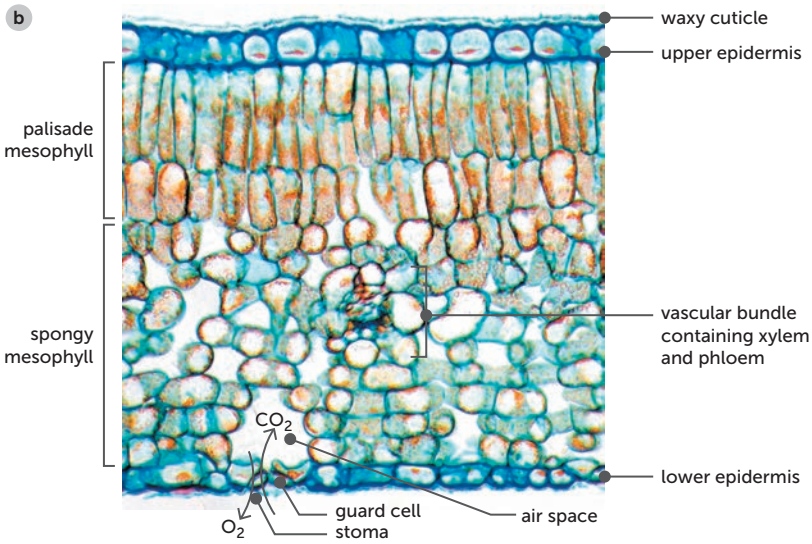

Question set 13.3

Remembering

1 Absorption is the movement of water and dissolved substances into the root hairs. Water moves by osmosis, which is passive movement, from a high water content in soil to the lower water content in the root hairs. Some substances (ions) can be actively transported across the membrane into the roots with the use of transport proteins. This requires energy.

2 The features of the xylem that make it an effective water transporter include:

- lignified walls that prevent the collapse of xylem vessels as water is 'sucked' up the plant via the transpiration stream
- the narrowness of the vessels that allow the forces of adhesion and cohesion to work to their best advantage
- the pits in the sides of the walls of vessels in some plants that aid the adhesion forces.

3 Translocation is the active movement of organic substances (sugars) in solution, from source to sink, through the phloem of vascular plants. It is multidirectional depending on the needs of the plant. Sugars, usually in the form of sucrose, are actively transported against a concentration gradient (from high to low concentration) into the sieve cells. This requires energy.

4 The energy for translocation comes originally from the Sun. Photosynthesis converts light energy into chemical energy in the form of sucrose. The sucrose is then broken down to release energy to allow translocation and other functions in the plant to occur.

5 The phloem is an ideal transport system for nutrients because it allows the movement of nutrients throughout the plant in all directions. The nutrients are dissolved in the cytoplasm of the cells of the phloem and move through sieve cells via openings at the ends of each of the cells.

6 The main function of the leaf is to allow maximum levels of photosynthesis to occur. It absorbs sunlight via chloroplasts in its cells, it is the focal point for the passage of water and it allows carbon dioxide to enter via the stomata.

7 Substances that enter leaves and that are used for photosynthesis include carbon dioxide, water and sunlight (though sunlight is not strictly a substance, but an energy form).

Understanding

8 The forces that enable water to move through the xylem vessels and reach the top of the tallest tree are adhesion (the attraction that exists between water molecules and the molecules of the xylem vessel) and cohesion (the attraction that exists between individual water molecules).

9 The energy for transpiration comes from sunlight, which works to evaporate water from the leaves of the plant.

10 Mineral ions in a plant go towards the construction and provision of various organelles and other plant structures; for example, ions are required in the production of chloroplasts and chlorophyll.

11 Answers will vary.

Question set 13.4

Remembering

1 Arid describes a climate that has little or no rain.

2 An adaptation is any change in the characteristics of an organism that makes it better able to survive its environment. Structural adaptations of desert plants include small leaves (sometimes reduced to spines) which have a reduced number of stomata and hence reduce water loss; and sunken stomata, which decrease the concentration gradient between internal and external leaf environment, leading to reduced evaporation and reduced water loss.

Physiological adaptations of desert plants include having a reversed of opening and closing rhythm of stomata, so that the stomata are closed during the day and the plant avoids excessive water loss via evaporation.

3 A structural adaptation is a physical feature and a physiological adaptation is a process or function.

Understanding

4 A thick, impermeable waxy cuticle on the leaf surface; the waxy cuticle acts as a barrier to reduce water loss because the wax is not permeable to water.

5 Storing carbon compounds for later use; having the ability to control when and under what conditions they open their stomata. Some plants, such as pineapples and many cactuses and

orchids, have evolved mechanisms whereby they can open their stomata during the evening, when it is cooler, and effectively store carbon dioxide for use in photosynthesis in the daytime. They are able to close their stomata during the hottest part of the day.

Chapter review questions

Remembering

1 Oxygen, carbon dioxide, water and minerals

2 Xylem and phloem

3 Wind, temperature, humidity

Understanding

4 The major difference between animal and plant transport systems is that almost all animals have transport systems based on muscular systems. The animal circulatory system uses the mechanical action of muscle tissue. Plants lack muscle tissue.

5 Carbon dioxide enters the leaf via the stomata; oxygen may leave the leaf via the stomata. Carbon dioxide is required in the process of photosynthesis that occurs in the chloroplasts of the palisade and spongy mesophyll cells. It is also a product of cellular respiration that occurs either in the cytoplasm (anaerobic) or in the mitochondria (aerobic) of cells. Oxygen is produced as a by-product of photosynthesis and is also required in the aerobic respiration process that takes place in the mitochondria of the cells.

6 As the concentration of sugar in the phloem increases, water moves from the xylem into the sieve cells by osmosis. This increases the volume of liquid in the sieve cells, causing the sugary solution to move.

7 The xylem needs to be close to the phloem because the water needed for movement of sieve tube contents comes from the xylem. Osmosis occurs efficiently over small distances.

Applying

8 **a** A plant would be able to supply its own gaseous requirements when the rate of photosynthesis is equal to the rate of cellular respiration. In this way the amount of oxygen produced in photosynthesis would fuel the process of cellular respiration, and the amount of carbon dioxide produced in cellular respiration would drive photosynthesis.

b Carbon dioxide is usually taken in during the day, when the stomata are open. The stomata are closed at night and therefore carbon dioxide cannot diffuse in. Oxygen is also taken in during the day via the stomata; however, when the plant is producing its own oxygen via photosynthesis, it can use some of the oxygen it produces to perform respiration.

c A plant kept in the dark will lose weight. The products of photosynthesis would be used in cellular respiration and if the plant was kept in the dark it would not be able to replace those products.

9 If stomata were open all the time, there could be more water lost from the plant than gained from the soil. In this case, the plant would wilt and eventually die. If stomata stayed shut all the time, diffusion of carbon dioxide would be severely restricted. In this case, the rate of photosynthesis would be lower compared to the rate of cellular respiration. The plant would lose weight and eventually die.

10 a Water is lost through leaf stomata by the process of transpiration. Transpiration requires energy from the Sun to evaporate the water. This creates the transpirational pull that draws water into the roots.

b The energy for sugar transport comes from cellular respiration occurring in the mitochondria of the companion cells.

11 The absence of vascular tissue limits the size of mosses. The cells of a moss need to be almost in direct contact with their environment to ensure they are able to obtain all their requirements.

Analysing

12 Water enters the root from the soil by the process of osmosis. Mineral ions are taken up by the root by diffusion and active transport.

13 The adhesion and cohesion forces of water in xylem vessels allow movement of water. In xylem, the thickened, lignified walls normally prevent the water column from breaking. The narrow, thickened xylem vessels arise in dead xylem tissue. The process of water movement through the plant does not require the expenditure of plant energy; therefore, it can successfully occur in non-living cells. Phylum tissue, on the other hand, relies on energy expenditure. Cellular respiration must occur; this requires living cells that contain specifically, mitochondria.

Evaluating

14 Costs include loss of water, which can lead to wilting (when the water loss is higher than the water absorption) and reduced growth. Transpiration causes the stomata to open, benefitting the plant by enabling gas exchange, including the diffusion of carbon dioxide needed for photosynthesis. When water is sufficient, transpiration leads to turgidity. Transpiration also cools plants and enables flow of mineral nutrients and water from roots to shoots.

Creating

15 Responses will vary.

Practice exam questions

1 C

2 D

3 C

4 A

5 D

6 A

7 B

8 a False (1 mark); water travels to the leaves in the xylem, or the phloem transports sugars, not water (1 mark).

b True (1 mark); a high surface-area-to-volume ratio maximises substance uptake (1 mark).

9 a Diffusion is where molecules/solutes/substances move from an area of high concentration to an area of low concentration. Osmosis specifically refers to the movement of water molecules from an area of high concentration to an area of low concentration through a semipermeable membrane (or from less concentrated solution to more concentrated solution). (2 marks)

b Either movement of gases into and out of the leaf, or diffusion of carbon dioxide into the leaf, or diffusion of oxygen out of the leaf, or diffusion of some nutrients from the soil into the roots. (1 mark)

c Movement of water from the soil into the roots. (1 mark)

10 For transport of water, any five of: (5 marks)

- water is transported in the xylem (vessels)
- transport is in one direction from roots to leaves
- water is obtained by absorption/osmosis
- water enters through the root system of the plant
- xylem cell structure is tubular/elongated/made of lignin
- this is passive movement (up the column/tubes due to the combined processes in next point)
- it is caused by root pressure, capillary action and transpiration.

For transport of photosynthesis products, any five of: (5 marks)

- photosynthesis products include sugars/sucrose/glucose
- these substances are transported in the phloem
- transport is in multi/two directions
- transport is to growth areas or storage/from source to sink/in the root and shoot systems of the plant
- phloem cells consist of sieve plates/sieve tubes and companion cells
- cells contain pores which allow the movement of glucose molecules into and out of sinks/sources/cells
- process requires energy/is an active process called translocation.