NSW BIOLOGY 3&4

Module 3 Biological Diversity
Module 4 Ecosystem Dynamics

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Contents

Module 4 Ecosystem Dynamics

Introduction

This book covers the Biology content specified in the NSW Biology Stage 6 Syllabus. Sample data has been included for suggested experiments to give you practice to reinforce practical work in class.

Each book in the *Surfing* series contains a summary, with occasional more detailed sections, of all the mandatory parts of the syllabus, along with questions and answers.

All types of questions – multiple choice, short response, structured response and free response – are provided. Questions are written in exam style so that you will become familiar with the concepts of the topic and answering questions in the required way.

Answers to all questions are included.

A topic test at the end of the book contains an extensive set of summary questions. These cover every aspect of the topic, and are useful for revision and exam practice.

Words To Watch

account, account for State reasons for, report on, give an account of, narrate a series of events or transactions.

analyse Interpret data to reach conclusions.

annotate Add brief notes to a diagram or graph.

apply Put to use in a particular situation.

assess Make a judgement about the value of something.

calculate Find a numerical answer.

clarify Make clear or plain.

classify Arrange into classes, groups or categories.

comment Give a judgement based on a given statement or result of a calculation.

compare Estimate, measure or note how things are similar or different.

construct Represent or develop in graphical form.

contrast Show how things are different or opposite.

create Originate or bring into existence.

deduce Reach a conclusion from given information.

define Give the precise meaning of a word, phrase or physical quantity.

demonstrate Show by example.

derive Manipulate a mathematical relationship(s) to give a new equation or relationship.

describe Give a detailed account.

design Produce a plan, simulation or model.

determine Find the only possible answer.

discuss Talk or write about a topic, taking into account different issues or ideas.

distinguish Give differences between two or more different items.

draw Represent by means of pencil lines.

estimate Find an approximate value for an unknown quantity.

evaluate Assess the implications and limitations.

examine Inquire into.

explain Make something clear or easy to understand.

extract Choose relevant and/or appropriate details.

extrapolate Infer from what is known.

hypothesise Suggest an explanation for a group of facts or phenomena.

identify Recognise and name.

interpret Draw meaning from.

investigate Plan, inquire into and draw conclusions about.

justify Support an argument or conclusion.

label Add labels to a diagram.

list Give a sequence of names or other brief answers.

measure Find a value for a quantity.

outline Give a brief account or summary.

plan Use strategies to develop a series of steps or processes.

predict Give an expected result.

propose Put forward a plan or suggestion for consideration or action.

recall Present remembered ideas, facts or experiences.

relate Tell or report about happenings, events or circumstances.

represent Use words, images or symbols to convey meaning.

select Choose in preference to another or others.

sequence Arrange in order.

show Give the steps in a calculation or derivation.

sketch Make a quick, rough drawing of something.

solve Work out the answer to a problem.

state Give a specific name, value or other brief answer.

suggest Put forward an idea for consideration.

summarise Give a brief statement of the main points.

synthesise Combine various elements to make a whole.

SURFING

NSW BIOLOGY 3&4

Module 3

BIOLOGICAL DIVERSITY

CONTENT FOCUS

In this module you will:

- Understand the importance of biodiversity in balancing the Earth's ecosystems.
- Explore how biodiversity can be affected slowly or quickly over time by natural selective pressures and also how human impact can affect biodiversity over a shorter time period.
- Learn about the theory of evolution by natural selection and the effect of various selective pressures.
- Understand the importance of monitoring biodiversity (for example by observing abiotic factors in the environment) to be able to predict future change and allow ecologists to design strategies to reduce the effects of adverse biological change.
- Investigate adaptations of organisms thet increase the organisms' ability to survive in their environment.
- Engage with all the Working Scientifically skills for practical investigations inviolving the focus content to collect, process and analyse data and identify trends, patterns and relationships related to biological diversity.

1 Assumed Knowledge Module 3

QUESTIONS

1. Define evolution.
2. What is natural selection?
3. Distinguish between biotic and abiotic factors.
4. What is meant by the 'physical conditions' of the environment?
5. Many species compete for resources. What is meant by 'resources'?
6. The diagram shows the photic zone in a body of water.

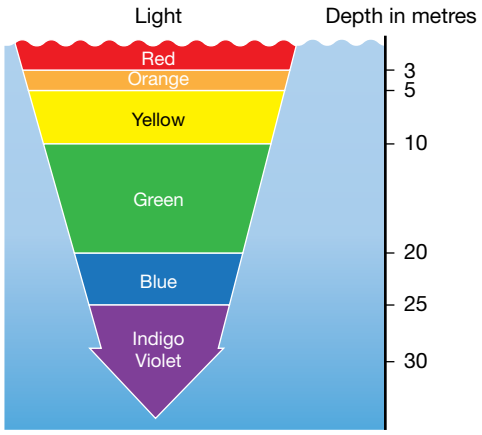

Figure 1.1 Photic zone in water.

(a) What is meant by the photic zone?
(b) Outline the importance of the photic zone.

7. Discuss how abiotic factors can lead to desertification.
8. Define an adaptation.
9. Use an example to show how a named adaptation assists in a specific environment,
10. What is meant by the habitat of an organism?
11. The diagram shows the red kangaroo, *Macropus rufus*.

Figure 1.2 Red kangaroo, *Macropus rufus*.

(a) How does the binomial system help identify this kangaroo?
(b) Describe one adaptation of the red kangaroo to its environment.

12. What is meant by topographic factors?
13. What conditions occur in Australia with El Nino?
14. The diagram shows ecological succession.

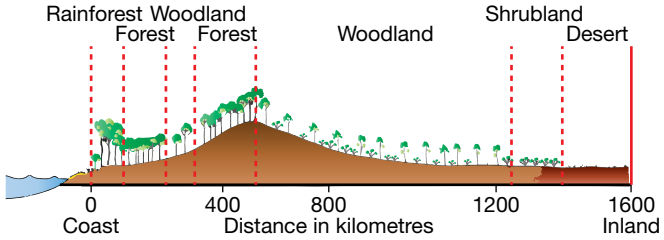

Figure 1.3 Ecological succession.

Define ecological succession.

15. Define speciation.
16. What is biodiversity?
17. The diagram shows a cane toad.

Figure 1.4 Cane toad.

Outline why there is concern in Queensland and the Northern Territory about the spread of cane toads across the land.

18. The diagram shows the digestive system of a koala.

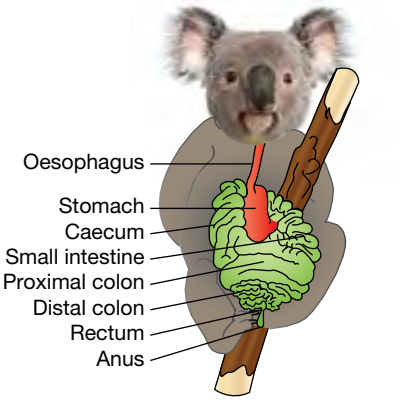

Figure 1.5 Digestive system of a koala.

Identify a structural adaptation of the koala digestive system.

19. Identify some areas of evidence for evolution.
20. Define palaeontology.
21. Define biochemistry.
22. Draw a flow chart to show the evolution of the vertebrates from the ancestral fish.
23. Identify the factors that determine the features of an organism.
24. Use an example to show how environment influences the appearance of an organism.

2 Abiotic and Biotic Features Of the Environment

The **environment** includes all living and non-living things in our surroundings. The environment can be divided into **abiotic** (non-living) and **biotic** (living) components.

The **abiotic features** include all factors that relate to climate, e.g. temperature, rainfall, wind, light intensity, day length and humidity. Abiotic features also include the chemical features such as pH of the soil or water, salinity in the soil/water, and availability of ions or gases. Other abiotic features include resources used by organisms such as nesting materials; landforms; soil type; and water drainage.

The **biotic features** include all living things – members of the same species and members of other species. Other species may be competitors for the same food source or nesting site, predators, food sources, disease-causing pathogens or decomposers which break down the wastes and eventually the dead body of the organism.

The environment can also be classified as either **aquatic** (living in water) or **terrestrial** (living on land). Aquatic environments are subdivided into freshwater and marine (saltwater) environments. **Estuarine** environments occur where a freshwater river meets the sea, causing a fluctuation in salt levels with higher salinity when the tide comes in and lower salinity when the tide goes out.

To compare the abiotic characteristics of aquatic and terrestrial environments, it is necessary to look at such features as viscosity, buoyancy, pressure, temperature variation, availability of gases, water and ions, and light penetration.

Viscosity refers the thickness of the medium, e.g. air or water, and its ability to resist internal movement through it. The thicker the medium, the higher the viscosity and the more internal friction it offers to the organism. Viscosity affects the ability of the organism to move around; for example, water is more viscous than air so many aquatic animals are more streamlined than land animals so that they can move rapidly through the water.

Buoyancy is the force giving an upward thrust. Buoyancy is determined by the density of the medium and determines the floating ability of the organism. Air provides little upthrust, so most terrestrial organisms need a skeleton or some means to support their own weight. Salt water provides more upthrust than fresh water, as shown by placing an egg in salt water and in fresh water – it will float on top of the salt water but will sink to the bottom of the beaker filled with fresh water.

Pressure is the force exerted on a body by its medium. In water, pressure depends on depth – the deeper the water, the higher the pressure. While on land, pressure depends on altitude – the higher the altitude, the lower the pressure.

Temperature variation is important as many chemical reactions in the body are temperature dependent; if the temperature rises too high, enzymes denature and if the temperature drops too low, enzymes become inactive. All enzymes have an optimum temperature at which they operate with maximum efficiency, e.g. human enzymes operate best at 37.5°C. Usually the temperature of water varies less than the air temperature on land; however, this does depend on geographical location and the size of the body of water. If the body of water is large, e.g. the Pacific Ocean, temperature variation is much smaller than in a small body of water such as a small pond. Water temperature decreases with depth.

The **availability of gases**, e.g. oxygen and carbon dioxide, and **ions**, e.g. nitrates, phosphates, calcium ions will determine whether a particular environment is suitable for a specific species. Gases are more readily available in air than in water, e.g. a litre of air contains about 210 cm^3 oxygen while a litre of water at 15°C contains about 6 cm^3 oxygen. In water the amount of dissolved gases depends on other factors such as temperature, depth and turbulence. Hot water holds less dissolved oxygen than cold water. This means that there is more oxygen and carbon dioxide in the Antarctic and Arctic oceans than in warm tropical water. The availability of gases also depends on the rate of diffusion – diffusion of gases is much faster in air than in water. Diffusion in air is about 10 000 times faster than through water.

The **availability of water** is a major concern for animals and plants on land and in water. On land many organisms use evaporation (sweating) as a cooling mechanism, but this can lead to dehydration. The extent and depth of root systems of many land plants is determined by water availability. In aquatic environments water availability can be a problem as water moves by a process called **osmosis** and organisms in salt water tend to lose water by osmosis while organisms in fresh water tend to gain water by osmosis.

Light penetration is especially important for plants for photosynthesis. In aquatic habitats light penetration is a critical factor as light only penetrates to about 100 metres. This means that algae and photosynthesis rarely occur below 100 metres in oceans and seas. Most terrestrial environments have good light penetration, although many plants have specific adaptations for full sun/partial sun/full shade. Tropical rainforests have vertical levels with different amounts of light penetration, ranging from the emergent tree level which receives full sunlight to the forest floor which receives little direct light.

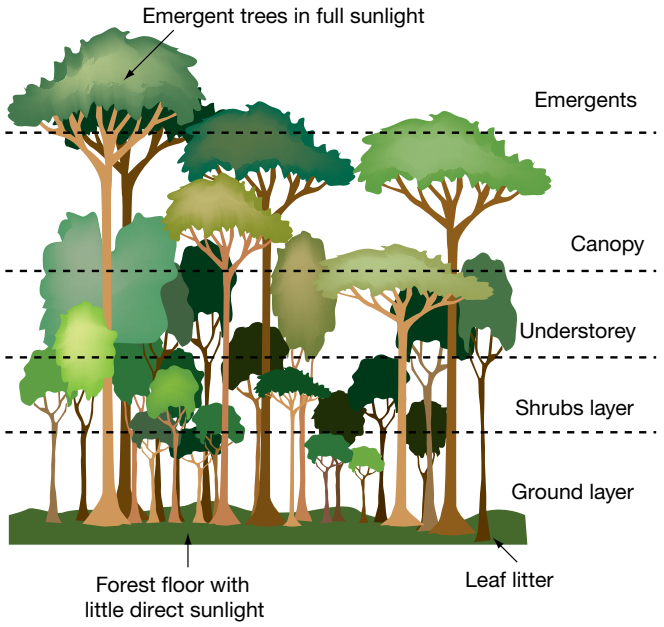

Figure 2.1 Vertical levels in a rainforest.

QUESTIONS

1. Outline the difference between abiotic and biotic features of the environment, using examples.
2. Identify the abiotic features that are involved with the 'climate' of an area.
3. What is meant by an 'aquatic' environment?
4. What is meant by a 'terrestrial' environment?
5. Explain how the salinity of the water changes in an estuarine environment.
6. (a) Define viscosity.
   (b) Explain why many aquatic animals have a more streamlined body shape than land animals.
7. Compare buoyancy in an aquatic and terrestrial environment.
8. Explain why the seas provide habitats with minimum temperature variation.
9. Outline how pressure changes with depth in the ocean.
10. Draw a table to show the differences in at least six abiotic features between aquatic and terrestrial environments.
11. Describe how the turbulence of water influences the availability of gases.
12. Compare water availability in aquatic and terrestrial environments.
13. Explain why a jellyfish has form while in water but collapses into a mass when placed on land.
14. Many aquatic mammals such as seals and whales have a thick layer of blubber. Identify the abiotic feature of their aquatic environment which requires this layer of insulation.
15. Areas along the Murray River in Victoria and South Australia have a salinity problem – the water in the river is becoming very salty. Outline how this change in abiotic environment could affect organisms in the area.
16. Which of the following only include abiotic factors?
    (A) Light, substrate, temperature, rainfall.
    (B) Light, salinity, pH, grazing pressure.
    (C) Substrate, water movement, predation, pH.
    (D) Predation, pathogens, grazing pressure.
17. Which of the following would show the greatest temperature variation in one day?
    (A) A fast flowing river.
    (B) A small pond.
    (C) A lake.
    (D) An ocean.
18. Humidity can be measured using the difference in temperature between a normal thermometer or 'dry bulb' and a thermometer with a wet base or 'wet bulb'. The wet bulb is cooled by evaporation which depends on the humidity. The table below shows part of the conversion table for a wet and dry bulb thermometer to work out humidity.

	Temperature difference (°C) (dry bulb minus wet bulb)									
	1	2	3	4	5	6	7	8	9	10
	Relative humidity (%)									
Dry bulb temperature (°C) 20	93	83	74	66	59	51	44	37	31	24
21	93	83	75	67	60	53	46	39	32	26
22	93	83	76	68	61	54	47	40	34	28
23	93	84	76	69	62	55	48	42	36	30
24	93	84	77	69	62	56	49	43	37	31
25	93	84	77	70	63	57	50	44	39	33
26	93	85	78	71	64	58	51	46	40	34
27	93	85	78	71	65	58	52	47	41	36
28	93	85	78	72	65	59	53	48	42	37
29	93	85	79	72	66	60	54	49	43	38

If the dry bulb thermometer reads 26°C and the wet bulb thermometer reads 20°C, what is the relative humidity?
(A) 51%
(B) 44%
(C) 58%
(D) 60%

3 Abiotic and Biotic Features Of Aquatic Environments

A **biome** is one of the world's major ecosystems usually named after the dominant vegetation of the area. Most of the world is covered by aquatic biomes which are divided into freshwater biomes and marine biomes. The salt concentration in marine biomes averages around 3% while the salt concentration in freshwater biomes is less than 1%.

Around 75% Earth's surface is covered by ocean biomes. The abiotic features of the ocean biomes, e.g. temperature, amount of evaporation and wind patterns influence the world climate and all other biomes. Photosynthesis carried out by phytoplankton and marine algae is highly important in recycling atmospheric carbon dioxide.

The abiotic features, and thus the biotic features of aquatic biomes, change with depth. Light falling on water can be absorbed, reflected or scattered. Most visible light is absorbed in the top 10 metres. The **photic zone** is the region where there is sufficient light for photosynthesis. The **aphotic zone** is where there is no light.

When light enters water the long wavelengths are preferentially absorbed. This means that the long wavelengths of light (red, orange and yellow) can only penetrate short distances while the shorter wavelengths (blue and violet) can penetrate further. Oceans appear blue because blue light is not strongly absorbed by water.

The amount of 'green' in the colour of oceanic water indicates the amount of chlorophyll (phytoplankton) present. The availability of light strongly affects the distribution of aquatic organisms.

Thermal energy in sunlight warms surface water. This means that water temperature decreases with depth in aquatic biomes. Temperature also varies with latitude from freezing near the poles to 30°C at the equator.

Pressure in water increases with depth, e.g. at 10 metres the pressure is twice the surface air pressure. Aquatic organisms require specific adaptations to enable them to change depth or to live at great depths.

QUESTIONS

1. Define biome.
2. Name the two types of aquatic biomes and state how they are classified.
3. Distinguish between the photic zone and the aphotic zone.
4. Identify which wavelengths of light penetrate least and furthest into water.
5. Explain why oceans appear blue.
6. Explain why the colour of ocean water around some islands often appears green.
7. Outline how temperature can vary in ocean biomes.
8. How does pressure affect aquatic organisms?

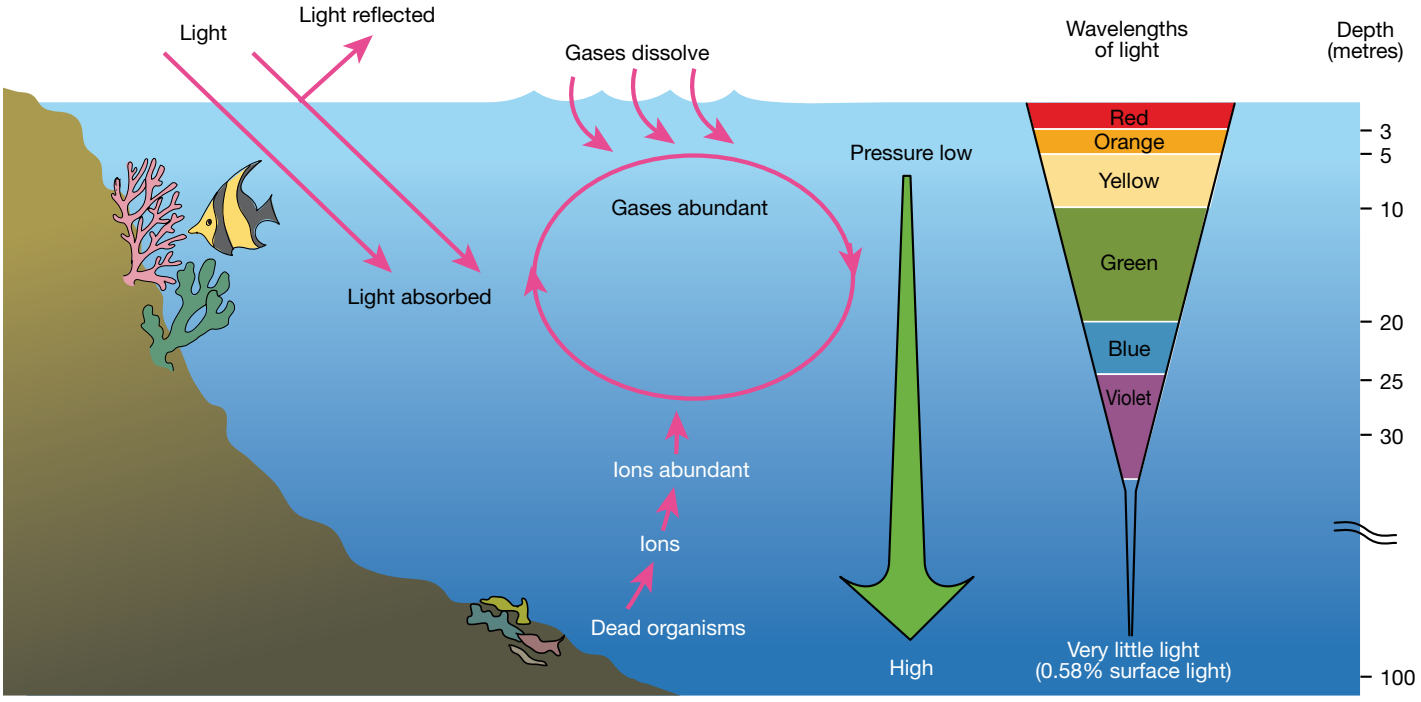

Figure 3.1 Ocean characteristics.

4 Australia and Abiotic Characteristics

Australia is an island continent with its greatest width across the Tropic of Capricorn. The abiotic features, e.g. geology and climate of Australia determine where different plants and animals can live. South of the Tropic of Capricorn there are temperate forests and woodlands with the east coast receiving year-round rain with warm/hot summers and mild/cool winters and snow in the high country. North of the Tropic of Capricorn rainfall and temperatures are higher and the Top End has wet and dry seasons. Central Australia is arid with sparse and sporadic rainfall usually in winter in the south and in summer in the north.

Rain shadow effect

The Great Dividing Range down the east coast creates a rain shadow effect making inland Australia much drier than the coastal regions. The Monaro region in NSW is affected by both the Snowy Mountains and the coastal ranges to create a dry rain shadow area.

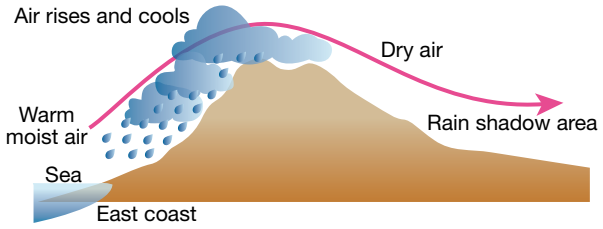

Figure 4.1 Rain shadow effect.

El Nino and La Nina

El Nino (boy-child) is an extensive warming of the eastern Pacific Ocean that changes the weather pattern for many countries, including Australia. Both El Nino and La Nina are associated with a change in the air surface pressure in the western Pacific known as the Southern Oscillation and are called El Nino/La Nina Southern Oscillation (ENSO) phenomenon.

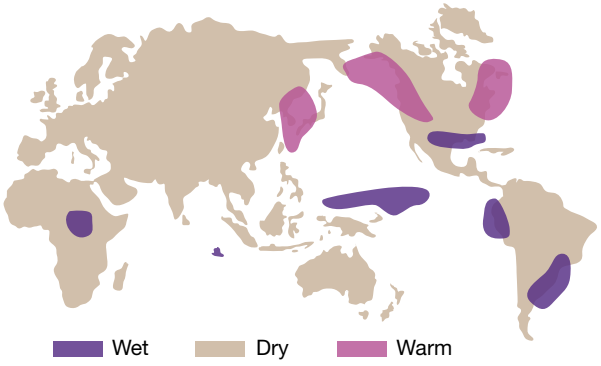

Figure 4.2 Areas affected by El Nino.

El Nino is warm water in the eastern Pacific and high air surface pressure in the western Pacific while La Nina is cold water in the eastern Pacific and low air surface pressure in the western Pacific. El Nino brings drier conditions for the south-eastern states in Australia. It begins with warm water in the eastern tropical Pacific Ocean near Peru that causes weaker than normal easterly trade winds. La Nina leads to higher rainfall in Australia.

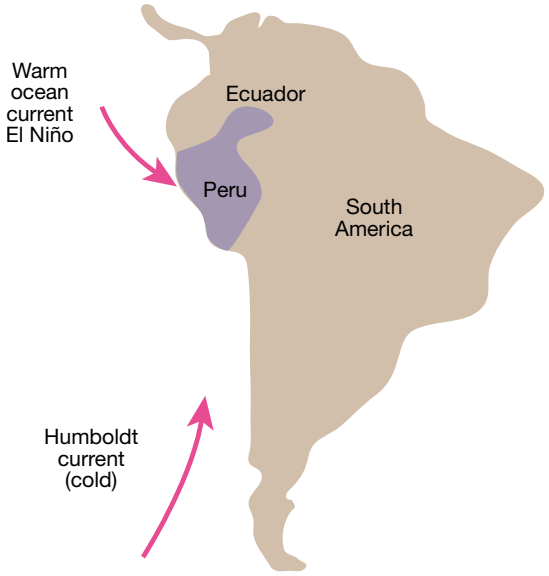

Figure 4.3 El Nino.

The floods across Queensland and northern NSW in 2011 were a result of La Nina. Meteorologists had predicted the wet weather in July 2010 after determining the sea surface temperature, air pressure and winds. La Nina also involves the cold water in the South Pacific pushing warm water against the east coast of Australia which leads to cyclones forming and crossing the coastline.

QUESTIONS

1. Use examples to show the range of abiotic conditions found in Australia.
2. Describe the rain shadow effect.
3. Explain how Australia is affected by the rain shadow effect.
4. What is ENSO?
5. Explain how ENSO can affect climate in Australia.
6. In 1997-98 there was a strong El Nino and the next decade saw a series of smaller El Ninos. Explain how this affected the climate in Australia.
7. How are other areas, besides Australia, affected by El Nino?
8. At the beginning of 2010 nearly 70% of NSW was in drought. What conditions could have led to this situation?
   (A) La Nina (B) El Nino
   (C) La Nita (D) El Nintendo

5 Natural Selection and Biotic Factors

Evolution is the change in a population over time. **Biological evolution** occurs when there is a natural selection pressure for a particular characteristic that increases the chances of survival in a changing environment. In humans, biological evolution is slowing down while cultural evolution is rapidly advancing and changing our way of life.

The mechanism for evolution is **natural selection**. Within a population individuals are characterised by a variety of inherited traits. In a changing environment, some of those traits will provide an advantage. Individuals with these traits will survive, breed and pass these traits on to their offspring so that, over time, these traits will become more common in the population. The population will evolve.

Biotic factors include all living things. This involves relationships with members of the same species and with other species.

Competition for resources

Competition can occur between individuals of the **same species** or between **different species**. The resources can be for the food supply, for access to water, for a nesting site, for nesting materials, etc. In Australia, the introduction of many species, e.g. rabbits, foxes, cane toad, bamboo, prickly pear, brumbies, Indian myna bird, feral rock pigeons and the fire ant has caused serious competition for resources with native species. This competition has led to the extinction of several species and many other species are on the endangered list. As Australia drifted north and the climate became drier and hotter, competition for resources also influenced which kangaroo survived to reproduce.

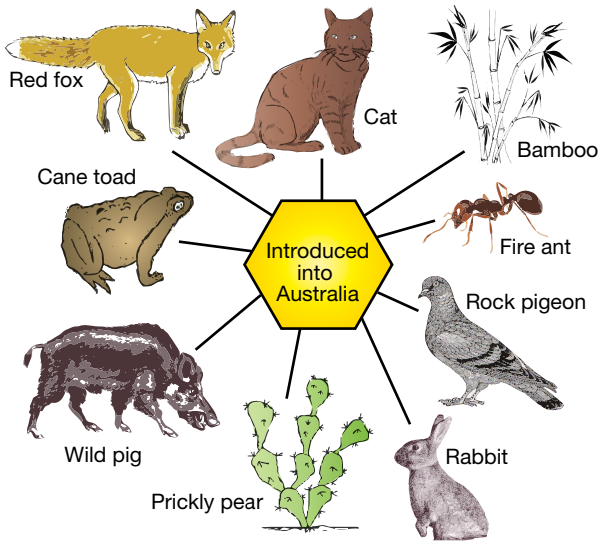

Figure 5.1 Species introduced into Australia.

Predation

A **predator** is an organism that feeds on living species. Most people think of predators as large and carnivorous but zooplankton prey on phytoplankton and other zooplankton and when a herbivore eats grass it is predation though we use the terms **grazing** and **browsing**. In Australia it was hoped that the introduction of the fox (predator) would help control the population of rabbits (prey). The release of domestic cats into Australia into the wild to become feral cats has contributed to the extinction and endangerment of many native species. A case study in Sherbrooke Forest, Victoria showed a decline in the size of the superb lyrebird (*Menura novaehollandiae*) largely due to predation of juvenile birds by cats.

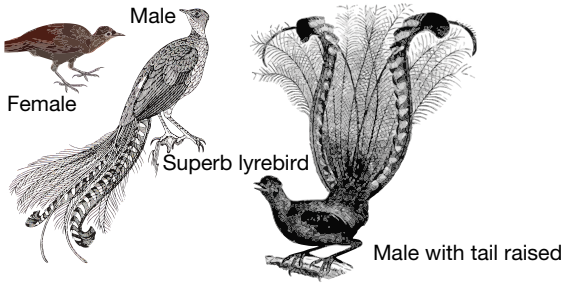

Figure 5.2 Lyrebird (*Menura novaehollandiae*).

Symbiosis

Symbiosis refers to a relationship where organisms of two different species live together in direct contact. These relationships can benefit both species in **mutualism**, or one species benefits (usually the smaller benefits) and the host is neither harmed nor helped in **commensalism** or one species, the parasite benefits and lives on the host which is harmed in **parasitism**. Natural selection has led to the development of many symbiotic relationships.

Lichens are a mutualistic symbiotic relationship between a fungus and either a photosynthetic alga or cyanobacterium in a relationship that both are dependent on each other for survival in their terrestrial environment. Nitrogen fixing ***Rhizobium*** bacteria form root nodules on the roots of many leguminous plants in a mutualistic relationship helping the plant to grow in nitrogen poor soils. ***Acacias,*** e.g. wattles are legumes though the plants are not totally dependent on the *Acacia* rhizobia for survival as wattles can survive without nodules but the plant flourishes better with nodules.

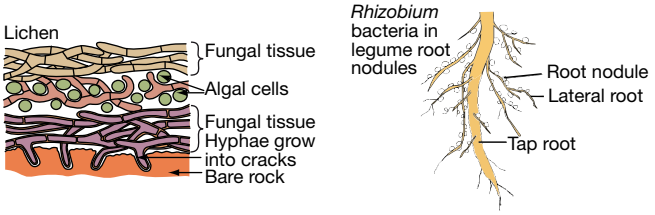

Figure 5.3 Mutualism.

Epiphytes are plants that grow attached to another plant using it for position and support and do not obtain nutrients or water directly from the host in a commensal relationship, e.g. Australian *Dendrobium* spp (orchids).

Endoparasites live within the host, e.g. tapeworms while **ectoparasties** feed on the surface of the host, e.g. lice, aphids. Many endoparasites have complex life cycles to enable them to transfer from host to host.

Disease

A **disease** is any condition that impairs or interferes with the normal functioning of the body. A **pathogen** is a disease-causing parasite that lives on or in a host. Pathogens include viruses, bacteria, fungi and single celled eukaryotes. Modern biological control often uses pathogens to control a pest, e.g. the introduction of the **myxoma virus** to Australia in 1950 to control the rabbit population. Myxomatosis is a highly infectious disease that causes skin tumours, blindness, fatigue, fever and death.

QUESTIONS

1. Define evolution.
2. Distinguish between biological evolution and cultural evolution.
3. Explain how natural selection leads to evolution.
4. Define biotic factors.
5. The introduction of the rabbit has increased competition for resources, leading to changes in several other species. Choose one native Australian species and explain how the introduction of the rabbit has led to changes.
6. Define symbiosis.
7. Distinguish between mutualism, commensalism and parasitism.
8. Explain why the evolution of lichen shows the importance of mutualism relationships between species.
9. The diagram shows an orchid.

Figure 5.4 Orchid plant.

Explain how natural selection has favoured the relationship between the tree and the orchid.

10. Distinguish between endoparasites and ectoparasites.
11. Since European settlement in 1788, many native species are either threatened or have become extinct. Although extinction is a natural process, what has caused the rapid decline of many native Australian species?
    (A) Competition with introduced species.
    (B) Loss of habitat from farming and logging.
    (C) Urban development.
    (D) All of the above.
12. The native burrowing bettong, *Bettongia lesueur*, is the only rat kangaroo to live in a burrow.

Figure 5.5 The native burrowing bettong, *Bettongia lesueur*.

When rabbits and foxes were introduced, this native became extinct on the mainland. Once it had been found across inland Australia in shrublands and semi-desert, but now it exists only on four islands off the coast of Western Australia. It has been suggested that we should reintroduce the burrowing bettong into fox-free areas on the mainland. Which of the following shows the result of such an action?
    (A) It will never lead to their survival on the mainland as rabbits will always take over the burrows.
    (B) It will never lead to their survival on the mainland as all necessary habitats have been destroyed.
    (C) It will succeed if predators and competitors are controlled.
    (D) It will succeed if they are immunised against such diseases as myxomatosis.
13. Competition *must* occur between two species of birds when:
    (A) They are found in the same area at the same time and season.
    (B) They use the same limited resources for their nests.
    (C) Both are the food source of the wedge-tailed eagle.
    (D) Both are susceptible to the same bacterial infection.
14. The oldest angiosperm (flowering plant) fossils are dated from the Cretaceaous period about 120 mya and by the end of the Cretaceous (around 65 mya) they were the dominant plant form on Earth. What feature gave them a survival advantage?
    (A) Ability to attract insect and animal pollinators.
    (B) Use of wind to spread pollen.
    (C) Tough leaves with a vascular system.
    (D) Ability of male gamete to swim to female gamete.

6 Natural Selection and Abiotic Factors

Evolution is the change in a population over time and the mechanism for evolution is **natural selection**.

Abiotic factors are non-living factors including those that relate to climate, e.g. temperature, rainfall, wind, light intensity, day length and humidity.

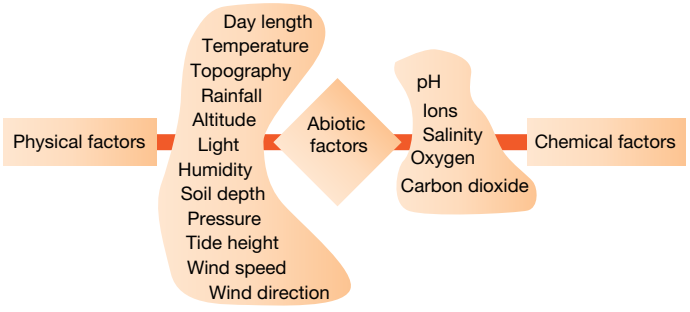

Figure 6.1 Abiotic conditions.

Changes in physical conditions

The distribution and abundance of a species is determined by the physical and chemical nature of the environment. Each ecosystem can be described by its temperature and rainfall requirements, e.g. deserts have low erratic rainfall and high temperatures.

A change in the physical conditions, e.g. temperature or rainfall, will act as a selection pressure for evolution. For example, in the past 25 million years the physical conditions in Australia have changed, with increased aridity causing a decrease in rainforests and an increase in open woodlands and grasslands with poor quality grasses. These changes have altered the selecting pressure on the kangaroo so that the ancient kangaroo, which was much smaller with generalised molars, has evolved into the modern day red kangaroo, which is much larger in size and eats grasses using its high crested molar teeth. In the red kangaroos there has been a reduction in the number of toes, the disappearance of a 'big' toe and an increase in toe length, which all assist in increasing the speed of the red kangaroo and changing to a hopping gait.

Figure 6.2 Red kangaroo and musky rat kangaroo.

The musky rat kangaroo, found only in rainforest in north Queensland, has several primitive features and is believed to resemble the early kangaroo. For example, it still has five toes on its hind foot, doesn't ho p but gallops like a horse when moving fast, it has no specialised teeth and its stomach is a simple sac.

Changes in chemical conditions

A change in the chemical conditions in the environment can have a marked effect on plant life. Many plants prefer a specific soil type and the introduction of mining has led to the evolution of plant varieties especially tolerant to mineral wastes, e.g. plants near copper mines.

The use by humans of insecticides and antibiotics has led to the evolution of resistant varieties, e.g. strains of staphylococcus bacteria that are resistant to penicillin. In Australia, the change in the physical conditions, with increasing temperatures and lower rainfall as Australia drifts north, has also led to a change in the chemical composition of the soil. Increased erosion and leeching have helped to alter the soil type and have influenced the evolutionary path of Australian flora, e.g. eucalypts.

Soil salinity is the salt content of the soil. **Salination** can be caused by several processes, e.g. mineral weathering and extensive irrigation. As ground water rises it brings the salt to the surface and evaporation can leave dry salt ponds. Many native Australian plants are salt tolerant with deep roots and a high demand for water. The replacement of native woodland trees for farming crops which require less water meant rainwater seeped down to the water table which slowly began to rise bringing salt to the surface. The change in the chemical composition of the topsoil has dramatically decreased the viability of the area as farmland.

QUESTIONS

1. What is meant by abiotic factors?
2. Construct a table to distinguish between physical abiotic factors and chemical abiotic factors.
3. Outline the relationship between ecosystem and physical factors.
4. Use an Australian case study to show how changes in the physical or chemical conditions have led to changes in a species.
5. Explain how mining can influence the evolution of the plants in the area.
6. Use an Australian example to show how changes in physical and chemical conditions and increased competition for resources have led to changes in a species.

7. As Australia has drifted north, the continent has become drier and the soils poorer. There has been a change from the Antarctic beech forests to sclerophyllous plants. Fossils of eucalypts, with their 'capped' fruit, appear about 25 million years ago. Fire became frequent from about 100 000 years ago and acted as a selecting agent. Discuss why fires assisted the evolution of some of the sclerophyllous plants, such as eucalypts, but led to the extinction of other species.

8. *Procoptodon* were the short faced kangaroos. They had elongated hind limbs with a single large toe with a hoof-like nail on the foot. It has been suggested these features would allow them to reach high speed. There were four species of *Procoptodon* and all were grass eaters. The closest living relative of *Procoptodon* is the banded hare wallaby in Western Australia.

Figure 6.3 *Procoptodon pusio.*

   (a) Identify the features of *Procoptodon* that suggest it was able to reach fast speeds.
   (b) How is *Procoptodon* related to extant species?

9. (a) What is meant by soil salinity?
   (b) Outline a cause of soil salination.

10. When scientists refer to a 'change in the physical conditions in the environment' what do they mean?
   (A) The climate has altered in some way.
   (B) A predator has migrated into the area.
   (C) Disease has wiped out a large number of organisms.
   (D) The food source has become scarce.

11. When is natural selection *least* likely to occur?
   (A) During changes in the chemical conditions in the environment.
   (B) During static and unchanging conditions.
   (C) During introduction of a competitive species.
   (D) At the beginning of an ice age.

12. Salinity is a term to describe the salt content of soil or water. Australia has a salinity problem as many plants and animals cannot survive in high salinity areas. There are two types of salinity – dryland salinity and irrigation salinity. What causes soil salinity?
   (A) Surface water bringing salt into the area.
   (B) Underground water table rises and brings salt to the surface.
   (C) 'Salt rain' adding salt to the chemical composition of the soil.
   (D) Excessive amounts of fertiliser added to the soil.

13. Many areas of Australia are suffering from increasing salination. What human activity would add most to the increasing salinity problem?
   (A) Planting bushes like saltbush (*Atriplex*).
   (B) Grazing sheep on grassland.
   (C) Removing feral rabbits.
   (D) Clearing the native vegetation for European style agriculture.

14. When is competition *least* likely to occur between 2 species of herbivores?
   (A) When they are found in the same area at different times and seasons.
   (B) When they use the same limited resources for their burrows.
   (C) When both eat the same food source.
   (D) When there is limited available vegetation.

15. Over the past 25 million years Australia has moved northwards due to plate tectonics and the climate has become more arid. Kangaroos have diversified. The most primitive living kangaroo is the musky rat kangaroo, *Hypsiprymnodon moschatus*, which lives in rainforests and eats fruits and small invertebrates. By 10 million years ago there were five main groups of kangaroos – the carnivorous kangaroos (*Propleopus*), the musky rat kangaroos (*Hypsiprymnodon*), the rat kangaroos (*Caloprymnus*), the sthenurine kangaroos (*Sthenurus*) and the macropodine kangaroos (*Macropus*).

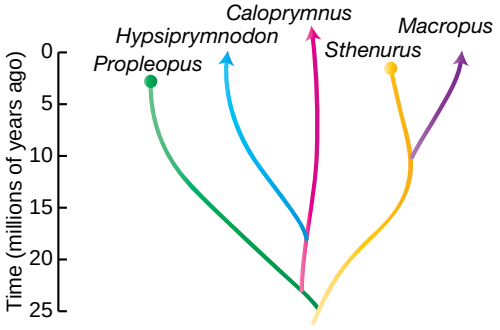

Figure 6.4 Evolution of kangaroos.

   What is this is an example of?
   (A) Convergent evolution.
   (B) Homologous structures.
   (C) Adaptive radiation from a common ancestor.
   (D) Evolution through inheritance of acquired characteristics.

16. In Australia the climate has changed over the last 25 million years. How has increasing aridity changed the plant vegetation?
   (A) Grassland → woodland → rainforest
   (B) Woodland → rainforest → grassland
   (C) Rainforest → woodland → grassland
   (D) Rainforest → grassland → woodland

7 Activity – Model For Natural Selection

Some biology students decided to perform a first-hand investigation to model natural selection. They used green, red, yellow and orange cards to represent different coloured beetles and used a dice with one side orange, two sides yellow and three sides red to represent predation.

Figure 7.1 Beetle cards.

They started with 40 cards representing 40 beetles in the original population, which consisted of 10 green cards, 10 yellow cards, 10 red cards and 10 orange cards. They shuffled the cards and then dealt them out in pairs. Each pair reproduced one offspring according to rules constructed by the students, so that 20 offspring were added to the population. The students then rolled the dice, simulating predation, and 20 cards were removed as 'eaten by a predator'. This method kept the beetle population constant at 40 beetles for every year. The numbers were recorded for year 1.

They repeated this method, accumulating results for '7 years' for this beetle population. Their results are in the table below.

Table 7.1 Student results for beetle population.

Year	Red	Green	Orange	Yellow	Total
1	10	10	10	10	40
2	6	12	12	10	40
3	2	14	13	11	40
4	1	19	12	8	40
5	0	22	15	3	40
6	0	28	12	0	40
7	0	33	7	0	40

QUESTIONS

1. In this experiment by the students, what is the 'selecting agent'?
2. How did the beetle population change over time?
3. (a) Outline how the students kept the population total constant over each year.
   (b) Explain why it was important to keep the population total constant.
4. (a) For this population what was the 'favourable characteristic for survival'?
   (b) In nature, name an environment which could represent where this beetle population could be found and explain why you chose this environment.
5. If the students decided to simulate a model for beetles in a sandy desert, how could they change the method so that the results would show natural selection for desert beetles?
6. Explain how changing the colours on the sides of the dice to 1 green : 1 red : 1 yellow : 1 orange would influence evolution.
7. (a) Describe an experiment you could perform to model natural selection that differs from the one described above.
   (b) Explain how this model of natural selection could be applied to nature.
   (c) Describe one other factor which leads to the evolution of a new species.
8. Explain why scientists use models.
9. A new predator was introduced to a large population of butterflies that showed variation in wing colours. Over time and several generations of butterflies there was a change in the frequency of the different wing colours. More butterflies had red-orange markings and the yellow varieties became rarer. What is one conclusion?
   (A) The butterflies changed their wing colour to aid survival.
   (B) The butterflies acquired the red characteristics because there was a need.
   (C) The yellow butterflies migrated to a desert where they would be more camouflaged.
   (D) The predator acted as a selecting agent in the environment.
10. Which of the following best describes natural selection?
    (A) The mechanism for evolution.
    (B) Survival of the strongest.
    (C) Producing mutations to survive in a changing environment.
    (D) Changing to fit in with the environment.

Use the information below for the next THREE questions. Several biology students wished to investigate natural selection. They painted toothpicks several different colours – purple, yellow, green, blue and red. They then marked out an area 50 cm × 50 cm on the school lawn. They randomly spread 30 toothpicks of each colour on the marked area. Using a stopwatch they had to pick up, one by one, as many toothpicks as possible in 30 seconds.

Their results are recorded in the table.

Trial	Number of toothpicks picked up in 30 seconds				
	Purple	Yellow	Green	Blue	Red
1	16	20	3	25	9
2	22	35	1	19	17
3	11	41	2	9	8
4	14	29	7	22	10
5	15	38	5	13	12

11. What could the students conclude?
(A) You get faster at picking up toothpicks with practice.
(B) Predators are most likely to see yellow-skinned animals in grasslands.
(C) Over many generations green toothpicks will dominate.
(D) Green toothpicks are least likely to be picked up from green grass.

12. If these results were used as an analogy so that the human was a predator, e.g. bird, and the toothpick was a food source, e.g. caterpillar, which characteristic is most favoured for survival of the caterpillar by natural selection in this environment?
(A) Purple (B) Yellow
(C) Red (D) Green

13. Why did the students repeat the experiment five times?
(A) To make sure they got the right results.
(B) To find a more statistically valid answer.
(C) To spend the maximum amount of the lesson time out of the classroom.
(D) To prove they were better than the other groups.

14. The diagram shows a transect across an area near a copper mine. The area was surveyed three times over several years.

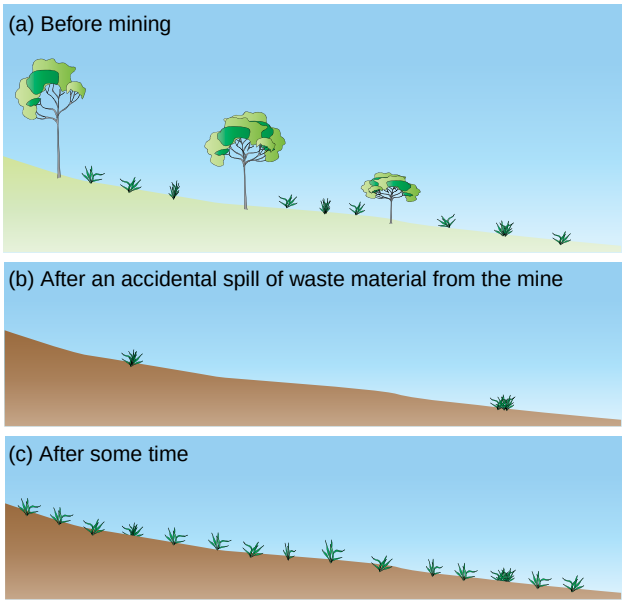

Figure 7.2 Transect across an area near a copper mine.

What is a reasonable deduction from these transects?
(A) Copper caused a mutation in the grass, making it immune to copper in the soil.
(B) Grass is better able to acquire characteristics in response to changed environmental pressure than trees and shrubs.
(C) There is greater genetic diversity in grass than in trees.
(D) Before mining, grass possessed a natural resistance to copper.

15. In a population, a certain gene is found to have a frequency of 25%. When would a decrease in the frequency of this gene occur?
(A) When the gene became recessive.
(B) When individuals with the gene had fewer offspring.
(C) When individuals with this gene were immune to a lethal disease.
(D) When the population size decreased.

16. The Wollemi pine has been found in the Wollemi National Park which is about 150 kilometres north-west of Sydney. There are 38 trees in two small stands. Some of the trees may be more than 1000 years old. Genetic tests have posed an interesting problem. It appears as though there are no genetic differences between the 38 trees. Why does such a limited gene pool worry scientists?
(A) Surrounding eucalypt species are more advanced and will be more successful in competing for resources.
(B) The trees cannot reproduce sexually by seeds.
(C) Seeds are due to mutate; this could occur before we have enough cuttings.
(D) Any change could wipe out the whole population.

17. How could students increase the reliability of their results in an experiment to model natural selection?
(A) Repeat the experiment several times to see if they get the same results each time.
(B) Use more accurate measuring devices.
(C) Make sure their method will give results that answer the aim.
(D) Check secondary sources to find out what other people have done on the same subject.

18. Which scientist proposed the theory of natural selection?
(A) Samuel Wilberforce.
(B) Charles Darwin.
(C) Gregor Mendel.
(D) Thomas Huxley.

19. Parrots are considered to be a Gondwanan bird. Parrots and their relatives belong to the Order Psittaciformes which includes the budgerigars, cockatoos, lorikeets, rosellas, parakeets, macaws, and lovebirds and sizes range from the 8 cm pygmy parrots of New Guinea to the 1 m giant macaws of South and Central America. On the other Gondwanan continents the parrots inhabit rainforests, however they have diversified in Australia and inhabit many other types of habitats and thus the Australian species show a wide colour range including red, green, yellow, black, white, grey, and pink. Considering their rainforest habitat, what is the predominant colour in present-day parrots from the Gondwanan lands besides Australia?
(A) Red (B) Pink
(C) White (D) Green

Answers

1 Assumed Knowledge Module 3

1. Evolution is the change in a population over time.
2. Natural selection is the mechanism for evolution.
3. Biotic factors refer to living things and abiotic factors refer to non-living things.
4. Physical conditions of the environment refer to features such as temperature, rainfall, humidity, topography and wind speed and direction.
5. Resources refers to anything that is used by the organisms, e.g. nesting material, food supply, water source.
6. (a) The photic zone is the top layer of a body of water where light can penetrate for photosynthesis.
   (b) The photic zone is highly important in aquatic ecosystems as the availability of light determines the distribution and abundance of photosynthetic organisms such as algae, water plants and cyanobacteria.
7. Desertification is the process when an area with good soil becomes a barren desert. Abiotic factors that can cause desertification include heavy rain and storm water washing down slopes and dry wind blowing fine particles of organic matter, silts and top soil from an area. This leaves large sandy particles and stones that will form the desert.
8. An adaptation is a characteristic which helps an organism survive in its environment.
9. The webbing between the toes of a frog is an adaptation for an aquatic environment to assist swimming in water.
10. The habitat is the small part of the ecosystem in which the organism lives.
11. (a) The binomial system uses the genus and species names, e.g. *Macropus rufus* to identify this particular species of kangaroo. This stops confusion which can be caused if common names are used and different areas have different common names for the same species.
    (b) A red kangaroo will lie down in the shade in the middle of a hot day to conserve energy and protect itself from the heat of the midday sun.
12. Topographic factors are abiotic factors that relate to features of an area such as the angle and aspect of a slope, altitude.
13. El Nino is warm water in the eastern Pacific and high air surface pressure in the western Pacific that bring drier conditions for the south-eastern states in Australia and weaker than normal easterly trade winds.
14. Ecological succession is a transition in species composition across an area, e.g. when species begin to inhabit barren ground or reclaim a disturbed community.
15. Speciation is the origin of a new species, e.g. due to natural selection and isolation.
16. Biodiversity refers to the genetic variety found in the different life forms on Earth.
17. Cane toads are an introduced species. They release a toxin poison which kills many native Australian predators, e.g. red-bellied black snake and the toads outcompete native frog species to occupy suitable habitats.
18. The koala has a very large caecum which is a structural adaptation that provides the space for the digestion of eucalyptus leaves.
19. Areas of evidence that support the theory of evolution include – 1. Fossil evidence. 2. Comparative embryology. 3. Biogeography. 4. Comparative anatomy. 5. Biochemistry such as DNA sequencing and DNA-DNA hybridisation.
20. Palaeontology is the study of life from the past based on fossil remains.
21. Biochemistry is the study of molecules and how they react in organisms.
22. Fish → amphibian → reptile → bird / mammal
23. Both genes and environmental factors determine the features of an organism.
24. In plants, e.g. pea plants, the environment can have a great influence on the appearance of an organism. If the plant has the genetic code to be tall, but is grown in poor soil which has few nutrients, then the plant will not reach its full height potential and may appear to be a dwarf plant.

2 Abiotic and Biotic Features Of the Environment

1. Abiotic features are the non-living features of the environment, e.g. climate, soil type, landforms. Biotic features of the environment are the living organisms, e.g. other members of the same species and other species such as competitors, predators, pathogens.
2. 'Climate' refers to such features as temperature, rainfall, wind, light intensity, day length, humidity.
3. An aquatic environment means living in water and can be either a freshwater environment or a marine environment.
4. Terrestrial environment means living on land.
5. Estuarine environments occur where a freshwater river meets the sea. Salinity fluctuates with the movement of the tides. At high tide, when the salt water comes in, the salt level rises. Conversely, at low tide, the salt water goes out and the estuary has low salt levels.
6. (a) Viscosity refers to the thickness of the medium and its ability to resist internal movement through it.
   (b) Aquatic animals have a more streamlined body shape than land animals as the higher viscosity of water means there is more resistance to movement in water than to movement in air. For example, tuna have a highly streamlined shape which allows fast speed with little resistance to movement in water, while a fast land animal (e.g. cheetah) has a streamlined shape but not as streamlined as the tuna.
7. Buoyancy is a force that gives an upthrust and both an aquatic and terrestrial environment provide some degree of upthrust. However, water provides a much greater upthrust than air. Air has little buoyancy.
8. Temperature variation refers to the range of temperatures found in a particular habitat. Since seas are very large bodies of water there needs to be a very large input of energy to raise the temperature of the sea, or a very large loss of energy to lower sea temperature. Sea temperatures do not change quickly or greatly. On the other hand, habitats such as deserts heat up very quickly during the day, and temperatures drop dramatically at night. Thus compared with other habitats seas provide habitats with minimum temperature variation.
9. In oceans, pressure increases with depth.
10.

Abiotic feature	Aquatic environment	Terrestrial environment
Buoyancy	Water is buoyant and provides upthrust.	Air has little buoyancy.
Pressure	Water pressure increases with depth.	Air pressure decreases with altitude.
Viscosity	Water has higher viscosity with more resistance to movement.	Air has lower viscosity with less resistance to movement.
Temperature variation	Temperature of large bodies of water stays relatively constant. Water heats up/cools down more slowly than air. Temperature decreases with depth.	Temperature can vary significantly both diurnally and seasonally. Temperature decreases with altitude.
Availability of oxygen	Oxygen is less available that in water and availability decreases with depth. More oxygen dissolves at lower temperatures.	Oxygen readily available but decreases with altitude.
Availability of water	Abundant water but high salt concentrations cause water loss through osmosis, e.g. marine biomes.	Availability depends on the environment which ranges from plentiful in rainforests or scarce in deserts. Dehydration is a constant problem.
Ion availability	Marine biomes have high levels of sodium and chloride ions. Fresh water has less ions and organisms require adaptations for osmoregulation.	Ion availability depends on soil type, pH and the amount of plant growth.

11. Turbulence refers to the amount of disturbance in the water, e.g. still water is found in a lake and turbulent water is found rushing over stones in rapids. Turbulent water has greater surface area in contact with the air, allowing more gases to dissolve into the water. Thus turbulent water has greater availability of gases than still water.
12. Both aquatic and terrestrial environments have problems with water availability and organisms in these environments have problems maintaining the required water balance in their bodies. On land the problem involves obtaining and keeping the needed amounts of water. Aquatic environments do not have this problem – they have sufficient water. However, aquatic environments have the problem of osmosis. In marine environments, the high salt content of the water means that water tends to move out of organisms into the salt water, while in freshwater environments, water tends to move from the water into the organism. Both aquatic and terrestrial environments have water availability problems, but the problems are different.
13. Jellyfish do not have a rigid skeleton; they are supported by the buoyancy of the water. When taken out of water, the air does not provide sufficient upthrust for the jellyfish and the jellyfish cannot support its own weight. It therefore collapses into a formless mass when on land.
14. The abiotic factor is the heat conduction ability of air and water. Water conducts heat better than air which means that endotherms (warm blooded animals) will lose heat due to conduction more easily in water than in air.
15. The increasing salinity of the Murray River means that the water in plants will move out of the plant by osmosis. The plants will dehydrate. This in turn affects the entire food web of the area and if sufficiently severe could wipe out the current ecosystem.
16. A
17. B
18. C

3 Abiotic Features Of Aquatic Environments

1. A biome is one of the world's major ecosystems usually named after the dominant vegetation of the area.
2. The two types of aquatic biomes are freshwater biomes (salt concentration < 1%) and marine biomes (salt concentration averaging 3%).
3. The photic zone is where there is sufficient light for photosynthesis while the aphotic zone has no light.
4. Red light (long wavelength) penetrates the least into water while blue light (short wavelength) penetrates furthest into water.
5. Oceans appear blue as blue light is least absorbed by water compared to the other wavelengths of light.
6. The water around some oceanic islands appears green due to the presence of phytoplankton which contain chlorophyll. The water is nutrient rich, warm, shallow and suitable for aquatic life.
7. The temperature of the water in ocean biomes varies with depth, e.g. deep water is colder than surface water, and also varies with latitude with warmer water near the equator and colder water near the poles.
8. Aquatic organisms require specific adaptations to live at great depths or to change depth as pressure rapidly increases with depth.

4 Australia and Abiotic Characteristics

1. Different areas of Australia have different abiotic conditions. Eastern Australia has year-round rain with warm/hot summers and mild/cool winters and snow in the high country. The Top End has wet and dry seasons and central Australia is arid with sparse and sporadic rain in winter in the south and in summer in the north.
2. The rain shadow effect is caused when a mountain blocks the wind carrying warm moist air. As the air rises to go over the mountain the temperature drops and rain falls on that side of the mountain. The air, now dry, continues over the mountain and dries the land. The other side of the mountain is called a 'rain shadow' area.
3. The mountains down the east coast of Australia create a rain shadow effect causing inland Australia to be drier than the coastal region. The Monaro region in NSW is affected by the Snowy Mountains and coastal range to make it a rain shadow plateau.
4. ENSO is the El Nino/La Nina-Southern Oscillation phenomenon which involves changes in the temperature of the western Pacific (El Nino/La Nina) and the air pressure changes in the eastern Pacific (Southern Oscillation).
5. La Nina involves much colder water in the eastern Pacific and low air surface pressure in the western Pacific. This brings rain and floods to eastern Australia. Cyclones are more likely to form and cross the coast, e.g. conditions in 2011. El Nino involves much warmer water in the eastern Pacific and high air surface pressure in the western Pacific and brings drought.
6. The 1997-1998 El Nino caused drought in Australia and the following decade led to many areas being declared in drought. There were water restrictions and a desalination plant was built in Sydney due to worry about lack of drinking water supplies.
7. El Nino causes rain and thunderstorms on the west coast of South America, warmer and drier winters in the Canada and increased rain in Kenya and Tanzania.
8. B

5 Natural Selection and Biotic Factors

1. Evolution is the change in a population over time.
2. Biological evolution occurs when there is a natural selection pressure for a particular characteristic that increases the chances of survival in a changing environment. Cultural evolution is a change in lifestyle, e.g. music, clothing, speech, dance patterns, beliefs.
3. Within a population individuals are characterised by a variety of inherited traits. In a changing environment some of those traits will provide an advantage. Individuals with these traits will survive, breed and pass these traits on to their offspring so that, over time, these traits will become more common in the population. The population will evolve and this mechanism is called natural selection.
4. Biotic factors include all living things, e.g. relationships with members of the same species and with other species.
5. The introduction of the rabbit, combined with the introduction of the fox to control the rabbit, has led to the extinction of the burrowing bettong, *Bettongia lesueur*, from the mainland. The species is still found on four islands off the coast of Western Australia when once they were found in most arid and semi-arid regions.
6. Symbiosis refers to a relationship where organisms of two different species live together in direct contact.
7. In mutualism both species benefit, in commensalism one species benefits and the other is neither helped nor harmed and in parasitism the parasite benefits and the host is harmed.
8. Lichens consist of fungi living in a mutualistic relationship with photosynthetic algae or cyanobacteria. The fungi cannot survive without the organic macromolecules produced by the autotroph and although the autotroph can produce its own food many lichens are found in dry terrestrial habitats where the algae or cyanobacteria could not survive on their own.
9. The relationship between the orchid and the tree is commensalism with the orchid benefitting and the tree being neither harmed nor helped. The evolution of epiphytic orchids was an adaptation for rainforest dwelling. Rainforest trees are tall and little light penetrates to the forest floor. Being able to perch on a branch higher up in the canopy with increased access to sunlight favoured the evolution of epiphytes.
10. Endoparasites live within the host, e.g. tapeworms while ectoparasties feed on the surface of the host, e.g. lice, aphids.
11. D
12. C
13. B
14. A

6 Natural Selection and Abiotic Factors

1. Abiotic factors are non-living factors including those that relate to climate, e.g. temperature, rainfall, wind, light intensity, day length and humidity.

2.

Physical factors	Chemical factors
Day length	pH
Temperature	Ion availability
Topography	Salinity
Rainfall	Oxygen
Altitude	Carbon dioxide
Light	
Humidity	
Soil depth	
Pressure	
Tide height	
Wind speed	
Wind direction	

3. Each ecosystem can be described by its temperature and rainfall requirements, e.g. deserts have low erratic rainfall and high temperatures, rainforests have high rainfall, e.g. 1500 mm with tropical rainforests and temperate rainforest determined by latitude.
4. In the past 25 million years the physical conditions in Australia have changed, with increased aridity causing a decrease in rainforests and an increase in open woodlands and grasslands with poor quality grasses. These changes have altered the selecting pressure on the kangaroo so that the ancient kangaroo, which was much smaller with generalised molars, has evolved into the modern day red kangaroo, which is much larger in size and eats grasses using its high crested molar teeth.
5. Mining, e.g. copper mining, can release wastes into the surrounding areas and these wastes can be toxic and kill many of the plants. If a plant has a natural tolerance for the waste mineral, e.g. copper tolerance, then it will survive while the others in its population will die. It will reproduce and pass this favourable characteristic on to its offspring. Over time the area will revegetate with this resistant variety.
6. In the past 25 million years there has been a change in the physical conditions in Australia as Australia moved north, with the climate increasing in temperature and decreasing in rainfall. Becoming drier and hotter influenced the chemical composition of the soil as erosion and leaching removed many nutrients. Competition for resources in this changing land, where the rainforests were giving way to shrubland and then to grassland, meant there was natural selection acting on the ancestral kangaroo. The red kangaroo evolved from this ancestral type and is highly successful due to several features, e.g. high crested molar teeth to grind the poor quality grasses into a paste and a reduction in the number of toes and a hopping gait to travel fast across the grassland.
7. In Australia, bushfires have occurred naturally as a result of lightning strikes and hot summer temperatures or as a deliberate strategy by the Aboriginal Australians in land management. The frequency of these fires means that those plants that are not fire adapted will not be able to recover while plants like eucalypts will recover, spread their seeds and rapidly dominate the landscape.
8. (a) Features of Procoptodon that suggest the ability to reach fast speed are an elongated hind limb with a single large toe with a hoof-like nail on the foot.
   (b) Protocoptodon is unlikely to be the direct ancestor of any extant species and its closest living relative is the banded hare wallaby in Western Australia.
9. (a) Soil salinity is the salt content of the soil.
   (b) Salination can be caused by several processes, e.g. mineral weathering and extensive irrigation. As ground water rises it brings the salt to the surface and evaporation can leave dry salt ponds.
10. A
11. B
12. B
13. D
14. A
15. C
16. C

7 Activity – Model For Natural Selection

1. Selecting agent is the roll of the dice and the choice of colours on the side of the dice.
2. The beetle population began with equal numbers of green, red, yellow and orange beetles. Over time it changed, with green beetles gradually increasing and red beetles, followed by the yellow, decreasing and finally disappearing.
3. (a) To keep the population total constant, there were 20 beetles 'born' each year and 20 beetles 'eaten' by predation each year.
   (b) It was important to keep the population total constant as this shows that there was no threat to the survival of the species – only the composition of the population changes over time.
4. (a) Favourable characteristic is green colour.
   (b) Natural environment could be green leaves of leafy shrubs, e.g. grassland or forest, as this would have little red colour and provide the predominately green colour to camouflage the green beetles.
5. In a sandy desert, the predominant colour would be yellow, so the students should change the colours on the dice so that yellow is not represented and three sides of the dice are green. The other three sides of the dice can be split between red and orange, depending on which colour the students want to be the next favourable colour.
6. Changing the colour of the sides to 1 : 1 : 1 : 1 means that evolution would not occur. There may be changes from year to year in the numbers of each colour of beetle but that would be due to random probability. For natural selection to occur, you need a selection pressure which favours one particular characteristic and in a 1 : 1 : 1 : 1 situation none are favoured.
7. (a) To model natural selection you could paint several toothpicks different colours, e.g. red, yellow, blue and green, mark out an area 50 cm × 50 cm on the school lawn, place 50 toothpicks of each colour randomly on the quadrat and count the number of each colour of toothpick that was picked up one by one in 30 seconds. It has been found that students pick up fewer green toothpicks than the other colours. The experiment shows that the human trying to pick up as many toothpicks as possible creates a selecting pressure which favours the green toothpicks being left on the grass.
   (b) In nature, a green prey that lives in grass, e.g. green caterpillar, is less likely to be picked up and eaten by a predator such as a bird than a red, yellow or blue caterpillar. This selecting pressure will lead to natural selection favouring a green colour.
   (c) Isolation is usually needed for evolution to occur. If there is no contact with other populations of that species, e.g. due to geographical barriers such as desert, mountain range or ocean, natural selection will occur, the isolated population will change and eventually the changes will be so numerous they will not be able to interbreed with the other groups – that is, they form a new species.
8. Scientists use models as a way of representing scientific principles to make them easier to understand, give a visual representation and to be able to show and predict what will next happen.
9. D
10. A
11. D
12. D
13. B
14. D
15. B
16. D
17. A
18. B
19. D

8 Succession

1. Ecological succession is a transition in species composition of a biological community as species begin to inhabit barren ground or reclaim a disturbed community.
2. Primary succession is the colonisation of a site that has never before sustained life, e.g. new volcanic island or moraine from a retreating glacier.