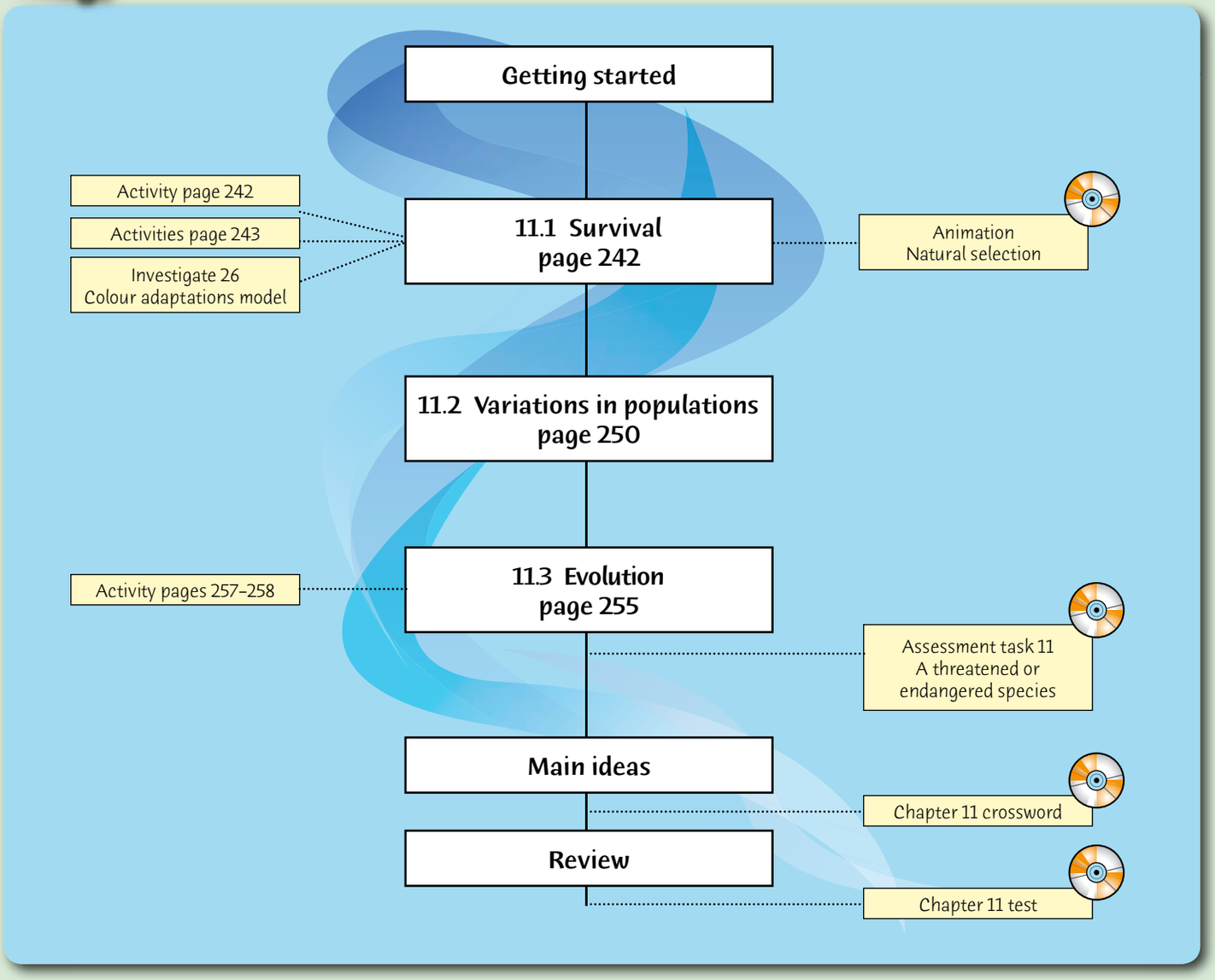
11 Diversity of life

Planning page



Essential Learnings for Chapter 11

Essential Learnings	References		
	Student book (page number)	Workbook (page number)	Teacher Edition CD (Assessment task)
Knowledge and understanding ***Life and living*** In ecosystems, organisms interact with each other and their surroundings	pp. 242–263	pp. 89–91, 93	Assessment task 11 A threatened or endangered species
Changes in ecosystems have causes and consequences that may be predicted	p. 247		Assessment task 11 A threatened or endangered species
The diversity of plants and animals can be explained using the theory of evolution through natural selection	pp. 250–263	Exercise 9 p. 92	
Science as a human endeavour Immediate and long-term consequences of human activity can be predicted by considering past and present events	Science bits pp. 252, 259		
Ways of working Evaluate data, information and evidence to identify connections, construct arguments and link results to theory	Investigate 26 pp. 244–245 Activity pp. 257–258 Check and Challenge pp. 262–263		
Reflect on learning, apply new understandings and justify future applications	Science bits p. 252		

QSA Science Essential Learnings by the end of Year 9

Vocabulary

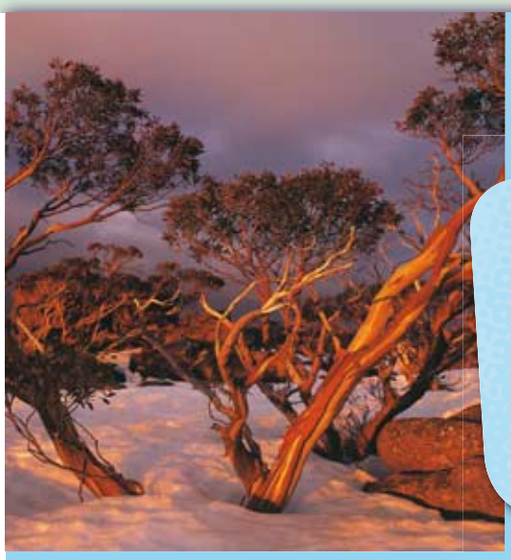
abiotic
adaptation
adapted
behavioural
biotic
ecosystem
environment
evolution
extinction
functional
habitat
mutation
offspring
predators
relationship
species
structural
variation

Focus for learning

List the adaptations of organisms in different habitats (page 241).

Equipment and chemicals (per group)

Activities page 243	3 or 4 preserved animals (or photos of animals)
Investigate 26 pages 244–245	60 coloured toothpicks, plastic disks or beads (20 green, 20 red and 20 yellow)
Activity pages 257–258	2 dice (different colours), 32 pieces of 2 cm x 2 cm card (two different colours) or plastic counters

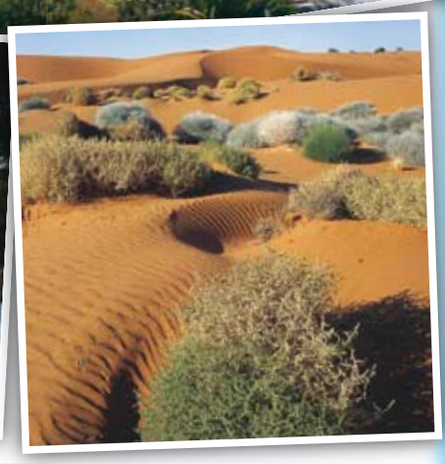


11 Diversity of life

Getting Started

The photos show four different Australian environments.

- For each photo think of some of the living things that might live in that environment.
- Make a list of the characteristics that the animals and plants would need to be able to survive in each environment.



Starting point

1. In addition to the photos on this page, you could ask the students to bring in some of their own photos of the natural surroundings of the local area and add them to the discussion.
2. It is worth organising a field trip to view one or more different environments for the class to experience. Arrange this well in advance and make sure you follow the school's procedure for running an excursion. Prepare an activity booklet for the students to fill in and submit for assessment. Include questions about differences and similarities between the environments, and activities involving diagrams or sketches.
3. If an excursion is not possible, organise a wildlife officer to give a presentation to the class about biodiversity, particularly relating to the local area. There are many education programs where snake or reptile handlers come out to schools and allow students to touch and view animals close up. Make sure you choose a presentation which is appropriate to this chapter.
4. The class could become involved in raising money to donate to a zoo or wildlife organisation for animal preservation. Ask the students to investigate possible organisations to see how good they really are. What percentage of the money goes to looking after the wildlife? What else is the money used for? Keen students could arrange for a representative from the organisation to come to the school to give a presentation about their work. Alternatively, the class could choose to support a world aid group.
5. Give the students a true/false or another easy-to-mark quiz as a pre-test to identify the areas they know least about. It may be a useful evaluation tool to use the same test at the end of the chapter so you and the students can see what progress they have made.

marinethemes.com/David Fleetham

11.1 Survival

In previous studies you learnt that an **ecosystem** is the system of relationships among organisms and the way they interact with the non-living things in their habitat.

The survival of an organism in an ecosystem depends on living as well as non-living factors. For example, the survival of an organism not only depends on its ability to get food and be protected from predators, competitors and disease-causing organisms, but also on the supply of water and air, a suitable temperature and weather conditions, and good soil.

The *biotic factors* in an ecosystem describe all the living things that interact with an organism—its food, predators, competitors and disease organisms.

The non-living or *abiotic factors* include temperature, light, humidity, the availability of air and water, and soil fertility. These factors are extremely important for the survival of any organism. For example, microscopic algae (plankton) are found only in the surface waters of the ocean where there is sufficient light for photosynthesis.

Activity

Work in a small group for this activity.

Look at the photo of the coral reef community. Write a brief report on the survival of an organism on the coral reef using the following three points as your structure.

1. Choose an organism that lives on the reef. Make a list of all the biotic factors that will influence its survival. Give examples if possible.
2. Construct a food web for the organism.
3. Describe the abiotic factors that may affect the survival of your organism. Give examples.
4. Check your report and rewrite it if necessary, so that another group can read it.

Swap your report with another group. Read their report and assess its good points and poor points. Make some brief notes.

Give the report back to the group and discuss your group's opinion of the report.

Hints and tips

- Encourage ESL students or those who experience language difficulties to write a list of new words and their meanings in a glossary. ESL students should also write each new word in their native language. Where appropriate, the students could draw diagrams to illustrate word meanings and write sentences with the words/terms used correctly.
- Be clear with your explanations of biotic and abiotic factors. Check that the students understand the difference by getting them to list factors of each type using the photos on page 241.

Activity notes

- It is a good idea to set a time and word limit for this activity.
- Remind students about the importance of positive feedback about other groups' reports rather than focusing on negative points. They should aim to critique the work from the point of view of the teacher.
- An alternative or extension activity is to investigate other communities. Print out and laminate some coloured photos of communities within an ecosystem. Then each group of students could investigate a different community (or ecosystem) using the same structure as in the Activity.

Learning experience

Get the students to make their own set of flash cards which they can add to progressively. Give them coloured paper to use. Each card should be easy to read and include a term/word, its meaning, and an example of how the term/word is used. For this page, students can start with *ecosystem*, *habitat*, *biotic factors*, *abiotic factors* and *photosynthesis*.

Adaptations

The survival of an organism also depends on the characteristics of the organism itself. For example, the organisms in the photos below live in quite different habitats, and each organism has characteristics that enable it to survive in its own particular habitat.These characteristics are called **adaptations** (ADD-ap-TAY-shuns).

For example, the jabiru in Fig 3 lives in wetland areas of northern Australia. It has very long legs to enable it to walk through the swampy areas where it finds food. Its beak is long and pointed so it can collect snails, worms and fish from the water and mud. It also has large, strong wings to help it escape from enemies.

Fig 3 Jabiru

Fig 4 Dolphin

Fig 5 Kookaburra

Activities

A Look at the animals in Figs 3, 4 and 5 above. For each animal, list all the physical and biological factors that may affect its survival in its habitat. Suggest how the animal's adaptations help its survival.

B Your teacher will supply you with three or four preserved animals (or photos of animals). Work in a group for this part of the activity.

Infer where each animal lives and describe its habitat. Then use your observations and also your knowledge of the animals to make inferences about how well their characteristics help them survive in their habitat.

For each animal record your observations about its size, shape, colour and other characteristics that you think are important in its survival.

Hints and tips

Develop a class chart with the students, listing the factors/influences which contribute to the survival of organisms. The chart can then be added to progressively. Pin the chart up in the room or save the document for future use if it is done electronically.

Activity notes

- Warn students not to shake the specimen jars, which need to be handled with care.
- Display a wide and varied range of organisms at the front of the classroom so that the students can make their own specimen selections. If you have stuffed animals, use these too.
- Explain to the class why the specimen colours may not be a true representation of the animal's actual colour. If there is time, students could search the internet to find coloured photos of the organism to help with their observation records.

Types of adaptations

The katydid (KAY-tee-did) in the photo above is similar to grasshoppers. It eats the leaves and shoots of plants. Birds and carnivorous insects such as preying mantises feed on katydids.

A katydid has a number of adaptations that ensure its survival. Its body is sideways flattened and is leaf-green in colour. This helps to camouflage it amongst plants. It also quivers, making it appear like a leaf moving in the wind. It has very keen eyesight and long, strong legs that help it escape quickly when threatened by predators. It lays a very large number of eggs in the soil.

For convenience, we can classify adaptations into three groups—structural, functional and behavioural.

Structural adaptations refer to the shape and size of the organism and how the various parts of its body are put together; for example, the katydid's flattened body, its colour, and the shape and size of its legs.

Functional adaptations refer to the working of an organism's body; for example, the katydid's egg-laying ability and the way it can digest plant leaves and shoots are functional adaptations.

Behavioural adaptations are to do with how the organism behaves; for example, the quivering of the katydid mimics the movement of leaves and makes it hard to see in the bushes.

Investigate

26 COLOUR ADAPTATIONS MODEL

Aim

To use a model to explain the effect of colour on the survival of organisms in different habitats.

Materials

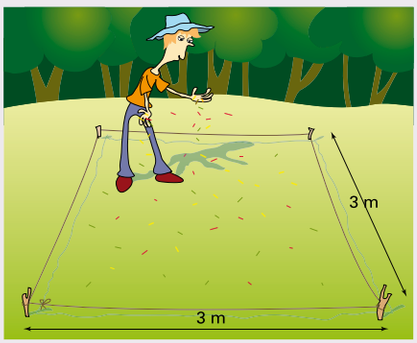
- 60 coloured toothpicks, plastic disks or beads (20 green, 20 red and 20 yellow)

Planning and Safety Check

- Work in groups of three. One member will be the scatterer, the other two will be the predators.
- Carefully read through the Method and prepare data tables for Steps 3 and 4.
- You will need to do this investigation on at least two different surfaces or 'habitats'; for example, grass, dirt, sand, concrete, carpet or leaf litter.

Method

1 Measure out a 3 m x 3 m area on your selected surface. Mark the corners of the square with pieces of paper, sticks or rocks. You could mark the area with string if you have some.



Lab notes

- This investigation works best with coloured toothpicks rather than disks or beads on the various surfaces. Coloured paperclips are another alternative.
- It's essential here to spend some time getting a good colour match for your 'local' grass or another surface as the results are not that convincing otherwise. (Give the lab technician a bit of extra notice for this investigation so they have time to prepare the colour matching).

Research

Ask students to research an invertebrate indigenous to Australia and present their findings as a report in the form of a booklet, multimedia presentation or poster. The report should describe the adaptations which ensure its survival, a colour photo of the organism and any other relevant and interesting information, such as its habitat. Students could then construct a scale model of their invertebrate to accompany the report.

Learning experiences

Get students to draw posters about each section in this chapter (11.1, 11.2 and so on) and display them around the room. Each poster should introduce the section, clearly outline the main points and include pictures or diagrams.

2 Ask the 'predators' not to look, then scatter the toothpicks randomly over the marked area.

3 Give the 'predators' 15 seconds to find as many toothpicks as they can.
Count the numbers of each colour of toothpick found and record the data.

4 Collect all the toothpicks then repeat Steps 1 to 3 using other surfaces.
Record the results in your data table.

Discussion

1 For each colour calculate the survival rate as a percentage of the original 20.

$$\text{\% survival rate} = \frac{\text{number remaining}}{20} \times 100$$

2 Draw a bar graph of the percentage survival rates for the three different colours.

3 Compare the survival rates for the different surfaces. Suggest why they are different.

4 Compare your survival rates with those of other groups. Your teacher may pool the class data and calculate averages, and then organise a class discussion.

5 Suppose the three different-coloured toothpicks were part of a large toothpick population in a particular 'habitat'. Assume the same 'predators' were present. Predict what might happen to the toothpick population in the area over a period of time. Give reasons for your prediction.

6 Do you think your model was a good one? Suggest ways in which you could improve it.

7 Using the results of your model, write a generalisation about the effect of camouflage (colour) on the survival of organisms in a particular habitat.

8 You may have heard of the term *selection* or *natural selection*. Use your generalisation from Question 7 to suggest a meaning for this term.

Natural selection

In Investigate 26 you probably found that of the three colours of toothpicks, the green ones were the most difficult to find on grass, while the yellow or red ones were easily seen and picked up by the 'predators'. As a result, the green toothpicks had a higher survival rate on grass.

In any population of organisms there are *variations* among the individuals. For example, in a population of field mice, you might see dark-coloured ones and light-coloured ones, short ones and long ones, ones with larger ears and ones with shorter ears.

In the toothpick model, there were colour variations in the toothpick population. When equal numbers were placed on grass, more of the green coloured toothpicks survived than either of the other colours. In this case, biological factors (the 'predators') caused a change in the make-up of the population. The green toothpicks had the most favourable characteristics for a grass habitat and are said to be *selected*.

In a natural ecosystem, this selection of favourable characteristics is called **natural selection**. The organisms in a population that have favourable characteristics survive in a particular habitat, breed and pass their characteristics on to their offspring.

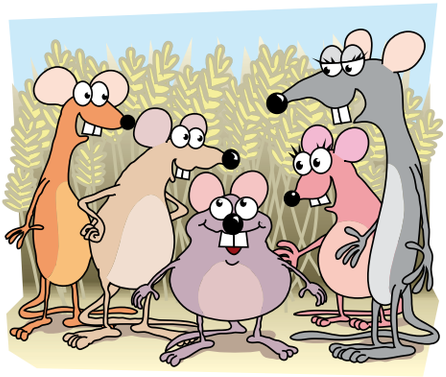


Fig 9 In a population of field mice you usually see variations in colour, size and shape.

Lab notes

Ask students to thoroughly clean up each 'habitat' at the end of the investigation. It is unlikely you will get all the toothpicks back, so have some spares available.

Hints and tips

You may like to investigate the story about England's peppered moths (*Biston betularia*).

- The insects used to be mostly light in colour, with occasional darker forms. Light-coloured lichen growing on tree trunks meant that the light-coloured moths were very well camouflaged, while the dark ones stood out and were easily seen and eaten by hungry birds.
- Pollution from the Industrial Revolution killed much of the pale lichen covering the tree trunks. This meant the trunks appeared darker so that now the dark moths were better camouflaged. Therefore, hungry birds ate more of the lighter moths, with the result that the dark ones became the dominant form.
- When pollution decreased, the lichen grew back and the tree trunks became lighter again, so the light-to-dark moth ratio changed yet again.
- The variation in the peppered moth population was a result of natural selection.

Other examples include the house sparrow in North America which has adapted to differences in climate, the mosquito species *Wyeomyia smithii* which has adapted in response to global warming, and some insects which have become resistant to pesticides.

Learning experience

The students could explain how a species' survival is increased by adaptations to its structure, function and behaviour. Get them to take photos of different animals and have a show-and-tell lesson where each student presents their ideas to the class. As an extension exercise, get the students to write a 'What am I?' quiz question for their animal. Collect all the questions and have a quiz using the questions at the end of the chapter, or from time to time throughout the chapter, selecting only a few animals at a time.

What happens if the conditions change?

Suppose there is a drought and the grass in our model dies, leaving bits of dead grass and sand-coloured soil. The green toothpicks will now be more easily seen by the 'predators' than the yellow ones. Under these conditions the yellow toothpicks have a higher survival rate than the green ones. The yellow toothpicks are better adapted to this habitat, and after some time the make-up of this population will be different from the toothpick population on the green grass.

To see what happens to a population of organisms when factors change, open the **Natural selection** animation on the CD.

Working with technology

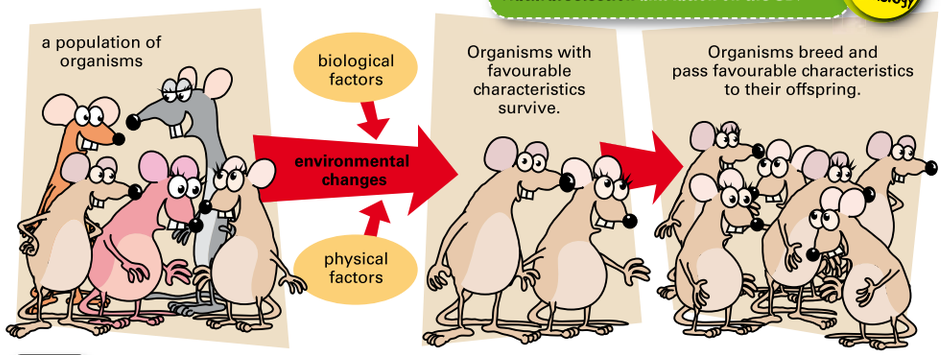


Fig 10 How natural selection works

science bits

Adapted to fire

During a hot, dry summer the chance of bushfires anywhere throughout Australia is quite high. Bushfires destroy houses and other property and burn out hectares of bush. The fires also kill animals which cannot escape from the flames.

However, fire is part of the Australian environment and many native plants are fire-tolerant. Some even need fire for their survival. For example, the seeds of some wattles need the heat from fires to germinate, and the thick woody banksia fruit (shown in the photo) open and release their seeds only when heated by fire.

Many eucalypts have very thick, fire-resistant bark that protects the living cells inside the trunk from damage. The old leaves that are destroyed by the fire are quickly replaced by new shoots. In this way the eucalypt recovers from the fire damage while other types of plants are killed. Eucalypts are adapted to fire and this helps in their survival.

One species of eucalypt called the candlebark gum even spreads fires. Pieces of burning bark break off the trunk and are carried by the wind to start fires a long way away from the original trees.

Hints and tips

Recent claims have been made that Australia's megafauna on the Nullarbor died out because of changes to the vegetation from bushfires, rather than from climate change. Perhaps it is only some plants, and not animals, that can adapt to bushfires. Discuss this with the class. (Interestingly, there are some indigenous plants which require smoke to germinate.)

Animation

Students should view the animation *Natural selection* on the CD.

Learning experience

If there have been bushfires in the local area, organise a field trip to one of the fire sites to investigate adaptations and species survival.

Learning experiences

- Ask students to create their own creature. They need to describe the organism, the environment it lives in, how it reproduces, its life span, how it communicates, its effect on other animals in its ecosystem (ie is it a competitor, predator, etc?), how it is affected by other animals, and adaptations that ensure its survival.
- Alternatively, you could give them the following scenario:

  A previously undiscovered animal is found. You are the scientist who has discovered this animal. Write a media report about the animal, including an illustration or digitally created image. Explain why this animal has never been recorded before. What does it feel like to be the scientist who discovered it? How did you discover it? How has it been able to stay undiscovered for so long? What type of habitat does it live in? Where does it fit into the animal kingdom? What has ensured its survival? What will threaten its survival?

  This scenario actually occurred in the plant world when the Wollemi Pine was discovered in NSW in 1994. Seeds were taken from it and propagated to help ensure its survival. Make sure the students write their report in the context of this chapter.

The River Red Gum ecosystem

For thousands of years large forests of the River Red Gum have flourished along the Murray River and other large rivers that flow into it. However, over the last 200 years huge changes have occurred to these forests.

The Murray River floodplain

The River Red Gums are well adapted for the floods that once occurred regularly along the Murray. Under natural conditions, the river flooded every one or two years for about two to three months, as the snow melted in the Snowy Mountains.

The floodwaters carry fertile soil, and branches and leaves from dead trees, which are caught around the roots of the trees. Over thousands of years, soil rich in nutrients has built up the floodplain.

The River Red gum ecosystem

A River Red Gum forest can produce 250 million seeds per hectare! Most seeds fall in spring and early summer when the floods recede, and the seeds germinate in the warm moist soil.

The seeds create food for ants and other insects as well as some birds. The flowers attract nectar-eating birds, insects and possums. In turn, these herbivorous animals are the prey for echidnas, goshawks and water rats.

Human impact

Farms established along the Murray river required a dependable water supply for crops. To regulate the water flow, over 100 dams and weirs have been built along the river. As a result, the following changes have occurred to the natual cycle:

- flooding now occurs only every 10 years
- flooding lasts for several days only instead of several months
- the total volume of water has been reduced.

Questions

Use the information on this page and from the websites below to complete the following.

1. Draw a food web for the organisms in the River Red Gum ecosystem.
2. Describe how the River Red Gum is well adapted for life on the floodplain.
3. What physical factors have changed since agriculture was established on the Murray River?

WEBwatch

Go to www.scienceworld.net.au and follow the links to the websites below.

River Red Gum

Click on the Redgum Forests icon and download the fact sheet, which contains information on the Redgum Forests, water management and timber production.

River Red Gum Forests

This website contains very good information about the human impact on the River Red Gum ecosystem.

Hints and tips

- Revise with the class how to draw food webs. There are many interactive computer programs and websites on constructing food webs which could be used as an introductory activity.
- If computer access is limited, you could ask the students to complete their research into the River Red Gum ecosystem for homework.

Homework

Ask students to present points about the following statement: *Jobs for humans are more important than homes for other animals and preserving habitats.*

Divide the class into two even groups. Ask one group to individually research and jot down points agreeing with the statement. The other group does the same but lists points *against* the statement. This could be extended into a class debate which could be conducted here or in Chapter 13.

Learning experiences

Students could write an imaginative essay about the life of a River Red Gum. They could imagine they are a tree with a life span of many hundreds of years. What story would the tree tell about its environment and the state it is in now? What experiences has it endured? How does it feel about the changes? What does its future look like?

Learning experience

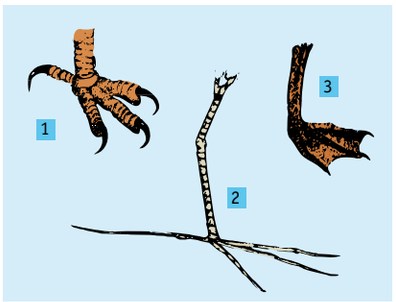
Ask the students to design a board game called 'Diversity of life'. It could be designed so that it uses packs of cards with questions relating to species survival, variations in populations and 'wild cards' (general science knowledge). More sophisticated games could use a graded system and have an 'Einstein' level. Give the students enough time, but a limited amount, to create their games. Small groups work best. When they have finished, give the class time to swap and trial them.

Check!

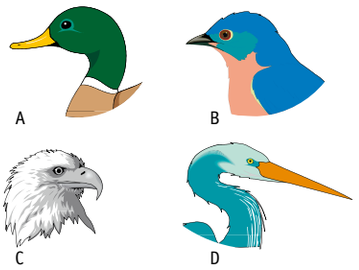
1 Classify the following statements according to whether they refer to structural, functional or behavioural adaptation.
- **a** Frill-necked lizards raise the large spiny layer of skin behind their head when they are threatened.
- **b** Sharks have a very streamlined shape.
- **c** Sea turtles lay up to one hundred eggs in the breeding season.
- **d** When sea turtle eggs hatch, the young turtles dig through the sand and head directly for the water.
- **e** Many plants that live on the rainforest floor have very large leaves.
- **f** Fungi release enzymes that are able to break down the dead organism they are growing on.
- **g** The large front legs of a preying mantis have spines on them.

2 Certain plants have prickles or thorns on them.
- **a** What is the advantage to the plant of having these structures?
- **b** Name three plants that have these structures.

3 Look at the three types of birds' feet in the diagram below.
- **a** Describe the habitat in which each bird might live.
- **b** How does the structure of its feet help the survival of each bird in its habitat?



4 The diagram below shows four types of birds' beaks. Three of them belong to the birds in Question 3. Can you match them? Give reasons for your choice.



5 The sugar glider is a small possum-like animal that lives in eucalypt forests. At night it feeds on the nectar in the flowers in the forest canopy. It has a thin layer of skin that stretches from its front legs to its back legs.

- **a** Suggest a reason for the skin between the sugar glider's legs.
- **b** Suppose the animal did not have the skin between its legs. What problems would the animal then have to face?
- **c** Suggest why the animal feeds at night.

6 Explain the process of natural selection in your own words. Infer what might happen in the long term to a population of a particular type of animal whose individuals looked, functioned and behaved identically.

Check! solutions

1 These characteristics are:
- a behavioural
- b structural
- c functional
- d behavioural
- e structural
- f functional
- g structural

2 a The main advantage of a plant having thorns is that they make the plant less appealing to animals which might eat it. Because of this, the plant will live longer and increase its chance of reproducing.

b Three examples of plants with prickles or thorns are roses, bougainvillea and cactus.

3 a Bird number 1 has feet which are adapted to grasping a branch or prey. Bird number 2 has feet which are adapted to standing on plants which float in the water. Bird number 3 has feet which are adapted to walking on mud and swimming in water.

b The structure of each type of feet helps the survival of the bird in the following ways:
- Bird number 1 survives in its habitat because it can capture and kill other animals.
- Bird number 2 survives in its habitat because it can walk on the water plants while searching for smaller animals for food.
- Bird number 3 survives in its habitat because it can move quickly on the water to catch its own food or to escape predators.

4 Bird A matches foot number 3 because this bird's beak is used to gather food from the water in lakes and rivers. Bird C matches foot number 1 because it has a sharp hooked beak for tearing the flesh of animals. Bird D matches foot number 2 because it has a long pointed beak for digging in the mud of shallow lakes.

5 a The most likely reason for this structural adaptation is that the skin will act as a 'wing' and allow the animal to glide from tree to tree.

b If the animal did not have this skin it would not be able to glide. This would mean that it would have to travel along the ground to get from tree to tree which would increase its chances of being caught by predators.

c The animal feeds at night because the air is cooler and it is also harder for predators to see and capture it. This is a behavioural adaptation.

6 Natural selection is a process in which those organisms with the most favourable characteristics survive and breed in an environment. If all individuals in a population were identical, the whole population could die if the conditions in the environment changed, eg if a drought occurred or a new disease was introduced.

challenge

1 A certain type of moth called the peppered moth has two main variations—a light form and a dark form.

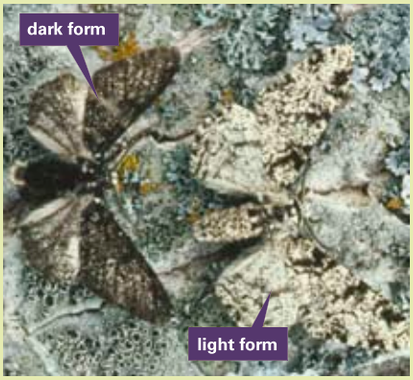


Fig 16 The light and dark forms of the peppered moth on a lichen-covered tree

During the day, the light form rests on light-coloured trees and rocks, while the dark form rests in cavities in trees and rocks and in caves.

a What do you think would be the main predators of the peppered moth?

b Suggest why the moths rest during the day. Which type of adaptation is this?

c In an experiment, students caught and counted the moths in a particular place. Over three nights, they caught 15 light-coloured moths and 46 dark-coloured ones. Write an inference to explain their results.

2 The drains in a town were sprayed for mosquitoes using a pesticide called BBB. After the first spraying, most of the mosquitoes died. The pesticide was used for the next five years. However, the number of mosquitoes killed decreased each year. After the tenth year of spraying, very few mosquitoes were being killed by BBB.

a Suggest why not all the mosquitoes died after the first spraying with BBB.

b Could this be called natural selection? Explain your answer.

3 The body temperature of birds and mammals is fairly constant and changes very little even when the surrounding temperature changes greatly. Other animals have body temperatures that change with the surrounding temperature.

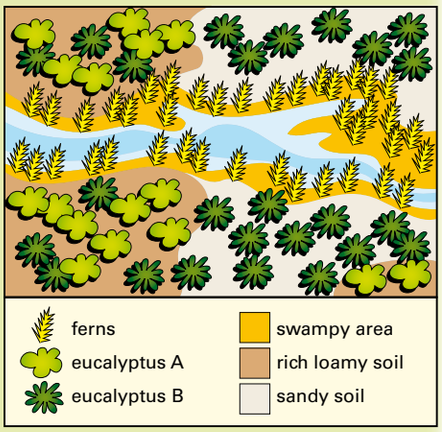
a Suggest why a constant body temperature might be an advantage for the survival of a particular animal.

b Which type of adaptation is a constant body temperature? Explain your answer.

c Explain the following observations.

- Snakes, frogs and insects are rarely found in places with snow and ice.
- Snakes are very slow-moving on cold mornings.
- Fish can exist in the Arctic and Antarctic regions.

4 The diagram below shows the distribution of three types of plants. Use the information in the diagram to decide, giving reasons, whether each statement below is true or false.



a Eucalyptus trees are not adapted to live in water-logged soil.

b The distribution of ferns depends only on the type of soil.

c Eucalyptus B is adapted to different soil types.

Challenge solutions

1 **a** It is likely that the main predators of these moths are birds.

b It is likely that the moths rest during the day so that they are not easily seen and preyed upon by birds. This is a behavioural adaptation.

c Since there are three times as many dark-coloured moths as light-coloured ones, the dark-coloured ones must be better adapted to this particular place and avoid capture by predators.

2 **a** Some mosquitoes were naturally resistant to this chemical and were not killed by the first spraying.

b This is a good example of natural selection because those mosquitoes which were not killed by the first spraying lived and bred. The next generation of mosquitoes had a higher proportion of mosquitoes which were resistant to this chemical.

3 **a** A constant body temperature is an advantage because it means that the animal remains active in cooler weather. This means that it can continue to feed and reproduce.

b This is classed as a functional adaptation. This is because it concerns the functioning of the body to produce heat to keep warm in cold weather.

c The following are possible explanations:

- If the temperature is low enough for snow and ice then it is too low for these animals to remain active.
- Snakes are not able to produce their own body heat and must rely on heat from the sun to become active.
- Fish have functional adaptations which enable them to remain active even in water which is very close to freezing.

4 **a** True. Neither Eucalyptus A or B grows in the swampy area which is the blue area on the map.

b False. The ferns grow along the edge of the swampy area in both types of soil.

c True. Eucalyptus B grows in both loamy soil and sandy soil.

Hints and tips

- Spend a few minutes revising the previous section and work from Chapter 6. Conduct a quick quiz on this earlier material, making sure to include a few open-ended thinking questions. Go through the answers immediately after the quiz so that the students have instant feedback.
- It is important to give the students ongoing assessment, as well as meaningful feedback that assists their learning and allows them to see improvement in their knowledge and understanding. One way is to give two similar tasks but at different times during the chapter so that they can act on suggested improvements. Every student needs to be given the opportunity to show they can improve and should be encouraged whenever possible.

11.2 Variations in populations

You learnt in the first section that those organisms that are well adapted to their environment survive and breed.

In the case of the coloured toothpicks, the green ones had the most favourable colour for survival on grass while the yellow or red ones had the least. However, on soil or sand the yellow and red toothpicks have the more favourable colours, while the green toothpicks have the least.

Variations in characteristics are very important for the survival of organisms. If conditions in the environment change, some varieties of the organism will survive while others will die.

Genes and variations

In Chapter 6 you found out that many of your characteristics are inherited. And there are variations in most of these characteristics which give rise to many differences in height, eye colour, hair colour, skin colour, head shape etc.

Fig 18 There is a huge range of hair colour in the human population.

Hair colour in humans, for example, is controlled by a number of genes. It is the way these genes work together that gives rise to the differences in colour.

Variations of genes in sex cells

In Investigate 15 on page 130 you found that you could make 8 different types of sex cell from a body cell containing 3 pairs of chromosomes. This means that the genes that came from the mother and those that came from the father become mixed up in the sex cells.

It is the way the chromosomes separate from each other during cell division in the testes or ovaries that produces such an assortment of genes in the ova and sperm.

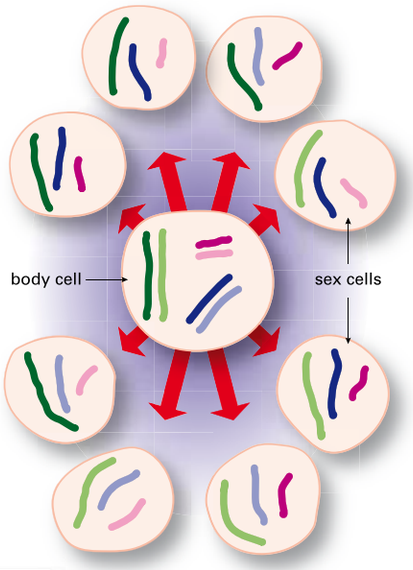


Fig 19 Eight sex cells containing different combinations of chromosomes can be made from a body cell with 3 pairs of chromosomes.

Humans have 23 pairs of chromosomes in each body cell. This means that nearly 8 million different sex cells can be made containing different combinations of chromosomes and genes. No wonder there can be a range of variations of characteristics even in one family!

Learning experience

Get the students to make a concept map using this page as a starting point and linking concepts from this chapter with Chapters 6 and 7. Allow the students to work on this map progressively until the end of the chapter. When they have finished their maps, collect and assess them. Let the students see how you have marked their work, but collect the maps again and keep them so that they can add to the maps when they are studying Chapter 13. Make sure to give positive feedback about their work so that they have the opportunity to show improvement when they add to it later. It is best that they work individually for this task.

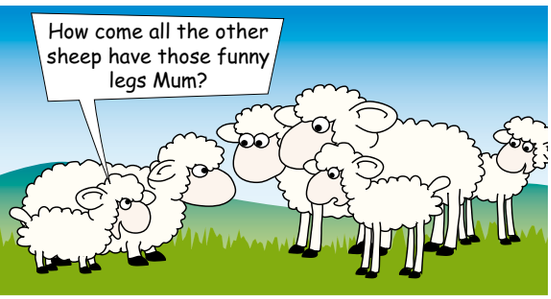
Learning experience

Ask the class to come up with a list of questions they would like to investigate in relation to diversity of life. For example, why is variation in a species a good feature? Are we likely to end up with little variation in the human population if we mix different ethnic groups? Because of globalisation and multiculturalism, some minority ethnic groups are disappearing. Ask the students to predict what the human race might look like 100 years from now and give reasons why.

Mutations produce variations

In the late 1700s in the north-east of the USA a farmer was checking the lambs which had been born during the previous few days. He noticed one lamb had short legs. He thought it was deformed and was going to kill it, but then he noticed that it ran around quite normally, and its mother fed it and didn't reject it. So he kept it.

The lamb grew to an adult sheep and had a number of lambs, some of which had short legs.



He used the short-legged sheep to build up a flock. The farmer realised that the short-legged sheep had some advantages. They produced the same high-quality wool and meat as the other sheep, but they couldn't run or jump as much as the others. This meant he didn't have to build such high fences.

What caused the changes? A gene on a chromosome in one of the sex cells of the parents of the short-legged lambs had altered. The sex cell was fertilised and produced a lamb—a short-legged one. Alterations to genes are called **mutations** (mew-TAY-shuns).

Mutations are a source of variations in a population of organisms. It is a way that new genes can be introduced into the population.

Mutations occur naturally but the rate is very low. However, exposure to high energy radiation from X-rays or radioactive substances like uranium, can increase the rate of mutations. Certain chemicals such as formalin and mustard gas, which was used in World War I and other wars, can also increase mutations in the DNA in cells.

Science in action

Did a mutation help humans adapt to the cold?

It is thought that in very ancient times humans migrated from Africa to northern Europe. How did these people cope with the severe cold of their new homelands? Scientists from the University of California have suggested a mutation in the DNA caused the body cells to change their energy allocation.

The cells in your body produce energy for two purposes: to heat your body and for body functions such as walking, running, exercising and thinking.

In the African environment, people who have cells that allocate more energy to body functions are better adapted to this environment. They can run faster and longer, and function better in the hotter climate.

For people in cold countries, their body cells allocate more energy to heating the body. The scientists suggest the mutation helped the ancient people survive the harsh cold of the northern European winters. This mutation was then passed on to following generations.

Fig 21 The cells of people that live in very cold climates allocate a large amount of energy to maintain their body tempeature.

Hints and tips

Explain to students that if humans are exposed to high-energy radiation (ionising radiation) it can cause the cells in the body to die or mutate. The radiation will likely cause damage to DNA chains within the cell nucleus. Damage to one strand can normally be repaired by using the other as a template, but breaks to both strands will normally lead to cell death. Mutations occur when human reproductive cells are exposed to radiation, but the damage to the DNA chain is slight. The damage is small enough to allow the cells to survive but they react differently to the original ones. All cells are most susceptible to radiation damage when dividing, so reproductive organs are most vulnerable.

Homework

It is suggested that a mutation has helped humans adapt to the cold. If African people were to relocate to a very cold climate, how might their bodies adapt to the new environment? Would they feel the cold more than people who have always lived in a cold climate? Give reasons for your answers.

Learning experience

1 Get the students to list advantages and disadvantages for sheep having short legs or long legs. Can they think of (or research) other examples where mutations have occurred and the outcome is positive (eg bare-bellied sheep)? What are some negative mutations that have occurred in humans?

2 Fast-working students, or gifted and talented students, could research why high-energy radiation can increase the rate of mutations, then present their findings to the class. How were some war veterans and their offspring affected?

Learning experience

The students could draw some fun cartoons of plants or animals illustrating a mutation, including a caption to explain in simple words how mutations occur.

How do mutations affect you?

If a mutation occurs in one of your body cells, usually very little change will occur. Sun spots are sometimes caused by mutations in the DNA in skin cells due to exposure to the sun.

Sometimes, however, if sun damage occurs to the growing regions of the skin, mutations may occur which cause cells to reproduce uncontrollably. These cells become cancerous.

If a mutation occurs in a sex cell, and that cell is fertilised, the mutation is then passed on to the child. This mutation is said to be inherited.

Most mutations are harmful and many are fatal, so the new organism usually dies before it can reproduce and pass on the mutation. However, a small number of mutations are beneficial. These beneficial mutations are the source of variations in a population of organisms.

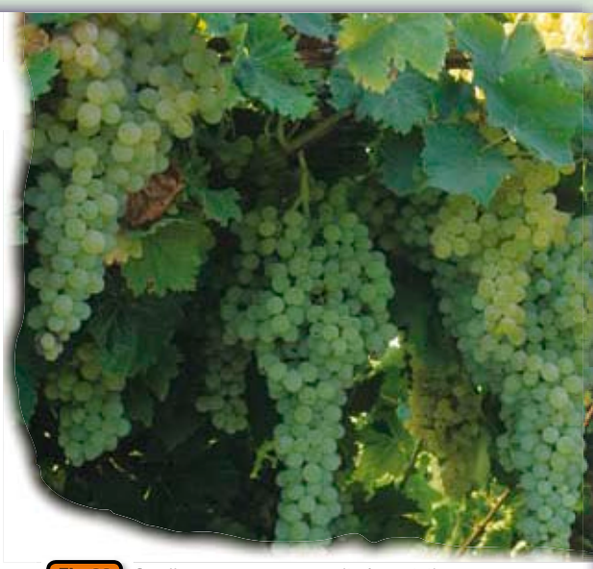


Fig 22 Seedless grapes are a result of a mutation that caused the seeds not to form in the fruit. This characteristic is probably bad for the survival of the grape population but it is good for grape-eating humans!

science bits

Radiation dangers

At 1:30 am on Saturday night 26 April 1986 a nuclear reactor at Chernobyl in the Ukraine went out of control and exploded. Lumps of flaming uranium blasted through the heavy concrete and steel roof of the nuclear reactor. Nine tonnes of highly radioactive material were hurled into the night sky.

In 2006, twenty years after the disaster, scientists found that radiation levels around the site were still very high in the soil and in plants and animals.

The high energy radiation from nuclear material such as uranium can cause mutations in DNA. For the people around Chernobyl the incidences of cancers caused by radioactive materials has increased dramatically, particularly thyroid gland cancer, as well as lung and bone cancers.

Hints and tips

Students may not realise that in the 1950s and 1960s the British used Australian soil and people to conduct their nuclear testing program (atomic bombs), so it is a good idea to discuss this with them. One site was Maralinga in South Australia. During the tests, many army personnel were deliberately exposed to the blasts just to see what effect radiation had on them. Fallout from the ground blasts led to massive contamination of the Australian interior. It is reported that the fallout from Maralinga reached as far as Adelaide and Melbourne.

Issues

Present the information about Maralinga to the students and ask them to further research the issue and find out what immediate and long-term effects the testing has had on the people exposed to the radiation. How has the indigenous population been affected? What are the students' viewpoints—how do they feel about this issue? They could present their information as a media article, journal article or interview.

Learning experiences

1 Get the students to draw a 'fishbone'

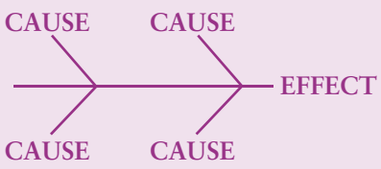


diagram showing different causes and corresponding effects relating to aspects of this chapter.
Either choose one component to investigate thoroughly or look at a broad spectrum relating to the diversity of life. You may wish to consider different causes for human mutations and the effects they can have, or causes for variations in environments and their effects. For example, if a human is exposed to high levels of radiation via sun exposure from UV rays, the effect of this may be skin cancer. Another example is when farmers clear trees for animals to graze, causing a change in the ecosystem. Effects from this may be a diminishing species population, land erosion or soil salinity.

2 As an extension activity you may choose to show a DVD about the Chernobyl disaster. 2006 was the twentieth anniversary of the Chernobyl accident and schools were given the opportunity to obtain a free educational DVD explaining the disaster's effects. The DVD is called *Chernobyl Heart* and it is worthwhile for all students to view it. Be mindful that some students may be very sensitive and may be upset by the presented material. You will need to explain to them that this is real life and sometimes we cannot brush it aside. Give the students time to reflect and then write a response to how they feel about what they viewed.

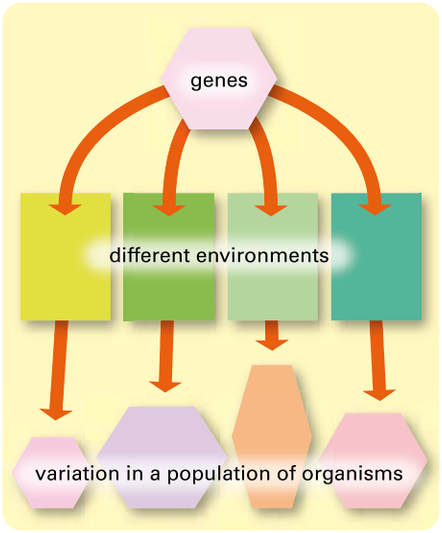
Variations and the environment

Suppose you had two identical twin baby mice. This means they each have the same genes, and they should grow up to look exactly the same. Not necessarily! Suppose you fed one with high quality food and gave it plenty of exercising equipment. The other you fed the minimum amount of food and kept it in a bare cage. The twin mice would grow up to be quite different.

Fig 24 Environmental factors can influence how an organism grows and develops

In many cases environmental conditions can play a major role in determining how an organism develops. The organism's genes are the *potential* blueprints for development but it is the combined genetic and environmental factors that *actually* determine how an organism develops. Environmental factors include biotic factors such as food availabilty and diseases, as well as abiotic factors such as temperature, water and air availability, length of daylight and soil fertility.

Fig 25 This young child from Brazil is suffering from extreme malnutrition. Her growth is stunted, her resistance to disease is poor and her mental development may be limited—all due to environmental conditions.



Hints and tips

- Remind students to add to their glossary and flash cards for this chapter, if they have them.
- Take a few minutes to revise and reinforce past work in this chapter before moving onto the next section. The students could write down a paragraph or jot down a series of dot points about what they have learnt so far, then share it with the person next to them. You could also ask them to write down an area they found challenging and if they would like it reviewed, and what they feel they have grasped or understood. Collect their responses and evaluate what they have written.

Homework

Most mutations are harmful, but ask students to come up with a list of some mutations which have been beneficial. They could draw a table with four columns, with the headings 'Plant/Animal', 'Type of mutation', 'Benefit' and 'Source of information'. Students will probably find surfing the internet the quickest research method, but remember that not all the information on websites is reliable.

Learning experience

Grow some seedlings in controlled environments for the students to observe. Make sure the seedlings are from the same root or seed stock. Tomato or corn seedlings work well. Ask the students to design an experiment to investigate the effect different environments may have on the seedlings. Remind them of the importance of controlling variables. (It would be unethical to do an experiment using animals, so only use plants.)

Learning experience

Can the students think of any places in the world, Australia or their local area where environmental conditions have played a major role in determining what happens to an organism? In agriculture, do farmers alter or create their own 'environments'? This is a very broad topic so you may choose to give students a more specific task. Otherwise the students could present their information as a series of dot points and then comment on what they think about the topic. This helps to minimise copying of information.

Check!

1 Some of the following statements are incorrect. Select the incorrect ones and change them to make them correct.
   - **a** Mutations are alterations to genes.
   - **b** Human sperm contain 23 pairs of chromosomes.
   - **c** Hair colour in humans is controlled by a single gene.
   - **d** X-rays and radioactive substances can decrease the rate of mutations in organisms.

2 **a** Give an example of a human characteristic that is controlled by a single gene.
   - **b** Give two examples of human characteristics that are controlled by more than one gene.

3 A young man had a leg amputated after a car accident. He marries and has children. Will any of his children have only one leg?

4 In one person, a mutation occurs in the DNA in a skin cell. In another person, a mutation occurs in the DNA in a sex cell.
   - **a** Why could the mutation in the sex cell affect the human population, whereas the mutation in the skin cell would not?
   - **b** What might happen to the person as a result of a mutation in a skin cell?

5 Suggest why harmful mutations are generally not passed on to the next generation.

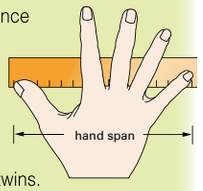
6 A variation due to a mutation occurs in a watermelon. The new plant produces large very fleshy, sweet fruit with a very thin skin.
   - **a** Why would it be unlikely that this new watermelon would survive in the wild?
   - **b** Why would the new variety of watermelon be good if you were a farmer?
   - **c** Suggest how the farmer could breed this variety from the newly discovered single watermelon plant.

challenge

1 Selective breeding has been used by farmers and breeders for many hundreds on years. The two dogs in the photos are very different.
   - **a** Describe their major differences.
   - **b** What purpose did the breeders have in mind for the dogs when they selected them for breeding?
   - **c** Using the word *mutations*, describe how such huge variations in dogs might have arisen.

2 A farmer grows some apple trees from cuttings. This means that all the apple trees contain the same genes because they came from the same parent tree.
She grows the trees in two paddocks, one on the western side of a hill and the other on the eastern side.
The western trees produce large sweet apples while the eastern trees produce a small crop of hard-skinned, smaller apples.
   - **a** Why should the trees have produced the same quality apples?
   - **b** Suggest reasons for the differences in the type of fruit produced by the trees in the two paddocks.

3 Your handspan is the distance from the tip of your thumb to the tip of your little finger on your stretched out hand. Handspan varies between individuals of the same age.
Suppose you measured the handspan of identical twins.



   - **a** Would you expect their handspans to be the same. Explain your answer.
   - **b** If their handspans were different, how would you account for the difference?

Check! solutions

1 **a** Correct.
b Incorrect. Human sperm contain 23 *single* chromosomes. See pages 128–130.
c Incorrect. Hair colour in humans is controlled by *several* genes.
d Incorrect. X-rays and radioactive substances can *increase* the rate of mutations in organisms.

2 **a** Examples are widow's peak, attached ear lobes, long second toe and genetic diseases like cystic fibrosis. Refer to page 132.
b Examples are height, weight, hair colour, eye colour and most other characteristics.

3 Most physical characteristics, including the number of legs, are controlled by genes. The amputation of a leg will not influence the genes in the man's body and will therefore not influence the number of legs his children will have.

4 **a** The difference is that the sex cell (sperm or egg) containing the mutation may be passed on to children and therefore can influence the next generation, whereas the skin cell will not.
b The mutation in the skin cell may cause that cell to divide and grow in an unusual way and may result in a skin cancer which could cause illness and possibly death.

5 Harmful mutations often cause the death of an organism before it is able to reproduce.

6 **a** This watermelon would be unlikely to survive in the wild because the thin skin would not provide protection against dehydration and small animals trying to get to the fleshy fruit. If the fruit, including the seeds, are destroyed there will not be a next generation.
b This variety would be good if you were a farmer because it would be attractive to customers in a fruit shop.
c In order to breed this variety, the farmer would need to collect and store seeds from this plant and then plant them under suitable conditions.

Challenge solutions

1 **a** The major differences are in size, body shape, colour and hair length.
b It is likely that the breeders of the larger dog (Great Dane) did so for the purpose of hunting or as a guard dog. It is likely that the smaller dog (silky terrier) was originally bred for hunting rabbits in their burrows or as a household pet.
c All dogs belong to the same species and had a common ancestor many thousands of years ago. Suppose that a long time ago a *mutation* occurred and that one of the pups in a litter was larger than the others. The owner might have realised that a larger dog would be useful for hunting, and then used this dog for breeding. Over many generations more and more dogs would have had this gene and become larger. A similar process would also occur for other desirable characteristics in dogs.

2 **a** If the growth of an organism was dependent only on its genes, then all the apple trees should have produced the same quality apples. However the characteristics of organisms depend on both the genes that are inherited

11.3 Evolution

The diprotodon above was the largest marsupial that has ever lived on this planet. Now extinct, it lived in Australia from about 1.6 million years ago until about 50 000 years ago.

It was approximately the size of a modern-day hippopotamus and lived in open forests or grassland, eating leaves, shrubs and grasses. The closest living relatives of the diprotodon are the wombat and the koala.

Why did the diprotodon die out?

Early in this chapter you learnt that two major factors in an ecosystem influence the way organisms live and survive: biotic factors and abiotic factors. For example, recent high summer temperatures and drought conditions in Australia have killed many trees that have been growing for years. And these abiotic factors have been experienced for a relatively short period of time.

Imagine the effect on the survival of organisms if these changed weather conditions continued for hundreds or thousands of years. Those organisms that cannot tolerate the changes would die, while those that have favourable characteristics for living in the new conditions would survive and reproduce. This is the process of *natural selection*. There is more about this on page 259 (***Extinction of the giants***).

Wombats and koalas

Fossils of diprotodon show that its bone structure is very similar to the bone structure of wombats and koalas. Scientists have also matched the DNA fingerprints of koalas and wombats. These fingerprints show that the wombats and koalas are very closely related. Unfortunately DNA is not available from the diprotodon fossils to check the genetic relationship.

Fig 30 The wombat—a distant cousin of the diprotodon?

What is a species?

In your study of science you have learnt that scientists classify organisms into groups. For example, all insects belong in one group. However, there are so many different types of insects that they are classified into smaller groups, for example beetles and cockroaches. The groups become smaller and smaller until you reach a **species**. This group contains organisms with very similar features. Organisms belonging to the same species can interbreed to produce offspring, but organisms from different species cannot. For example, all dogs are the same species. Even though there is a large variation in the shapes and sizes of dogs, they can breed and produce puppies.

Although wombats and koalas are very similar they are not the same species. In other words, they do not breed in nature. So how do we get different species of organisms? Did the diprotodon, wombat and koala have a common ancestor? On the next page you can see how scientists infer different species could form.

and on the environment in which they grow. In this case where the genes are the same, the differences must be due to the two different environments.

b In this case, there are a number of possible differences in environmental conditions on the western and eastern sides of the hill. They may be differences in soil type and fertility, competition from other plants, grazing animals and rainfall.

3 a Yes, you would expect the handspans of identical twins to be the same since they have identical genes. This assumes that they have similar conditions such as exercise and diet.

b The reasons why their hand spans would not be exactly the same might include amount of exercise each of the individuals did when they were in their growing years, their diet and their general health.

Hints and tips

- This section is designed to allow you to develop the Essential Learning: The diversity of plants and animals can be explained using the theory of evolution through natural selection, eg Australian marsupials would have had a common pouched ancestor. It is not intended to be a more detailed study of evolution. This is done in *ScienceWorld 3* Chapter 9.
- If the students wrote the 'What am I?' questions on page 245 (see Learning experience) now is a good time to do the quiz.
- Allow the class time to add to their concept maps (see Learning experience, page 250) by adding words and linking sentences from this page.
- Many inferences are made in the theory of evolution so it is particularly important to remind students what an inference is.
- Be sensitive towards and encourage tolerance from the students about other class members' viewpoints on the evolution theory. Allow time for the students to express their views and explain why they have them. It may initiate an interesting class discussion. Be mindful that as educators we are not here to give our own viewpoint but to explore all viewpoints so that the students can form their own educated opinions.

Research

Get the students to do a species search. Tell them to choose five different plant or animal groups and then find out how many recorded species are known. If it is possible, they could print out lists of the species names. From this exercise the class will be able to recognise how diverse life is.

Learning experience

Get the students to draw a concept cartoon using the information in section 11.3. A concept cartoon is a stylised drawing that illustrates a real-life situation or a theory. Minimal text in caption bubbles is used to depict the ideas/concepts and this makes it accessible to most learners, including those with language difficulties. It might be useful to title it 'Evolution: what do you think?'

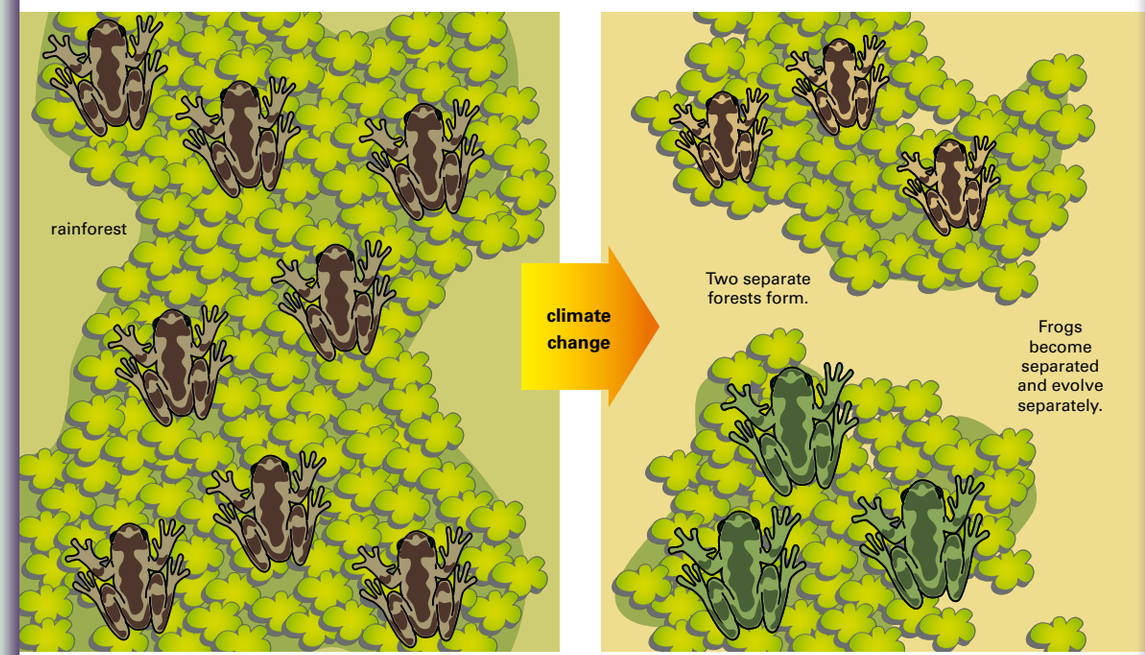
How new species form

The green-eyed frog lives in the rainforest areas of North Queensland between Townsville and Cooktown. There are two species of green-eyed frog. Let's call them frog A and frog B. They live in different areas—frog A lives in the northern forests and frog B lives in forests closer to Townsville. Scientists suggest they came from a single species common ancestor.

A few million years ago during the last Ice Age, cooler, drier conditions on Earth caused the rainforests to retreat. This resulted in two separate forests—the northern forests and the southern forests. Scientists infer that the frog population was separated and formed two distinct groups during this time. The biotic and abiotic factors in each ecosystem were different, and the more favorable characteristics of each frog group were passed from generation to generation.

It is thought that natural selection in each of the forest ecosystems produced two different species of green-eyed frogs.

Fig 31 This green-eyed frog lives in streams in the rainforests of North Queensland.



Learning experience

A good revision tool is to do the following challenge with the class—it takes some teacher preparation time but is well worth it.

1. Prepare four sets of recall or closed-style questions on an A4 sheet of paper divided into quadrants, with one set of questions in each quadrant.
2. Divide the class into four even groups of mixed abilities and assign each group a corner of the room.
3. Each student takes a question sheet and folds it into four so that the first set of questions is showing, then individually answers the question set.
4. Students then swap their question sheet with another member of a different group who will mark it.
5. The marks for each group are tallied on the board (use a ratio marking scheme if the groups are not all the same size).
6. The students then go back to their corners and complete the second set of questions. The process is repeated until all the question sets are done.
7. The group with the highest score wins the competition. You may like to give out small prizes, such as lollies or other treats.

Activity

Natural Selection Game

In this game one team will be predators and another team will be the prey.

In any population there are variations of characteristics. The predators in this game need good eyesight to catch the prey. The prey need good camouflage to avoid the predators.

This game has two aims:

- to see how many prey survive after a number of rounds, and whether the camouflage characteristics in the population have changed
- to see how many predators survive after a number of rounds, and whether the eyesight characteristics in the population have changed.

At the end of the game, the winning team is the one that has the highest total score of all remaining cards added together.

For this game you will need the following:

- a 6 x 6 grid (6 rows and 6 columns) on an A3 piece of paper
- two 6-sided dice (different colours are best)
- 16 prey and 16 predators (see Note below)

Teacher Note:

- Use the A4 6 x 6 grid template in the Teacher Edition and photocopy it to A3 size.
- Cut out about 40 pieces of 2 cm x 2 cm card for the prey, and the same for the predators but on a different coloured card. Alternatively round plastic counters can be used.
- The Teacher Edition has more detailed notes on playing this game.

Prey setup

In this game the prey are eaten by the predators. Some prey are easy to see (score of 1), others are well camouflaged (score of 7). Use a pen to number the prey cards as shown in the table.

Degree of camouflage		Number of pieces
1	worst	1
2		2
3		3
4		4
5		3
6		2
7	best	1

A prey piece with poor camouflage

Predator setup

Some predators have poor eyesight (score of 1), others have good eyesight (score of 7). Use a pen to number the predator cards as shown in the table.

Degree of eyesight		Number of pieces
1	worst	1
2		2
3		3
4		4
5		3
6		2
7	best	1

A predator piece with good eyesight

Recording your results

Copy the data table below to record the numbers of predators after each round. Make up another data table for the prey numbers.

	Predator numbers						
	Eyesight scores						
Round number	1	2	3	4	5	6	7
Start	1	2	3	4	3	2	1
1							
2							
…							

Activity notes

- The A4 6 × 6 grid template can be found on the teacher CD in the back of this book. Make sure you photocopy the grid at A3 size to be used as the game board. Do not cut this sheet up.

ScienceWorld 2
Natural Selection Game

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

- If you are not able to use coloured paper for the prey and predator cards, get the students to write 'Predator' or 'Prey' on the cards. Alternatively, make a template with the names on it, then photocopy and cut up the squares. To save time, cut the squares yourself. An A3 paper trimmer is a great investment for any science department.
- Carefully read the instructions with the students as a class and allow time for questions before letting them begin.
- Aim to have even numbers of students per group, otherwise one person will miss out or have to take it in turns to be predator or prey.
- Allocate a specific amount of time to the groups so they can draw their results tables. Check they are correct before they start playing the game.

Activity notes

- Allow the students about five minutes to play a practice game so they can ask any further questions if they are unsure of the rules. This will help avoid disputes.
- Playing the game will take about one lesson. Make sure to go through the questions in 'Keeping score' with the class and compare results. How similar are they?

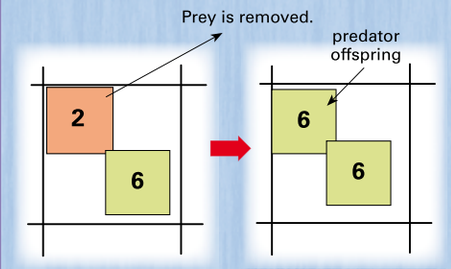
The players
The game is best for two or four players. One team is the prey and has 16 cards. The other team is the predators and has 16 different coloured cards.

Starting the game—placing the cards

1 Both teams should turn their cards over so that the numbers are face down.
2 The prey team starts by rolling two dice. One dice gives the column coordinates and the other gives the row coordinates. For example, a dice roll of 2 and 5 means square 2 across and 5 down.
3 Place a card on the square rolled. Repeat this by rolling the dice for all 16 cards.
4 The predator team then uses steps 2 and 3 to place their cards on the grid.

Round 1

1 If a predator is on a square without a prey, it starves to death and the card is removed and returned to the card pool.
2 If a prey is alone on a square without a predator, it can reproduce and produce one offspring. To do this, place another prey card of equal number on the same square.
3 If a predator and prey are on the same square, the predator can eat the prey if its eyesight score is greater than the prey's camouflage score. If eaten, the prey is removed from the square and returned to the card pool.

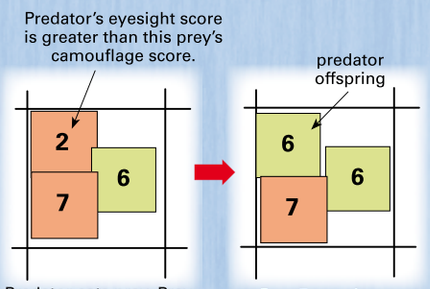


Predator's eyesight score is greater than prey's camoflauge score.

Predator eats prey. Prey is removed. Predator has one offspring.

If the prey's camouflage score is greater than the predator's, the prey and predator cards remain, but the prey doesn't reproduce. If the scores are the same, flip a coin to see who wins.

4 When a predator eats a prey, it breeds and produces one offspring. To do this, place another predator card (offspring) of equal number on the same square.
5 If there are two or more prey on a square with a predator, the predator can eat both if its eyesight score is greater than either of the individual prey's camouflage score. The predator then produces *two* offspring.



Predator eats prey. Prey is removed. Predator has one offspring.

Prey 7 remains on square.

Keeping score

1 At the end of round 1 enter the results in the predator and prey data tables.
2 For the next round, take all the surviving cards off the board and use the dice to place them on the board as before.
3 Look at the predator and prey numbers and scores after the final round. How do they compare with the starting numbers? Has natural selection changed the distribution of characteristics in the predator and prey populations? Explain.
4 Is it possible for a predator or prey to become extinct? Explain.
5 Who won? To find out, add up the scores on all the predator cards and compare them with scores on the prey cards.

science bits

Extinction of the giants

About 2 million years ago giant mammals and flightless birds, collectively called *megafauna*, roamed throughout Australia. But by the end of the Ice Age about 10 000 years ago, they had almost all disappeared. What was the cause of their extinction? Some scientists infer that the rapid climate change during the last Ice Age caused their disappearance. Others infer that humans caused their extinction.

Fig 33 The now extinct giant pug-faced kangaroo, Procoptodon, stood more than 2.5 metres tall and looked like a cross between a koala and a kangaroo.

Inference 1: Human-caused extinction

It is thought that humans arrived in Australia between 40 000 and 60 000 years ago. Improved dating techniques have shown that there was a sudden increase in bushfires about this time. People hunted the large flightless birds and marsupials for food and burnt the bush to encourage food plants to survive and spread. This large-scale burning changed the environment and made it unsuitable for the megafauna. The moist forests and shrubs changed to grassland, and the megafauna found it difficult to find food. Other animals such as emus and kangaroos eat mainly grasses, which is why they survived in the changed environment.

Inference 2: Climate-caused extinction

Many scientists do not think that humans caused the extinction of the megafauna. They infer that a change in climate over tens of thousands of years caused dramatic changes to the environment.

About 30 000 years ago Australia's climate started to change. Most of the inland areas became very dry and lakes dried up. The animals which ate leaves and seeds either died or moved further east where there was water and food. There is fossil evidence that diprotodon lived in the same ecosystem as humans for more than 20 000 years.

Scientists supporting inference 2 believe that the indigenous hunters did not overkill the megafauna. Instead, for social and cultural reasons, the animals were harvested in a sustainable way.

Questions

1 What is meant by the term megafauna? Are there any megafauna that currently live on Earth?

2 Suggest why emus and kangaroos have survived in central Australia over the last million years whereas diprotodons and other megafauna have not.

3 It is possible that the megafauna extinction was caused by a combination of humans and climate. Write a brief story describing how this might have happened.

4 What is meant by 'social and cultural reasons'? Why would these force people to harvest the animals in a sustainable way?

WEBwatch

Go to www.scienceworld.net.au and follow the links to the websites below.

Oz fossils
A very interesting site full of great information and interactive graphics and games.

Ice Age Animals and their Extinction
This site contains theories about extinction and information about Australian Ice Age animals.

Hints and tips

Australia's megafauna may in fact have died out because of changes to the vegetation from bushfires, rather than from climate change. Dr John Long, head of science at Museum Victoria, and Dr Gavin Prideaux, palaeontologist at the Western Australian Museum, reported their findings in the *Nature* journal in 2007. In their report they suggested that the Nullarbor vegetation changed from fire-sensitive woodland to the shrub grass we have today. The scientists suggest an increase in bushfires is the most likely explanation for the vegetation shift, and that climate was not a significant factor. The report suggests it is yet to be determined whether the increased number of bushfires was related to the arrival of humans.

Homework

Print out some recent articles detailing the latest information about the suggested cause of the megafauna extinction. Ask the students to review the articles by writing dot points into a table with the headings 'Evidence', 'Inference' and 'Personal opinion'.

Learning experience

It is very worthwhile getting the students to do the Webwatch if you have access to computers. Otherwise ask them to do it as a homework exercise.

Hints and tips

There is much debate surrounding the ideas of *macro-evolution* and *micro-evolution*. Ask the students to do some research and come up with their own conclusions. The following simplified definition could be given to the class:

Micro-evolution is the adaptations and changes within a species, while macro-evolution is the addition of new traits or a transition to a new species. Micro-evolution is a fact that is observable throughout nature. Macro-evolution is a theory that has not been observed.

Assessment task

This would be a good place to set *Assessment task 11: A threatened or endangered species*, found on the CD.

Homework

The students could write a case study on the life of Charles Darwin. They may like to present their information as a series of diary entries or a narrative of his life.

The process of evolution

The formation of two different green-eyed frog species is an example of the process of **evolution**. This is a scientific theory which suggests that through a process of natural selection, populations of organisms change over time. For example, scientists infer that the diprotodon, wombat and koala had a common ancestor. Over millions of years of changing conditions and separation of populations, these three quite different species were formed. These animals looked similar but could no longer breed together.

There are three steps that are important for evolution to occur.

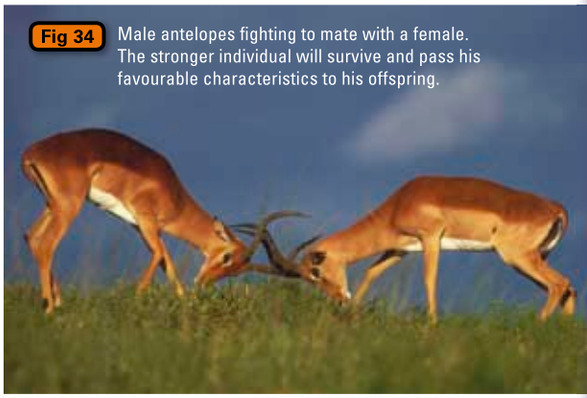


Fig 34 Male antelopes fighting to mate with a female. The stronger individual will survive and pass his favourable characteristics to his offspring.

Step 1 — Variations
Some variations give individuals a better chance of survival.

→

Step 2 — Selection
Biotic and abiotic factors (eg limited food supply, changing climate) select favourable variations.

→

Step 3 — Reproduction
Individuals that survive will reproduce and pass their genes on to their offspring.

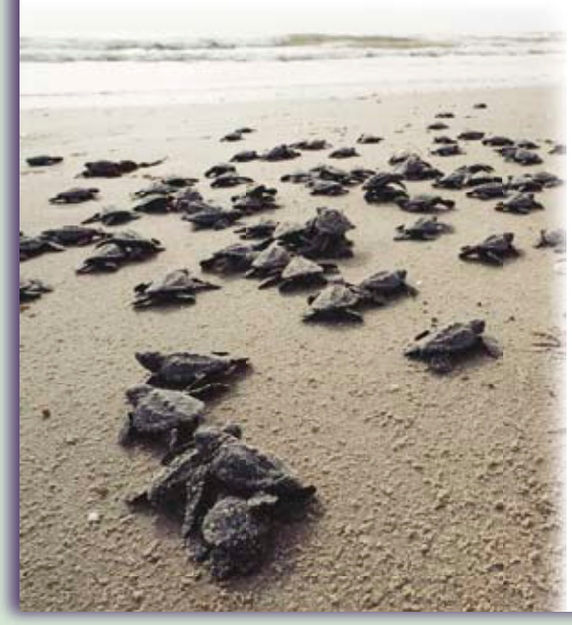


Fig 35 Turtles lay thousands of eggs. Most of the offspring die or are eaten by predators. The survivors struggle to find food from a limited supply so they can grow and reproduce.

Charles Darwin and natural selection

The term *natural selection* was first used by Charles Darwin in his book *On the Origin of Species by means of Natural Selection*, which was first published in 1859.

Darwin developed his ideas of natural selection after studying animals and plants on his journey on *HMS Beagle*. This five-year voyage took him from England to South America, the Pacific and Australia. He collected many specimens and was amazed at the diversity of organisms he observed in his travels. His idea that organisms change over time was very controversial at the time. But he started many other scientists thinking about the origins of life on Earth.

Evidence for evolution

A scientific theory is developed from many observations and tests. Scientists use the data from these observations and tests to make inferences and models. Gradually a theory takes shape that can be used to predict future events. Theories are often modified as new data is collected and discoveries are made. Therefore, unlike a scientific fact, a theory is never fixed.

The evidence that is used to make inferences about evolution has been gathered by many different people using many different techniques.

Fossil evidence

Fossils are the preserved remains of once-living organisms. They are important pieces of evidence for the idea that forms of life on Earth have changed over millions of years.

The ages of fossils and the rocks that they are found in can be determined using radioactive dating techniques. An evolutionary timeline like the one below can be constructed.

Age of rocks (millions of yrs)	Fossils found in rocks
2	first true humans
15	first apes
70	first flowering plants
150	mass extinction of dinosaurs
250	first birds first mammals first reptiles first ferns
400	first land arthropods marine molluscs and arthropods
600	bacteria and protists

The fossil record is far from complete. It shows only a small fraction of the types of organisms that have lived on the Earth. However, like adding pieces to a half-finished jigsaw puzzle, new fossil discoveries add to the record.

Fig 37 This archaeopteryx fossil is one example of an organism, now extinct, that is very different from any organism living today.

Comparing molecules in cells

At the time of developing his ideas about how life has changed on Earth, Darwin had no knowledge of DNA or genes. He did not know how characteristics were passed from one generation to the next.

DNA studies have shown amazing similarities between the DNA of related organisms. For example, 98.8% of chimpanzee DNA is identical, to human DNA, while gorilla DNA is 98.4% identical.

Scientists have also shown that there are certain proteins in cells that are common to all forms of life. For example, the protein that duplicates the DNA prior to mitosis is the same in all animals and plants. This is further evidence for the idea that life on Earth shared common ancestors.

Hints and tips

It is important to point out to students that fossil records are far from complete and show only a small fraction of the types of organisms that live and have lived on the Earth.

Research

Get the students to research and explain to the class how radioactive dating (eg carbon-14 dating) works. They should also consider the following questions:

- How reliable is this method?
- What inferences are made when scientists use radioactive dating techniques?

Learning experience

Revise the chapter by conducting a quick quiz or giving them a set of problem-solving questions.

Learning experience

Get the students to finish their concept maps and collect and assess them so they are ready for Chapter 13.

Check!

1 Photos A and B show two different species of frogs. Photos C and D show two types of cats, which are both the same species.

Photo A

Photo B

Photo C

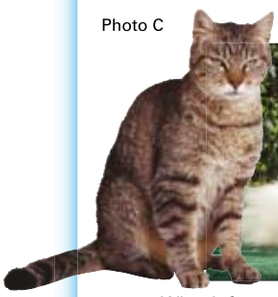


Photo D

a What information would scientists use to classify the frogs as different species?
b Why are the cats considered the same species?

2 How do scientists know that wombats and koalas are closely related?

3 Explain what the term evolution means. In your explanation use the words *mutations*, *variations*, *inherited* and *natural selection*.

4 The wombat and the diprotodon lived at the same time in Australia. The diprotodon is now extinct but the wombat is still living. Suggest an inference for this observation.

5 Organisms like spiders lay hundreds of eggs at one time. Birds, on the other hand, lay only a few eggs at a time. Suggest reasons for this.

6 A scientist finds a species of possum in a forest that is very similar to another species of possum in a forest 300 km away. The scientist thinks the two different species might have had a common ancestor. Suggest how the two species might have formed.

7 The Giant Koala lived in the same sort of habitat as the modern koala. Scientists think that both koalas lived at the same time. However the Giant Koala has been extinct for 50 000 years. Suggest some inferences for the extinction of the Giant Koala.

8 The burrowing frog below lives in Central Australia in sandy creeks. Most of the year these creeks are dry. The frog burrows deep into the sand in the dry creek banks. It comes out at night to eat insects. It can also hold a relatively large amount of water in its body.

a List the adaptations this frog has to enable it to survive in its harsh desert habitat.
b 50 000 years ago the climate in the area was much wetter. Various species of fossil frogs have been found. Suggest how the burrowing frog may have evolved from the fossil species.

Check! solutions

1 **a** A species is a group of organisms that will interbreed to produce fertile offspring. If these frogs were to be classified as separate species, a scientist would need to be sure that they did not interbreed.
b All cats are considered to be the same species because they will interbreed to produce kittens.

2 Scientists know that the wombat and koala are closely related because they look similar and have similar skeletons to each other and to the extinct diprotodon. More recently this has been confirmed using the results of studies that have been done comparing their DNA.

3 A mutation is a change to the DNA of an organism. Some of these *mutations* are *inherited* and lead to *variations* in the offspring. Most of these mutations are harmful, but sometimes a mutation provides an advantage for the organism and it is inherited. This process is called *natural selection* and is the basic process of evolution.

4 Extinction occurs when an organism is not well suited to a changing environment. In the case of the diprotodon the reason may have been climate change, hunting by indigenous people or a combination of both. The smaller wombat may have been able to find protection against both of these threats by burrowing underground.

5 Generally, animals that take good care of their young have fewer offspring and vice versa. Spiders generally take little care of their young and consequently many die very early in their life. Birds, on the other hand, will take good care of the few eggs they lay and thereby increase the chance that the chicks will hatch and grow to maturity.

6 The way that one species develops into two is usually that there is some sort of barrier, such as a body of water, that splits a population into two. Over time these groups may develop different breeding patterns so that even if they meet they will no longer interbreed. When this happens there are two different species. Refer to page 256 for another example and more information.

7 This is a similar situation to that in Check! 4. In this case changes in the environment obviously favoured the smaller animal. It may be that food was scarce and smaller animals need less food, or it might be that the smaller animals could climb trees to find food or escape hunters or predators whereas the larger animals could not.

8 **a** The main adaptations of this frog are:
- It burrows deep into sand.
- It comes out at night to eat insects.
- It is able to store a large amount of water in its body.

b Natural selection can be used to explain this. For example, a frog that was able to burrow would be more likely to survive and reproduce than one that could not burrow. Over time the changing conditions favoured the burrowing frog.

challenge

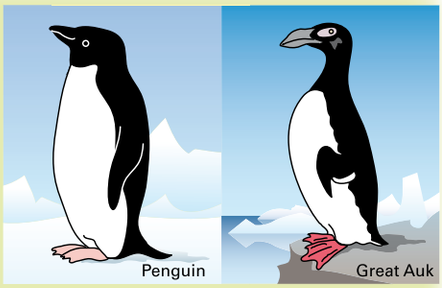
1 The Mexican blind cave fish is a popular aquarium fish. However, in nature it lives in dark water-filled caves. It is very similar to a fish that has vision and lives in the open lakes around the caves, but it is a different species.
The blind cave fish is highly sensitive to movements in the water. It has no pigment in its skin, which gives it a pink appearance. Its skin would burn if it lived in direct sunlight

Fig 42 The Mexican blind cave fish

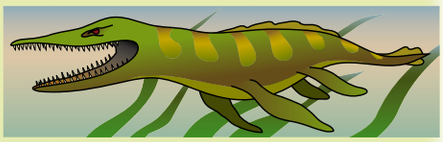
- **a** How is the blind fish suited to its natural habitat?
- **b** Imagine some fish with vision were introduced to the cave. What difficulties would these fish have?
- **c** What difficulties would blind fish have if they were introduced to the open lakes?
- **d** Suppose the blind cave fish and the fish with vision had a common ancestor. Suggest how a population of blind cave fish might have become established in caves?

2 The penguin is a flightless bird. It lives in the Antarctic region and feeds mainly on fish.
The Great Auk is recently extinct but was also a flightless bird. It lived in the Northern Hemisphere close to the Arctic and ate mainly fish. The two birds are different species and are not closely related.

- **a** In which ways is the penguin similar to the auk?
- **b** Suggest what environmental factors might favour the penguin but have made the auk extinct.



3 *Kronosaurus queenslandicus* is an extinct reptile that lived in Central Queensland about 110 millions years ago. It was about 9 meters long and had well developed teeth.



- **a** From your observations, make inferences about the type of habitat Kronosaurus lived in.
- **b** Fossils show that crocodiles lived in the same habitat as Kronosaurus. Suggest some ideas about why Kronosaurus became extinct but crocodiles did not.

4 In Chapter 7 you learnt that about 200 million years ago the supercontinent Gondwana started separating into smaller continents.

- **a** Use this knowledge to explain why there are numerous marsupial fossils in South America and Australia but none in Europe or Africa.
- **b** There are many types of living marsupials in Australia but only two in South America. Suggest reasons for this.

5 Charles Darwin is famous for convincing the scientific community of his time that species have evolved from common ancestors. However he wasn't the only person to have ideas about evolution.

- **a** Find out more about Charles Darwin. Go to **www.scienceworld.net.au** and follow the links to **About Darwin**.
- **b** Use the internet to find out about the ideas of Jean Baptiste Lamarck and Alfred Wallace, and how they compared with Darwin's ideas.

Challenge solutions

1 a The blind fish is suited to its natural habitat in a number of ways:
- It is highly sensitive to movements in the water.
- It has no pigment in its skin and therefore would be almost transparent (clear) and difficult to see, even in darkness.

b If fish with vision were introduced they would be at a disadvantage because their sight is no good to them in the darkness and they would probably lack the sensitivity to water movement. These two factors would make obtaining food and reproducing very difficult.

c If these blind fish were introduced to open lakes they would be at a considerable disadvantage because:
- They would not be able to see all of the dangers, eg birds from above.
- They would be vulnerable to damaging solar radiation.

d Again the process of natural selection has operated. When the first fish entered the caves, the fish in the population that were highly sensitive to water movement had a big advantage for finding food and a mate for reproducing. Those fish that did not spend energy on vision and making pigment would also be at an advantage. If the fish population in the caves became isolated from the ones outside, the genes for both of these characteristics would be passed on to the next generation and the blind fish in the population would increase and become a new species over time.

2 a The penguin and the auk are similar in the following ways:
- They are similar-sized animals.
- Both are flightless birds.
- Both live in cold regions and eat mainly fish.

b It is likely that the extinction of the auk was caused by one or more of the following factors:
- Hunting by humans in Antarctica is more isolated and there are no people living permanently there.
- Auks may have competed with humans for fish as food.
- Predators of auks may have been introduced.
- Climate change may have been a factor, eg a mini Ice Age occurred in the northern hemisphere from the sixteenth to the nineteenth centuries, but did not occur in the southern hemisphere.

3 a From its body size and shape we can infer it is likely that this animal lived in water. From its teeth we can infer that it was a predator, and captured and ate fish and other marine animals.

b Again this is an example of natural selection. Obviously the crocodiles had advantages compared to Kronosaurus which enabled them to survive and reproduce. Perhaps the crocodiles, having legs, were able to swim in water and walk on land, whereas Kronosaurus had flippers and could live only in water. This means that if all of the inland seas dried up the Kronosaurus population would all die and the species become extinct.

4 a Marsupials are mammals with a pouch, eg kangaroos and possums. The observation that there are marsupial fossils in South America and Australia suggests that at the time that the marsupials evolved these two continents were joined together. In contrast, the fact that there

continued

are no marsupial fossils on Europe or Asia suggests that these continents had separated from Gondwana before the marsupials had evolved.

b There are a number of possible reasons for this observation, for example:
- There were fewer marsupials in the South American part of Gondwana to start with, so there are fewer living species now.
- After separation of the continents, the physical conditions in South America were less favourable to marsupials than in Australia.
- After separation, in South America the increase in the populations of large predators, eg pumas and jaguars, fed on marsupials.

5 a On the linked site you will learn about Darwin's early life, his trip to South America and Australia in 1831 to 1836, and the publication of his famous book *The Origin of Species*.

b You will see that Wallace had similar ideas to Darwin but Lamarck had the idea that acquired characteristics could be inherited, eg he believed that a giraffe had a long neck because it was continually trying to stretch to reach leaves on trees for food. These long necks were then inherited by its offspring.

Main ideas solutions

1 ecosystem
2 biotic
3 adaptations, functional
4 natural selection
5 sex cells, mutations
6 environmental
7 species
8 evolution

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

adaptations
biotic
ecosystem
environmental
evolution
functional
mutations
natural selection
sex cells
species

1 An _____ is the system of relationships among organisms and the way they interact with the non-living things in their habitat

2 The survival of an organism depends on _____ factors as well as abiotic or non-living factors.

3 _____ are characteristics that help an organism survive in its habitat. They can be classified as structural, _____ or behavioural.

4 _____ is a process by which those organisms with characteristics best suited to their environment survive and reproduce.

5 Variations in a population are due to different combinations of chromosomes when _____ are being made, as well as alterations to genes called _____.

6 How an organism's inherited characteristics develop are due to combined genetic and _____ factors.

7 A _____ is a group of organisms that have similar features and can interbreed and produce offspring.

8 _____ is a theory which suggests that by natural selection, species change over long periods of time and develop into new species.

Try doing the Chapter 11 crossword on the CD. Working with technology

REVIEW

1 For each of the terms below, write a sentence to show that you understand its meaning.
species biotic factors
evolve adaptation

2 Which of the following would you class as a functional adaptation? (There may be more than one answer.)
A Dolphins have a layer of fat under their skin.
B Dolphins sometimes follow ships.
C Female dolphins give birth to live young and produce milk on which to feed them.
D A dolphin is able to make many sounds with its voice box.
E Dolphins have a streamlined shape.

3 Which of the following would you class as a physical factor in an ecosystem? (There may be more than one answer.)
A the number of predators in the area
B the availability of light
C the density of trees in the area
D the amounts of nutrients in the soil

4 Which one of the following is *not* an inherited characteristic? There may be more than one answer.
A eye colour
B shape of ears
C sunburn
D ability to roll the tongue into a tube
E chicken pox

Review solutions

1 Organisms that look very similar and can breed to produce offspring are classed as the same *species*. See page 255. Over a long period of time and through a process of natural selection, different species *evolve* from common ancestors. See page 255.
Biological factors describe all the predators, competitors, food sources and disease organisms that interact with an organism in its habitat. See page 242.
An *adaptation* is a characteristic which enables an organism to survive in its habitat. See page 243.

2 **C** and **D**—Functional adaptations are those that refer to the functioning or working of an organism's body. See page 244.

3 **B** and **D**

4 **C** and **E**

5 Skin colour is controlled by more than one gene. The genes work together to give rise to many colour variations. See page 250.

REVIEW

5 The colour of human skin varies from very dark to very pale. Explain in terms of genes why there are variations in this inherited characteristic.

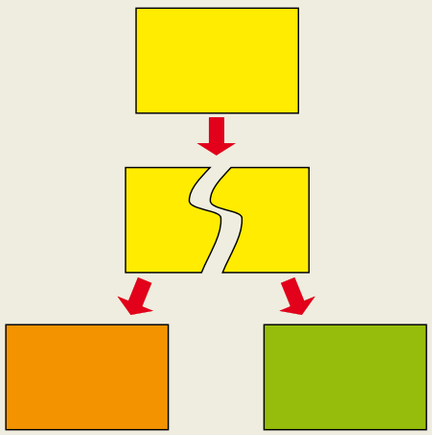
6 In an experiment similar to the one on colour adaptation, 20 disks of each colour were scattered over an area 3 m by 3 m. The 'predators' found as many as they could in 10 seconds and the results were tabled.

Colour of disk	Number found
blue	20
green	17
yellow	4
red	8

a Draw a bar graph of the results.
b Infer the type of surroundings over which the disks were scattered.
c Explain how this experiment can be used as a model for natural selection.

7 How would you explain to a class of young science students what the term *mutation* means? Use an example in your explanation.

8 The model below shows how two species can be formed from an original one. Sketch the diagram in your notebook. Then use labels on the diagram to explain how the process occurs.



9 The genes in an organism's body determines their *potential* characteristics, but the environment and genetics together determine the person's *actual* charcteristics.
Explain what this statement means, giving an example.

10 A certain species of moth has two forms—a dark form and a light form. Both species live in open forests and rest on the bark of trees or in litttle caves in the daytime. Biologists have found that there are usually equal numbers of the moth in the forests. Birds are the main predators of the moth.

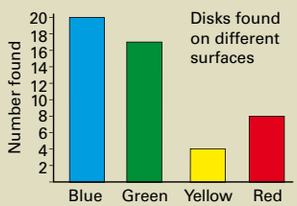
Dark form of moth Light form of moth

a The black moths usually rest in little caves in the daytime. Suggest why they do this.
b Suggest what would happen if many of the trees with light bark were removed.
c Suppose 100 light moths and 100 dark moths were released into a forest containing trees with dark coloured bark. Suggest how the species might change after a long period of time.

11 Read the four statements below. Explain how each one is an important part of the process of evolution.
a Organisms produce more offspring than can survive.
b There is a limited food supply.
c A population shows variations which can be inherited.
d Some variations give individuals a better chance of survival.

Check your answers on pages 323–324.

6 a

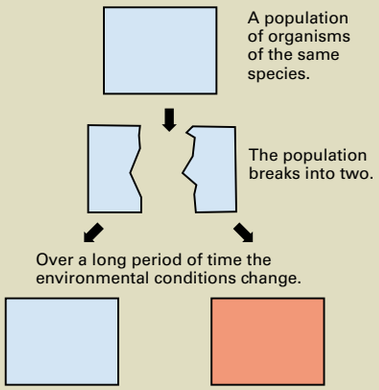


b The yellow and red disks were similar in colour to the surroundings since fewer of them were found than blue and green. The surroundings might have been a yellow-red coloured sand or soil.

c The four different-coloured disks represent the variations in a population. On this particular surface, the yellow and red disks have a better chance of survival. Over time the 'predators' will reduce the blue and green disks and the population will consist mainly of red and yellow disks.

7 Your body cells contain information which is passed on from generation to generation. The pieces of information are called genes. Sometimes a part of a gene will change at random. This change could be beneficial or harmful to the organism and its offspring. These changes to genes are called mutations.

8



9 The genes that you carry will determine your physical characteristics and how your body functions. For example, your size, height, colour of eyes, shape of body etc. However, environmental factors such as food and clean water supply, the presence of disease-causing organisms and accidents, can change the way you would otherwise have developed. For example, lack of good food can stunt your growth and mental development.

10 a The black moths are well camouflaged in the darkness of the caves and are not easily seen by predators.

b Without the camouflage protection of the light coloured bark, predators would easily see and catch these moths.

c The light-coloured moths would not be camouflaged against the darker trees and predators would easily see and catch them. Over a long period of time the proportion of light moths in the population would decrease.

11 a Many of the offspring die as they compete for food and living space. Only the strongest will survive and pass on their genes to their offspring.

b The limited food supply will mean that the ones with the best eyesight, ability to catch food and strongest or fastest body will survive and pass on their genes to their offspring.

c The variations in a population means the organisms with the most favourable characteristics will pass on the genes to their offspring.

d Some variations in organisms give individuals a survival advantage over others. For example, a frog that is able to store more water in its body than other frogs in the population will survive in long droughts.