3 Classification

Our planet contains an amazing variety of living things. Scientists classify these living things into groups on the basis of their similarities and differences. In this chapter, you will find keys to unlock the doors of classification of living things on Earth.

Perhaps one day you will use this background in classification to develop your own classification keys to identify life that has not yet been discovered on Earth, or 'life' on other planets?

This image shows a type of seahorse called a sea dragon. Is it like a horse or can it be classified as something else?

OVERARCHING IDEA

- Patterns, order and organisation

SCIENCE UNDERSTANDING

There are differences within and between groups of organisms; classification helps organise this diversity.

Elaborations

Considering the reasons for classifying, such as identification and communication

Grouping a variety of organisms on the basis of similarities and differences in particular features

Considering how biological classifications have changed over time

Classifying using hierarchical systems such as kingdom, phylum, class, order, family, genus and species

Using scientific conventions for naming species

Using provided keys to identify organisms surveyed in a local habitat

THINK ABOUT CLASSIFICATION

- Are sea monkeys alive?
- How can you use a key to unlock the door to classification?
- Which jellyfish was named in honour of a Queensland radiologist?
- I live in damp places, have thick leathery leaves and don't have vascular tissue. What am I?
- Why bother classifying living things?
- Which animals have their skeletons on the outside?
- I have scales and lungs and live on land. What am I?
- In terms of biological classification, which class do you belong to?
- Which living animal is most like the extinct diprotodont?
- What do insects have in common with Greece?
- What did prehistoric pelycosaurs use their sail-like fins for?
- Which herb helps relieve constipation?

YOUR QUEST

Sorting out dragons

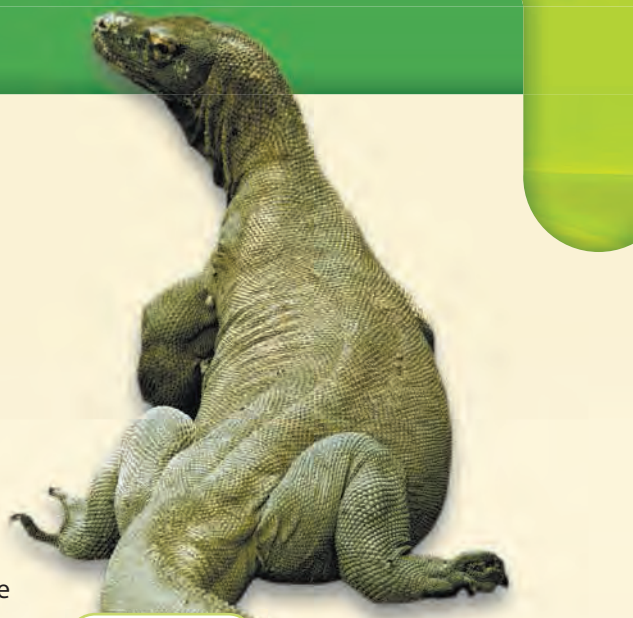
Harry Potter met a dragon, as did Shrek and Bilbo Baggins. In fact, dragons feature in almost every culture from around the world — but did they really exist? If they did, were they somehow related to snakes, lizards or birds?

Think

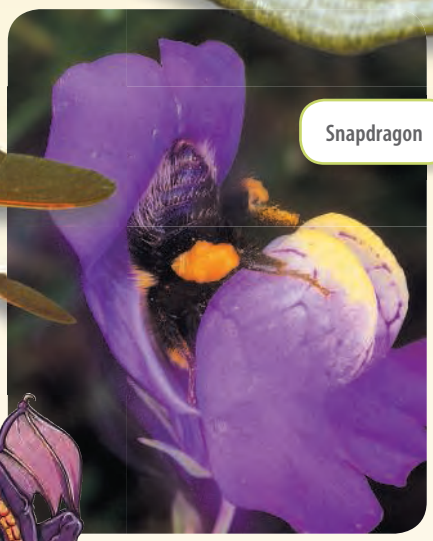
What sorts of features do the dragons on these pages have in common? How are they different? What criteria could you use to divide the dragons up into groups?

Dragon impostors?

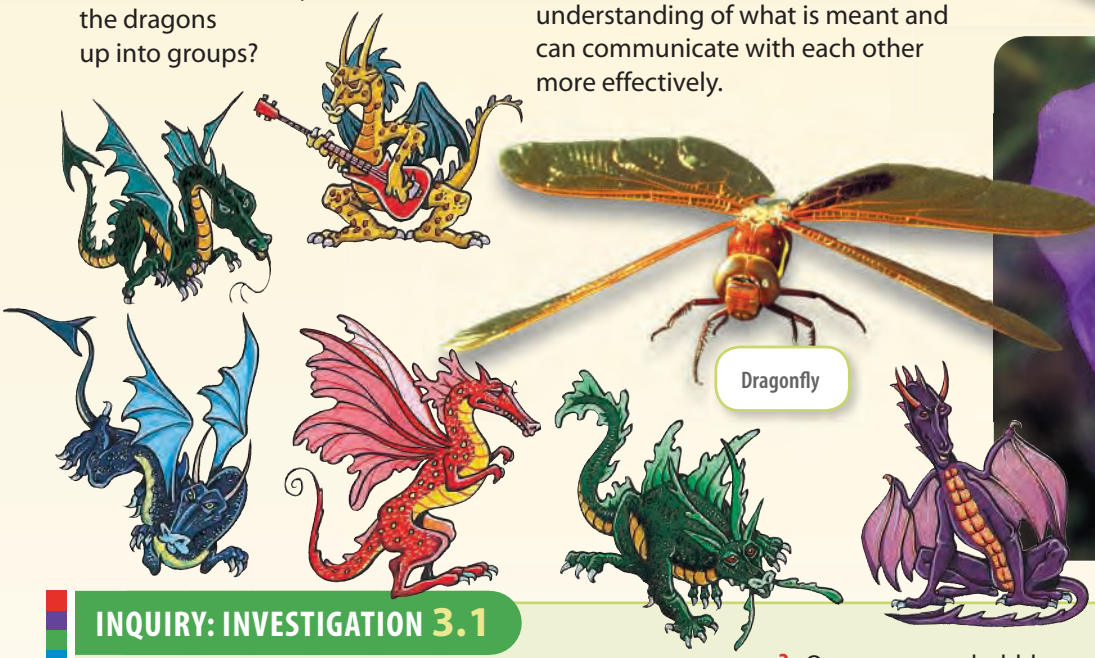
The names of some plants and animals include the word 'dragon'. Look at the sea dragon on the opposite page and the 'dragon' examples below and at right and suggest why this is. The use of these common names can lead to misunderstandings about the similarities and differences of these organisms. One reason scientists use a classification or naming system is so that we have a shared understanding of what is meant and can communicate with each other more effectively.



Komodo dragon



Snapdragon



Dragonfly

INQUIRY: INVESTIGATION 3.1

Dragon mapping

Form a group of four and allocate the roles of scribe, captain/organiser, timekeeper and encourager.

1. Brainstorm all that your group knows about dragons. Each person then uses that information to construct a bubble map of different dragons and their features (see section 5.9 for more information about bubble maps).
2. Compare your bubble map with those of others in your group. On a new piece of paper, the group scribe should collate all of the group's ideas into a group bubble map, adding any extra points that arise during your group sharing.
3. On your group bubble map, use one colour to highlight the features that are common to all dragons.
4. Can any of the dragons shown above be grouped using the features left uncoloured in your bubble map? If so, highlight each group in a different colour.
5. Organise your group's bubble map into a cluster map to show how your dragon information can be grouped or clustered (see section 2.8 for more information about cluster maps).
6. Use the internet to find out more about one area in your group's cluster map.
7. Report back to your group and produce a group summary that you can present to the class.

Patterns, order and organisation

Quidquid latine dictum sit, altum sonatur. Have a go at saying this Latin phrase as if it were a magic spell. While this looks and sounds a little scary and alien, its translation seems to match its meaning — 'whatever is said in Latin sounds profound'. *Res ipsa loquitur* — which literally means 'the matter speaks for itself'.

Science spells magic?

You may have heard modifications of scientific language spoken by wizards, elves, dragons and witches in books you have read or movies you have seen. Many spells and incantations are derived from Classical languages, particularly Latin and Greek.

Although the English language is a mixture of many different languages, it was during the sixteenth and seventeenth centuries that new discoveries created the need for new words to communicate them. Because Latin was the scholarly authoritative language of the time, many of the new words were derived from this language. Roots of Greek words, another classical language of the time, were also used.

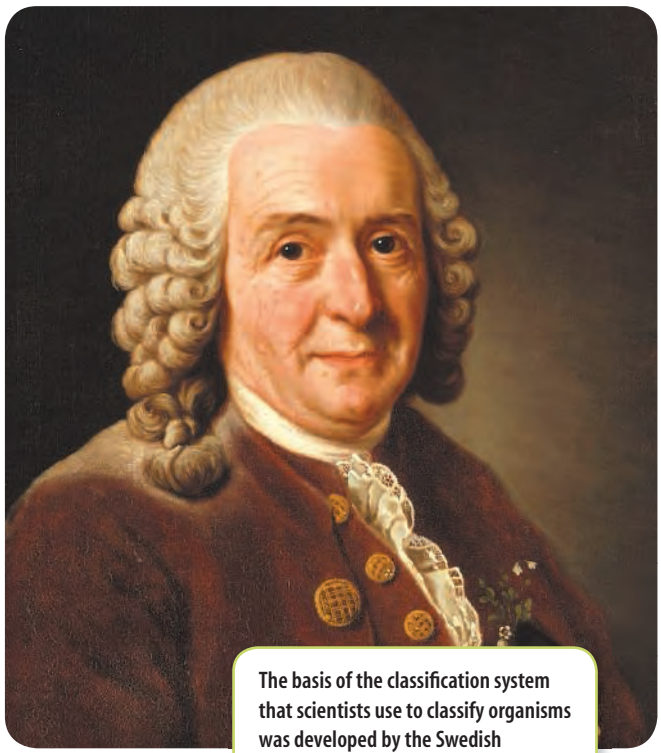
Harry Potter spell	Latin 'root'	Suggested meaning	Effect of spell in Harry Potter stories
Aparecium	appareo	To become visible or to appear	Invisible ink becomes visible
Confringo	confringo	To break into pieces, to bring to naught	Objects explode in flames
Geminio	gemino	To double	Duplicates an object
Lumos	lumen	Light	Produces light from wand tip

Historic keys?

Etymology is the term used to describe the study of words, their origin and grammar. Words are often made up of a prefix at the beginning of the word and a suffix at the end. Some examples of prefixes and suffixes that you might come across in science are shown in the table on the following page. Being aware of this pattern will help you to unlock the meaning of many new scientific words that you come across.

Chunking patterns

Our brain is very good at recognising patterns and grouping things of similar patterns together. By organising information into small chunks, it is easier to remember. **Taxonomy** is an example of a formal classification system of living things. Classification of living things (also known as **organisms**) enables scientists to put some order on the natural world. In this way, all scientists are able to communicate with each other and know that they are talking about the same kind of organism.



The basis of the classification system that scientists use to classify organisms was developed by the Swedish biologist Carl Linnaeus (1707–1778).

INQUIRY: INVESTIGATION 3.2

Cryptonym game

KEY INQUIRY SKILLS:

- questioning and predicting
- processing and analysing data and information
- communicating

- In teams, begin by writing each of the scientific terms in the table below on a card.
- One player should shuffle the cards and then observe which term is on the top card without letting others in the team see.
- Place the card face down and 'act out' its meaning.
- The first team member to identify the term gets to shuffle the cards and act out the next term.

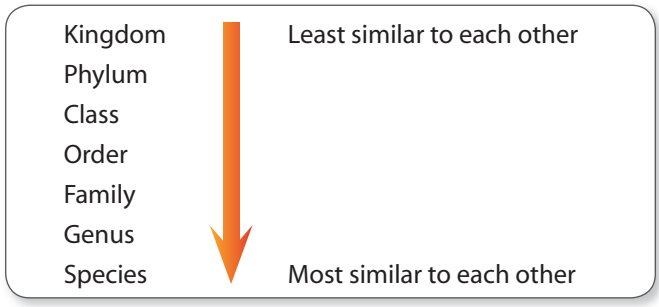
DISCUSS AND EXPLAIN

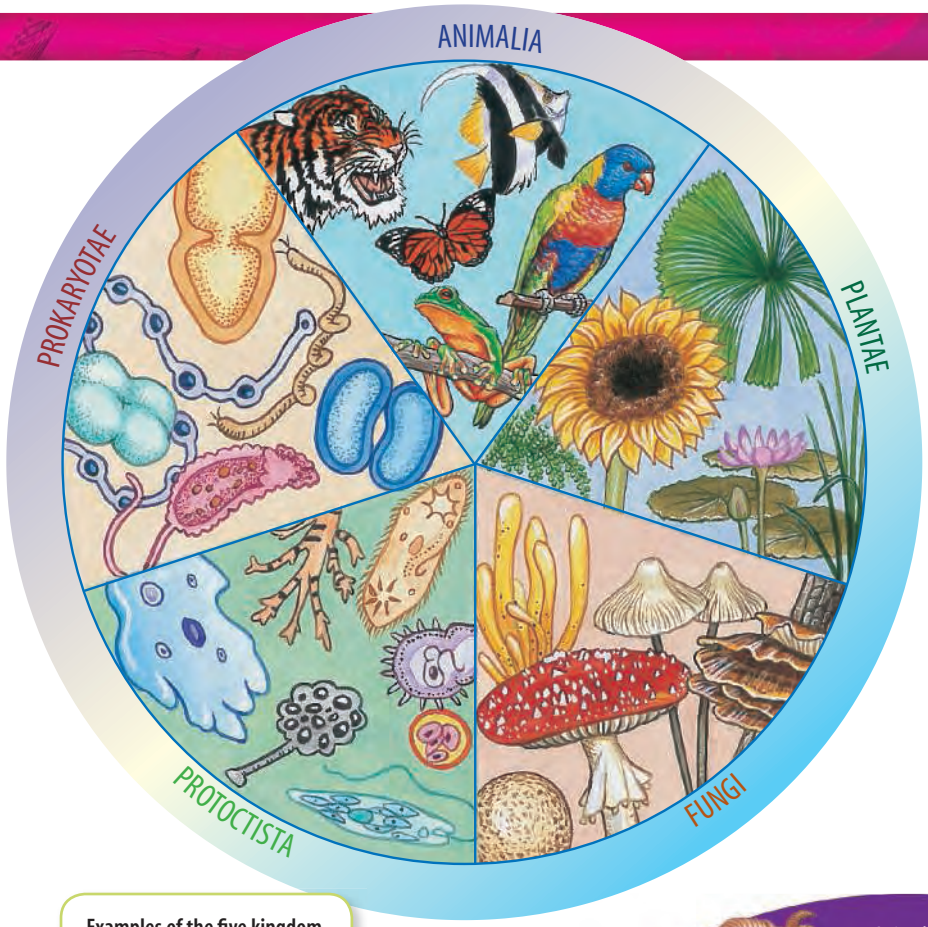
1. A *crypto*graph refers to secret writing and a *crypto*nym is a secret name. Suggest the meaning of 'crypto'.
2. Identify the types of questions that were most helpful in predicting the correct name on the card.
3. Suggest how you could transfer what you have learned in this activity to predicting the meaning of scientific terms.

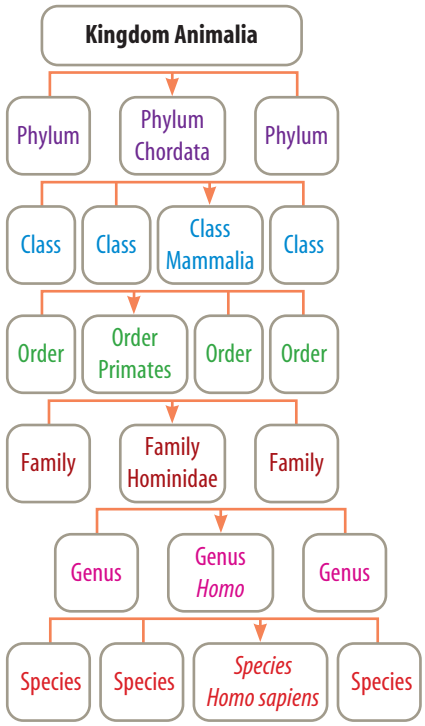
Latin/Greek prefix or suffix	Meaning	Scientific term
bio + *ology*	life + study	Biology
etymon + *ology*	true + study	Etymology
heteros + *trophe*	different, other + to feed or eat	Heterotroph
echinus + *dermis*	spiny + skin	Echinodermata (e.g. sea urchin)
anthros + *zoion*	flower + animal	Anthrozoa (e.g. sea anemone)
epi + *dermis*	outside + skin	Epidermis
arthron + *pous*	joint + foot	Arthropod (e.g. insect)
gastro + *pous*	stomach + foot	Gastropod (e.g. snail)
poly + *dactylus*	many + finger or toe	*Polydactylus*
kroko + *deilos*	pebble + worm	*Crocodylus*
photo + *synthesis*	light + make, build	Photosynthesis
exo + *skeleton*	outer, external + skeleton	Exoskeleton

Living groups

The Swedish naturalist Carolus Linnaeus (1707–1778) is considered to be the 'father of taxonomy' because it was his classification system that formed the basis of our current system. He developed a naming system that could be used for all living things. It involved placing living organisms into groupings based on their similarities. The largest groupings were called **kingdoms** and the smallest groupings were called **species**. The smaller the grouping, the more alike its members are. It's a little like the *kingdom* being the country that you live in, the *phylum* the state, the *genus* the street that you live in and the *species* your street address. The hierarchy of classification is:

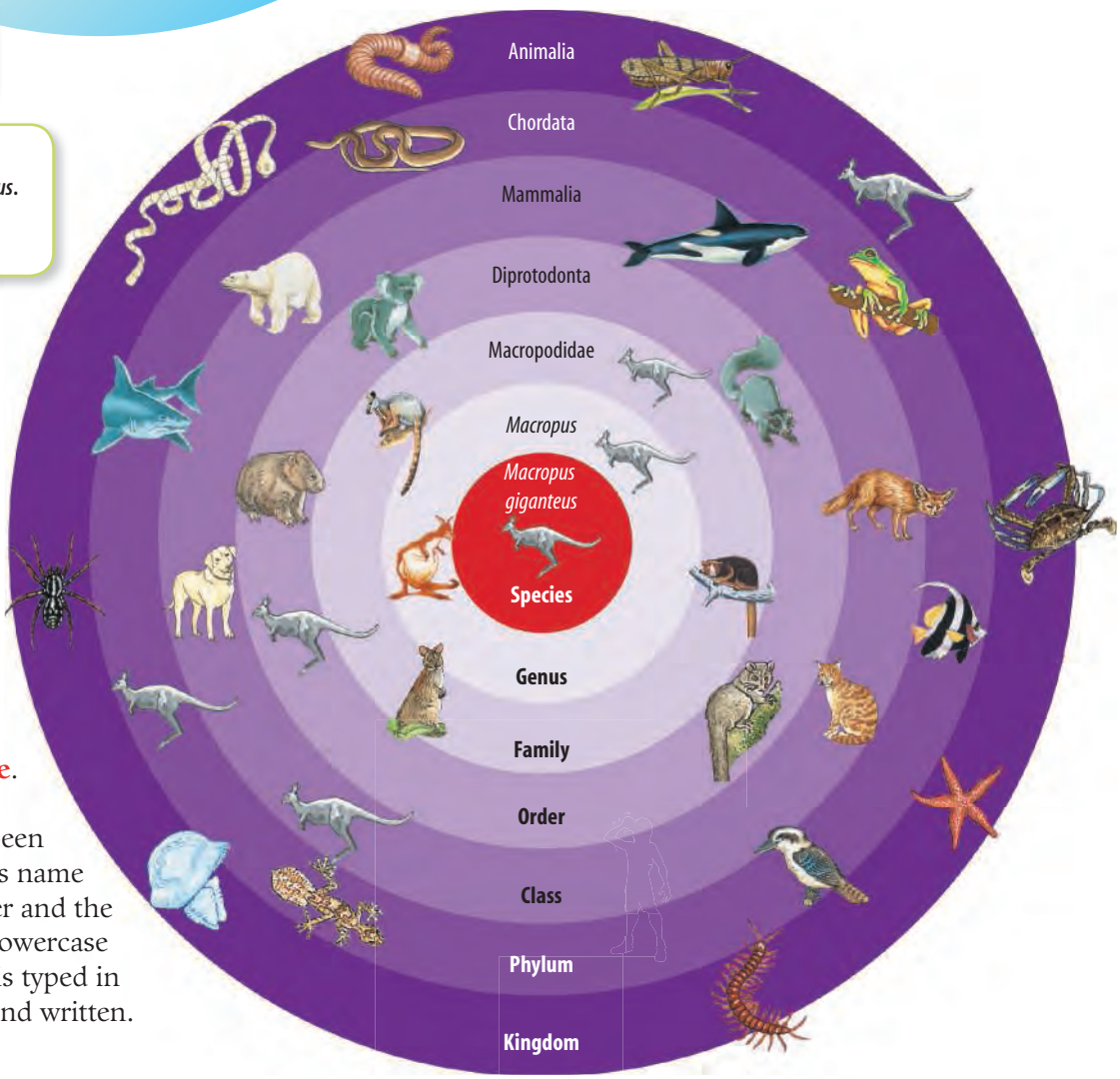






Examples of the five kingdom classification groups

The scientific name for the Eastern grey kangaroo is *Macropus giganteus*. *Macropus* is the genus name and *giganteus* is the descriptive name.



What is a species?

Organisms in the same species closely resemble each other and can interbreed to produce fertile offspring. The species or scientific name is made up of two names based on Carl Linnaeus's **binomial system of nomenclature**. The scientific names of organisms have usually been 'Latinised', and the genus name begins with a capital letter and the descriptive name with a lowercase letter. The species name is typed in *italics*, or underlined if hand written.

Many of the words used in our classification system tell a story about history and language.

Common name: Major Mitchell's cockatoo
Species name: *Cacatua leadbeateri*

What's the story?

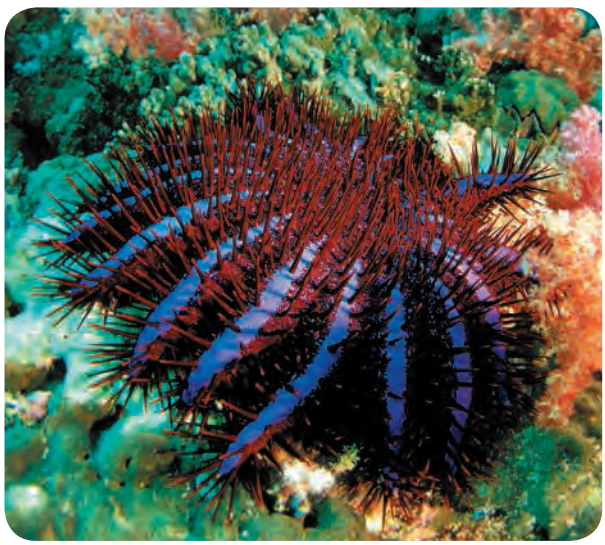
- *Cacatua* — derived from the Greek terms meaning 'dawn' and 'crest', referring to the crest like the rising dawn
- *leadbeateri* — named after British naturalist Benjamin Leadbeater
- cockatoo — this word originates from the Malay name for the bird, *kakaktua*, from *kakak* meaning 'sister' and *tua* meaning 'old'.

Common name: Freshwater crocodile
Species name: *Crocodylus johnstoni*

What's the story?

- *Crocodylus* — derived from the Greek terms *kroko*, meaning 'pebble', and *deilos*, meaning 'worm'
- *johnstoni* — named after Johnson, the first European to discover and report it. Note that his name was actually Johnson and had been misspelt!

Common name: Crown-of-thorns starfish
Species name: *Acanthaster planci*



What's the story?

- *Acanthaster* — derived from the Greek terms *acantha*, meaning 'spiny' or 'thorny', and *aster*, meaning 'star'
- *planci* — possibly named after Max Planck, a German physicist

Common name: Box jellyfish
Species name: *Chironex fleckeri*

What's the story?

- *Chironex* — derived from the Greek and Latin terms *cheiro*, meaning 'hand', and *nex*, meaning 'murder' or 'violent death'
- *fleckeri* — named after Dr Hugo Fleck, a radiologist in Cairns, Qld, for his contribution to science

Examples of drought-tolerant Australian plants

Common name: Native wisteria, 'Happy Wanderer'
Species name: *Hardenbergia violacea*

What's the story?

- Genus named after Countess von Hardenberg
- Wisterias named after the American anatomist Caspar Wistar by the English botanist Thomas Nuttall

Common name: Snow gum
Species name: *Eucalyptus pauciflora*

What's the story?

- Genus name comes from the Greek terms *eu-*, meaning 'good' or 'well' and *calyptos* or *kalyptos*, meaning 'veiled' or 'covered'
- Species name comes from the Latin terms *pauci-*, meaning 'few', and *florus*, meaning 'flowered'

Common name: Kangaroo paw
Species name: *Anigozanthos flavidus*

What's the story?

- Species name comes from the Greek terms *anis*, meaning 'unequal', *anthos*, meaning 'flower', and *flavidus*, meaning 'yellow'
- Common name is due to its similar appearance to a kangaroo paw

Common name: Golden wattle
Species name: *Acacia pycnanthus*

What's the story?

- Genus name comes from the Greek term *akakia*, meaning 'thorny Egyptian tree' (after the first thorny species discovered)
- Species name comes from the Greek terms *pyknos*, meaning 'dense', and *anthos*, meaning 'flower'
- In 1988 the golden wattle was proclaimed Australia's national floral emblem.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Name the person who is recognised as having developed the naming system for all living things.

2 Use a flowchart to show the names of the groupings in the hierarchial classification system, from largest to smallest.

3 Identify which group contains members that have the most in common in each of the following pairs.
(a) Kingdom and species (b) Genus and family
(c) Order and phylum (d) Class and order

4 Describe the binomial system of nomenclature and give an example.

5 State the common names of:
(a) *Crocodylus johnstoni* (b) *Cacatua leadbeateri*
(c) *Chironex fleckeri* (d) *Cherax destructor*.

6 Identify the meaning of the following prefixes or suffixes.
(a) Epi (b) Gastro (c) Dermis
(d) Exo (e) Photo

THINK AND DISCUSS

7 Use the information in the table to answer the following questions.

Species name	Common name
Cherax destructor	Crayfish
Rhyothemis phyllis	Dragonfly
Crocodylus johnstoni	Freshwater crocodile
Felis domestica	House cat
Felis leo	Lion
Crocodylus porosus	Saltwater crocodile
Antirrhinum australe	Snapdragon

(a) Identify the species name of a lion.
(b) State the common name of the organism that belongs to the species *Felis domestica*.
(c) State the name of the genus to which a crayfish belongs.
(d) Suggest why it might be useful to know whether a crocodile was of the species *Crocodylus porosus* or *Crocodylus johnstoni*.

8 Construct a Venn diagram to show the similarities and differences between the classification of saltwater and freshwater crocodiles.

INVESTIGATE

9 Research and report on how the box jellyfish *Chironex fleckeri* got its scientific name. Research the various types of jellyfish that can be found in Australian waters. Suggest why it is important to know the name of the type of jellyfish. Which features are used to classify them?

10 Research and report on the one of the following.
- British naturalist Benjamin Leadbeater and other species named after him
- The naming of *Crocodylus johnstoni* and other crocodiles
- The scientist Max Planck, the Max Planck Institute and *Acanthaster planci*
- The significance of the naming of *Cherax destructor*
- Radiologists in Australia — what do they do?
- Careers associated with identifying, classifying and naming organisms

11 (a) Research features, classification and the life cycle of a crown-of-thorns starfish. How is it different from other types of starfish found in Australian waters? Outline research on its impact on the Great Barrier Reef.
(b) In a team of four, imagine that you are investigating the impact of this starfish on the Great Barrier Reef. In your team, formulate questions that you would need to consider in your research.

12 Research Carl Linnaeus and the binomial system of nomenclature. Document his contributions to the taxonomy of plants and animals.

13 Investigate the classification of dragonflies, snapdragons and Komodo dragons. Use a mind map to report your findings.

14 Outline features that crayfish, yabbies and lobsters have in common. How does the classification system deal with them?

eBookplus

15 Test your ability to classify the world's living creatures by completing the **Time Out: 'Kingdom'** interactivity in your eBookPLUS. **int-0204**

CREATE

16 Create a cartoon to show how to write the scientific name of an organism.

17 In pairs or groups, create a song or poem to help you to remember the following and then present your finished product to the class.
(a) The order of the groupings kingdom, phylum, class, order, family, genus and species
(b) Rules for writing scientific names
(c) Which groups you belong to

18 Construct a target map to show the classification groups that you belong to in a scientific context and then do the same for another animal that does not belong to the same kingdom as you.

Keys to unlock identity

WHO do you think you are? WHAT are you? HOW can I tell?

Giants in a lost world

In 2009, scientists discovered creatures trapped within a 'lost world' in an extinct volcano (Mt Bosavi) in Papua New Guinea. One of the creatures discovered was a gigantic silvery-grey rat with thick woolly fur. It was about 82 centimetres long and weighed around 1.5 kilograms — the size of a domestic cat. Along with the discovery of this new species of rat (*Mallomys* spp.), were 16 species of frogs, 1 species of gecko, 3 species of fish and at least 20 species of insects and spiders.

That's one big rat! The volcano's crater was 2.5 miles wide and rimmed with walls nearly half a mile high.

Giant 'animal-eating' plants

In 2007, scientists on an expedition to catalogue the different species of pitcher plant found in an area in the Philippines discovered a giant 'rat-eating' carnivorous pitcher plant. The pitchers of these plants were open and completely filled with fluid containing digestive enzymes that broke down the bodies of the large insects (and possibly rats by misadventure) that were trapped in it.

Giant 'rat-eating' plant *Nepenthes attenboroughii*, named after the science documentary broadcaster and naturalist Sir David Attenborough.

Why classify?

Scientific curiosity has resulted in the discovery of an increasing number of living things. This has led to the increased need to classify living things into groups. Classifying things into groups makes them easier to remember, describe and identify.

When scientists such as those in the above expeditions find an unknown organism, they make observations about its features and behaviour. Various technologies can also be used to obtain information about its chemistry and genetic information. This information is used to sort the organisms into groups on the basis of similarities and differences. Classification of organisms into groups enables more effective communication and understanding.

Where do I fit?

The original classification system developed by the Swedish biologist Carl Linnaeus had only three main kingdoms and, although many scientists now are using a five kingdom classification system, this is also under question.

Scientists have discovered things like viruses, viroids and prions that show some features of living things, but other features of non-living things. With new discoveries and advances in technology, the classification system will continue to change to incorporate new information.

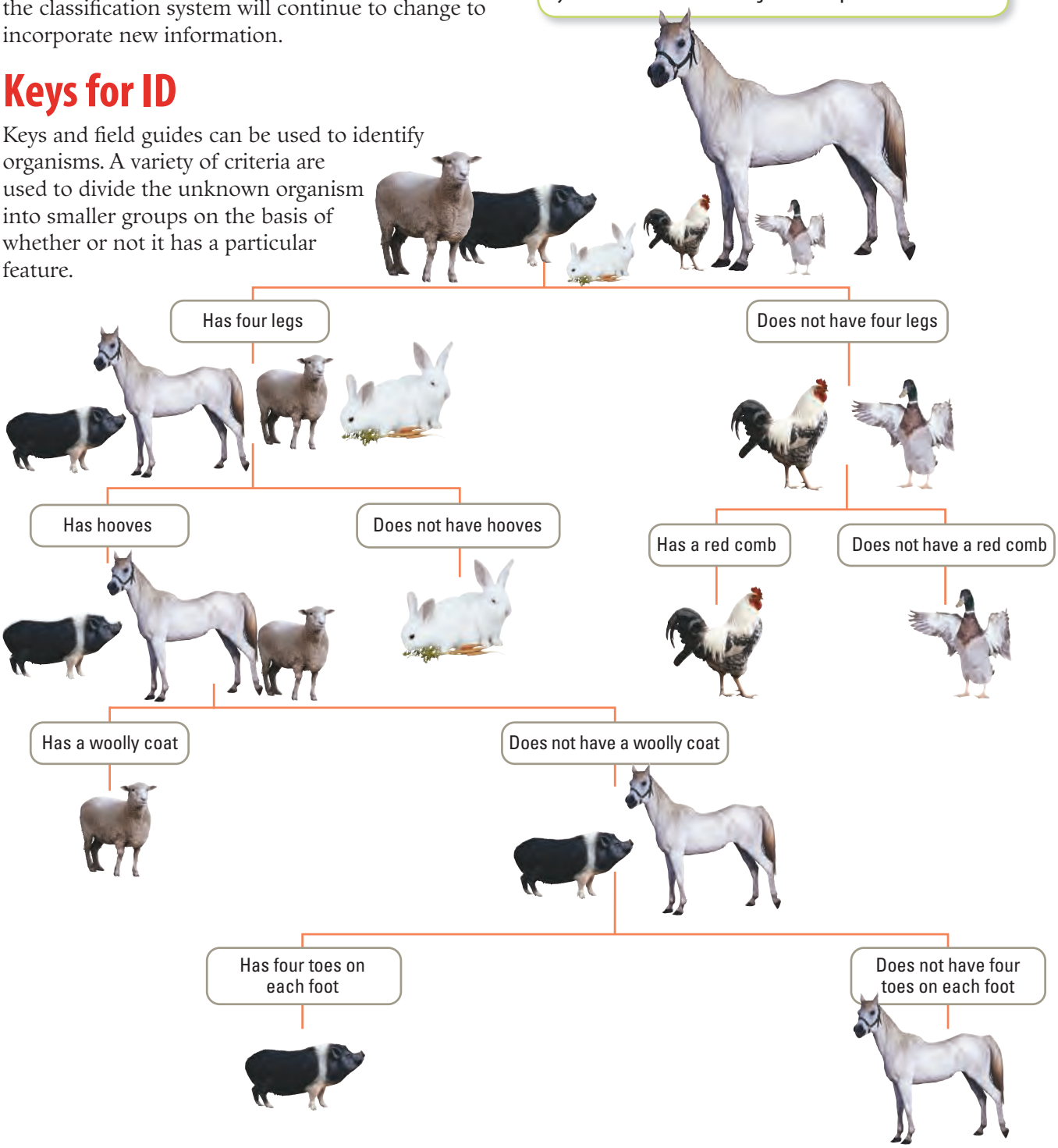
Keys for ID

Keys and field guides can be used to identify organisms. A variety of criteria are used to divide the unknown organism into smaller groups on the basis of whether or not it has a particular feature.

DICHOTOMOUS KEYS

Dichotomous keys provide choices at each branch (*dichotomous* = 'cutting in two'). Features such as size, colour, behaviour and habitat are not good for classification because they can change throughout the life of the organism. It is better to use the presence or absence of structural features or differences in these features.

In a dichotomous key, you always select from two choices. In this key, you decide whether or not an organism has a particular feature.

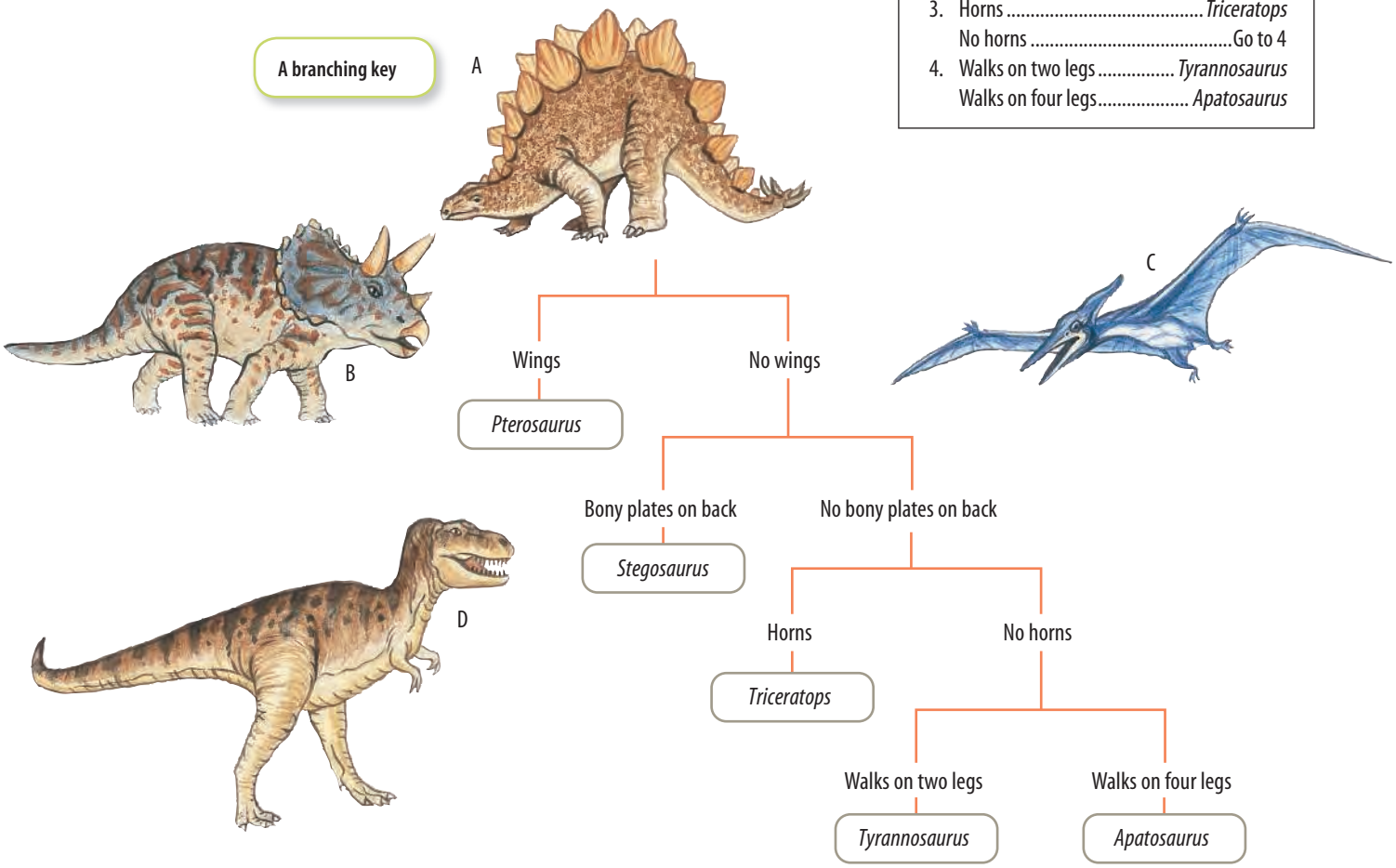


Dichotomous keys can be presented as branching keys or tabular keys. Examples of each of these keys can be seen below and on the right. To convert information from a branching key to a tabular key, each fork of the branching key is given a number which becomes the step number in the tabular key. Tabular keys are often used because more information can fit into a smaller space.

A tabular key

1.	Wings	*Pterosaurus*
	No wings	Go to 2
2.	Bony plates on back	*Stegosaurus*
	No bony plates on back	Go to 3
3.	Horns	*Triceratops*
	No horns	Go to 4
4.	Walks on two legs	*Tyrannosaurus*
	Walks on four legs	*Apatosaurus*

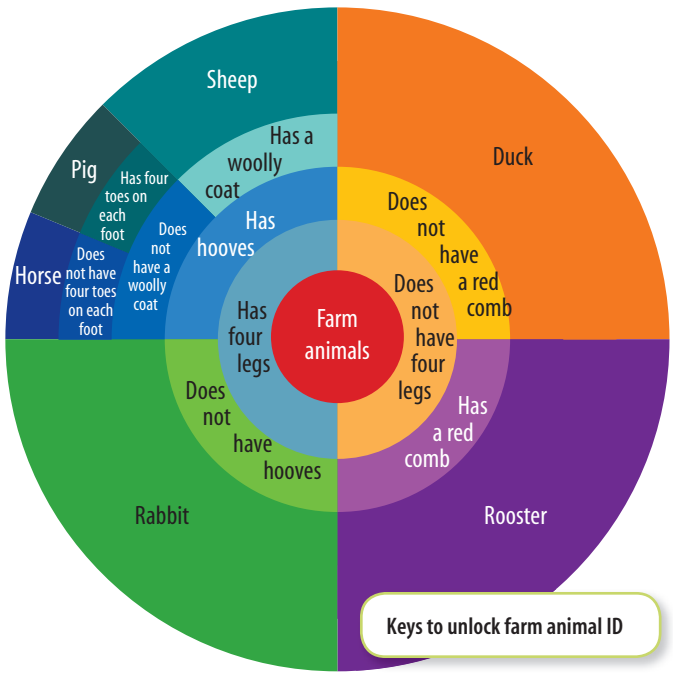
A branching key



CIRCULAR KEYS

Circular keys can also be used to unlock identity. To read this type of key you start in the middle and work outwards, choosing one of the options in each layer. The final layer provides you with the solution of the organism's identity.

Carefully observe the dinosaurs on this page and consider features that could be used to separate them into groups. Consider how you could use these features in the design of a circular key that would enable each individual to be identified.



Keys to unlock farm animal ID

INQUIRY: INVESTIGATION 3.3

Making a class key

KEY INQUIRY SKILLS:

- processing and analysing data and information
- evaluating
- communicating

Equipment:

tape measures or string and rulers

- Measure, observe and record at least 10 different characteristics for each member of the class. You may like to include some of the following:
  wrist size (cm)
  distance from elbow to shoulder (cm)
  foot length (cm)
  height (cm)
  eye colour
  hair colour
  wears watch
  pierced ears.
- Have each member of the class select a secret code name.
- Use some of these recorded class characteristics to construct a key (tree map or dichotomous key) that will separate out as many individuals (using their code name) as possible.
  (*Hint:* You may find it best to describe measurements as 'greater than' or 'less than' a particular measurement.)
- Have someone from outside the class use the key to find the identity of one of the class members.

DISCUSS AND EXPLAIN

1. How successful was your key?
2. If you were to do the activity again, what would you do differently to improve its success?
3. Were some characteristics of more use than others? Explain.

INQUIRY: INVESTIGATION 3.4

Making a class field guide

KEY INQUIRY SKILLS:

- processing and analysing data and information
- evaluating
- communicating
- planning and conducting

Equipment:

paper, pencils
photocopies of photographs of each student (e.g. the school class photograph copied), or students can sketch each class member themselves

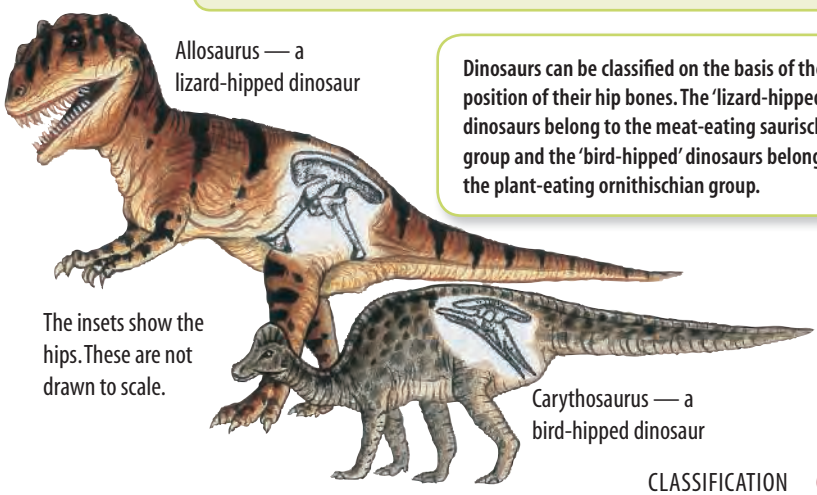
- Work in pairs. If there is an odd number of students in your class, your teacher might agree to participate.
- Observe your partner and record data such as height, hair colour, eye colour etc.
- Interview your partner to find out some other details such as favourite music, movie, sport, colour, food etc.
- Allowing about half an A4 page for each class member, present the information and photograph/sketch.
- Make the pages into a book or poster.
- Use the class field guide to see how easy it is to identify each student.
- Try making a field guide for the teachers in your school.

DISCUSS AND EXPLAIN

1. What are the benefits of a field guide?
2. Which features do you think would be most useful to include in a field guide to assist in identifying a class member? Why?
3. Which features would be most useful to include in a field guide for:
   (a) plants
   (b) birds
   (c) insects?
4. Describe any problems that you encountered when you were constructing the field guide.

FIELD GUIDES

Field guides are a commonly used type of reference book to help people identify organisms. These guides are specially designed to assist you in 'on-the-spot' identification. They often contain brief written descriptions and pictures and are small enough to take outside when you are observing wildlife. There are also a number of electronic 'field guide' databases available.



Dinosaurs can be classified on the basis of the position of their hip bones. The 'lizard-hipped' dinosaurs belong to the meat-eating saurischian group and the 'bird-hipped' dinosaurs belong to the plant-eating ornithischian group.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Suggest why scientists classify living things.

2 Some types of features are not very useful as classification criteria. Explain why this is the case, including examples.

3 Identify three features that would be useful as classification criteria.

4 State the name of the Swedish biologist that our current classification system is based on.

5 Suggest reasons why the current classification system may change.

6 What is a dichotomous key? Give an example of such a key.

7 Suggest why tabular keys are sometimes used instead of branching keys.

8 Outline the differences between field guides, branching keys, circular keys and tabular keys.

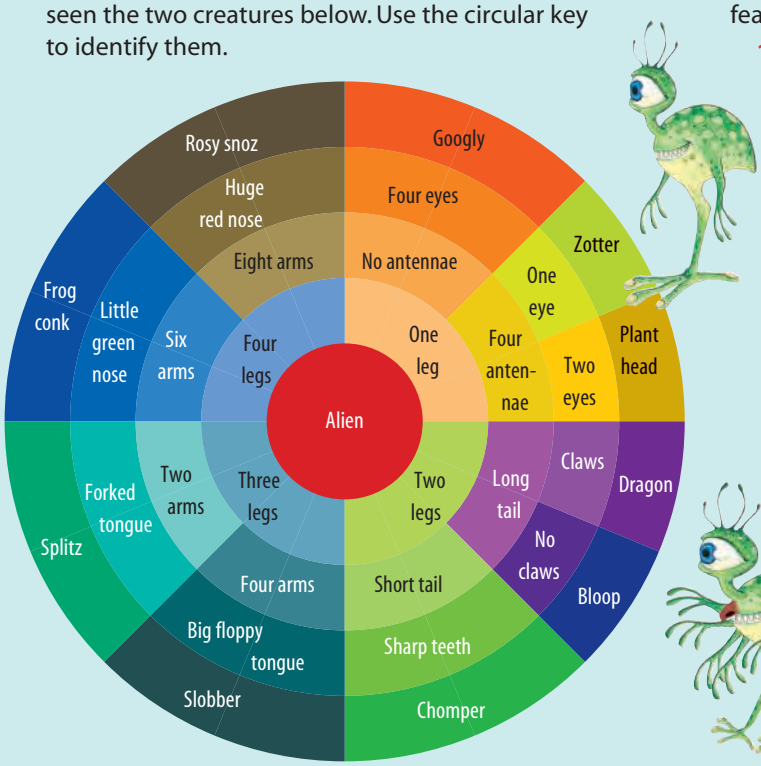
9 State the name of the genus to which the giant rat discovered in the extinct volcano in Papua New Guinea in 2009 belongs.

10 Identify who the giant 'rat-eating' carnivorous pitcher plant discovered in 2007 in the Philippines was named after.

THINK AND DISCUSS

11 Use the dinosaur keys on page 68 to identify the dinosaurs illustrated on that page.

12 Imagine that you have landed on another planet and seen the two creatures below. Use the circular key to identify them.



13 Explain how supermarkets provide an excellent example of the effectiveness of a classification system. Include the types of criteria that are used. Construct a dichotomous key that would enable ten different supermarket items to be identified.

INVESTIGATE

14 Cave people were often interested in only two groups of living things — those that were useful to them and those that were dangerous. Research and report on examples of bush and native foods and their parts that can be eaten and those that are poisonous. Display your findings in a format that includes dividing them into groups using relevant criteria.

15 Research and report on the various types of pitcher plants and how they are classified.

16 Research and report on one of the discoveries below and report your findings as a newspaper article, poster, PowerPoint presentation or journal entry. Include the types of information that were used to classify and identify it in your presentation.

- *Homo floresiensis* (possible human ancestor)
- *Fruitadens haagarorum* (tiny dinosaur)
- *Mycena luxaeterna* (glowing fungus)

17 Observe the types of grass or insects in your local environment and construct a simple key to classify them.

18 Find and use two different online classification databases for either plants or animals. Comment on features that you find most useful in the database.

19 If you could meet and talk to a dinosaur, which one would it be and what questions would you ask? Find out the answers to your questions and use them to write an article for a class newspaper about dinosaurs.

eBookplus

20 Use the **Giant rat** weblink in your eBookPLUS to view the video of the initial sighting of a giant rat in Papua New Guinea.

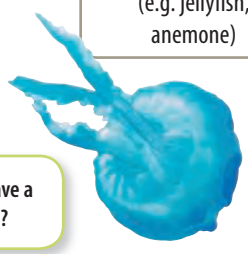
21 Use the **Giant pitcher plant** and **Poisonous pitcher plant** weblinks in your eBookPLUS to discover more about pitcher plants.

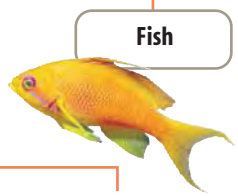
work sheets
- 3.1 My own zoo
- 3.2 A catalogue of cats

Which animal?

Do you have a backbone? It may seem a strange question to ask, but this is one of the key criteria used to classify animals into groups. Animals that have internal skeletons or backbones are called **vertebrates**, whereas animals with external or no skeletons are referred to as **invertebrates**. Most of the animals on our planet are invertebrates (95 per cent) and only 5 per cent are vertebrates.

- **Animals**
  - Has no backbone → **Invertebrates**
    - Legs with joints → **Arthropods** (e.g. ant, scorpion, butterfly)
    - No legs
      - Body covered with a shell or rough spiny skin
        - Soft body usually covered with a shell → **Echinoderms** (e.g. sea urchin)
        - Body covered with a rough, spiny skin → **Molluscs** (e.g. oyster, slug, octopus)
      - Body not covered with a shell or rough spiny skin
        - Has tentacles → **Cnidarians** (e.g. jellyfish, anemone)
        - Has no tentacles → **Worms** (e.g. earthworm, leech); **Porifera** (sponge)
  - Has a backbone → **Vertebrates**
    - Body temperature is constant
      - Has feathers → **Birds**
      - Has no feathers → **Mammals**
    - Body temperature is not constant
      - Has lungs when fully grown
        - Moist skin with no scales → **Amphibians** (e.g. frog)
        - Scaly skin → **Reptiles** (e.g. crocodile, lizard)
      - Has gills when fully grown → **Fish**





Do you have a backbone?

Endoskeletons and exoskeletons

Did you know that 75 per cent of all animals in the world have a skeleton on the outside of the body? These external skeletons are called **exoskeletons**. They may be thick and hard like those of crabs and lobsters or as thin and tough as those of ants and centipedes. As these animals grow, they sometimes moult or discard their old exoskeleton before growing a bigger one.

Although exoskeletons are good for jumping and swimming, they do not allow flexibility for the twisting and turning actions that are possible for animals with an inside skeleton (**endoskeleton**). In an animal with an exoskeleton, the muscles are attached inside the skeleton, whereas the muscles in an animal with an endoskeleton are connected to the outside of the skeleton. The human endoskeleton is an internal skeleton which is made of bone and cartilage and clothed in muscle and skin.

No skeleton at all

Some animals, such as worms and jellyfish, have no skeleton at all. The body is supported by the pressure of fluid within it. What do you think would happen if a lot of fluid was lost? How can animals without skeletons move?

Earthworms expand and contract their bodies to burrow through the soil. They use two sets of muscles to do this. One set of muscles wraps around the body. When these contract, the body becomes long and thin, enabling the worm to poke into crevices in the soil. The second set of muscles runs along the length of the body. When these contract, the worm becomes short and fat. This helps to anchor the worm in place, pushing the soil apart to form a burrow. By shortening the rest of its body, the worm pulls itself up and moves through the soil.

Long and thin one moment, short and fat the next.
A worm burrows through the soil.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Construct Venn diagrams to show the similarities and differences between:
   (a) vertebrates and invertebrates
   (b) endoskeleton and exoskeletons.

2 Identify which group, vertebrates or invertebrates, is more abundant on Earth.

3 List four criteria that can be used to divide invertebrates into groups.

4 Describe the difference between the way in which muscles are attached in animals with endoskeletons and those with exoskeletons.

5 Worms have no skeleton and no legs. Describe how they are able to move.

USING DATA

Use the dichotomous key on the previous page to complete the following.

6 Identify ways in which vertebrates are different from each other.

7 State the grouping and list the features of:
   (a) a sea urchin
   (b) an amphibian
   (c) a sea anemone.

8 Identify which have (a) most in common and (b) least in common.
   (i) Fish and worms
   (ii) Fish and amphibians
   (iii) Mammals and birds
   (iv) Molluscs and worms

9 List the characteristics of:
   (a) an arthropod
   (b) a cnidarian
   (c) a poriferan.

THINK AND DISCUSS

10 (a) Play the *Cryptonym* game (refer to Investigation 3.2 for instructions), but create new cards using scientific terms or animal groups that appear in this section.
   (b) List the types of questions that were most useful in determining the identity of the term on the card.
   (c) Share your list with other team members.
   (d) Select the best questions from your group and share them with the best of another group.

11 On a bushwalk, Briana found two animals. The first animal had a backbone, was living in a damp environment and had moist, smooth skin without scales. The second animal did not have a backbone, legs or a shell, but had long purple tentacles.
   (a) Use the classification dichotomous key on the previous page to suggest which group each of the animals belonged to.
   (b) Was either animal difficult to classify? If so, explain why.
   (c) Suggest modifications to the dichotomous key that would make it more effective in identifying these animals.

THINK, DISCUSS AND DESIGN

12 Carefully observe the pictures of the marine animals above.
- (a) Label features that you consider may be useful as criteria to classify and identify the organisms.
- (b) Design a dichotomous key that would enable each of these organisms to be identified.
- (c) Test your key on other students or family members to see how it works.
- (d) Compare your key with those of others in the class.
- (e) Make any necessary modifications to improve the effectiveness of your identification key.
- (f) Convert your dichotomous key into either a tabular or circular key.
- (g) Identify which features were most useful and which were least useful. Suggest reasons for this.
- (h) Use your key to try to classify two animals not shown above. Suggest any modifications that would enable them to be identified using your key.

13 The Great Barrier Reef is home to a diversity of living things. There are links between many of them, without which not only they but also other organisms may not survive. Find out more about the animals living on the Great Barrier Reef. Research and report on:
- (a) one invertebrate and one vertebrate
- (b) links between four different organisms
- (c) the issue of the crown-of-thorns starfish
- (d) the issue of tourism and the sustainability of the Great Barrier Reef
- (e) identify current research questions being investigated.

Present your findings as a PowerPoint presentation, poster, picture book, podcast or newspaper article or in a multimedia format.

INVESTIGATE AND CREATE

14 The Australian Biological Resources Study Eureka Prize recognises scientists and their research. In 2009, the Eureka Prize was for early career species discovery (taxonomy). The award was presented to Dr Conrad Hoskin (a herpetologist) by the great-great-grandson of Charles Darwin.
- (a) Research and report on the research of each of the 2009 Eureka Prize finalists: Dr Claire Baker (an entomologist from Queensland), Dr Conrad Hoskin (a herpetologist from ACT) and Dr William White (an ichthyologist from Tasmania).
- (b) Identify the differences between the following scientific careers:
  - (i) ichthyologist
  - (ii) entomologist
  - (iii) taxonomist.
- (c) Research and report on the research of Eureka Prize finalists from other years.
- (d) Research and report on current Australian research in any of these fields.
- (e) Imagine that you are one of these types of scientists. Create a journal (with 'photos' and diagrams) of what a week in your life might be like.

15 The term 'yabby' is derived from one of the many Australian indigenous languages and refers to the common freshwater crayfish. The most familiar species of yabby is *Cherax destructor*.

- (a) Find out locations within Australia where members of the species *Cherax destructor* may be found.
- (b) Research *Cherax destructor* to find the following details.
  - (i) Overall body structure
  - (ii) Names and functions of key structures
  - (ii) Types of food eaten and their scientific names
  - (iii) Feeding and digestive structures and how they work
  - (iv) Life cycle, structures and method of reproduction
- (c) Some Australian states and territories have regulations regarding yabbies. Find out what they are and suggest reasons for them.
- (d) Design and construct a technique or model that enables you to catch yabbies without harming them.

16 Use the internet to find examples of Australian Aboriginal rock cave art. Can you identify any of the different types of animals depicted in the paintings? If so, which features helped you identify them?

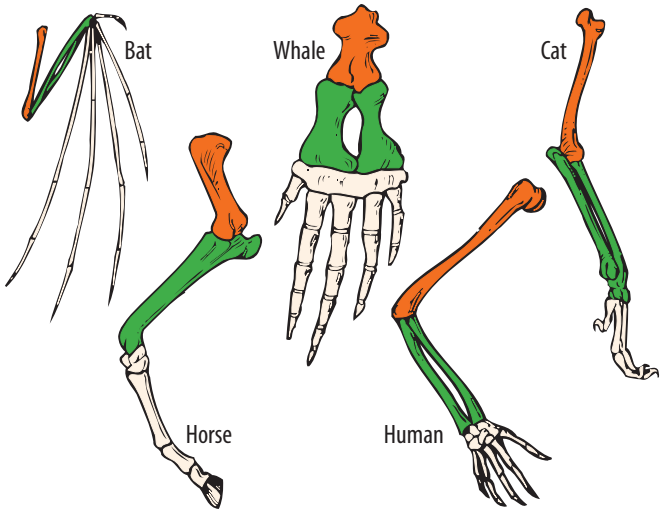
Got a backbone!

What do you have in common with a jawless fish like a lamprey, you may ask? The answer is that you both have backbones. Lampreys represent one of the earliest vertebrates.

Did you know that the lamprey was one of the earliest vertebrates?

Similar, but different?

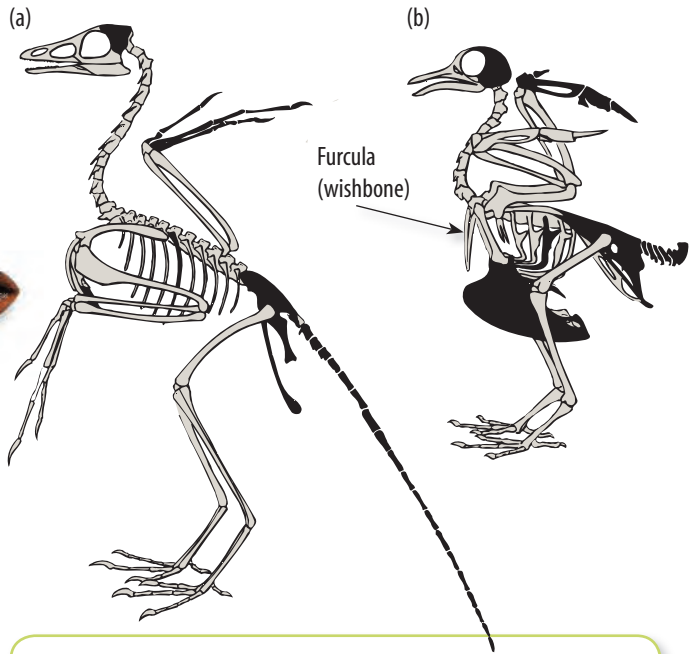
Although there are many different groups of vertebrates, they all share some common features because they have shared common ancestors at some point in their evolution. Some scientists study these structural similarities to determine how recently they may have shared common ancestors. One example is the study of bones that are similar in shape.



The structures shown have the same basic structure since they are all derived from a vertebrate forelimb. Do they have identical functions?

Linking features?

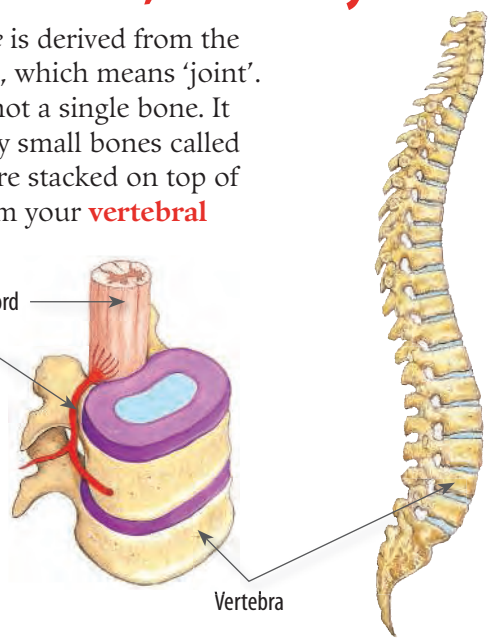
You can also see similarities between the skeleton and backbone of a modern day chicken and that of an extinct animal called *Archaeopteryx* that some scientists suggest is the link between dinosaurs and birds.



Skeleton of (a) *Archaeopteryx* and (b) a modern flying bird. The black regions on the skeletons show distinctive reptilian features (at left) and bird features (at right).

Not just one bone, but many

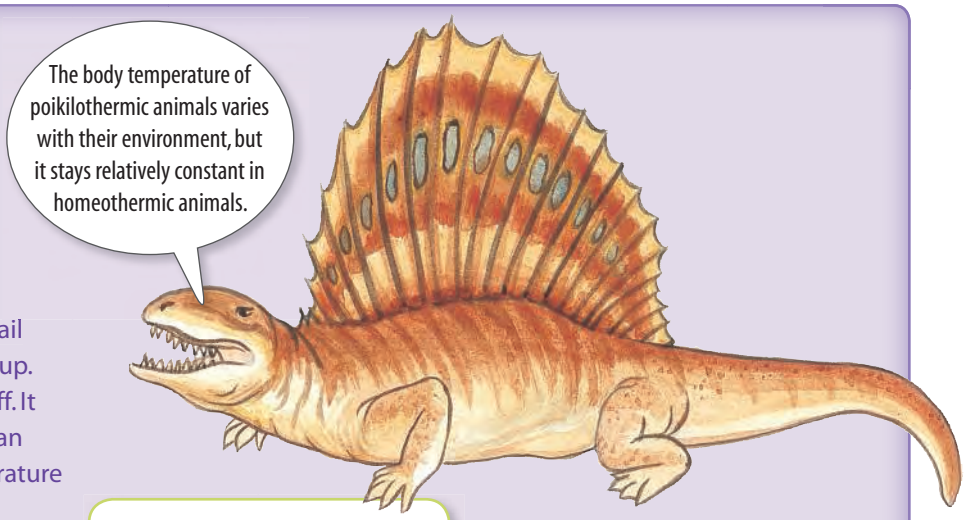
The word *vertebrate* is derived from the Latin word *vertebra*, which means 'joint'. Your backbone is not a single bone. It is made up of many small bones called **vertebrae** which are stacked on top of one another to form your **vertebral column**.



Your backbone is made up of many bones called vertebrae.

HOW ABOUT THAT!

Dimetrodon was a meat-eating pelycosaur. The pelycosaurs were the most successful reptiles of the Permian period. They looked like big lizards with huge sail-like fins on their backs. The pelycosaurs used this 'sail' to regulate their body temperature. They could stand in the early morning sun with the sail arranged towards the sun to warm them up. They could turn it into the wind to cool off. It is thought that this fin arrangement was an early stage in the development of temperature regulation of mammals.



***Dimetrodon* — a mammal-like reptile**

Wallaby, possum, echidna, dog, human, dolphin, whale

Examples

- Skin with hair or fur
- Females with mammary glands that secrete milk
- Constant body temperature

Characteristics

Mammals

Kookaburra, emu, penguin, cockatoo, galah, parrot, seagull

Examples

- Skin with feathers
- Eggs with hard shell
- Beak for feeding
- Constant body temperature

Characteristics

Birds

- Skin with scales
- Eggs with membranous or leathery shells laid on land
- Lungs for breathing
- Changing body temperature

Characteristics

Snake, lizard, tortoise, crocodile

Examples

Reptiles

Vertebrates are animals that have a backbone made of bones called vertebrae.

Fish

Examples

Goldfish, barramundi, shark, bream, stingray

Characteristics

- Found only in water
- Changing body temperature
- Gills for breathing
- Most have eggs without a shell.
- Skin with scales

Amphibians

Characteristics

- Soft moist skin without scales
- Eggs without a shell usually laid in water
- Larvae usually live in water.
- Adults usually live on land and have lungs.
- Changing body temperature

Examples

Frog, toad, salamander

The five main groups of vertebrates are fish, amphibians, reptiles, birds and mammals.

INQUIRY: INVESTIGATION 3.5

Flash 'n' mind

1 You can make a set of *Flash 'n' mind* cards for yourself or for your team. Each card is about one-eighth of an A4 page in size, and made of coloured cardboard. You will need about 50 flash cards.

2 Type or write creatively the following terms on five separate cards: vertebrates, mammals, birds, reptiles, amphibians, fish.

3 On 21 separate cards, write each dot point from the characteristics sections on page 75.

4 Using the internet, clipart, magazines or other sources, find as many photographs or pictures as you can of the animals listed on page 75. Paste these images onto separate flash cards.

5 Shuffle your cards and, without looking at the figure on page 75, try to arrange them into a similar mind map. As you are laying each card down, say aloud why you are putting it in that place. If you are doing this as a team, discuss any differences of opinion. Once completed, check page 75 to see how you did.

6 As a team, use your *Flash 'n' mind* cards to design and play as many games as you can to help you learn the characteristics and examples of each vertebrate group.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Identify the feature that jawless fish such as lampreys have in common with humans.

2 Suggest why vertebrates all share some common features.

3 What does the Latin word *vertebra* mean?

4 Describe the relationship between vertebrae and your backbone.

5 Construct Venn diagrams to show the similarities and differences between:
(a) mammals and birds
(b) reptiles and amphibians
(c) fish and mammals.

6 Identify the group to which each of the following vertebrates belongs.
(a) Snake
(b) Cane toad
(c) Goldfish
(d) Whale
(e) Emu
(f) Shark
(g) Lamprey

7 Suggest the function of the huge sail-like fins on the back of pelycosaurs.

8 (a) Copy and complete the table below.
(b) Are the answers to these criteria the same throughout the life cycle of the organism? Discuss your response with others in your class.

THINK

9 Identify the group to which each of the following animals belongs.
(a) I have lungs but no legs. My offspring are found in membranous-shelled eggs and use lungs to breathe.
(b) I have moist skin but no scales, and two pairs of legs. Although I have lungs and live on land, my young usually live in water and use gills to breathe.
(c) I have a constant body temperature, have feathers, and lay eggs with a hard shell.
(d) I have a changing body temperature, gills and fins.

10 Suggest why it is thought that the pelycosaurs were a link between reptiles and mammals.

Feature	Mammals	Birds	Reptiles	Amphibians	Fish
Constant body temperature?					
Body covering?					
Egg laying? If so, what type of shell?					
Does it have lungs?					
Two examples					

11 Using the table from question 8 and the translations in the table below, in which scientific classification groups would you place the vertebrates shown below?

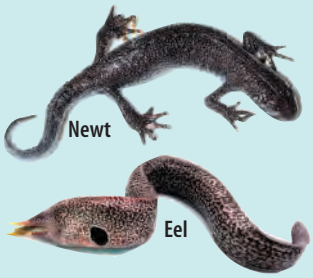
Latin or Greek word	English translation	Scientific classification
Amphis + bios	Double, both sides + life	Amphibia
Chondros + icthyes	Cartilage + fish	Chondrichytes
Marsypos	Pouch	Marsupialia
Osteon + icthyes	Bone + fish	Osteichtyes
Repere	To creep	Reptilia
Rodere	To gnaw	Rodentia
Siren	A kind of mermaid	Sirenia


Hamster


Stingray


Quokka


Dugong



INVESTIGATE

12 Goldfish and sharks are fish. Apart from their size, how are they different from each other? Construct a Venn diagram to summarise your findings of the structural and behavioural similarities and differences.

13 Play the *Cryptonym* game (refer to Investigation 3.2 for instructions), but create new cards using scientific terms or animal groups that appear in this section.

14 Research and report on the issues and implications of tourism and overhunting on populations of the Australian freshwater crocodile *Crocodylus johnstoni*, and share your findings with others.

USE DATA, INVESTIGATE AND CREATE

Use the evolution figure on the right to answer questions 15, 16 and 17.

15 Which of the following pairs would you suggest shared the most recent common ancestor?
(a) Birds and dinosaurs or turtles and lampreys?
(b) Marsupials and monotremes or placentals and marsupials?

16 Select two of the vertebrates in the figure below and create a PowerPoint presentation or web page to show how they are similar and how they are different.

17 Find out about the features and 'lives' of two types of vertebrates in the figure below, construct puppets of each and present a story or play about their lives.

18 Find out about the evolutionary history of lampreys and present your findings to the class as an annotated timeline.

The branches of this evolution tree diagram show how recently each group shared common ancestors.

Mammals

Do you possess skin with hair or fur and have a constant body temperature? If you do, you could be one of the three types of mammals! The key criterion used to divide mammals is the way in which they give birth to their young.

Placenta, pouch or egg?

You are classified as a **placental mammal** because you grew inside your mother, receiving your needs via a placenta, and were born at a well-developed stage. **Marsupials**, however, are born at a very early stage of development and then grow inside their mother's pouch. **Monotremes** are laid in leathery-shelled eggs.

Unique for its mammals

Australia is unique in terms of the diversity of mammals that live here. Two-thirds of the world's marsupials live in Australia and monotremes are found naturally only in Australia and the nearby islands. Particularly in the spotlight is our platypus. Because of its uniqueness, research is currently being performed in a variety of different scientific fields.

Mammals:
- have skin with hair and fur and have a constant body temperature
- have females with mammary glands that can secrete milk
- can be divided into three groups based on the way they give birth to their young.

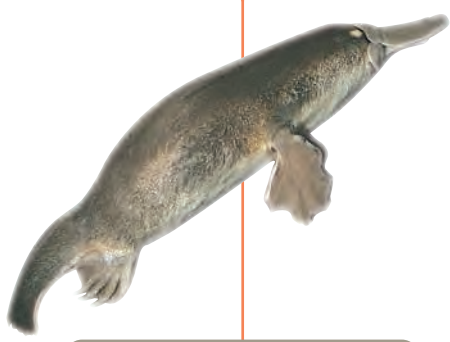
Placental mammals

- Young grow inside the body of their mother and are attached by a cord to the placenta, which supplies their food.
- Young are well developed when they are born.
- Most mammals are placental mammals. Examples include horses, mice, humans, cats, cows and pigs.

Marsupials

- Although blind and naked, newborn marsupials crawl from their mother's birth canal to her pouch and attach themselves to the nipple to feed.
- Young are born at a very early stage of development.
- Two-thirds of the world's marsupials live in Australia. Examples include kangaroos, wombats, possums and koalas.

Monotremes



- Young are laid in leathery-shelled eggs.
- Monotremes are found only in Australia and some nearby islands. There are only two types of monotremes: the platypus and the echidna.

What kind of creature is this?

When European explorers returned from Australia with stories of 'strange' animals such as kangaroos, wallabies, koalas and wombats, people were surprised. Australian animals seemed so different from those common in Europe and other countries.

Imagine their disbelief when the platypus was first described to them. This strange animal had webbed feet and a bill like a duck, but it had no feathers. It laid leathery eggs like lizards and crocodiles, but it did not have scales on its skin. It also had fur and a large tail like that of an otter but, like a reptile, it had only one opening for ejecting faeces and urine.

In London in 1799, an Australian sailor presented a platypus specimen to Dr George Shaw, a prominent biologist of the time. It was so different that Shaw considered it a hoax and tried to cut off the duck-bill with scissors. The scissor-marks are still visible on the preserved platypus skin in the British Museum (Natural History) in London.

It is thought that the reason for the existence of Australia's unique animals like the platypus is Australia's isolation from the other continents after they separated millions of years ago. The animals evolved over time to be well suited to the unique Australian environment.

It's got webbed feet, a bill, fur and lays leathery legs — is it real?

GENOME

The platypus was the first Australian animal to be included in the Human Genome Project. The platypus (*Ornithorhynchus anatinus*) genome (genetic information) was published in 2008 and has brought new insights into mammalian evolution.

XXXXX-RATED SEX

Platypus sex is X-rated . . . in a big way! Sex is determined in most mammals by the X and the Y chromosomes — XX (two X chromosomes) will result in a female and XY (one X and one Y chromosome) will result in a male. In platypuses, however, it gets really interesting! Instead of having a single pair of sex chromosomes, platypuses have a set of ten chromosomes to determine sex. So a female would be XXXXXXXXXX and a male would be XYXYXYXYXY!

MONOTREME MILK

Teams of Australian scientists at the University of Melbourne, Deakin University and the Australian National University have been studying the milk produced by various mammals. Their research suggests that the milk from monotremes is very different from the milk of other mammals. This supports the theory that placental and marsupial mammals are more closely related to each other than they are to monotremes.

VENOM

Platypus venom contains a cocktail of more than 50 different substances. Studies have suggested that some of these substances may be useful in the future as new painkillers. It will be exciting to see what new medicines may result from these findings.

A long, long time ago . . .

If you could travel back in time, you would be amazed by the types of megafauna (giant animals) that roamed our Australian continent. Imagine 'wombats' the size of cars (*Diprotodon optatum*), giant flightless birds (*Genyornis*) and lizards 7 metres long (*Megalania*). You might face fearsome lion-like marsupials (*Thylacoleo*) and wolf-like *Thylacinus*, not to mention having giant kangaroos (*Ptovspyofons*) bounding past.

WHAT DOES IT MEAN?

The word *megafauna* comes from the Greek word ***megas***, meaning 'great' or 'large', and the Latin word ***fauna***, meaning 'animals'. The Latin term ***flora*** means 'plants'.

Marsupial mammals have existed in Australia for about 35 million years and due to our 'isolation' many different types have evolved. The story of the history of our mammals is told in our fossil records.

QUESTIONS OF THE PAST IN THE FUTURE

Archeologists and other scientists in a variety of fields are working together to answer questions such as 'Why did the megafauna become extinct?' and 'Why do platypuses have so many sex chromosomes?'.

Theories that have been suggested as to why the megafauna became extinct include the following.

- Aboriginal people may have hunted them as a food source.
- Aboriginal people may have brought diseases with them that infected and killed them.
- Fires lit by Aborigines may have led to a change in the types of vegetation.
- The climate became drier and vegetation changed so that food sources became scarce.

Currently, research supports the theory that the lighting of fires changed the type of vegetation and was the main cause for the extinction of the megafauna.

GIANT KANGAROO

The extinct giant kangaroo, *Procoptodon*, was heavily built and stood about 2.5 metres high. Procoptodons may have weighed about four times as much as the largest kangaroos of today. They had a short face and deep skull with huge molar teeth. Their molars may have helped them to eat tough plant foods. Procoptodons may have used their very long forelimbs to pull down the branches of trees and shrubs.

Some marsupial fossil finds and events	Epoch (millions of years ago)		Major mammal events
Present	HOLOCENE 0.01–present	Quaternary period	Humans investigate Earth's history.
Most of the large Pleistocene marsupials became extinct about 15 000–30 000 years ago.	PLEISTOCENE 1.64–0.01 mya	Quaternary period	Aborigines arrived in Australia about 55 000 years ago.
Many giant browsing marsupials became extinct; there were grazing kangaroos and lots of diprotodons.	PLIOCENE 5.2–1.64 mya	Tertiary period	*Homo habilis*, the earliest known human, appeared in East Africa.
Primitive marsupial 'mice' and 'tapirs' were found at Lake Eyre, South Australia, and diprotodons at Bullock Creek, Northern Territory.	MIOCENE 23.5–5.2 mya	Tertiary period	Lots of marsupial mammals were living in Australia and South America.
First Australian marsupials occurred about 23 million years ago. Diprotodons and a relative of pygmy possum fossils were found in Tasmania.	OLIGOCENE 35.5–23.5 mya	Tertiary period	First marsupials appeared in Australia. First primates appeared.
Lots of marsupial fossils of this age were found in South and North America.	EOCENE 56.5–35.5 mya	Tertiary period	Swimming and flying mammals appeared.
Dinosaurs became extinct about 65 million years ago.	PALAEOCENE 65–56.5 mya	Tertiary period	More mammals appeared after dinosaurs became extinct.

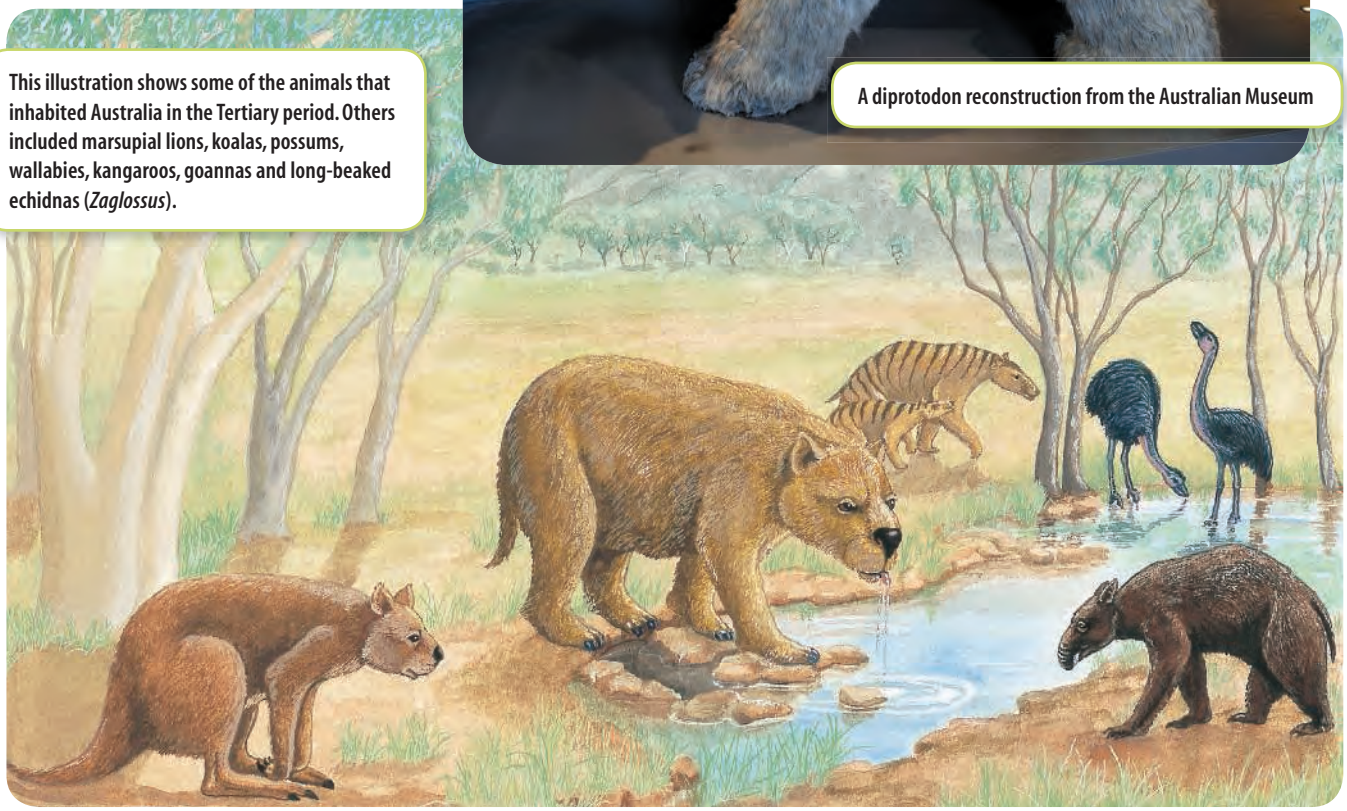
Cenozoic era

A timeline of some marsupial fossil finds and major mammal events

DIPROTODONS

The members of this group are all extinct. They were the largest of all the marsupials. *Diprotodon optatum*, often referred to as the diprotodon, was the largest known marsupial to have ever lived. The skeleton of the diprotodon suggests that the animal was about the size of a rhinoceros, being about three metres long and possibly weighing about two tonnes.

A diprotodon reconstruction from the Australian Museum



This illustration shows some of the animals that inhabited Australia in the Tertiary period. Others included marsupial lions, koalas, possums, wallabies, kangaroos, goannas and long-beaked echidnas (*Zaglossus*).

UNDERSTANDING AND INQUIRING

REMEMBER AND THINK

1 Construct a three-column table and use it to summarise the main characteristics of each of the three groups of mammals.

2 Outline how marsupials are different from all other animals.

3 Suggest how placental mammals got their name.

4 Identify which group of mammals the following animals belong to.
(a) Echidna (b) Possum (c) Cat

5 How many chromosomes decide the sex of a platypus? Suggest how is this different to the situation in other mammals.

6 Suggest how we know that marsupials have existed in Australia for millions of years.

7 List features of the following and suggest which living animal it is most similar to today.
(a) *Procoptodon*
(b) *Diprotodon optatum*

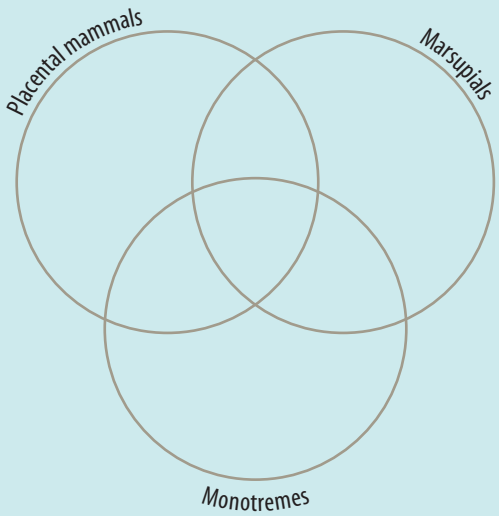
8 Outline the importance of the findings related to the genome of the platypus.

9 Suggest why Australian mammals are so different from those found in other countries.

10 List theories as to why Australia's megafauna became extinct. Which of these theories is currently supported by research?

THINK AND DISCUSS

11 Construct a triple Venn diagram to show the similarities, differences and examples of the three mammal groups.



Look at the illustration of prehistoric animals on the previous page.

12 Which animals alive today are they most similar to? Give reasons for your answers.

13 How are present-day wombats different from their ancient ancestors?

ANALYSE AND EVALUATE

14 Use the timeline on page 80 to answer the following questions.
   (a) List the seven epochs in the table on page 80 in order of most recent to least recent.
   (b) In which epoch did marsupials appear in Australia? How do we know this?
   (c) Earth's greatest ice age was in the Pliocene epoch. When was this? What other events occurred then?

15 Look up other sources to find out what other important events occurred, and add these to your timeline.

INVESTIGATE

16 Find out more about one placental mammal, marsupial or monotreme and present your information in a poster or PowerPoint presentation.

17 Did you know that adult hedgehogs have 5000 spines? So that the birth canal is not damaged when the mother is giving birth, the initial spines of a newborn are covered with a layer of skin. The spines pop through hours after birth. Although hedgehogs are mammals and they look a little like echidnas because of their spines, they are not classified as monotremes.
   (a) Find out whether hedgehogs are placental mammals or marsupials.
   (b) How do hedgehogs differ from echidnas?
   (c) A porcupine also has spines. What type of mammal is a porcupine?
   (d) How are porcupines different from hedgehogs and echidnas?

18 Find out more about Australia's prehistoric marsupials, and present your information as a poster, poem, story or PowerPoint presentation.

19 Find out about the different climates, environments and organisms for one of the epochs in the Cenozoic era, and then write a story about an imaginary journey back in time.

20 Besides the Cenozoic, what are the other four eras used to describe the history of the Earth? Draw a timeline showing all five eras, including their periods, times in millions of years and any other information you can locate.

21 What do taxonomists in museums do? Why is their work important?

22 Research and report on one of the following topics of research in Australia.
- Platypus genome
- Platypus milk and lactation
- Platypus venom
- Platypus sex chromosomes and mating
- Koala diet
- Koala diseases
- Koala reproduction
- Tamar wallabies
- Bilbies

Present your findings as a poster, PowerPoint presentation, web page, picture book or journal article.

23 Find out the names and features of some Australian mammals and create new *Cryptonym* cards. Play the *Cryptonym* game (refer to Investigation 3.2 for instructions) with your new set of cards.

24 Imagine you are an Australian paleontologist with a time machine. Document a week in your journal. Share your journal with two others and find out about their adventures. Present the three journal entries to the class.

eBookplus

25 Use the **Platypus** weblink in your eBookPLUS to find out more about the evolutionary theories, features and reproduction of platypuses.

work sheet 3.3 Looks can be deceiving

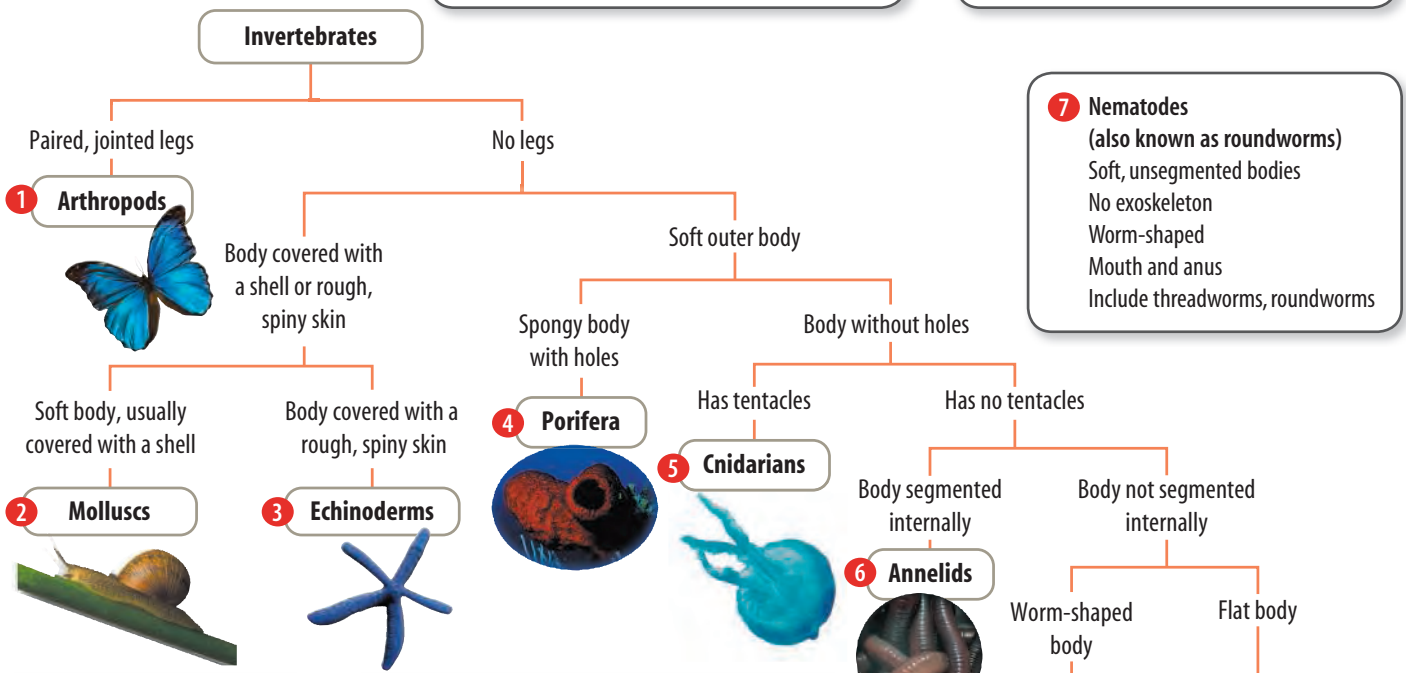
No backbone!

Feel a little itchy? Did you feed something in your sleep — or were you awake? Was it a flea, an insect, a worm, or a louse? Did it burrow its way inside you to feed or did it get its food while crawling on your skin? Chances are it might have been an invertebrate — a creature with no backbone.

1 Arthropods
Body divided into segments
Exoskeleton
Paired, jointed legs
Most have antennae
Include centipedes, spiders, crabs, ants, grasshoppers, moths

3 Echinoderms
(pronounced ee-KAI-no-derms)
Most have a soft body over an internal skeleton
Rough, often spine-covered 'skin'
Body has a five-part pattern
Move through water by taking water in and pushing it out of tubes in their bodies
Include sea stars, sea urchins, sea cucumbers

6 Annelids
(also known as segmented worms)
Internal segments with some repeated organs
Soft bodies with an obvious head
No exoskeleton
Mouth and anus
Include earthworms, leeches



7 Nematodes
(also known as roundworms)
Soft, unsegmented bodies
No exoskeleton
Worm-shaped
Mouth and anus
Include threadworms, roundworms

2 Molluscs
Most have a shell
Soft body, not divided into segments
No legs, but may have tentacles
Have a strong 'foot' muscle to help them move
Include oysters, octopus, scallops, slugs, snails

4 Porifera
Spongy body with no body organs or tissue
Exoskeleton made of fibres or pointed 'needles'
Water and food enter through tiny pores (holes) in body
Wastes pass out through one big opening
Include barrel sponges, glass sponges, tube sponges

5 Cnidarians (pronounced ny-DAIR-ee-ins — the 'C' is silent)
Hollow, soft body
No body organs
Take in food and pass out waste through one opening
Have tentacles containing stinging cells, which fire shots of toxin
Include box jellyfish, sea anemone, Portuguese man-of-war, coral

8 Platyhelminthes (pronounced plat-ee-hel-MIN-theez; also known as flatworms)
Soft, flat, usually unsegmented bodies
No exoskeleton
Mouth but no anus
Include tapeworm, fluke

Inside or outside?

Some organisms obtain their nutrients from feeding off other living organisms. These are called **parasites**. **Endoparasites**, such as tapeworms, live inside their hosts, whereas **ectoparasites**, such as head lice, live on the outside. Some of these organisms also act as carriers or **vectors**, transporting disease-causing organisms from one animal to another.

No backbone

No backbone? Animals without backbones are called invertebrates. Many invertebrates have an exoskeleton (skeleton on the outside) and some have no skeleton at all. About 95 per cent of animals are invertebrates. Have a look at the invertebrate dichotomous key on the previous page to see how many of the features, groups and examples you recognise.

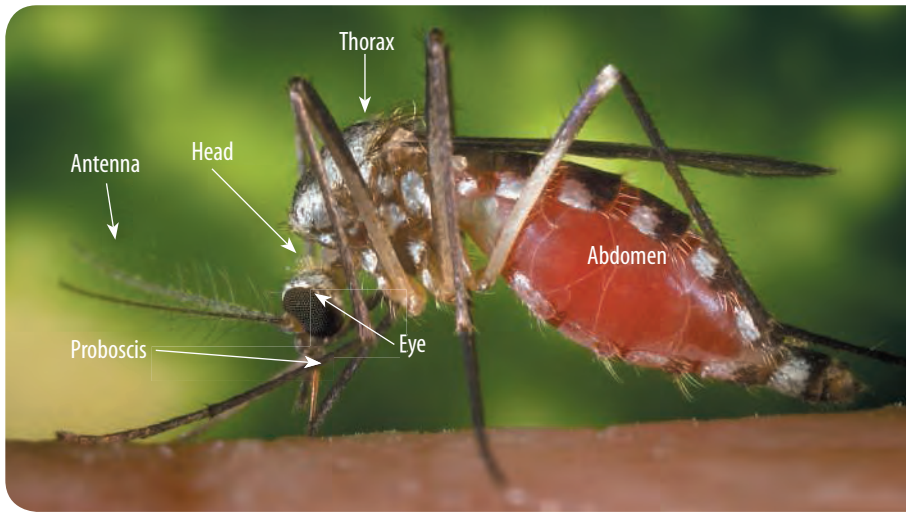
Invertebrates beware!

A number of the invertebrate groups contain organisms that may find you quite tasty. There are some well known human parasites in the following groups of invertebrates:

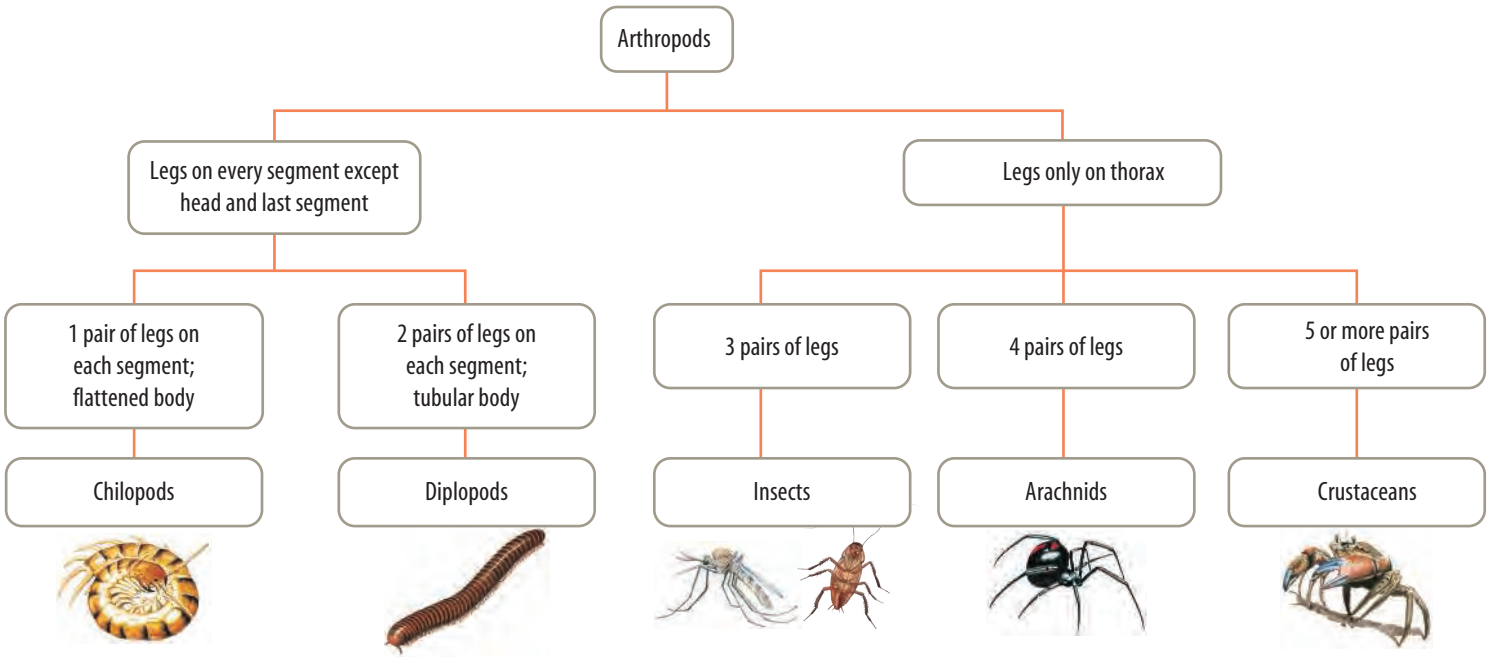
- arthropods (for example, head lice, mosquitoes, fleas, ticks and mites)
- nematodes (for example, threadworms, hookworms and pinworms)
- platyhelminthes (for example, liver flukes and tapeworms)
- annelids (for example, leeches).

Arthropods

About 80 per cent of invertebrates are **arthropods**. Arthropods can be classified on the basis of the organisation and number of their legs. The figure below shows the head, thorax and abdomen of a mosquito. As there are three pairs of legs attached to the thorax, it is classified as an insect.



Insects' bodies are divided into three parts — the head, thorax (chest) and abdomen (stomach) — and have three pairs of legs attached. Most have either one or two pairs of wings, a characteristic that separates them from any other invertebrate animal. The proboscis of a female mosquito has sharp needles that poke out when a blood vessel in its victim is pierced.



Insects

All insects have the same basic mouthparts, but over millions of years, depending on their particular diet, they have developed in different ways. Most insects either bite off pieces of food and chew them or suck up liquids such as nectar or blood.

SAP AND SWEET SUCKERS

Some insects may obtain their food by sucking sap from plants. The shape of an insect's head can often suggest the sort of food it eats. A sap-sucking insect usually has a tiny head with a long, pointed tube extending from its mouth which it uses to suck up sap.

Moths and butterflies have a long tubular **proboscis** that unrolls to reach the nectar within a flower. Dragonflies also have extendable mouthparts for hunting.

Although adult mosquitoes feed on the sugar in plants, the females in some species must have one or more blood meals to produce eggs. In most species of mosquito, the female has a sharp, tubular proboscis well suited to piercing and sucking. Male mosquitoes never suck blood. Female mosquitoes may pass on malaria, yellow fever, elephantiasis and filariasis while obtaining blood, because they inject infected saliva into their hosts.

A hawk moth has an unusually long proboscis — it is often longer than its body. Moths and butterflies don't blow up their proboscis; they use muscles that act like an elastic rod, coiling it up again so that it may be kept coiled under the head.

BITE AND CHEW

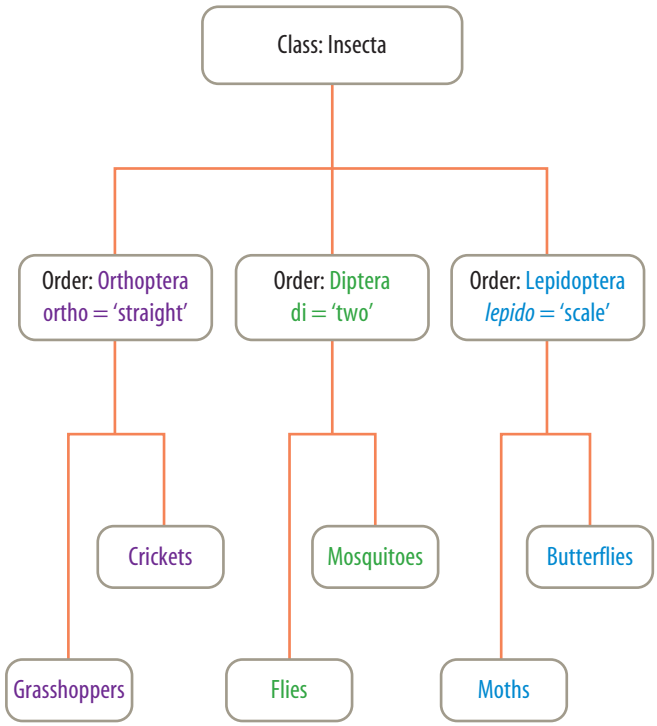
Some insects have feeding structures that are designed for biting and chewing. They usually eat plants and have a large head to support the strong muscles and jaws that are needed to get through the tough plant tissue.

WHAT DOES IT MEAN?

The term *platys* comes from the Greek term meaning 'flat'; *helminth* comes from the Greek word for 'worm'; *nema* comes from the Greek term for 'thread'; and *mollusc* comes from the Latin term ***mollis***, meaning 'soft'.

HOW ABOUT THAT!

Bedbugs (*Cimex lectularius*) come out at night and feed on the blood of mammals and birds. Their mouthparts are well suited to piercing their host's skin. They have barbed structures for piercing and sawing. The bugs have a pair of tubes, one of which inject saliva containing a substance that stops the blood from clotting, while the other sucks up the blood and saliva mixture. They usually feed just before dawn if the temperature is above 13°C and may take five minutes or more to extract their meal before scurrying off to digest it and rest.



Using the knowledge that *pteron* is Greek for 'wing' and the prefix translations above, can you suggest a feature that these insects all share, and one that can be used to separate them?

UNDERSTANDING AND INQUIRING

REMEMBER

1 Define the term 'parasite'.

2 Outline the difference between endoparasites and ectoparasites.

3 What do all invertebrates have in common?

4 Identify the name of the invertebrate group to which each of the following organisms belongs.

(a) Threadworm
(b) Earthworm
(c) Jellyfish
(d) Tapeworm
(e) Tube sponge
(f) Sea urchin
(g) Slug
(h) Grasshopper

Use the invertebrate dichotomous key on page 83 to answer questions 5 and 6.

5 State which of the following pairs have (a) most in common and (b) least in common.

(i) Nematodes and platyhelminthes
(ii) Molluscs and annelids
(iii) Arthropods and cnidarians
(iv) Arthropods and annelids

6 For the pairs that you have stated in question 5, list what each pair has in common.

7 Construct a table to show examples of arthropods, nematodes, platyhelminthes and annelids that can be human parasites.

8 Suggest features that can be used to divide arthropods into groups.

9 Describe what a proboscis is used for.

10 Describe the features of the mouthparts of a bedbug that enable it to feed on humans.

11 Outline how the types of heads and mouthparts of insects can tell you about the way that they live and feed.

USING DATA, THINK AND DISCUSS

12 Who am I? Use the invertebrate key below to find the identity of the following.

(a) I do not have legs but I have a soft outer body and tentacles.
(b) I have a rough spiny body covering, a five-part body pattern and no legs.

13 Use the dichotomous key below to classify an octopus.

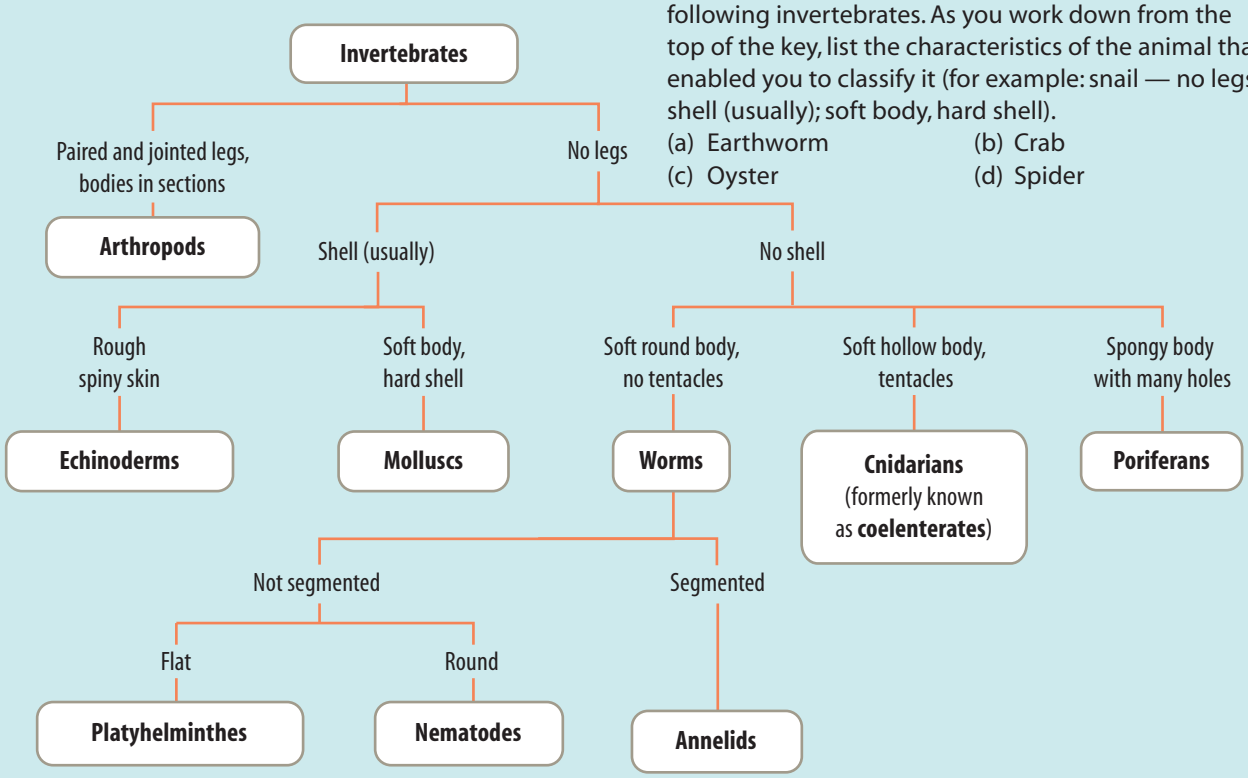
(a) To which group does it appear to belong?
(b) Check the lists of characteristics to see if the answer you gave in part (a) was correct. If you find that you were incorrect, suggest why.
(c) Classification is not always straightforward. Use the lists of characteristics to design a dichotomous key of your own that will make it easier to classify an octopus.
(d) Test your key by using it to classify a snail, a starfish and an earthworm. Does your key seem to work?

14 Use the lists of features of the invertebrate groups to state which group (or groups):

(a) has jointed and paired legs
(b) usually has a hard shell
(c) can have tentacles
(d) has a body with many holes.

15 Use the dichotomous key below to classify each of the following invertebrates. As you work down from the top of the key, list the characteristics of the animal that enabled you to classify it (for example: snail — no legs; shell (usually); soft body, hard shell).

(a) Earthworm
(b) Crab
(c) Oyster
(d) Spider



16 (a) In a table, list the features of slugs, earthworms and snails.
(b) Highlight or circle features that they all have in common.
(c) Which two appear to have most in common?
(d) Use the invertebrate key to see if your data is supported by their classification group.
(e) Discuss your findings.

17 Find out why cnidarians are no longer classified as coelenterates.

18 Use the circular key on the right to identify the 'insect' creatures from another planet.
(a) Describe the characteristics of a trisee, a peeler and a bitpart.
(b) Make a sketch of a gazer and a bozo.
(c) Which of the following are most similar: a bisharp, a noner and a peeler?

19 (a) Use the insect key below right to classify a variety of insects into their groups.
(b) Did you have any difficulties using the key? Suggest any changes that you could make to improve it.

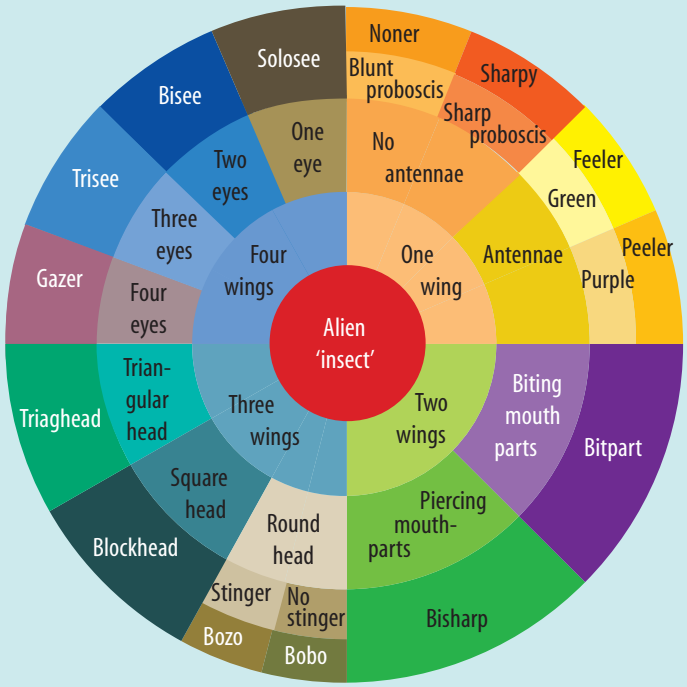
20 (a) Using the information on page 83 and images from the internet, clipart and magazines, create a set of *Flash 'n' mind* cards for invertebrates (see Investigation 3.5).
(b) Design as many different games as you can that use the cards to help you learn the characteristics and examples of each invertebrate group.
(c) Play some of your card games with your team and also with other teams.
(d) Combine your invertebrate cards with your vertebrate cards from Investigation 3.5 to create a floor mind map to share with others what you have learnt.

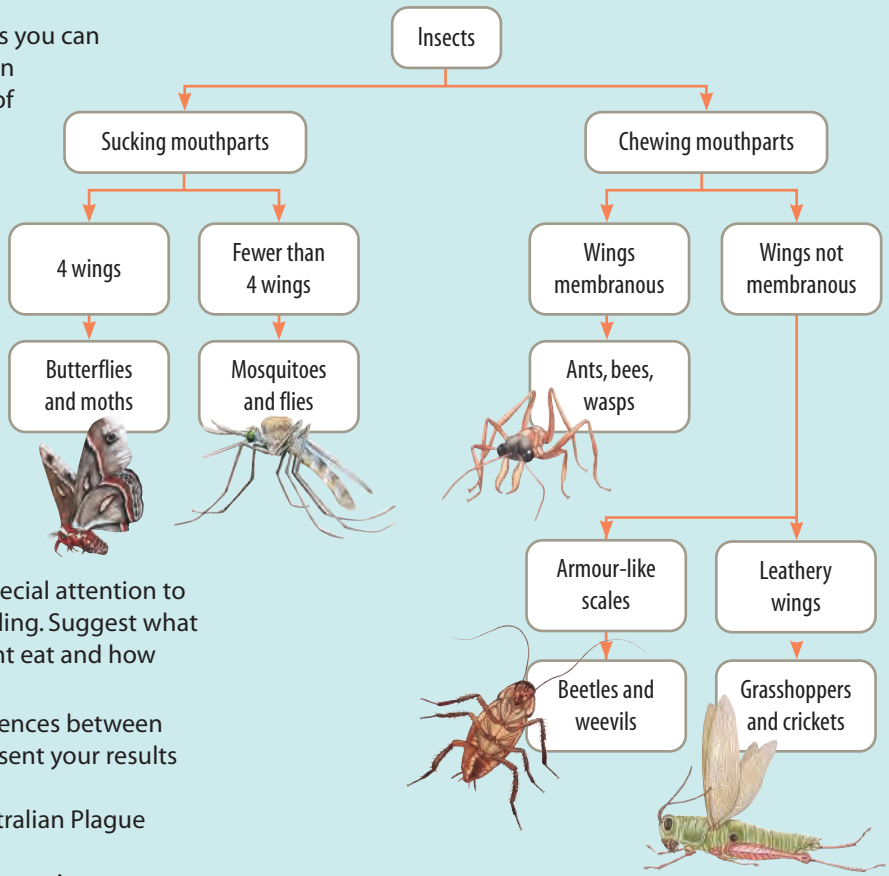
21 Design and make masks to model the feeding parts of several different insects.

22 Use a magnifying glass or stereo microscope to observe and sketch the heads of a range of insects. Pay special attention to the parts that may be involved in feeding. Suggest what types of food each of the insects might eat and how they might obtain these.

23 (a) Find out the similarities and differences between locusts and grasshoppers and present your results in a Venn diagram.
(b) Research the functions of the Australian Plague Locust Committee (APLC).
(c) Identify, research and report on a question or problem related to locust plagues.

24 Find out the names and features of invertebrates that can be found in Australia and create new *Cryptonym* cards. Play the *Cryptonym* game (refer to Investigation 3.2 for instructions) with your new set of cards.





Zooming in . . . human endeavours into classification

Science is full of wonder, just waiting to be explored. More than in any other career, the scientist can be both an adventurer and an explorer. The opportunities to discover new things are almost endless, with the journey of discovery full of many twists and turns along the way.

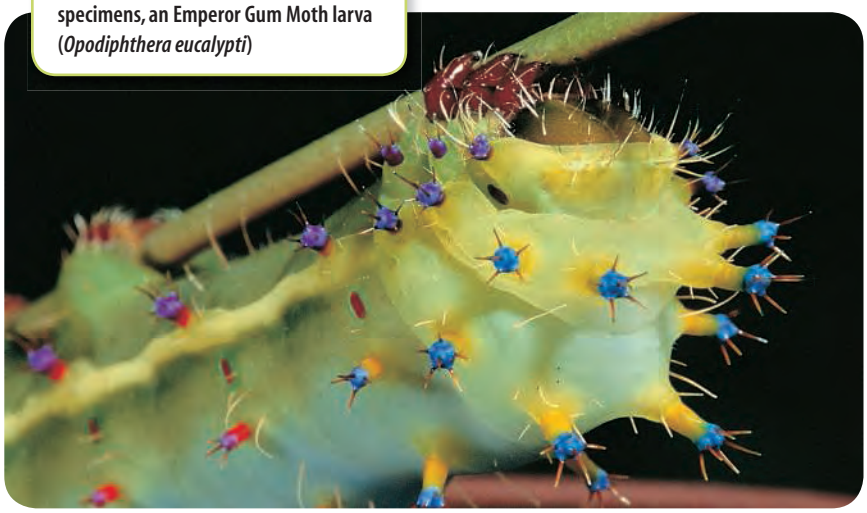
The life of scientist Denis Crawford is one such adventure. He asks questions, makes observations and experiences new challenges as he tries to make sense of the world around him.

Denis Crawford photographing the Sorsdal Glacier

Caring for 'crawlies'

In 1977, the 'call of the wild' beckoned Denis. For the next 10 years he was involved in **entomological** research with the Department of Agriculture. He immersed himself in the world of insects. During the day he collected caterpillars and maintained breeding colonies in his laboratory. Here he could study not only the insect's reproductive cycle but also the best way to control insect populations. Over two billion dollars worth of pesticide is used annually in Australia to rid crops of agricultural pests; Denis's caterpillars were responsible for half of this use. During this time he was often referred to as 'the caterpillar chef'. He found that the best food for the caterpillars was a blend of baked beans and agar, which he set into blocks and cut up into insect 'bite size' pieces.

One of Denis's creeping, crawling specimens, an Emperor Gum Moth larva (*Opodiphthera eucalypti*)



Chemical colours

Educated in West Essendon, Victoria, Denis studied a mix of humanities and sciences. After completing Year 12, he spent 18 months at Dookie Agricultural College. From there he moved to the Organic Chemical Research Section of ICI, experimenting with 'colourful chemistry'. His job was to discover new colours of pigments, paints and inks, and then think up names to describe them.

Snappy travels

Denis became more and more interested in the challenges involved in 'capturing' the wonders of the world around him. At the end of his time at the Department of Agriculture, he travelled overseas, taking photographs of the natural world around him. On his return to Australia, over 500 of his photographs were placed in a photographic library. This library acted like an agent and sold Denis's photographs to magazines, journals and other parties.

Getting a closer look

Denis's dual interests in natural science and photography led him to enrol in the RMIT's Applied Science (Photography) degree course in 1991. His third-year project was on close-up insect photomicrography, that is, taking photographs using a scanning electron microscope. His aim was to produce a series of photographs in which dead insects were made to look alive. Denis successfully met the challenge he set himself, and at the end of 1993 his work on the project earned him the Chris Hales Imaging Award.

Strange looking . . .

Denis was increasingly seen to be 'staring at bushes, waiting for insects to move into the right spot'. He remembers the reactions of other people when they saw him lying 'fully stretched out on the footpath photographing harlequin bugs going about their daily business'. As Denis recalls, 'People stared at me, gave me strange looks and then crossed the street to avoid me. To "shoot" a bug properly you have to get down to their level . . . I had no choice!'

Denis's *Backyard Insects* book cover photograph of a honey bee

Backyard insects

Denis's insect photographs caught the attention of Paul Horne, an entomologist. He approached Denis with the idea of creating an informative and colourful book on everyday insects. Over the next two years, Denis produced over 100 'insect images' and Paul wrote the accompanying text.

One of Denis's insect images of a robber fly

Living in a freezer

The wilds of Antarctica had always held a fascination for Denis. Since he was young, he had loved to hear about Antarctic adventurers like Sir Ernest Shackleton, Captain Scott and Sir Douglas Mawson.

In 1994, he approached the Antarctic Division to offer his services as a photographer. Two years later, in January, he was on a ship travelling through rough seas and pack-ice. His mission was to photograph small fossils in the Vestfold hills, in eastern Antarctica. Fifteen of the 70 expeditioners disembarked with Denis at Davis Station. They included a palaeontologist, a meteorologist, an astrophysical engineer, a space plasma physicist and a zoologist.

Denis's first impressions of Davis Station were interesting: '… a Legoland on Mars … a colourful blockscape of buildings … all colour coded'. The Antarctic environment is, in fact, so unusual that NASA has used one of the ice-free regions as a training ground for astronauts in extraterrestrial living.

Finding frozen fossils

Denis was very excited about what he found, 'Fossils were sitting on the surface of what used to be a seabed four million years ago. After the last major glaciation, about 12 000 years ago, a glacier receded and exposed this seabed. Although most of the fossils were of shells, there were also fossils of ancient dolphins and whales. They were extraordinary!

An Antarctic fossil

'As you walk across the Marine Plain, you disturb very fine dust. This dust is the remains of four-million-year-old diatoms (phytoplankton), and from time to time you have to stop to wipe the diatoms out of your eyes.

'Sitting on the surface of this flat plain are many unique rocks which have been moved from other areas and deposited here by the glacier. There is a two-metre high "turtle skull" rock which has strange holes in it caused by the eroding winds.'

Life at the bottom of the world

Wind is an ever-present and important feature of Antarctica. The winds come off the great Antarctic plateau from the South Pole and fall downwards towards the sea. They are known as katabatic winds. When the wind hits the coast, it can be travelling at a speed of 200 kilometres per hour.

Denis's challenge was to photograph fossils in the field. 'It was so windy it was difficult to set up the tripod, and the camera kept shaking. As it was so cold, I had to wear thick gloves. This made it hard to operate the camera. I ended up photographing the fossils in the station lab.'

Sleeping arrangements on field excursions were also curious. 'Once I was outside in the field for five days. During this time, the research team stayed in round fibreglass huts. These huts were named on the basis of their shape and size. I slept in a "melon" but there were also "apples" and "Smarties". The "melons" slept two people, whereas the "apple" slept only one. Although we had torches, we didn't really need them, as in summer there were 20 hours of full sunlight. The rest of the time was like a "weird dusk". We had no television but we didn't miss it because there was so much to learn and so many adventures to live …'

Fire and ice

The Sorsdal Glacier lies at the end of Marine Plain. Denis was among a group of scientists who climbed it, starting at twilight and reaching the top at midnight. 'When we reached the top, we celebrated by eating a packet of TimTams and drinking Tang. It was the most stupendous sight. I'll never forget the colours … the sky was on fire and the ice was purple.

'Wow! … to capture the colour and feeling of the moment. Hand me my camera quickly!'

And now? Denis's latest passion involves his company Graphic Science. What adventures await him once he's finished that journey?

UNDERSTANDING AND INQUIRING

REMEMBER

1 Draw a flowchart of Denis Crawford's life. Include years where possible.
2 What is photomicrography?
3 What was Denis's job while he was in Antarctica?
4 How old were the fossils that Denis photographed in Antarctica?
5 What are diatoms and why did they get in Denis's eyes?
6 Why didn't Denis need to pack a torch for his Antarctic travels?

INVESTIGATE, THINK AND DISCUSS

7 Find out more about types of collaborative transnational Antarctic science research by researching projects associated with the Scientific Committee on Antarctic Research (SCAR), European Project for Ice Coring (EPIC) or Interpolar Transnational Art Science Constellation (I-TASC).

eBookplus

8 Use the **Antarctic connection** weblink in your eBookPLUS to identify a research question or problem being investigated through scientific research in Antarctica in each of the following fields: aeronomy, astrophysics, biology, geology, glaciology, meteorology and oceanography.
9 What do palaeontologists, meteorologists, astrophysical engineers, space plasma physicists and zoologists do? What might they be doing in Antarctica?
10 Find out more about the lives and expeditions of Sir Ernest Shackleton, Captain Scott and Sir Douglas Mawson.
11 What is an entomologist?
12 Investigate some of the caterpillars that destroy Australian crops. How can farmers control them?
13 Investigate glaciers. How are they able to move rocks from one place to another? Where are the nearest glaciers to Australia?
14 Find out about the lives and features of organisms which inhabit Antarctica. How are they suited to their environment?
15 Use the **Graphic Science** weblink in your eBookPLUS to see more examples of Denis Crawford's recent work.

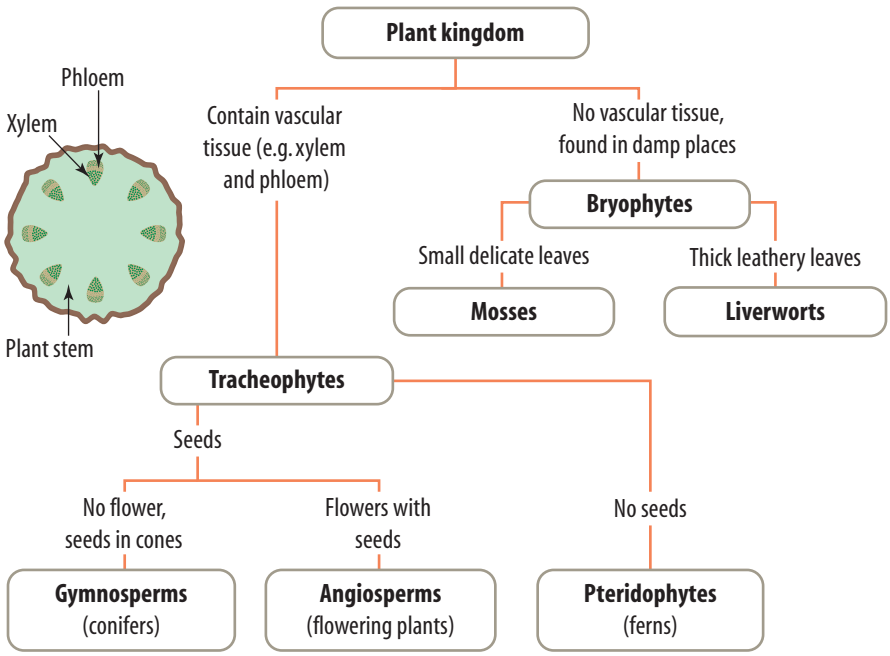
IMAGINE

16 Imagine you are going on an expedition to Antarctica. Suggest a scientific reason for your expedition. Carefully plan your trip including what types of scientists you would take. What two personal items would you take? Write an imaginary journal detailing your expedition.
17 Photograph some insects and use the photos to construct a class field guide to local insects. You will need to use reference books to find out about each insect.
18 Write a story about your future adventures. Include dates and key events. Your final story may take the form of a journal, biography, tape recording or video.

Which plant?

More than 23 centuries ago, a Greek philosopher named Aristotle developed one of the first widely used classification schemes. He divided plants into groups on the basis of their type of stem. Although this is still a useful system, like most classification systems it has limitations.

The features used to classify plants today are generally structural ones such as seeds, roots, stems, flowers and leaves. The key below shows how these features may be used to divide plants into five groups.



Plants that contain vascular tissue, such as ferns, conifers and flowering plants, belong to the group Tracheophyta (= 'windpipe' + 'plant') group. Vascular tissue consists of a system of cells making up tube structures that carry water and nutrients along the stem of a plant. Mosses and liverworts do not contain vascular tissue and are classified as Bryophyta (= 'moss' + 'plant').

Bryophytes (mosses and liverworts)

Characteristics:
- Found mainly in damp places
- Root-like structures very fine and hair-like
- Simple leaves or leaf-like structures
- Usually only a few centimetres long
- Spores are formed in a capsule

Examples: mosses, liverworts

An Australian moss (top) and liverwort (bottom)

Gymnosperms (conifers)

Characteristics:
- Found on land
- Have true roots, stems and leaves
- No flowers
- Form seeds between scales of a woody cone
- Most have fine, needle-like leaves

Examples: cypress, pine, cedar

Angiosperms (flowering plants)

Characteristics:
- Most found on land
- Most common type of plant
- Produce flowers, fruits and seeds
- Have true roots, stems and leaves

Examples: fruit trees, cereal crops, wattles, vegetables

Pteridophytes (ferns)

Characteristics:
- Found in moist, shaded areas no flowers, cones or seeds
- Spores, rather than seeds, found on the underside of leaf-like fronds
- Have proper roots and stems most less than a metre high (except tree ferns)

Examples: maidenhair fern, tree fern, bracken

The language of plants

Plants can be described using different words, depending on a person's purpose. For example, in describing a bottlebrush tree:

- a scientist would refer to its correct botanical name as *Callistemon citrinus* and say it belonged to the angiosperm or flowering plant group
- a gardener might say 'I planted a new tree called a bottlebrush'
- a horticulturist would tend to use both scientific and common names.

A bottlebrush flower

Words used to describe groups of plants

Scientific term	Common name
Bryophytes	Mosses and liverworts
Pteridophytes	Ferns
Angiosperms	Flowering plants
Gymnosperms	Conifers
Tracheophytes	Plants with stems

Gardeners use words like 'tree', 'shrub', 'herb' and 'grass' to describe groups of plants. To a scientist, a tree could belong to the angiosperm or gymnosperm group. A scientist would carefully examine the characteristics of the plant to find out whether it had flowers, seeds and fruit, or cones containing seeds. The scientific names for individual plants and groups of plants are more specific than the common names.

WHAT DOES IT MEAN?

The prefix *gymno-* comes from the Greek word ***gymnos***, meaning 'naked'; *angio-* comes from the term ***angios***, meaning 'a vessel'; *phyton* comes from the term ***phyton***, meaning 'plant'; and *pterido-* comes from the word ***pteron***, meaning 'feather'.

Evergreen quest

Have you ever grown a herb garden — your own 'evergreen quest'? Many believe that the use of herbal remedies to treat simple ailments is as old as the human race itself. From early hunting and gathering times, humans have had a close relationship with plants as both sources of food and medicine. Ancient civilisations of Egyptians, Chinese, Persian, Greeks and Romans all practised herbalism.

The herbs (and spices) in your kitchen could have medicinal properties — do you know what effects they might have on you?

GROW YOUR OWN

Try growing these common herbs in your own garden or planter box.

- Thyme is used to make tea for treating stomach cramps, indigestion, colic and gas retention.

- Lemon thyme smells and tastes like lemon. A few sprigs of lemon thyme in boiling water can make refreshing herbal tea. It is also useful for treating asthma and coughing, and is considered great for boosting your immune system.

- Sweet basil (such as Greek basil) has tiny leaves with a spicy fragrance. Basil is best eaten fresh, rather than dried, and goes well with tomato-based dishes. It also helps digestion and relieves constipation.

- Dill is valued for its leaves in spring and its seed in autumn. Its flowers are pale yellow and stems grey-green. Dill is added to soups and fish dishes to enhance their flavour. It has also been used as a hair restorer, and as a tea for digestive ailments and to help relieve flatulence.

- Lemon balm is fabulous in salads and refreshing in iced tea. Its healing properties include promoting the relief of tension and restlessness. It also soothes toothache and headaches and relieves stomach-aches, indigestion and heartburn. Freshly crushed leaves have been used to soothe and cleanse wounds.

- Rosemary can be added to roast potatoes and garlic for a tasty feast. Oil extracted from the leaves and flowers is also used for stomach complaints, gas retention and cramping muscles and limbs — and for aromatic baths.

- Parsley (such as Italian parsley) is rich in vitamins A and C. A brew made from the roots is recommended in all ailments of the digestive and urinary tracts. Freshly crushed leaves are also used as a compress for insect bites. Although parsley is often used as a garnish, tabouli is an example of a food made mainly from parsley.

HOW ABOUT THAT!

Don't get edible parsley mixed up with fool's parsley, which may look similar but can be poisonous. It can be distinguished from parsley by crushing its leaves, which give an offensive, nauseating odour resembling the stench of mouse droppings!

Plants beware

History is full of myths and stories about the 'magical' — and sometimes supernatural — properties and uses of plants, and about plants that carry out unusual 'unplant-like' activities. Some of these stories contain elements of truth.

WITCHCRAFT, SUPERSTITION AND CUSTOMS

For hundreds of years, some plants have been associated with witchcraft and superstition. For example, the four-leaved form of clover (*Trifolium repens*) that is occasionally found has been considered to be a token bringing good luck. Another type of clover, *Trifolium pratense*, was thought to guard against witchcraft. In some cultures, people once used garlic (*Allium sativum*) to protect them against witchcraft and sorcery; some even added it to animal foods to protect them against evil.

PLANTS THAT GET ON OUR NERVES

Inhabitants of tropical forests used some plants to make arrow poison. In Asia and South America, some species of the genus *Strychnos* were used to obtain arrow poison from their roots and bark.

The leaves of a stinging tree are covered in tiny stinging hairs.

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The poison used on the arrows was curare. Although a person hit with a poisoned arrow could still think and sense things for quite some time, organs involved in movement would gradually fail to function. In the end, the person's ability to speak would disappear, followed by the lack of movement in other areas (such as the face) and, finally, death.

Another type of plant with a sting is the stinging tree (*Dendrocnide excelsa*), which has large heart-shaped leaves covered with fine stinging hairs. It is commonly found in the rainforests of Queensland and New South Wales. Merely brushing against its leaves can result in a severe burning sensation which may persist for several months. Some people suggest that the juice of cunjevoi lilies (*Alocasia macrorrhizos*), squeezed over the stings, will relieve the stinging.

A Venus flytrap

PLANTS OF PREY

Some plants found in nitrogen-deficient soil 'eat' insects to supplement their nitrogen. Attracted by the smell of food and a safe landing place, insects can be lured into plants that are not what they seem. The Venus flytrap (*Dionaea muscipula*), for example, has a special trap with a hinged lid. As soon as an insect touches the trigger bristles on the trap's upper surface, the trap springs shut. The insect is then trapped in a cage-like prison. Acids and special substances called enzymes are secreted from the plant. These slowly break down the soft parts of the insect's body. It may take the Venus flytrap two weeks to fully digest a damselfly. When the trap reopens, the insect's hard exoskeleton, including its wings, is blown away by the wind.

A sundew is covered in a sticky substance

Sundews (*Drosera* spp.) are another group of insect-eating plants, of which there are more than 50 different species in Australia. The upper part of the leaf is covered with thin red tentacles which are covered in a sticky substance. If an insect touches the tentacles, they bend inwards and trap it. The body of the trapped insect is then digested.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Make a table to summarise the characteristics of bryophytes, pteridophytes, angiosperms and gymnosperms. Include the headings shown below.

Name of group	Where found	Type of stem	Flowers or no flowers	Seeds or spores	Other information	Examples
Bryophytes						

2 Use a table to summarise the information provided in this section. Use the headings 'Plant' and 'Interesting feature, characteristic or myth'.

3 Describe the advantages to plants of being able to catch and digest animals as well as to photosynthesise.

4 Match the scientific names to the common names:

(a) *Dendrocnide excelsa*	Garlic
(b) *Allium sativum*	Clover
(c) *Dionaea muscipula*	Four-leaved clover
(d) *Trifolium repens*	Venus flytrap
(e) *Trifolium pratense*	Stinging tree

THINK

5 Design a key which uses the following features, in the order in which they are shown, to separate ferns, mosses and liverworts, conifers and flowering plants.
(a) Seeds or no seeds
(b) Seeds in cones or seeds in flowers
(c) Stem or no stem

6 Make a list of 10 plants you already know. To which plant group does each belong?

7 Suggest what advantage it gives to plants to sting.

8 Construct a crossword using the information in this section.

9 Suggest why the inner surface of the leaves of a Venus flytrap has both nectar-producing glands and digestive glands.

INVESTIGATE

10 Design a key to help a gardener tell the difference between trees, shrubs, herbs and grasses. Ask at least five people to test your key.

11 (a) Find three examples each of a tree, shrub, herb and grass. Observe and record five characteristics for each of these plants.
(b) Using your observations, decide which scientific plant group each example belongs to.
(c) Use field guides or keys to identify the plants you observed.

12 What does a taxonomist in a herbarium do? Why is this job important?

13 (a) In pairs, walk around your school grounds and select ten plants.
(b) Draw a sketch of each and add as many details as you can next to your diagram.
(c) Construct a key to organise these plants into groups.
(d) Use field guides and the internet to find out the identity of these plants.
(e) Combine your data with that of other groups in your class and use it to construct a plant field guide and key for your school grounds.

14 Brainstorm with your team all the different plant names that you know. Select one of these and find out five interesting features to share with your team.

15 Find out the names and features of members of each of the plant groups that can be found in Australia and create new *Cryptonym* cards. Play the *Cryptonym* game (refer to Investigation 3.2 for instructions) with your new set of cards.

16 Australia has about a thousand species of plants that are considered to be toxic to humans and our livestock. Of these, 60 per cent are natives. Investigate and report on an example of a toxic plant within each of these Australian plant families:
(a) legumes (Fabaceae, Mimosaceae)
(b) nightshades and tobaccos (Solanaceae)
(c) buttercups (Ranunuclaceae)
(d) cycads (Cycadaceae, Zamiaceae).

17 Find out the meaning of 'toxicology' and then find examples of Australian plant toxicology research.

INVESTIGATE, CREATE AND SHARE

18 (a) Use the figure on the next page to organise and record your research on a herb of your choice.
(b) In the 'action' phase, use your information to set up an experiment to grow your herb.
(c) Take photographs throughout your experiment and keep a journal to record all of your observations.
(d) Throughout your experiment, share and discuss your results with others growing the same herb and also with others growing different herbs.
(e) As a class or in groups, organise your observations into a summary that can be shared with another class.

(f) Find examples of four recipes (for food or herbal value) that use your herb.
(g) Select a recipe to use some of the herb that you have grown to demonstrate the importance and value of your herb.

INVESTIGATE, DESIGN AND SHARE

19 (a) In your workbook, or using a computer, construct a table with the following headings.
- Herb
- Genus or species
- Description of useful plant part
- Beneficial effects
- Other details

(b) Complete the table with details on the following herbs, using the information in this section and your own research. In the 'Description' column, you could insert a photo or drawing of the herb.
(i) Peppermint (*Mentha piperita*)
(ii) Sweet basil (*Ocimum basilicum*)
(iii) Borage (*Borago officinalis*)
(iv) Thyme (*Thymus serpyllum*)
(v) Rosemary (*Rosmarinus officinalis*)
(vi) Parsley (*Petroselinum sativum*)
(c) Reformat your table into a visual map and share it with others in your group.
(d) Add relevant information from others in your group to your map.
(e) Select one of your herbs and find a recipe that uses it. When at home, make the food with the herb, take photographs and record your experience. Share your photographs and comments with other students.

THINK AND CREATE

20 Summarise the information on the herbs described in this section into a mind map.

21 All blackberry plants should be destroyed.
Is there a scientific basis for this claim? To help you evaluate this claim, construct a PMI chart on research relating to blackberry plants.

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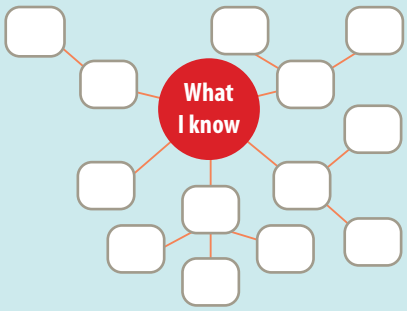
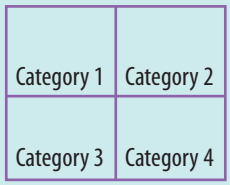
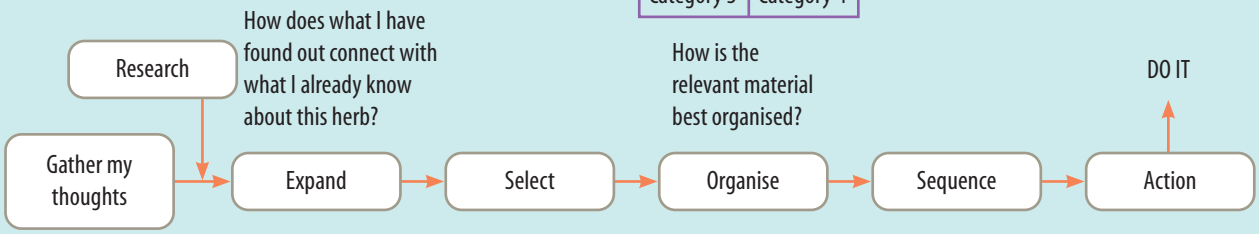
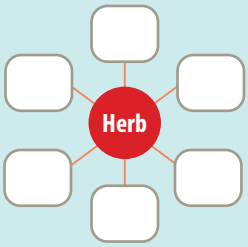
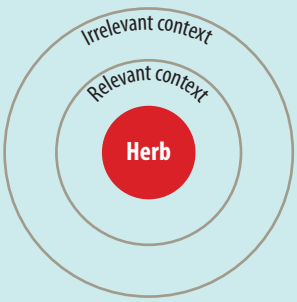
22 Use the **Save our waterways** weblink in your eBookPLUS to find out how to save our waterways from plant invasion. Research one example.

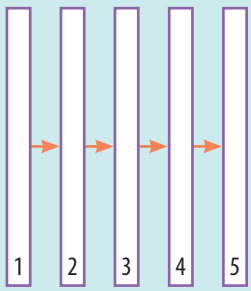






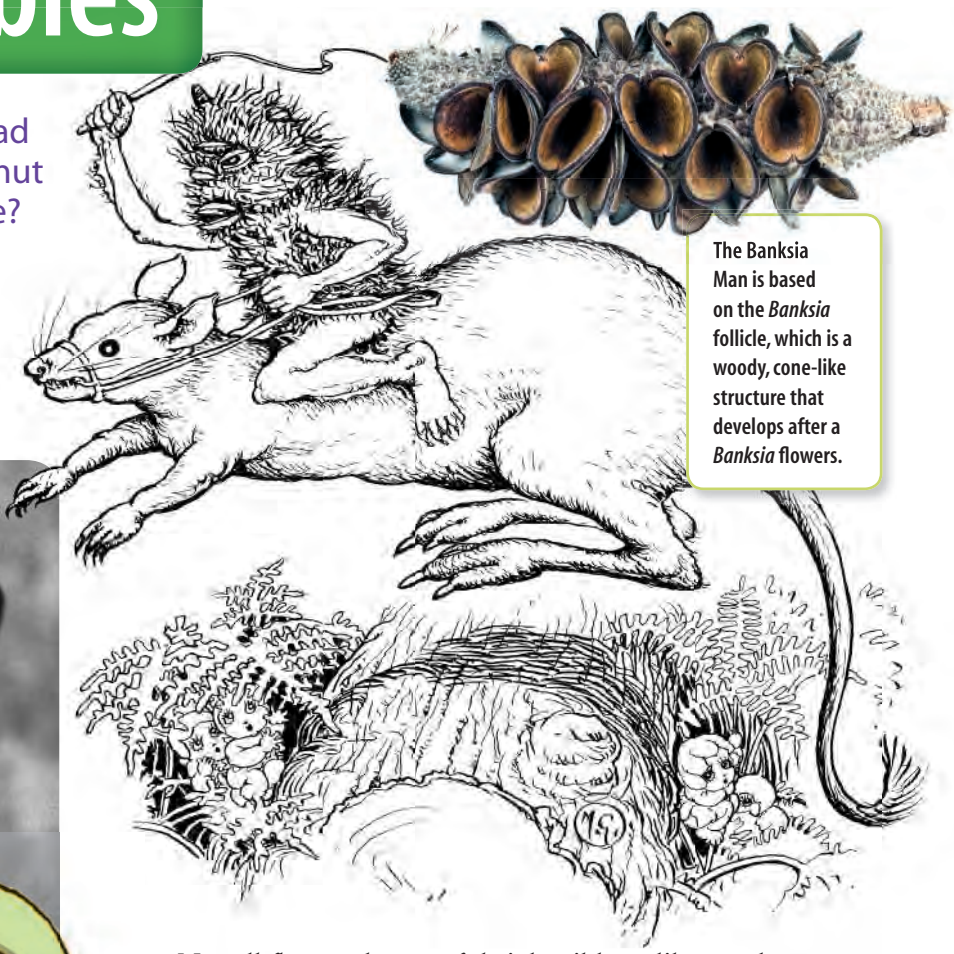






Gumnut babies

When you were young, did you read about the adventures of the Gumnut Babies, Snugglepot and Cuddlepie? They lived in the Australian bush and were constantly bothered by the Big Bad Banksia Man. Did you know they are based on real Australian plants?



The Banksia Man is based on the *Banksia* follicle, which is a woody, cone-like structure that develops after a *Banksia* flowers.

May Gibbs was the creator of Snugglepot and Cuddlepie. She was inspired by our Australian bush.

The Gumnut Babies Snugglepot and Cuddlepie

Not all flowers have soft bright ribbon-like petals. You may not even recognise the flowers of many of our native Australian plants.

The early landmass Gondwana was the centre of the origin of the family Proteaceae and it is in Australia that this family has the greatest diversity. This group includes banksias, grevilleas, hakeas, macadamias and waratahs. Many of these have roots that are very efficient at absorbing water and nutrients and they are often able to grow in soil that may be deficient in nitrogen and phosphorus.

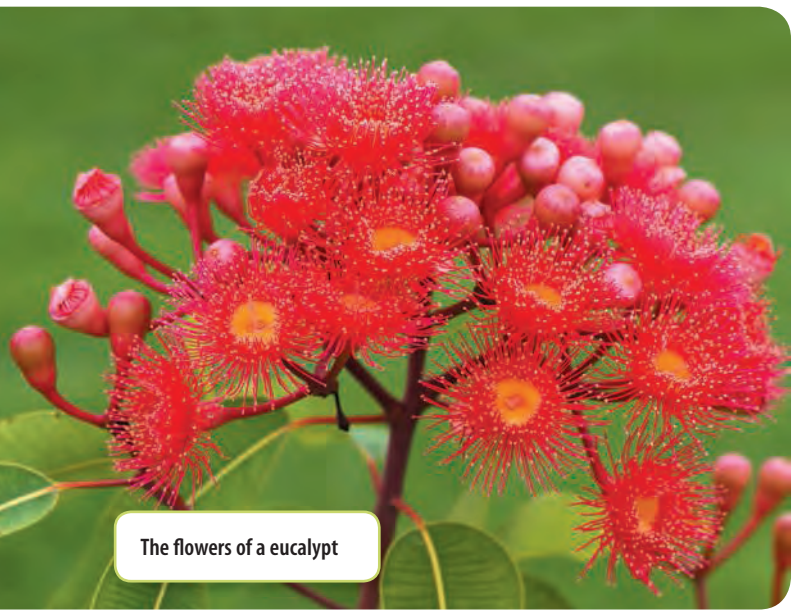
Inspiration for *Banksia*

The genus *Banksia* was named in honour of Sir Joseph Banks (1743–1820), the first European to collect *Banksia* specimens. Of the 76 species of *Banksia*, all but one is native to Australia. All members of this genus have distinctive flower clusters or spikes. Each of these spikes is made up of hundreds (sometimes thousands) of tiny individual flowers with long, stiff projecting styles. Once fertilised, the outer parts of the flower die off and

the fruit body develops into a hard, woody cone-like structure called a follicle. The seeds within these fruits are protected from foraging animals and fire. In many species, the seeds are not released until they are completely dried out or burnt.

The genus *Eucalyptus* includes gums, stringybarks, peppermints, boxes, mallees, ironbarks and ashes. Of the 800 species, all but 13 are endemic to Australia. Snugglepot and Cuddlepie, the Gumnut Babies, were inspired by the flowers of this group of plants.

A *Banksia* flower



The flowers of a eucalypt

An example of the flower structure of a *Grevillea*

An example of the flower structure of a member of the Proteaceae family

UNDERSTANDING AND INQUIRING

REMEMBER

1. List four Australian members of the Proteaceae family.
2. Recall who the *Banksia* genus is named after.
3. Describe the fruit and flowers of the *Banksia*.
4. List four Australian examples of the *Eucalyptus* genus.
5. State which type of plant Snugglepot and Cuddlepie, from May Gibbs's stories, were inspired by.

INVESTIGATE

6. Each Australian state and territory has its own floral emblem. Research:
   (a) the key features of each plant
   (b) why these plants were selected
   (c) any scientific research or interesting information.
   Present your findings in a visual, colourful and entertaining format to advertise each state or territory.
7. Find out who each of these Australian plants were named after and why they received these names.
   (a) Waratah
   (b) Proteus
   (c) Grevillea
   (d) Hakea
   (e) Banksia
8. On your own or in a team, write your own story, poem or play about our native flora.
9. Create 'Aussie flora' puppets for each of the Australian states and territories and write a script to advertise or celebrate each state.
10. Select two examples of Australian plants. Research and report on the history and importance of these plants.
11. Who was May Gibbs? Why did she include Australian plants in her stories?
12. Research a variety of Australian plants and create your own picture-book story. Have a book launch and invite friends, family and students from other year levels.
13. Investigate and report on Australian research into Australian plants.

Floral emblems of Australia

State Australian Capital Territory
Common name Royal Bluebell
Scientific name *Wahlenbergia gloriosa*

State New South Wales
Common name Waratah
Scientific name *Telopea speciosissima*

State Victoria
Common name Common Heath
Scientific name *Epacris impressa*

State Queensland
Common name Cooktown Orchid
Scientific name *Dendrobium phalaenopsis*

State South Australia
Common name Sturt's Desert Pea
Scientific name *Swainsona formosa*

State Tasmania
Common name Tasmanian Blue Gum
Scientific name *Eucalyptus globulus*

State Northern Territory
Common name Sturt's Desert Rose
Scientific name *Gossypium sturtianum*

State Western Australia
Common name Red and Green Kangaroo Paw
Scientific name *Anigozanthos manglesii*

Plants no more

Algae, fungi and lichen were once considered the most primitive plants on Earth. These organisms do not produce flowers or seeds, nor do they have roots, stems or leaves. On the basis of current information, many biologists no longer consider them plants.

While most of these organisms are harmless to humans and other animals, some are not. For example, some fungi can cause disease and blue-green algae can poison water supplies.

Algae

Characteristics:
- All live in water
- Often unicellular
- No true roots, stems, leaves or flowers
- No special tissue for transporting food or water
- Divided into groups depending on their colour
- Make their own food using photosynthesis

Examples: diatom, *Euglena*, Neptune's necklace, sea lettuce

Giant kelp (seaweed) is an alga.

Fungi

Characteristics:
- No true roots, stems, leaves or flowers
- Usually multicellular; some unicellular
- No chlorophyll and unable to make their own food
- Usually obtain their food from other living or dead organisms
- Produce enzymes which break down food outside their cells
- Broken-down food is absorbed through their cell walls

Examples: yeast, mould, mushroom, toadstool

Not all mushrooms are safe to eat! Some mushrooms and toadstools can be poisonous.

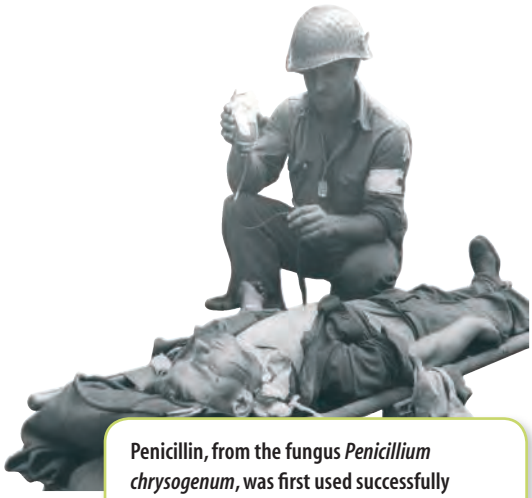
Lichens

Characteristics:
- Found on bare rocks, bark of trees, in cold polar regions and on mountain tops
- No true roots, stems, leaves or flowers
- Made up of two different organisms: an alga and a fungus
- Algal cells live among tiny fungal threads
- Algal cells photosynthesise and supply the fungus with food
- Fungus provides protection and anchorage for the algal cells
- Grow very slowly and are extremely long-lived
- Often responsible for breaking down rocks, allowing other organisms to grow

Several types of lichen may grow together.

The key below can be used to separate algae, fungi and lichens from plants.

1a	No roots, stems, leaves or flowers	Algae, fungi and lichens
1b	Distinct leaves: with or without roots or flowers	Go to 2
2a	No true roots or flowers	Bryophytes
2b	True roots: with or without flowers	Go to 3
3a	No flowers or seeds, reproduce by spores	Pteridophytes
3b	Seed-bearing plants	Go to 4
4a	Seeds in cones	Gymnosperms
4b	Seeds produced in an ovary/flower	Angiosperms



Penicillin, from the fungus *Penicillium chrysogenum*, was first used successfully in 1941 to treat an infection caused by a bacterium. This antibiotic is used to treat many formerly fatal diseases.

Better dry between your toes or you may get the fungal infection athlete's foot (*Tinea pedis*).

Mushrooms are fungi we eat; and yeasts are very important in making bread and wine.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Construct a table that summarises the characteristics of lichens, algae and fungi.

THINK

2 Construct a key to divide lichens, algae and fungi into separate groups.

3 Use your coloured thinking hats (see page 32) to describe your thinking on whether lichens, algae and fungi should be classified as plants.

4 Suggest reasons why lichens, algae and fungi were once classified as plants.

5 Which, if any, of these organisms do you think are most like plants? How?

6 If you were a biologist, would you classify any of these as plants? Why?

7 Within a group, prepare and then present a debate to the class on whether lichens, algae and fungi should be included in the plant kingdom.

INVESTIGATE

8 Look up lichens, algae and fungi in at least three different biology books and record whether they are classified as belonging to the plant kingdom or to a different group. Try to find at least one biology book published before 1980. Why have ideas about the classification of lichens, algae and fungi changed? Use your data to complete the table below.

9 Find out which features are used to classify fungi.

10 What are slime moulds? Describe their characteristics. Into which kingdom would you classify them?

11 Design an investigation, using slices of bread, to find out which conditions are best suited to growing moulds.

12 Find out more about the discovery of penicillin and the influence it has had on medicine and disease. Present your findings as a newspaper report, PowerPoint presentation, cartoon, poem or song.

13 What are the symptoms of tinea? How do you get it and how can it be prevented and treated? Present your findings in a concept map.

14 Find out the names and features of members of each of the groups algae, fungi and lichen that can be found in Australia and create new *Cryptonym* cards. Play the *Cryptonym* game (refer to Investigation 3.2 for instructions) with your new set of cards.

Reference title	Date published	Lichen grouping	Fungi grouping	Algae grouping
e.g. Text A	1983	Plant kingdom	Plant kingdom	Plant kingdom
e.g. Text B	1990	Fungi kingdom	Fungi kingdom	Protoctista kingdom

Is it alive?

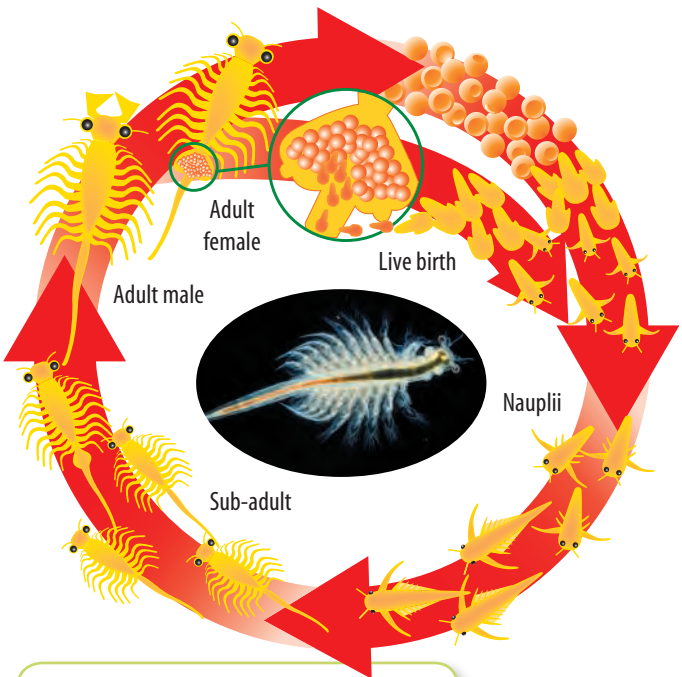
Living or not? Developments in technology are providing us with details about our world that we were previously unaware of. These new discoveries may not only lead to new types of classification systems, but may also change the way we 'see' and understand the world in which we live.

Instant life?

Just add water … and 'hey presto', you've brought sea monkeys to instant life! Are they really alive? Are they really monkeys? Can you create them just by mixing up sachets of powered ingredients and adding water?

Sea monkeys are not really monkeys … but they are alive! They are made up of cells that require nutrients and produce wastes. They belong to the animal kingdom and are classified as members of the Arthropoda phylum and Crustacea class. They are actually a type of brine shrimp belonging to the species *Artemia salina*. As they can tolerate very salty water they are naturally found in salt lakes. Their gills help them to cope with high levels of salt by absorbing and excreting ions and producing very concentrated urine from their maxillary glands.

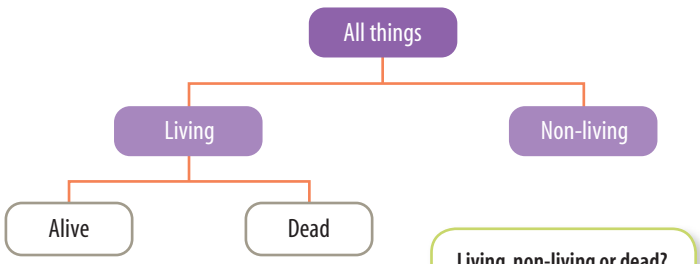
The 'magic' behind the sea monkeys appearing to become instantly alive is the process of **cryptobiosis**. This is a type of 'suspended animation' of the egg. One of the powders in the sachets sold in the sea monkey package contains *Artemia salina* eggs in their cryptobiotic stage. When these eggs come into contact with water this phase ends and they begin their next stage of development and grow into 'sea monkeys', which swim around in their watery environment.



The life cycle of the sea monkey (*Artemia salina*)

Living, non-living or dead?

So, how can you tell whether something is alive or not? There are features that all living things (or organisms) share. When living things die, we say that they are dead or no longer living. Non-living things have never been alive.



Living, non-living or dead?

HOW ABOUT THAT!

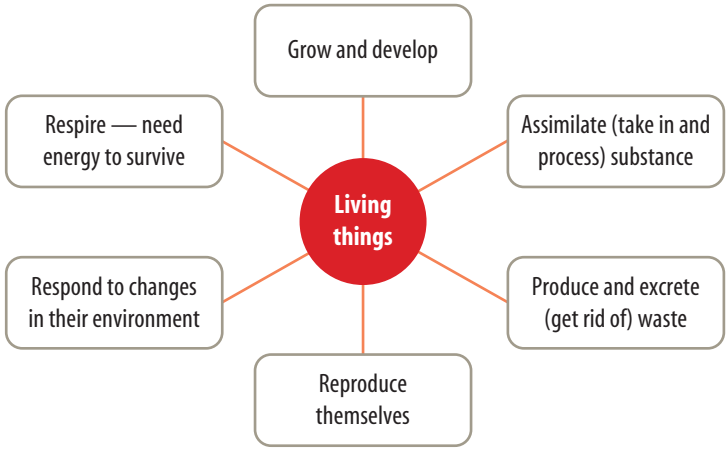
Stromatolites — look like rocks but are alive

These excellent specimens of stromatolites live in Hamelin Pool Marine Nature Reserve in Shark Bay in Western Australia. At first scientists thought they were rocks, but they are in fact layered fossil records of living algae called cyanobacteria.

Made up of cells

Cells are the building blocks that make up all living things. Organisms may be made up of one cell (**unicellular**) or many cells (**multicellular**). These cells contain small structures called organelles that have particular jobs within the cell and function together to keep the organism alive.

Cells can be divided on the basis of the presence and absence of particular organelles and other structural differences. Organisms can be classified by the different types of cells they are made up of.



Features common to all living things

WHAT DOES IT MEAN?

The prefix *uni-* comes from the Latin term meaning 'one'. The prefix *multi-* comes from the Latin term meaning 'many'.

CELL OR CELL-LESS?

Protoctistan cells and **prokaryotic** cells are both very small and are living things. The types of cells that make them up are different. If you were to view the cellular details of protoctistans such as *Amoeba*, *Euglena* and *Paramecium* under a microscope, you would notice that they were more complex in their structure than prokaryotic cells.

There are other small things on Earth that show some features of living things but not others. These are not made of cells. **Viruses**, **viroids** and **prions** are three groups that are not made up of cells, but appear to show some features of living things when they have infected the cells of living organisms.

Past its 'use by' date?

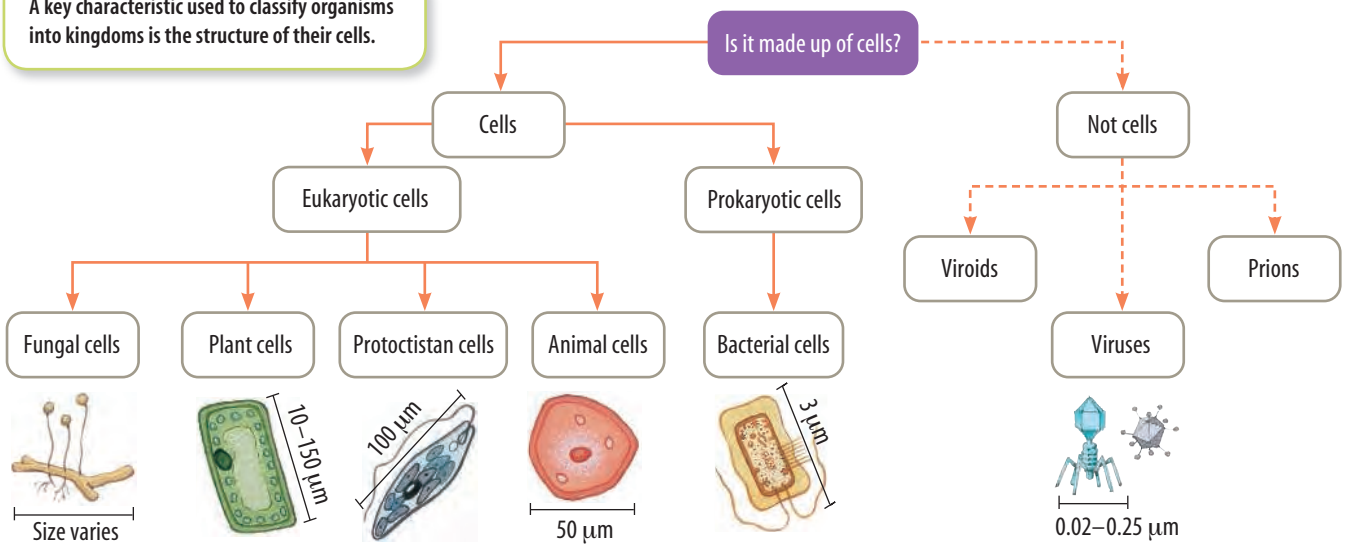
In the past an organism that caused disease was called a **pathogen**. With the discovery of these other agents of disease, the definition needs to be updated so that they can also be included.

In the future, developments of new technologies may result in our 'discovery' of pathogenic agents — it might be that they are currently in existence, but we are as yet unaware of their presence!

What definition could now be used to classify something as living or non-living? Which criteria should we use? Who should decide? When (if ever) should a scientific definition be modified? When (if ever) should classification systems change?

These are some of the questions that challenge scientists. Questions that have been created by unlocking mysteries — with the discoveries leading to the awareness of even more mysteries to be explored.

A key characteristic used to classify organisms into kingdoms is the structure of their cells.



INQUIRY: INVESTIGATION 3.6

Living, non-living or dead?

- Copy and complete the table below.

Characteristics	Robo-bilby (electronic toy) 	Bilby 	Bilby fossil 
Independent movement			
Requires oxygen			
Requires water			
Requires nutrients			
Produces and excretes wastes			
Grows as it gets older			
Responds to changes its environment			
Reproduces itself			

- Construct another table the same as the one above but replace the bilbies with:
  (a) paper
  (b) fire
  (c) a tree.
- Complete the table.

DISCUSS AND EXPLAIN

1 Identify which of the three bilbies is non-living. List the characteristics it has.

2 Identify which of the three bilbies is living. List the characteristics it has.

3 Which, of the paper, fire and tree, is non-living?

4 Does the living thing have all of the characteristics listed?

5 Which characteristics does the living thing have that the non-living thing does not?

UNDERSTANDING AND INQUIRING

REMEMBER

1 (a) State the scientific name for sea monkeys.
(b) State the phylum that sea monkeys belong to.

2 Suggest how sea monkeys can tolerate living in very salty water.

3 Define the term 'cryptobiosis'.

4 Outline the difference between living, non-living and dead.

5 Name and describe the building blocks that make up organisms.

6 Use a Venn diagram to show the relationship between viruses and bacteria.

7 Are sea monkeys living or non-living? Give reasons for your response.

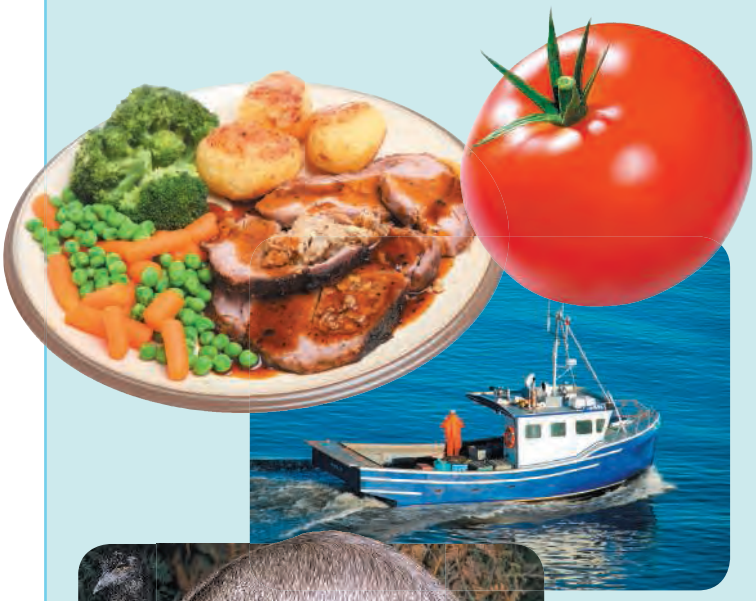
THINK AND DISCUSS

8 Virology is the study of viruses. Find out about some virology research that is currently occurring in Australia and identify a related research question that is of particular interest to you.

9 Carefully observe the items below.
(a) Construct a table to show your classification of each of the items in the drawing as either living, non-living or dead.
(b) Which of the things were difficult to classify? Why?
(c) Which characteristics of living things did the non-living or dead classified items *not* display?

Living, non-living or dead?

10 Again, carefully observe the items below. These items can be divided into a number of different groups by using different classification criteria. Using criteria other than living, non-living and dead:
(a) divide the items into four groups
(b) give each group a name and list the features that you used as criteria
(c) compare your classification groups with those of others in the class
(d) comment on similarities, differences or patterns in terms of how the items were classified.



11 When conditions are not suitable, seeds from some plants may remain dormant rather than germinate. For example, lotus seeds can germinate after being dormant for more than a century.
(a) In their dormant state, are the seeds living, non-living or dead?
(b) Use Venn diagrams to show how the seeds are:
(i) similar to viruses
(ii) different from viruses.

12 Suggest why scientific definitions of classification systems sometimes change over time.

INVESTIGATE, DISCUSS AND SHARE

13 Find out more about the history, advertising strategies and commercial success of sea monkeys. Who 'discovered' them and developed a commercial business around them? How effective was the advertising? How accurate are their claims? Construct a PMI chart, then present your information as a poster, PowerPoint presentation or newspaper article.

14 In 1972, a US patent was granted for 'hatching brine shrimp or similar crustaceans in tap water to give the appearance of instantaneous hatching'. What is a patent? What do you think about the idea of patenting living organisms? Research this patent and then share and discuss your opinions with others.

15 Research and report on a disease that is caused by a protoctistan, prokaryote, prion, virus or viroid, presenting your information in a multimedia format.

16 (a) Find out the shape of four different viruses and make stuffed toy or puppet models.
(b) Create a story or play that the viruses can act out.
(c) Design and construct any other puppets or toys that your story requires.
(d) Construct a key that can be used to identify the characters in your story.
(e) Perform your story or play to an audience.

work sheets
3.4 Animal features
3.5 The great debate
3.6 Is it alive?

Tree maps, mind maps and Venn diagrams

To show the hierarchy of ideas within a topic

why use?

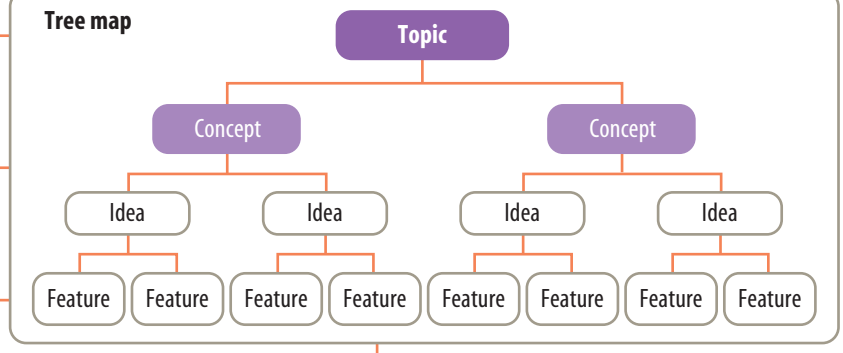
1. On small pieces of paper, write down all of the important ideas related to your topic.
2. Arrange your pieces of paper in groups related to the main ideas within the topic.
3. Within each group, arrange the ideas into their order of importance.
4. Now draw your tree map with the main ideas at the top and others below it.

how to ...?

How do parts or ideas relate to each other?

question

Tree map



also called

Branching diagram; dichotomous tree

comparison

Similarity

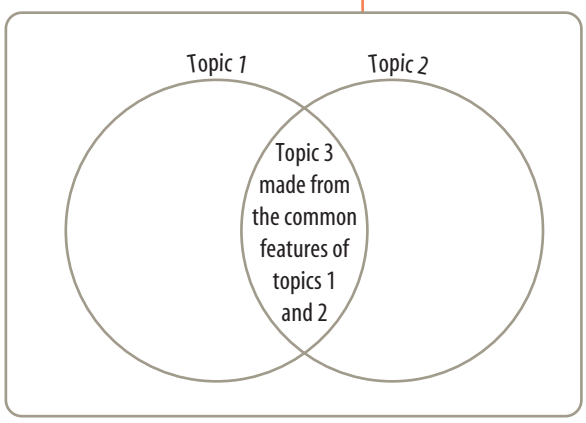
Main concepts are identified and used to divide into groups.

Difference

Venn diagrams explicitly show similarities and differences rather than showing a hierarchical division.

Venn diagram

example



comparison

Similarity

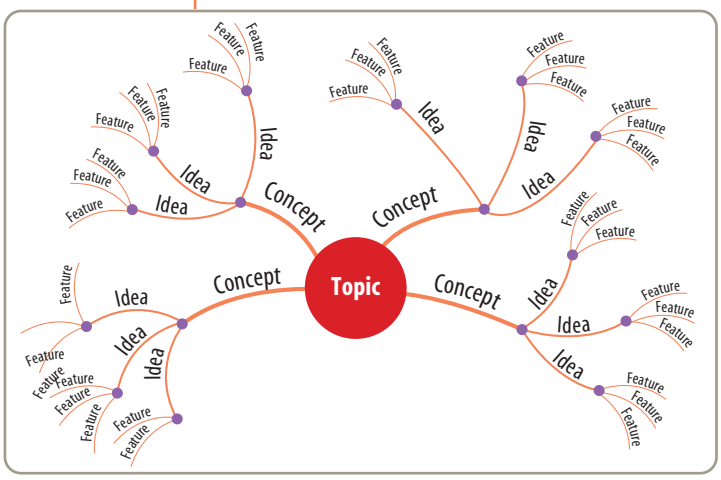
Main concepts are identified and broken down into groups.

Differences

Mind maps radiate out from centre and use 'free' lines; not all ideas are organised horizontally.

Mind map

example



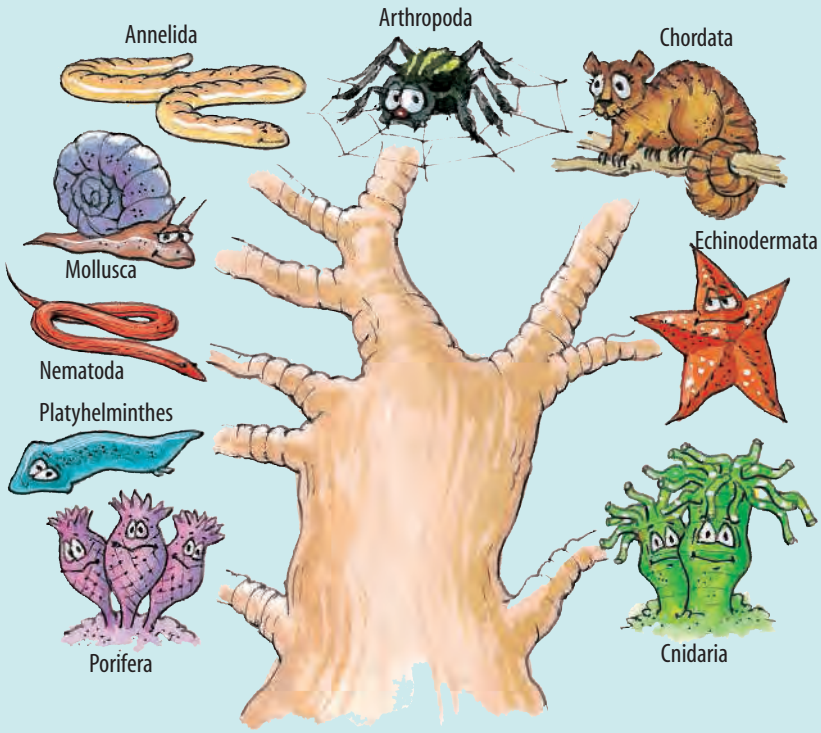
UNDERSTANDING AND INQUIRING

THINK AND CREATE

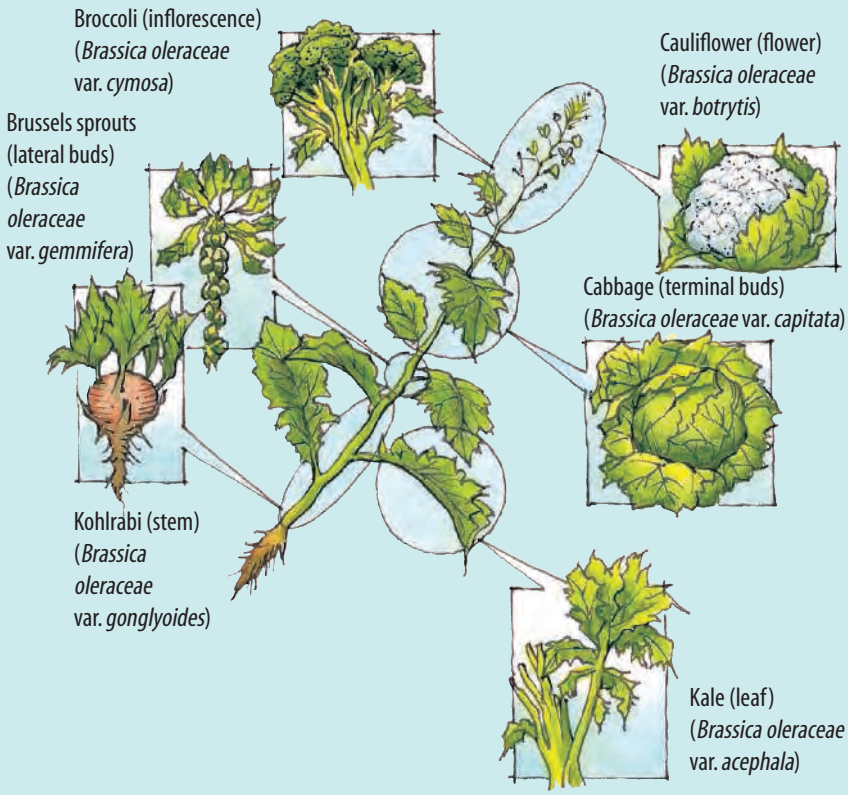
1 Carefully observe the features of animals in the animal kingdom evolutionary tree.
   (a) Construct a mind map to record as many features for each animal as you can.
   (b) Compare your mind map with those of others in the class.
   (c) Discuss similarities and differences in your mind map observations.
   (d) If you wish, modify your mind map to include new ideas from your discussions.
   (e) Based on the features recorded in your mind map, construct a tree map or a dichotomous key that would enable the identification of each animal group.

2 Carefully observe the features of vegetables in the figure below right.
   (a) State the species names for the following vegetables.
      (i) Cauliflower
      (ii) Cabbage
      (iii) Broccoli
      (iv) Brussels sprout
   (b) State the genus to which all of these vegetables belong.
   (c) Discuss with your partner your observations on the features of these vegetables.
   (d) Construct a mind map to record as many features for each vegetable as you can.
   (e) Compare your mind map with those of others in the class.
   (f) Based on the features recorded in your mind map, construct a tree map or a dichotomous key that would enable the identification of each vegetable species.
   (g) These vegetables were produced by artificial selection and share a common ancestor. Find out what artificial selection is and then research and report on the history of these vegetables.

3 Research an infectious disease, including the scientific name of the organism or agent that causes it. Present your findings in a mind map.



The animal kingdom evolutionary tree, based on genetic and structural information



All of these vegetables were produced by artificial selection and share a common ancestor. Could this have happened by natural selection also?

4 The table below provides information about some poisonous plants.
(a) Construct a dichotomous key that allows identification of each plant.
(b) Considering two plants at a time, use the information in the table to construct four different Venn diagrams.

Common name	Botanical name	Poisonous parts	Symptoms	Degree of toxicity	Type of plant
Bird of paradise 	*Caesalpinia gilliesii*	Pods, seeds	Gastroenteritis	Mild *	Shrub
White cedar 	*Melia azedarach*	Fruit (6–8 can kill small child)	Nausea, spasms	High ***	Tree
Daphne 	*Daphne odora*	All parts, especially berries	Burning sensation in mouth/stomach, vomiting, collapse	High ***	Shrub
Oleander 	*Nerium oleander*	All parts, and smoke from burning wood	Vomiting, dizziness, irregular pulse, collapse	High ***	Shrub
Poinsettia 	*Euphorbia pulcherrima*	Leaves, sap, seeds	Delirium, gastroenteritis; sap injurious to eyes and mouth	Moderate **	Shrub
Wisteria 	*Wisteria sinensis*	Seeds, pods	Gastric pain, vomiting	Mild *	Climber

* Mild symptoms may occur if a large quantity of the poisonous parts are eaten. ** Causes discomfort and irritation but is not lethal.
*** Can cause serious illness or death.

STUDY CHECKLIST

DIVERSITY OF LIVING THINGS: CLASSIFICATION

- state the difference between 'unicellular' and 'multicellular'
- explain why biologists classify living things
- describe the hierarchy of biological classification
- distinguish between the five kingdoms
- use hierarchical systems to classify organisms into groups
- define the term 'taxonomy'
- describe the binomial system of nomenclature
- use scientific conventions for naming species
- explain how structural features can be used to classify organisms into groups
- use simple taxonomic dichotomous keys to identify, sort and name organisms
- interpret and design dichotomous keys to classify organisms
- classify vertebrates based on their characteristics
- classify invertebrates into groups using a dichotomous key
- distinguish between the following groups of organisms: vertebrates and invertebrates; placental, monotreme and marsupial mammals; different classes of arthropods; different types of insects; different plant phyla; prokaryotes and protoctistans; fungi, algae and lichens; prions, viroids and viruses
- provide examples of Australia's unique flora and fauna
- suggest why biological classifications have changed over time

CURRENT ISSUES, RESEARCH AND DEVELOPMENT

- describe the patterns and history of naming organisms
- describe research and discoveries by Australian scientists in the field of taxonomy
- describe examples of collaborative transnational Antarctic scientific research
- outline issues relevant to the patenting of living organisms

INDIVIDUAL PATHWAYS

eBookplus

Activity 3.1
Classification
doc-6051

Activity 3.2
Further classification
doc-6052

Activity 3.3
Developing biological classification
doc-6053

ICT

eBookplus Summary

eLESSON

Growing plants in Australia
This video lesson is presented by a top Australian horticulturalist and provides you with tips for successfully growing plants in Australia. Watch this video as an introduction to your experiments with plants.

Searchlight ID: eles-0055

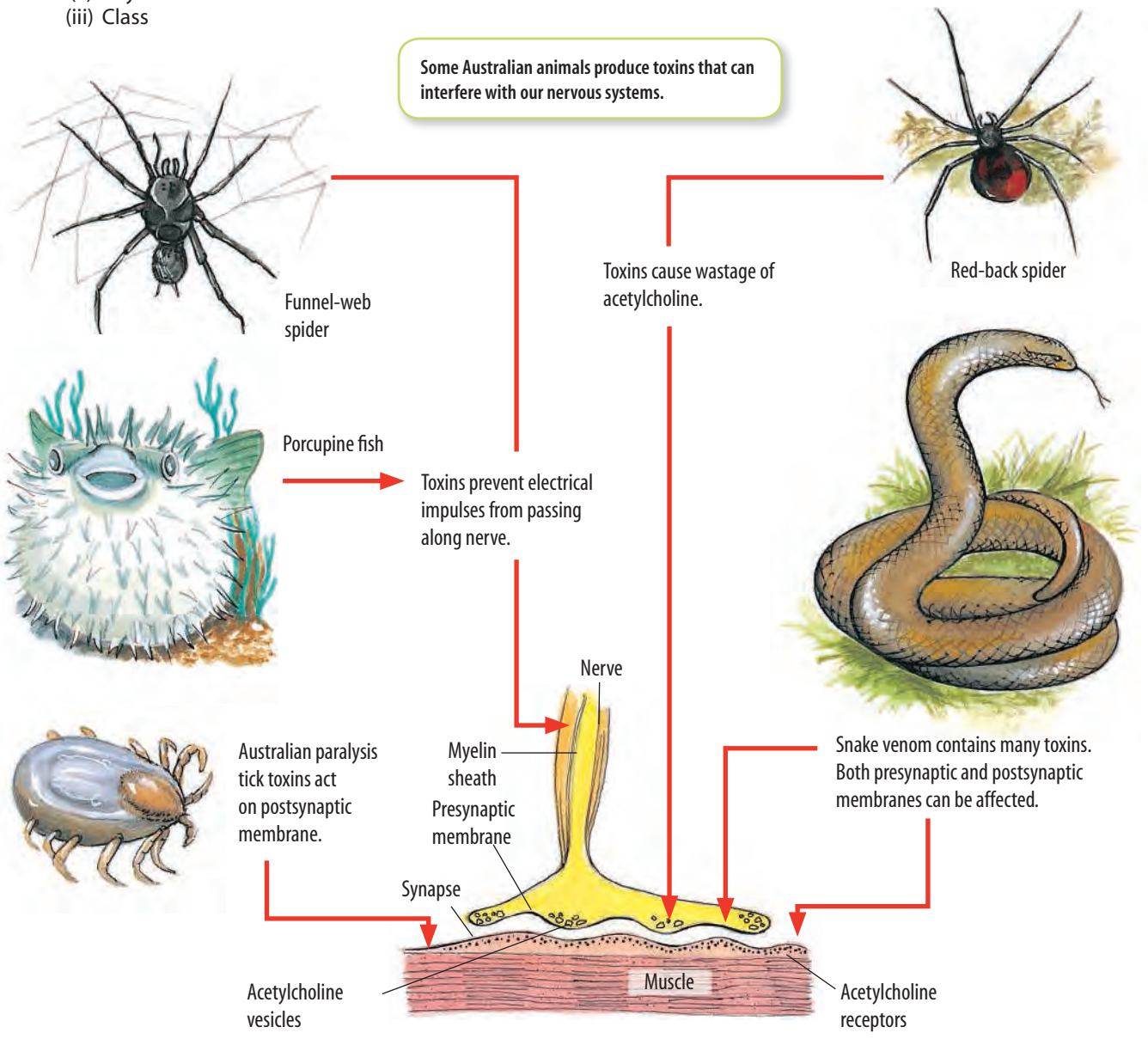
INTERACTIVITY

Time Out: 'Kingdoms'
This exciting interactivity tests your ability to classify a series of the world's living creatures into their correct kingdoms. You must answer quickly before your time runs out.

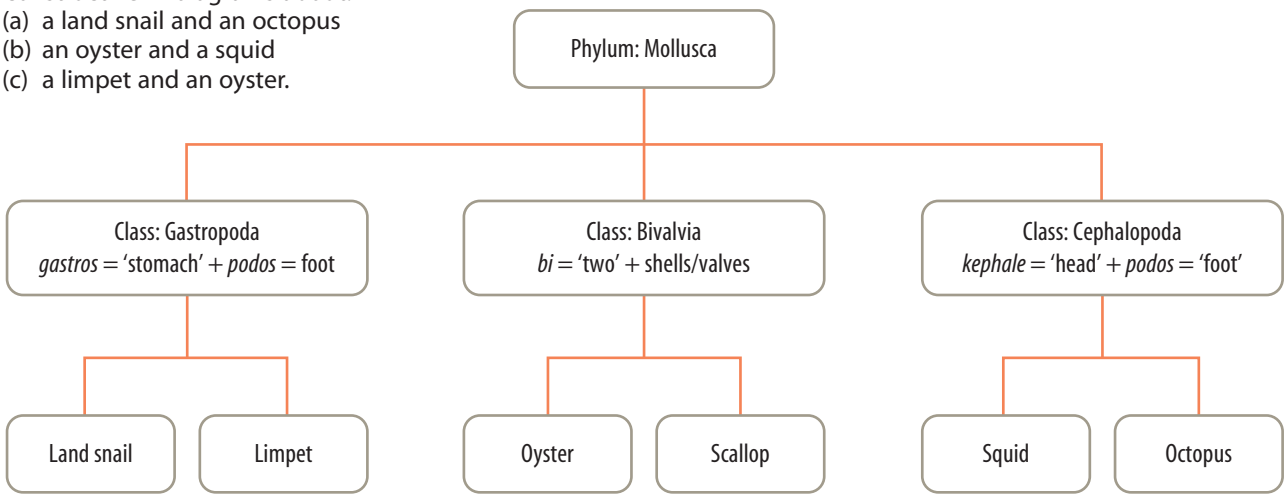
Searchlight ID: int-0204

LOOKING BACK

1 The figure below shows examples of some Australian animals.
   (a) Carefully observe and record the features of each organism. Discuss your observations with your partner and add any missing from your list. Record your observations in mind maps, tables or annotated diagrams.
   (b) Identify each of the organisms in the figure as a vertebrate or an invertebrate. Justify your responses.
   (c) Did you find any of the specimens difficult to identify? If so, suggest questions or details that would assist you in making a decision.
   (d) On your own or with a partner, construct a dichotomous key that would enable you to identify each specimen.
   (e) Use the details that you have recorded to suggest the following levels of classifications (and more if you can) for each animal.
      (i) Kingdom
      (ii) Phylum
      (iii) Class
   (f) List the types of questions that were most useful in your research for part (e).
   (g) Select one of the animals and research:
      (i) other features that could be used to identify it
      (ii) the name of a particular species that belongs to this group
      (iii) the effects of the toxin that it produces.
   Prepare a poster, brochure, PowerPoint presentation or animation that enables you to present your findings to the class.
   (h) Investigate and report on an example of research in which the Australian Venom Research Unit (AVRU) is involved.
   (i) Imagine that you are a scientist on an expedition to discover new organisms. Create a diary (including annotated diagrams of your findings). Prepare newspaper and journal articles to communicate your discoveries to the world.



2 Using your own knowledge and the information provided in the diagram below, construct Venn diagrams about:
(a) a land snail and an octopus
(b) an oyster and a squid
(c) a limpet and an oyster.



3 (a) Suggest which two of the organisms shown below are most closely related.
(b) Give a reason for your suggestion.







WARNING ON JELLY INVASION

Holly Lloyd-McDonald
Herald Sun, 12 March 2005

JELLYFISH have invaded bayside beaches, with 22 children stung yesterday.

And with a hot Labour Day long weekend ahead, emergency services and the Melbourne Aquarium have warned swimmers to be on the lookout.

Seventy-six students from Chelsea Heights Primary School were at Chelsea Beach for the end of a week-long beach awareness program when students started to complain of itching and stinging.

As the Grade 6 students were ferried back to the Wells Rd campus, 22 of them fell ill with nausea and lethargy.

Principal Danny Mulqueen said paramedics were called and the school's first aid plan was implemented, with critical and non-critical patients separated.

'Young kids were stung and sore, and others get distressed too when they see them,' Mr Mulqueen said.

Metropolitan Ambulance Service group manager Andrew Watson said three ambulances were sent but there were no serious injuries.

Melbourne aquarium aquarist David Donnelly said the culprits were blue blubber jellyfish. The jellyfish has a pale blue tinge, short stumpy tendrils and a big head, or bell.

Mr Donnelly said a 'smack' — the collective noun for jellyfish — of the species, which he numbered in their thousands, had been pushed into the bay in recent weeks by currents and huge krill production in northern Bass Strait.

A concerned bayside resident who walks his dog on Melbourne's southeastern beaches also contacted Melbourne Aquarium yesterday to report foreshores studded with dead blubbers.

'If people leave them alone they won't get stung — but it's a mild tingle and uncomfortable, and it subsides quickly,' Mr Donnelly said.

'The best thing to do is to wear stockings, although I'm not sure how men would feel about that!'

Up to six different species of stinging jellies can reside in the bay at any time, with blue blubbers likely to stay from three days to three weeks.

Mr Donnelly warned beachgoers not to touch any dead stingers because their tentacles could still pack a punch.

'My opinion is the blubber sting is low-risk with no serious adverse reactions.'

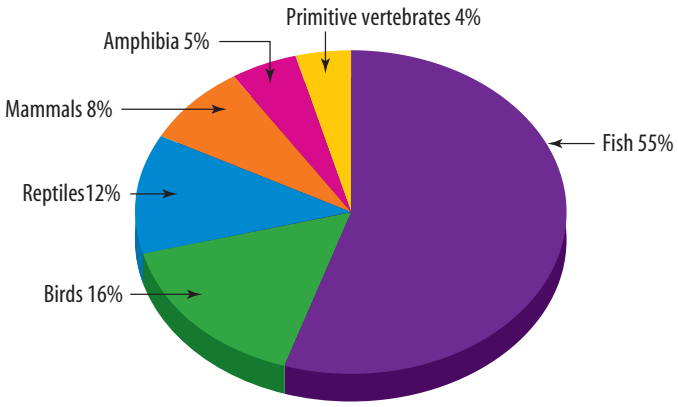
The marine expert recommended Stingose to ease the impact of the tingles, and paramedic Mr Watson recommended washing affected areas with clean water.

'Just keep an eye out and consult a doctor if the symptoms persist,' he added.

(c) The common names for these plants are: borage, pincushion flower, fennel, spearmint, primrose, coltsfoot and peppermint. With your partner, try to match the common names of these plants with their scientific names.
(d) Find out more about these plants and how they are classified into their groups.

4 Read the article 'Warning on jelly invasion' above and answer the following questions.
(a) List some of the symptoms that the students swimming in bayside beaches complained of.
(b) Name the type of jellyfish that stung the students.
(c) What does the jellyfish look like?
(d) What is the collective noun for a group of jellyfish?
(e) How many jellyfish had been pushed into the bay?
(f) What does the article suggest as the reason for increased numbers of jellyfish?
(g) How many different species of jellyfish may be found in the bay at any one time?
(h) Describe ways to prevent getting stung and how stings could be treated.

5 The pie chart on the right shows some of the different kinds of vertebrates.
(a) State which are in greatest abundance.
(b) Recall the name of:
(i) a primitive vertebrate
(ii) a fish
(iii) an amphibian
(iv) a reptile
(v) a bird
(vi) a mammal.
(c) Construct a mind, concept or tree map to show how these vertebrates are different.



work sheets 3.7 Summing up
3.8 Crossword

projectsplus

Snakes alive!

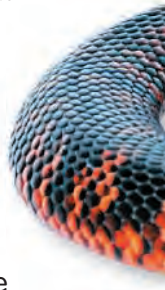
SEARCHLIGHT ID: PRO-0088

Scenario

Every year in Australia, an average of around 4000 people are bitten by snakes. Some of these snakes are non-venomous and their bite results in little more than a nasty wound, but many are venomous with a bite that is deadly unless medical intervention can be reached in time — in fact, Australia has more venomous snake species than any other country in the world! You can encounter a snake just about anywhere — on bushwalking trails, in your back garden, in a shed, even swimming in the ocean — so it is really important that you know what kind of snake you are looking at.

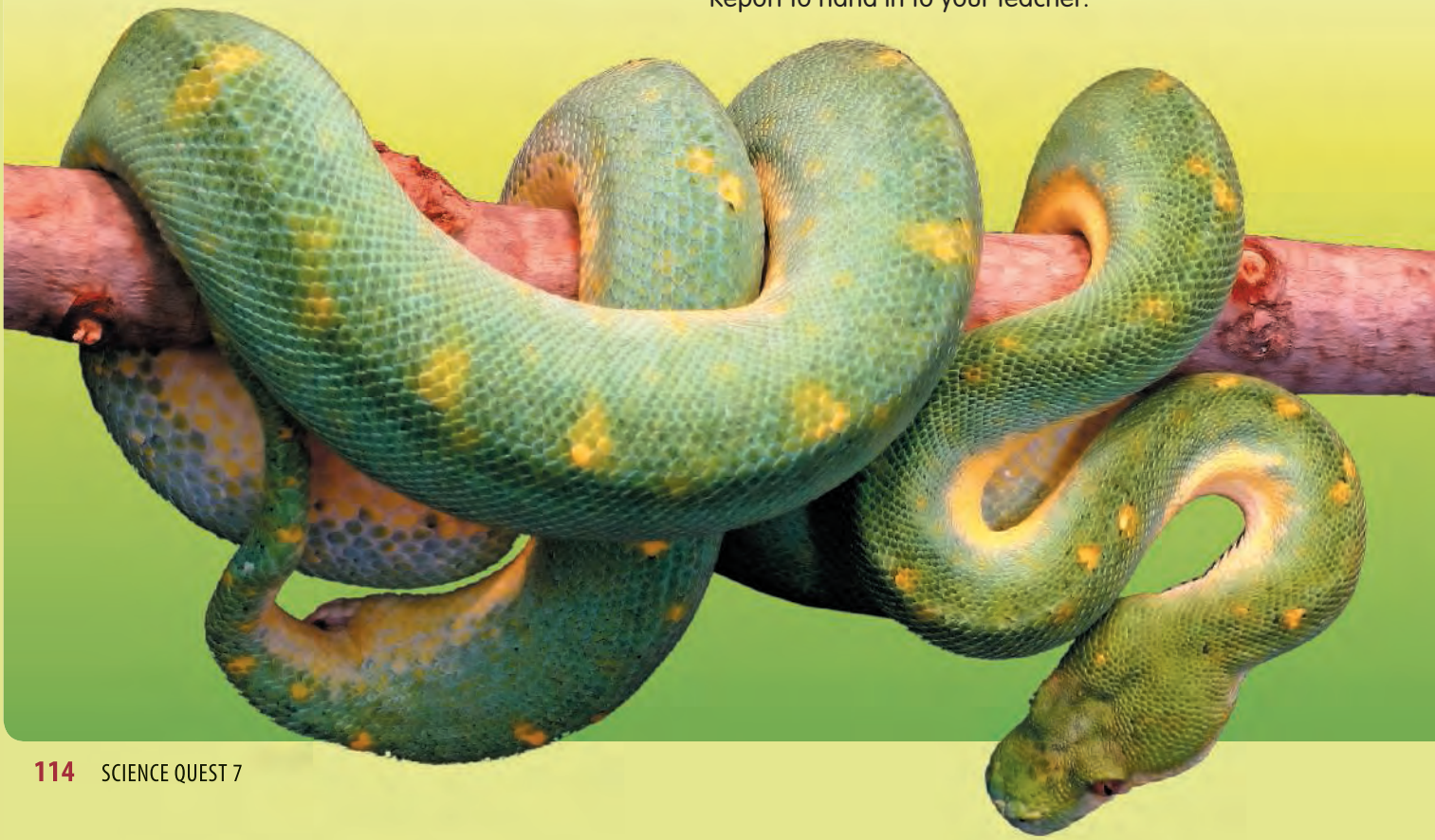
Your task

Your group has been approached by State Parks and Wildlife to create a Snake Safety brochure, copies of which will be sent out to all bushwalking clubs and National Park centres in your state for distribution to bushwalkers, campers and nature lovers. The main part of the brochure will be an easy-to-follow identification key which allows the reader to quickly and easily determine the species of snake they have encountered and so learn whether it is venomous or non-venomous. The brochure will also contain a diagram indicating on a state map where different venomous species are usually found, as well as advice on what to do if you encounter a snake and what first aid you should render if someone is bitten by a venomous or non-venomous snake. You may also like to include some interesting snake statistics, or a Snake Fact or Fiction section.



Process

- Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button to set up your project group. You can complete this project individually or invite other members of your class to form a group. Save your settings and the project will be launched.
- Navigate to your Research Forum. Here you will find a number of pre-loaded topics that you can use to start organising your research into snakes. You can also add other research topics that you think may help you in your task.
- Make notes of what you find out about the venomous and non-venomous snakes of Australia and how to deal with them. Enter your findings as articles under your topics in the Research Forum. Each person in the group should find at least three sources (other than the textbook, and at least one offline such as a book or encyclopedia) to help you discover extra information. You can view and comment on other group members' articles and rate the information that they have entered. When your research is complete, print out your Research Report to hand in to your teacher.



SUGGESTED SOFTWARE

- ProjectsPLUS
- Microsoft Publisher
- Word processing software
- Internet access

Your ProjectsPLUS application is available in this chapter's Student Resources tab inside your eBookPLUS. Visit www.jacplus.com.au to locate your digital resources.

- Visit your Media Centre and download examples of the different types of identification keys from the Images library. Determine which format you think would be best to use for the snake identification key in your brochure. When you have decided which format you would like to use, download the appropriate template to use as the basis of your own brochure from the Templates section.

MEDIA CENTRE

Your Media Centre contains:

- a brochure template
- examples of the different types of identification keys
- a selection of images
- an assessment rubric.

- Use the template to create your brochure. You may alter the format and theme of your brochure so that the information is easily located and read and to make it more eye-catching. Remember — if people don't notice it, they won't pick it up. Your Media Centre also includes images to help bring your brochure to life, as well as blank maps of the Australian states that you can use to produce your venomous snake region diagrams.
- When your brochure is finished, print it out ready for submission.