4 The living world

In this chapter you will …

Science Understanding

- group a variety of organisms on the basis of similarities and differences in particular features
- use a key to classify organisms
- consider how biological classifications have changed over time

Science Inquiry Skills

- use observations of various organisms to classify them into groups
- use appropriate laboratory equipment to observe the structural features of the same animals and plants

Based on Australian Curriculum, Assessment and Reporting Authority (ACARA) materials

Getting started

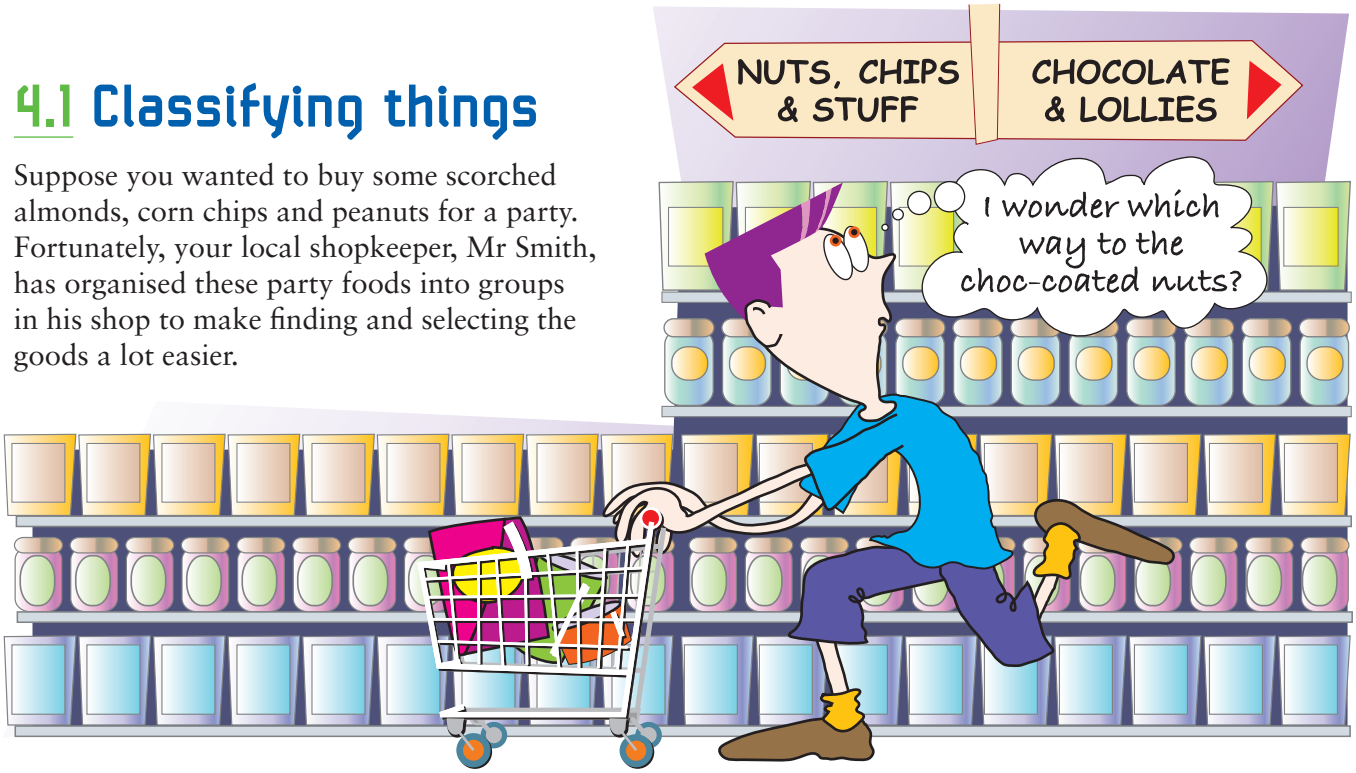
Read through this list of living things:

frog, snake, pine tree, magpie, spider, fern, worm, mosquito, dolphin, bat, horse, rose, starfish, moss, gum tree, fish, lizard, chicken, seaweed, sugar glider, platypus

- Sort the organisms into three or four groups so that the organisms in each group have similar features.
- Which features did you use to group the organisms? Compare the way you grouped them with the way other people did.

4.1 Classifying things

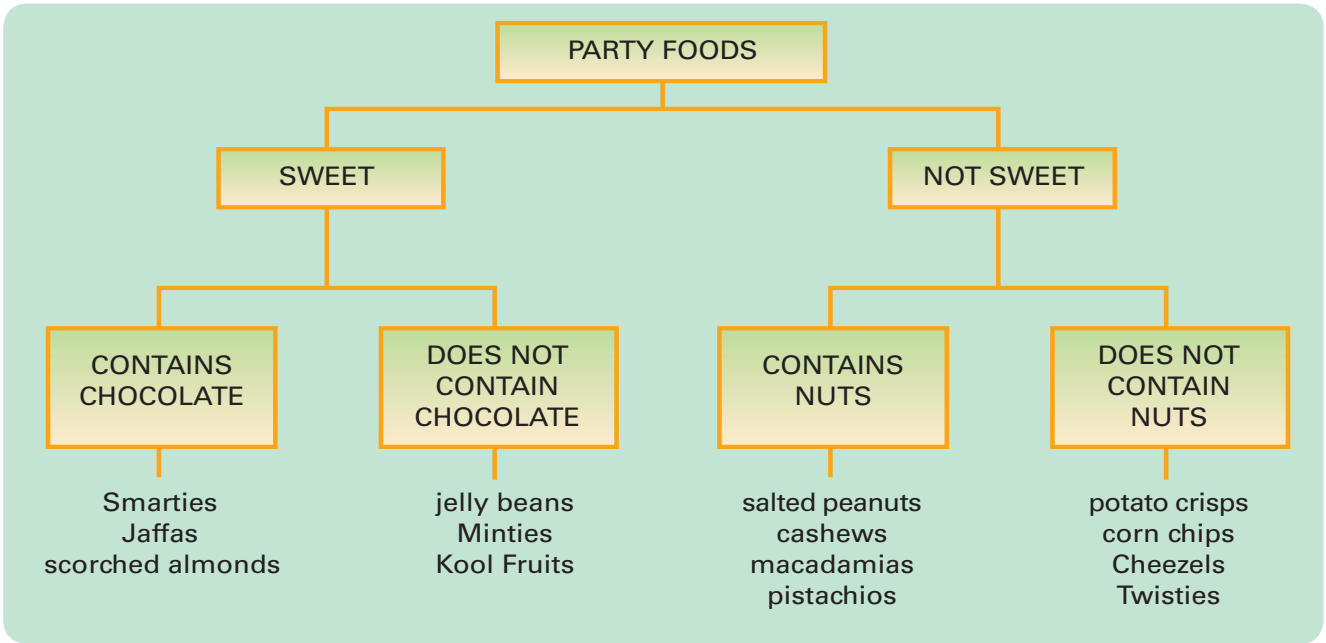
Suppose you wanted to buy some scorched almonds, corn chips and peanuts for a party. Fortunately, your local shopkeeper, Mr Smith, has organised these party foods into groups in his shop to make finding and selecting the goods a lot easier.



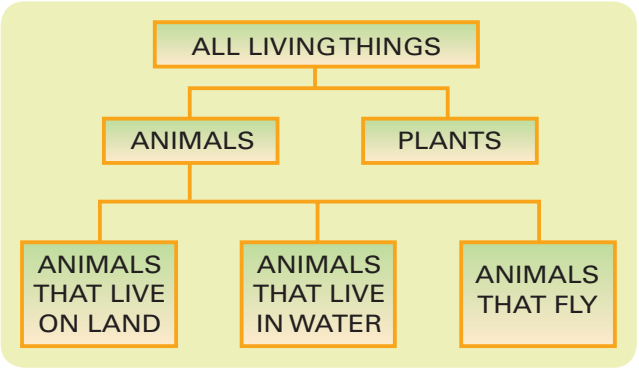
One group contains sweets that have chocolate in them—bars of plain chocolate, nut chocolate, caramel chocolate and many others. This group also contains chocolate-covered nuts and sultanas, as well as sweets that have chocolate centres, like Jaffas and Smarties.

Mr Smith uses certain *characteristics* or features of the confectionery to sort them into groups. This process is called **classification**. Each group contains items with similar features. The diagram below shows how Mr Smith classifies his party foods.

Classifying foods makes it easier to find goods in your local store or supermarket because you know that each group contains things with similar features.



Like the items in Mr Smith's shop, the living things on this planet can be classified into groups. For example, the ancient Greeks used their observations to classify living things into two large groups—animals and plants. They further classified the animal group into three smaller groups, as shown below.



Using keys

Objects can be classified using a **key**. Mr Smith used a key to classify his party foods. The Greeks used a key to classify living things. By using a key, you can easily classify objects or identify an unknown object, like the buttons in the key below. The best way to make a key is to have *two* alternatives for each characteristic. For example, in the key below, buttons are first classified into two groups—plastic and non-plastic. Each of those groups is then classified into two smaller groups, and so on.

Activity

1 Into which groups would you place the following food items using Mr Smith's method of classification.

jelly babies, Freddo Frog, Kool Mints, caramel popcorn, Burger Rings, M&Ms, butterscotch, Maltesers, jelly snakes, Mars bar, rice crackers, Crunchy bar, beer nuts, Cherry Ripe, nougat, licorice

Draw a key and add the foods to the appropriate group.

2 Use the ancient Greek method of classifying animals to place the animals in the list in **Getting started** on page 76 into their appropriate group.

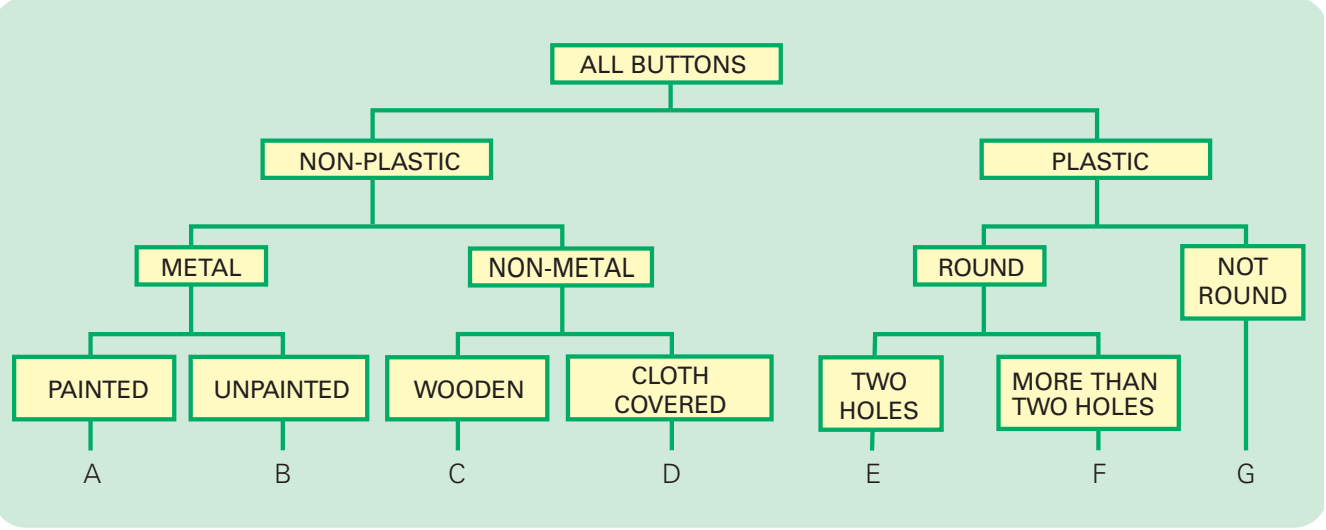
Can you see any problems with this classification method? Explain with examples.

3 Work in a small group for this activity.

Your teacher will give you 10 or 12 assorted buttons.

Use the button key below or make up your own to classify the buttons so that each button is in a separate group.

If you have made up your own key, draw it on a large piece of paper and present it to the class.



Activity

Work in a group of three or four for this activity. Your task is to make a key which you can use to classify the people in your class into a number of different groups.

1 Look for characteristics where the differences are clear-cut, permanent and likely to be agreed upon by others.

2 Make sure there are two alternatives for each characteristic. For example, male and female, or can roll your tongue and cannot roll your tongue.

Here are some other characteristics that you may find useful.

- earlobe attached/unattached
- folds arms left over right/right over left
- freckles on nose/no freckles
- second toe longer/shorter than big toe
- light-coloured hair/dark hair
- blue eyes/not blue eyes

3 Make a draft copy of the key.

Compare your key with those made by other groups.

4 Test the key by classifying the people in your class. Modify your key if necessary and test it again.

What makes things living?

In **Getting started**, you devised a way to classify about 20 living things. How do you know something is living?

Look at the rock-like things in the photo below. These thing are actually alive. They belong in the same plant group as cactuses, and lives in very dry areas of Australia and other countries. They are called a *rock plants*.

There are seven characteristics used to tell whether a thing is living or not living.

Living things

- are able to move
- need oxygen
- need food or nutrients
- produce and eliminate wastes
- grow
- respond to changes
- reproduce

Biologists (scientists who study living things) know that rock plants are alive. They have all of the seven characteristics in the list above, even though some of the characteristics, such as their movement and their response to changes, are very hard to see!

Any living thing is called an **organism**, regardless of whether it is the size of a massive blue whale that weighs 170 tonnes, or a microscopic euglena (you-GLEEN-a) that weighs only a millionth of a gram.

The euglena in the photo above consists of one cell. A **cell** is the basic unit of organisms, and all organisms are made of one or more cells. The euglena is called a *unicellular* organism, while organisms made of many cells are called *multicellular* organisms.

A blue whale is made of billions of cells that have different shapes and functions. There are skin cells, liver cells, muscle cells, and bone cells.

Classifying living things

You may have found in the activities on the previous page that there are problems in classifying animals using the ancient Greek method. For example, animals that live in water include dolphins, starfish, fish, platypuses and frogs, but these five animals have little else in common. You could also use colour or size to classify these animals. However, there is so much variation in colour and size that this method would also prove unsatisfactory.

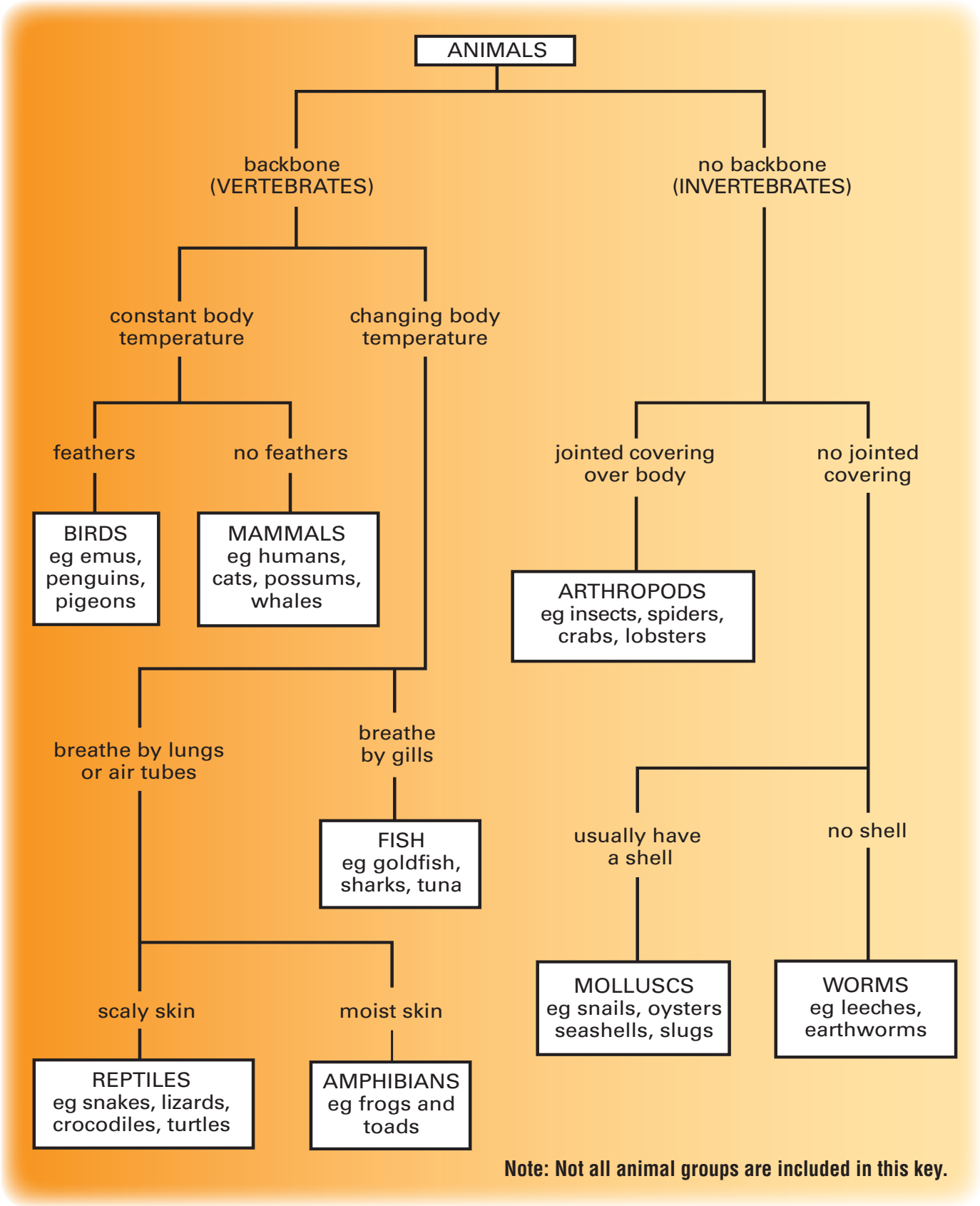
Over the last 200 years or so, biologists throughout the world have developed a better method of classifying living things. What characteristics do a dolphin, platypus, fish and frog have in common? One of these is the presence of bones, including a backbone. Animals that have backbones are called **vertebrates** (VER-te-brates). This is similar to the word *vertebra*, which is one of the bones in the backbone. Animals without backbones are commonly called **invertebrates**.

The presence of a backbone is part of an animal's *structure*. The use of structural characteristics is one way in which biologists classify organisms. The number of legs, the presence or absence of lungs or gills, feathers and a scaly skin are all structural characteristics.

The way an organism *functions* is also used to classify living things. For example, mammals and birds have a fairly constant body temperature, while all other animals have a body temperature that changes with the outside temperature. Body temperature is a functional characteristic.

The key on the next page can be used to classify animals.

Fig 1 A dolphin is a mammal and has a constant body temperature.



Note: Not all animal groups are included in this key.

Investigation 9 Animal keys

Aim

To classify animals using a key.

Materials (per class)

- at least 20 different live or preserved animals, each with a number
- hand lens (optional)

Planning and Safety Check

- Work in pairs and read through the Method. Then design a data table for at least eight animals that you have to classify.
- Many of your animals will not be alive, so you will have to research some of the functional characteristics of these animals or rely on your general knowledge of them before you can classify them fully.

Method

1 You have to classify at least eight animals. Choose one animal and work through the animal key on the previous page.
Discuss the animal's characteristics with your partner and then classify it.
Record the name or number of the animal and the group in which you have classified it.

2 Use the key to describe the animal. For example, SPECIMEN 2—REPTILE (lizard) has a backbone, changing body temperature, breathes by lungs and has a scaly skin.

3 Repeat Steps 1 and 2 for each of the other animals.
Record all your observations and descriptions. Be prepared to discuss your results with other members of the class.

Check

1 Each group below contains one item which has different characteristics from the other three. Choose the odd one out and give a reason for your choice.
- a iron, steel, copper, plastic
- b shirt, tablecloth, socks, skirt
- c pencil, felt pen, rubber, crayon
- d surfboard, skateboard, bicycle, rollerblades

2 Copy and complete the following sentences.
- a The process of sorting things into groups with similar characteristics is called _____.
- b Animals with backbones are called _____.
- c Animals are classified using _____ and _____ characteristics.
- d Living things are called _____ .
- e Living things can be classified using a diagram called a _____ .
- f There are _____ characteristics used to tell a thing is living or non-living.

3 Use the button key on page 78 to answer the following.
- a Describe all the buttons in group E.
- b Into which group would you place a painted metal button?
- c Into which group(s) would you place these two buttons?

How would you change the key to classify them?
- d Describe the differences between the buttons in groups A and D. In which ways are they similar?

4 Classify the objects in each of the lists below into two groups, and write down the characteristics you used to classify them.
- a apple, pear, capsicum, banana, tomato
- b brown snake, sea snake, turtle, tree snake, lizard, python, goanna
- c surfboard, sailboard, canoe, skateboard, dinghy, surf ski, catamaran

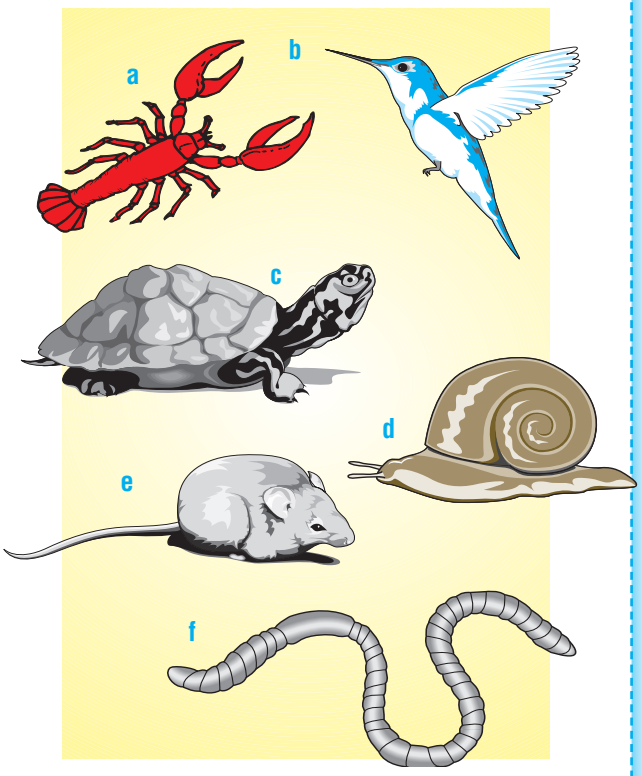
5 The list of characteristics below could be used to classify organisms.
- feeds its young with milk
- has two large eyes on the front of its head
- changes body colour and pattern with different backgrounds
- has two large canine teeth in each jaw
- squirts out black ink when disturbed
- hibernates during very cold weather

For each characteristic, decide whether it is structural or functional and make two lists. For those characteristics that you are uncertain about, list them under the heading 'uncertain'. Discuss your decisions with your partners.

6 Why do biologists use body structure and function instead of size, colour or behaviour when classifying animals?

7 List the seven characteristics used to decide whether something is living or non-living. (The order is not important.)

8 Use the key on page 81 to describe the characteristics of each of the animals below.



9 Use the animal key to name the group to which each of the following animals belong.
- **a** This animal has no backbone and has a soft body with a shell.
- **b** This animal has a backbone, a changing body temperature and gills.
- **c** This animal has a hard, jointed covering over its body and no backbone.
- **d** This animal is a vertebrate with a constant body temperature and feathers.

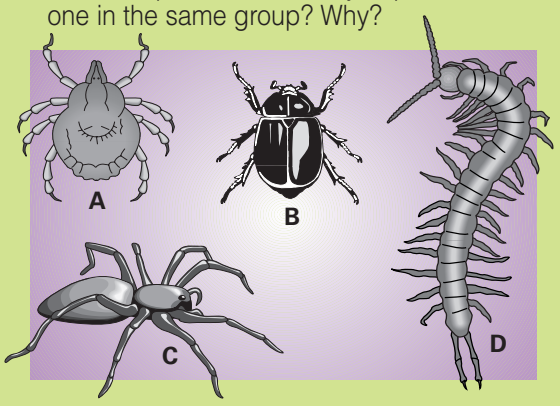
10 Write a sentence using the word 'multicellular' so that a reader will know what the word means. Give examples of multicellular organisms.

11 In which ways are birds and mammals similar? In which ways are they different?

12 How can you tell a reptile from an amphibian, and a fish from an amphibian?

Challenge

1 Look at the arthropods below.
- **a** Use the animal key on page 81 to describe the features of arthropods.
- **b** Design a key that could be used to classify the arthropods below. Did you put more than one in the same group? Why?



2 A fruit bat and a parrot are about the same size, they both have wings and fly, and both eat the same sorts of foods. Suggest why biologists classify them in different groups.

3 Not all animal groups are shown in the key on page 81. For example, the groups to which starfish and jellyfish belong are not shown. Use the library or the internet to find out the names of these two groups and the characteristics of the animals in these groups.

4.2 The five kingdoms

Until the beginning of last century, biologists classified all living things into two groups—animals and plants. These large groups are called **kingdoms**.

When bacteria (microscopic organisms) were first observed and identified, biologists did not know which kingdom to put them in because they had features that were quite different from microscopic plants and animals. Some biologists began using a three-kingdom system of classification. Bacteria were grouped with microscopic plants and animals, and these were placed in the third kingdom.

However, with the invention of very powerful microscopes and new scientific techniques, other important differences between organisms in these three kingdoms were identified. It became obvious that the three-kingdom system was not a satisfactory method of classification. Most biologists throughout the world now recognise *five* kingdoms.

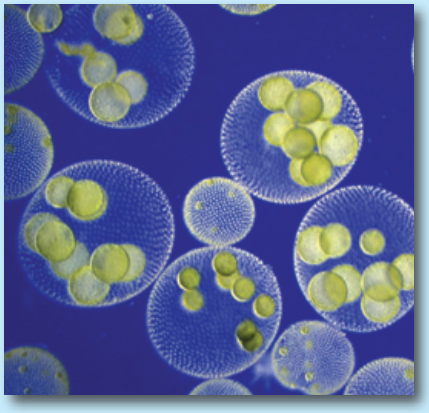
Fungi were originally placed in the plant kingdom. But fungi cannot make their own food like plants. Because of this important difference they were placed in a kingdom of their own.

The five kingdoms

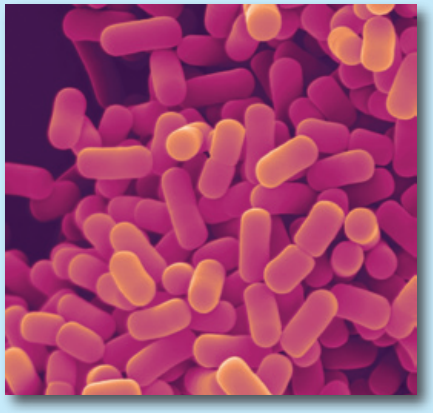
ANIMAL KINGDOM

PLANT KINGDOM

FUNGI KINGDOM
(contains moulds, mushrooms, toadstools, yeasts)



PROTIST KINGDOM
(contains algae and microscopic organisms)



MONERA KINGDOM
(contains bacteria and blue-green algae)

Animals

The organisms in the animal kingdom eat other organisms to obtain energy and materials for growth and movement. There are many different types of animals, but they are all multicellular organisms. Some live on land, others live in the sea or in fresh water, and others can fly.

All large land animals are vertebrates. The system of bones in these animals gives support and allows them to live on land successfully. The largest vertebrate that has ever lived on Earth is thought to be the blue whale. It can measure up to 35 metres in length and weigh 170 tonnes! The water of the ocean helps support its huge weight.

Plants

These multicellular organisms contain the green pigment **chlorophyll** (KLOR-oh-fill). This substance is able to absorb the energy from sunlight. The plants use this energy to make food, in the form of sugars, from carbon dioxide and water, and give off oxygen. This process is called **photosynthesis** (foe-toe-SIN-thu-sis). The word is made up from the words *photo*, meaning 'light', and *synthesis*, meaning to 'make'.

PHOTOSYNTHESIS

carbon dioxide + water —(energy)→ **sugars + oxygen**

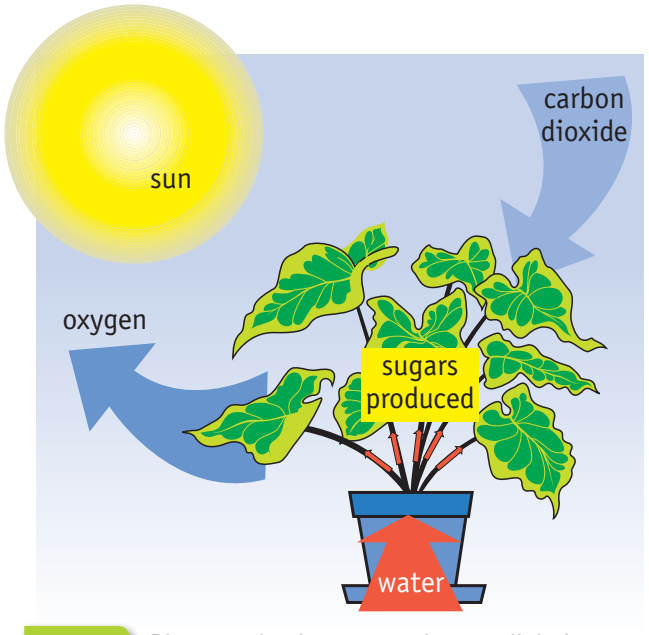


Fig 2 Photosynthesis occurs when sunlight is absorbed by the green chlorophyll in plants.

Plants cover much of the surface of the Earth. They vary in size from very small mosses a few millimetres wide to the largest living thing—the mountain ash of southern Australia, which grows to over 100 metres in height. The plant kingdom also contains the *oldest* living organism—King's Iomatia, which is found in the rainforests of Tasmania and is thought to be 43 000 years old.

The plant kingdom is divided into four groups —mosses, ferns, conifers and flowering plants.

Fig 3 King's Iomatia

Fungi

The organisms in this kingdom include mushrooms, toadstools, bread mould and yeasts. They are similar to plants in that they are generally fixed to the ground and do not move around.

Fungi do not contain chlorophyll, so they cannot make their own food. Therefore, they have to obtain nutrients from other sources. They do this by growing on things they can use as a source of nutrients, such as dead plants or animals. Chemicals released from fungi break down the remains of the plant or animal into simpler substances that can easily be absorbed by the fungi.

Fungi reproduce by **spores**. These are made in caps or bulbs that stick up from the rest of the fungus. For example, in a mushroom, the dark-coloured gills under the cap are the organs that make spores. The rest of the mushroom grows on or under the ground (see Fig 4 below).

Spores are tiny cells with a hard coat around them to stop them from drying out. They are very light and are easily carried on the wind. A single mushroom can produce up to 2000 million spores!

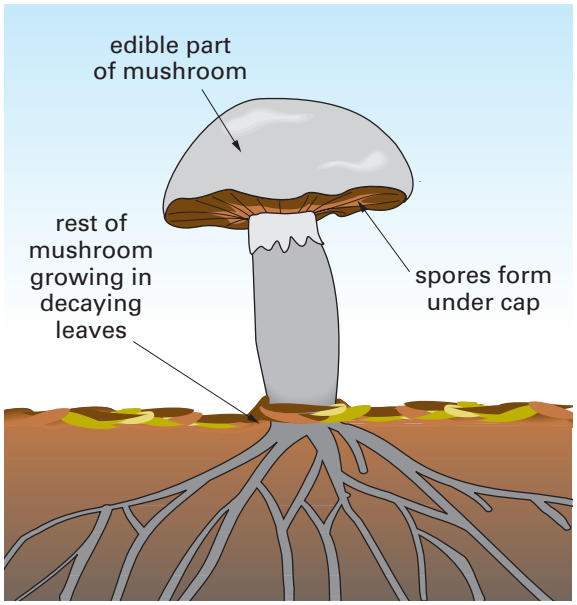


Fig 4 The edible part of a mushroom is where the spores are made. The rest of the fungus grows in the material it breaks down for food.

Helpful and harmful fungi

Fungi are very important organisms because many of them break down or decompose dead organisms. These fungi are called *decomposers*.

Fungi such as mushrooms can be eaten, and yeasts are used for making bread, beer and wines. Other fungi are used to make medicines such as antibiotics.

Some fungi grow on living things and are called *parasites*. They obtain all their nutrients for growth from the organism they grow on. For example, ringworm is a fungus that grows on human skin. It takes its food from the cells in the skin and makes the skin itchy, inflamed and sore. Powdery mildew is a fungus that grows on leaves, and it may eventually kill the plant.

Fig 5 The fungi growing on this orange will decompose it until very little remains.

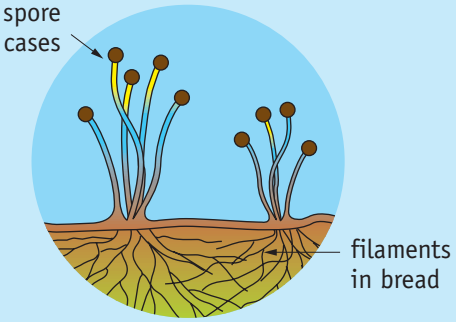
Fig 6 Powdery mildew is a parasitic fungus that grows on the leaves of some plants.

Activity

For these activities you will need a large, flat, field mushroom, some bread mould and a hand lens or microscope.

1 To grow bread mould, moisten some stale bread and leave it in an open container for a day. Then cover the container and leave it in a warm place for a few days.

Place a small piece of bread mould on a slide. Use a hand lens or microscope to observe the thread-like filaments of the mould and the round spore cases.



2 Observe the dark gills on the underside of the mushroom cap. To collect the spores, tap the cap over a piece of white paper. You may need a hand lens or microscope to observe the spores.

WEBwatch

Go to **www.OneStopScience.com.au** and access the webwatches below.

Fun facts about fungi

Interesting and easy-to-read site with information on types of fungi, examples and photos.

Fungi of Australia

A very informative site that covers types of Australian fungi; uses of fungi, including Aboriginal uses, and information about interesting examples of fungi.

OneStopScience

Protists

The **Protist** kingdom includes organisms that have a very simple structure. Most of them are unicellular and most live in water—either fresh water or sea water. Algae (singular: *alga*) are included in this group. Many types of algae are unicellular, but some, like the seaweeds you see at the beach, are multicellular.

Like plants, algae contain chlorophyll and can photosynthesise. However, algae are classified as protists because they have a much simpler structure than plants—they have no roots, stems or leaves.

Fig 7 Algae are different from plants because they do not have stems, roots or leaves.

Monerans

The organisms in the kingdom Monera (MON-er-a) have the simplest cell structure of all living things. They are all microscopic, unicellular and have a very simple cell structure. They include bacteria and blue-green algae. Organisms in this kingdom are called **monerans**. (Note: Blue-green algae are different from green algae which belong to the Protist kingdom.)

Bacteria are very important because many of them break down dead animals and plants. Some bacteria cause diseases in animals and plants; for example, tetanus and tuberculosis. Other bacteria are used to make cheese, yoghurt and antibiotics. Many of the differences between the organisms in the five kingdoms can be seen in the structure of their cells.

Fig 24 These rod-shaped bacteria, magnified 20 000 times, are found in the wastes of animals including humans.

Activity

Types of cells

All cells are held together by a structure called a cell membrane. Plant cells have a firm cell wall made from *cellulose* around the cell membrane, whereas animal cells have no cell wall. Fungi also have cellulose cell walls, but the cells do not contain chlorophyll as plant cells do.

The table below shows the characteristics of the cells in each of the five kingdoms.

Use the information in the table to design a key that can be used to classify the cells of organisms from the five kingdoms.

You observe a unicellular organism that has chlorophyll and no cellulose in its cell wall. What problems would you have in classifying it?

Animals	Plants	Fungi	Protists	Monerans
Multicellular	Multicellular	Multicellular	Mostly unicellular	Unicellular
No cell wall	Cellulose cell wall	Cellulose cell wall	Some have a cellulose cell wall	No cellulose in cell wall
No chlorophyll	Have chlorophyll	No chlorophyll	Some have chlorophyll	Some have chlorophyll

Viruses—are they alive?

Viruses are extremely small (much smaller than bacteria) and are not made of cells. Viruses have features of both living and non-living things. For example, they can form crystals like non-living matter, but they reproduce like other living things.

Viruses are completely parasitic because they rely on another organism (called the host) for all their requirements. They can reproduce only inside another organism, where they invade the organism's cells and use the cell materials to make new viruses. In this process, some of the cells are often destroyed, making the organism sick or causing its death. Human diseases caused by viruses include influenza, mumps and AIDS (HIV).

WEBwatch

To find out more about the virus that causes AIDS go to **www.OneStopScience.com.au** and follow the links to **How AIDS works.**

OneStopScience

Investigation 10 Classifying organisms

Aim

To classify various organisms into kingdoms.

Materials (per class)

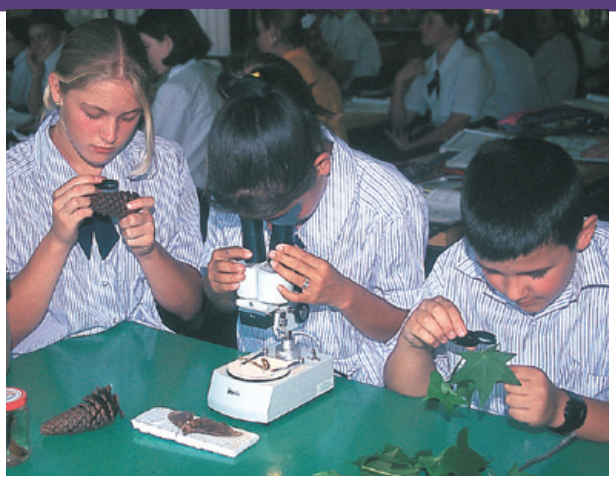
- about 20 stations around the laboratory each containing a numbered specimen or photo
- hand lenses or stereomicroscope

Planning and Safety Check

- Do not remove from its container any specimen that has been preserved in formalin. This substance is harmful to the skin and has harmful vapours.
- Read through the Method and draw up a data table for your results.
- To observe some of the specimens, you will need a hand lens or stereomicroscope.

Method

1 There will be a living or preserved organism, or a photo of one at each station. For each one, record its number and observations about its structure, size, colour and any other features that may help you classify it.



2 Observe at least 10 organisms. Then work in a group to classify the organisms into kingdoms, using the information on pages 84–88.

Discussion

1 Your group may be asked to present your results for two or three selected specimens to the class. For each specimen, give its number, its kingdom and the reasons why you placed it in this group.

2 Make a list of the kingdoms represented in this investigation and the special characteristics of the organisms in each.

Check

1 Explain what each of the following words means by writing a sentence to show its meaning. Then check your explanation with the one in the text or in the glossary.

photosynthesis	vertebrate
decomposer	parasite
kingdom	spores

2 Copy and complete the following sentences.

- **a** The green substance _____ absorbs the energy of sunlight and uses it in the process of _____.
- **b** Bacteria are classified as _____ because they have a very simple _____ structure.
- **c** Fungi do not contain _____ therefore they rely on other organisms for _____.
- **d** The kingdom Monera contains _____ and _____.
- **e** Seaweeds are a type of _____ that belong in the _____ kingdom.
- **f** Spores are very tiny _____.

3 Use the list below to match each organism to its description.

animals	fungi	algae
bacteria	protists	plants

- **a** The organisms which belong to this kingdom are mostly unicellular.
- **b** These organisms are multicellular and contain chlorophyll.
- **c** These organisms are plant-like, but do not contain chlorophyll.
- **d** These organisms are very small and have a very simple structure.
- **e** The organisms in this kingdom are multicellular and eat other organisms for food.
- **f** These organisms contain chlorophyll, but do not have the structures common to plants.

4 Fungi are often called decomposers.

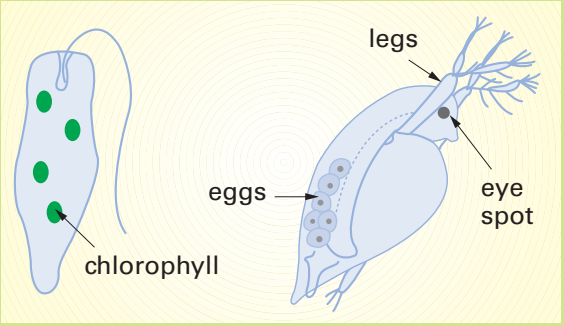
- **a** Why is this? What other organisms could also be called decomposers?
- **b** Is there a difference between a decomposer and a parasite? Explain your answer.

5 The photo below shows an organism growing on a dead tree. To which kingdom do you think this organism belongs? Give reasons for your answer.

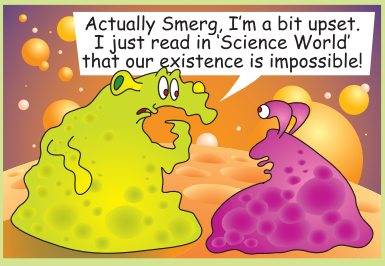
Challenge

1 Below are two organisms; one is classified as a protist and the other as an animal.

- **a** Both organisms are microscopic, but one is five times larger than the other. Which one is smaller? Suggest why.
- **b** Suggest why they are placed in two separate kingdoms.
- **c** Suggest how the protist is able to move.



2 In a science fiction story, organisms called blobs have the characteristics of protist organisms but are as large as a car or a house. Suggest why protist-like organisms could not be this size in real life.



4.3 Animals and plants

The animal and plant kingdoms contain the organisms that are most familiar to you. If you were asked to name a type of organism, it is likely you would name an animal or a plant.

The animal kingdom

On page 81, the key shows you how animals can be divided into two large groups—the vertebrates and the invertebrates. Of these, the invertebrates contain many more types of animals than the vertebrates. There are about 950 000 different types of animals on Earth. Of these, about 800 000 are arthropods!

Arthropods are invertebrate animals with a jointed body-covering that supports and protects their bodies. This covering is called an **exoskeleton** (*exo* means *out*) because it is on the outside of the arthropod's body.

Most arthropods are *insects*. Members of this group of arthropods have six legs and three distinct body segments—a head, thorax and abdomen. *Arachnids* belong to another group of arthropods that includes spiders and ticks. These animals have eight legs and only two distinct body segments. Crabs, prawns and lobsters are called *crustaceans* and breathe through gills. Most crustaceans live in water.

Fig 9 A lobster is an arthropod. Its exoskeleton supports and protects its body.

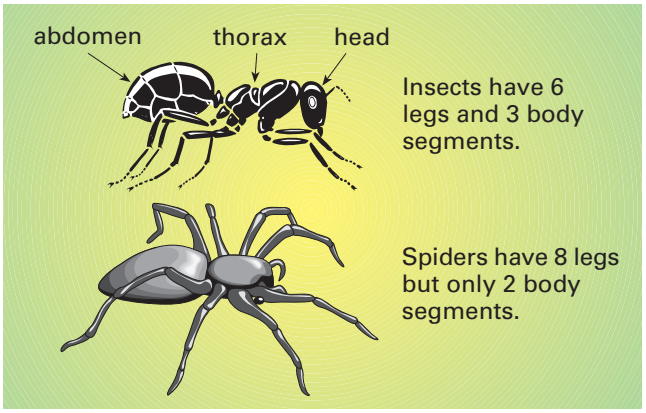


Fig 10 The differences between insects and spiders

The second largest group of animals is the **molluscs.** Most of the animals in this group have shells; for example, snails and oysters. Molluscs live in water (both sea water and fresh water) or in moist surroundings. This is because they take in oxygen through a delicate membrane underneath their shells which has to be kept moist. When conditions are dry, many molluscs can withdraw their bodies into their shells. They seal the opening and can stay like this for long periods of time until water is again available.

Some molluscs have no shell (eg slugs and octopuses) or a small internal shell (eg squid and cuttlefish).

The vertebrate animals are those with an internal skeleton or *endoskeleton*. Biologists have classified these animals into five groups. There are photos and descriptions of them on the next page.

Fig 11 Molluscs, such as these periwinkles, move by sliding over the ground on a film of mucus.

The vertebrates

Fish The animals in this group live in water and breathe the oxygen dissolved in the water through gills. Fish have a changing body temperature (they are incorrectly called cold-blooded). Most fish lay their eggs in water and the young hatch outside the mother's body. Sharks and rays are fish, but have a skeleton made from cartilage instead of bone.

Amphibians These animals have a moist skin and include frogs, toads and salamanders. Their eggs have no protective covering and are laid in water. The larvae of amphibians live in water and breathe through gills, while the adults live on land and breathe through lungs. These animals have a changing body temperature.

Mammals These animals have a constant body temperature and usually have hair or fur that keeps them warm in cold weather. They breathe air through lungs. Most mammals give birth to live young and feed them on milk. Humans are mammals.

Reptiles These animals have a dry, scaly skin and a changing body temperature. Turtles, snakes, lizards and crocodiles belong to this group. They all lay eggs with a tough, flexible covering, and all breathe air through lungs.

Birds All the animals in this group have a constant body temperature (they are warm-blooded). They have feathers and breathe air through lungs. They lay eggs with a hard outer shell.

Investigation 11 Observing animals

Aim

To observe the features of animals that belong to different groups.

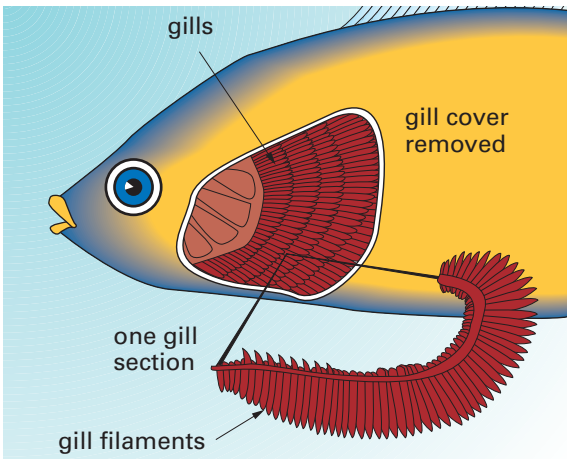
Materials

- a freshly-killed fish, preferably with gills (from the fish markets or a fish shop)
- part of a cooked crab, eg a leg or claw
- dissecting board or dish
- dissecting scissors, probe and forceps
- disposable gloves
- an insect and a spider (either freshly killed, preserved or a good photo) for Part C
- hand lens
- stereomicroscope (optional)
- glass dish, eg petri dish

PART A Observing a fish

1 Observe the outside of the fish.
Sketch the shape of the fish and label the various structures that help it live successfully in water.

2 Look inside the fish's mouth and observe the gills. Then open the gill covers on the outside behind the head.
What do you think is the function of the gill covers? Suggest why fish open and close their gill covers when they swim.



3 Use scissors to cut one gill section from the fish. Use the hand lens (or stereomicroscope) to observe the gills.

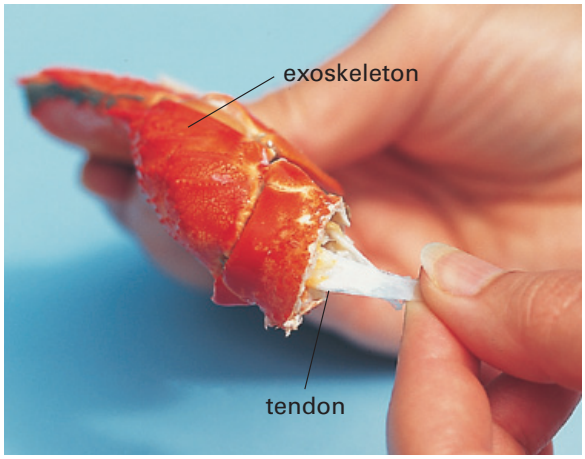
4 Place the gills in a shallow dish of water. Observe the gills again with the hand lens.
What differences do you see when the gills are in water? Suggest how this helps the fish survive.

5 Use scissors to cut the flesh away from the backbone. This flesh is the muscles that move the backbone.
Observe the flexibility of the bones and the joints in the backbone.

PART B Observing an exoskeleton

1 Use the crab leg to observe the exoskeleton (shell). Look at the joints to see how the hard pieces of exoskeleton are connected.
Sketch the crab's leg and label the hard and softer parts.

2 Break some of the shell away to expose the white or pinkish flesh. This is a muscle which moves part of the leg.
Keep breaking away the shell and remove the muscle until you find a piece of hard, shiny, white tendon. Try pulling on this tendon to move the leg.



PART C Observing other arthropods

1 Look at the insect and the spider. Compare the number of legs and the number of body segments.

2 Compare the thickness of the exoskeleton of the insect and the spider with that of the crab.

3 Use the hand lens to observe the various structures of each arthropod. If you can find a grasshopper, look along the side of its abdomen with the hand lens. You will see tiny holes through which it breathes.

Make a labelled sketch of interesting structures on each arthropod.

Discussion

1 What happens to gills in and out of water? Suggest why fish suffocate and die when they are left out of water.

2 Suggest why fish have such large muscles along their backbones. Do they have a similar bone arrangement to humans? For example, do they have ribs?

3 Suggest why the thicknesses of the exoskeletons of the crab, insect and spider are different? Would it help the insect to have a very thick exoskeleton?

4 Arthropods do not grow as large as most vertebrates. Use your knowledge of exoskeletons to suggest why this is so.

Science as a Human Endeavour

The Tasmanian tiger or thylacine (THIGH-la-scene) looks similar to modern day dogs, but is classified as a marsupial. Marsupials, like possums, koalas and wallabies, give birth to immature young which then develop further in a pouch.

The thylacine is now considered extinct. The last documented animal died in captivity in Hobart Zoo in 1936. However, many people believe that others exist in the undisturbed forests of central Tasmania.

In 1999, a project was undertaken by a team of biologists from the Australian Museum to bring the thylacine back to life just like the dinosaurs in the film *Jurassic Park*.

Cells from a preserved thylacine pup were extracted in the hope that the DNA (the substance that carried the animal's genes) could be used to produce offspring. However, the project proved too difficult and was scrapped in 2005. New technologies and techniques might be used to continue the project in the future.

The thylacine was an amazingly unique Australian marsupial. Use the website links to answer the questions below.

1 How was the thylacine similar to present-day dogs? How was it different?

2 What factors may have caused the animal's extinction on mainland Australia? In Tasmania?

3 How did they propose using the cells of the thylacine pup to produce offspring?

WEBwatch

Go to **www.OneStopScience.com.au** and access the webwatches. Click on the **thylacine** link to find out more about the history of the Tasmanian tiger (thylacine).

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The plant kingdom

This kingdom includes all the multicellular organisms that can photosynthesise and make food from carbon dioxide and water, using the energy of sunlight.

Look at the plant key below. This is another way to draw a key. Both types of keys are used by biologists when studying living things.

You can use this plant key to identify the four main groups in the plant kingdom.

Plant key

1	No stem	Mosses
	Stem	go to 2
2	Makes spores	Ferns
	Makes seeds	go to 3
3	Has flowers	Flowering plants
	No flowers	Conifers

Mosses

Mosses are the simplest plants. They have simple leaves, very simple roots and no stem.

In larger plants, water from the ground is carried up to the leaves in the stem. Because mosses have no stem, their leaves have to be close to the water on the ground. This is why most mosses grow only to a few millimetres high and live in moist places.

Mosses reproduce by spores. These tiny cells are found in spore cases that grow at the top of the plant. When the conditions are right, the spores are released. If they fall on to moist ground they will form new moss plants.

Ferns

Ferns are much larger than mosses. They have a stem as well as leaves and roots. The stem is called a *rhizome* (RYE-zome) and it grows horizontally under the surface of the soil.

The fern that you see is the leaf or *frond*. These grow up from several places along the rhizome. The new fronds are curled up, but as they grow they uncurl (see Fig 13 right).

Fig 12 Mosses are very simple plants. They are small and have a very simple leaf and root structure.

If you cut a rhizome and observe it under a microscope you will see tiny tubes. These tubes carry water and food to all parts of the fern. Because it has these tubes in the stem, roots and fronds, ferns can grow much taller than mosses. Mosses have to be close to the ground so that all parts of the plant are near a supply of water.

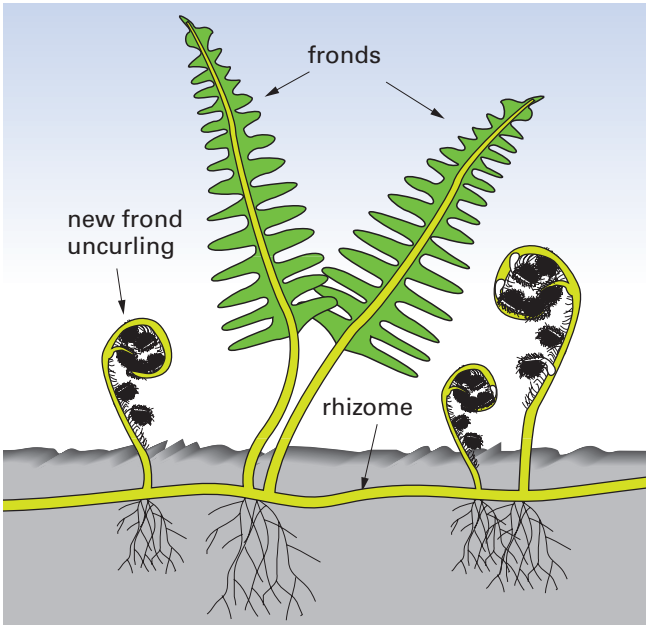

Fig 13 Fern stems or rhizomes grow horizontally under the ground.

Fig 14 Spore cases on the underside of a fern frond

Ferns, like mosses, reproduce by spores. At certain times of the year, ferns grow tiny rows of brown spots under their leaves. These brown spots are spore cases and are filled with thousands of spores. When the spores are mature, the spore cases break open, and the spores fall out and are dispersed by the wind.

Conifers

Conifers have stems, roots and leaves and reproduce by seeds instead of spores. Seeds are larger and more complex than spores. Conifers include pines and fir trees. These all have cones that contain the seeds. Male cones are small and produce pollen, while female cones are mostly large and woody and produce eggs.

Fig 15 Waterlilies are flowering plants.

Flowering plants

Flowering plants have stems, roots and leaves and reproduce by seeds. They include grasses, bushes, shrubs, most trees and even water plants such as waterlilies. The flowers produce pollen and eggs, although some types of flowering plants produce only pollen or only eggs. When the eggs are fertilised by the pollen, they develop into seeds. These seeds are contained in a fruit that may be fleshy and edible—such as in a pumpkin, apple or grape, or hard and woody as in a walnut, wattle or eucalypt.

Fig 16 The seeds of apples, watermelons, pawpaws, kiwifruit and grapefruit develop inside fleshy, edible fruit.

Plant medicines

For thousands of years, plants have been the source of medicines for illnesses and injuries.

Early Europeans scraped the bark of the willow tree and used it to ease headaches and pain. We now know that the bark contained a chemical called salicylate which chemists use to make aspirin.

Australian Aborigines had a wealth of knowledge about plant medicines. Medicines were prepared by crushing the plant and soaking it in water, often for a long time. The patient would drink it or have it rubbed on a wound. Ointments were made by mixing crushed leaves in animal fat.

Today chemists often use the active substance from a plant to make a synthetic 'copy' that is then used in modern medicines.

WEBwatch

Go to **www.OneStopScience.com.au** and access the webwatches. Click on the **Aboriginal medicines** link to find out more about plant medicines.

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Check

1 Use the list below to match the organism to its description.

mosses arthropods ferns
reptiles conifers mammals

- a These plants produce seeds in a cone.
- b The organisms in this group have a constant body temperature.
- c These organisms contain chlorophyll but do not have a stem.
- d These organisms include arachnids and crustaceans.
- e Female organisms in this group lay eggs with a tough, flexible covering.
- f These plants produce spores but have a stem and leaves.

2 How would you tell the difference between:
- a a conifer and a flowering plant?
- b a fern and a conifer?
- c a moss and a fern?

3 *Amphibians usually live close to water. In times of drought, they often burrow into moist soil. In the colder months of the year they hide in burrows or under logs and rocks.*
For each of the three sentences in the description above, suggest why amphibians show this behaviour.

4 Why are snakes and earthworms classified in different groups (see page 81)?

5 Use the key on page 95 to write a description for the plants in the photos below.

6 There are two ways of drawing keys. Use the information in the key on page 95 to draw the other type of key.

7 Whales and dolphins spend all their life in water. Why are they classified as mammals?

8 In the two polar areas on Earth where snow and ice are present all year round, some of the following animals might be seen on the icepacks—polar bears, penguins, seals and sea lions.
To which groups do these animals belong? How can they survive when other animals such as insects, reptiles and amphibians cannot?

Challenge

1 The animal key on page 81 contains three invertebrate groups—arthropods, worms and molluscs. However, there are a number of other invertebrate groups. Use the information below to redesign the invertebrate part of the animal key on page 81.

Arthropods (insects, spiders, crabs): jointed covering over body

Molluscs (snails, clams, oysters, mussels, squid, octopuses): soft body, not segmented, usually with a shell

Echinoderms (starfish, sea urchins, sea cucumbers): hard, spiny skin, all live in the sea

Flatworms and roundworms (tapeworms, liver flukes, threadworms, nematodes): long, flat or round soft body with no body segments, poorly developed gut

Segmented worms (earthworms, leeches, beach worms): long, round and soft body divided into segments, well-developed gut

2 Tan and Kif were studying mangroves—flowering plants that grow in salty water along river banks. They used the key below to identify the mangroves they observed when they were on a field trip.

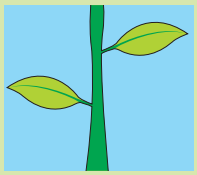
a Tan observed a mangrove that had salt crystals on its leaves, and its leaves were growing alternately on the stem. Which mangrove was Tan observing?

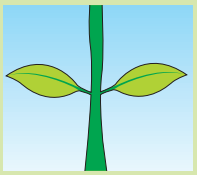
b There may be terms in the key that you have not seen before. Draw a sketch of what you think buttress roots and 'knobbly knee' roots are. Discuss your sketches with other people.

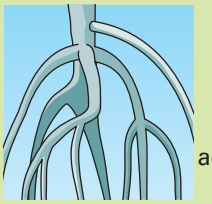
c Write a description for the yellow mangrove.

d Kif noticed a mangrove with opposite leaves and aerial prop roots. Which mangrove was he observing? What further observation would be necessary to be sure of the type of mangrove it was?

e In which way is a black mangrove different from an orange mangrove?







MAIN IDEAS

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

algae
chlorophyll
classified
conifers
decomposers
fungi
key
kingdoms
mosses
oxygen
protists
reproduce
structural
vertebrates

1 Living things can be _____ into groups by observing their similarities and differences. A good way to do this is to use a _____.

2 Biologists find _____ and functional features much more useful to classify organisms than features such as colour, shape or size.

3 The need for _____ and food, and the ability to _____ are some of the seven characteristics used to show something is living.

4 Biologists usually classify organisms into five _____: animals, plants, _____, protists and monerans.

5 Most _____ are unicellular organisms and have very simple cell structures. _____ are plant-like protists which contain chlorophyll but have no stem, roots or leaves.

6 Fungi do not contain _____ and reproduce by spores. Most fungi are _____ because they help break down the bodies of dead organisms.

7 Animals can be classified into two main groups: _____ which have bones, and invertebrates which do not.

8 The plant kingdom is divided into four main groups: _____, ferns, _____ and flowering plants.

Working with technology

Try doing the Chapter 4 crossword at www.OneStopScience.com.au.

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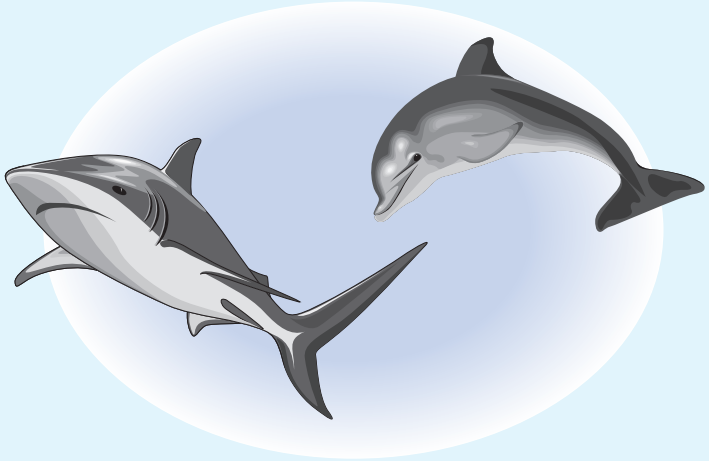
REVIEW

1 Leon catches an animal in a pond. Which characteristic would be the most useful in classifying the animal?
- **A** whether or not it has a backbone
- **B** what type of food it eats
- **C** whether it lives in a group or on its own
- **D** its colour

2 In which kingdom does this organism belong?
- **A** plant
- **B** protist
- **C** monera
- **D** fungi

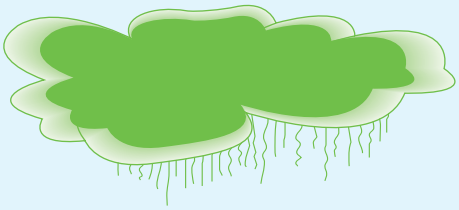
3 Zian classified the two animals in the diagram below in the same group because they both live in the ocean, have a similar shape and feed on fish. Bruno disagreed with her and said they belong in different animal groups. Who was correct and why?



4 Which characteristic can be used to tell a fern from a conifer?
- **A** where it grows
- **B** whether it has a stem or not
- **C** its colour
- **D** whether it produces seeds or spores

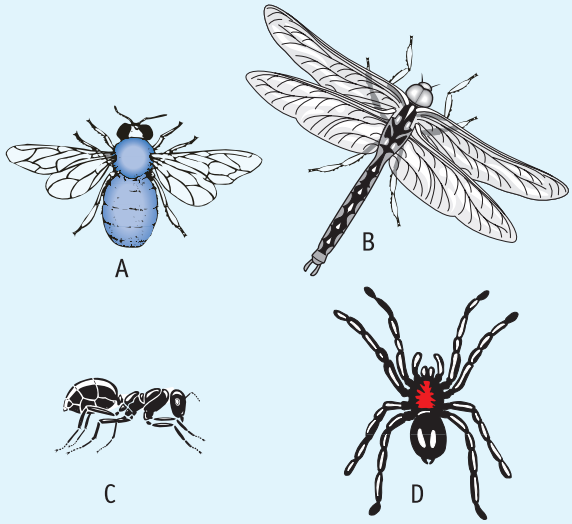
5 How can you tell the difference between a reptile and an amphibian?

6 Into which group would you put this organism? It is green in colour, has very small root-like structures, is quite small (about 10 mm across) and lives in moist places.

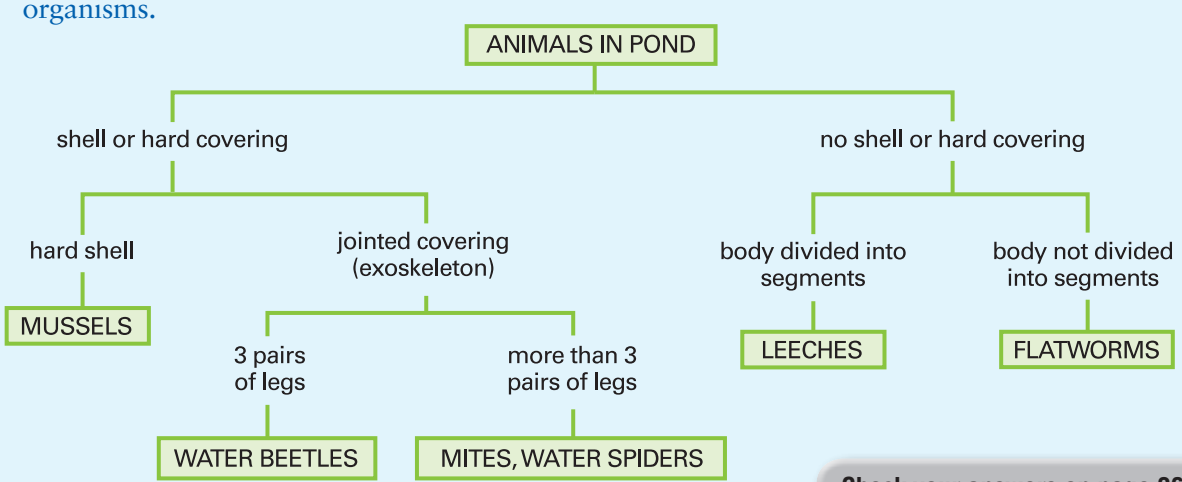


7 Which of the following statements is *incorrect*?
- **A** Turtles and lizards belong to the reptile group of the animal kingdom.
- **B** Flowering plants, conifers and ferns all produce seeds.
- **C** Mammals and birds are two groups of vertebrates which have a constant body temperature.
- **D** Bacteria and fungi are decomposers because they break down the bodies of dead organisms.

8 Look at the diagrams of the four organisms.
- **a** In which *two* ways are they similar?
- **b** How is organism D different from the others?
- **c** Make up a key that could be used to classify these four organisms.



9 The key below was used to classify some organisms in a pond.
- **a** Describe in one sentence the characteristics of mites and water spiders.
- **b** How are flatworms and leeches similar? How are they different?
- **c** You observed a frog and some fish in a pond. Why would this key be unsuitable for classifying these animals?



Check your answers on page 268.

Working with technology

Go to www.OneStopScience.com.au to access interactive activities to help you revise this chapter.

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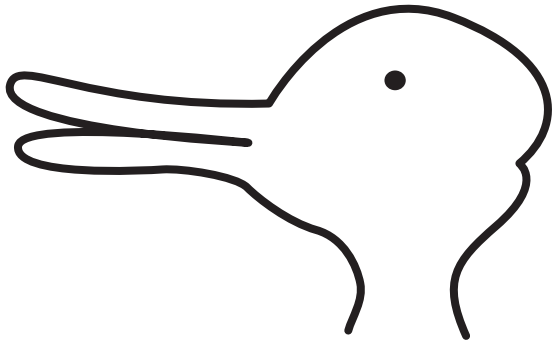
Science Inquiry Skills

Becoming a trained observer

1 Look at the sketch on the right.

- What does it look like to you?
- What do other people see in it?
- Why do you think different people see different things?

Did you see two different animals—one facing the right and one facing the left? Different people will make different observations, depending on their past experiences.



2 A medical student watches two radiologists studying a chest X-ray and discussing, in technical terms, what is wrong with the patient's lungs. The student is puzzled because all he can see in the X-ray are the shadows of the heart and ribs and a few spidery blotches between them. However, as the weeks go by and he looks at many different chest X-rays he realises that he has to forget about the ribs and try to see the lungs behind them. Once he does this, he sees so much more than he could to start with.

- Why can the student now make better observations of chest X-rays than he could to start with?

3 Look at the photo on the right. The red material on the rocks is a living thing called a lichen.

- Into which of the five kingdoms described in this chapter would you classify it? Why?

Without a good knowledge of biology your answer is probably not much more than a guess. For hundreds of years, biologists thought lichens were single organisms. However they now know that a lichen is two different organisms living together. Most of the lichen is a fungus, but it also contains unicellular algae.

- With this knowledge, how would you now classify the lichen? Explain your answer.