CHAPTER 8

# Classification


## You will discover

How living things are classified by scientists

That most animals with skeletons have them outside their bodies

That not all living things are plants or animals

Why mushrooms and toadstools are not plants

You want to borrow the latest action movie from your local video store. Where do you look? Certainly not under 'Romance' in the 'Weekly' section. You know where to start your search because the store has classified the videos. To help us organise our world we classify many things.

Scientists classify, or group, living things using their similar features. Fortunately, most scientists throughout the world use the same system for classifying living things.

Knowing how a living thing is classified helps us understand how it survives in the environment. If it is dangerous or poisonous, your life could depend on your ability to classify it.

1 Explain in your own words why videos and DVDs in a video store are classified.

2 Make a list of the features of the animal in the photograph below.

3 Explain how you know that the animal is not an insect.

4 What feature enables you to classify this particular spider as dangerous?

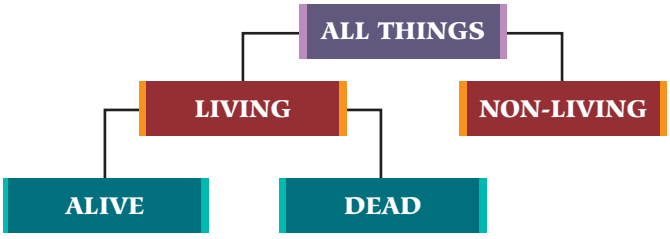
Imagine that you were bitten by this redback spider. Your life might depend on knowing how it is classified.

# It's alive!

Classification means sorting things into groups. Before sorting living things into groups we need to make sure we know what 'living' means. We can sort all things into two groups — **living** or **non-living**. The features, or characteristics, that something has tell us to which group it belongs. The 100 million or so different kinds of living things on Earth, called **organisms**, have some features in common.

## Living or non-living?

A 'living' thing is alive right now, or was alive at some time. You are a living thing. Phar Lap is a famous horse that once lived, but is now dead. Things that were never living are described as 'non-living'. Non-living things are objects such as drink cans, CD-ROMs, stones and nose studs.




Some living things are easy to classify as living or non-living. For example, it's clear that your classmates are living things. So is a family pet. So are the plants, weeds and fungi growing in your garden. The mould on stale bread and the bacteria that give you food poisoning are also living things. It's harder to see the features that show they are alive. This makes them more difficult to classify as living or non-living.

## Living things

### Need energy

*All living things that are alive need energy. Animals get their energy by eating food made up of other animals and plants. Plants use the Sun's energy to make their own food and, hence, their own energy supply. This process is called* ***photosynthesis****. Fungi such as mushrooms and mould can't make their own food but have to get their food by growing on other organisms (living or dead).*

### Need air

*All living things that are alive absorb air, use some of the oxygen and other gases in it, and release it, along with some waste gases. Many land animals breathe the air in and out through their nose and mouth. Some animals, including insects and worms, absorb and release air through their skin. Gases dissolved in water move in and out of sharks and other fish through gills. Gases in the air move in and out of plants through tiny holes in their leaves.*

### Produce waste products

*All living things that are alive produce waste. Chemical reactions take place inside organisms when they make or digest food and whenever they use energy. The waste products are the substances left over from chemical reactions inside the organism. Others are substances that are taken in but not used. Not all waste can be seen. For example, we cannot see the carbon dioxide that plants produce as waste. Other wastes are more obvious!*

### Can move

*All living things that are alive can move by themselves. They do not need to be pushed or pulled. The movement of plants is hard to see. The whole plant doesn't move, but parts of it do. The growth of stems towards the Sun, the growth of roots into the ground and the opening and closing of flowers are examples of plant movement.*

### Respond to changes in their environment

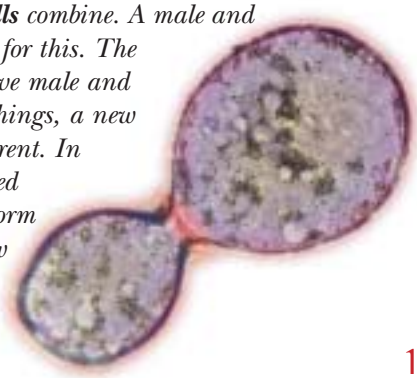
*All living things that are alive respond (or react) to things that happen to them or around them. Humans shiver if it suddenly gets colder. A dog might bark when it sees a stranger. The pores in the leaves of plants close when it gets hot to reduce water loss.*

### Grow as they age

*All living things that are alive grow. Usually this means they get bigger and sometimes change in shape as they get older. Some living things grow very quickly (e.g. a teenager having a growth spurt). Others grow much more slowly.*

### Can reproduce themselves

*All living things that are alive produce others like them. In some living things, including most animals and plants, new individuals form when two* ***cells*** *combine. A male and female cell are usually needed for this. The flowers of flowering plants have male and female parts. In some living things, a new individual forms from one parent. In bacteria and other singled-celled organisms, new individuals form when a cell splits into two new cells that are identical.*



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MI VERBAL/LINGUISTIC

## Activities

### REMEMBER

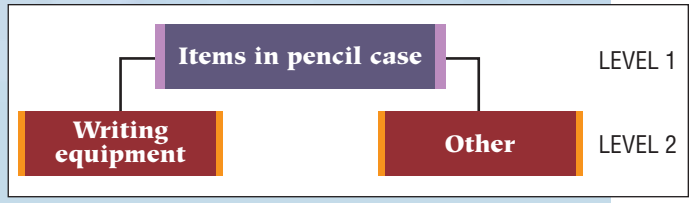
1. What is the difference between a living thing and a non-living thing?
2. List the features that all living things have.

### THINK

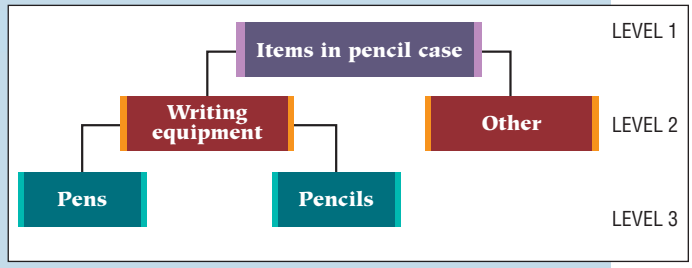
3. Non-living things often have some, but not all, of the features of living things. What features do the following non-living things share?
   (a) A hot-air balloon
   (b) Your television set

### SKILLBUILDER

4. Classify all the things in your pencil case into two groups. Group them as either 'writing equipment' or 'other'.




5. Now classify the writing equipment in your pencil case to a third level. Group them as either pens, pencils or other.




6. Find a way of going further and classifying pens, pencils or both to a fourth level.
7. Walk around your garden. List everything you see as either 'living' or 'non-living'. If some of your living items are dead, mark them with a cross.

### CREATE

8. Create a colourful collage that illustrates as many examples as you can find of one of the typical features of living things.

✓ checklist

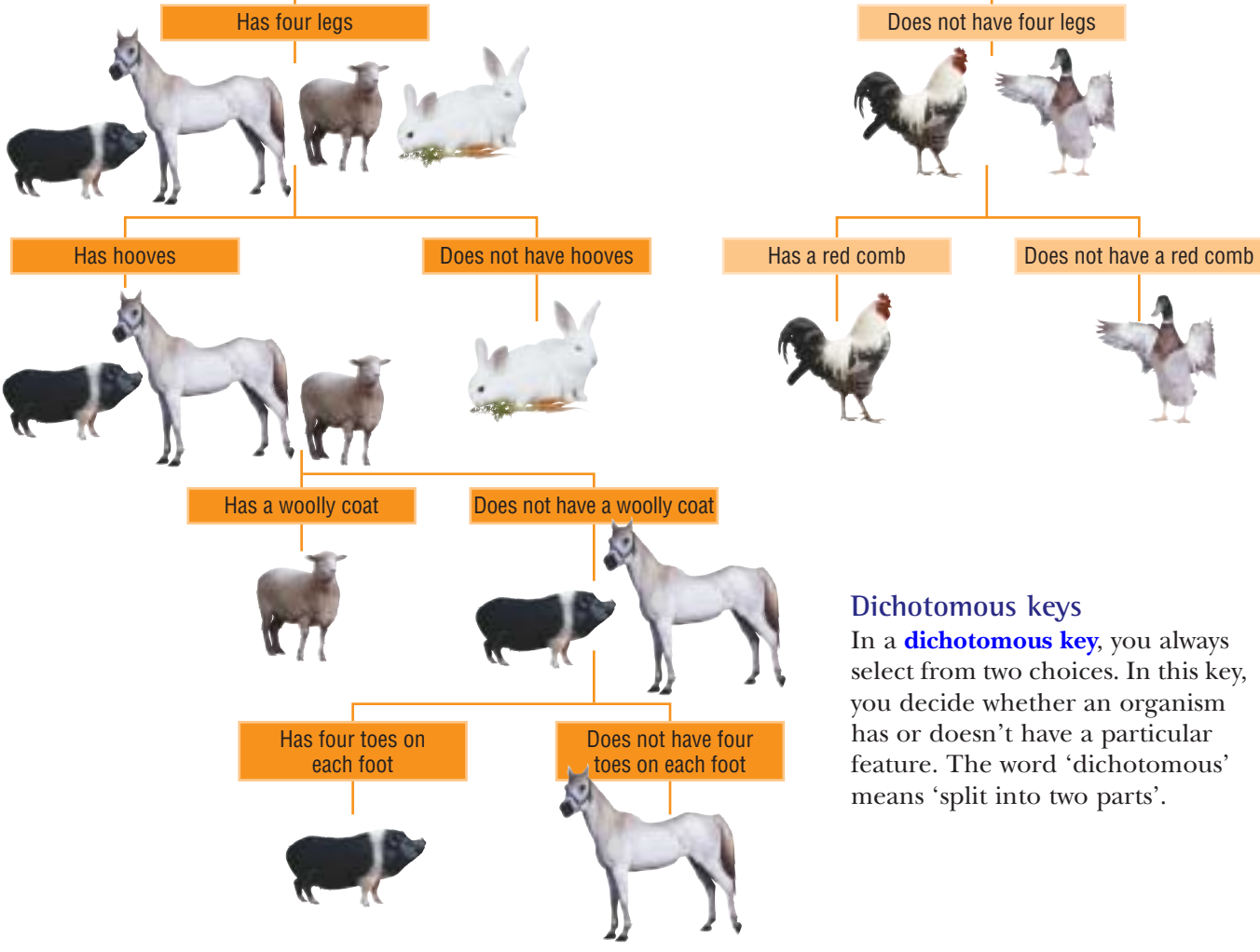
I can:

- ☐ explain why classification is helpful
- ☐ describe the difference between living and non-living things
- ☐ develop different ways of classifying the same items.

# This or that?

Think about what you do when you find a strange object. You are curious. You want to know what it is. You note its features — its size, shape, colour, feel and smell. You compare it in your mind with objects that have the same or similar features. Scientists follow a process like this one when they try to identify and classify a newly discovered **organism**. But they often use **keys** like the one below to help them.

Keys provide a simple way to classify organisms. There are many different types of key. When you want to classify an organism, you need to observe its characteristics or features. Be careful if using colour or size as characteristics. This is because these may change over time. For example, the Arctic fox changes colour from season to season; a chameleon (a type of lizard) changes colour according to its mood; and animals and plants change in size and shape during their lifetime.




## Dichotomous keys

In a **dichotomous key**, you always select from two choices. In this key, you decide whether an organism has or doesn't have a particular feature. The word 'dichotomous' means 'split into two parts'.

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## Tabular keys

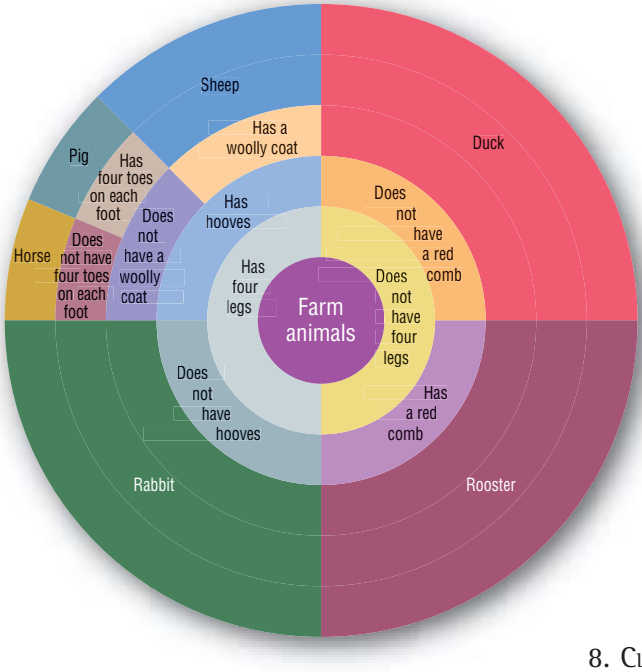
The same information about farm animals can be set out using a **tabular key**. In a tabular key, you read through the numbered items in order. Each item presents two options. As you proceed, more and more information is given until one of the animals shown below can be identified. When this happens, the animal's name is stated. If there is not enough information to identify an animal, you are told to go to another numbered item and make another choice.

**Key**

| | | |
|---|---|---|
| 1. | Has four legs | *Go to 3* |
| | Does not have four legs | *Go to 2* |
| 2. | Has a red comb | Rooster |
| | Does not have a red comb | Duck |
| 3. | Has hooves | *Go to 4* |
| | Does not have hooves | Rabbit |
| 4. | Has a woolly coat | Sheep |
| | Does not have a woolly coat | *Go to 5* |
| 5. | Has four toes on each foot | Pig |
| | Does not have four toes on each foot | Horse |

## Circular keys

Circular keys are also very useful. To read a circular key, start in the middle and work outwards. As you go, choose one of the options given at each layer. When you get to the outer layer of the circle, you will have identified the organism.




# Activities

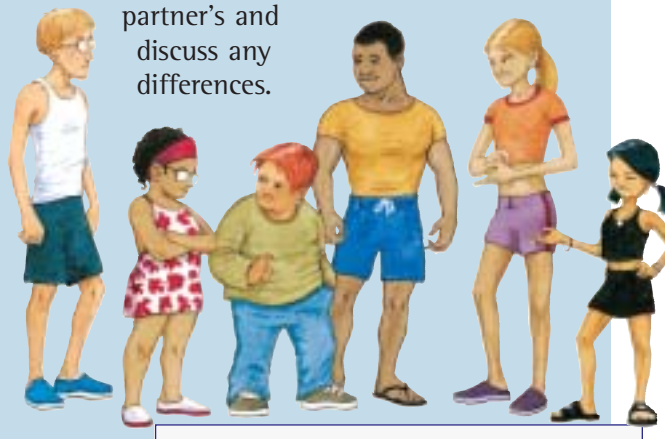
### THINK

1. Suggest why the ability to classify organisms is important in the following situations:
   (a) You have been bitten by a spider.
   (b) You are very hungry and find a bush with berries in the forest.
2. Imagine that you have landed on another planet. Weird creatures live there. You noted the characteristics of some that you saw and prepared the circular key shown below. Use it to help you classify the creature you have just found, shown here.

Alien creature


### CREATE

3. Construct a dichotomous key to classify the following people. Compare your key with a partner's and discuss any differences.



**checklist**

I can:

- ☐ explain what keys are and describe their uses
- ☐ draw a dichotomous key and a tabular key
- ☐ use a key to identify an unknown creature.

# Living kingdoms

Imagine how difficult it would be to identify one of the millions of living things in the world if people couldn't agree on one system for classifying (or grouping) them. Fortunately, there is a worldwide classification system that most scientists do agree on. It groups living things according to the structural features they have in common. Structural features include skull shape, teeth, number of legs, as well as the structure of the **cells** that make them up.

## Sorting things out

Swedish naturalist Carl von Linné (1707–1778) — also known as Linnaeus — was the first person to develop a proper system for classifying living things. It is known as the Linnaean system.

Using the Linnaean system, only two names are needed to identify an **organism** — a genus name and a **species** name (see the diagram below). This two-part name, called a scientific name, is always written in Latin. The genus name starts with a capital letter. For example, *Felis catus* is the scientific name of the organism with the common name (or everyday name) of house cat. *Musa acuminata* is the scientific name for a banana tree.

**Taxonomists** are scientists who decide how organisms are classified. They divide **living** things up into smaller and smaller groups based on their common features or characteristics. The smaller the group, the more features its members have in common. For example, members of the same family will have more features in common than members of the same class. Members of a species have more in common than members of a genus.


* 'Phylum' for Kingdom Animalia
** 'Division' for Kingdom Plantae

How living things are classified, using the Linnaean system

When members of the same species mate, they are able to produce **fertile** young. This is possible even though the individuals are not identical. For example, not all domestic cats (*Felis catus*) have the same colour, type of fur or ear shape. But all cats can mate with each other to produce fertile young. In the same way, not all banana trees look the same size and shape but they are still one species. They can reproduce to give more banana plants, which can then reproduce and give more banana plants and so on.

If members of different species mate, their offspring will not be fertile.


The five kingdoms into which organisms are classified

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## The five kingdoms

Most scientists today accept that there are five different kingdoms: Animalia, Plantae, Monera, Protoctista and Fungi.

Animalia includes worms, snails, fish, frogs, insects, reptiles, birds and mammals (such as dogs, camels and humans). They are complex organisms made up of many, often millions, of cells. They obtain food by eating or absorbing other living (alive or dead) things.

Plantae includes mosses, grasses, flowering plants, shrubs and trees. They are made up of many cells that contain **chlorophyll**. Chlorophyll allows plants to use the energy of sunlight to make their own food from carbon dioxide and water. Oxygen is released as a waste product. This food-making process is called **photosynthesis**.

Fungi includes mushrooms, toadstools, moulds, mildew and **yeasts**. They are usually made up of many cells, but may be only one. Unlike plants, they have no true leaves, flowers, stems — or chlorophyll. They obtain their food by growing on other organisms (alive or dead).

Protoctista includes green **algae** (from single-celled **diatoms** to multi-celled organisms such as **kelp**) and the single-celled **amoeba**. Although they may have some of the features of plants or animals, they cannot be classified as either of these. They mostly live in water.

Monera includes bacteria and **cyanobacteria**. They are the simplest organisms on Earth, being made up of one cell. Most get their food from other organisms such as dead animals and plants. Some bacteria cause disease; other bacteria are used to make foods such as yoghurt.


### Activities

**REMEMBER**

1. List each of the five kingdoms and give two examples of each.
2. Although they are not identical to each other, what ability do members of the same species have?
3. Explain the difference between a common name and a scientific name.

**THINK**

4. Describe one way in which members of Kingdom Fungi are different from members of Kingdom Plantae.
5. To which kingdom do each of the following organisms belong: lizard, *E. coli* bacteria, brown seaweed, toadstool, moss.
6. The red kangaroo (*Macropus rufus*) and the grey kangaroo (*Macropus giganteus*) are members of the same genus. Can they breed with each other to produce fertile young? Give a reason for your answer.

**CONNECT**

7. Search the Internet to find more information (including pictures) about each of the five kingdoms. Use this information to create your own 'kingdom wheel' similar to that shown on the left. Use an A3 sheet of paper.

✓ checklist

I can:

- ☐ explain why Linneaus is famous
- ☐ show in a diagram how an organism is classified
- ☐ explain how organisms are classified into five kingdoms.

# The animal kingdom

How many different **species** of animal can you think of? Not even scientists know how many there are on Earth. Over one million animal species have been classified so far, but hundreds of new species are being discovered every year. The task of classifying newly discovered animals begins with carefully observing their body characteristics.

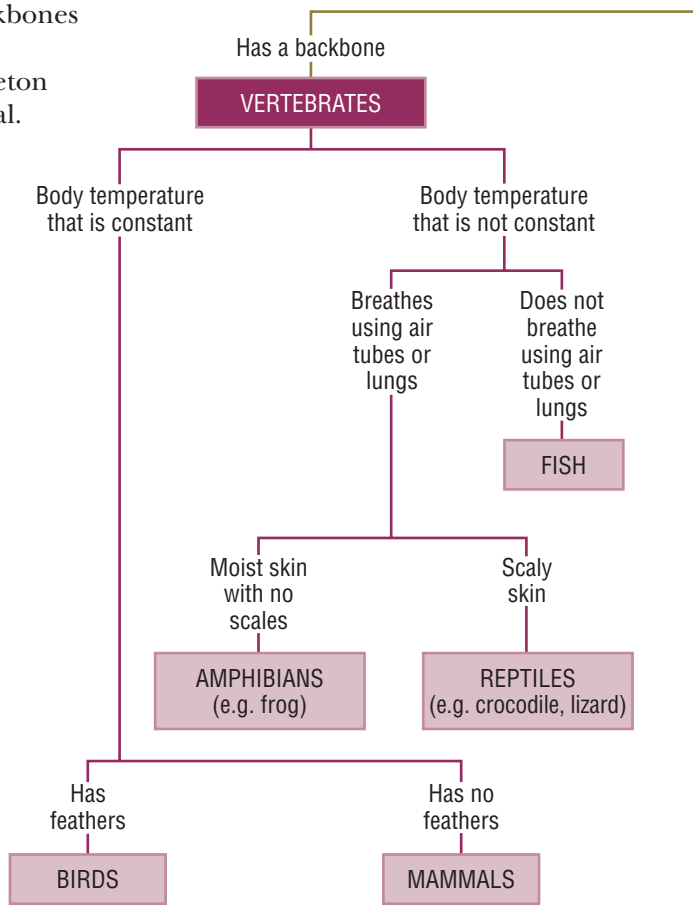
There is a huge variety of animals on Earth. They range from the massive blue whale (about 24 m long and 100 000 kg in weight) down to creatures that that are so small that we need a microscope to see them. Animals hop, swim, fly, walk and slide through their environments. Some live all their lives in water; others live in the soil, on icy slopes or in tree tops. Each type of animal has characteristics that best suit the environment in which it lives.

## Vertebrates

There are many ways in which the massive animal kingdom could be broken down into smaller groups of animals that are more alike. Most scientists today start grouping them by whether or not they have a backbone. Animals with backbones are called **vertebrates**. The backbone is part of the skeleton inside the body of the animal. The scientific name for the vertebrates is Phylum Chordata.

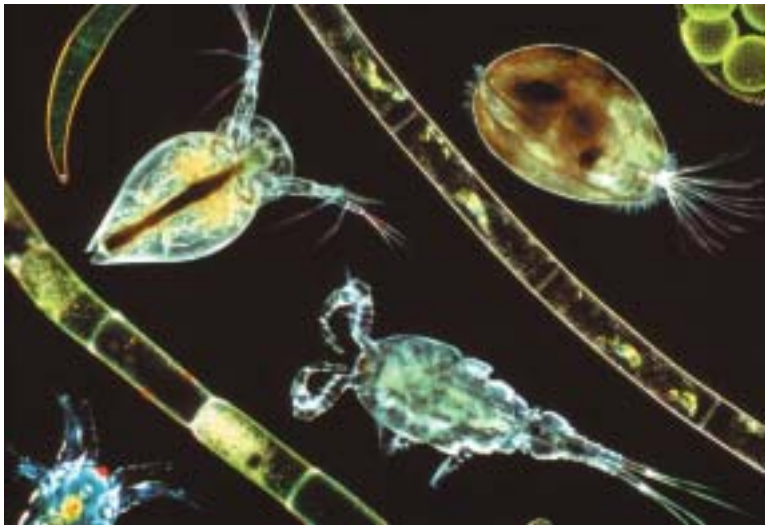
## Invertebrates

Animals without a backbone are called **invertebrates**. These animals may have an external skeleton (called an **exoskeleton**), or no skeleton at all. An exoskeleton may be a shell or a hard, jointed covering that encloses the body. A growing animal with an exoskeleton sheds it from time to time. It is then replaced by a larger exoskeleton. This shedding is necessary because an exoskeleton does not grow like the bones in our skeleton do.




Dichotomous key showing how the main groups of animals are classified


The largest animal on Earth, the blue whale, feeds on some of the smallest animals on Earth. In the summer feeding season an average-sized blue whale feeds on up to 4 tonnes of tiny animals like those shown below every day.



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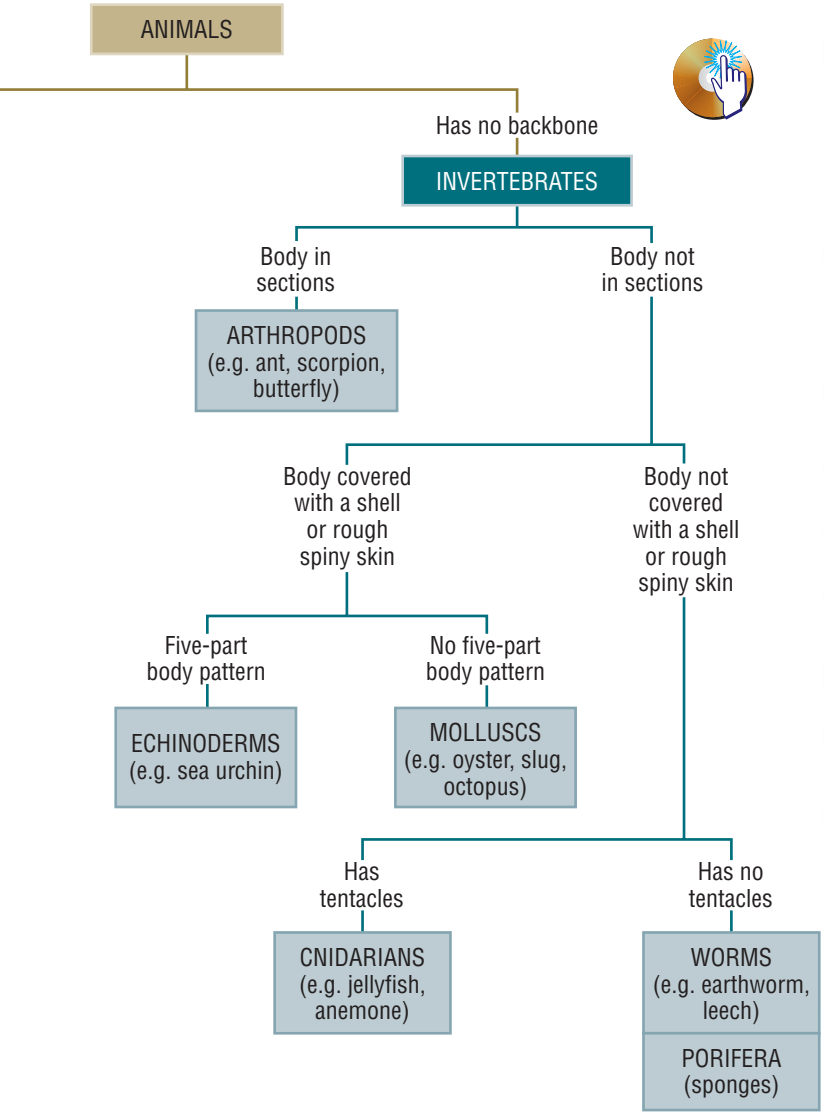
Three-quarters of all animal species have an exoskeleton. Most of these are **arthropods** (e.g. insects, spiders). Animals with exoskeletons are usually not as flexible as those with skeletons inside the body. Exoskeletons prevent an animal from bending and twisting easily because the muscles are attached to the inside of the hard skeleton. The muscles of animals with an internal skeleton are attached outside the skeleton and can pull on parts of the skeleton to move it in many directions.

Some animals with no skeleton at all have strong muscles (e.g. worms, jellyfish). Their muscles contract (get shorter) and stretch to allow their bodies to move through their environment.




## Activities

### REMEMBER

1. Describe the difference between vertebrates and invertebrates.
2. What is an exoskeleton?
3. What is the largest group of animals with an exoskeleton?

### THINK

4. Which group of animals is the most common – vertebrates or invertebrates?
5. Is a snail a vertebrate or an invertebrate? Give a reason for your answer.
6. Worms have muscles around and along their bodies. These allow them to become long and thin one moment and short and fat the next. How might this help them move through the earth?
7. The system most scientists use for classifying animals that can be seen without a microscope starts by dividing them into those with and without a backbone. Suggest at least one other way to divide them into two groups.
8. Select a characteristic for the following group of animals to divide it into:
   (a) two groups
   (b) three groups.
   dolphin, slug, beetle, horse, jellyfish, dog, spider, ant
   Explain your choice of characteristic in each case.

### SKILLBUILDER

9. Study the dichotomous key opposite.
   (a) To which group does each of these animals (below) belong?
   - One with a backbone, a changing body temperature and that does not use air tubes or lungs
   - One with no backbone, legs or covering shell and that has tentacles with stinging cells.

   (b) Work through the key backwards to list as many characteristics as you can for:
   • birds • molluscs • reptiles.

✓ checklist

I can:
- ☐ understand how animals are commonly classified
- ☐ explain the difference between vertebrates and invertebrates
- ☐ use data about animals in a dichotomous key to come to conclusions.

# Inner backbones

Most animals have a skeleton on the outside of their body. This external type of skeleton is found in insects, for example. Other animals have no skeleton at all, such as worms. But when we think of animals, we usually think of those that have a skeleton with a backbone inside the body. These animals with a backbone, much like yours, are called **vertebrates**.

Vertebrates have the following characteristics:

- When they first start developing, they have a **cartilage** rod in their back. Cartilage is softer than bone. Your nose and ears are made mostly of cartilage.
- As they develop, the cartilage rod is replaced by a bony backbone made up of bones called **vertebrae**.
- They have gill slits near the throat when they start developing. In air-breathing vertebrates, these slits change into other structures or disappear completely. In humans, the gill slits disappear before birth.

Vertebrates can be 'broken down' further into the five groups described in the key opposite.

VERTEBRATES

Body temperature that is constant

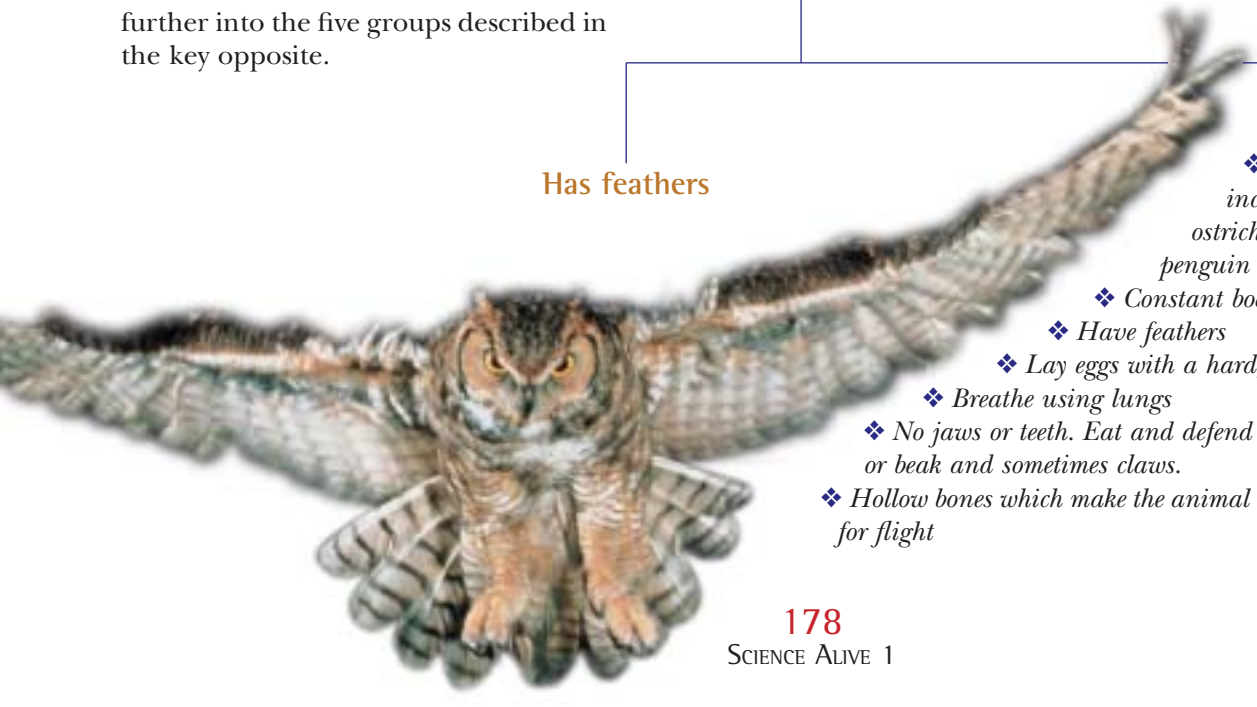
Breathes air using tubes or lungs

Moist skin with no scales

**Amphibians**

- *About 3200 **species** including toad, frog and salamander*
- *Changing body temperature*
- *Thin, smooth skin with no hair or scales*
- *Reproduce and lay eggs in water (mostly) or wet earth. Eggs have no shell.*
- *Usually start their life in water (with gills) and live as adults both on land and in water (with lungs)*

Has feathers



**Aves (birds)**

- *About 9300 species including owl, finch, ostrich, duck, parrot and penguin*
- *Constant body temperature*
- *Have feathers*
- *Lay eggs with a hard, brittle shell*
- *Breathe using lungs*
- *No jaws or teeth. Eat and defend themselves with bill or beak and sometimes claws.*
- *Hollow bones which make the animal light and well suited for flight*

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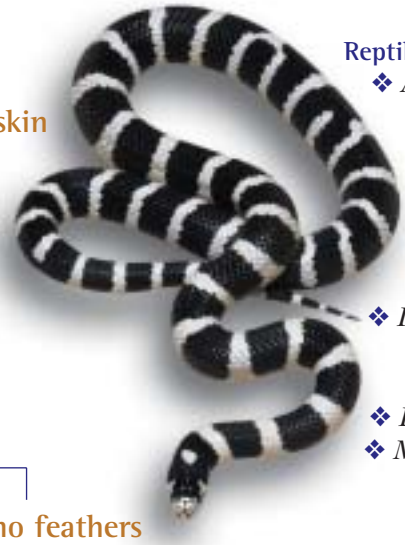
Body temperature that is not constant

Does not breathe air using tubes or lungs

### Fish

- *Group has more species than all other kinds of vertebrates put together. Some have bony skeletons, like salmon and goldfish. Others, like sharks and stingrays, have skeletons of cartilage.*
- *Live only in water*
- *Most have changing body temperature*
- *Most have scales and a slimy coating that make the body waterproof*
- *Most have fins to help them turn when swimming*
- *Breathe through gills*



Scaly skin

### Reptiles

- *About 6000 species including turtle, crocodile, snake and lizard*
- *Changing body temperature*
- *Skin has dry scales that overlap. These help to retain the body's moisture. Many reptiles shed their skin a number of times each year.*
- *Lay eggs mostly on land. Shells are leathery, making the eggs watertight and less likely to break open.*
- *Breathe using lungs*
- *Most have very good eyesight*

Has no feathers

### Mammals

- *About 4000 species including dolphin, rabbit, giraffe, platypus, rat and you*
- *Constant body temperature*
- *Skin has fur or hair, even if only a few bristles*
- *Breathe using lungs*
- *Newborns feed on their mother's milk, produced by* ***mammary glands***
- *Three types — placental mammals that give birth to fully developed young, marsupials whose young develop in a pouch and monotremes that lay eggs.*

## Activities

### REMEMBER

1. Apart from an internal skeleton with a backbone, what other features do all vertebrates have?
2. Name the five groups into which vertebrates are commonly divided. To which group do you belong?

### THINK

3. Which groups of vertebrates have a changing body temperature? Explain what this means and how this characteristic affects the animal's behaviour.
4. Which group of vertebrates has the following characteristics?
   (a) Changing body temperature; lays eggs in water; thin, smooth skin
   (b) Dry overlapping scales, breathes using lungs, lays eggs mostly on land

### SKILLBUILDER

5. To which group of vertebrates do the following animals belong?
   (a) Turtle
   (b) Emu
   (c) Human
   (d) Dolphin

### INVESTIGATE

6. Fish can be divided into three separate groups. Find out what the groups are, the characteristics of each group and list two examples from each group.

✓ checklist

I can:

- ☐ describe the features of a vertebrate
- ☐ list the sub-groups into which vertebrates are divided.

London Science

London Town: 23 November 1799 Weather: Overcast, drizzle, 30 °F

# Platypus Hoax Exposed!

Examining the so-called Platypus (an Artist's Impression)

The so-called Platypus is no more than a clever Hoax. This is the firm Opinion of Dr Shaw, a highly respected Scientist with the British Museum.

Dr Shaw made his Announcement last Week after inspecting a stuffed Creature sent to England from the Colony of New South Wales. Although he was not able to cut the Bill off with Scissors, Dr Shaw said it did not take long to find the Hidden Stitches.

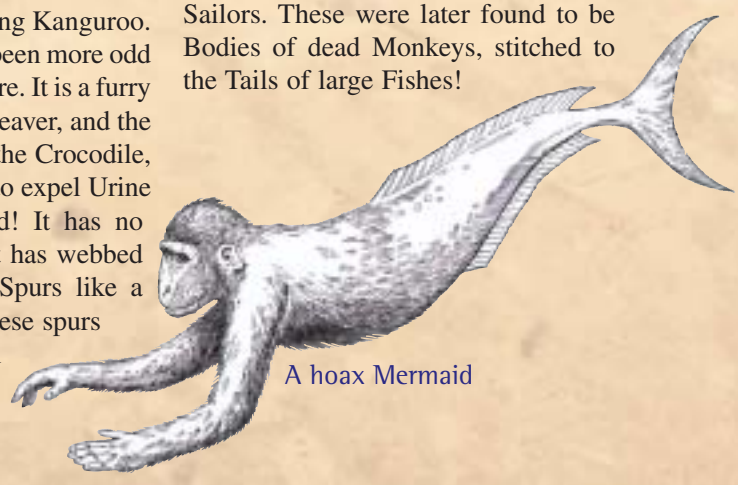
'It is the practical Joke of some **Taxidermist**', he said. 'This Skin is just a Combination of Skins of other Animals. They have all been sewn together to look like they belong to a single, absurd Beast. It insults our Intelligence!'

The stuffed Specimen and a Sketch of the Creature were sent to Dr Shaw earlier this Year. A Number of bizarre and ugly Animals have already been found in the remote Colony since it was settled eleven Years ago. There was the fierce Koala Bear. And, of course, the strange hopping Kanguroo.

None, however, have been more odd than this so-called Creature. It is a furry Beast with a Tail like a Beaver, and the Bill of a Duck. Yet, like the Crocodile, it has only one Opening to expel Urine and Faeces. How absurd! It has no Feathers or Scales. Yet it has webbed Feet like a Goose and Spurs like a Rooster. What's more, these spurs contain poisonous Venom like that of a Snake.

Dr Shaw's Verdict was quite clear. 'Of course, a Creature that has Hair and gives Milk, but with a Bill and webbed Feet, could not possibly exist. It could not be classified as a Mammal, Bird, Reptile or Amphibian — nor for that matter any other Class of Animal. These People in the Colony are suggesting it belongs in a Sub-class of its own. The very Idea is ridiculous! You would think someone who wanted to fool us would have made a more believable Animal', he said.

Dr Shaw has good Reason to suspect a Trick. Recently, there have been a number of Cases where smart Taxidermists, eager to improve their business Prospects, have been caught selling 'Mermaids' to our British Sailors. These were later found to be Bodies of dead Monkeys, stitched to the Tails of large Fishes!



A hoax Mermaid

# SENIOR TAXIDERMIST BRITISH MUSEUM

The British Museum wishes to employ an experienced Taxidermist to prepare animal specimens for its Collection from the Colonies.

**Experience required in:**

- skinning Animals
- preparing plaster casts of animal Bodies
- sewing Skins together
- mounting Animals in a lifelike Pose.

**Abilities needed:**
a very good knowledge of Anatomy, an Eye for Detail, artistic Ability, and a strong Stomach.

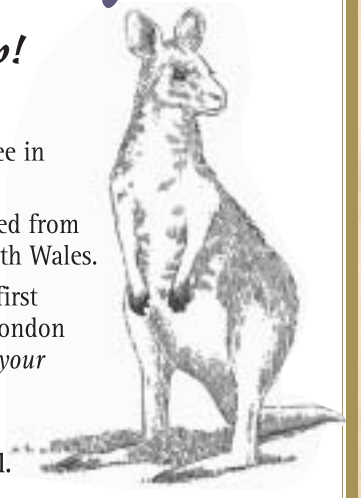
## In Search of 'the Watermole'

Ever since this strange 'Platypus' was sent to London, it is reported that Colonists everywhere are looking for more specimens. They call it a 'Watermole' in the Colony.

Captain Hunter, the current Governor, says he first saw one in 1797. He says he watched an Aborigine sit for over an Hour beside a Lagoon near the Hawkesbury River. He had his Spear poised, waiting for the Creature to surface. You never know what sort of Stories you are going to get out of these faraway Colonies!

# *See a Kanguroo!*

***Roll up . . . roll up!***



See one of the strangest Creatures you will ever see in your Life.

It's alive – and just arrived from the Colony of New South Wales.

If you missed seeing the first Kanguroo brought to London town in 1796 – *now's your Chance.*

It does not bite or spit – but watch out for its Tail.

*Only three pence!*

Long Queues expected, so hurry!

## Activities

### REMEMBER

1. Why did Dr Shaw think the platypus was so peculiar?
2. What had previously happened to make Dr Shaw suspicious about the strange skin he was sent?
3. What other 'strange' animals had already been found in New South Wales by 1799?

### THINK

4. What features of the platypus are:
   (a) like those of other mammals?
   (b) unlike those of other mammals?

### INVESTIGATE

5. Today, the platypus and the echidna are classified as a special type of mammal known as a monotreme. Find out which feature separates these two animals from all other mammals?

### CREATE

6. Make a model of the platypus using materials such as fur, plastic and paint. We now know that only the male platypus has spurs. They are on the inner side of each hind 'leg'.

### COMMUNICATE

7. Conduct a class role-play of what it must have been like for people of London town to see a kangaroo for the first time. Imagine what would be said. Some can be members of the public (adults and children), some can be museum staff and some can be scientists like Dr Shaw.

### CONNECT

8. Go to www.jaconline.com.au/science/weblinks and click on the Platypus link for this textbook. Look for facts about where the platypus is found, what it eats, and what sort of home it makes. Complete a poster that includes diagrams, sketches, a map and, if possible, pictures.

✓ checklist

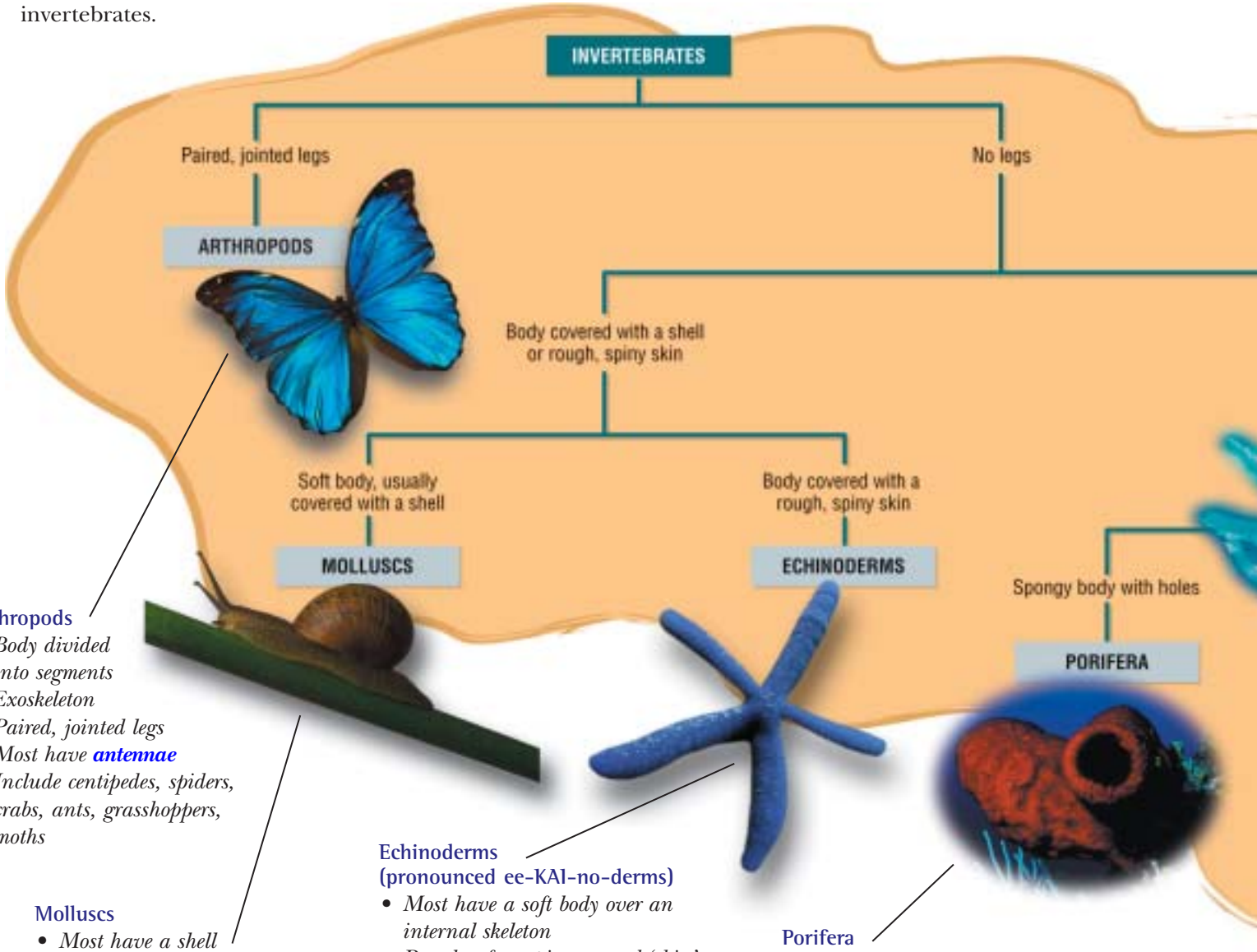
I can:

- ☐ understand why it was hard to classify the platypus
- ☐ explain why a platypus is like and unlike other mammals
- ☐ appreciate the need for adequate evidence before accepting or rejecting ideas.

# Spineless wonders

The main characteristic of **invertebrates** is that they don't have a backbone. Most of them have an **exoskeleton** — a skeleton on the outside of their body. Some of them have no skeleton at all. Some of them, like sea stars, have a skeleton (but no backbone) inside their bodies.

No-one knows how many **species** of animal there are on Earth. What is known for sure is that most of them are invertebrates. The **dichotomous key** below describes some of the characteristics of invertebrates.




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

**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*

**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*

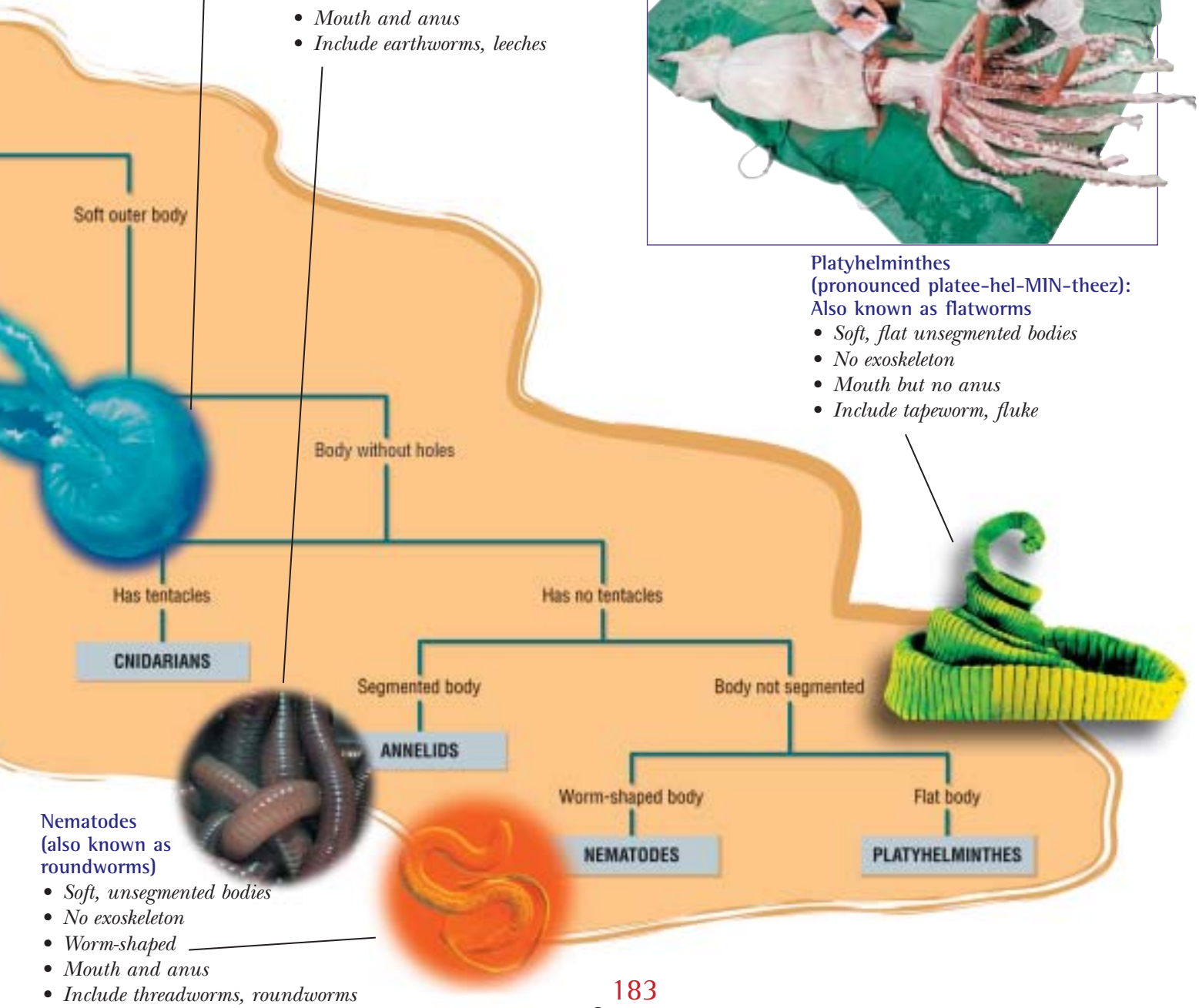
**Porifera**
- *Spongy body with no body organs or tissue*
- *Exoskeleton made of fibres or pointed 'needles'*
- *Water and food enter through tiny pores (holes) in body*
- *Wastes pass out through one big opening*
- *Include barrel sponges, glass sponges, tube sponges*

**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*

**Annelids**
**(also known as segmented worms)**

- *Soft, segmented bodies with an obvious head*
- *No exoskeleton*
- *Mouth and anus*
- *Include earthworms, leeches*




**Nematodes**
**(also known as roundworms)**

- *Soft, unsegmented bodies*
- *No exoskeleton*
- *Worm-shaped*
- *Mouth and anus*
- *Include threadworms, roundworms*

**Platyhelminthes**
**(pronounced platee-hel-MIN-theez): Also known as flatworms**

- *Soft, flat unsegmented bodies*
- *No exoskeleton*
- *Mouth but no anus*
- *Include tapeworm, fluke*




The largest invertebrate is a mollusc called the giant squid. Its scientific name is *Architeuthis dux*. It lives in the very deep parts of the ocean. Its eyes are as large as soccer balls. Its beak-like mouth can cut through steel cables. The giant squid can be as long as 18 m. Two of its ten tentacles are much longer than the others. These are used to catch food.

In 1966, two lighthouse keepers in South Africa watched a giant squid wrap its tentacles around a baby whale to drown it. The whale's mother could do nothing to save her calf.

## Arthropods


*Mosquito*

About 80 per cent of invertebrates are **arthropods**. The insect is the most common arthropod. There are about six million insect species known to exist. Many insects **pollinate** flowers. Some provide us with food (e.g. bees provide honey). Insects are a food source for many animals such as other insects, birds and fish. Some insects feed by chewing; others, like the mosquito, suck up their food (sometimes human blood!) through a long thin tube called a **proboscis**. The proboscis of some insects rolls up at the end when not in use (a bit like a party whistle). All insects have three pairs of legs. An insect's legs are connected to the middle section of its body, called a **thorax**.


*Spider*


*Crab*


*Centipede*

Like the mosquito, all other insects have:

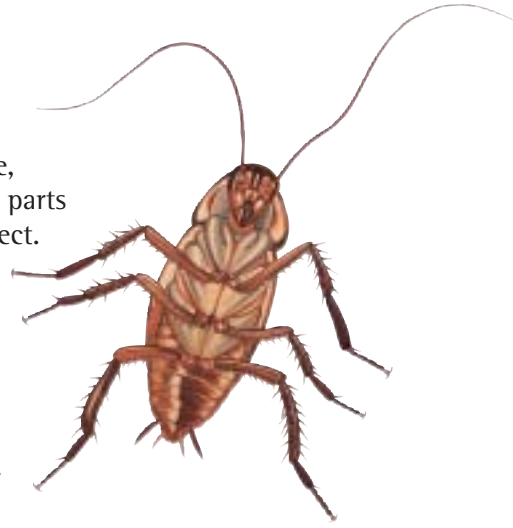
- an exoskeleton
- a body made up of three segments — head, thorax and **abdomen**
- one pair of antennae. Most insects smell using their antennae. (Some insects use their feet to taste things.)
- internal tubes that end in openings in their sides, through which they breathe.


*Millipede*

The other arthropods shown in this column are not insects. The spider, crab, millipede and centipede all have more legs than insects. There are also other significant differences.

## What body features can I see on an insect?

You will need:
preserved or freshly killed cockroach or grasshopper
hand lens
disposable gloves
probe
pen
paper.



- Place the insect upside down on a viewing slide. With the unaided eye, see if you can identify all the body parts labelled in the diagram of your insect.
- Try to identify the three main segments of the insect – the head, the thorax and the abdomen. Remember that the insect's legs are attached to its thorax.
- Some insects have **cerci**. The cerci of a cockroach are very large. They detect the tiniest motion and help warn the cockroach of approaching danger. Some insects have cerci that are more like stumps than hairs. The cerci of some insects are too small to see or not present at all.

1. Does your insect have cerci that you can see with a hand lens? If it does, sketch them.
2. Based on what you see without the hand lens, sketch the detail of one of the insect's back legs.

- Now use a hand lens to look at the back legs.

3. What feature can you observe more clearly on the insect's back leg? What purpose do you think these serve?

- Use the hand lens to look at the head of the insect.

4. Does it have a proboscis or chewing mouthparts? Draw a labelled diagram of the insect's feeding parts.

- Insects breathe through tiny holes called **spiracles**. Look at the side of your insect with a hand lens to see if you can find a 'line' of spiracles. You are more likely to see these on a grasshopper.
- Look at one of the eyes of the insect. There are many lenses in each eye. (You have only one in each eye.)

5. How do you think these extra lenses might help the insect's vision?

- Hold the insect with two hands. Without snapping it in two, see if you can gently bend the tail end of the body sideways (not upwards) towards the head.

6. What feature of the insect makes it difficult to bend its body?

The cockroach is an amazing insect. It has been around for about 350 million years. If you cut off its head, it will stay alive for about a week. It dies only because it has no mouth to drink through. It can also run faster than any other insect – almost four kilometres per hour. It can also change direction very quickly. If a cockroach loses a leg, a replacement will appear next time it sheds its exoskeleton.

# Activities

## REMEMBER

1. What is an invertebrate?
2. Give examples of two invertebrates that have an exoskeleton, and two that have no skeleton at all.
3. What group of invertebrates do each of the following animals belong in: spider, leech, sea star, moth.
4. List the main characteristics of all insects.

## THINK

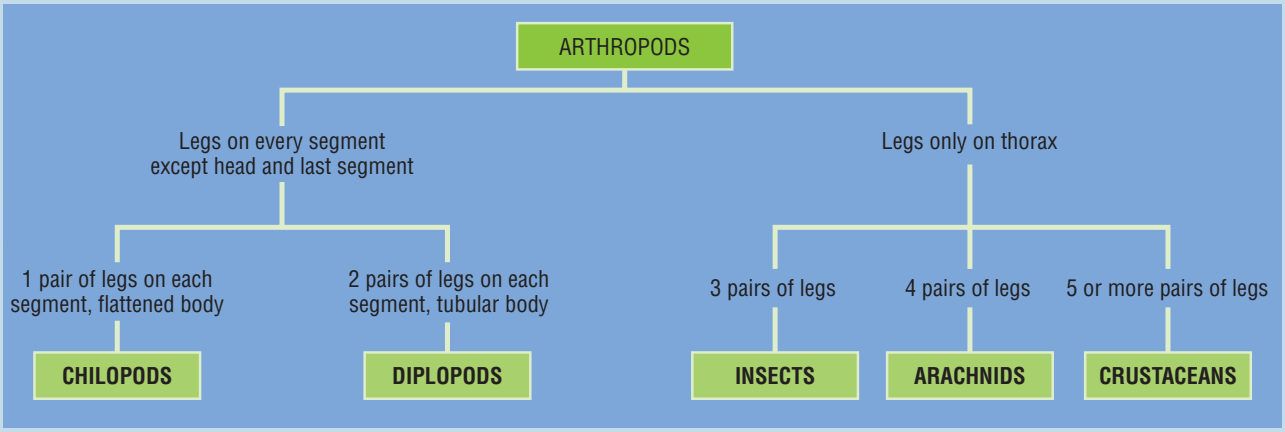
5. Write a paragraph listing as much evidence as you can to support the statement: 'The cockroach is an arthropod'.
6. A snail is a mollusc. So is the giant squid. In what ways are they alike and in what ways are they different?

## SKILLBUILDER

7. Describe the characteristics of the following animals using the labels used to classify them in the dichotomous key on pages 182–3: coral, earthworm, fluke, centipede.
8. If you found an animal with a soft, segmented body, no legs or tentacles or hard external covering, how would you classify it, based on the data given in the dichotomous key?
9. (a) Use the key below to classify the five arthropods shown opposite.
   (b) Why is the key below not a dichotomous key?

## CONNECT

10. Go to www.jaconline.com.au/science/weblinks and click on the Giant Squid link for this textbook to discover more about this amazing creature.
11. Go to www.jaconline.com.au/science/weblinks and click on the Cockroach link for this textbook to discover more about this amazing creature.




checklist

I can:

- ☐ describe the features of invertebrates
- ☐ use a dichotomous key to classify invertebrates
- ☐ describe the features of arthropods.

# The plant kingdom

We must have plants to live. They provide the oxygen we breathe, the food we eat and the food eaten by animals we eat. They also provide medicines, and raw materials such as timber and cloth fibres. Scientists think there may be about 350 000 **species** of plants, but no-one is sure. Plants are classified on the basis of such features as the presence of roots, stems, leaves, seeds and flowers.

Like most members of the animal kingdom, plants are complex **multicellular organisms**. Unlike animals, they:

- have structures such as roots, stems and leaves
- have thick **cell** walls
- make their own food through a process called **photosynthesis**
- are not free to move from place to place.

## Classifying plants

One of the main ways plants can be grouped is by whether or not they have transport tissue. Known as **vascular tissue**, this transport tissue consists of two sets of tubes. One set, made of **phloem cells**, transports food from the leaves to the rest of the plant. The other set, made of **xylem cells**, transports water and minerals from the soil to the rest of the plant.

Plants with vascular tissue are called **tracheophytes**. They have roots, stems and leaves. They include flowering plants, conifers and ferns. Plants that do not have vascular tissue are called **bryophytes**. They are usually very small plants. Bryophytes include mosses and liverworts.

| Plant group | Location |
|---|---|
| Flowering plants (e.g. roses, fruit trees, grasses, eucalyptus trees)  | Mostly on land |
| Conifers (e.g. firs, pines and spruces)  | On land |
| Ferns (e.g. maidenhair fern, fishtail fern)  | Damp, shady, cool regions |
| Mosses (e.g. sphagnum moss)  | Damp, shady, cool regions |
| Liverworts  | Damp, shady, cool regions |

| Stem and roots | Leaves | Flowers | Seeds |
|---|---|---|---|
| Yes | Yes | Yes | Yes. Reproduce from seeds. Seeds form inside flower, which develops into a fruit. |
| Yes | Yes. Mostly fine and needle-shaped. | No | Yes. Form on scales of cones. |
| Yes | Leaves are fronds which uncurl as they get bigger. | No | No. Reproduce from **spores** on leaves. These are released from brown spore cases that form on the underside of leaves. |
| No stem. 'Roots' are more like fine hairs. | Yes, but simple structure. Tiny and dainty. | No | No. Reproduce from spores. |
| No stem. 'Roots' are more like fine hairs. | Yes, but simple structure. Flat, thick and leathery. | No | No. Reproduce from spores. |

## Activities

### REMEMBER

1. Explain the ways that plants differ from animals.
2. What is the main difference between bryophytes and tracheophytes?
3. Which groups of plants are called tracheophytes?
4. Which groups of plants are called bryophytes?
5. State two differences between conifers and flowering plants.

### THINK

6. Suggest why plants with vascular tissue are usually larger than ones without it.
7. A description of three plant specimens follows. Name the plant group to which each may belong.
   (a) A plant found beside a rainforest creek with no seeds or clear root system and with thick leaves
   (b) A plant with an obvious root system, a stem, leaves and with fruit containing seeds
   (c) A plant found in a cool, shady rainforest, with a horizontal stem and curled up new leaves with rows of brown spots underneath them

### SKILLBUILDER

8. Use the information in this spread to create a key that shows one way to classify plants. Start by deciding which feature best divides plants into two groups. For each group, decide what features they have in common, and how they differ. This will help you decide how to break them down further into sub-groups. If you need some help with drawing keys, check some shown earlier in this chapter.

### CONNECT

9. Go to www.jaconline.com.au/science/weblinks and click on the Corpse Flower link for this textbook. Find out what purpose the flower's dreadful smell serves.

✓ checklist

I can:

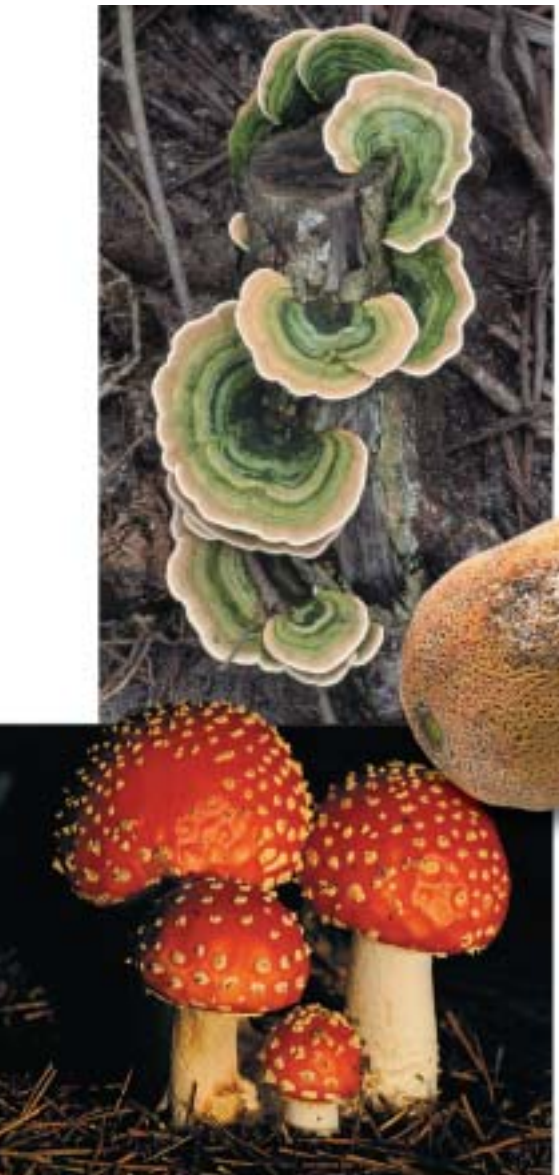
- ☐ explain some of the main features of plants
- ☐ use data to create a classification key.

# The other kingdoms

Most of the **living** things that we recognise are plants or animals. But some of the most spectacular and unusual living things belong to the other three kingdoms of living things — Kingdom Fungi, Kingdom Monera and Kingdom Protoctista. Within these lesser-known kingdoms are **organisms** that can keep us alive, make us sick or even kill us.

## Kingdom Fungi

Fungi come in an amazing variety of shapes and colours. Perhaps the most familiar are the mushrooms we eat. But fungi also include toadstools, truffles, mould, mildew and **yeast**.



Fungi used to be classified as plants. However, unlike plants, they have no true roots, leaves, stems or flowers. Also, they do not contain **chlorophyll**. This means they cannot make their own food. Instead, they produce chemicals to break down food from outside sources. The broken-down food is then absorbed into the fungi. Different sorts of fungi feed on different sorts of food. Some grow on or in dead animal or plant matter (e.g. vegetable scraps, cow dung, decaying fruit) and slowly break it down (or decompose it). Some grow on or in living **organisms**. Such fungi are called **parasites**.

Fungi grow from tiny **spores** released by a 'parent' fungus. These are blown through the air, or carried by animals. Some fungi have interesting ways of releasing their spores. The *Pilobolus*, which lives in cow dung, releases its spores by exploding. Spores can be shot up to two metres high by the force of the explosion, which is set off by sunlight.

Some fungi cause plant diseases such as stem rot, and painful infections such as **tinea** and ringworm. The antibiotic penicillin is made from a fungus. So is yeast, which is used in the making of bread and beer.

## Under the microscope

Members of two of the kingdoms — Monera and Protoctista — are generally so small that they can be seen properly only under a microscope. To see some monerans you would even need to use the more powerful **electron microscope**.

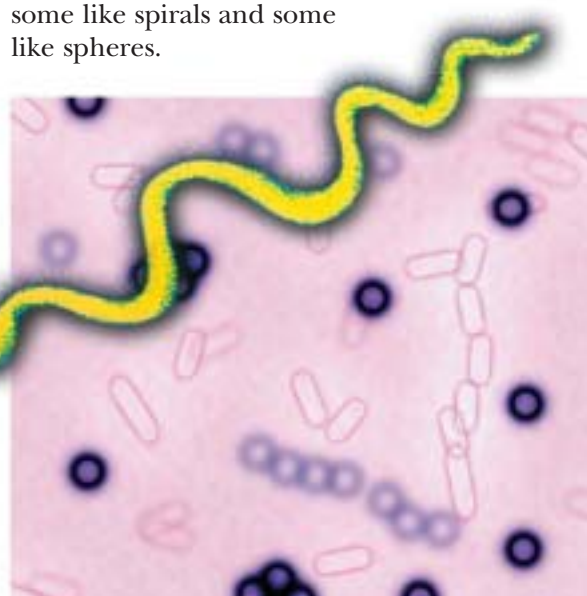
## Kingdom Monera

Monerans are thought to be the first form of life to exist on Earth. They are very simple organisms consisting of one **cell** without a **nucleus**. They are everywhere — in water, in soil, in the air and in your body. You might know them as bacteria.

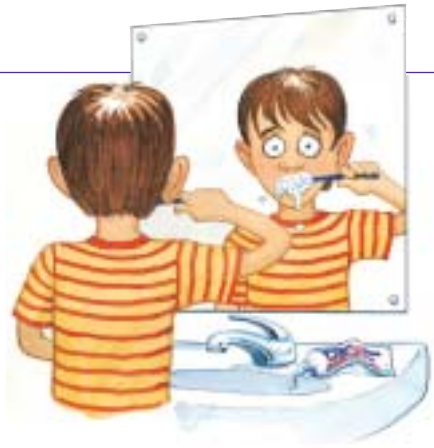
Monerans can be both helpful and harmful. Some cause illnesses such as cholera and pneumonia. Some cause tooth decay. Some, such as *Salmonella*, can give you food poisoning. On the positive side, other monerans that live in your intestine help you to digest food and make vitamins. Others are used to make foods such as yoghurt and vinegar.

**Cyanobacteria**, sometimes called blue-green **algae**, are another member of Kingdom Monera. Like some plants, this group makes its own food using **photosynthesis**.

Bacteria are classified by their shape. Some are shaped like rods, some like spirals and some like spheres.




Did you know that toothpaste contains the remains of lots of crushed diatom shells? When diatoms die, their microscopic shells pack down in layers to form diatomaceous earth (which is what is used in toothpaste). This is why toothpaste is a bit gritty.



## Kingdom Protoctista

This kingdom could be described as the 'leftovers'. It includes organisms that don't belong in any of the other four kingdoms. Most protoctists are made up of only one cell. Unlike bacteria cells, the cells of protoctists have a nucleus.

Some protoctists (e.g. **diatoms** and algae) have features that are a bit like plants. Algae, for example, make their own food using photosynthesis, like a plant. Yet algae have no true roots, leaves or stems and no **vascular tissue**. Other protoctists, such as the blob-like ***amoeba*** and *plasmodium* which causes malaria, are more animal-like. Others are a bit like fungi, such as the one that destroyed the potato crop in Ireland in 1845–46, causing the death of about 30 per cent of the population.

An amoeba — animal-like, but is only one cell


## How do I classify lichen?

You will need:
piece of lichen (You will find it growing on rocks and tree trunks in colder, wetter regions, especially towards the tops of ranges and hills.)
stereomicroscope
probe.

Look carefully at the lichen under a microscope.

- Identify any true roots, stems, leaves or flowers.
- Identify any thread-like parts.

1. Describe the appearance of the lichen. Can you see two different sorts of organism?
2. Lichen is actually made up of a fungus and an alga, growing together. Which part do you think is the fungus, and which the alga? Why?
3. What benefits do you think the algal cells in lichen provide for the fungus part?
4. What benefits do you think the fungus provides for the algal cells?
5. How would you classify lichen? Why?
6. What does this suggest about the difficulties that scientists sometimes face in trying to classify organisms?

## Activities

### REMEMBER

1. List at least two characteristics of:
   (a) fungi
   (b) monerans
   (c) protoctists.

### THINK

2. Some scientists argue that algae, lichen and fungi are plants. Give some reasons why they might believe this.
3. Ringworm is a little worm that gets under your skin and burrows around in the shape of a ring. Is this statement true or false? Explain.
4. Algae is a member of Kingdom Protoctista. Why do you think it is misleading, and a bit confusing, to refer to cyanobacteria as blue-green algae?

### INVESTIGATE

5. Place each of the following items in its own sealed plastic bag: a thick slice of bread, a tomato, and a damp piece of bark from a moist part of the garden. Leave each bag in a warm place for about a week, or until you notice mould or mildew starting to form on each item. Look carefully at the different moulds that form. If possible, also observe them with a stereomicroscope. **Do not open the plastic bag.** List features of the moulds that would help you to classify them. Consider colour, texture, shape, etc.

✓ checklist

I can:
- ☐ describe the characteristics of fungi, monerans and protoctists
- ☐ explain why it is hard to classify some organisms.

# Check and challenge

## CLASSIFICATION

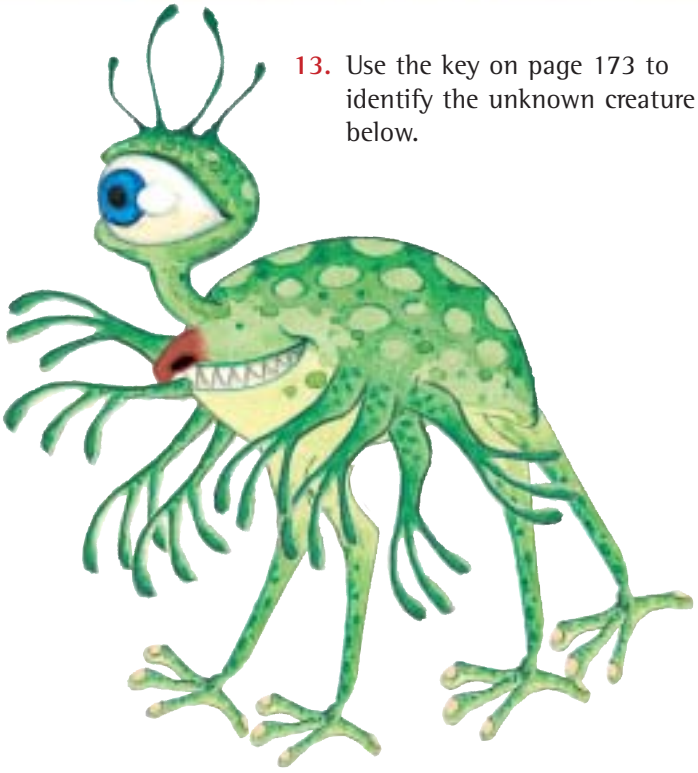

### Living things – similarities and differences

1. List the characteristics of all living things.
2. Why is it helpful to classify living things?
3. Briefly describe the different ways in which:
   (a) you and a plant take in and release air
   (b) you and a plant take in water
   (c) a wattle tree and a dog get their food
   (d) a mushroom and a single-celled protoctist reproduce.
4. Copy and complete the following table.

| Groups of organisms | Ways they are alike | Ways they are different |
|---|---|---|
| Amphibians and reptiles | | |
| Molluscs and echinoderms | | |
| Rose bushes and ferns | | |

### Sorting organisms using dichotomous keys

5. (a) Explain the difference between vertebrates and invertebrates.
   (b) Why are these two groups commonly the first groups identified when drawing a dichotomous key for animals?
   (c) List the five groups of the vertebrates.
6. Do all invertebrates have an exoskeleton? Explain.
7. Which feature of arthropods makes it possible to divide them into five different groups?
8. Why was it so difficult to classify the platypus when the animal was first found? What makes it different from the other two groups of mammals?
9. Mushrooms were once classified as plants.
   (a) Suggest why they could have been classified as plants.
   (b) What features of mushrooms are different from those of plants?
10. Draw up a dichotomous key to classify the animals pictured below. First, list the featues of each animal, based on what you can see here and what you know about the animal. Think about their shape, the way they move, eat and reproduce. How many sub-groups of animals are you able to identify from your key?
11. Draw up a tabular key to classify the pictured animals.
12. To which group of invertebrates does the sea star shown below belong?



13. Use the key on page 173 to identify the unknown creature below.

## Five kingdoms

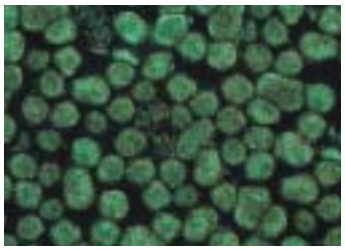
14. Name the five kingdoms into which living things are usually grouped. List examples of two organisms from each of the kingdoms. What characteristics does each pair of organisms have in common?
15. To which kingdom do the following organisms belong? Explain why in each case.
algae, ant, *Salmonella* bacteria, mildew, moss, tapeworms
16. Imagine that you are Linnaeus speaking for the first time to a group of naturalists about the new system of classification you have developed. Be prepared to role-play this presentation for the class if asked.


## Viruses — living things?

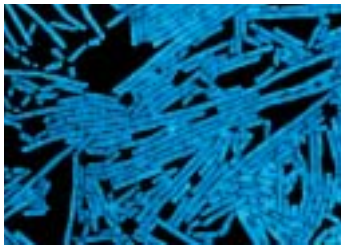
Viruses are very small — much smaller than bacteria. The influenza virus, for example, is only 100 nanometres in diameter. (One nanometre is one-millionth of a millimetre.) Viruses can be seen only with an electron microscope.

Viruses are not cells and therefore have no **nucleus**. They are made up of a strand of **genetic** material within an outer coat of **protein**. This genetic material is the same as that in the nucleus of living cells. It contains the instructions for reproducing the virus.

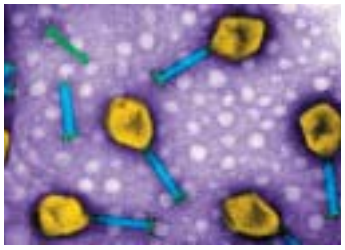
Viruses cannot function on their own. They do not eat or pass waste. In fact, a virus may stay **dormant** for many years. Like some chemicals, viruses can form crystals. But like living things, they can also reproduce. The big difference is that they can only reproduce inside a living cell. In this respect, they are like **parasites**. Once inside **a host cell**, they force it to reproduce millions of new virus particles. Eventually, the host cell may die and burst open.



Influenza A virus



Tobacco mosaic virus (TMV, RNA virus)



T4 bacteriophage (DNA virus)

1. Do all viruses look the same? Consider their different shapes and sizes.
2. In what ways are viruses like living things, and not like living things. List as many points as you can. In particular, think how viruses are like members of the Kingdom Monera.
3. Many seeds of desert plants lie dormant in the ground — sometimes for years. They burst into life only following rain. Discuss the following questions as a class:
   (a) Are the seeds of desert plants alive when they are lying dormant?
   (b) Are viruses alive when they lie dormant, waiting for a host cell to invade?
   (c) What are the similarities and differences between such a plant seed and a virus?

# Summary of key terms

**abdomen:** the end part of an insect's body behind the thorax

**algae:** commonly known as seaweed. An organism belonging to Kingdom Protoctista which lives in water. It contains chlorophyll, and may range from a single-celled organism to a multi-celled long structure such as seaweed.

**amoeba:** microscopic organism consisting of one cell which has a thin membrane. It belongs to Kingdom Protoctista but has animal-like features.

**antennae:** the pair of fine probing feelers on the head of many invertebrates (e.g. flies, crabs)

**arthropod:** animal that has an exoskeleton, a segmented body and jointed legs (e.g. insects, crabs)

**bryophyte:** plant that does not contain vascular tissue (e.g. mosses and liverworts)

**cartilage:** a waxy, whitish, flexible substance that lines or connects bone joints or, in some animals such as sharks, replaces bone in supporting body tissue. Your ears and the tip of your nose are shaped by cartilage.

**cell:** the microscopic 'building block' of which all living things are made

**cerci:** a pair of movement detectors at the rear of many insects. They may look like antennae.

**chlorophyll:** a green substance found in plants which enables them to use the Sun's energy to make food from carbon dioxide and water

**cyanobacteria:** a single-celled organism belonging to Kingdom Monera. Although it is known as blue-green algae, cyanobacteria are related to bacteria rather than algae, which belong to Kingdom Protoctista.

**diatom:** microscopic organism, consisting of one cell, which lives in water. Belongs to Kingdom Protoctista, but has plant-like features (e.g. it contains chlorophyll).

**dichotomous key:** a diagram used to classify things by grouping them into smaller and smaller groups that are more and more alike, based on choosing one of two features

**dormant:** inactive — but capable of being active again at some time in the future

**electron microscope:** a microscope for viewing very small objects. An electron microscope is much more powerful than a light microscope and can magnify things up to a million times.

**exoskeleton:** skeleton or shell that lies outside the body

**fertile:** able to successfully breed with members of its own species

**genetic:** describes material in living things which contains information about features that can be passed on to the next generation

**host cell:** a cell which is being used by a virus to reproduce itself

**invertebrate:** an animal without a backbone

**kelp:** a large, brown seaweed

**key:** a way of showing how a group of things can be broken up into smaller and smaller groups that are more and more alike. A key can be drawn as a diagram or table.

**living:** being alive or once alive

**mammary glands:** milk-producing glands in a female mammal

**multicellular:** made up of more than one cell

**non-living:** not being alive and not ever having been alive

**nucleus:** the control centre of a cell. It also holds the 'codes' responsible for producing new cells.

**organism:** any living thing

**parasite:** an organism that survives by being inside or attached to another living organism from which it obtains its food

**phloem cell:** long, narrow cell that forms long tubes in plants with true leaves, stems and roots. The tubes made from phloem cells move the food made in the leaves to other parts of the plant.

**photosynthesis:** process whereby an organism uses the Sun's energy to make food (sugars) from carbon dioxide and water

**pollinate:** to transfer pollen from the stamen of a flower (the male part) to the pistil of a flower (the female part). Often insects help to pollinate flowers by transporting the sperm (male cells) on their body parts.

**proboscis:** a long feeding tube attached to the head of some insects. It sometimes rolls up when not in use.

**protein:** a chemical that is needed for the growth and repair of the cells that make up living things

**species:** a group of animals with many features in common. Members of the same species can mate with each other to produce fertile young under natural conditions.

**spiracles:** small openings in the body through which some animals breathe. All insects have spiracles.

**spore:** a reproductive cell of some organisms (e.g. ferns and fungi) that is protected within the organism until the time is ready for it to be released

**tabular key:** a way of classifying things by selecting one of the characteristics given for each consecutive number in a list of numbers. A choice either identifies the item or refers you to a later number in the list so you can make another choice.

**taxidermist:** a person who stuffs the skins of dead animals so that they are lifelike

**taxonomist:** a scientist who classifies living things by sorting them into groups that have more and more similar characteristics

**thorax:** the section of an insect's body between its head and its abdomen

**tinea:** a painful skin disease caused by a fungus that often occurs between the toes

**tracheophyte:** plant that contains vascular tissue

**vascular tissue:** tissue that allows food, water and nutrients to be carried through a plant. The tissue consists of tubes consisting of phloem cells or xylem cells.

**vertebrae:** the bones that make up the backbone

**vertebrate:** an animal that has a backbone, or internal skeleton

**xylem cell:** long narrow cell that forms long tubes in plants with true leaves, stems and roots. The tubes made from xylem cells move water and dissolved minerals up from the roots to the rest of the plant.

**yeast:** a fungus which causes certain foods (e.g. dough) to rise