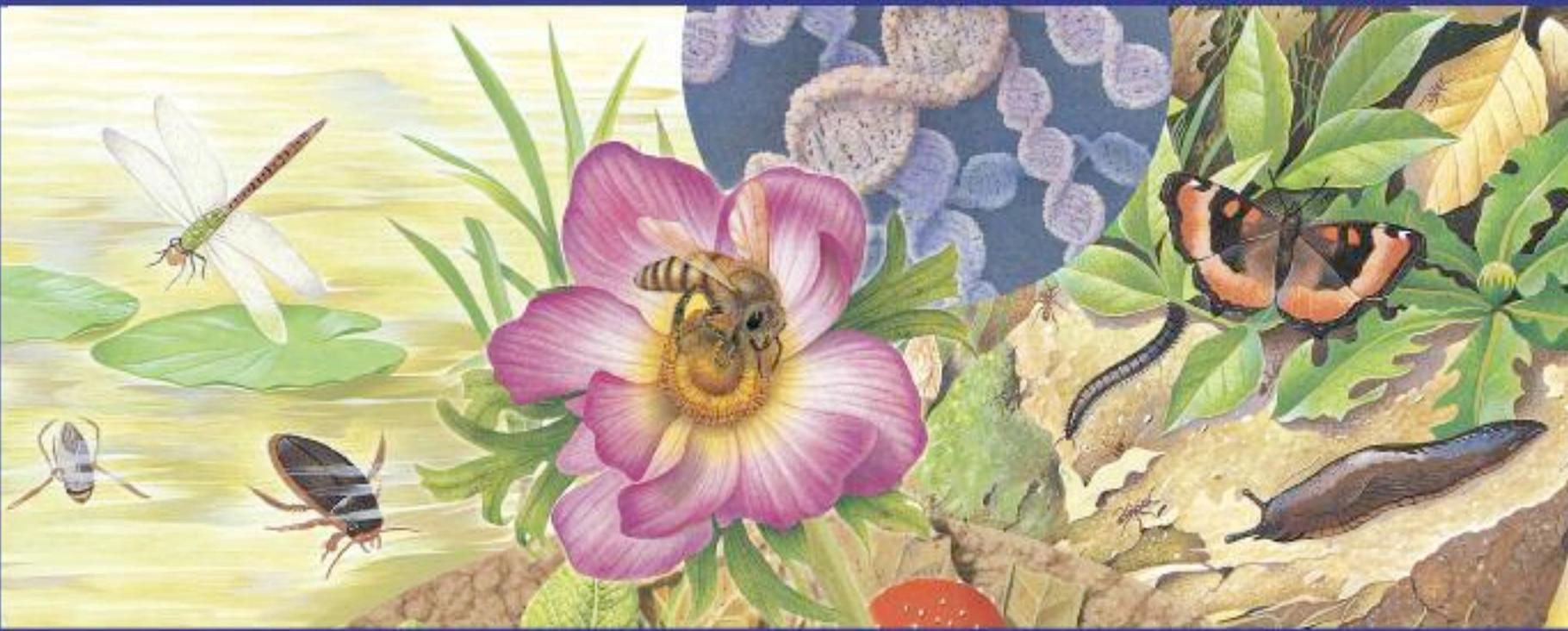


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# BIOLOGY



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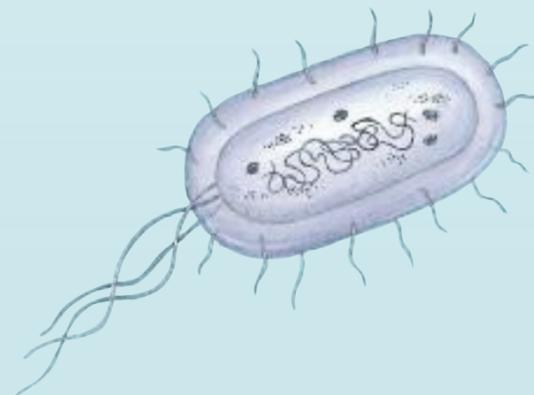
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# CONTENTS

LIFE	6
CLASSIFICATION	8
EVOLUTION	10
MICRO-ORGANISMS	12
PLANTS & FUNGI	14
ANIMAL MOVEMENT	24
ATTACK & DEFENCE	26
MIGRATION	28
INDEX	30
PLANT FUNCTIONS	16
FLOWERS & SEEDS	18
TREES	20
ANIMAL BEHAVIOUR	22



ANIMAL MOVEMENT	24
ATTACK & DEFENCE	26
MIGRATION	28
INDEX	30



# ABOUT THIS BOOK

Each double page contains a brief introduction, explaining the general subject, followed by key words arranged in alphabetical order. To look up a specific word, turn to the index at the back of this book: this will tell you which page to go to. If you want to learn more about a subject, take a look at the factfile, or follow the arrows to read related entries.



### INTRODUCTION

This explains the general subject and provides some basic knowledge.

### BOLD WORDS

These highlight useful words that do not have their own entry.

### FACTFILE

The factfile provides extra information on the subject. Facts are presented in easy to read bullet points.

## PLANTS & FUNGI

**T**he second largest kingdom of living things is the plant kingdom. The key feature of a plant is that it obtains energy from sunlight by photosynthesis (☀️). Plants do not have sensory organs and, although they can grow towards light or water, they cannot move freely around their environment. Fungi, once thought to be plants, are now classified as a separate kingdom. Fungi include: mushrooms, yeasts (🍷) and moulds. They decompose dead or dying plants and animals and take their energy from the nutrients they release.

**Annual plant** A plant that germinates (🌱), flowers and dies within one growing season (usually a year). Annual plants include corn, lettuce, beans and marigolds.

**Aquatic plant** A plant that lives in water.

**Biennial plant** A flowering plant that takes two years to complete its life cycle. In the first year, it stores energy obtained through photosynthesis. In the following year, it uses this energy to flower and make seeds. Biennials include hollyhocks and pansies.

**Bryophyte** A non-vascular plant, such as a moss, that absorbs water and minerals through its leaves and reproduces using spores (🍄).

**Clubmoss** A low-growing, green plant with scale-like leaves. Club mosses reproduce using spores (🍄).

**Conifer** A cone-bearing plant, also known as a **gymnosperm**. Conifers reproduce using seeds formed in scaly cones (🌲). All conifers are bushes or trees. Most have long, narrow leaves that do not fall in autumn.

**Cycad** A palm-like woody plant that produces seeds via cones (🌴). Cycads grow in tropical regions and were common during the time of the dinosaurs.

**Dicot** A flowering plant with two cotyledons (🌱) and petals in multiples of four or five. Most flowers, bushes and trees are dicots.

**Epiphyte** A plant that grows on other plants for support, typically to reach more light. Epiphytes collect rainwater and leaf litter, which provide them with nutrients. Epiphytes include bromeliads and orchids.

**Fern** A flowerless green plant with a long, stiff stem, and branching leaflets (🌿) known as "fronds". Ferns grow in damp places and can live in low light levels. Some tropical ferns grow as epiphytes.

**Flowering plant** A plant, also known as an **angiosperm**, that covers and produces fruits containing seeds (🌱).

**Ginkgo** An ancient, non-flowering plant with fan-shaped leaves. The only surviving species is native to China.

**Gnetophyte** A woody, seed-bearing plant. Gnetophytes include: Ephedra, a shrub from the US; Gnetum, a tropical forest vine and Welwitschia, a cactus-like plant.

**Hemiparasite** A plant that obtains energy through both photosynthesis and by parasitic means. Mistletoe is a hemiparasite.

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**Herbaceous plant** A plant whose leaves and stem die down to soil level at the end of the growing season. Herbaceous plants include irises, peonies and carrots.

**Horsetail** A spore-bearing vascular plant with a rigid, hollow stem. Horsetails are brush-like in appearance and are often found near rivers, lakes or swamps.

**Moss** A bryophyte with leafy stems. Many species spread across the ground, forming a mat.

**Mould** A furry growth of fungi on damp or decaying organisms.

**Mushroom** An umbrella-shaped fruiting body, grown when a fungus reproduces. The mushroom's top, or cap, releases millions of tiny fungal spores (🍄) that blow away in the wind. Poisonous mushrooms are often called **toadstools**.

**Mycelium** The network of threads in a fungus. Mycelia grow into the bodies of dead or dying organisms, causing them to decompose. They then absorb the released nutrients.

**Non-vascular plant** A plant, such as a bryophyte, that has no tube-like vessels for carrying water and nutrients. Non-vascular plants normally live in damp places.

**Parasitic plant** A plant that takes water and nutrients from another plant, known as the host. Parasitic plants may attach themselves either to the outside or inside of the host.

**Perennial plant** A plant that lives for more than two years. Many smaller perennials are herbaceous. All trees and most shrubs are perennial.

**Shrub** A low-lying plant with woody stems branching out from a base just above the ground.

**Succulent** A plant that stores water in its stem, leaves or roots. Most succulents have small leaves and waxy surfaces in order to prevent water loss.

**Vascular plant** A plant with tiny, tube-like vessels that carry water, nutrients and sugar around its body. Vascular plants all have roots, stems and leaves.

**Vine** A plant with a long, thin stem that climbs up other plants, rocks or other structures for support.

### FACTFILE

- ☀️ Flowering plants are the prevailing group of land plants around the world, except for colder regions, where coniferous plants dominate.
- 🌱 The first land plants evolved around 500 million years ago from green algae.
- 🌿 The world's oldest organism is the slow-growing, Araucarioxylon, found in California and believed to be 1,000 years old.
- 🍄 A scientist who studies plants is called a botanist.
- 🍷 The pitcher plant (right) is a carnivorous plant that lures insects using the scent of its nectar. Insects fall into bottle-shaped pitchers filled with rainwater and the plant's digestive juices, and drown.

### ARROWS

These arrows show you where to look up other words mentioned in the entry. For example, (👉26) tells you to go forward to page 26 and (👈6) tells you to turn back to page 6.

### KEY WORDS AND ENTRIES

Key words are arranged alphabetically across each double page. Each entry provides a short explanation of what the key word means.

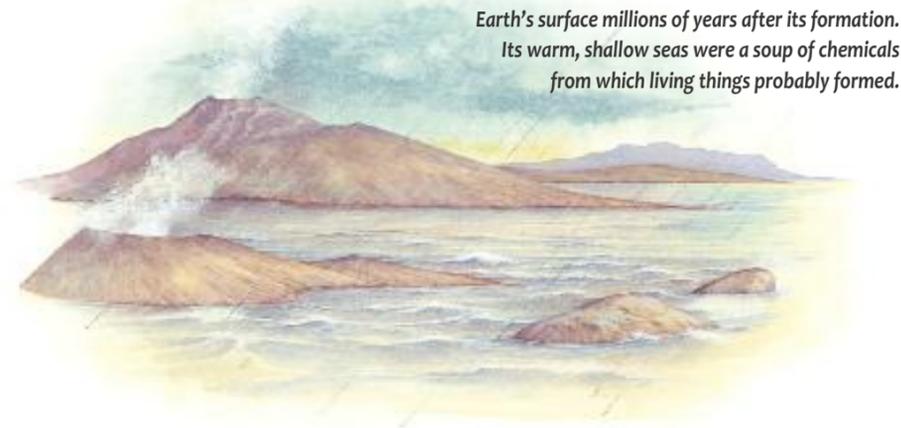
### PAGE NUMBER

Page numbers are easy to find at the side of the page.

# LIFE

Living things are called organisms. Organisms can be classified, or put into groups, according to their similarities, relationships and ancestry. Most scientists think that organisms are divided into three domains: archaea, bacteria and eukaryota. Each of these is then divided into further groups, or ranks, of decreasing size: kingdom, phylum, class, order, family, genus and species.

**Animal kingdom** The largest eukaryotic kingdom. Animals can sense their surroundings, move independently and take in energy by eating other living things.



Earth's surface millions of years after its formation. Its warm, shallow seas were a soup of chemicals from which living things probably formed.

**Archaea** One of the three domains. Archaea are a group of single-celled organisms with no cell nucleus (▶12). They differ from bacteria (▶12) in their chemical make-up. Within this domain there is just one kingdom, also called archaea.

**Carbon** A common chemical that forms a part of all living cells.

**Class** The taxonomic rank above order and below phylum.

**Domain** The highest rank into which life is divided. The three domains are: bacteria (▶12), archaea and eukaryotes. Bacteria and archaea, distinguished by their chemical make-up, are each split into one kingdom. Eukaryotes are divided into four kingdoms.

**Eukaryotes** One of the three domains. Eukaryotic organisms have one or more cells and, unlike archaea or bacteria, their cells have a nucleus and organelles (▶12). Eukaryotes are divided into four kingdoms: animals, plants, fungi and protists.

**Family** The taxonomic rank above genus and below order.

**Fungi kingdom** One of the eukaryotic kingdoms. It includes mushrooms, yeasts, moulds and mildews. Most fungi feed on dead and decaying organisms, and reproduce using spores (▶19).

**Genus** The taxonomic rank above species and below family.

**TAXONOMIC CHART** (left) showing how, for example, tigers are classified.



TAXONOMIC RANK	NAME (scientific and common)	ORGANISMS INCLUDED
Domain	<i>Eukaryota</i> Eukaryotes	Protists, fungi, plants and animals
Kingdom	<i>Animalia</i> Animal kingdom	Vertebrates, arthropods, molluscs, sponges, worms and others
Phylum	<i>Chordata</i> Vertebrates	Mammals, birds, reptiles, amphibians and fish
Class	<i>Mammalia</i> Mammals	Carnivores, ungulates, primates, insectivores, rodents, marsupials and others
Order	<i>Carnivora</i> Carnivores	Cats, dogs, civets, hyenas, bears, mongooses, weasels, raccoons, seals, sea lions, walruses and others
Family	<i>Felidae</i> Cats	Big cats, cougars, cheetahs, servals, lynxes, caracals, ocelots and domestic cats
Genus	<i>Panthera</i> Big cats	Jaguars, tigers, lions and leopards
Species	<i>Panthera tigris</i> Tiger	6 subspecies: Bengal, Indochinese, Malayan, Sumatran, Siberian and South China tiger

**Hybrid** An organism that is the offspring of parents from two different species. Hybrids are usually unable to reproduce.

**Kingdom** The taxonomic rank above phylum and below domain. All organisms are split into six kingdoms: archaea, bacteria, protists, fungi, plants and animals.

**Linnaeus, Carolus (1707-1778)** Swedish scientist who invented the system of two-part scientific names and introduced ranks, including kingdom, class and order.

**Order** The taxonomic rank above family and below class.

**Organism** Any living thing. All organisms consist of a cell or cells. They convert chemicals to provide materials for growth and the release of energy to power life processes. All organisms can reproduce and respond to changes in their surroundings.

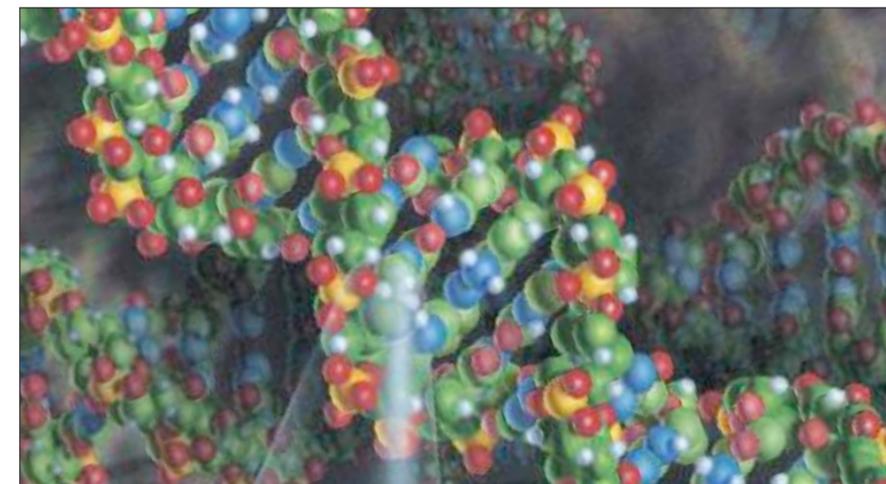
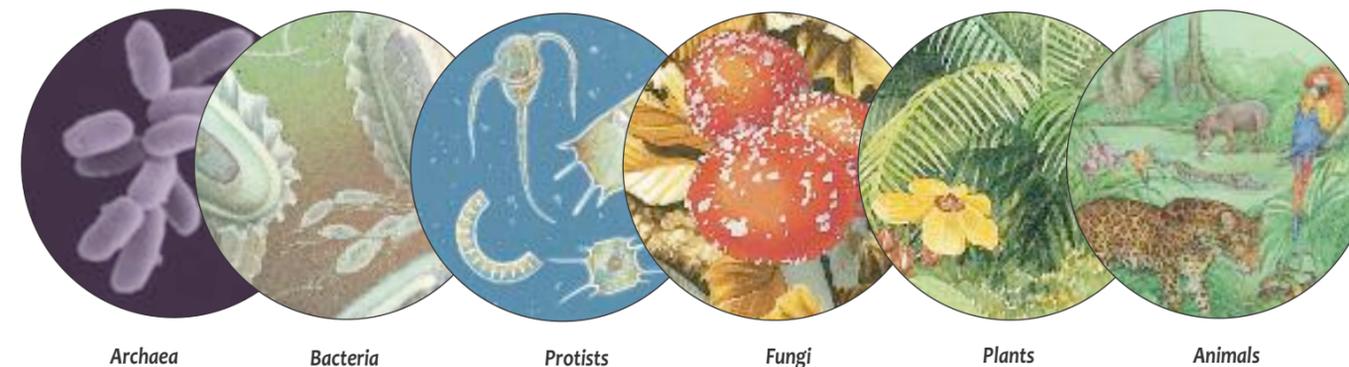
**Phylum** The taxonomic rank above class and below kingdom. Instead of phyla, the plant kingdom is split into **divisions**.

**Plant kingdom** One of the eukaryotic kingdoms. Plants obtain energy from light via photosynthesis (▶16). They also absorb water and minerals from the ground. Plants cannot move freely around their habitat.

**Protist kingdom** One of the eukaryotic kingdoms. A protist is made up of a single cell containing a nucleus (▶11).

**Rank** A level, such as species, genus or class, within the taxonomic system.

## THE SIX KINGDOMS



Every cell in every organism contains DNA (▶10). This is a model of its structure.

**Reproduction** The production of offspring. All living things can reproduce.

**Respiration** A process that takes place in all living things, by which chemicals are broken down to release energy. Most organisms need oxygen for respiration.

**Scientific name** A two-word name for a species. The first word is its genus (eg. *Panthera*). The second is its specific name (eg. *tigris*), which identifies it as one species (*Panthera tigris*) within that genus.

**Species** A group of organisms that are usually similar in appearance, and that are able to breed together and produce young that can also breed successfully.

**Subspecies** A subgroup of a species, often geographically isolated from other subspecies. Different subspecies could breed successfully if brought into contact.

## FACTFILE

★ The first life-forms on Earth appeared about 3700 million years ago, probably in the sea. They were formed when certain simple chemicals joined to each other to form more complex ones, although it is not known how this first occurred.

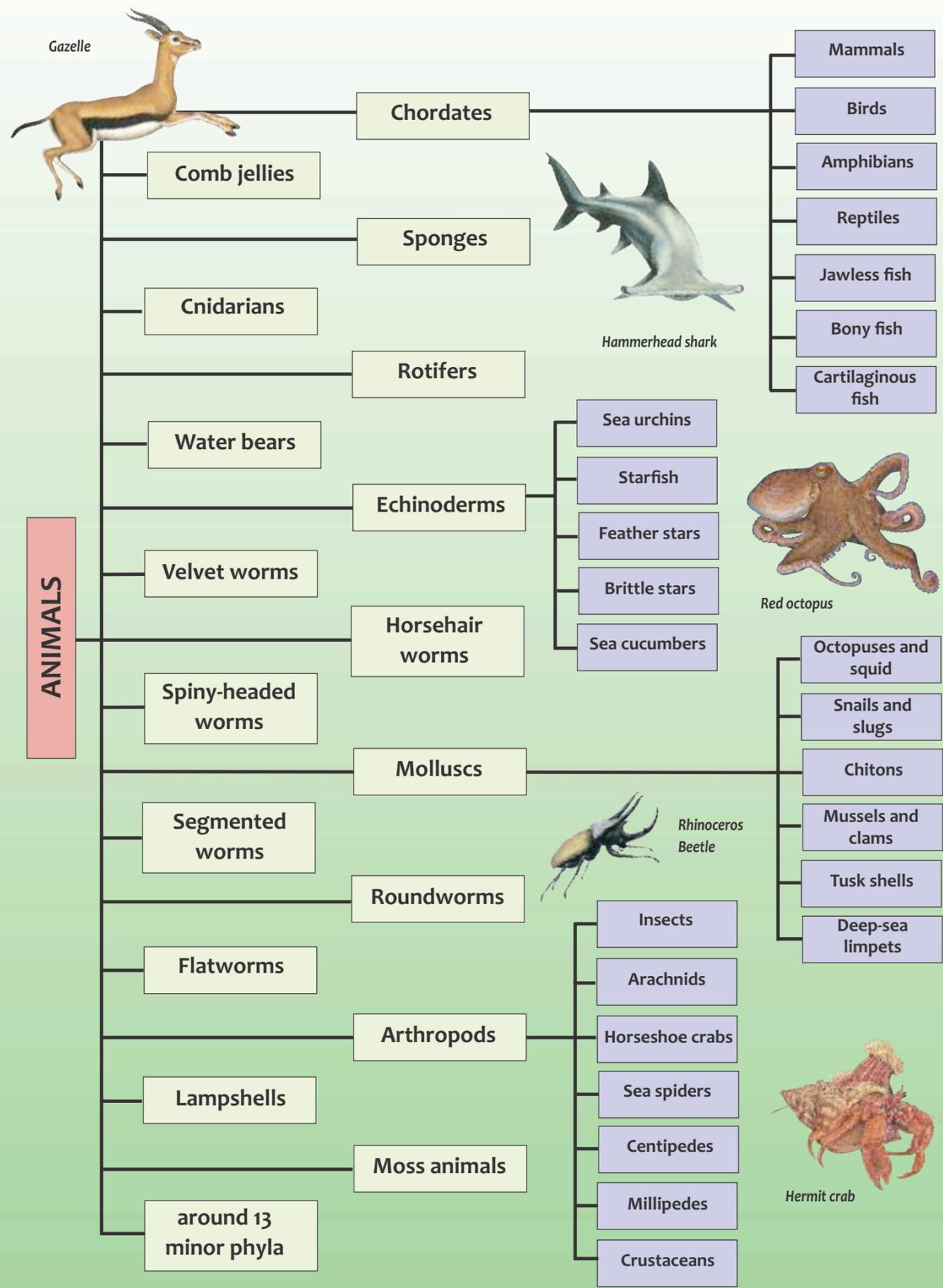
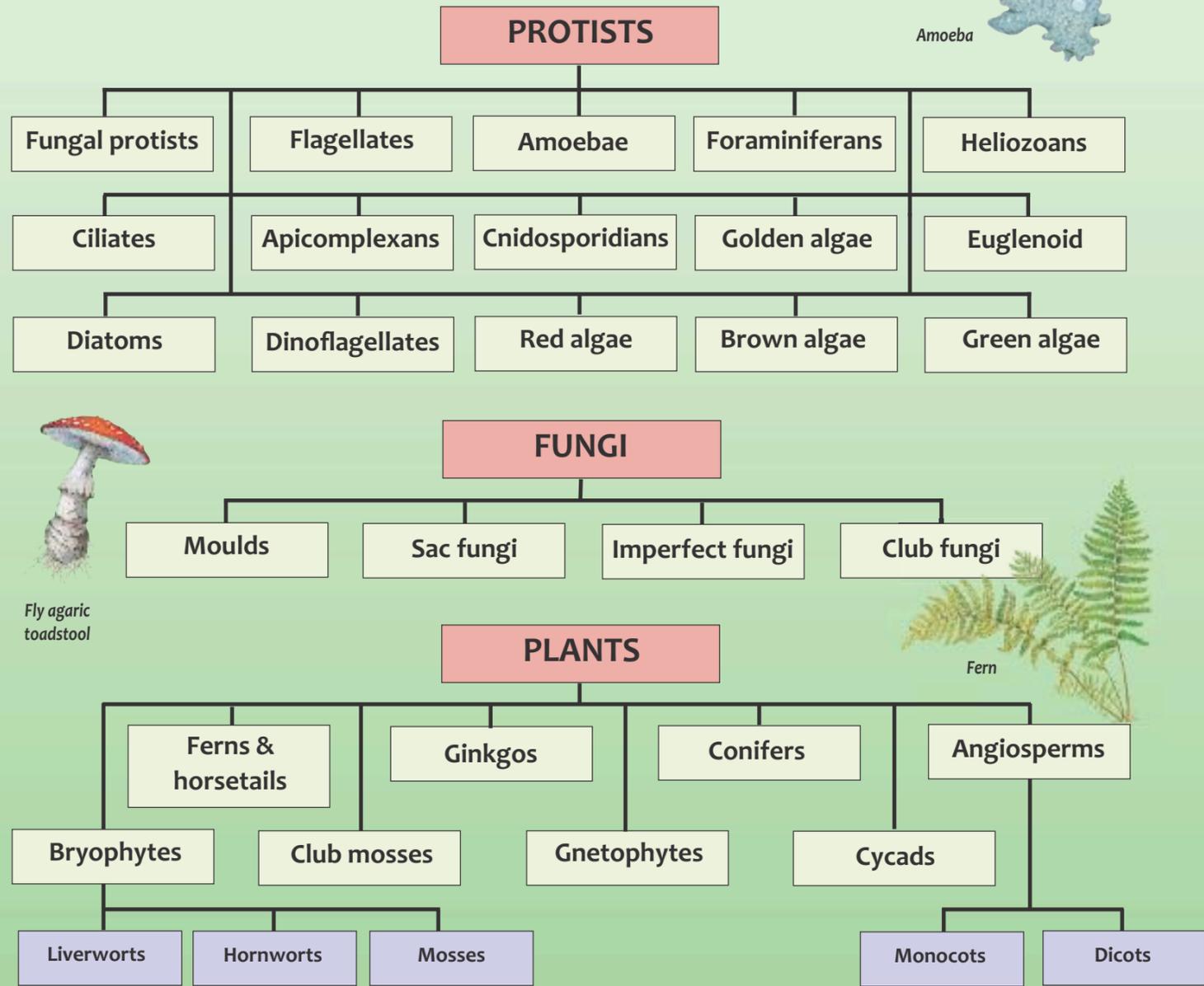
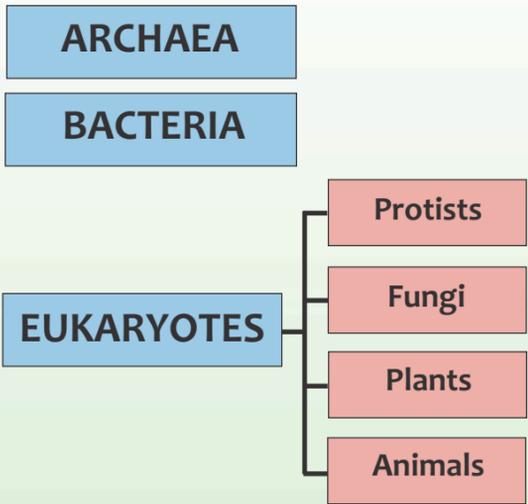
★ People once thought living things could appear from nothing. For instance, it was believed that maggots developed from rotting meat. In 1668, Italian Francesco Redi showed this was not the case by proving maggots developed from eggs laid by flies. To prove his theory, he placed meat in two jars—one open, one sealed. Days later, there were maggots only in the open jar, the one that flies had been able to enter.

**Taxonomy** The classification of all living things into ranks of varying sizes, including species, genus, family, class, order, kingdom and domain.

# CLASSIFICATION

Classification is a way of grouping all organisms together to show how they are related to one another. This chart shows how the three domains (6) of life are split into kingdoms and classified by biologists.

**KEY:** Domain (Blue box), Kingdom (Red box), Phylum/Division (Yellow box), Class (Purple box)



# EVOLUTION

**E**volution is the process by which living things gradually change; this may make them better suited to their environment. Variations within species mean that some individuals are better suited to their lifestyle than others. These individuals are more likely to survive and reproduce, passing on the features that helped them survive. However, conditions change naturally with time: some foods may become scarcer or the climate may change. Evolution may allow some organisms to survive in the new conditions.

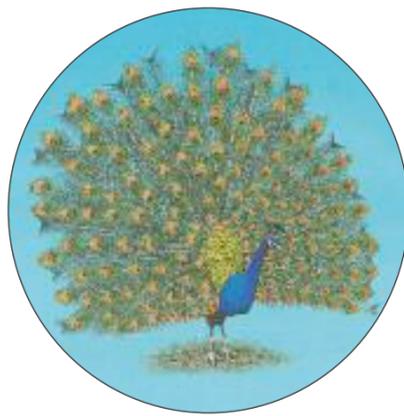
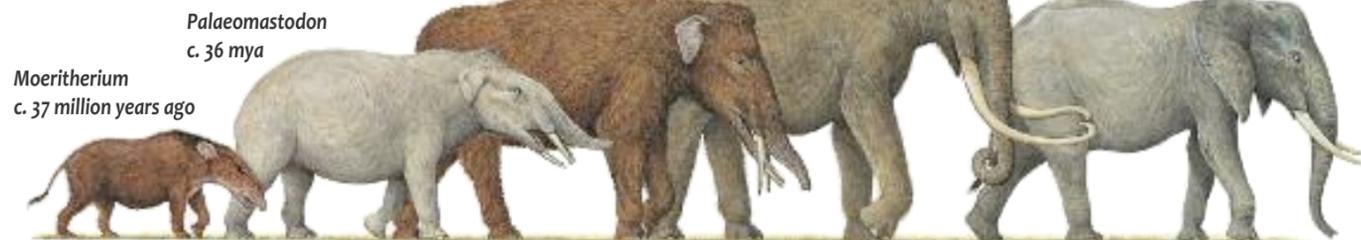


As a result of genetic mutation, albinos such as this rat (right) have no pigment in their skin, hair or eyes.

**Adaptation** The process whereby living things tend, over several generations, to become better suited to their environment. Organisms are adapted to climate, available foods and the avoidance of predators.

**Adaptive radiation** The evolution of many different species, such as Hawaiian finches, from a single species. It often happens when a species moves to a new area and individuals take to different ways of life.

Scientists can trace the evolution of a species by examining fossils. Here are some of the ancient relatives of modern elephants.



A male peacock's tail feathers show sexual selection.

**Analogous structure** A structure with the same function that is found in unrelated species. For example, the wings of birds, bats and insects are analogous, because they evolved independently.

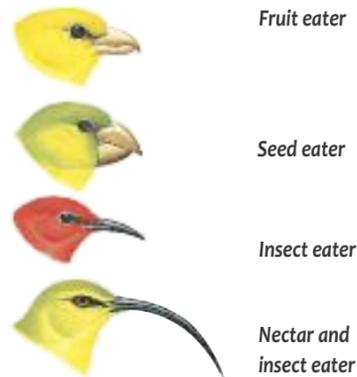
**Convergent evolution** The evolution of similar features in living things that are unrelated but whose ways of life are alike. For example, whales and sharks both have streamlined bodies and fins that enable them to move through water easily.

**Darwin, Charles (1809-1882)** British scientist who established the theory of evolution by natural selection. In 1859, he published his theory in his book *On the Origin of Species*.

**Divergent evolution** The process of two or more closely related species becoming more dissimilar, often when they live in different habitats. For example, the desert-living kit fox is paler than the woodland-living red fox, an adaptation that helps it blend in with its surroundings.

**DNA (Deoxyribonucleic acid)** A chemical inside the cells (12) of all living things. DNA can copy itself and carries the instructions (genes) needed to build and run a cell.

**Embryology** The study of animals' early development. Similarities between the embryos of mammals, birds, reptiles and fish indicate that they evolved from a common ancestor.



Hawaiian finches—an example of adaptive radiation

**Extinction** The process whereby every member of a species or subspecies dies out.

**Fossil** The remains of once-living things preserved in rock. If a dead organism is quickly buried by sand or mud, its remains may, over millions of years, turn into rock. Fossils show long-extinct organisms that provide evidence for evolution.

**Genes** A set of instructions that tell an organism how to grow and maintain itself. Genes are contained within DNA. Because they control the way cells are built, genes help determine an organism's features.

**Genetics** The branch of science that deals with **heredity**—how features are passed on, or **inherited**, from parent to offspring via the genes.

**Homologous structure** A structure shared by species that may look different but evolved from a common ancestor. For example, bat wings and human arms look different but are built from the same set of bones.

**Mendel, Gregor (1822-1884)** Austrian priest who observed that most features of a plant are determined by the features of its parents. He published his findings in 1866.



**Mutation** A change to the structure of a gene. This may occur spontaneously or be triggered by outside factors such as radiation or chemicals. Many mutations are harmful and cause damage if passed on to offspring. Some are beneficial and result in offspring that are more likely to survive, breed and pass on the mutated gene.

**Natural selection** The process whereby organisms best suited to their environment are more likely to survive and reproduce. If their offspring inherit the same features, they, too, have a better chance of survival. Individuals less well adapted may not survive to reproduce. Natural selection is the driving force of evolution.



A fossil ammonite

**Parallel evolution** The development of similar features in related, but different, species. For example, Old World and New World porcupines, which both share an ancestor, evolved spines independently.

**Sexual selection** A type of natural selection that occurs because one sex prefers certain features in individuals of the opposite sex. For example, female peahens choose their mate on the basis of his tail feathers. A male peacock with large tail feathers has a greater chance of mating and passing on his genes.

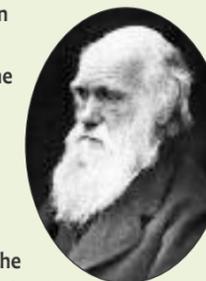
**Speciation** The formation of a new species as a result of divergent evolution. If one group within a species becomes isolated, does not breed with other groups, and so evolves separately, its members will gradually become more and more different and eventually form a new species.

## FACTFILE

★ For thousands of years, humans have bred domestic animals or crops with “desirable” features to emphasise those features in the next generation. This is called “artificial selection”.

★ Natural selection does not always make organisms more complex. Sometimes it makes creatures simpler. For example, the ancestors of fleas, like most insects, had wings. In the course of evolution, fleas have lost their wings as an adaptation to moving easily through fur or feathers.

★ Charles Darwin (right) spent five years on board the HMS Beagle, making observations about the plants and animals encountered on the ship's journey. During the expedition, he sent over 5000 fossil, plant and animal specimens back to England.



**Variations** Differences between individuals of the same species. They are the result of an individual's unique combination of genes, including inherited mutations.

**Vestigial organ** A body part that has become smaller or seemingly functionless in the course of evolution. For example, the appendix in some herbivores is large and involved in digesting plant material; in humans it is small and vestigial and plays no obvious part in digestion.

**Wallace, Alfred Russel (1823-1913)** English scientist who, independently of Darwin, proposed a theory of evolution by natural selection in the 19th century.



The embryos of a fish, turtle, cow and human all look similar: they evolved from the same ancestor.

# MICRO-ORGANISMS

**M**icro-organisms are tiny living things that are far too small for us to see without a powerful microscope. They are all around us: in the air, in the water, even inside our bodies. Micro-organisms include bacteria, viruses, protists and some fungi. Other microscopic life-forms include the young of some plants or animals.

**Alga (plural: algae)** A plant-like protist found in water or moist ground. Algae make food by photosynthesis (▶16). They range from single-celled organisms to large, multicellular forms, such as seaweed.

**Amoeba** A protozoan with no definite shape. Amoebae live in water and move by flowing like a bag full of jelly. They feed on other micro-organisms, such as bacteria, and reproduce by splitting in two.

**Apicomplexa** A group of parasitic protozoans, including the species that cause malaria in humans. Most apicomplexans invade and live inside the cells of other organisms.



Salmonella bacteria (red) invading human cells. The bacteria move with the help of tail-like flagella.



Dinoflagellate

**Aspergillus** A microscopic fungus (▶14) that grows on decaying matter and soil. Some species can cause disease in humans.

**Bacterium (plural: bacteria)** A simple single-celled organism. Bacteria are found nearly everywhere, including in air, water, ice, rocks and inside other organisms. Some bacteria cause disease in humans.

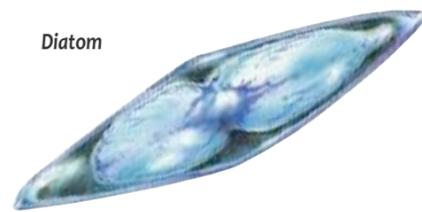
**Bacillus** A rod-shaped bacterium.

**Cell** A tiny “building block” which makes up the tissues in all living things. It is typically a bag of jelly containing a nucleus and other working parts, called organelles.

**Ciliate** A large protozoan covered with hair-like cilia. These beat back and forth to make the organism move.

**Coccus** A spherical, or ball-shaped, bacterium.

**Cyanobacterium** A bacterium, also known as blue-green algae, that produces its own food using photosynthesis (▶16).



Diatom

**Diatoms** Single-celled algae that live in ponds, rivers and oceans. Diatoms are protected by a hard case.

**Didinium** A freshwater ciliate that feeds on protists much larger than itself.

**Dinoflagellate** A marine alga with a strong, rigid cell wall and pointed horns that help it to float upright.

**Euglena** A protist that makes its food by photosynthesis (▶16) and moves by flicking its tiny, whip-like flagellum.

**Flagella** Tail-like projections that enable some micro-organisms to swim. Flagella are used in a whipping motion to propel organisms through the water.

**Foraminiferan** A small protozoan, with a rigid, case-like cell wall, like a beautifully-shaped shell.

**Heliozoan** A spherical, freshwater protozoan, surrounded by long, stiff projections that are used to catch prey.

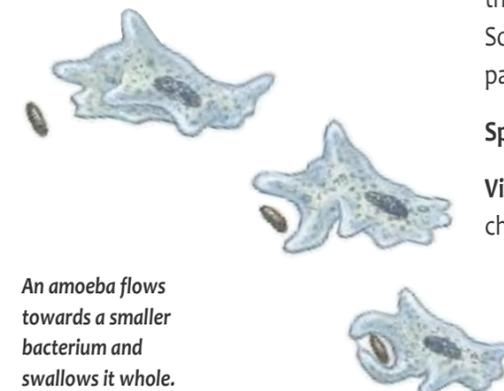


Billions of protists live in the sea.

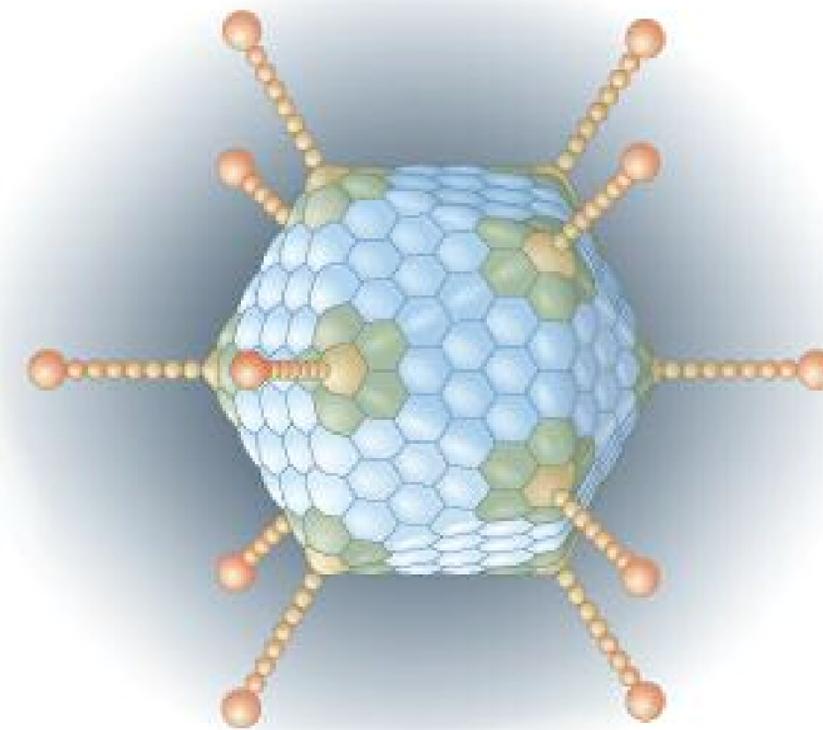
**Multicellular** Consisting of more than one cell.

**Nucleus** A large structure in some cells, that contains a cell’s genes (▶10) and therefore controls all cell activities.

**Organelle** A tiny structure inside some cells. Each type of organelle has its own specific function. The word organelle means “little organ”.



An amoeba flows towards a smaller bacterium and swallows it whole.



A computerized model of an adenovirus (above), one of the viruses that causes the common cold. It has an outer protein shell made of triangular sections. Inside it is a length of DNA.

**Prokaryote** A single-celled organism, such as a bacterium, that lacks a nucleus and organelles.

**Protist** An organism made up of a single cell containing a nucleus. Protists live mainly in water and damp places. Some (algae) make energy by photosynthesis (▶16) but others (protozoans) take in food.

**Protozoan (plural: protozoa)** A protist that obtains energy by eating food. Some protozoa sift food particles from passing water. Others actively hunt prey.

**Spirillum** A corkscrew-shaped bacterium.

**Virus** A microscopic package of chemicals that causes disease and can only reproduce by invading the cells of a living organism. Some human diseases, such as colds and flu, are caused by viruses.

**Vorticella** A transparent protozoan with a bell-shaped body attached to a stalk. Hair-like cilia waft food into its mouth.

**Yeast** A microscopic, single-celled fungus (▶14) found in soil and on plants. Yeasts contain chemicals that change sugar into alcohol and carbon dioxide gas.

## FACTFILE

- ★ Bacteria are the commonest living things.
- ★ A quarter of a million bacteria can fit on to a single pinhead.
- ★ Yeast is used in the manufacture of some food and drinks. In bread-making, it produces the gases that make dough rise.
- ★ The earliest living things on Earth were prokaryotes.
- ★ Viruses can exist in a dormant state for years when not in contact with the living cells of a host. But as soon as it infects a host, a virus becomes active and invades cells in order to reproduce.

This E. coli bacterium (above) is approximately 0.0015 mm long. It is much larger than a virus (above, left) which is only about 0.0001 mm long.

# PLANTS & FUNGI

The second largest kingdom of living things is the plant kingdom. The key feature of a plant is that it obtains energy from sunlight by photosynthesis (▶16). Plants do not have sensory organs and, although they can grow towards light or water, they cannot move freely around their environment. Fungi, once thought to be plants, are now classified as a separate kingdom. Fungi include: mushrooms, yeasts (▶13) and moulds. They decompose dead or dying plants and animals and take their energy from the nutrients they release.

**Annual plant** A plant that germinates (▶18), flowers and dies within one growing season (usually a year). Annual plants include corn, lettuce, beans and marigolds.

**Aquatic plant** A plant that lives in water.

**Biennial plant** A flowering plant that takes two years to complete its life cycle. In the first year, it stores energy obtained through photosynthesis. In the following year, it uses this energy to flower and make seeds. Biennials include hollyhocks and pansies.

**Bryophyte** A non-vascular plant, such as a moss, that absorbs water and minerals through its leaves and reproduces using spores (▶18).



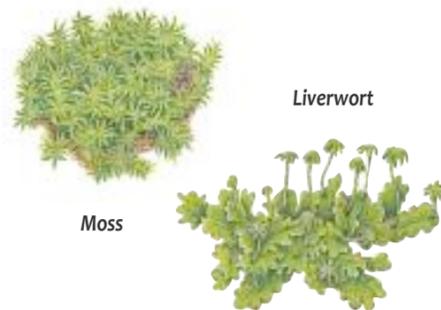
The fronds of a fern



Magnolia

**Cactus** A succulent that has adapted to open its stomata (pores) only in the cool of the night. Most cacti are covered in spines to stop animals eating them. They are one of the few plants that flourish in deserts.

**Carnivorous plant** A plant that obtains nutrients by digesting animals. Carnivorous plants live in places where soils are lacking essential minerals. They trap animals using pitfall traps, sticky surfaces and snap traps.



Moss

Liverwort

**Clubmoss** A low-growing, green plant with scale-like leaves. Club mosses reproduce using spores (▶18).

**Conifer** A cone-bearing plant, also known as a **gymnosperm**. Conifers reproduce using seeds formed in scaly cones (▶20). All conifers are bushes or trees. Most have long, narrow leaves that do not fall in autumn.

**Cycad** A palm-like woody plant that produces seeds via cones (▶20). Cycads grow in tropical regions and were common during the time of the dinosaurs.



Inside a fungus's fruiting body, a toadstool (1), fungal spores are formed (2) and released (3). In suitable conditions a spore grows a hypha (4).

**Dicot** A flowering plant with two cotyledons (▶16) and petals in multiples of four or five. Most flowers, bushes and trees are dicots.

**Epiphyte** A plant that grows on other plants for support, typically to reach more light. Epiphytes collect rainwater and leaf litter, which provide them with nutrients. Epiphytes include bromeliads and orchids.

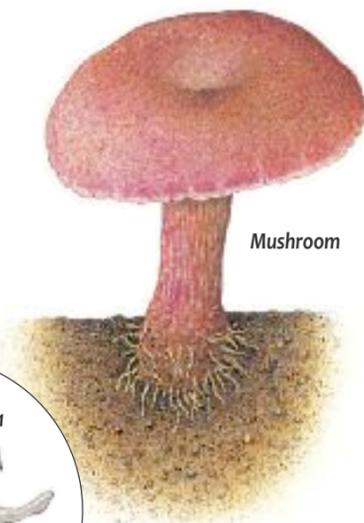
**Fern** A flowerless green plant with a long, stiff stem, and branching leaflets (▶16) known as "fronds". Ferns grow in damp places and can live in low light levels. Some tropical ferns grow as epiphytes.

**Flowering plant** A plant, also known as an **angiosperm**, that flowers and produces fruits containing seeds (▶18).

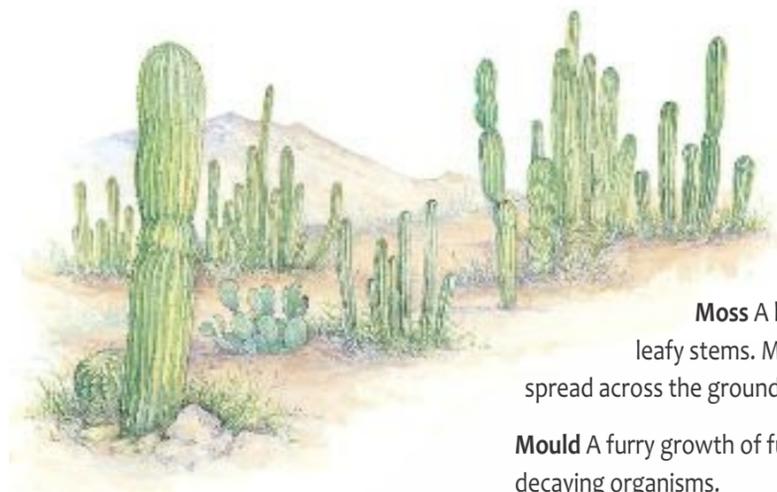
**Ginkgo** An ancient, non-flowering plant with fan-shaped leaves. The only surviving species is native to China.

**Gnetophyte** A woody, seed-bearing plant. Gnetophytes include: *Ephedra*, a shrub from the US; *Gnetum*, a tropical forest vine and *Welwitschia*, a cactus-like plant.

**Hemiparasite** A plant that obtains energy through both photosynthesis and by parasitic means. Mistletoe is a hemiparasite.



Mushroom



Assorted cacti growing in an American desert

**Moss** A bryophyte with leafy stems. Many species spread across the ground, forming a mat.

**Mould** A furry growth of fungi on damp or decaying organisms.

**Mushroom** An umbrella-shaped fruiting body, grown when a fungus reproduces. The mushroom's top, or cap, releases millions of tiny fungal spores (▶18) that blow away in the wind. Poisonous mushrooms are often called **toadstools**.

**Mycelium** The network of threads in a fungus. Mycelia grow into the bodies of dead or dying organisms, causing them to decompose. They then absorb the released nutrients.

**Non-vascular plant** A plant, such as a bryophyte, that has no tube-like vessels for carrying water and nutrients. Non-vascular plants normally live in damp places.

**Parasitic plant** A plant that takes water and nutrients from another plant, known as the host. Parasitic plants may attach themselves either to the outside or inside of the host.

**Perennial plant** A plant that lives for more than two years. Many smaller perennials are herbaceous. All trees and most shrubs are perennial.

**Shrub** A low-lying plant with woody stems branching out from a base just above the ground.

**Succulent** A plant that stores water in its stem, leaves or roots. Most succulents have small leaves and waxy surfaces in order to prevent water loss.

**Herbaceous plant** A plant whose leaves and stem die down to soil level at the end of the growing season. Herbaceous plants include irises, peonies and carrots.

**Horsetail** A spore-bearing vascular plant with a rigid, hollow stem. Horsetails are brush-like in appearance and are often found near rivers, lakes or swamps.



Crocus, a monocot

Buttercup, a dicot

**Hornwort** A flat bryophyte that releases spores (▶18) from horn-shaped capsules.

**Hyphae** A long, thin thread forming the mycelium of a fungus.

**Lichen** Algae (▶12) and fungi living together. The algae makes food via photosynthesis. The fungus gathers water and forms a protective layer over the algae. Because of this relationship, lichens are very hardy.

**Liverwort** A small, mat-like bryophyte. Liverworts have either simple leaves or flat green bodies that look like leaves.

**Monocot** A flowering plant with just one cotyledon (▶18) and petals in multiples of three. Monocots include lilies and tulips.

## FACTFILE

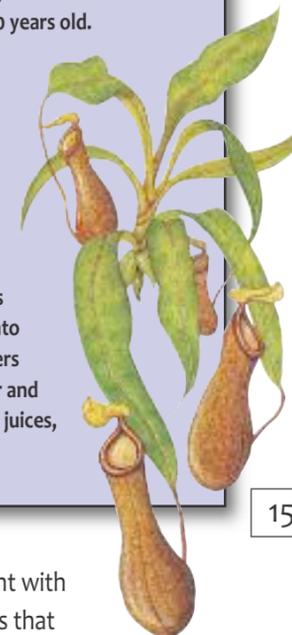
★ Flowering plants are the prevailing group of land plants around the world, except for colder regions, where coniferous plants dominate.

★ The first land plants evolved around 500 million years ago from green algae.

★ The world's oldest organism is the slow-growing Jurupa oak, found in California and believed to be 13,000 years old.

★ A scientist who studies plants is called a botanist.

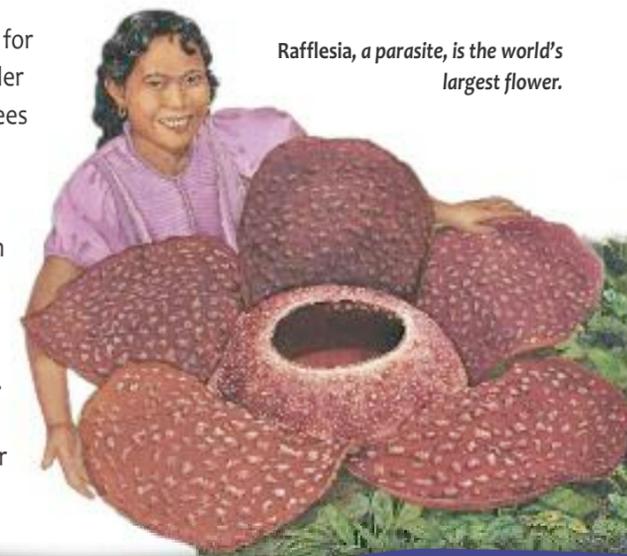
★ The pitcher plant (right), is a carnivorous plant that lures insects using the scent of its nectar. Insects fall into bottle-shaped pitchers filled with rainwater and the plant's digestive juices, and drown.



**Vascular plant** A plant with tiny, tube-like vessels that carry water, nutrients and sugar around its body. Vascular plants all have roots, stems and leaves.

**Vine** A plant with a long, thin stem that climbs up other plants, rocks or other structures for support.

Rafflesia, a parasite, is the world's largest flower.

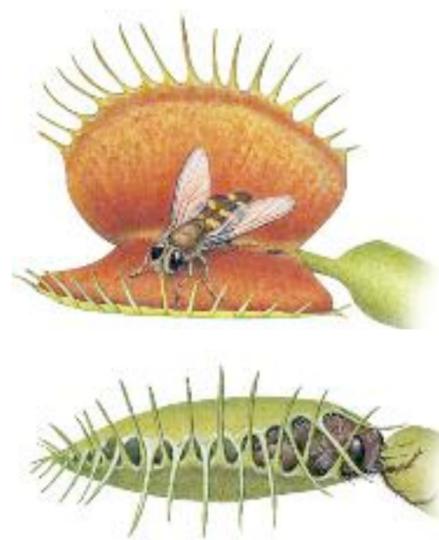


# PLANT FUNCTIONS

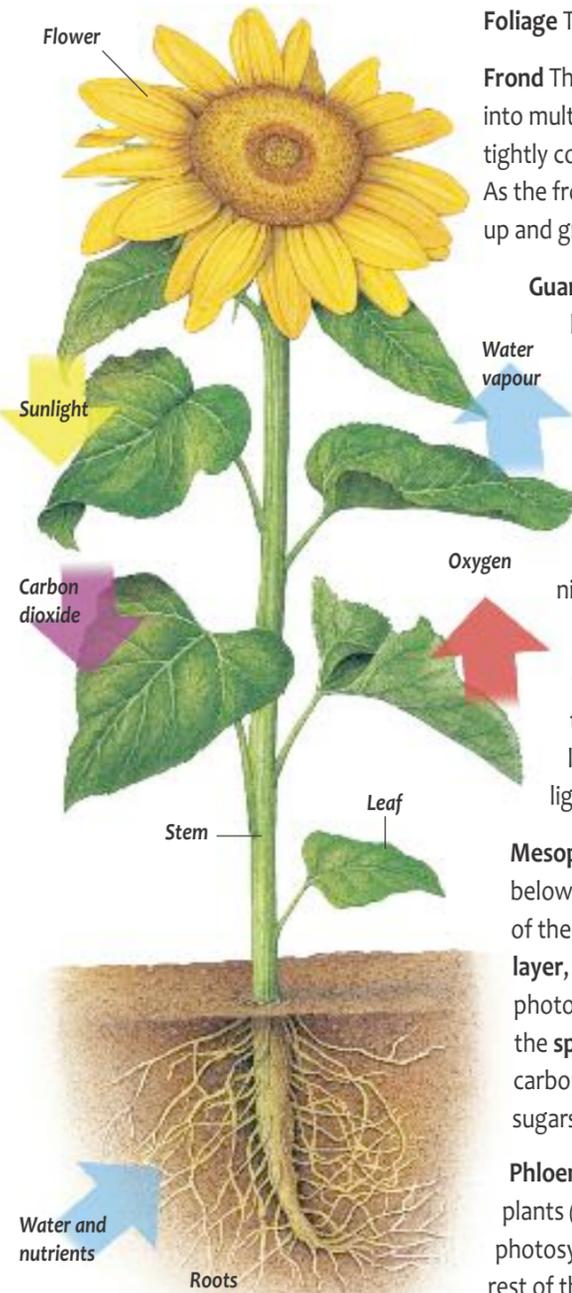
**A** plant's body has specialized parts for different jobs. Its leaves make food using energy from sunlight, a process called photosynthesis. Most plants have roots that take in water, minerals and other substances from the soil, as well as a stiff stem that supports the plant above the ground. Flowering plants have male and female parts that make seeds (➡18). Other plants reproduce either asexually (➡18) or through the dispersal of spores (➡18).

**Bud** A small growth on a stem or branch that will develop into a flower, stem or leaf. In some plants, buds are enclosed within protective, modified leaves called **scales** until they are ready to grow.

**Chlorophyll** A green pigment, present in all green plants, that absorbs sunlight and uses the sun's energy to carry out photosynthesis.



The Venus fly trap is a carnivorous plant that takes nutrients from insects instead of the soil. Like other plants, it also makes food using photosynthesis.



**Foliage** The leaves of a plant.

**Fron**d The leaf of a palm or fern, divided into multiple leaflets. Fronds grow from tightly coiled buds at the base of a plant. As the frond unrolls, its tiny leaflets open up and grow.

**Guard cells** Two crescent-shaped cells located either side of a plant's stoma. The cells become larger or smaller to adjust the size of the stoma's opening. Guard cells are activated by light so that they open the stomata during the day and close them at night to reduce water loss.

**Leaf** A flat surface on a plant where photosynthesis and transpiration take place. Most leaves are broad so that as much light as possible can fall on them.

**Mesophyll** The soft inner layer of a leaf below the epidermis. The upper layer of the mesophyll, called the **palisade layer**, contains chloroplasts for photosynthesis. The lower layer, called the **spongy mesophyll layer**, is where carbon dioxide, water vapour and sugars move around between cells.

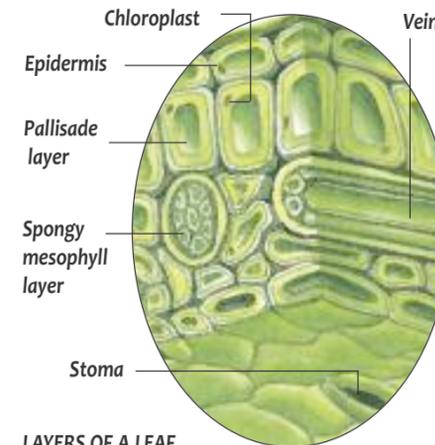
**Phloem** The tissue inside vascular plants (➡15) that carries sugars made by photosynthesis from the leaves to the rest of the plant.

**Photosynthesis** The process by which green plants use sunlight as an energy source to combine carbon dioxide from the air and water from the soil to make sugars plants use as food. Plants use this sugar to power their life activities. Photosynthesis also produces oxygen, which seeps out into the air.

**Rhizoid** A root-like structure in plants such as mosses. Rhizoids may anchor a plant to the ground, absorb water, or both. Unlike true roots, rhizoids do not contain vascular tissue (xylem and phloem).

**Rhizome** A horizontal stem that grows beneath the ground. Shoots and roots grow from the rhizome.

**Root** The part of a vascular plant (➡15) that normally grows below ground. Roots anchor a plant and take in water and dissolved minerals from the soil. The first root to grow is the **primary root**, which then sprouts sideways **lateral roots**.



LAYERS OF A LEAF

**Root hairs** Fine growths at the tip of each root. They increase the surface area of roots so they can take up more nutrients.

**Simple leaf** A leaf not divided into leaflets.

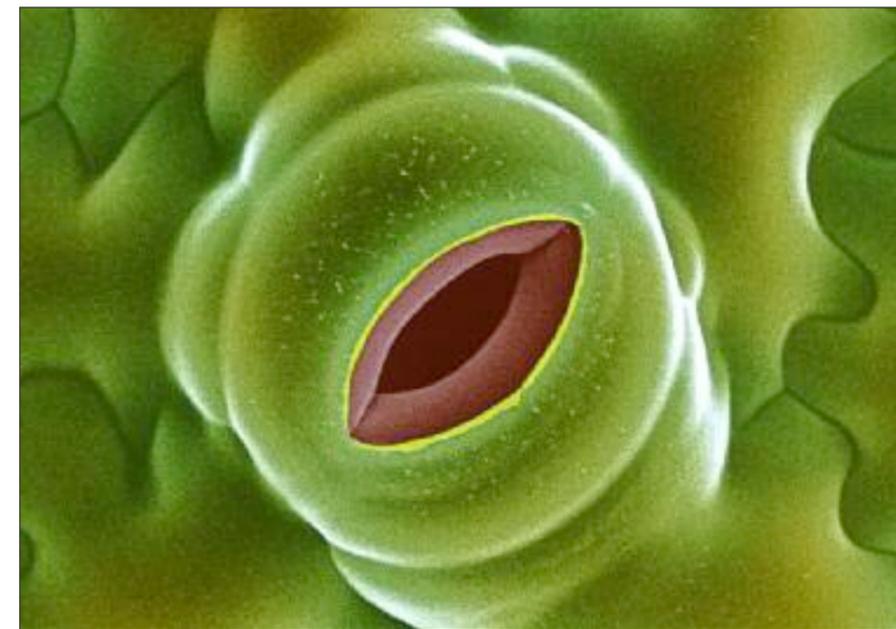
**Shoot** A new growth on part of a plant.

**Stem** The long, stiff part of a vascular plant (➡15) that supports its leaves, flowers, fruits or cones. It contains tissues that carry water and nutrients around the plant.

**Stoma (plural: stomata)** A tiny hole on the underside of a leaf, through which carbon dioxide enters and oxygen seeps out.



A compound leaf, with seven leaflets.



Close-up photograph of guard cells surrounding a stoma on the underside of a leaf.

**Tendr**il A modified leaf used by climbing plants to wrap around objects for support.

**Transpiration** The controlled release of water as vapour through a plant's stoma.

Loss of water in the leaves creates suction, which draws up water from the roots. This water carries nutrients absorbed by the roots around the rest of the plant.



A simple leaf

**Tropism** The growth or slight movement of a plant in response to a change in its environment. For example, **phototropism** is the movement of a plant towards or away from light and **geotropism** is the growth of a plant in response to gravity.

**Tuber** A thick, underground stem or root that stores food for the next growing season. Potatoes are a type of stem tuber.

**Vascular tissue** Xylem and phloem tissues that carry water, and minerals and sugars dissolved in it, around vascular plants (➡15).

**Veins** Xylem and phloem cells in a leaf that support its structure and transport water and nutrients to all of its cells.

**Xylem** The tissue in vascular plants (➡15) that carries water and dissolved minerals from a plant's roots to the rest of the plant. This liquid is called **sap**.

## FACTFILE

★ The word photosynthesis means "making with light".

★ 65-80% of a plant is made up of water.

★ The deepest living plant root ever found went 60 m below ground.

★ The largest simple leaf ever found was 3 m long and nearly 2 m wide. It belonged to an arum plant in Malaysia.

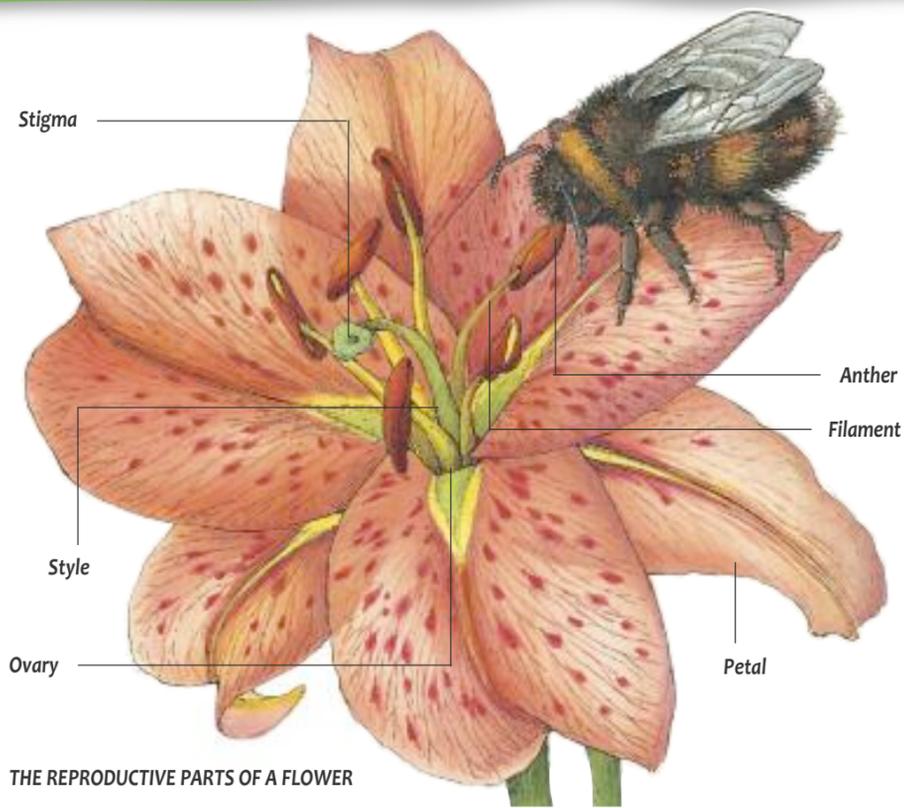
★ Some species of bamboo, grow up to 91 cm per day, making them the world's fastest-growing plants.



The edible part of a carrot is its primary root.

# FLOWERS & SEEDS

The main function of a flower is to reproduce—make seeds which grow into new plants. A typical flower has both male and female parts. The male parts produce tiny grains of pollen, which must reach the female parts of a flower of the same kind. The male cell will fuse with, or fertilize, the female cell, and the female parts will then start to develop into seeds. Seeds have a better chance of growing away from their parent plant, so many are adapted to be dispersed by wind, water or animals.



THE REPRODUCTIVE PARTS OF A FLOWER

**Berry** A small, fleshy, stoneless fruit containing one or many seeds. Berries include tomatoes and gooseberries.

**Bulb** A round, underground stem with thick leaves emerging from the top and roots emerging from the bottom. The leaves store food between growing seasons. Tulips and onions grow from bulbs.

**Carpel** The female reproductive organ of a flower, consisting of an ovary, style and stigma. Some flowers have one carpel, while others have a cluster of carpels, called a **pistil**.

**Catkin** A dangling cluster of flowers that disperse pollen via the wind. Catkins are found on willows, birches and oak trees.

**Coconut** The fruit of a coconut palm tree (19), a seed surrounded by a husk. It may fall into the sea and float to other beaches where it grows into more trees.

**Cotyledon** A leaf-like structure, otherwise known as a **seed leaf**, that is present inside a seed before it germinates. After germination, the cotyledons begin the process of photosynthesis.

**Dispersal** The process by which a plant scatters its seeds.

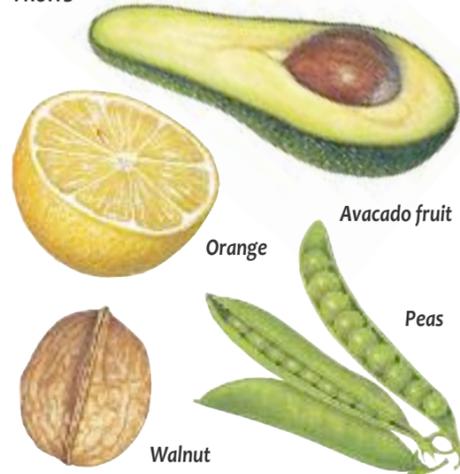
**Embryo** A young plant inside a seed.

**Endosperm** The part of a seed where food is stored for the developing embryo.

**Filament** A stalk-like part of a flower that holds the male anther.

**Flower** The reproductive part of a flowering plant. Some flowers have both male and female organs, while others have only one or the other.

## FRUITS



Avacado fruit

Orange

Peas

Walnut



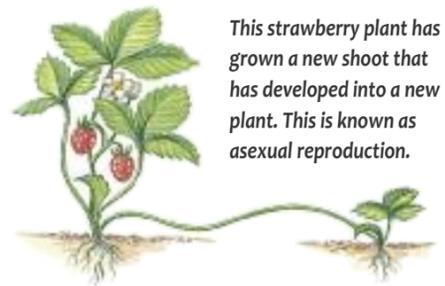
Seeds and pollen carried by the wind

**Fruit** An outer coat surrounding a seed or seeds. It is formed from a flower's ripe ovary and may be soft or hard. Some fruits have tasty flesh that attracts animals to eat them so they will disperse seeds in their droppings.

**Germination** The growth of a plant from a seed. Germination requires water, oxygen and a favourable temperature.

**Nut** A fruit with a very tough outer case.

**Ovary** A flower's female reproductive organ where egg cells, or ovules, are produced. Once the eggs are fertilized by male cells (pollen), the ovaries begin to enlarge into fruit.



This strawberry plant has grown a new shoot that has developed into a new plant. This is known as asexual reproduction.

**Petal** A leaf-like structure surrounding the reproductive parts of a flower. Together, the petals of a flower form the **corolla**. Petals are often brightly coloured to attract insects, which pollinate flowers as they move from plant to plant to drink nectar.

**Pollen** Tiny, dust-like particles produced by anthers. They contain the male sex cells.

**Pollination** The transfer of pollen from the male to the female parts of a flower. Pollen grains are light and many are carried in the air. Others are sticky and carried by animals that drink nectar from flowers.

**Seed** A small case, containing an undeveloped plant embryo and a supply of food. This provides energy for the plant to grow until it develops the ability to photosynthesize.

**Sepal** A small, green, leaf-like structure beneath the petals of a flower. The sepals protect the flower when it is in bud.



A coconut floating towards a beach where it may grow into a new tree.

**Spores** Tiny, dust-like particles that grow into new plants. Non-flowering plants such as ferns reproduce using spores, as do fungi (14). Each spore contains DNA (12) contained within a protective coat.

**Stamen** The male reproductive part of a flower, consisting of an anther and filament.

**Stigma** The part of the carpel at the end of the style, where pollen is received.

**Stone** A large hard seed inside a fleshy fruit.

**Style** The long, thin part of the carpel connecting the ovary to the stigma.

**Testa** The protective layer around a seed, also known as the **seed coat**.

**Water dispersal** The movement of seeds away from their parent plants via water. Most aquatic plants and some land plants use water as a means of dispersal.

## FACTFILE

★ Some seeds, such as those of apples, do not germinate until they have been in cold temperatures for a length of time. This shows that winter has passed and conditions are right for growing.

★ A few seeds, such as those of the ironwood tree, do not germinate unless they have been scorched by fire. Other plants will have been burnt, so the ground is bare and ready for new life.

★ The largest seed in the world comes from the giant fan palm. One fruit weighs up to 20 kg and takes around 10 years to grow to its full size.

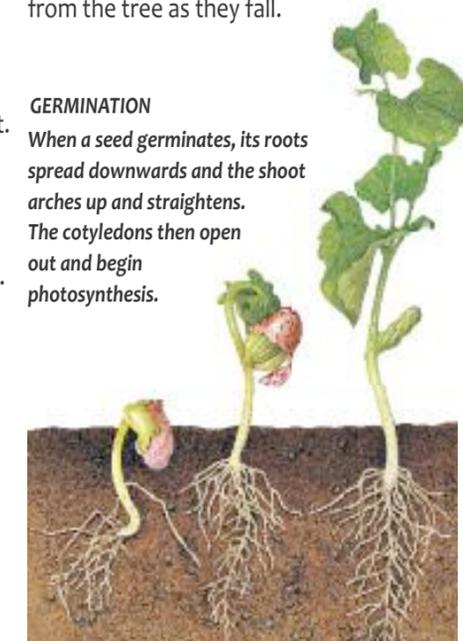
★ The smallest flowering plant in the world is the *Wolffia globosa*. It is 0.6 mm long and 0.3 mm wide.



**Wind dispersal** The movement of seeds away from the parent plant via the wind. Some seeds, such as dandelions, have fluffy "parachutes" to help them stay in the air and therefore drift further away. Others, such as sycamores, have "winged" seeds that twirl away from the tree as they fall.

## GERMINATION

When a seed germinates, its roots spread downwards and the shoot arches up and straightens. The cotyledons then open out and begin photosynthesis.



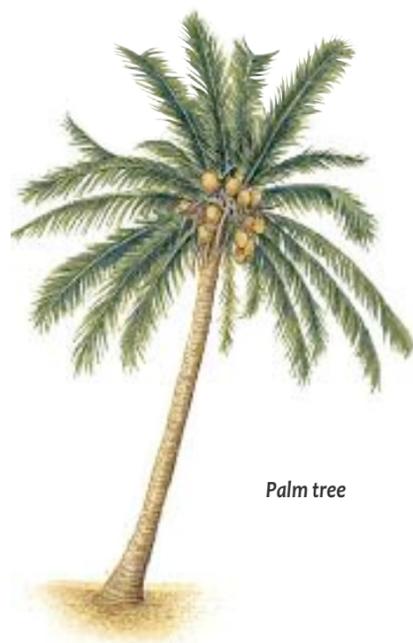
# TREES

A tree is a tall perennial plant (♣ 15) with a woody stem and branches high above the ground. Its branches, which divide into smaller twigs, spread out leaves so that they all receive as much sunlight as possible. The roots below ground anchor the tree and soak up water and nutrients from the soil. There are two main kinds of tree: broadleaf trees and conifers. Different trees have leaves of different shape. These are often the easiest way to tell different species apart.

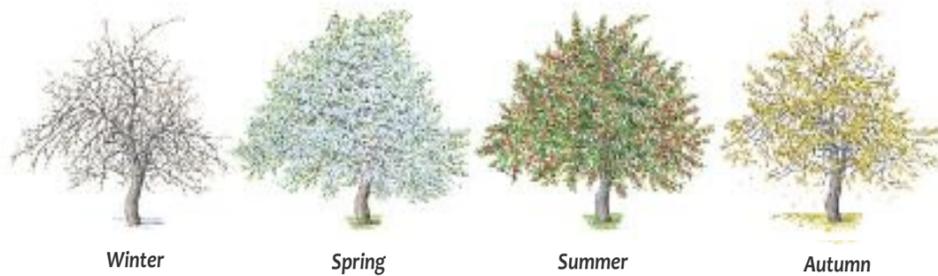
**Bark** The tough outer layer on the stem of trees, shrubs and vines. The **outer bark** protects against damage, cold and water loss. The **inner bark**, or phloem (♣ 16), carries sugars made in the leaves around the rest of the tree.

**Branch** A division of a tree trunk that supports twigs, leaves, flowers and fruit.

**Broadleaf tree** A flowering tree that produces fruits with seeds inside. Many broadleaf trees are deciduous but some, such as holly, are evergreen.

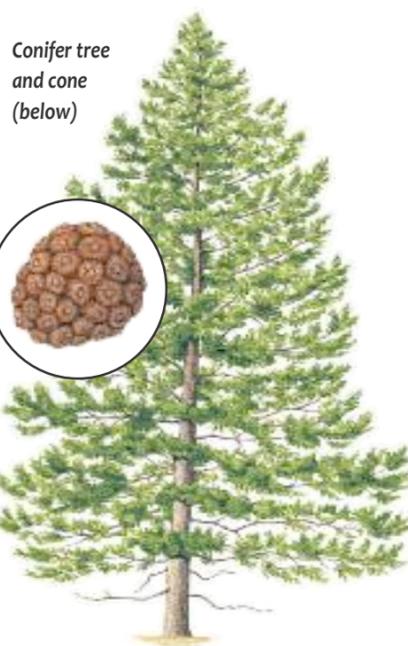


Palm tree



A deciduous tree through the seasons

**Cone** The reproductive parts of a coniferous tree. Conifers have male and female cones. When ripe, the male cone releases pollen, which is carried by the wind to female cones. Seeds then develop inside the female cone while on the tree.



Conifer tree and cone (below)

**Coniferous tree** A tree, such as a pine or fir, that grows its seeds inside cones and has needle-like leaves. Coniferous trees typically have a narrow, conical crown shape. Almost all coniferous trees are evergreen but some, such as larches, are deciduous.

**Crown** The upper branches and leaves of a tree. Each species has a characteristic shape based on the number and angle of its twigs and branches. Most crowns either have a rounded or crown shape.

**Deciduous** A tree, such as an oak, maple or birch, that sheds its leaves in the autumn. This allows it to conserve water during the cold months. In the spring it grows new leaves.

**Endogenous tree** Any tree that grows new wood interspersed with old wood fibres, rather than in a specific area of new growth. Endogenous trees include palms and cacti.

**Evergreen** A plant, such as a pine or holly, that has leaves all year round. Evergreen plants constantly lose and replace their leaves throughout the year.

**Exogenous tree** Any tree that grows in width by forming new layers of wood under the inner bark each year. Most trees are exogenous.

**Growth layer** A layer of a plant's trunk just beneath the inner bark. It makes new bark on the outside and new sapwood on the inside.

**Heartwood** The inner core of a tree's trunk made of old, hardened sapwood. The heartwood gives a tree its strong "backbone".

A giant sequoia, the biggest tree on Earth.

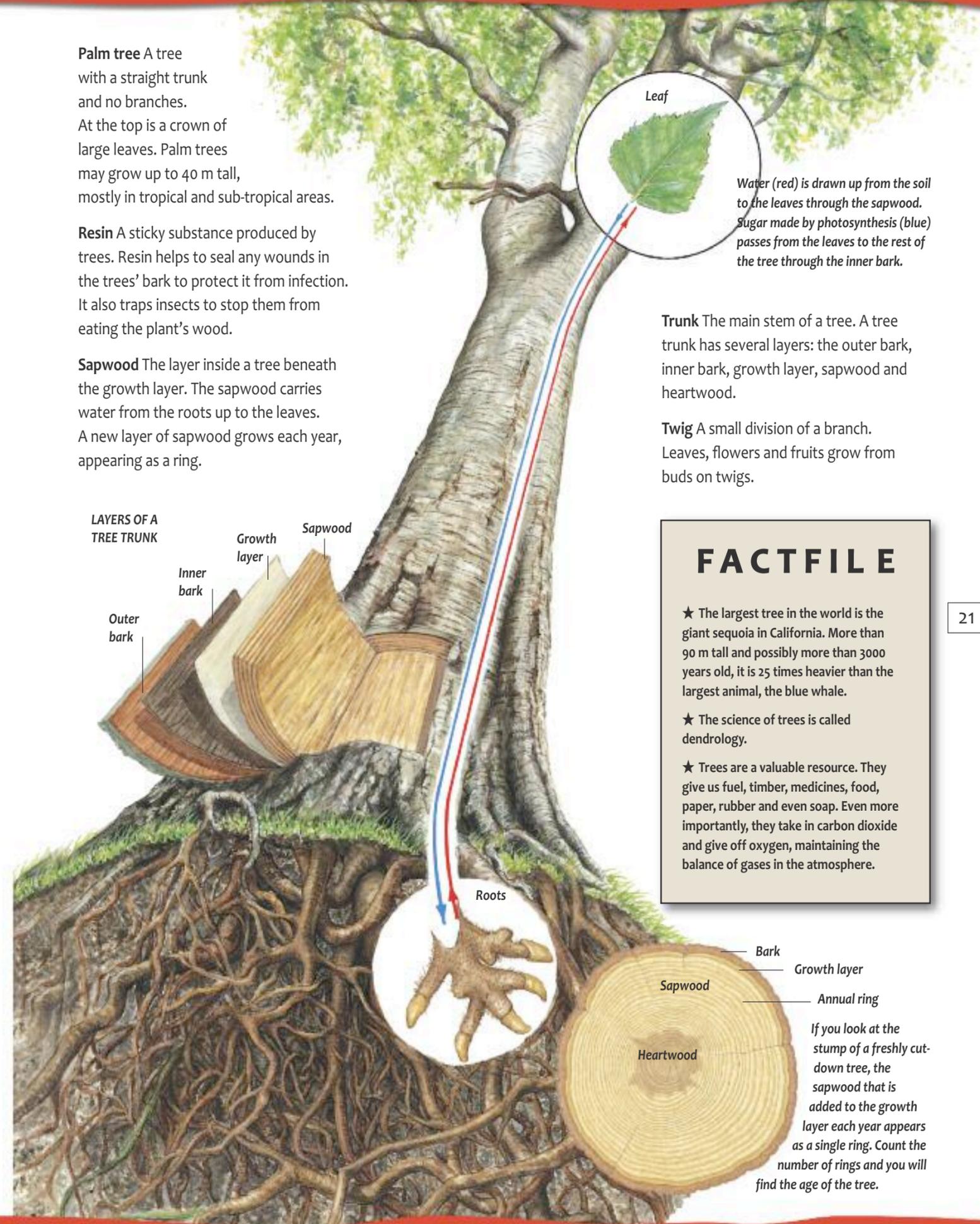
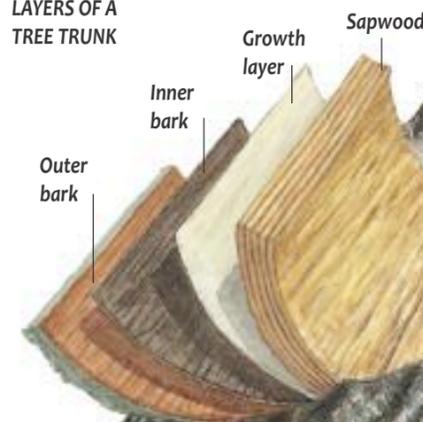


**Palm tree** A tree with a straight trunk and no branches. At the top is a crown of large leaves. Palm trees may grow up to 40 m tall, mostly in tropical and sub-tropical areas.

**Resin** A sticky substance produced by trees. Resin helps to seal any wounds in the trees' bark to protect it from infection. It also traps insects to stop them from eating the plant's wood.

**Sapwood** The layer inside a tree beneath the growth layer. The sapwood carries water from the roots up to the leaves. A new layer of sapwood grows each year, appearing as a ring.

LAYERS OF A TREE TRUNK



Leaf

Water (red) is drawn up from the soil to the leaves through the sapwood. Sugar made by photosynthesis (blue) passes from the leaves to the rest of the tree through the inner bark.

**Trunk** The main stem of a tree. A tree trunk has several layers: the outer bark, inner bark, growth layer, sapwood and heartwood.

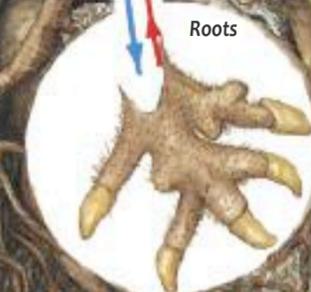
**Twig** A small division of a branch. Leaves, flowers and fruits grow from buds on twigs.

## FACTFILE

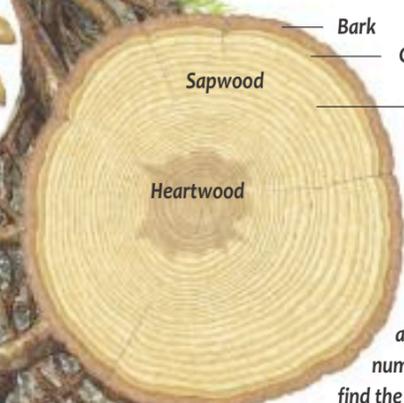
★ The largest tree in the world is the giant sequoia in California. More than 90 m tall and possibly more than 3000 years old, it is 25 times heavier than the largest animal, the blue whale.

★ The science of trees is called dendrology.

★ Trees are a valuable resource. They give us fuel, timber, medicines, food, paper, rubber and even soap. Even more importantly, they take in carbon dioxide and give off oxygen, maintaining the balance of gases in the atmosphere.



Roots



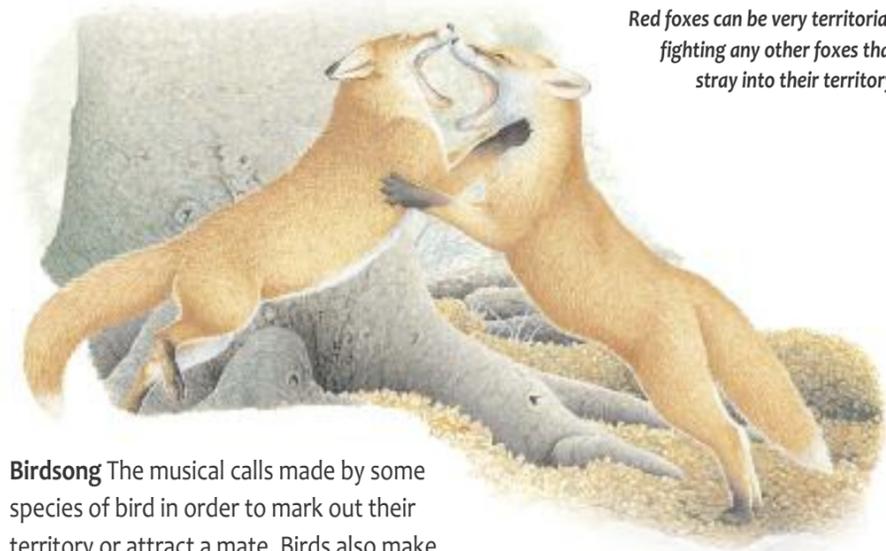
Bark  
Growth layer  
Sapwood  
Annual ring  
Heartwood

If you look at the stump of a freshly cut-down tree, the sapwood that is added to the growth layer each year appears as a single ring. Count the number of rings and you will find the age of the tree.

# ANIMAL BEHAVIOUR

**A**nimal behaviour includes all the things an animal does and how it does them, including finding food, avoiding predators, mating and breeding. It also examines the relationship of animals to their environment and to other animals. Some animals live in complex social groups. Others are usually solitary, but will group together to mate or raise their young. Most animal behaviour is directed towards increasing the chances of an animal's survival.

**Alpha animal** An individual that leads and influences the rest of its group. The alpha has the best food and the first pick of mates. He or she is often the largest, strongest or oldest member of the group. In some species, such as baboons, the alphas all descend from one "royal" family.



Red foxes can be very territorial, fighting any other foxes that stray into their territory.

**Birdsong** The musical calls made by some species of bird in order to mark out their territory or attract a mate. Birds also make shorter calls to alert others to danger.

**Brood parasite** An animal that tricks other species into raising its young. For example, cuckoos lay their eggs in the nests of other birds. The young hatch and push the eggs around them out of the nest, securing all of the nestlings' food for themselves.

**Circadian rhythm** A 24-hour body clock that guides the behaviour of most organisms, affecting patterns such as sleep and digestion. Circadian rhythms continue regardless of light and dark.

**Colony** A group of one kind of animal living together. Some animals, such as ants, form permanent colonies, co-operating to feed and breed as part of a unit. Other animals gather only to breed.

**Commensalism** A relationship between two living things in which one benefits and the other is unaffected. For example, jackals sometimes follow tigers, feeding on the remains of their kills.



Honeybees form eusocial colonies.

**Competition** The struggle for survival within or between species as they compete for limited food, water or territory. Competition allows natural selection (11) to occur, with animals better suited to their habitat and lifestyle being more likely to survive.

**Courtship** Behaviour used to attract a mate. Some animals, especially birds, have elaborate courtship behaviour, often involving "dances". It helps the animals to select partners that are sexually mature, strong, fit and healthy.

**Echolocation** The method by which some animals, such as bats and whales sometimes navigate and find their prey. They emit high-pitched sounds and listen to the echoes to build up a picture of their surroundings.

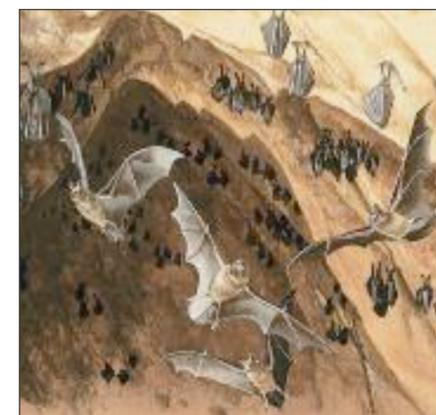
**Ethology** The study of animal behaviour.

**Eusocial animals** Animals that live in tightly organized units and depend on one another for survival. Different groups within the unit are responsible for certain tasks such as finding food, raising young or defending the group. Most eusocial animals are insects, such as ants and bees.

**Fixed action pattern** Instinctive animal behaviour as a result of an animal's genes (10). For example, it is thought that some bird courtship displays are fixed action patterns.

**Hibernation** The process whereby some mammals spend winter in a state of reduced body activity. Body temperature drops significantly, enabling the animal to conserve energy.

**Imitation** Behaviour where an animal copies another animal's actions. In the 1980s, researchers observed one Japanese macaque (a monkey) washing her food in the river, rather than brushing it off like other macaques. This useful behaviour was soon imitated by those around her.



Most bats are nocturnal. They live in large groups in dark places such as caves or trees.

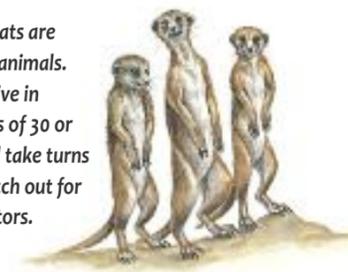


A male and female albatross perform their mating "dance"

**Imprinting** A form of learning where some newborn birds or mammals recognize and follow the first moving thing they see, usually a parent.

**Nest** A structure built by an animal or insect in which it cares for its eggs or young.

**Meerkats are social animals. They live in groups of 30 or so and take turns to watch out for predators.**



**Nocturnal** Active during the night and inactive during the day. In hot areas, animals may be nocturnal to avoid the heat of the day. Some animals, such as bats, hunt at night to avoid competition with others—in the case of bats, birds.

**Parasite** A living thing that depends on another living thing (a **host**) for needs such as food and shelter.

**Parasitoid** A parasite that kills its host. The young of some insects are parasitoid.

**Social animals** Animals that live in groups. They may share tasks such as finding food or looking out for predators. A few kinds of animals, such as wolves and lions, work together in packs to hunt.

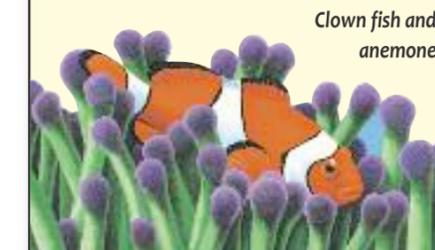
**Symbiosis** A relationship between members of two species in which one or both benefit. For example, clownfish live among the venomous tentacles of sea anemones which do not harm the fish but kill its enemies. The anemone may feed on animals attracted to the clownfish.

**Territory** An area that an animal or group of animals defends against others of its kind. This removes competition for food and protects young from potential danger. Animals mark their territory by leaving their scent around its borders, or by making loud calls.

## FACTFILE

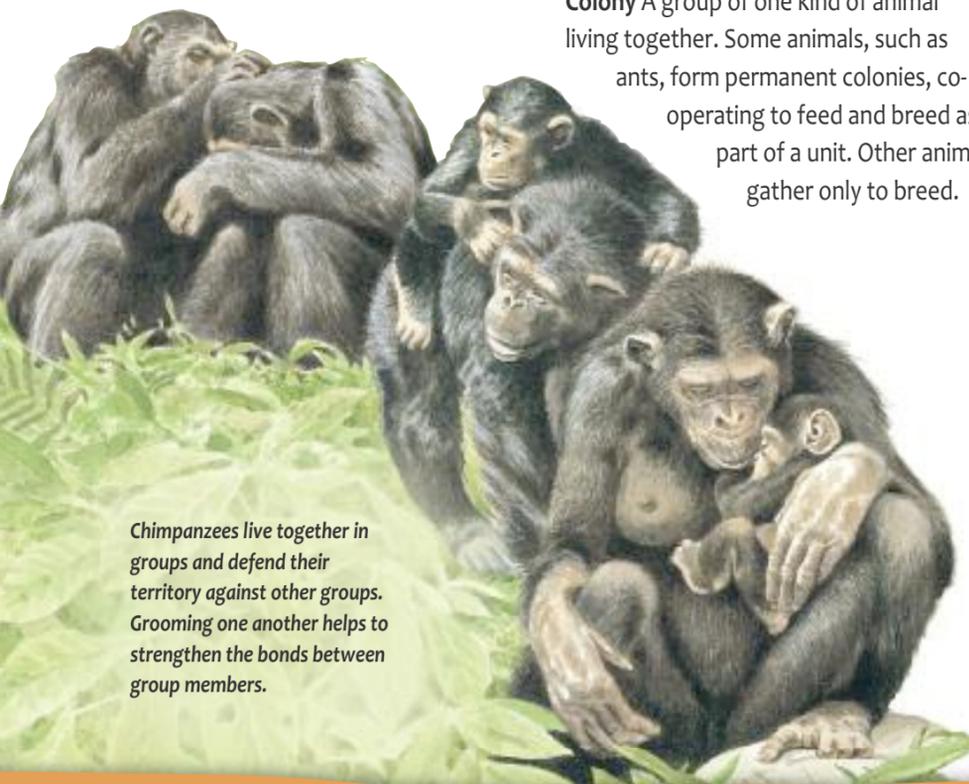
★ Animals of the same species living in different regions may have varying "dialects" in the calls they use.

★ Many animals use body language and facial expressions to communicate with one another. For example, maintaining eye contact, or staring, is a sign of aggression in many species.



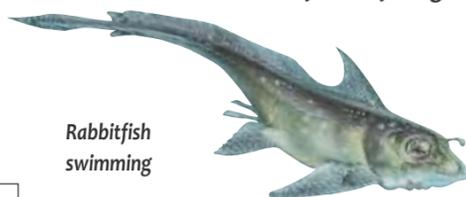
Clown fish and anemone

Chimpanzees live together in groups and defend their territory against other groups. Grooming one another helps to strengthen the bonds between group members.



# ANIMAL MOVEMENT

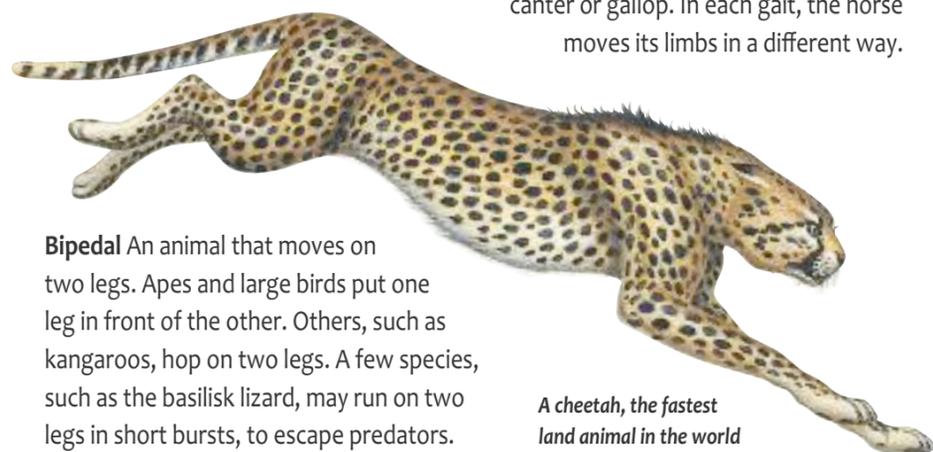
One of the key features of an animal is its ability to move around. Most creatures can run, walk, jump, hop, slither, swim or fly. Limbs are not vital for movement. Snakes are limbless, yet they can slither on the ground, swim in water and even climb trees. A few animals do not move about, at least as adults. For example, barnacles are stuck to seashore rocks, although they were mobile when they were young.



Rabbitfish swimming

**Aerial movement** Movement through the air by flying or gliding. Very small animals, such as insects, may also be picked up and carried by the wind.

**Arboreal movement** Movement through trees. Many arboreal mammals have long limbs to reach across gaps and sharp claws to grip bark. Frogs and lizards cling to trees with their sticky finger pads, and snakes use their muscular bodies to climb branches.



A cheetah, the fastest land animal in the world

**Bipedal** An animal that moves on two legs. Apes and large birds put one leg in front of the other. Others, such as kangaroos, hop on two legs. A few species, such as the basilisk lizard, may run on two legs in short bursts, to escape predators.

A spider monkey uses its prehensile tail to help it move through the treetops.

## Brachiation

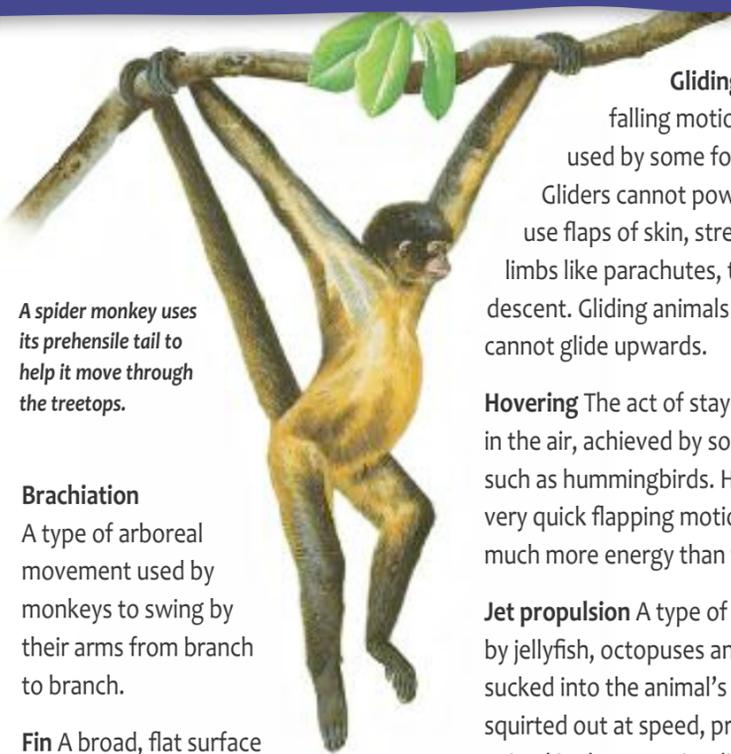
A type of arboreal movement used by monkeys to swing by their arms from branch to branch.

**Fin** A broad, flat surface projecting from the body of aquatic animals, including fish and whales, used for steering and balance.

**Flipper** A specialized limb in a marine mammal, such as a seal, used to propel it through the water.

**Flying** Movement through the air using wings. Only birds, bats and insects can fly. They flap their wings down to create a lifting force, and back to push themselves forward. There are two kinds of flapping flight: hovering and forward flight.

**Gait** The pattern in which an animal moves its limbs. Most animals have several gaits used for different speeds or terrain. For example, a horse may walk, trot, canter or gallop. In each gait, the horse moves its limbs in a different way.



## Gliding

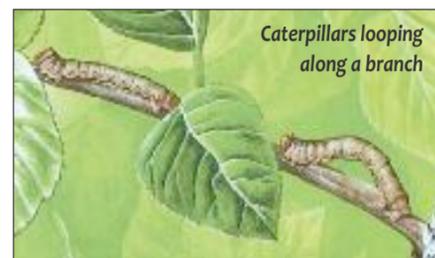
Controlled falling motion through the air, used by some forest animals.

Gliders cannot power their flight, but use flaps of skin, stretched between limbs like parachutes, to slow their descent. Gliding animals can steer but cannot glide upwards.

**Hovering** The act of staying in one position in the air, achieved by some flying animals, such as hummingbirds. Hovering uses a very quick flapping motion and burns up much more energy than forward flying.

**Jet propulsion** A type of movement used by jellyfish, octopuses and squid. Water is sucked into the animal's body sac and squirted out at speed, propelling the animal in the opposite direction.

**Jumping** A type of movement used by animals such as kangaroos, rabbits and fleas. Jumping animals have long back legs, used to power them forward.



Caterpillars looping along a branch

**Limbless movement** Movement in water or overland without the use of legs. Limbless animals use muscles in their body to propel themselves forward. Snakes slither or swim using undulatory motion. Snails and slugs crawl on one slimy foot. Earthworms use peristalsis and leeches use looping.

**Looping** A type of movement used by some caterpillars and leeches. The animal secures its rear end and reaches forward with its front end. With the front of its body in place, it pulls forward its rear end to form a loop and starts the cycle again.

**Muscle** A body part that gets shorter, or contracts, to move another body part.



Penguins swimming underwater

**Peristalsis** Wavelike muscle contractions down a tube. Earthworms, use peristalsis to crawl forwards.

**Prehensile** Capable of grasping. Some animals, such as monkeys, have a prehensile tail, used as an extra limb when climbing through the trees.



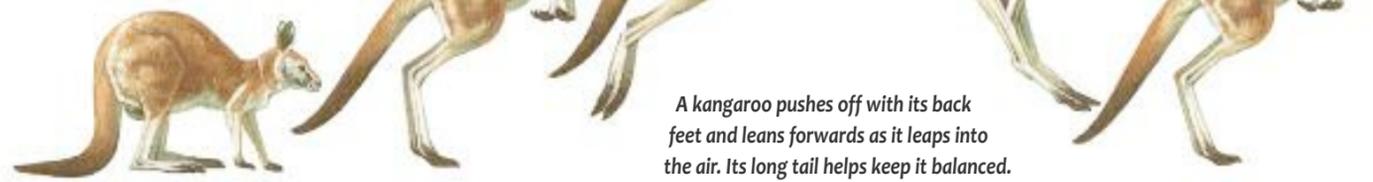
Duck flying

**Quadrupedal** An animal that moves on two legs. Most land mammals are quadrupedal.

**Sessile** An animal that is not able to move about as an adult. For example, mussels are stuck to seashore rocks, but were mobile during their young stages.

**Sidewinding** Sideways, undulatory motion used by some snakes to ease movement across sand or slippery surfaces. In the desert, snakes may sidewind so that only one patch of their body is in contact with the hot sand at a time.

**Soaring** A type of flight used by some large birds, such as eagles, to stay in the air, seldom flapping their wings. Soaring birds use rising air currents to keep them aloft. They can fly for many kilometres in this fashion, using little energy.



A kangaroo pushes off with its back feet and leans forwards as it leaps into the air. Its long tail helps keep it balanced.

## Swimming

Movement through water. Aquatic creatures must be streamlined so the water slips past them easily. Fish such as sharks swish their tails from side to side to provide a forward propulsive force, while whales move them up and down. Other aquatic animals, such as eels, move by undulation. Aquatic birds and turtles flap their limbs to "fly" through the water.

**Streamlined** A smooth shape that reduces air or water resistance. Animals that fly or swim must be streamlined so that the air or water slips past them easily and they use less energy to move through it.

**Terrestrial movement** Movement over land, by walking, running, crawling, jumping or slithering.



A sidewinder (above) moving over desert sand

## FACTFILE

★ The fastest land animal, the cheetah, sprints at more than 100 km per hour. Its sharp claws, which are permanently extended, act like spikes on running shoes, providing good grip on the ground.

★ The fastest marine animal is the sailfish, which can reach speeds of up to 110 km/h.

★ A vulture, followed by scientists in a motorized glider, was observed gliding 75 km without flapping its wings once.

★ Hummingbirds are the fastest-flapping birds, using up to 80 wingbeats per second.

★ Most gliders, such as this sugar glider (right), are able to soar up to 90 m between tree branches.



## Undulatory movement

A wave-like motion that pulls an animal's body into an S-shape. Undulatory motion is how snakes crawl and eels swim

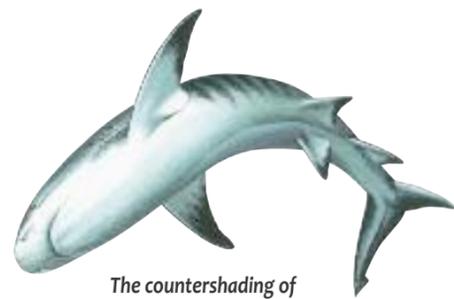
**Walking** The slowest gait in terrestrial bipedal or quadrupedal movement. When walking, at least one foot is always on the ground. In contrast, during **running**, all the feet may be off the ground at once.

**Wings** A pair of structures that enable an animal to fly by flapping. In birds and mammals these are modified front limbs. Birds have feathered wings. Bats' wings are made of skin stretched between their long fingers. Most insects have one or two pairs of wings.

# ATTACK & DEFENCE

**M**eat-eating predators obtain their food by hunting and attacking other creatures: their prey. Most predators are strong and agile, with keen senses and weapons such as sharp teeth and claws. Animals use a variety of means to defend themselves. Some have hard bodies, spines or foul-tasting flesh. Some use speed to escape, while others may fight back, kicking out with hooves or charging with tusks or horns. Safety in numbers also helps—many eyes and ears are more likely to detect predators.

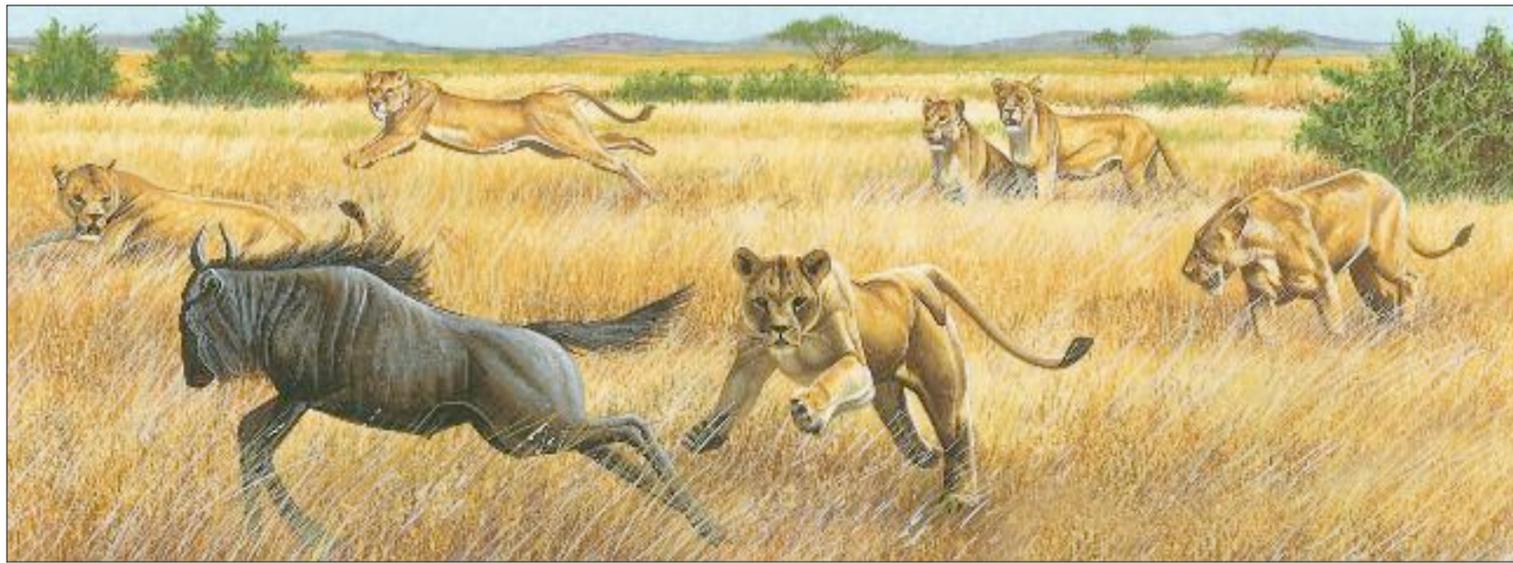
**Adrenaline** A chemical released into the bloodstream when an animal senses danger. It makes the heart beat faster, sending more blood around the body, so the muscles can work harder.



The countershading of a tiger shark

**Ambush** A surprise attack. In an ambush, a predator hides until its prey approaches, when it suddenly darts out. Ambushes use less energy than long chases.

**Apparent death** A type of self-defence where an animal feigns death if threatened. This deters those predators that prefer to make their own kill. Many snakes feign death. The Virginia opossum also uses apparent death, also called “playing possum”.



A group of female lions ambush a wildebeest.

**Armour** A hard body covering that helps protect animals. Armour may take the form of a hard shell, as in tortoises, or overlapping scales, as in armadillos. Some reptiles also have armour-like, scaly skin.

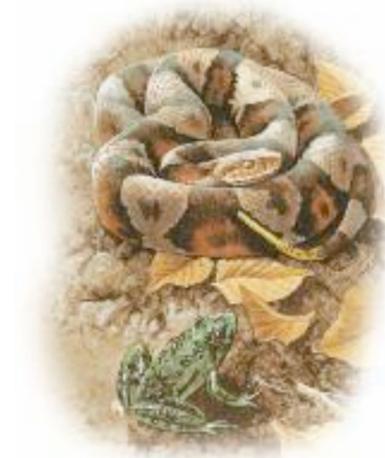
**Autotomy** The action of deliberately losing a body part, used by some animals to distract predators while they escape. For example, some lizards can shed the tip of their tail, which continues to twitch as the lizard runs away. Insects and spiders shed their limbs in a similar way.

**Camouflage** The means by which animals escape the notice of predators or prey, using their colours, patterns or body shape to blend in with their surroundings.



The talons of an owl are suited to snatching up prey.

**Chemical defence** A form of self-defence where an animal sprays toxic liquids over its attacker. This is common in insects and in some mammals, such as skunks.



A copperhead pit viper uses its yellow tail tip to attract small animals, then strikes with its fangs.

**Countershading** A type of camouflage used by many fish. A dark back enables the fish to blend in with the depths when seen from above; a pale underside enables it to merge with the light surface waters when seen from below.

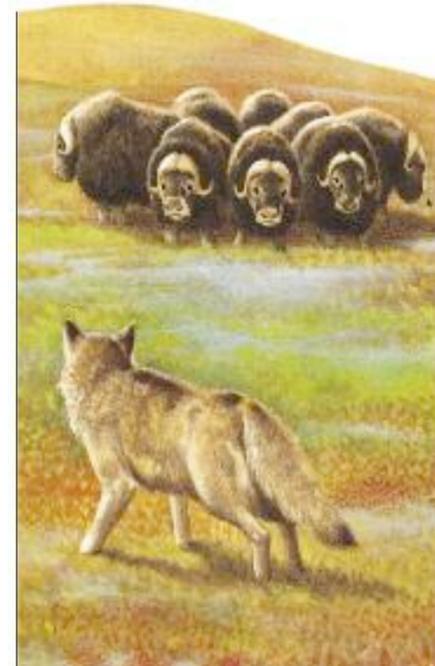
**Mimicry** A similarity between two species that protects one or both of them. Some animals mimic other, more dangerous species, in order to scare off predators. For example, some harmless flies have similar markings to bees and wasps.

**Mobbing behaviour** An attack launched by a group of animals in order to drive away an attacker. Mobbing is common in animals such as nesting birds, whose young are at risk.

**Pack-hunter** A predator that hunts as part of a group. Pack-hunters increase their chance of success by surrounding prey, or working to bring down large prey.

**Predator** An animal that kills and eats other animals.

Musk oxen form a circle around their young to defend them from wolves.



**Prey** An animal that is hunted and eaten by other animals.

**Pronking** A sudden, stiff-legged leap into the air, used by some herd animals, especially gazelles, as they run from predators. It is thought to be a signal to the pursuing predator that the individual is fit and the predator would do better to chase another animal in the herd.

Porcupine



**Spines** Sharp, needle-like protrusions on the body of animals such as hedgehogs, porcupines and porcupine fish. When threatened, a porcupine curls into a ball or backs into its attacker, leaving spines embedded in its attacker's skin.

**Startle display** A sudden action intended to intimidate or startle an attacker. Some animals flash bright colours or patterns to startle predators. Other animals suddenly puff up to make themselves appear larger, or leap out to scare their predator.

**Sting** A short, sharp organ belonging to some animals, such as bees, ants and scorpions. Stings inject venom into other animals, in order to paralyze or kill prey, or harm attackers.

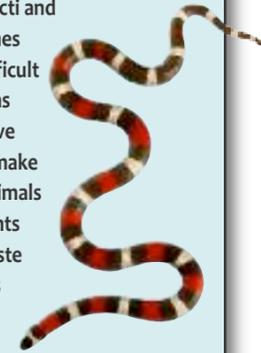
**Venom** A poisonous substance found in the bodies of some animals, including species of snake, spider, scorpion and fish. It can be used for killing prey or defence, and is usually injected with a sharp sting or bite. Venomous predators may give warning that they are about to strike.

## FACTFILE

★ When attacked, a sea cucumber can squirt out its insides as a distraction whilst it escapes. It later grows them back!

★ Most predators depend on stealth to creep up on prey. Owls' feathers have soft edges so they make hardly any sound as they fly. Cat's paws enable them to pad softly over ground without being heard.

★ Plants also need defences from being eaten by animals. Because they are rooted to the ground, they cannot escape. Some varieties, such as cacti and brambles, have spines that make them difficult to eat. Some, such as stinging nettles, have stinging hairs that make them painful for animals to touch. A few plants are poisonous or taste foul to stop animals eating them.



The harmless milk snake (above) mimics the bright colours of the venomous coral snake.

**Warning colours** Bright colours and markings that warn that an animal tastes bad or is poisonous to eat. Certain fish, beetles, caterpillars, moths and butterflies have horrible-tasting or poisonous flesh. Predators soon learn to avoid them because they recognize their colours. Warning colours may also signal that an animal is venomous. For example, several venomous snakes are brightly coloured.



The caterpillar of a hercules moth is brightly coloured and covered in spines in order to deter predators from eating it.

# MIGRATION

**M**igration is the movement of an animal or a group of animals from one place to another. This usually takes place once a year, in a certain season. Animals may migrate to find food or to reach conditions more suitable for breeding. Migrations take place over land, by air and by water. Birds migrate the farthest, because flight enables them to cover long distances. An animal that migrates is called a migrant.



Every autumn, monarch butterflies migrate from Canada to Mexico, where they cluster in their millions on tree trunks.

**Complete migration** A migration where all members of a species migrate together. Complete migrations are typical of caribou (reindeer) and many birds, including warblers and shorebirds.

**Homing** The ability of an animal to travel towards a set location, such as a home or breeding ground, from an unfamiliar starting point. Homing may depend on celestial, magnetic or olfactory navigation. Pigeons are well known homing birds.

**Irruption** Any migration that occurs at random intervals. Irruptions may involve some, many or all of a population. For example, lemmings are known for their irruptive migrations, which occur if there is a shortage of food, or if they become overcrowded.

**Latitudinal migration** The movement of animals north and south to different climates. In the northern hemisphere, the north is colder than the south, and many animals migrate south for the winter. Animals return in the summer when the north is warmer and food is plentiful once more.



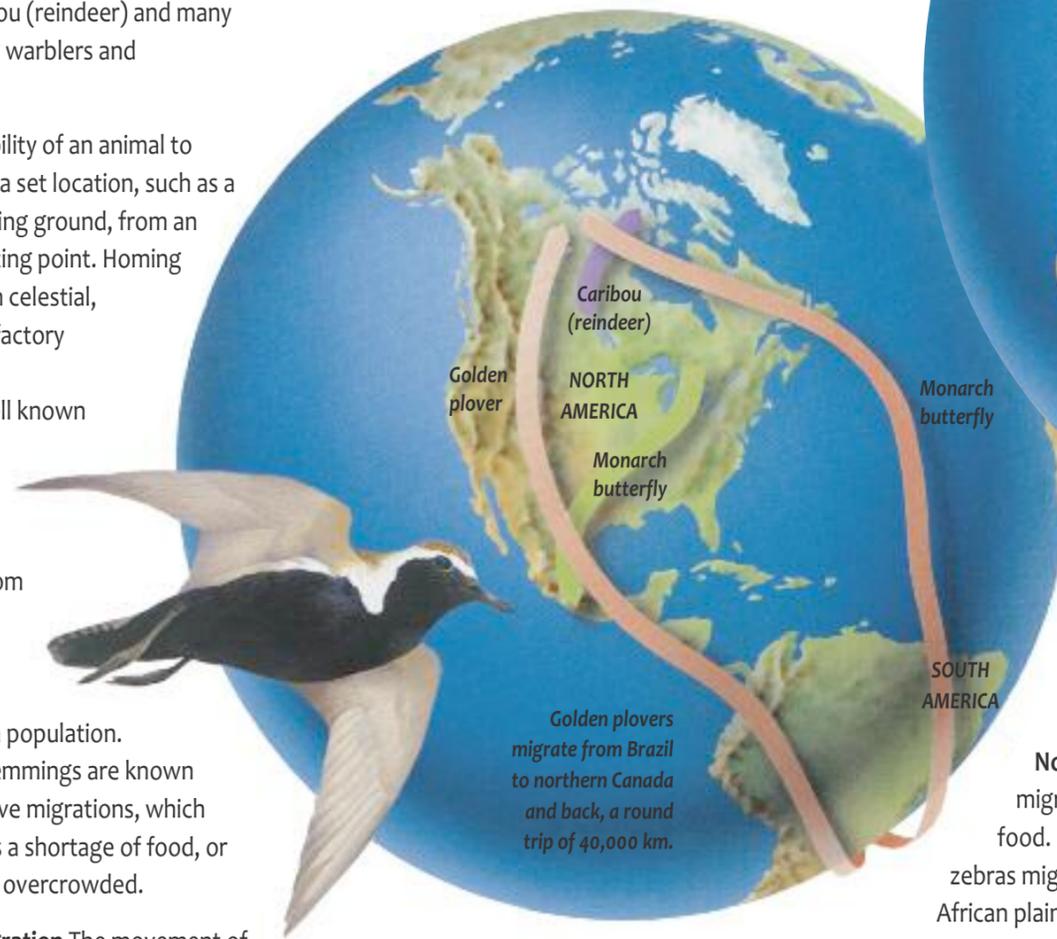
The noctule bat flies up to 1600 km across eastern Europe in the spring.

## Altitudinal migration

The movement of animals from a high altitude to a lower one, for example up and down a mountain. Many animals leave mountain peaks in winter as plants become covered in snow.

**Celestial navigation** Navigation using the stars, sun and moon. For example, it is thought that starlings navigate using the sun to tell which direction they are flying in. Warblers, flycatchers and other night-time flyers are thought to navigate by referring to the position of the stars.

**Compass navigation** The ability of an animal to travel in a compass direction, for example north, without reference to landmarks and regardless to starting point.



**Magnetic navigation** Some animals can detect the Earth's magnetic field and use it as a guide when they migrate. Bats, sea turtles and birds use magnetic navigation. Scientists think they can do this because their brains contain tiny particles of a magnetic mineral called magnetite.



Each year, swarms of locusts fly 3200 km around the Sahara desert. in a nomadic migration.

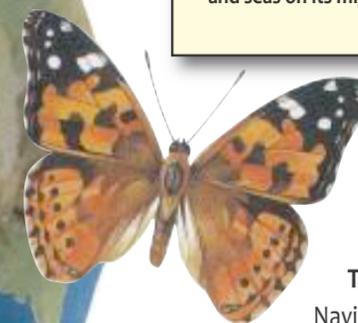


The willow warbler's migration takes it from Siberia to the southern tip of Africa each winter.

**Olfactory navigation** Navigation that relies on mental maps based upon scent. Olfactory navigation is usually used over small distances. Salmon and some species of salamander are believed to use olfactory navigation during migrations.

## FACTFILE

- ★ Caribou (reindeer) migrate farther overland than any other animal, walking up to 1300 km every spring from the coniferous forests of Canada to their summer pastures in the Arctic.
- ★ Many migrating animals feed intensively before migrating, in order to build up their fat reserves for the journey.
- ★ A willow warbler's body holds enough energy to enable it to fly 60 hours non-stop. This enables it to fly across deserts and seas on its migratory route.



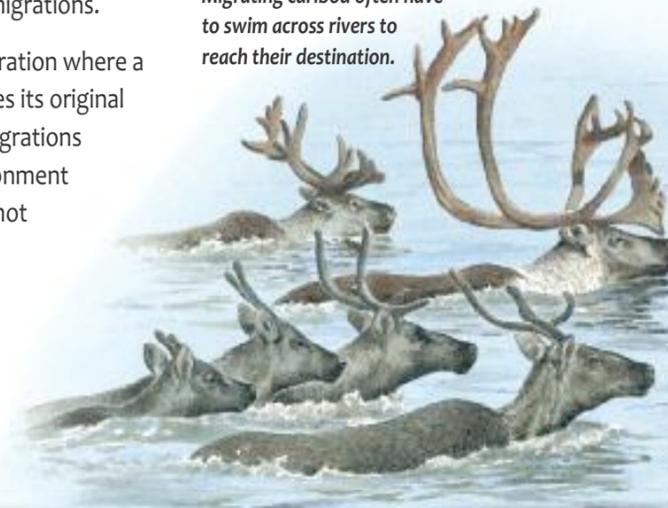
Painted ladies are the farthest-travelled Old World (not from Americas) butterflies.

## True navigation

Navigation that depends on recognition of major landmarks such as rivers, mountain ranges or even roads and cities. Marine animals, such as dolphins, navigate by remembering the shape of the ocean floor.

**V-formation** A pattern formed by migrating birds in the air in order to save energy. Air movements caused by the flapping of the bird in front provide extra lift for the birds behind it. Geese, ducks, pelicans and cranes all fly in this formation.

*Migrating caribou often have to swim across rivers to reach their destination.*



## Partial migration

The migration of just some members of a species, usually to breed. The herring gull, red-tailed hawk and golden eagle are all partial migrants. Partial migrations are much more common than complete migrations.

**Removal migration** A migration where a species permanently leaves its original environment. Removal migrations take place when an environment is destroyed or if there is not enough food to go round.

**Seasonal migration** Migration that matches the change in seasons. Most animal migrations are seasonal.

**Navigation** The ability of an animal to travel from one point to another

**Nomadic migration** The random migration of animals in search of food. For example, wildebeest and zebras migrate nomadically across the African plains. Once they have eaten the plants in one area they move to another.

# INDEX

## A

adaptation 10-11  
adaptive radiation 10  
adrenaline 26  
algae 12-13, 15  
  brown 8  
  golden 8  
  green 8, 15  
  red 8  
alpha animal 22  
ambush 26  
amoebae 8, 12-13  
analogous structure 10  
angiosperm 8, 14  
animal movement 24-25  
  aerial 24  
  arboreal 24  
  limbless 24  
  terrestrial 25  
  undulatory 25  
animals 6-11, 22-29  
  behaviour in 22-23  
  courtship in 22-23  
  methods of attack by 26-27  
  methods of defence by 26-27  
anther 18-19  
apicomplexa 8, 12  
apparent death 26  
archaea 6-8  
armour 26  
artificial selection 11  
asexual reproduction 16, 18-19  
*Aspergillus* 12  
autotomy 26

## B

bacillus 12  
bacteria 6-8, 12-13  
bark 20-21, 24  
berry 18  
bipedal 24-25  
birdsong 22  
brachiation 24

branch 16, 20-21  
breeding 22, 28  
bromeliad 14  
bryophyte 8, 14-15  
bud 16, 19  
bulb 18

## C

cactus 14-15, 20, 27  
camouflage 11, 26  
carbon 6  
carbon dioxide 13, 16-17  
carpel 18-19  
catkin 18-19  
cells 6-7, 10, 12-13, 16-19  
chemical defence 26  
chlorophyll 16  
chloroplast 16-17  
cilia 12-13  
ciliate 8, 12  
circadian rhythm 22  
class 6-9  
classification 6-9  
clubmoss 8, 14  
coccus 12  
coconut 18-19  
colony 22  
commensalism 22  
competition 22-23  
cone 14, 17, 20  
conifers 8, 20  
corolla 19  
cotyledon 14-15, 18-19  
countershading 26  
crown (tree) 20-21  
cyanobacterium 12  
cycad 8, 14

## D

Darwin, Charles 10-11  
deciduous 20  
diatoms 8, 12  
dicot 8, 14-15  
*Didinium* 12  
digestion 11, 22

dinoflagellate 8, 12  
disease 13  
dispersal 18-19  
  animal 18  
  ballistic 18  
  water 19  
  wind 19  
division 7, 8-9  
DNA 7, 10, 19  
domain 6-8

## E

echolocation 23  
embryo 11, 18-19  
embryology 10  
endosperm 18  
epidermis 16-17  
epiphyte 14  
ethology 23  
*Euglena* 12  
eukaryotes 6, 8-9  
eusocial animals 23  
evergreen 20  
evolution 10-11  
  convergent 10  
  divergent 10  
  parallel 11  
extinction 10

## F

family 6-7  
fern 8, 14, 16, 19  
fertilization 18-19  
filament 18-19  
fin 24  
fixed action pattern 23  
flagella 13  
flipper 24  
flowers 14, 16-19, 21  
flying 24-25  
foliage 16  
foraminiferan 8, 13  
fossils 10-11  
frond 14, 16  
fruits 14, 17, 18-21

fungi 6-9, 12-15, 19  
  club 8  
  imperfect 8  
  sac 8

## G

gait 24  
genes 10-11, 13, 23  
genetics 11  
genus 6-7  
geotropism 17  
germination 14, 18-19  
ginkgo 8, 14  
gliding 24-25  
gnetophyte 8, 14  
growth layer (tree) 20-21  
guard cells 16-17  
gymnosperm 14

## H

heartwood 20-21  
heliozoan 8, 13  
hemiparasite 14  
heredity 11  
hibernation 23  
homing 28  
homologous structure 11  
hornwort 8, 15  
horsetail 8, 15  
host 23  
hovering 24  
hybrid 7  
hyphae 15

## IJK

imitation 23  
imprinting 23  
inheritance 11  
irruption 28  
jet propulsion 24  
jumping 24-25  
kingdom 6-9, 14

## L

leaflet 14, 16-17  
leaves 14-15, 17, 18, 20-21  
  compound 16-17  
  simple 15, 17  
lichen 15  
limb 24-25  
Linnaeus, Carolus 7  
liverwort 8, 14-15  
looping 24

## M

mating 22  
Mendel, Gregor 11  
mesophyll 16  
micro-organisms 12-13  
migrant 28  
migration 28-29  
  altitudinal 28  
  complete 28  
  latitudinal 28  
  nomadic 29  
  partial 29  
  removal 29  
  seasonal 29  
mildew 6  
mimicry 26-27  
minerals 7, 16  
mobbing behaviour 27  
monocot 8, 15  
moss 8, 15  
mould 6, 8, 14-15  
multicellular 12-13  
muscle 24  
mushroom 6, 14-15  
mutation 10-11  
mycelium 15

## NO

natural selection 10-11, 22  
navigation 28-29  
  celestial 28  
  compass 28  
  magnetic 28  
  olfactory 28-29  
  true 29

nest 23  
nocturnal 23  
nucleus 6-7, 12-13  
nutrients 14  
nut 18-19

## O

order 6-7  
organelles 6, 12-13  
organisms 8-13, 15, 22  
  single-celled 6, 12-13  
ovary 18-19  
oxygen 16-17, 19

## P

pack-hunter 27  
palisade layer 16-17  
palm tree 18-20  
parasite 23  
  brood 22  
parasitoid 23  
peristalsis 25  
petal 14-16, 18-19,  
phloem 16-17, 20  
photosynthesis  
  7, 12-19, 21  
phototropism 17  
phylum 6-9  
pistil 18  
plants 6-8, 11, 14-15, 19  
  annual 14  
  aquatic 14, 19  
  biennial 14  
  carnivorous 14, 16  
  coniferous 15  
  flowering 14  
  functions of 16-17  
  herbaceous 15  
  non-vascular 15  
  parasitic 15  
  perennial 15, 20  
  succulent 15  
  vascular 15, 16-17  
pollen 18-20  
pollination 18-19  
predator 26-27

prehensile 24-25  
prey 26-27  
prokaryote 13  
pronking 27  
protein 13  
protists 6-8, 12-13  
protozoan 12-13

## QR

quadrupedal 25  
rank 6-7  
reproduction 7  
resin 21  
respiration 7  
rhizoid 16  
rhizome 17  
root hairs 17  
roots 15, 16-21  
  primary 17  
  vascular 17  
running 25

## S

sap 17  
sapwood 21  
scientific name 7  
seed coat 19  
seed leaf 18  
seeds 14, 16, 18-20  
sepal 19  
sessile 24-25  
sexual selection 10-11  
shoot 17, 19  
shrub 14-15, 20  
sidewinding 25  
soaring 25  
social animals 23  
speciation 11  
species 6-7, 10-12, 14-15,  
  17, 20, 22-24, 26-29  
spirillum 13  
spongy mesophyll  
  layer 16-17  
spores 6, 14-16, 19  
stamen 18-19  
startle display 27  
stem 15, 16-18

stigma 18-19  
sting 27  
stoma 14, 16-17  
stomata see stoma  
style 18-19  
subspecies 7, 10  
swimming 24-25  
symbiosis 23

## T

taxonomy 6-7  
tendrils 17  
territory 22-23  
testa 19  
toadstool 8, 14-15  
transpiration 16-17  
trees 14, 19, 20-21  
  broadleaf 20  
  coniferous 20  
  endogenous 20  
  exogenous 20  
  palm 21  
tropism 17  
trunk 20-21  
tuber 17  
twig 21

## V

variations 10-11  
vascular tissue 16-17  
venomous 23, 27  
vestigial organ 11  
v-formation 29  
vine 15, 20  
virus 12-13  
*Vorticella* 13

## WXY

walking 24-25  
Wallace, Alfred Russel 11  
warning colours 27  
wings 25  
xylem 16-17  
yeast 6, 13, 14

