

Characteristics and Classification of Living Organisms

Characteristics of Living Organisms:

All living organisms, whether they are single celled or multicellular, plants or animals, show the characteristics included in the definitions below: movement, respiration, sensitivity, growth, reproduction, excretion and nutrition.

One way of remembering this list of the characteristics of living things is by using the mnemonic **MRS. GREN**.

1. **Movement:** an action by an organism or part of an organism causing a change of position or place.
2. **Respiration:** the chemical reactions in cells that break down nutrient molecules and release energy for metabolism.
3. **Sensitivity:** the ability to detect or sense stimuli in the internal or external environment and to make appropriate responses.
4. **Growth:** a permanent increase in size and dry mass by an increase in cell number or cell size or both.
5. **Excretion:** removal from organisms of the waste products of metabolism (chemical reactions in cells including respiration), toxic materials, and substances in excess of requirements.
6. **Nutrition:** taking in of materials for energy, growth and development; plants require light, carbon dioxide, water and ions; animals need organic compounds and ions and usually need water.

Concept and Use of a Classification System:

Organisms can be classified into groups by the features that they share.

Species: a group of organisms that can reproduce to produce fertile offspring.

Binomial System of Naming Species: an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species.

By classifying organisms, it is possible to identify those most at risk of extinction. Strategies can then be put in place to conserve the threatened species.

By classifying organisms, it is also possible to understand evolutionary relationships. Vertebrates all have the presence of a vertebral column, along with a skull protecting a brain, and a pair of jaws (usually with teeth). By studying the anatomy of different groups of vertebrates it is possible to gain an insight into their evolution.

Classification is traditionally based on studies of **morphology** (the study of the form, or outward appearance, of organisms) and **anatomy** (the study of their internal structure, as revealed by dissection).

The use of **DNA** has revolutionized the process of classification. Eukaryotic organisms contain chromosomes made up of strings of genes. The chemical which forms these genes is called DNA (which is short for deoxyribonucleic acid). The DNA is made up of a sequence of bases, coding for amino acids and, therefore, proteins. Each species has a distinct number of chromosomes and a unique sequence of bases in its DNA, making it identifiable and distinguishable from other species. This helps particularly when different species are very similar morphologically (in appearance) and anatomically (in internal structure).

The process of biological classification called **cladistics** involves organisms being grouped together according to whether or not they have one or more shared unique characteristics derived from the group's last common ancestor, which are not present in more distant ancestors. Organisms which share a more recent ancestor (and are, therefore, more closely related) have DNA base sequences that are more similar than those that share only a distant ancestor.

Features of Organisms:

The features in the cells of all living organisms are the presence of cytoplasm, cell membrane and DNA as genetic material.

All living organisms also contain **ribosomes** in the cytoplasm, floating freely or attached to membranes called **rough endoplasmic reticulum** (ER). Ribosomes are responsible for protein synthesis.

The largest group of organisms recognized by biologists is the kingdom.

The five kingdoms are: **Animal, Plant, Fungus, Prokaryote** and **Protocist**.

Viruses are not included in any kingdom – they are not considered to be living organisms because they lack cell membranes (made of protein and lipid), cytoplasm and ribosomes and do not demonstrate the characteristics of living things: they do not feed, respire, excrete or grow. Although viruses do reproduce, this only happens inside the cells of living organisms, using materials provided by the host cell.

The Animal Kingdom:

Animals are multicellular organisms whose cells have no cell walls or chloroplasts. Most animals ingest solid food and digest it internally.

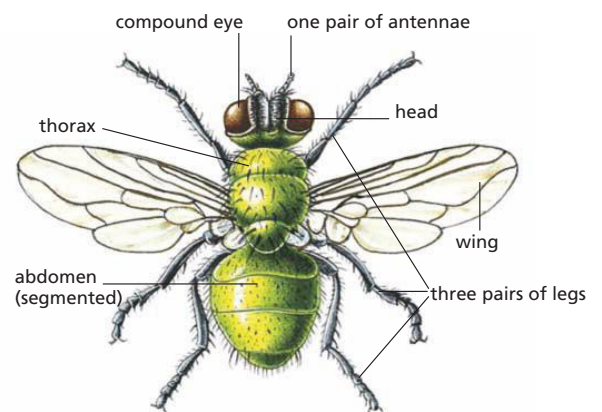
Invertebrates: organisms which do not have a vertebral column e.g. arthropods.

Arthropods: The arthropods include the crustacea, insects, centipedes and spiders.

The name arthropod means jointed limbs, and this is a feature common to them all. They also have a hard, firm external skeleton, called a **cuticle**, which encloses their bodies. Their bodies are segmented and, between the segments, there are flexible joints which permit movement. In most arthropods, the segments are grouped together to form distinct regions, the head, thorax and abdomen.

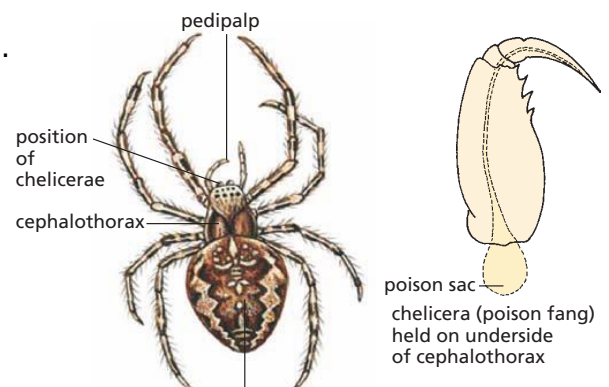
Insects: e.g. dragonfly, wasp

- Three pairs of legs.
- Body divided into head, thorax and abdomen.
- One pair of antennae.
- One pair of compound eyes.
- Usually have two pairs of wings.



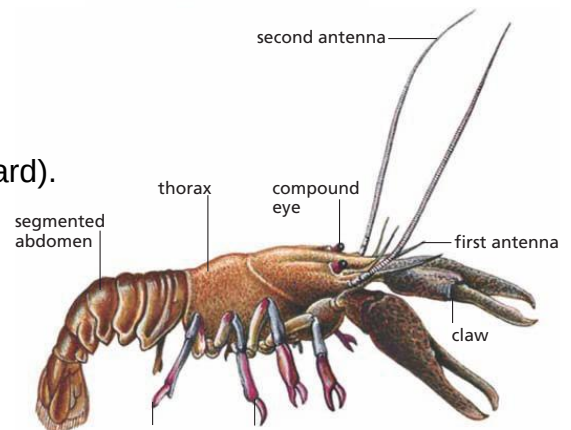
Arachnids: e.g. spider, mite

- Four pairs of legs.
- Body divided into cephalothorax and abdomen.
- Several pairs of simple eyes.
- Chelicerae for biting and poisoning prey.



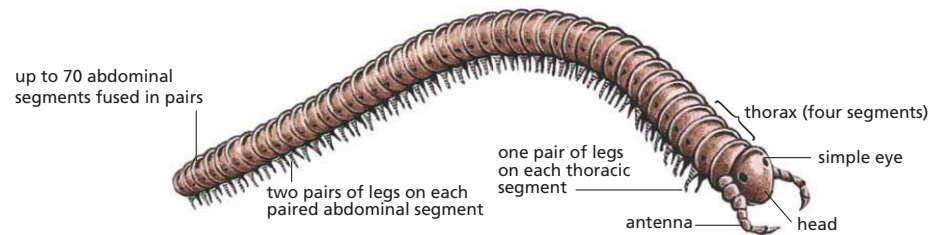
Crustacea: e.g. crab, woodlouse

- Five or more pairs of legs.
- Body divided into cephalothorax and abdomen.
- Two pairs of antennae.
- One pair of compound eyes.
- Exoskeleton often calcified to form a carapace (hard).



Myriapods: e.g. centipede, millipede

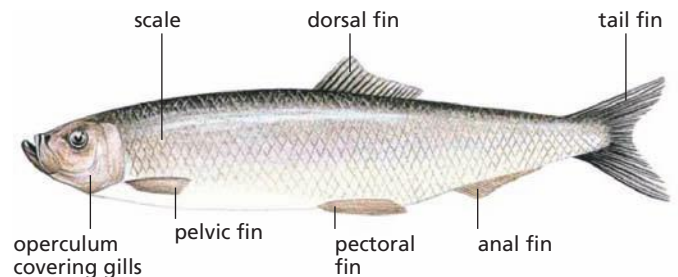
- Ten or more pairs of legs (usually one pair per segment).
- Body not obviously divided into thorax and abdomen.
- One pair of antennae.
- Simple eyes.



Vertebrates: Vertebrates are animals which have a vertebral column.

Fish:

Fish are poikilothermic (cold blooded) vertebrates. Many of them have a smooth, streamlined shape which offers minimal resistance to the water through which they move. Their bodies are covered with overlapping scales and they have fins which play a part in movement.

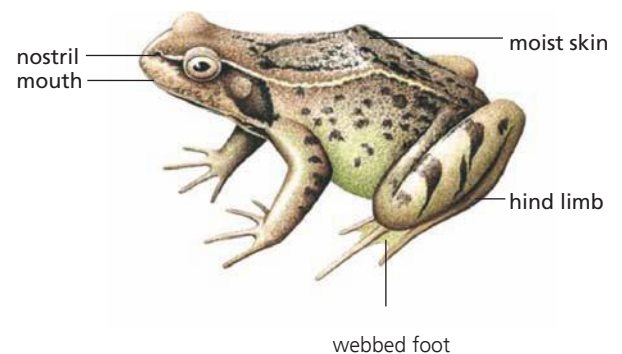


Fish breathe by means of filamentous gills which are protected by a bony plate, the operculum.

Fish reproduce sexually but fertilization usually takes place externally; the female lays eggs and the male sheds sperms on them after they have been laid.

Amphibia:

Amphibia are poikilothermic (cold blooded) vertebrates with four limbs and no scales. The class includes frogs, toads and newts. The name, amphibian, means 'double life' and refers to the fact that the organism spends part of its life in water and part on the land. In fact, most frogs, toads and newts spend much of their time on the land, in moist situations, and return to ponds or other water only to lay eggs.



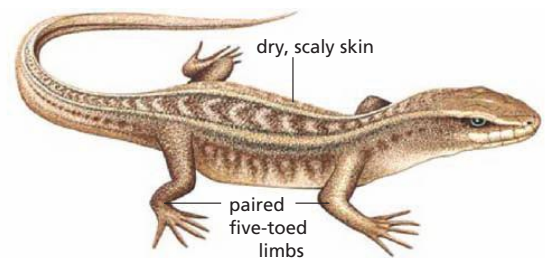
Amphibia have four limbs. In frogs and toads, the hind feet have a web of skin between the toes. This offers a large surface area to thrust against the water when the animal is swimming.

Amphibia have moist skins with a good supply of capillaries which can exchange oxygen and carbon dioxide with the air or water. They also have lungs which can be inflated by a kind of swallowing action. They do not have a diaphragm or ribs.

Reptiles:

Reptiles are land-living vertebrates. Their skins are dry and the outer layer of epidermis forms a pattern of scales. This dry, scaly skin resists water loss. Also, the eggs of most species have a tough, parchmentlike shell. Reptiles, therefore, are not restricted to damp habitats, nor do they need water in which to breed.

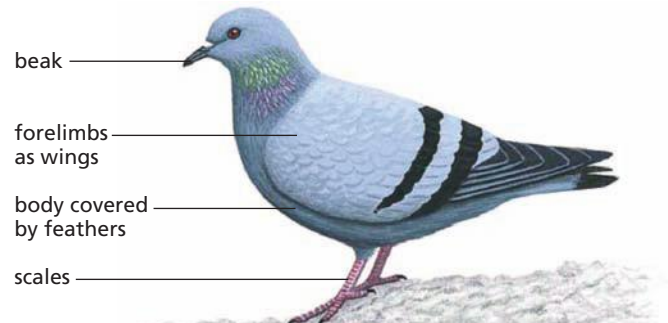
Reptiles are poikilothermic (cold blooded) but they can regulate their temperature to some extent. They do this by basking in the sun until their bodies warm up. When reptiles warm up, they can move about rapidly in pursuit of insects and other prey.



The reptiles include lizards, snakes, turtles, tortoises and crocodiles. Apart from the snakes, reptiles have four limbs, each with five toes. Some species of snake still retain the vestiges of limbs and girdles.

Birds:

Birds are homoiothermic (warm blooded) vertebrates. The vertebral column in the neck is flexible but the rest of the vertebrae are fused to form a rigid structure. This is probably an adaptation to flight, as the powerful wing muscles need a rigid frame to work against.



The epidermis over most of the body produces a covering of feathers but, on the legs and toes, the epidermis forms scales. The feathers are of several kinds. The fluffy down feathers form an insulating layer close to the skin; the contour feathers cover the body and give the bird its shape and colouration; the large quill feathers on the wing are essential for flight.

Birds have four limbs, but the forelimbs are modified to form wings. The feet have four toes with claws which help the bird to perch, scratch for seeds or capture prey, according to the species. The upper and lower jaws are extended to form a beak which is used for feeding in various ways.

Mammals:

Mammals are homoiothermic (warm blooded) vertebrates with four limbs. They differ from birds in having hair rather than feathers. Unlike the other vertebrates they have a diaphragm which plays a part in breathing. They also have mammary glands and suckle their young on milk.

Humans are mammals. All mammals give birth to fully formed young instead of laying eggs. The eggs are fertilised internally and undergo a period of development in the uterus.

The young may be blind and helpless at first, e.g. cats, or they may be able to stand up and move about soon after birth, e.g. sheep and cows. In either case, the youngster's first food is the milk which it sucks from the mother's teats. The milk is made in the mammary glands and contains all the nutrients that the offspring need for the first few weeks or months, depending on the species.



As the youngsters get older, they start to feed on the same food as the parents. In the case of carnivores, the parents bring the food to the young until they are able to fend for themselves.

Key Features of the Five Classes of Vertebrates:

Vertebrate class	Fish	Amphibia	Reptiles	Birds	Mammals
Examples	herring, perch, also sharks	frog, toad, newt	lizard, snake	robin, pigeon	mouse
Body covering	scales	moist skin	dry skin, with scales	feathers, with scales on legs	fur
Movement	fins (also used for balance)	four limbs, back feet are often webbed to make swimming more efficient	four legs (apart from snakes)	two wings and two legs	four limbs
Reproduction	produce jelly-covered eggs in water	produce jelly-covered eggs in water	produce eggs with a rubbery, waterproof shell; laid on land	produce eggs with a hard shell; laid on land	produce live young
Sense organs	eyes; no ears; lateral line along body for detecting vibrations in water	eyes; ears	eyes; ears	eyes; ears	eyes; ears with a pinna (external flap)
Other details	cold blooded; gills for breathing	cold blooded; lungs and skin for breathing	cold blooded; lungs for breathing	warm blooded; lungs for breathing; beak	warm blooded; lungs for breathing; females have mammary glands to produce milk to feed young; four types of teeth

The Plant Kingdom:

Ferns:

Ferns are land plants with quite highly developed structures. Their stems, leaves and roots are very similar to those of the flowering plants.

The stem is usually entirely below ground and takes the form of a structure called a **rhizome**. In bracken, the rhizome grows horizontally below ground, sending up leaves at intervals. The roots which grow from the rhizome are called adventitious roots. This is the name given to any roots which grow directly from the stem rather than from other roots.

The stem and leaves have sieve tubes and waterconducting cells similar to those in the xylem and phloem of a flowering plant. For this reason, the ferns and seed-bearing plants are sometimes referred to as vascular plants, because they all have vascular bundles or vascular tissue. Ferns also have multicellular roots with vascular tissue.

The leaves of ferns vary from one species to another, but they are all several cells thick. Most of them have an upper and lower epidermis, a layer of palisade cells and a spongy mesophyll similar to the leaves of a flowering plant.

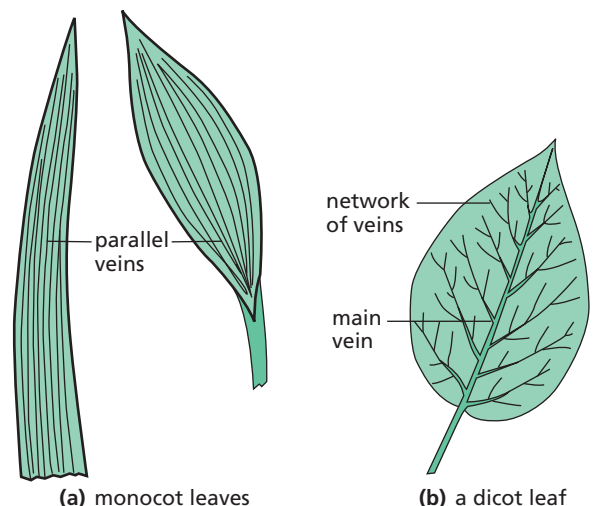
Ferns produce gametes but no seeds. The zygote gives rise to the fern plant, which then produces single-celled spores from numerous **sporangia** (spore capsules) on its leaves. The sporangia are formed on the lower side of the leaf but their position depends on the species of fern. The sporangia are usually arranged in compact groups.



Flowering Plants:

Flowering plants reproduce by seeds which are formed in flowers. The seeds are enclosed in an ovary.

Flowering plants are divided into two subclasses: monocotyledons and dicotyledons. Monocotyledons (monocots for short), are flowering plants which have only one cotyledon in their seeds. Most, but not all, monocots also have long, narrow leaves (e.g. grasses, daffodils, bluebells) with parallel leaf veins.



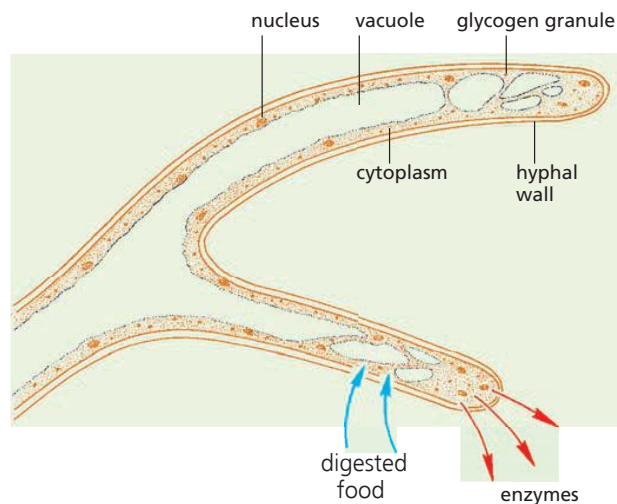
The dicotyledons (dicots for short), have two cotyledons in their seeds. Their leaves are usually broad and the leaf veins form a branching network.

Summary of the Key Features of Monocots and Dicots:

Feature	Monocotyledon	Dicotyledon
Leaf shape	Long and narrow	Broad
Leaf veins	Parallel	Branching
Cotyledons	One	Two
Grouping of flower parts (petals, sepals and carpels)	Threes	Fives

The Fungi Kingdom:

Most fungi are made up of thread-like hyphae, rather than cells, and there are many nuclei distributed throughout the cytoplasm in their hyphae.



The fungi include fairly familiar organisms such as mushrooms, toadstools, puffballs and the bracket fungi that grow on tree trunks. There are also the less obvious, but very important, mould fungi which grow on stale bread, cheese, fruit or other food. Many of the mould fungi live in the soil or in dead wood. The yeasts are single-celled fungi similar to the moulds in some respects.

The Prokaryote Kingdom:

These are the bacteria and the blue-green algae. They consist of single cells but differ from other single-celled organisms because their chromosomes are not organised into a nucleus.

Bacterial Structure:

Bacteria (singular: bacterium) are very small organisms consisting of single cells rarely more than 0.01 mm in length. They can be seen only with the higher powers of the microscope.

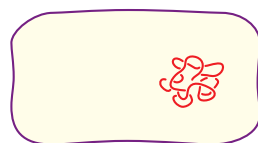
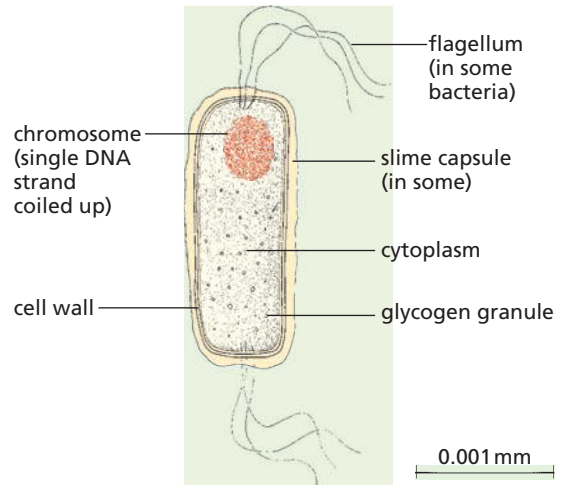
Their cell walls are made, not of cellulose, but of a complex mixture of proteins, sugars and lipids. Some bacteria have a **slime capsule** outside their cell wall. Inside the cell wall is the cytoplasm, which may contain granules of glycogen, lipid and other food reserves.

Each bacterial cell contains a single chromosome, consisting of a circular strand of DNA.

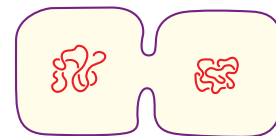
The chromosome is not enclosed in a nuclear membrane but is coiled up to occupy part of the cell.

Individual bacteria may be spherical, rod-shaped or spiral and some have filaments, called **flagella**, projecting from them. The flagella can flick and so move the bacterial cell about.

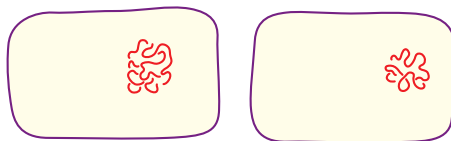
Bacterium Reproducing:



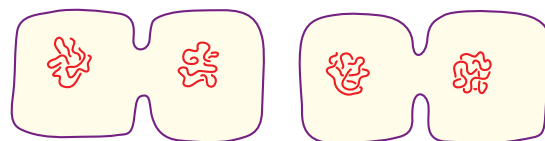
(a) bacterial cell



(b) chromosome replicates



(c) cell divides



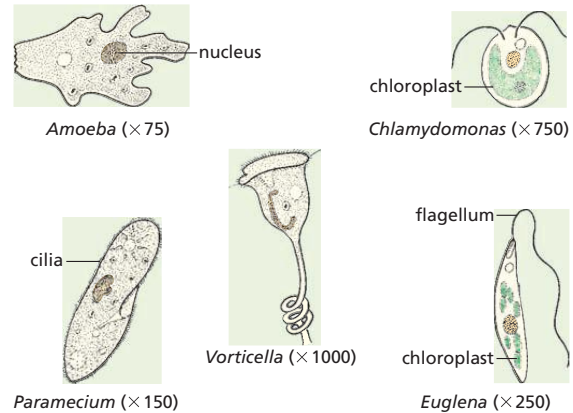
(d) each cell divides again

The Protoctist kingdom

These are single-celled (unicellular) organisms which have their chromosomes enclosed in a nuclear membrane to form a nucleus.

Some of the protoctista, e.g. *Euglena*, possess chloroplasts and make their food by photosynthesis. These protoctista are often referred to as unicellular plants or **protophyta**. Organisms such as *Amoeba* and *Paramecium* take in and digest solid food and thus resemble animals in their feeding. They may be called unicellular animals or **protozoa**.

Amoeba is a protozoan which moves by a flowing movement of its cytoplasm. It feeds by picking up bacteria and other microscopic organisms as it goes. *Vorticella* has a contractile stalk and feeds by creating a current of water with its cilia. The current brings particles of food to the cell. *Euglena* and *Chlamydomonas* have chloroplasts in their cells and feed, like plants, by photosynthesis.



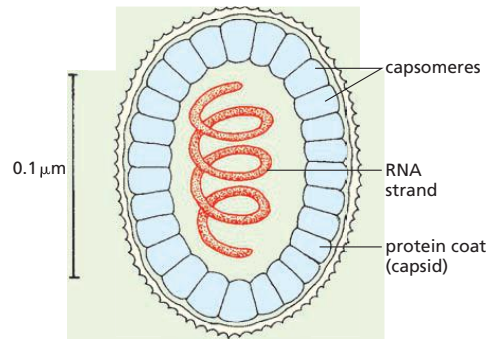
Viruses:

There are many different types of virus and they vary in their shape and structure. All viruses, however, have a central core of RNA or DNA surrounded by a protein coat. Viruses have no nucleus, cytoplasm, cell organelles or cell membrane, though some forms have a membrane outside their protein coats.

Virus particles, therefore, are not cells. They do not feed, respire, excrete or grow and it is debatable whether they can be classed as living organisms.

Viruses do reproduce, but only inside the cells of living organisms, using materials provided by the host cell.

The nucleic acid core is a coiled single strand of RNA. The coat is made up of regularly packed protein units called **capsomeres** each containing many protein molecules. The protein coat is called a **capsid**.



Dichotomous Keys:

Dichotomous keys are used to identify unfamiliar organisms. They simplify the process of identification. Each key is made up of pairs of contrasting features (dichotomous means two branches), starting with quite general characteristics and progressing to more specific ones. By following the key and making appropriate choices it is possible to identify the organism correctly.

Item 1 gives you a choice between two alternatives. If the animal is poikilothermic (cold blooded), you move to item 2 and make a further choice. If it is homoiothermic (warm blooded), you move to item 4 for your next choice.

The same technique may be used for assigning an organism to its class, genus or species. However, the important features may not always be easy to see and you have to make use of less fundamental characteristics.

VERTEBRATE CLASSES

1	{ Poikilothermic	2	
	{ Homoiothermic	4	
2	{ Has fins but no limbs	Fish	
	{ Has four limbs	3	
3	{ Has no scales on body	Amphibian	
	{ Has scales	Reptile	
4	{ Has feathers	Bird	
	{ Has fur	Mammal	