1: Characteristics of living organisms

The 7 characteristics that distinguish living things from non-living objects are: **N**utrition, **E**xcretion, **R**espiration, **S**ensitivity, **R**eproduction, **G**rowth and **M**ovement.

7 characteristics of living organisms

1. Nutrition	Take in Absorb Assimilate	**Nutrients**	**Organic** substances **Mineral** ions containing **raw materials/ energy** for: **Growth + Tissue repair**
Plants make their own food	Photo-synthesis	H_2O CO_2 Light	
2.Excretion	Removal	**Toxic** Materials	
		Waste Products of metabolism	By **chemical reactions** in cells (respiration…)
		Substance in **Excess**	
3.Respiration	Break down	**Food** in cells	Release **Energy**
4.Sensitivity	Sense Respond	**Changes** in the environment **(Stimuli)**	
5.Reprodution	Produce	**Offspring**	Prevent extinction of species
6.Growth	Increase	**Size** **Mass** of an organism	By increasing **cell number** and/or cell **size**
7. Movement	Change	**Position** or **Place**	of an **organism** or **part** of an **organism**
Ex: Parts of plants move very slowly to obtain more light for photosynthesis.			

Credit: Painting Above All Else Guard Your Heart
by Carmen Keys

Common misconceptions

- Don't confuse **respiration** with **breathing**.
- Don't use **faeces** or **defecation** as an example of **excretion** (faeces is indigested food- it has not been formed through metabolic processes).
- Some non-living things, such as a car, may appear to show some of the characteristics – but not all of them.

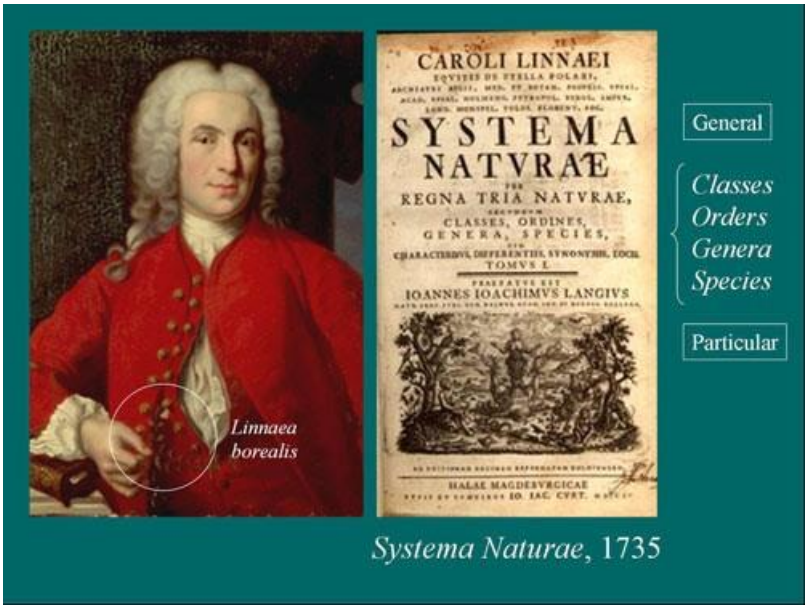
* **Characteristics of living organisms Quiz**

2: Classification of living organisms

Classification: The scientific method of dividing organisms into smaller and larger groups, on basis of their similarities.

Swedish botanist **Carolus Linnaeus** is the Father of Systematic Biology. He believed he could:

- Put every organism into a group (the science of TAXONOMY)
- Give every organism a name (the science of NOMENCLATURE).



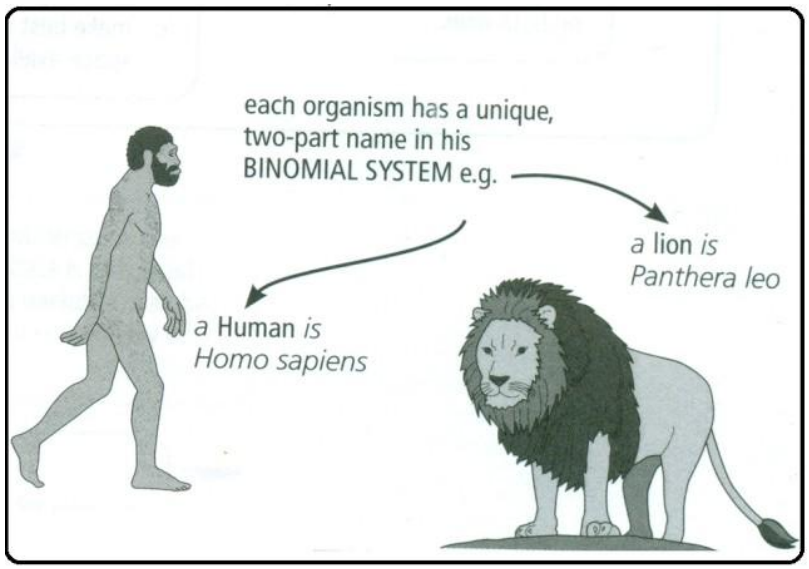
Carolus Linnaeus organized **taxonomy** (1735).

In his **BINOMIAL SYSTEM**, every living organism has a unique, **two-part name**:

- The first name is **Genus,** the second name is **species.**
- Names are written in Latin, printed in *italics*.
- The genus always has a **capital** letter, and the species always has a **small** letter.

For examples:

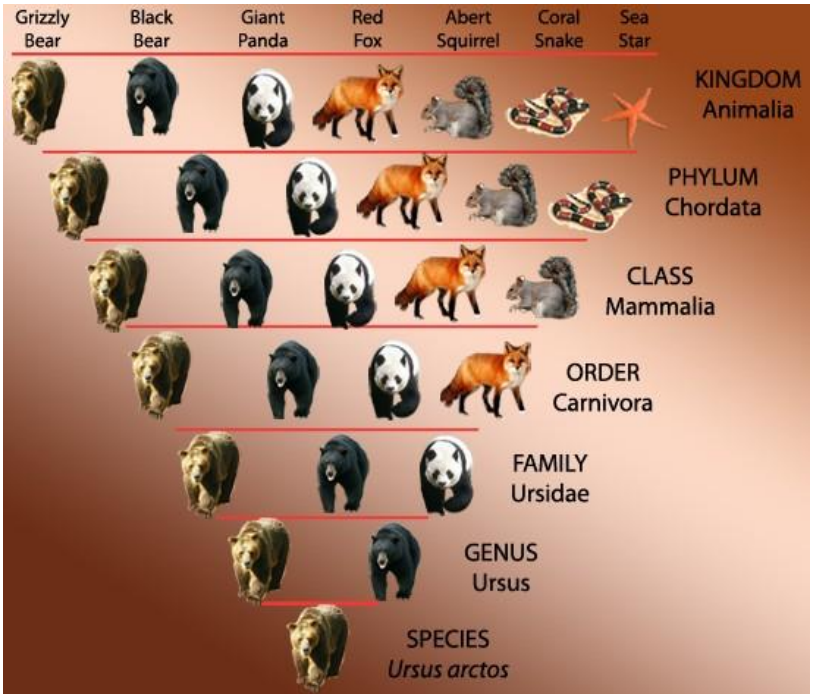
	Genus	Species	Abreviation
Human	***Homo***	***sapiens***	***H. sapiens***
Lion	***Panthera***	***leo***	***P. leo***
Wolf	***Canis***	***lupus***	***C. lupus***



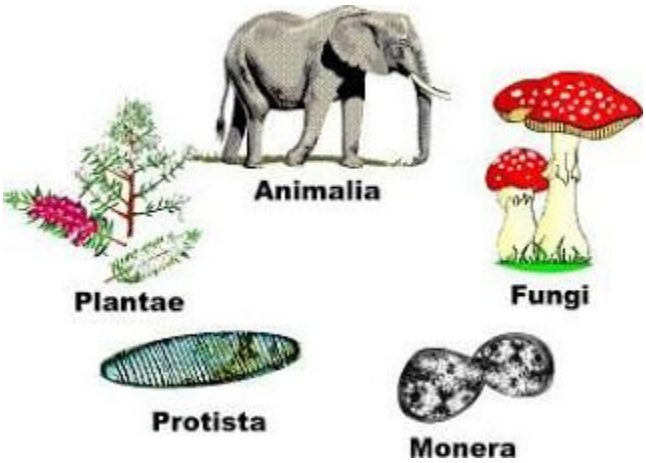
We still use this system today.

All life forms are categorized into a scheme that had 7 categorical terms. The biggest group are **Kingdom,** the smallest one is **Species**.

Each kingdom is divided into smaller group, which include genus and species. Organisms can exist in only one group at each level of classification. For example, an organism can only belong to one kingdom or one genus.

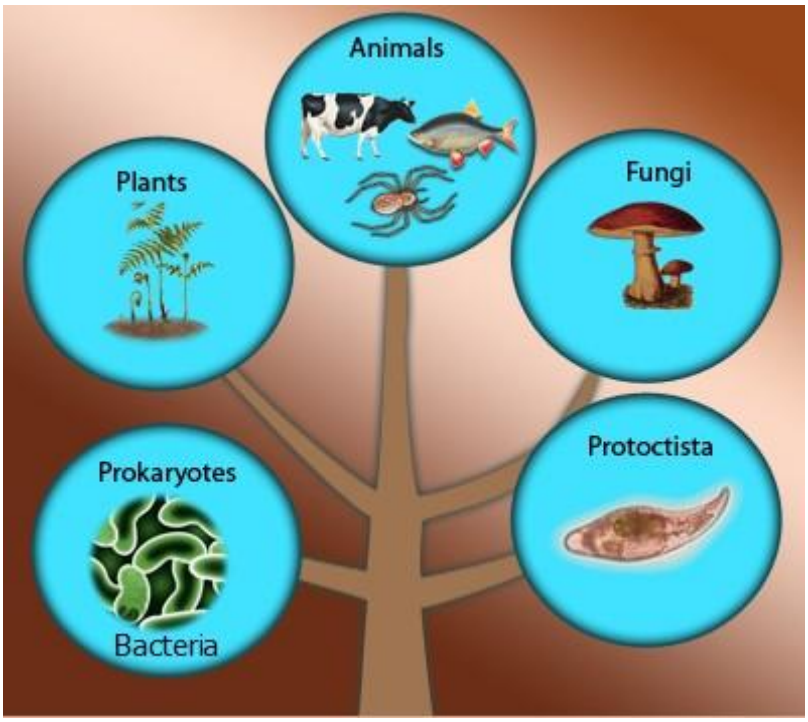


3: Five Kingdoms of living things



All living things are divided into 5 kingdoms. Each kingdom has certain characteristics that all members of that group shared. They are:

Animals, **P**lants, **F**ungi, **P**rotoctists, **B**acteria (Prokaryotes)

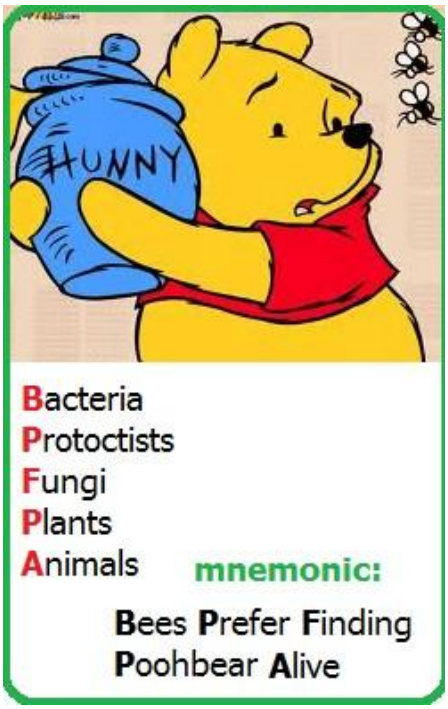


The characteristics that Linnaeus used to divide all organisms into one of the five groups included:

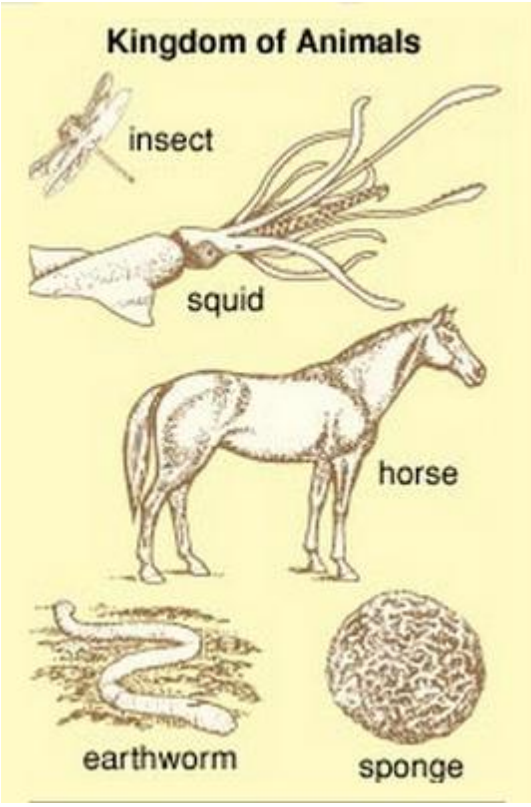
- How many cells made up their bodies, if their cells were very simple or had complex parts

- If they can move on their own
- If they could make their own food, or had to eat other creatures to survive ...

Mnemonic



4: Animal Kingdom – Classification



The animal kingdom contains many phyla. Some of them are:

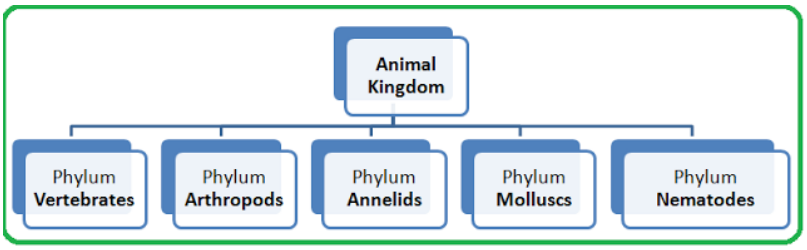
Vertebrates, Arthropods, Annelids, Molluscs, Nematodes.

It is not always easy to recognise an animal. For a very long time, people thought that's sea anemones were plants, because they tend to stay in one place and their tentacles look rather kike petals. Now we know that they are animals.

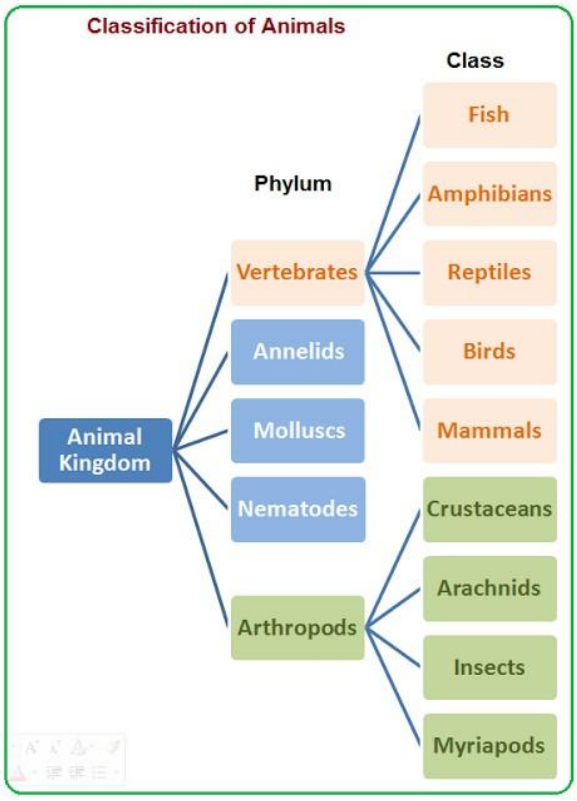
Sea anemones

One of the best way to tell if an organism is an animal is to look at its cells under the microscope. **Animal cells never have cell walls**.

Animals are classified into many phyla. Here are just some of these phyla:

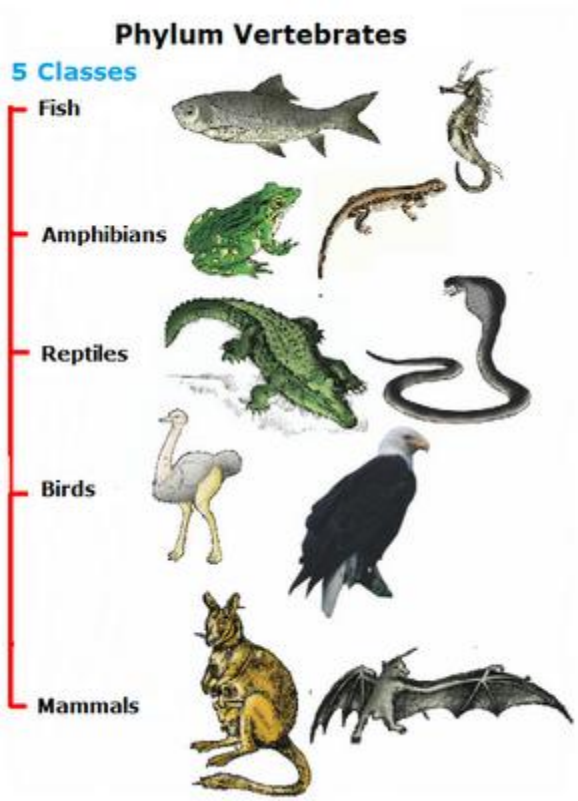


Classes in two of these phyla:



Details of each phylum and class are given in the next topics.

5 Phylum Vertebrates



Vertebrates are animals with backbones. They are divided into 5 groups called classes:

Fish, Amphibians, Reptiles, Birds and Mammals.

Details of each group are given in the table below. You only need to be able to describe visible external features, but other details can be helpful.

VERTEBRATES (ANIMALS WITH BACKBONES)

CLASS	EXTERNAL FEATURES	OTHER FEATURES
Fish (all aquatic)	• Scales • Fins • Eyes and lateral line	• Jelly-covered eggs; usually use external fertilisation • Ectothermic • Gills for gas exchange
Amphibians (always breed in water)	• Moist skin • Four limbs • Eyes and ears	• Jelly-covered eggs; external fertilisation • Ectothermic • Lungs/skin for gas exchange
Reptiles (lay eggs on land)	• Dry, scaly skin • Four limbs (not in snakes) • Eyes and ears	• Soft-shelled eggs; internal fertilisation • Ectothermic • Lungs for gas exchange
Birds (very few are aquatic)	• Feathers (scales on legs) • Two wings, two legs • Eyes and ears	• Hard-shelled eggs; internal fertilisation • Endothermic • Lungs for gas exchange
Mammals (very few are aquatic)	• Fur or hair • Four limbs • Eyes and ears • Nipples	• Live young (a few lay eggs) • Endothermic • Lungs for gas exchange • Feed young with milk from mammary glands

You could be asked to directly describe these in exam questions

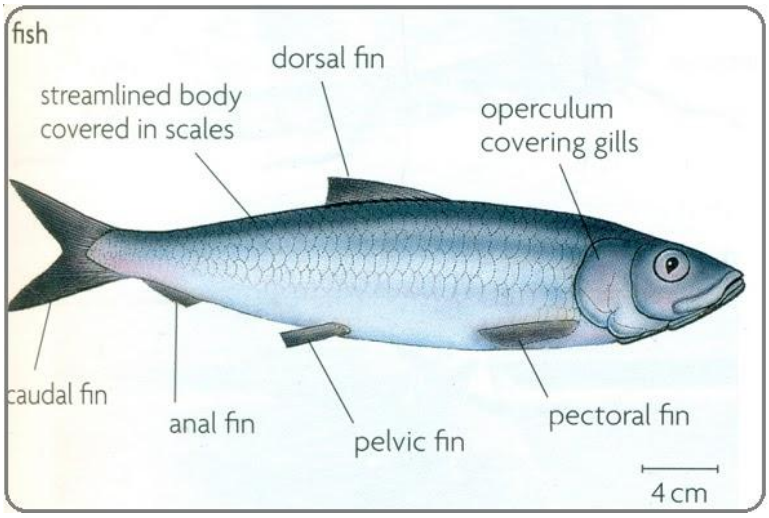
You could use these features in questions on other topics

Classification of vertebrates

Vertebrates are animals with backbones (part of an internal skeleton).
Vertebrates are divided into five groups called classes.
Details of each group are given in the table below.

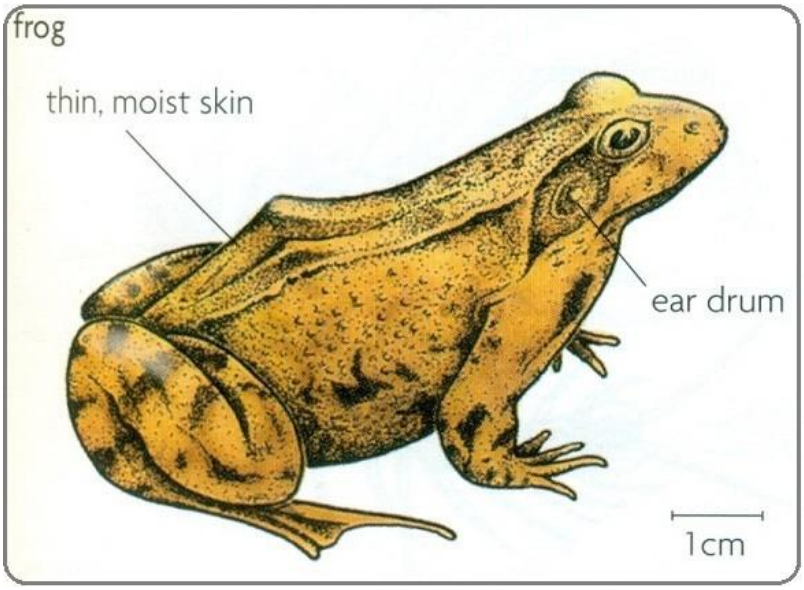
Vertebrate class	Body covering	Movement	Reproduction	Sense organs	Other details	Examples
Fish	Scales	Fins (also used for balance)	Usually produces jelly-covered eggs in water	Eyes but no ears, lateral line along body for detecting vibrations in water	Cold-blooded, gills for breathing	Herring, perch, shark
Amphibians	Moist skin	Four limbs, back feet often webbed to make swimming more efficient	Produces jelly-covered eggs in water	Eyes and ears	Cold-blooded, lungs and skin for breathing	Frog, toad, salamander
Reptiles	Dry, with scales	Four legs (apart from snakes)	Eggs with rubbery, waterproof shell – laid on land	Eyes and ears	Cold-blooded, lungs for breathing	Crocodile, python
Birds	Feathers, scales on legs	Wings, two legs	Eggs with hard shell	Eyes and ears	Warm-blooded, lungs for breathing, beak	Flamingo, pigeon
Mammals	Fur	Four limbs	Live young	Eyes, ears with pinna (external flap)	Warm-blooded, lungs for breathing, females have mammary glands to produce milk to feed young, four types of teeth	Elephant, mouse

1. Fish



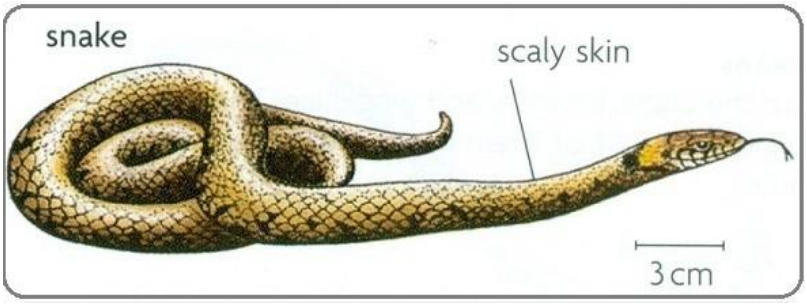
Scales- Fins - Eyes & lateral Lines - Gills.

2. Amphibians



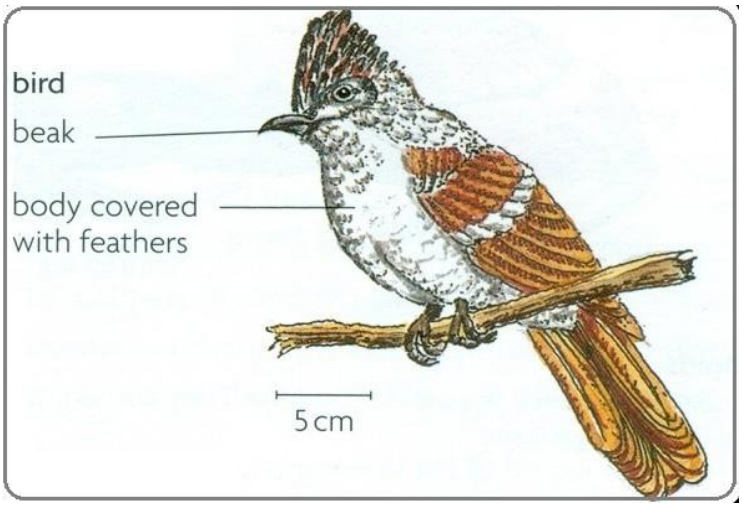
Moist scaleless skin - Eye & Ears - 4 limbs.

3. Reptiles



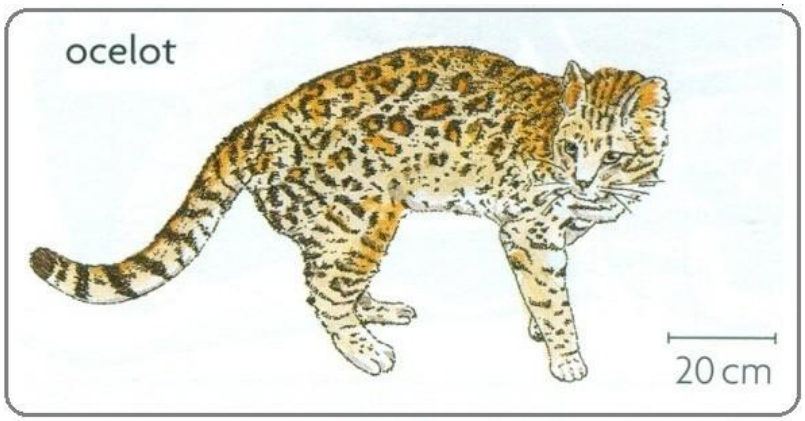
Dry scaly skin - Eyes & Ears - 4 legs (apart from snakes).

4. Birds



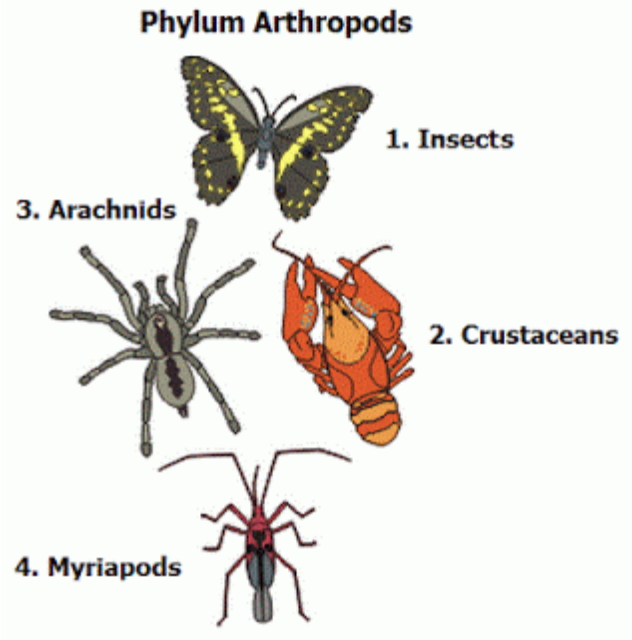
Beak - Feathers - Scales on legs - Wings - 2 legs.

5. Mammals



Fur - 4 limbs.

#6 Phylum Arthropods



There are more arthropods than any other group of animals, so they are divided into classes:

Insects, Crustaceans, Arachnids and Myriapods.

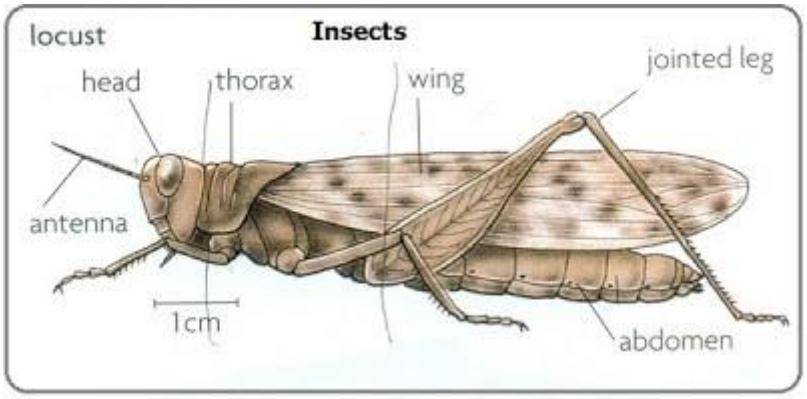
Special features of Arthropods:

- Invertebrates (**no backbone**)
- Waterproof **Exoskeleton** ----> Exist in very dry places, not confined to water or moist places like most invertebrates.
- **Segmented body**
- **Jointed legs** (exoskeleton prevents movement)

4 classes of Arthropods

1. Insects

Insects are a very successful group, due to their exoskeleton and **tracheae**, which are very good at stopping water from evaporating from insects's body, so they can live in **very dry** places.

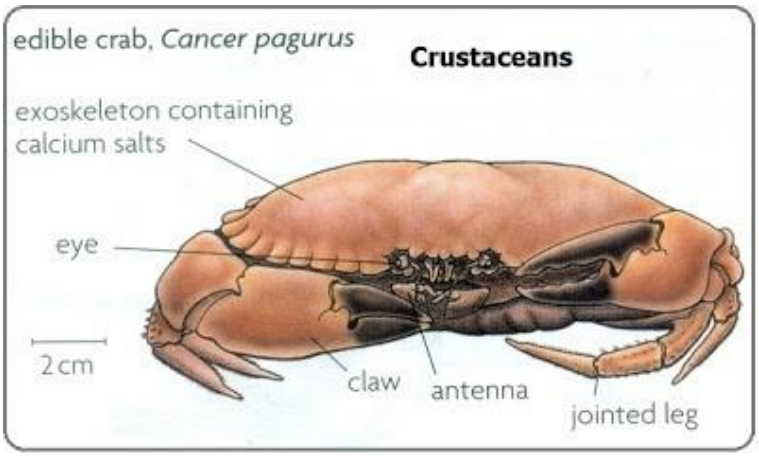


Key features of Insects:

- 3 pairs of **jointed legs**
- 1 or 2 pairs of **wings**
- 1 pair of antennae
- 3 body parts: **Head, Thorax, Abdomen**
- 1 pair of compound **eyes**
- Breath through **tracheae**

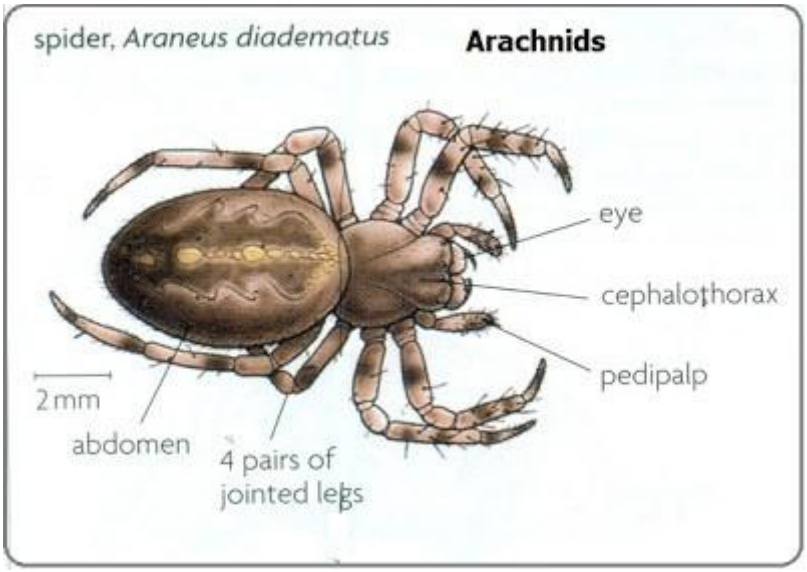
2. Crustaceans

These are the crabs, lobsters and woodlice. They breath through **gills**, so most of them live in **wet places** and many are aquatic.



3. Arachnids

These are spiders, ticks and scorpions. They are **land-dwelling** organisms.

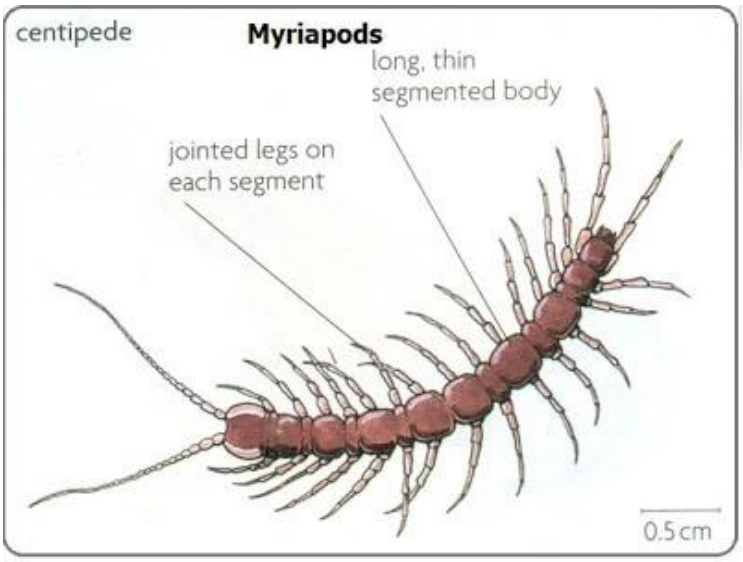


Key features of Arachnids

- 4 pairs of legs
- **no wings**
- 2 pairs of antennae
- 2 body parts: **Cephalothorax, Abdomen**
- several pairs of simple eyes
- all have **piercing jaws** since all are predator
- chelicerae (pointed mouthparts) for biting and poisoning prey

4. Myriapods

These are the centipedes and millipedes.



Key features of Myriapods

- long, thin body with **many segments** for moving easily through soil and leaf litter
- no obvious thorax and abdomen
- **each segment** has **jointed legs** (>9 pairs)
- 1 pair of antennae as sense organs in dark habitats
- simple eyes

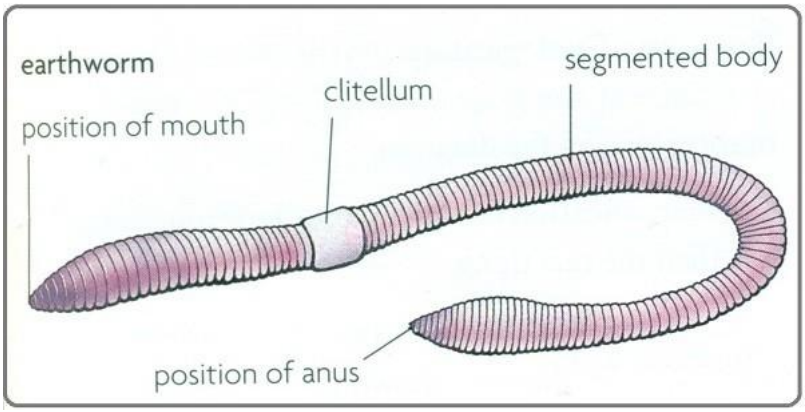
7 Other groups of invertebrates

Details about some more phyla of invertebrates:

Annelids, Nematodes, Molluscs.

1. Phylum Annelids

Annelids are worms, with bodies made up of ring-like segments. Most of them live in water, some like the earthworm live in moist soil.

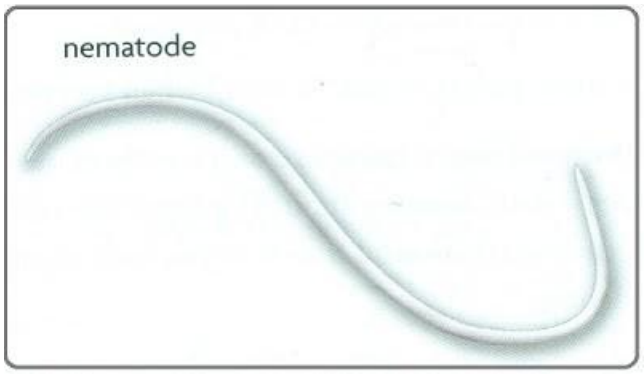


Key features of Annelids

- **many segments** on long body
- body covered with **mucus** to conserve water
- mouth and anus present
- **bristles** (stiff hair) usually present for movement
- many are hermaphrodite (intersex)

2. Phylum Nematodes

Nematodes are worms, but unlike annelids their bodies are not divided into segments. They are usually white, long and thin. They live in many different habitats. Many nematodes live in the soil.

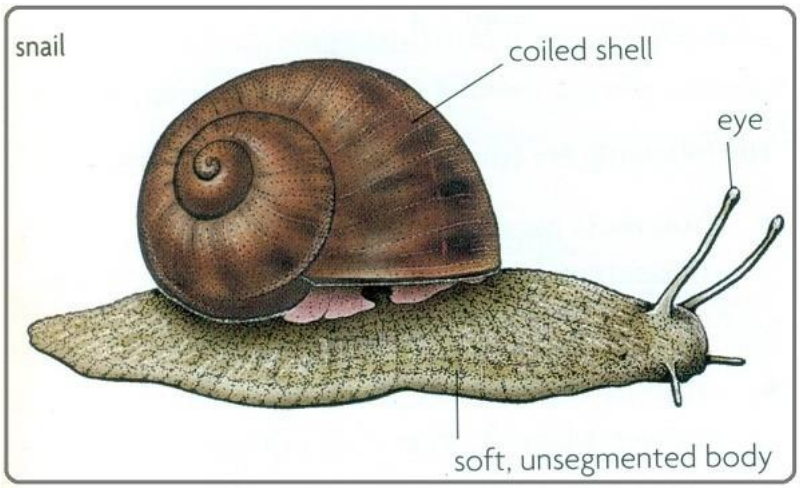


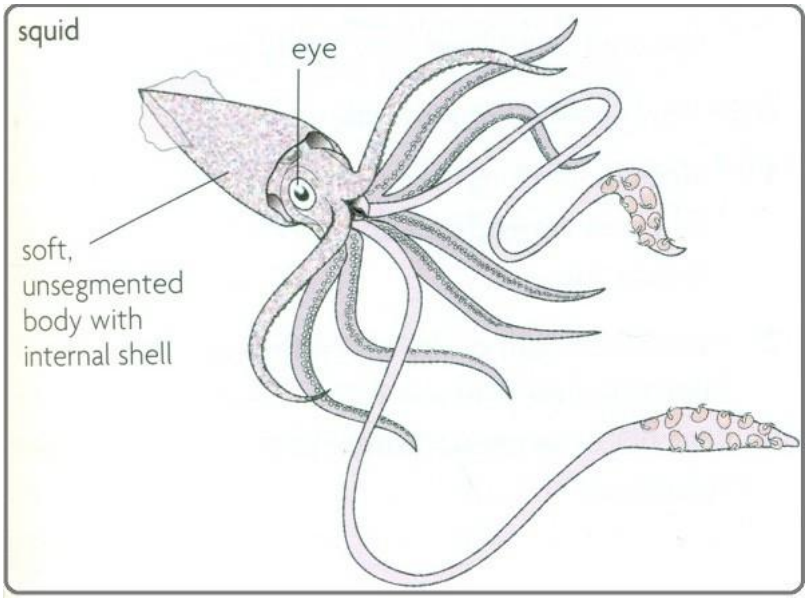
Key features of Nematodes

- **no segments**
- **long cylindrical** body
- body pointed at both ends

3. Phylum Molluscs

Molluscs are soft-bodies animals, sometimes with a shell (snails) or without (slugs).





Key features of Molluscs

- **soft, unsegmented body**
- **muscular foot** for movement or burrowing
- most have a **shelf** made of calcium carbonate (protection from predators/drying out
- often have **eyes** on retractable tentacles

Common misconceptions

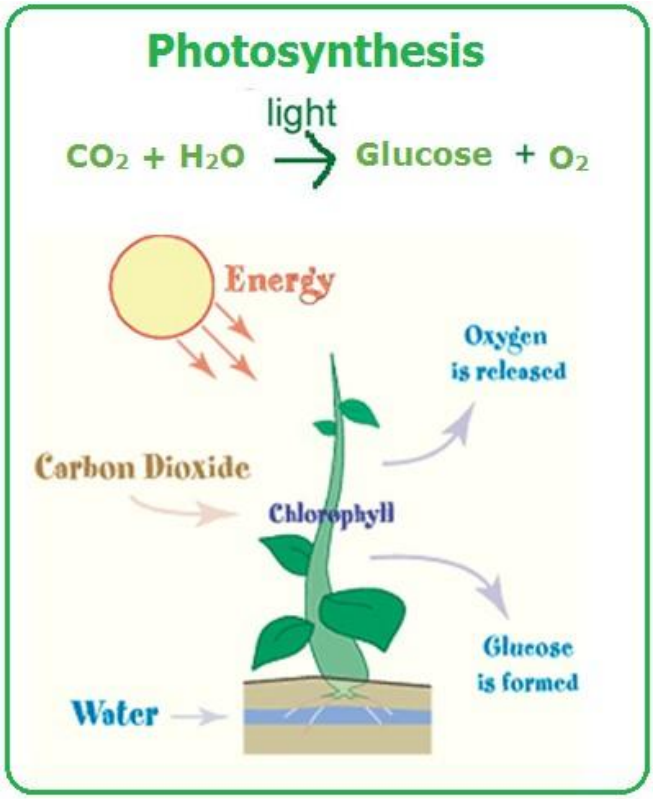
Students are often confused by the different **numbers of legs** in **insects**, **arachnids** and **crustaceans**.

They often loose the mark by stating that insects have **3 legs** instead of **3 pairs** of **legs**.

#8: Plant Kingdom

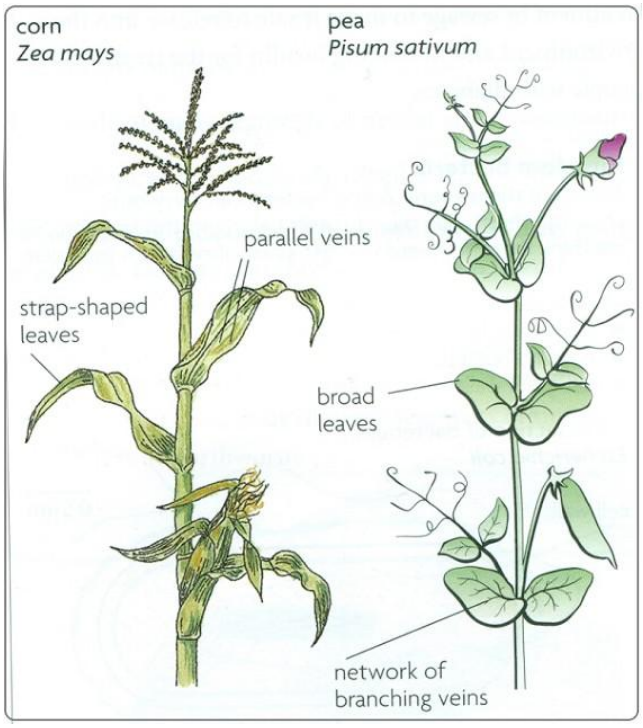
Plants are multicellular organisms, with cell wall made of **cellulose**. They include small organisms such as mosses, ferns and flowering plants.

At least some parts of a plant are green, thanks to pigment **chlorophyll**. Chlorophyll absorbs **energy** from sunlight for plant to make **glucose**, using **CO_2** and **H_2O** from environment. This is called **photosynthesis**.



Phylum Flowering plants

- have **roots**, **stems** and **leaves**
- have **xylem** and **phloem**
- reproduce by producing **seeds**
- seeds produced inside ovary, inside **flower**
- asexual reproduction is possible



They are divided into 2 groups, depending on number of ***seed leaves*** (***Cotyledon***):

1. **Monocotyledonous** (Monocots)
2. **Dicotyledonous** (Dicots)

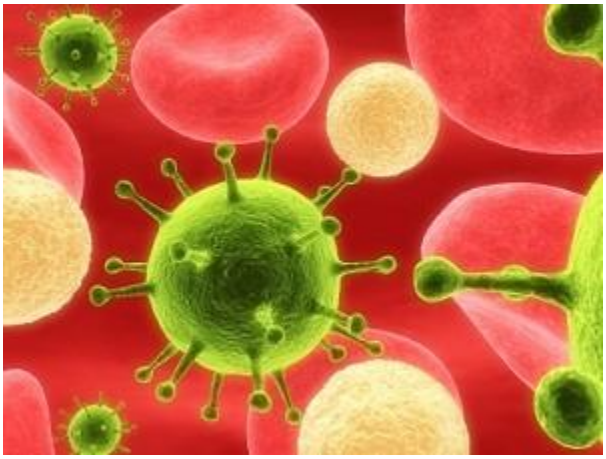
MONOCOTYLEDON
SEED LEAF

DICOTYLEDON
SEED LEAVES

Differences between Monocot and Dicot leaves

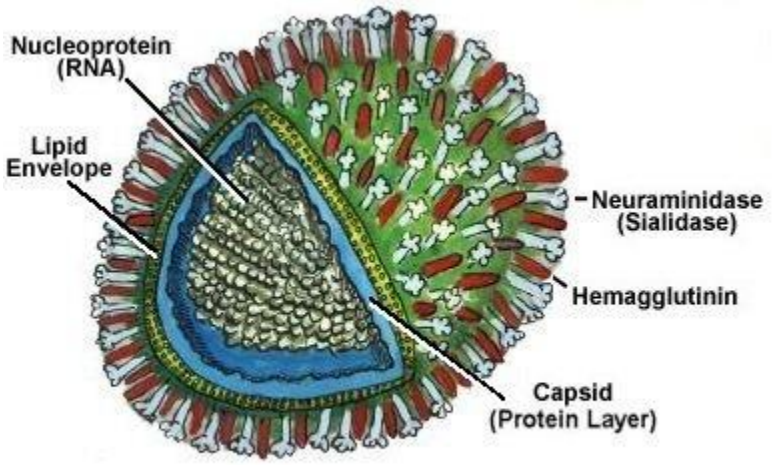
Feature	Monocot	Dicot
Leaf shape	long, thin	broad
Leaf veins	parallel	branching (network of veins)
Seed leaf	1	2
Example	Grasses	Trees

#9: Viruses



Viruses are **not** true **living things**. They are not considered to be alive, because on their own they can do nothing until they enter a living cell.

Viruses are complicated assemblies of molecules including proteins, nucleic acids, lipids, carbohydrates…



Influenza virus

When viruses encounter a cell, they take over cell's machinery. A series of chemical reactions occur that lead to the production of new viruses. Theses new viruses burst out of the cell and invade others, where the process is repeated. The host cell is usually killed when this happens.

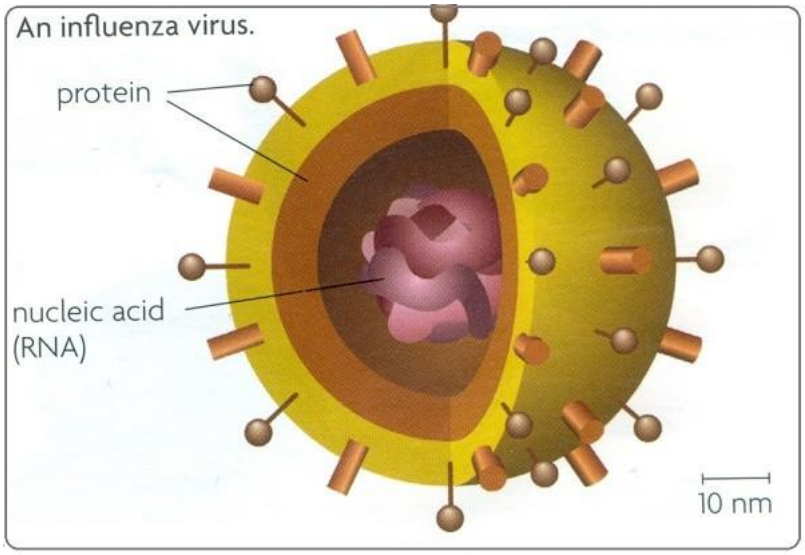
These steps are completely passive, that is, they are predefined by the nature of the molecules that comprise the virus particle. Viruses don't actually 'do' anything. **Without cells, viruses would not be able to multiply.**

Scientists do not classify a virus as a living thing. This is because:

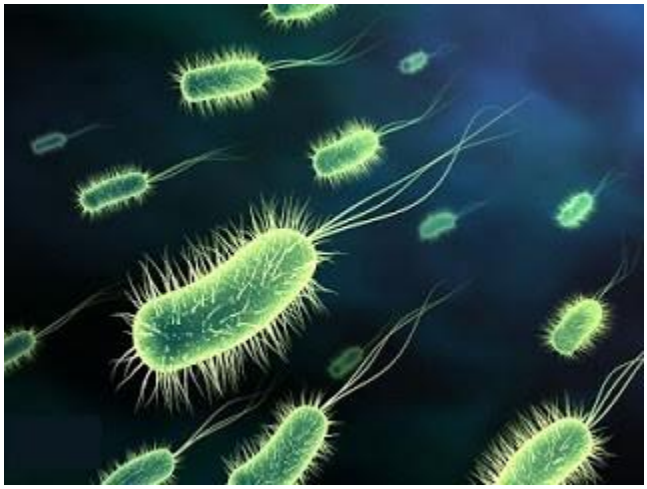
- it does not show all seven processes for life
- when it enters a cell it changes the way a cell works so it can make copies of the virus.

Key features of Viruses

- very **small** (100 times smaller than bacteria)
- **no** typical **cell structure**
- contain a strand of **DNA** or **RNA**
- surrounded by a protein coat called a **capsid**
- the only life process they show is **reproduction** (inside host cell)



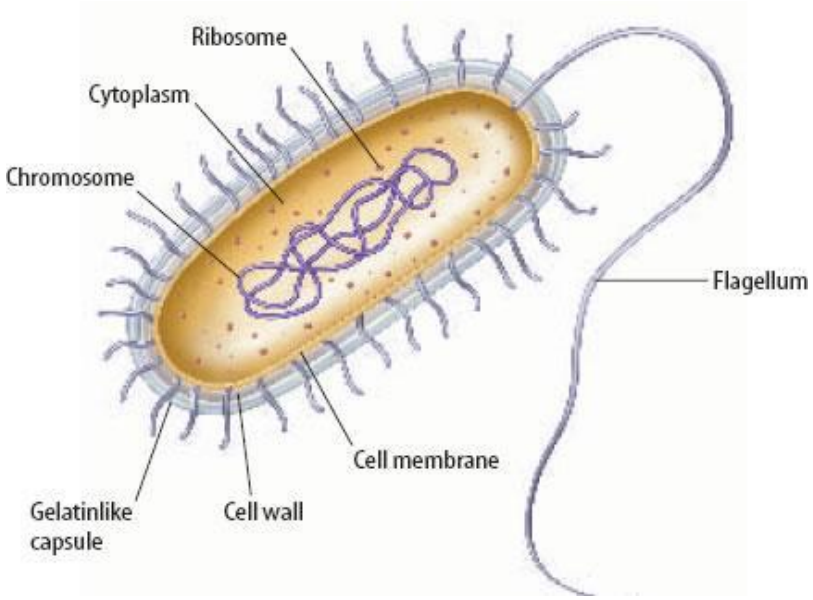
#10: Bacteria Kingdom



Bacteria cells are very different from the cells of all other organisms: they do **not have** a **nucleus.**

Some bacteria can carry out photosynthesis. The oldest fossils belong to this kingdom, so we think that they were the first kinds of organisms to evolve.

Bacterial cell structure



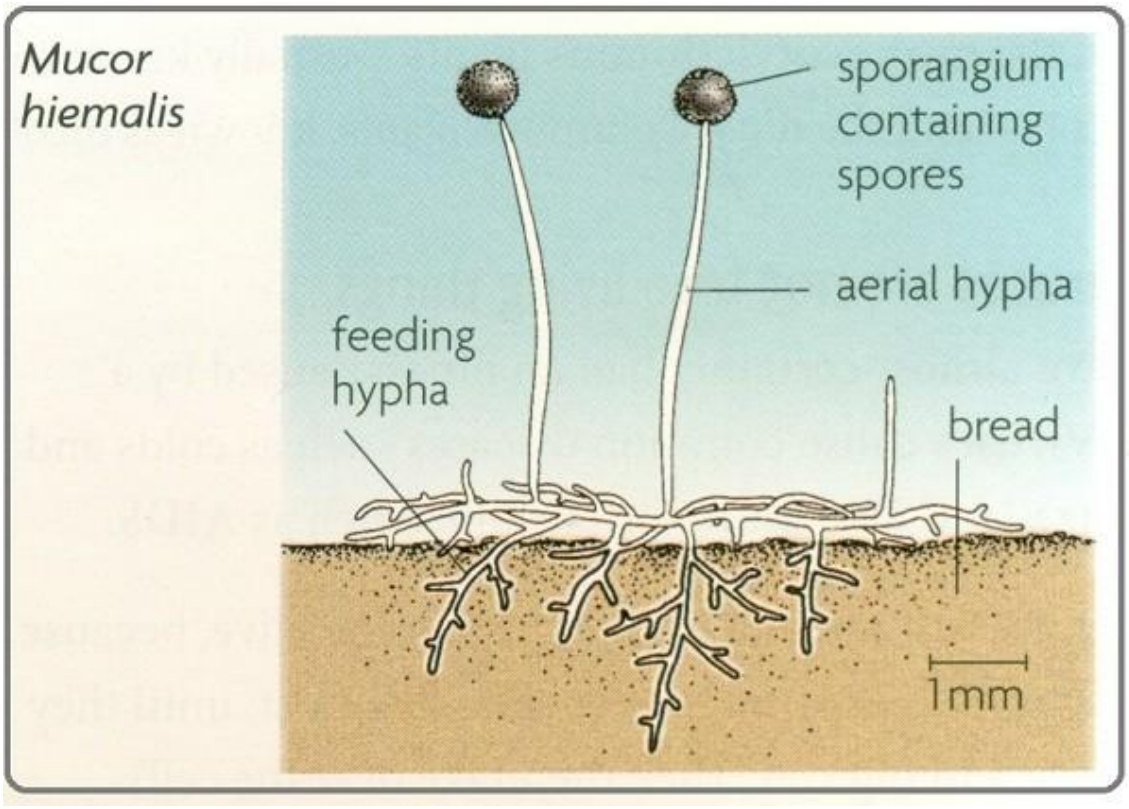
Features of Bacteria

- **small** (1000 times smaller than a plant cell)
- often **unicellular** (single-celled)
- have **cell wall,** which does **not** contain **cellulose** nor **chitin**
- have **cell membrane** and **cytoplasm,** containing **glycogen** granules
- **no nucleus,** only **DNA** int the form of a single, coiled chromosome
- some have a slime capsule
- some have one or more flagella (a lash-like appendage)

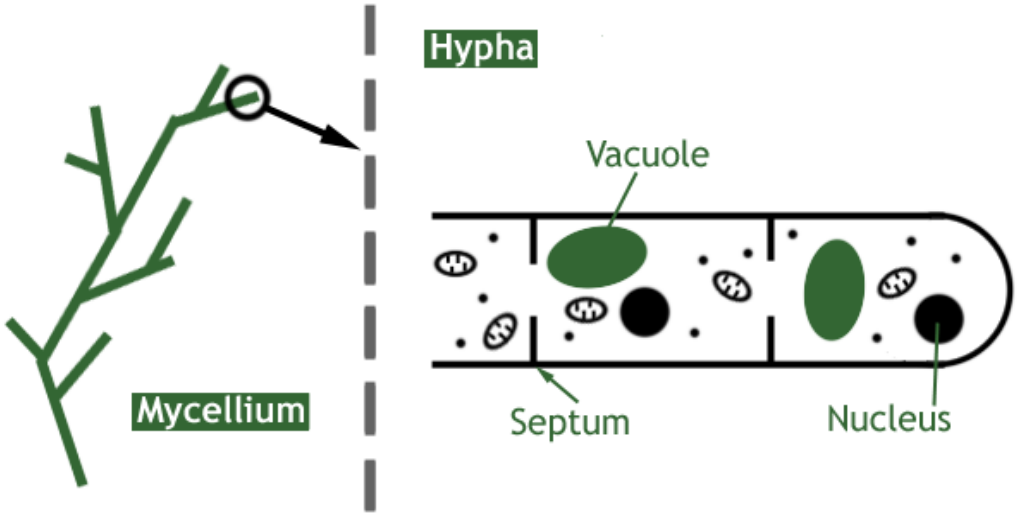
#11: Fungi Kingdom

For a very long time, fungi were classified as plants. However, they are very different from plants and belong to their own kingdom. Fungi **do not have chlorophyll** and do not photosynthesise.

They feed saprophytically, or **parasitically**, on organic material like faeces, human foods and dead plants or animals.

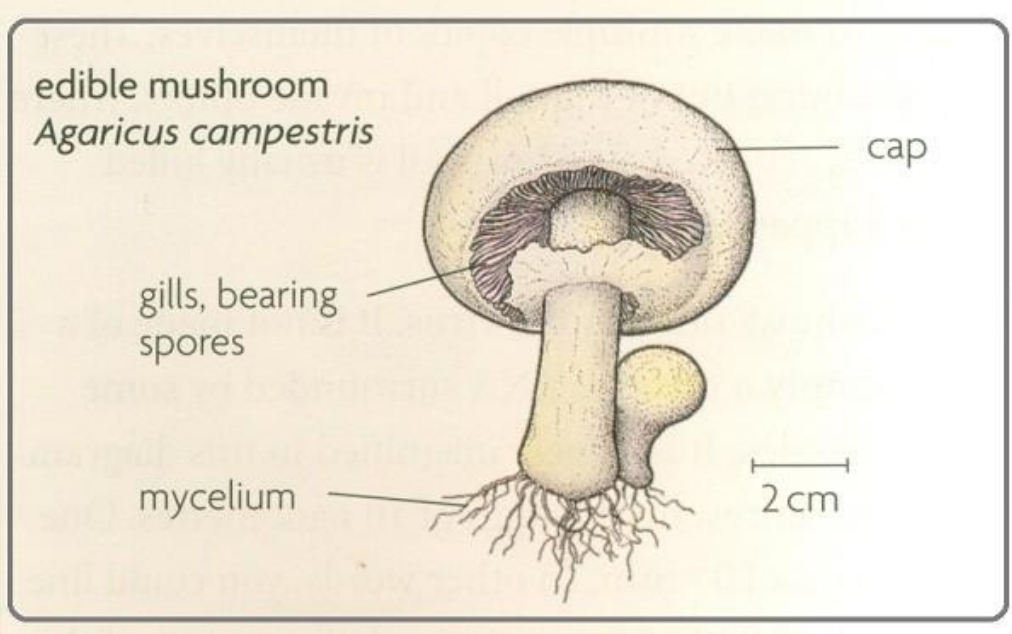


A fungus is made of **hyphae**, which are long tubes, collectively they are called **mycellium** and form branches that can cover many acres.

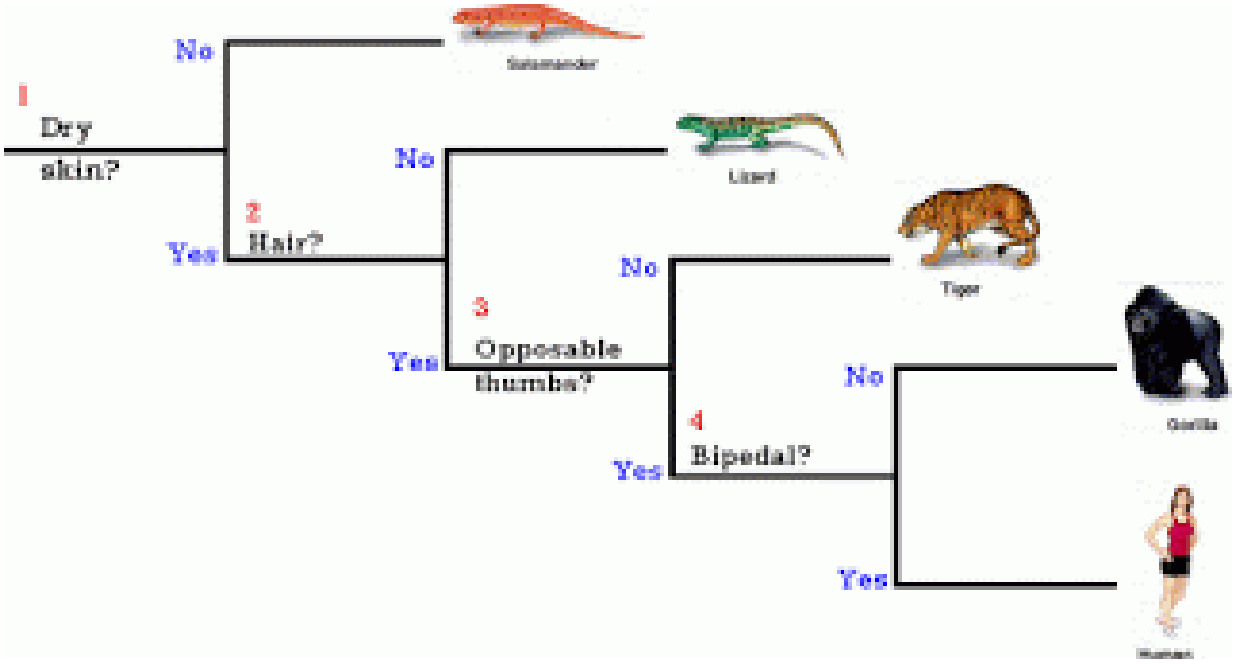


The hypha is a long tube and effectively one cell with many nuclei. It could be divided into comparments by **septa**; The tip is tapered, this is where it is growing outwards and is known as the extension zone.

Fungi grow specialised areas for reproduction called **fruiting bodies**. These can grow very large and be visible to the naked eye where they are known as **mushrooms**. It is from these that spores are produced.

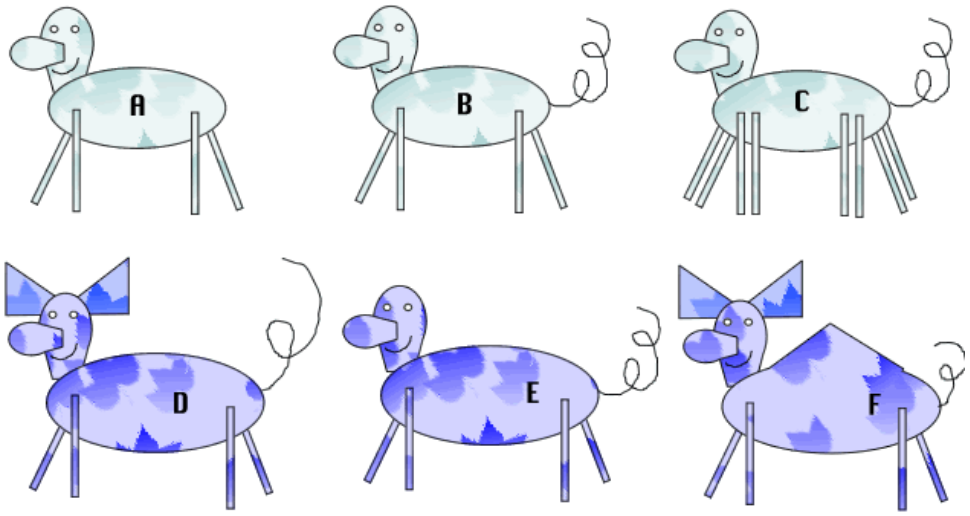


#12: Using simple keys



The identification of biological organisms can be greatly simplified using tools such as **dichotomous keys**. It is a written set of **choices**, each involving **two statements**, that leads to the **name** of an organism. Scientists use these to identify unknown organisms.

Consider the following animals. They are all related, but each is a separate species. Use the dichotomous key below to determine the species of each.



1.	Has green colored body .....go to 2
	Has purple colored body ..... go to 4
2.	Has 4 legs .....go to 3
	Has 8 legs ..... *Deerus octagis*
3.	Has a tail ..... *Deerus pestis*
	Does not have a tail ..... *Deerus magnus*
4.	Has a pointy hump ..... *Deerus humpis*
	Does not have a pointy hump.....go to 5
5.	Has ears .....*Deerus purplinis*
	Does not have ears .....*Deerus deafus*

Answers:

***A**: Deerus magnus* ***B**: Deerus pestis* ***C**: Deerus octagis*
***D**: Deerus purplinis* ***E**: Deerus deafus* ***F**: Deerus humpis*

As seen above:

- the keys are **mutually exclusive characteristics** of biological organisms.
- they often begin with **general** characteristics and lead to more **specific** characteristics.
- you simply compare the characteristics of an unknown organism against an appropriate dichotomous key.
- if the organism falls into one category, you go to the next indicated couplet.

By following the key and making the correct choices, you should be able to identify your specimen to the indicated taxonomic level.

Try this

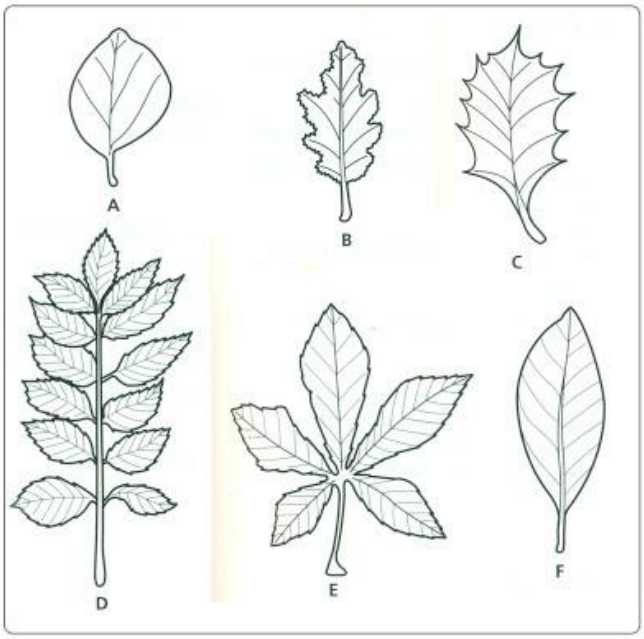


Figure above shows single leaves from six different trees. Use the key below to identify which tree each leaf comes from.

Make a table similar to the one below and put a tick in the correct box to show how you identify each leaf. Give the name of the tree. Leaf A has been identified for you as an example.

1	**a** Leaf with smooth outline	go to 2
	b Leaf with jagged outline	go to 3
2	**a** Leaf about the same length as width	*Cydonia*
	b Leaf about twice as long as it is wide	*Magnolia*
3	**a** Leaf divided into more than two distinct parts	go to 4
	b Leaf not divide into more than two distinct parts	go to 5
4	**a** Leaf divided into five parts	*Aesculus*
	b Leaf divided into ten or more parts	*Fraxinus*
5	**a** Leaf with pointed spines along its edge	*Ilex*
	B Leaf with rounded lobes along its edge	*Quercus*

[4 marks]

Leaf	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	Name of tree
A	✓		✓								*Cydonia*
B											

Answers

Leaf	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	Name of tree
B		✓				✓				✓	*Quercus*
C		✓				✓			✓		*Ilex*
D		✓			✓			✓			*Fraxinus*
E		✓			✓		✓				*Aesculus*
F	✓			✓							*Magnolia*

Additional sources:
http://www.biologycorner.com/bio1/notes_taxonomy.html
http://biology.clemson.edu/bpc/bp/Lab/104/Labmanual/LabEx/09Keys.pdf
http://www.biologyjunction.com/dichotomous_keying.htm

#13 Summary of Classification of Living things

- All living things have **7 characteristics**: **Nutrition, Respiration, Growth, Excretion, Movement, Reproduction and Sensitivity.**

- Living organisms are **classified** into groups according to how closely related they are. Each species of organism is given a unique two-word Latin name called a **binomial**. The first word of the binomial is the **genus** and the second word is the **species**.

- **Vertebrates** are classified into **5 classes**: **fish, amphibians, reptiles, birds and mammals.** They each have their own distinctive set of features. E.g. amphibians have a smooth skin, fish and reptiles have scales, birds have feathers and scales, and mammals have hair.

- **Arthropods** are invertebrates with joined legs and segmented bodies. They can be further classified into **insects, arachnids, crustaceans and myriapods.**

- **Annelids** are worm with **segmented** bodies but no legs.

- **Nematodes** are worms with **unsegmented** bodies.

- **Molluscs** have unsegmented bodies, and often have a **shell**.

- **Bacteria** are single-celled organisms whose cells do **not** have **nuclei.**

- **Fungi** include moulds, mushrooms and toadstools. They have cells with **cell walls** but do **not photosynthesise**.

- **Viruses** are **not** generally considered to be **alive** at all. They are not made of cells and cannot carry out any of the characteristics of living things on their own.

- **Flowering plants** can be classified in to **monocotyledonous** plants and **dicotyledonous** plants. **Monocots** have seeds with one cotyledon, and their leaves often have **parallel veins**. **Dicots** have seeds with two cotyledons, and their leaves generally have branching veins.

- A **dichotomous key** is a set of **paired contrasting descriptions** which lead you through to the identification of an unknown organism.