IGCSE BIOLOGY 0610 · CHAPTER 1 NOTES · ~12 MIN READ

# Characteristics & classification

The seven things every living organism does, how scientists name and group organisms, how to use a dichotomous key — and the features of each kingdom, vertebrate and arthropod group.

MRS GREN | Species & binomial names | Dichotomous keys | Kingdoms | Vertebrates & arthropods | Viruses

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No tag = **Core** (everyone) EXTENDED Extended only highlight = comes up again and again

Test yourself at the end

### IN 30 SECONDS

- All living organisms show **seven characteristics**: movement, respiration, sensitivity, growth, reproduction, excretion, nutrition (**MRS GREN**).
- A **species** is a group of organisms that can reproduce to produce **fertile offspring**. Every species has a two-part **binomial name**, e.g. *Homo sapiens*.
- Organisms are sorted into groups by shared **features**. A **dichotomous key** uses yes/no questions to identify an organism.
- EXT Classification reflects **evolutionary relationships**, and similar **DNA base sequences** mean a **more recent common ancestor**.

### BY THE END YOU CAN

- State and define the seven characteristics of living organisms.
- Define species and write a binomial name correctly.
- Use and construct a dichotomous key.
- Describe the main features of animals, plants, the vertebrate classes and the arthropod classes.
- Describe the five kingdoms, ferns, flowering plants and viruses. EXT

## 1 What makes something alive?

### The seven life processes

**M — Movement**: moving the body or a part of it to a new place

**R — Respiration**: reactions in cells that release energy from food

**S — Sensitivity**: detect stimuli and respond to them

**G — Growth**: permanent rise in size and dry mass

**R — Reproduction**: make more of the same kind of organism

**E — Excretion**: remove toxic waste and excess substances

**N — Nutrition**: take in materials for energy, growth and development

**Every living organism does all seven: "MRS GREN"**

The seven characteristics of living organisms. If a thing does not do all seven, it is not a living organism.

**Movement** — an action by an organism or part of an organism causing a **change of position or place**.

**Respiration** — the chemical reactions **in cells** that break down nutrient molecules and **release energy** for metabolism.

**Sensitivity** — the ability to **detect or sense stimuli** in the internal or external environment and to make **appropriate responses**.

**Growth** — a **permanent increase in size and dry mass** by an increase in cell number or cell size or both.

**Reproduction** — the processes that **make more of the same kind** of organism.

**Excretion** — removal from organisms of **toxic materials** and substances **in excess of requirements** (waste from metabolism).

**Nutrition** — taking in of materials for **energy, growth and development**. Plants need light, carbon dioxide, water and ions. Animals need organic compounds, ions and usually water.

MEMORY TRICK

**M R S G R E N** — **M**ovement, **R**espiration, **S**ensitivity, **G**rowth, **R**eproduction, **E**xcretion, **N**utrition. Two Rs: respiration and reproduction.

EXAM TIP

Always define each process using the **key phrase**: movement = *change of position*, growth = *permanent increase*, excretion = *toxic or excess*, respiration = *release energy in cells*.

COMMON MISTAKE

"Respiration is breathing." Breathing is moving air in and out of the lungs. **Respiration** is a chemical reaction in cells that releases energy.

COMMON MISTAKE

"Plants do not move." Plants move **parts** of themselves (leaves turn towards light, flowers open). Movement means a change of position of the organism **or part of it**.

COMMON MISTAKE

"Excretion is getting rid of faeces." Faeces are **egested** — undigested food that was never part of the body's cells. **Excretion** removes waste made **by** the cells ($CO_2$, urea).

### A quick test: is it alive?

- A **flame** seems to grow, move and use oxygen — but it does not reproduce, respond to stimuli, or make waste from cells. It is **not** alive.
- A **seed** shows few signs of life, but it is alive: it respires slowly and will grow when conditions are right.

PICTURE IT

Treat the seven processes as a checklist. If you cannot tick **every** box, the thing is not a living organism.

## 2 Species and naming

### What is a species?

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

- A horse and a donkey can breed to make a **mule** — but a mule is **sterile** (infertile), so horses and donkeys are **different species**.
- **Fertile** matters. Two organisms that can only produce infertile offspring do not belong to the same species.

## Binomial names

**Binomial system** — a naming system that gives every species a **two-word Latin name**: the **genus** (capital letter) then the **species** (small letter).

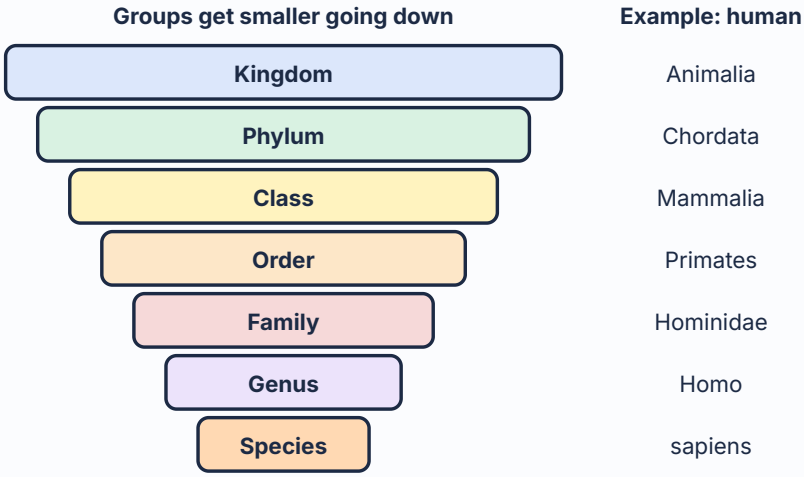
| Organism | Binomial name | Genus | Species |
|---|---|---|---|
| human | Homo sapiens | Homo | sapiens |
| lion | Panthera leo | Panthera | leo |
| tiger | Panthera tigris | Panthera | tigris |
| maize | Zea mays | Zea | mays |

- Typed names are in *italics*. In handwriting, **underline** each word separately.
- Lions and tigers share the genus *Panthera*, so they are **closely related** but are different species.
- Why use Latin names? One name is used by scientists **all over the world**. Common names vary: "robin" means a different bird in Britain and in America.

**EXAM TIP**

Write it correctly: **G**enus with a capital, species in lower case, e.g. *Homo sapiens*, **not** *homo Sapiens* and not *Homo Sapiens*.

## The classification hierarchy




**Mnemonic: King Philip Came Over For Good Soup**

Species = organisms that can breed to produce fertile offspring

Organisms are put into groups within groups. Each step down contains fewer organisms that are more alike.

- The groups, from biggest to smallest: **kingdom → phylum → class → order → family → genus → species**.
- Biologists group organisms using **shared features** — what they look like, how their bodies work and what their DNA says.

**MEMORY TRICK**

**K**ing **P**hilip **C**ame **O**ver **F**or **G**ood **S**oup = Kingdom, Phylum, Class, Order, Family, Genus, Species.

## How classification works

EXTENDED

- Classification should reflect **evolutionary relationships**: organisms that share a recent common ancestor are grouped together.
- Early classification used **appearance**. Today, scientists also compare **DNA base sequences**: the **more similar** the sequences, the **more closely related** the organisms and the **more recently** they shared a common ancestor.

WORKED EXAMPLE

EXT **The DNA base sequence of the same gene in three species differs as follows: species P and Q differ in 2 bases out of 100, species P and R differ in 14 bases out of 100. Which two are more closely related, and why?**

1. P and Q differ least
2. so their DNA is most similar
3. **so P and Q shared a common ancestor more recently than P and R did, which makes P and Q more closely related**

## 3 The main groups of organisms

### Animals and plants (Core)

| Feature | Animals | Plants |
|---|---|---|
| cells | many cells, **no cell walls** | many cells with **cellulose cell walls** |
| chloroplasts | none | present: they **photosynthesise** |
| nutrition | feed on organic substances made by other organisms | **make** their own food from $CO_2$ and water |
| carbohydrate store | **glycogen** | **starch** |
| movement | most can move from place to place | fixed in place (parts do move) |
| coordination | **nervous** coordination, quick responses | slow responses |

### The five kingdoms

EXTENDED

**ANIMALS**
many cells
no cell wall
no chloroplasts
feed on other organisms
e.g. humans, insects

**PLANTS**
many cells
cellulose cell wall
chloroplasts: make food by photosynthesis
e.g. ferns, maize

**FUNGI**
mostly threads (hyphae)
chitin cell wall
no chloroplasts
feed on dead matter
e.g. mould, yeast

**PROTOCTISTS**
mostly single-celled
have a nucleus
some have chloroplasts
e.g. Amoeba, Chlorella

**PROKARYOTES**
single-celled
NO nucleus
DNA free in cytoplasm
cell wall (not cellulose)
e.g. bacteria

**VIRUSES**
not made of cells
not in any kingdom
protein coat + DNA/RNA
multiply only inside host cells

**Core: animals and plants · Extended: all five kingdoms + viruses**

The five kingdoms, plus viruses, which belong to no kingdom.

- **Animals** and **plants** — as in the table above.
- **Fungi** — a cell wall made of **chitin**, no chloroplasts. They feed by releasing **digestive enzymes onto food** and absorbing the products (**saprotrophs**, living on dead matter). Examples: *Mucor* (made of threads called **hyphae**), and **yeast** (single-celled).
- **Protoctists** — mostly **single-celled** with a nucleus. Some have chloroplasts (*Chlorella*), some feed like animals (*Amoeba*). *Plasmodium*, which causes malaria, is a protoctist.
- **Prokaryotes** — **single-celled with no nucleus**; DNA is a circular loop in the cytoplasm. Examples: *Lactobacillus* (makes yoghurt) and *Pneumococcus* (causes pneumonia).

### Ferns and flowering plants

EXTENDED

| Feature | Ferns | Flowering plants |
|---|---|---|
| leaves | fronds (often divided into many leaflets) | many shapes |
| reproduction | **spores**, no flowers or seeds | **flowers**, then **seeds** inside fruits |
| roots and veins | yes | yes |

## Vertebrates

| | **Fish** salmon | **Amphibians** frog | **Reptiles** lizard | **Birds** pigeon | **Mammals** human |
|---|---|---|---|---|---|
| **Skin** | wet scales | moist, thin no scales | dry scales | feathers | hair or fur |
| **Breathing** | gills | lungs and skin | lungs | lungs | lungs |
| **Eggs young** | soft eggs in water | jelly eggs in water | leathery eggs on land | hard-shelled eggs on land | live young fed on milk |
| **Body temp.** | varies with surroundings | varies with surroundings | varies with surroundings | constant (warm) | constant (warm) |

Warm-blooded = constant body temperature (birds, mammals)

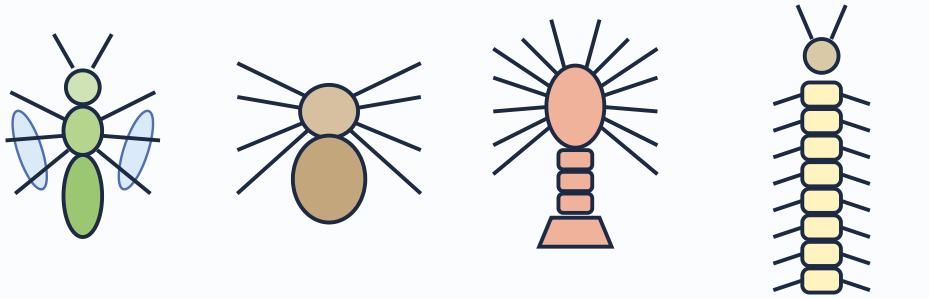
The five classes of vertebrate (animals with a backbone).

- All vertebrates have a **backbone**. Invertebrates (insects, snails, worms…) do not.
- **Warm-blooded** (birds, mammals) means the body keeps a **constant temperature** whatever the surroundings. The others change temperature with their surroundings.
- **Mammals** have **hair or fur**, **mammary glands** (they feed milk to their young) and give birth to **live young**.
- **Birds** have **feathers**, wings, a beak and lay **hard-shelled eggs**.

**EXAM TIP**

Remember one feature for each class: fish = **gills**, amphibians = **moist skin**, reptiles = **dry scales**, birds = **feathers**, mammals = **hair**.

## Arthropods



**INSECTS**
3 body parts
6 legs
usually wings
1 pair of antennae

**ARACHNIDS**
2 body parts
8 legs
no antennae
no wings

**CRUSTACEANS**
2 body parts
5+ pairs of legs
2 pairs of antennae

**MYRIAPODS**
long body, many segments
many legs (1–2 pairs per segment)

All arthropods: jointed legs · hard outer skeleton (exoskeleton) · segmented body

Arthropods have jointed legs and a hard exoskeleton. Count the legs and body parts to name the group.

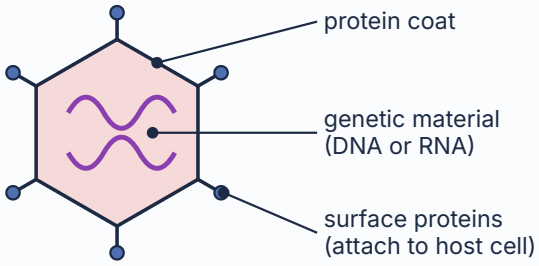
| Class | Body parts | Legs | Other features |
|---|---|---|---|
| insects | 3 | 6 | 1 pair of antennae, usually wings |
| arachnids | 2 | 8 | no antennae, no wings |
| crustaceans | 2 | 5 or more pairs | 2 pairs of antennae |
| myriapods | many segments | many pairs | 1 pair of antennae (centipedes and millipedes) |

**COMMON MISTAKE**

"Spiders are insects." Spiders have **8 legs and 2 body parts**: they are **arachnids**.

## Viruses

EXTENDED



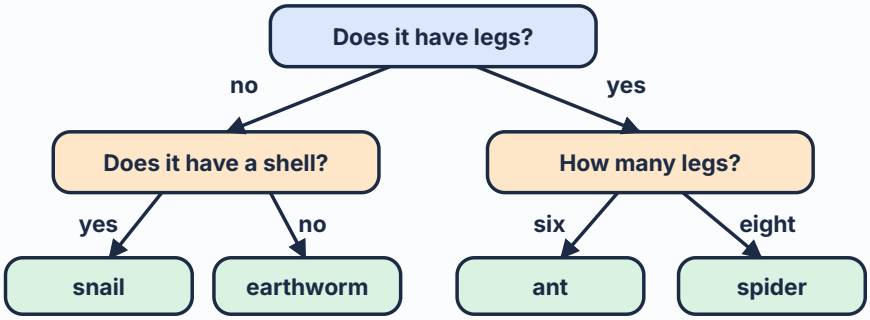

- NOT made of cells: no nucleus, cytoplasm or membrane
- Reproduce ONLY inside a living host cell
- Much smaller than bacteria (about 100 nm across)
- Antibiotics do not work on viruses
- Examples: influenza, HIV, tobacco mosaic virus

A virus is not a cell. It is a piece of genetic material inside a protein coat.

- Viruses have **no cell structure**: no nucleus, cytoplasm or cell membrane. They are far smaller than bacteria.
- They **reproduce only inside living host cells**, so they are not placed in any kingdom.
- Their genetic material is **DNA or RNA**. Examples: influenza, HIV, tobacco mosaic virus.
- **Antibiotics do not kill viruses** (see Diseases, immunity & drugs).

## 4 Dichotomous keys

### Using a key




**The same key written as numbered pairs of statements:**

| | | | | | |
|---|---|---|---|---|---|
| **1a** | Legs present → | **go to 2** | **2b** | Eight legs → | **spider** |
| **1b** | No legs → | **go to 3** | **3a** | Shell present → | **snail** |
| **2a** | Six legs → | **ant** | **3b** | No shell → | **earthworm** |

A dichotomous key is a series of two-choice questions. Follow the answers until you reach one named organism.

**Dichotomous key** — a way to identify organisms using a series of **paired statements** (yes/no questions), each leading to another question or to a name.

- Start at question 1. Choose the statement that fits. Follow the instruction (go to 2, or the name).
- Use **features you can observe** (number of legs, wings, shell) — not size or colour, which vary within a species.

### Building your own key

- **1** List the features of each organism.
- **2** Pick a feature that **splits the group** into two sets. Write it as a yes/no question.
- **3** Repeat on each set until every organism is **alone** at the end of a branch.
- **4** Check each organism can be reached by **only one route**. Test the key on a friend.

WORKED EXAMPLE

**Use the key on this page: a small animal has no legs and no shell. What is it?**

1. Question 1: does it have legs? **No**
2. Question 2: does it have a shell? **No**
3. **the animal is an earthworm**

## 5 Test yourself

### Test yourself — cover the answers first

**QUICK CHECK**

1. Name the seven characteristics of living organisms.
2. Define excretion.
3. What is a species?
4. Write the binomial name for humans correctly.
5. How many legs and body parts does an insect have?
6. Name the vertebrate class that has feathers.
7. What is the difference between respiration and breathing?
8. EXT Name the five kingdoms.
9. EXT Why are viruses not placed in any kingdom?

**EXAM-STYLE**

10. Define the term growth. [2]
11. A mule is the offspring of a horse and a donkey. Explain why horses and donkeys are classed as different species. [2]
12. Give three differences between a fungus and a plant. [3]
13. EXT Explain how DNA sequences help scientists to classify organisms. [3]

**Show answers**

1. movement, respiration, sensitivity, growth, reproduction, excretion, nutrition
2. removal of toxic materials and substances in excess of requirements from organisms
3. a group of organisms that can reproduce to produce fertile offspring
4. Homo sapiens (genus capital, species lower case)
5. 6 legs, 3 body parts
6. birds
7. respiration is a chemical reaction in cells releasing energy; breathing is moving air in and out of the lungs
8. animals, plants, fungi, protoctists, prokaryotes
9. they are not made of cells and only reproduce inside host cells
10. a permanent increase
    in size and dry mass (by an increase in cell number, cell size or both)
11. a mule is sterile
    so they cannot produce fertile offspring
12. fungi have chitin cell walls, plants have cellulose
    fungi have no chloroplasts, plants do
    fungi feed by absorbing digested food, plants make their own by photosynthesis
13. compare the base sequences of the same gene
    the more similar the sequences, the more closely related
    they share a more recent common ancestor

## Stuck on a question?

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