

Organisation of the organism

IGCSE Biology

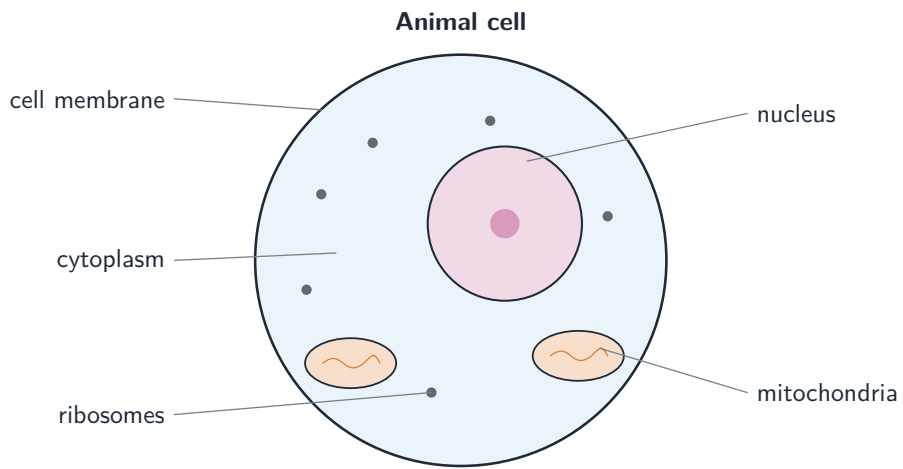
Cells: the building blocks of life

Every living thing is made of **cells** . A cell is the smallest part that can carry out the life processes. In this topic you compare a **plant** cell, an **animal** cell and the cell of a **bacterium** . All new cells are made by the **division** of cells that already exist.

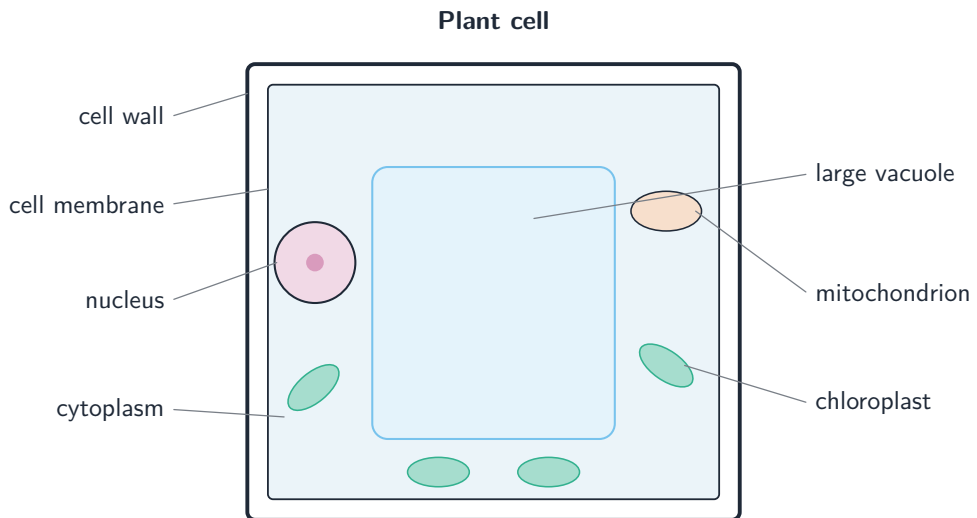
■ Which structures are in each cell?

Structure	Animal cell	Plant cell	Bacterial cell
cell membrane	yes	yes	yes
cytoplasm	yes	yes	yes
ribosomes	yes	yes	yes
nucleus	yes	yes	no – has a loop of DNA instead
mitochondria	yes	yes	no
cell wall	no	yes	yes (different material)
chloroplasts	no	yes (only in green parts)	no
large vacuole	no	yes	no
plasmids	no	no	yes

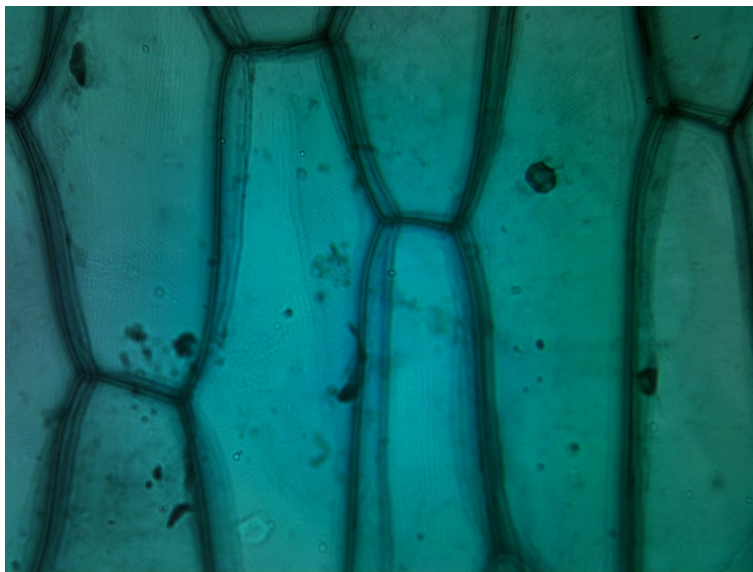
So plant and animal cells share five structures: cell membrane, cytoplasm, ribosomes, nucleus and mitochondria. A plant cell has three extra structures: a cell wall, a large vacuole and (in green parts) chloroplasts.



An animal cell: membrane, cytoplasm, nucleus, mitochondria and ribosomes



A plant cell also has a cell wall, a large vacuole and chloroplasts



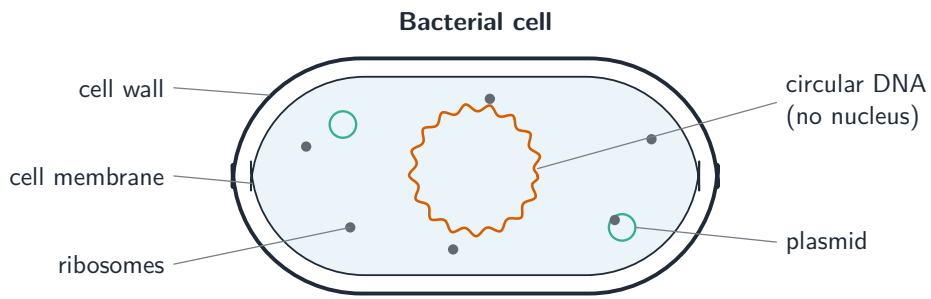
Onion epidermis cells under a light microscope – each cell has a clear cell wall

■ What each structure does

- **Cell membrane** – controls which substances enter and leave the cell.
- **Cytoplasm** – a jelly-like liquid where many chemical reactions happen.
- **Nucleus** – controls the cell's activities and holds the **genetic material**.
- **Ribosomes** – where **proteins** are made.
- **Mitochondria** – where **respiration** happens to release **energy**.
- **Cell wall** – made of **cellulose**; it gives a plant cell strength and a fixed shape.
- **Chloroplasts** – contain **chlorophyll**, a green substance that traps light for **photosynthesis**.
- **Large vacuole** – filled with **cell sap**; it helps keep the plant cell firm.

■ Bacterial cells

A **bacterium** is a **prokaryote** – its cell has **no** nucleus. Instead its DNA is a single loop (a ring), loose in the cytoplasm. Bacteria also have small extra rings of DNA called **plasmids**. A bacterial cell has a cell wall and cell membrane, cytoplasm and ribosomes, but no mitochondria and no chloroplasts.



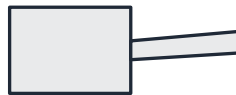
A bacterial cell has no nucleus – its DNA is a single loop, plus small plasmids

Specialised cells

Most cells are **specialised cells** – their shape and parts suit one special job.



red blood cell
(carries oxygen)



root hair cell
(absorbs water)



nerve cell
(carries impulses)

Specialised cells have shapes that suit their jobs

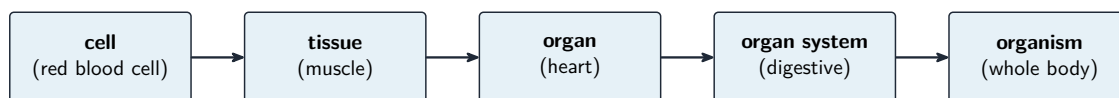
Cell	Job	How its shape helps
ciliated cells	move mucus along the trachea and bronchi	tiny hairs (cilia) on top sweep the mucus along
root hair cells	absorption of water and minerals from the soil	a long, thin “hair” gives a large surface
palisade mesophyll cells	photosynthesis	packed with chloroplasts, near the top of the leaf
neurones	carry electrical impulses	very long, to reach far across the body
red blood cells	transport oxygen	no nucleus and a dish shape, to carry more oxygen
sperm and egg cells	reproduction	the sperm can swim; the egg cell stores food

Sperm and egg cells are the sex cells, called **gametes** .

Levels of organisation

An **organism** made of many cells is built up in levels, from small to large:

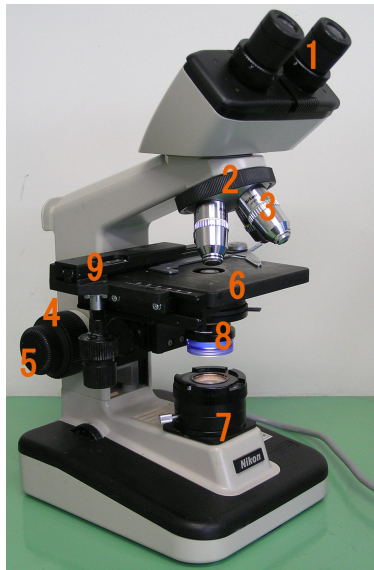
- **cell** – the smallest unit of life (for example a red blood cell).
- **tissue** – a group of similar cells that work together (for example **muscle**).
- **organ** – several different tissues that work together to do a job (for example the heart, or a leaf).
- **organ system** – several organs that work together (for example the **digestive system** , which breaks down food).
- **organism** – all the organ systems together make one whole living thing.



From a single cell up to the whole organism

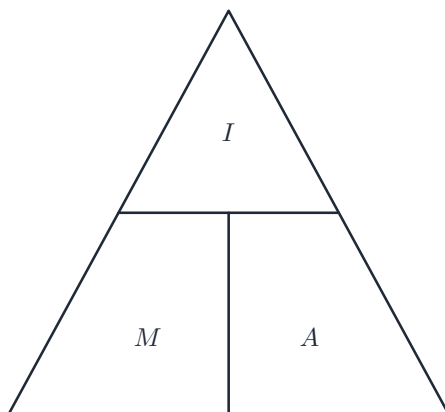
The size of cells: magnification

Cells are tiny, so you look at them under a **microscope**, which makes them appear much larger. How many times larger the image is, is called the **magnification**.



A light microscope, used to look at cells

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}}$$



I = image size

M = magnification

A = actual size

$$M = \frac{I}{A}$$

cover a letter to get its formula

Cover the quantity you want in the triangle to read off its formula

- **image size** = the size in the drawing or photo.
- **actual size** = the real size of the **specimen**.

Magnification has **no unit** – it is just a number, for example $\times 250$. You can rearrange the formula:

$$\text{actual size} = \frac{\text{image size}}{\text{magnification}}, \quad \text{image size} = \text{actual size} \times \text{magnification}$$

Worked example. A structure is shown at a magnification of 250. Its image size is 5.00 mm. So the actual size = $5.00 \div 250 = 0.02$ mm. Always put both sizes in the **same unit** before you divide.

■ Changing units (Supplement)

Cells are often measured in **micrometres** (μm), which are smaller than millimetres (mm):

$$1 \text{ mm} = 1000 \mu\text{m}, \quad 1 \mu\text{m} = 0.001 \text{ mm}$$

So $0.02 \text{ mm} = 20 \mu\text{m}$. To change mm into μm , multiply by 1000. To change μm into mm, divide by 1000.

Worked example. A cell is drawn 60 mm wide, and its real width is $30 \mu\text{m}$. Find the magnification. First make the units match: image size = $60 \text{ mm} = 60 \times 1000 = 60,000 \mu\text{m}$. Then magnification = image $\div$ actual = $60,000 \div 30 = \times 2000$. If you forget to convert and divide $60 \div 30$, you get $\times 2$ – a thousand times too small. This is the most common mistake in the whole topic.

Exam tips

- A plant cell has a cell wall, a large vacuole and chloroplasts; an animal cell has none of these. Both have a nucleus, cytoplasm, cell membrane, mitochondria and ribosomes.
- A cell with **no nucleus** but with plasmids and a loop of DNA is a bacterium.
- For magnification, cover the quantity you want: magnification = image $\div$ actual; actual = image $\div$ magnification.
- Always convert to the same unit before you calculate. Remember $1 \text{ mm} = 1000 \mu\text{m}$.
- For a specialised cell, link its job to the one feature that suits it (for example a red blood cell has no nucleus, so it can hold more oxygen).