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Cells, eukaryotic cells and the animal cell

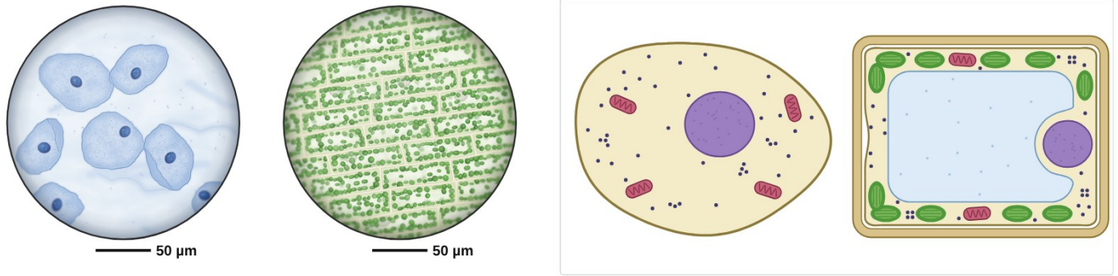
1. Cells: the building blocks

All living things are made of **cells**. A cell is the basic building block of all living things.

Most cells are far too small to see without a microscope. A typical animal cell is about 10 to 30 µm across, and a plant cell about 10 to 100 µm (1 mm = 1000 µm).

Inside each cell are smaller parts, called **sub-cellular structures**. Each one has a particular job. Together they keep the cell alive.

2. Real cells and cell diagrams



Real cells (painting)

Cell diagrams

Stains colour the cells: the blue is a dye. The green chloroplasts are their real colour.

A picture of cells seen through a light microscope is a **light micrograph**. Real cells are almost colourless, so animal cells such as cheek cells are often **stained**: a blue dye shows up the nucleus. Pondweed leaf cells need no stain: their chloroplasts are really green.

Exam pictures of cells are usually **diagrams**. A diagram is simplified on purpose:

- It draws mitochondria and ribosomes. In a light micrograph, mitochondria are too small to see clearly, and ribosomes cannot be seen at all.
- It shows one neat cell. Real plant cells are packed together in rows and share their walls.
- It colours the permanent vacuole. In real cells it is clear and hard to see.
- It draws the cell membrane as a separate line. In a real plant cell it is pressed against the cell wall.
- It always shows the nucleus clearly. In real plant cells it is often hidden behind chloroplasts.

> **Watch out:** the colours in a diagram are not real. Only the green of the chloroplasts is a real colour. The blue of stained cheek cells is a dye.

3. Eukaryotic cells

Animal and plant cells are **eukaryotic cells**. Every eukaryotic cell has:

- a **cell membrane** around the cytoplasm (in plant cells, just inside the cell wall)
- **cytoplasm** inside
- **genetic material** (DNA) enclosed in a **nucleus**.

"Eu-" means true: a eukaryotic cell has a true nucleus. Bacterial cells are prokaryotic: their genetic material is not in a nucleus (B1 L2 Bacterial cells).

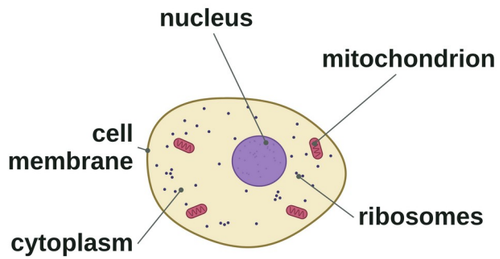
4. Inside an animal cell

Most animal cells have five parts. You need to know each one and its job.

Part	Job
nucleus	contains genetic material, which controls the activities of the cell
cytoplasm	a jelly-like substance where most of the chemical reactions in the cell happen; enzymes control the reactions
cell membrane	controls the movement of substances into and out of the cell
mitochondria	where aerobic respiration happens, releasing energy for the cell
ribosomes	protein synthesis: proteins are made there

Notes on the parts:

- The genetic material in the nucleus is **DNA**. It carries the instructions for making the cell's proteins (more in B1 L6 Cell division: mitosis).
- One **mitochondrion**, many **mitochondria**. Cells that need a lot of energy, such as muscle cells, have a lot of them.
- Ribosomes are tiny: about 25 nm across. They make proteins such as **enzymes** (B2 L3 Enzymes and digestion).



A diagram is simplified.

> **Watch out:** mitochondria **release** energy by respiration. Never write that energy is "made" or "produced".

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Plant cells, and animal and plant cells compared

5. Inside a plant cell

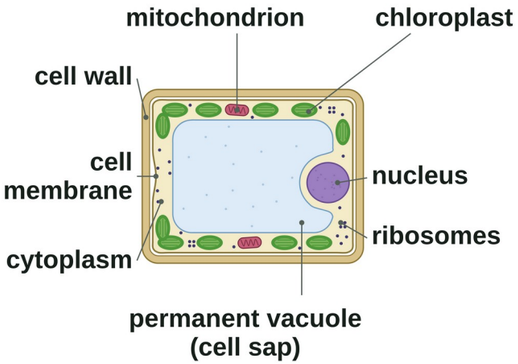
Plant cells have the same five parts as animal cells. They often have three more:

Part	What it is like	Job
cell wall	made of cellulose; outside the cell membrane	strengthens the cell
permanent vacuole	a space filled with cell sap, a weak solution of sugars and salts	helps to keep the cell firm
chloroplasts	green: they contain chlorophyll	absorb light to make food by photosynthesis

Algal cells, such as the cells of seaweeds and pond algae, also have a cell wall made of **cellulose**, and chloroplasts.

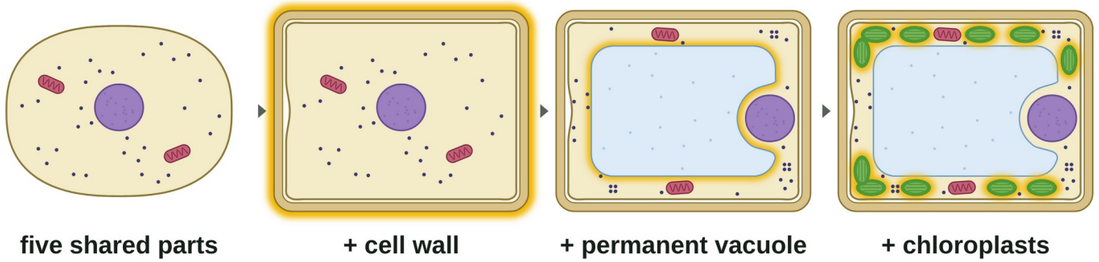
A full permanent vacuole pushes the cytoplasm out against the cell wall. This keeps the cell firm and helps the plant to stand up (more in B1 L9 Osmosis).

Watch out: the cell wall is not the cell membrane. Plant cells have both. The cell wall strengthens the cell. The cell membrane, just inside it, controls what goes in and out.



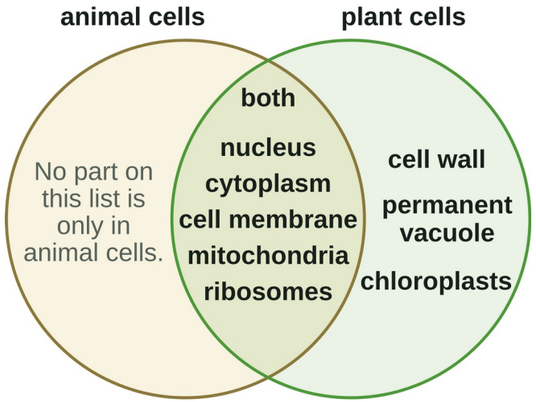
A diagram is simplified. Only the chloroplasts' green is a real colour.

Building a plant cell. Start with the five shared parts. Add a cell wall round the outside, a permanent vacuole in the middle, and chloroplasts in the cytoplasm: that is a plant cell.



6. Animal and plant cells compared

Part	Animal	Plant
nucleus	yes	yes
cytoplasm	yes	yes
cell membrane	yes	yes
mitochondria	yes	yes
ribosomes	yes	yes
cell wall	no	yes
permanent vacuole	no	often
chloroplasts	no	often



Plant cells have every part that animal cells have, and more. No part on the AQA list is only in animal cells.

Watch out: plant cells have mitochondria too. They respire all the time, day and night (section 9).

Watch out: animal cells have no cell wall and no permanent vacuole. The outside layer of an animal cell is the cell membrane.

Watch out: not every plant cell has chloroplasts. Onion bulb cells and root hair cells grow in the dark and have none.

7. Which cell is it?

- Look for the **cell wall** first. A cell wall and a permanent vacuole: a plant cell.
- No cell wall and no permanent vacuole: an animal cell.
- A cell wall made of cellulose and chloroplasts, living on its own in a pond: an algal cell.
- No chloroplasts does not mean an animal cell. Lots of mitochondria do not mean a plant cell.

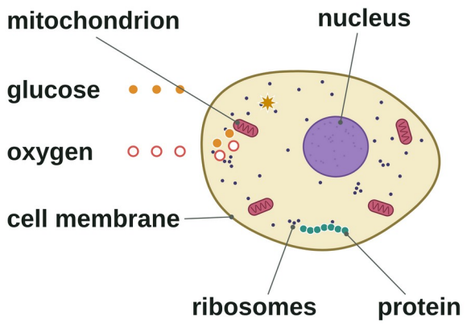
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Parts working together, day and night, and sizes

8. The parts work together

No part of a cell works alone. Follow glucose and oxygen into an animal cell:

- The **cell membrane** lets glucose and oxygen into the cell.
- In the **mitochondria**, aerobic respiration releases energy from glucose.
- The **nucleus** holds the instructions for making proteins.

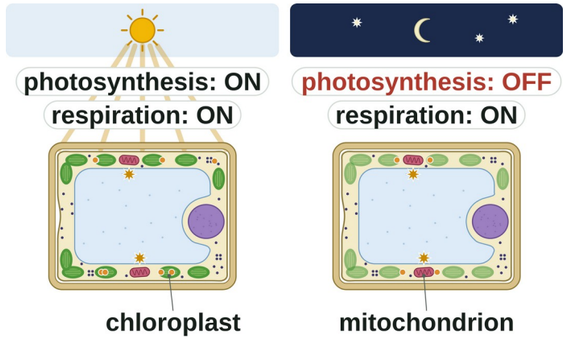


- At the **ribosomes**, proteins are made, using energy from the mitochondria.
- Most chemical reactions happen in the **cytoplasm**, controlled by enzymes. Waste carbon dioxide passes out through the cell membrane.

How substances get into cells is B1 L8 Diffusion.

9. Plant cells respire day and night

	Light	Dark
chloroplasts: photosynthesis	yes	no
mitochondria: aerobic respiration	yes	yes



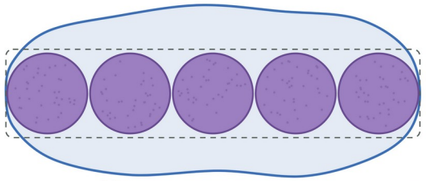
Chloroplasts absorb light to make food (glucose) by **photosynthesis**. This can only happen in the light.

Mitochondria release energy by **aerobic respiration**. Plant cells need energy all the time, so they respire all the time, day and night. At night they use food made in the day.

> **Watch out:** plant cells respire as well as photosynthesise. Chloroplasts do not make energy: they absorb light to make food. Mitochondria release energy from the food.

10. How big are the parts?

Part	About how big
plant cell	10 to 100 µm
animal cell	10 to 30 µm (a cheek cell about 50 µm)
nucleus	5 to 10 µm
chloroplast	about 5 µm
mitochondrion	about 1 µm
ribosome	about 25 nm (0.025 µm)



50 µm ÷ 10 µm = 5 nuclei

1 mm = 1000 µm
1 µm = 1000 nm

An **estimate** is a rough value worked out quickly with simple numbers. Use estimates to compare the sizes of the parts, and to check that an answer is sensible. Cells vary in size, so always say "about".

To estimate how many copies of a part would fit across a cell:

number that fit = width of the cell ÷ width of the part

Worked example: a plant cell is about 80 µm long. Its nucleus is about 10 µm across. Estimate how many nuclei would fit along the cell.

Step 1: check both sizes are in the same unit: 80 µm and 10 µm.

Step 2: divide: 80 ÷ 10 = 8.

Answer: about **8 nuclei**. Check: 8 × 10 µm = 80 µm.

A ribosome (about 25 nm) is 400 times narrower than a 10 µm nucleus: far too small to see with a light microscope. Electron microscopes show ribosomes (B1 L3 Using a microscope).

> **Watch out:** divide the size of the cell by the size of the part. Change both sizes into the same unit first (more in B1 L4 Magnification and cell size).

11. Answering "explain" questions about cells

Name the part, then give its job, then link the job to the question.

- Model answer: "A leaf cell has chloroplasts because they absorb light to make food by photosynthesis. A root cell has none because it is underground, in the dark."
- "The mitochondria make energy" scores nothing: write "the mitochondria release energy by aerobic respiration".

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Key words, exam tips and check yourself

Key words

Aerobic respiration: respiration that uses oxygen.

Cell: the basic building block of all living things.

Cell membrane: a thin layer around the cell that controls the movement of substances into and out of the cell.

Cell sap: a weak solution of sugars and salts that fills the permanent vacuole.

Cell wall: a layer outside the cell membrane that strengthens the cell; in plant and algal cells it is made of cellulose.

Cellulose: the tough substance that plant and algal cell walls are made of.

Chlorophyll: the green substance in chloroplasts that absorbs light.

Chloroplasts: green structures in some plant cells that absorb light to make food by photosynthesis.

Cytoplasm: a jelly-like substance where most of the chemical reactions in the cell happen.

Eukaryotic cell: a cell whose genetic material is enclosed in a nucleus, such as an animal or plant cell.

Mitochondria (one mitochondrion): the structures in the cytoplasm where aerobic respiration happens, releasing energy for the cell.

Nucleus: the part of a cell that contains the genetic material, which controls the activities of the cell.

Permanent vacuole: a space in a plant cell, filled with cell sap, that helps to keep the cell firm.

Photosynthesis: the process in which plants and algae use light to make glucose from carbon dioxide and water.

Ribosomes: tiny structures in the cytoplasm where proteins are made.

Sub-cellular structure: a part inside a cell that has a particular job, such as the nucleus or a mitochondrion.

Exam tips

- Learn the five parts that animal and plant cells share, and the three extra parts of plant cells.
- Learn a job for every part, in the exact words: "controls the activities of the cell", "controls the movement of substances into and out of the cell".
- Write "cell membrane" and "cell wall" in full. Write "permanent vacuole", not just "vacuole".
- Energy is **released** by respiration. Never write that energy is "made".
- In a light micrograph you cannot see mitochondria clearly, and you cannot see ribosomes at all. Look for the cell wall and the chloroplasts.
- In an estimate, show the division and give the unit.

Check yourself

Cover the answers, then check.

1. Name the five sub-cellular structures found in most animal cells.
2. Name three structures that plant cells often have but animal cells do not.
3. Name the sub-cellular structure where protein synthesis happens.
4. What is a plant cell wall made of, and what does it do?
5. Why do plant cells need mitochondria?
6. Give two reasons why a cell diagram looks different from a light micrograph of the same cells.
7. What does chlorophyll do?
8. A cell is about 45 µm wide. Its nucleus is about 9 µm wide. About how many nuclei would fit across the cell?

Answers

1. Nucleus, cytoplasm, cell membrane, mitochondria and ribosomes.
2. A cell wall, a permanent vacuole and chloroplasts.
3. The ribosomes.
4. Cellulose. It strengthens the cell.
5. To release energy by aerobic respiration, which they do all the time, day and night.
6. Any two: the diagram uses false colours; it draws mitochondria and ribosomes, which are too small to see clearly with a light microscope; it shows one neat cell, not cells packed together; it colours the clear permanent vacuole; it draws the cell membrane apart from the cell wall; it always shows the nucleus clearly.
7. It absorbs light (for photosynthesis).
8. 45 ÷ 9 = about 5 nuclei.

Common mistakes

- **Wrong:** "Plant cells do not have mitochondria." **Right:** they do, and they respire all the time.
- **Wrong:** "The cell wall controls what goes in and out." **Right:** the cell membrane does.
- **Wrong:** "Mitochondria make energy." **Right:** they release energy.
- **Wrong:** "Every plant cell has chloroplasts." **Right:** cells in the dark have none.