

Read a page,  
then cover it and  
draw the  
diagrams  
from memory.

# Cell biology

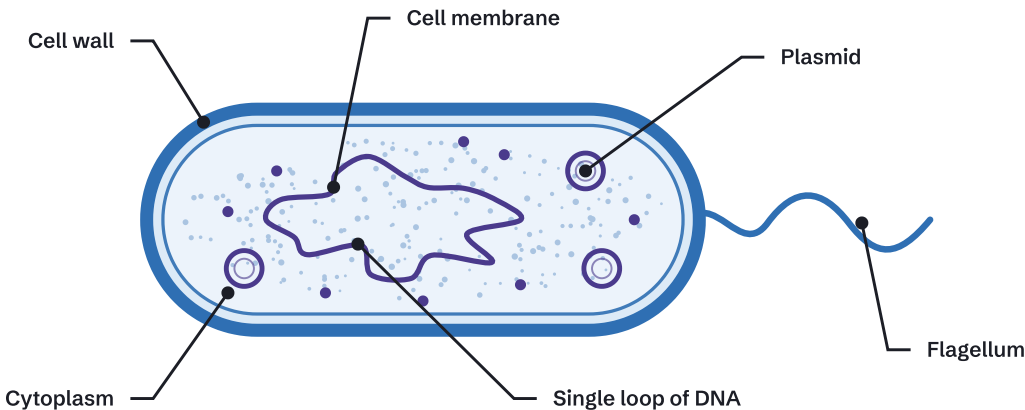
Revision notes for cells, microscopy, cell division and transport across membranes.

|   |                    |                                                                 |        |
|---|--------------------|-----------------------------------------------------------------|--------|
| 1 | Cell structure     | eukaryotic and prokaryotic cells, organelles, specialised cells | p. 1-2 |
| 2 | Microscopy         | light and electron microscopes, magnification                   | p. 3   |
| 3 | Cell division      | chromosomes, mitosis, stem cells                                | p. 3   |
| 4 | Transport in cells | diffusion, osmosis, active transport                            | p. 4   |

## 1 Eukaryotic and prokaryotic cells

Animal and plant cells are **eukaryotic**. Their genetic material is enclosed in a **nucleus**.

Bacterial cells are **prokaryotic**. They are much smaller than eukaryotic cells, and their genetic material is **not** enclosed in a nucleus. It is a single loop of DNA, and there may also be one or more small rings of DNA called **plasmids**.



### Orders of magnitude

Cell sizes are compared in powers of ten. A typical animal cell is about 10 times wider than a typical bacterium. To compare two sizes, divide one by the other and write the answer as a power of ten.

### Quick check

- 1 Which type of cell has its genetic material enclosed in a nucleus?
- 2 Name two structures found in a bacterial cell but not in an animal cell.
- 3 Where is the genetic material in a prokaryotic cell?

Answers: 1 Eukaryotic. 2 Cell wall and plasmids (or flagellum). 3 In the cytoplasm, as a single DNA loop plus plasmids.

Spec 4.1.1.1

Key words

eukaryotic

prokaryotic

plasmid

flagellum

Bacteria have no  
nucleus, but they  
still have DNA!

5 parts in both.  
3 only in plants.

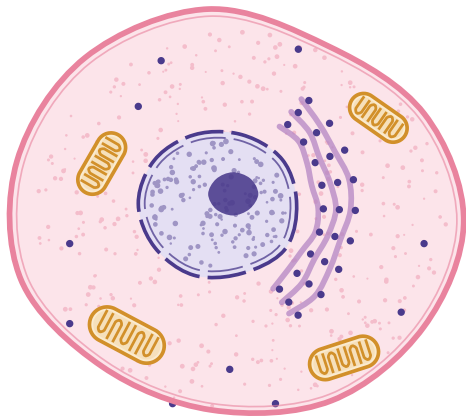
Bacterial cell walls  
are not made of  
cellulose!

Key words

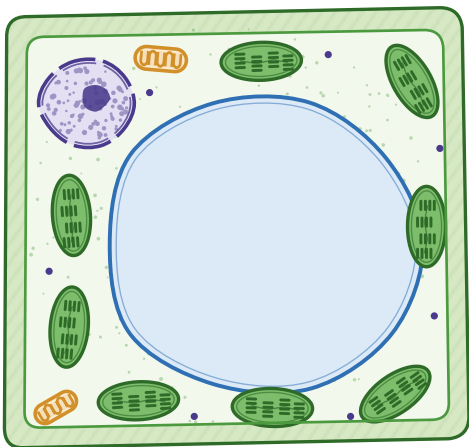
- specialised
- differentiation
- adaptation

Animal and plant cells

Animal cell



Plant cell

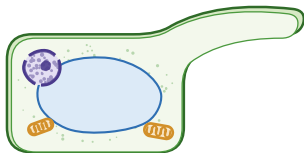


| Structure         | What it does                                         | Animal | Plant | Bacteria |
|-------------------|------------------------------------------------------|--------|-------|----------|
| Nucleus           | Contains the genetic material that controls the cell | ✓      | ✓     | -        |
| Cytoplasm         | Where most chemical reactions happen                 | ✓      | ✓     | ✓        |
| Cell membrane     | Controls what enters and leaves the cell             | ✓      | ✓     | ✓        |
| Mitochondria      | Where aerobic respiration happens                    | ✓      | ✓     | -        |
| Ribosomes         | Where proteins are made                              | ✓      | ✓     | ✓        |
| Cell wall         | Strengthens the cell. Made of cellulose in plants    | -      | ✓     | ✓        |
| Chloroplasts      | Absorb light for photosynthesis                      | -      | ✓     | -        |
| Permanent vacuole | Filled with cell sap; keeps the cell firm            | -      | ✓     | -        |
| Plasmids          | Small rings of extra DNA                             | -      | -     | ✓        |

Specialised cells

As an organism develops, cells differentiate: they gain structures that suit a particular job. Most animal cells differentiate early. Many plant cells keep the ability to differentiate throughout life.

Root hair cell



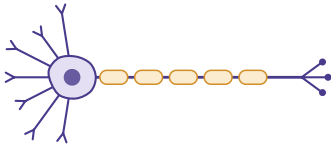
Long projection gives a large surface area to absorb water and mineral ions.

Sperm cell



Tail to swim. Many mitochondria release energy. Enzymes in the head digest a way into the egg.

Nerve cell



Long axon carries impulses a long way. Branched ends connect to other cells.

Quick check

- 1 Name the three structures plant cells have that animal cells do not.
- 2 Why does a sperm cell contain many mitochondria?
- 3 What does it mean when a cell differentiates?

Answers: 1 Cell wall, chloroplasts, permanent vacuole. 2 To release energy (by respiration) for swimming. 3 It becomes specialised for a particular job.

## 2 Microscopy

|                      | Light microscope             | Electron microscope                               |
|----------------------|------------------------------|---------------------------------------------------|
| <b>Magnification</b> | Up to about $\times 2000$    | Up to about $\times 2\,000\,000$                  |
| <b>Resolution</b>    | About 200 nm                 | About 0.2 nm, so it shows <b>much more detail</b> |
| <b>Specimens</b>     | Can be living                | Must be dead (viewed in a vacuum)                 |
| <b>Shows</b>         | Cells, nucleus, chloroplasts | Ribosomes, inside mitochondria and chloroplasts   |

Learn this equation!

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

$$\text{mm} \xrightarrow{\times 1000} \mu\text{m} \xrightarrow{\times 1000} \text{nm}$$

### Worked example

The image of a cell is 12 mm wide at a magnification of  $\times 400$ . How wide is the real cell, in  $\mu\text{m}$ ?

$$\text{real size} = 12 \div 400 = 0.03 \text{ mm} \checkmark$$

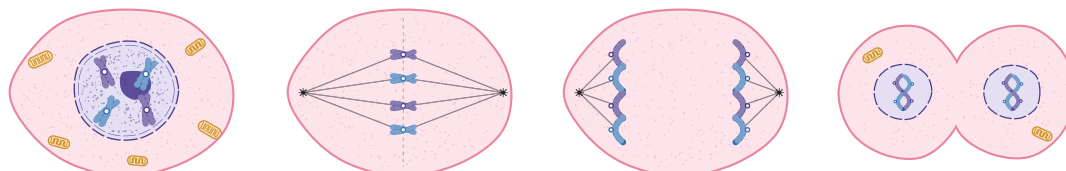
$$0.03 \times 1000 = 30 \mu\text{m} \checkmark$$

Do the division in mm, then convert at the end.

## 3 Cell division

The nucleus contains **chromosomes** made of DNA. Each chromosome carries a large number of **genes**. In body cells, chromosomes are in pairs: humans have 23 pairs.

In the **cell cycle**, a cell grows and copies its DNA, then divides by **mitosis** to make two **genetically identical** cells. Mitosis is used for growth, repair and asexual reproduction.



1 DNA copied, organelles made

2 Chromosomes line up

3 Pulled to each end

4 Cytoplasm and membrane divide

### Stem cells

A **stem cell** is an undifferentiated cell that can divide to make more cells of the same type, and can differentiate into other cell types.

| Where they come from     | What they can become                                |
|--------------------------|-----------------------------------------------------|
| <b>Human embryos</b>     | Most types of human cell                            |
| <b>Adult bone marrow</b> | Many types of cell, including blood cells           |
| <b>Plant meristems</b>   | Any type of plant cell, throughout the plant's life |

#### Key words

chromosome

gene

mitosis

stem cell

meristem



Key words

- concentration gradient
- partially permeable
- surface area to volume ratio
- respiration

4 Transport in cells

Diffusion

**Diffusion** is the spreading out of particles, resulting in a net movement from an area of **higher concentration** to an area of **lower concentration**. Oxygen and carbon dioxide move in and out of cells this way. The rate of diffusion increases with:

- a bigger difference in concentration
- a higher temperature
- a larger membrane surface area

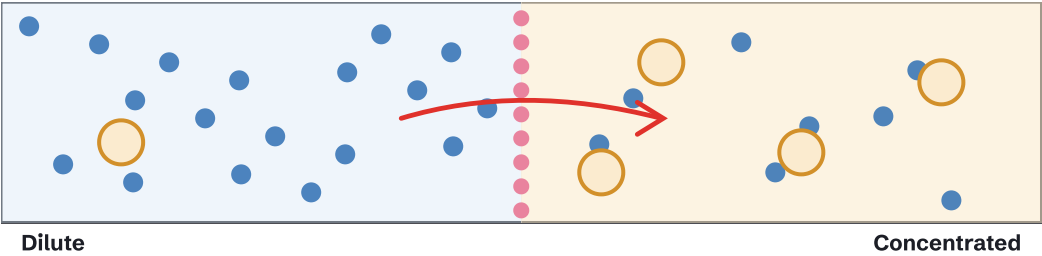
Small organisms have a large **surface area to volume ratio**, so diffusion across their surface is enough.

Larger organisms need exchange surfaces like the lungs and the small intestine.

| Cube side | Surface area       | Volume             | SA : V |
|-----------|--------------------|--------------------|--------|
| 1 cm      | 6 cm <sup>2</sup>  | 1 cm <sup>3</sup>  | 6 : 1  |
| 2 cm      | 24 cm <sup>2</sup> | 8 cm <sup>3</sup>  | 3 : 1  |
| 3 cm      | 54 cm <sup>2</sup> | 27 cm <sup>3</sup> | 2 : 1  |

Osmosis

**Osmosis** is the diffusion of water from a dilute solution to a more concentrated solution through a **partially permeable membrane**.



Osmosis is only ever about water.

Active transport

**Active transport** moves substances from a more dilute solution to a more concentrated solution, **against** a concentration gradient. It needs **energy from respiration**. Root hair cells use it to absorb mineral ions from dilute soil water, and the small intestine uses it to absorb sugar.

A favourite 6-mark question!

Compare the three

|                  | What moves                     | Direction                       | Energy needed?        |
|------------------|--------------------------------|---------------------------------|-----------------------|
| Diffusion        | Particles of a gas or a solute | High to low concentration       | No                    |
| Osmosis          | Water only                     | Dilute to concentrated solution | No                    |
| Active transport | e.g. mineral ions, sugar       | Low to high concentration       | Yes, from respiration |

Quick check

- 1 Give two factors that increase the rate of diffusion.
- 2 Which has the larger surface area to volume ratio: a 1 cm cube or a 3 cm cube?
- 3 What does active transport need that osmosis does not?

Answers: 1 Any two: bigger concentration difference, higher temperature, larger surface area. 2 The 1 cm cube (6 : 1). 3 Energy from respiration.