Topic 1: Cell biology

AQA GCSE Biology 8461 · spec 4.1 · sheets 1.1–1.3

Cell biology: the unit of life

- compare animal, plant and bacterial cells, and link each cell part to its job;
- explain how cells become specialised, and calculate **magnification**;
- culture bacteria safely and test **antibiotics** (biology only);

Cell biology: the unit of life (2)

- describe the **cell cycle**, **mitosis** and the uses of stem cells;
- explain **diffusion**, osmosis and active transport, and why large organisms need exchange surfaces.

Cell structure

- The **nucleus** contains DNA and controls the cell's activities.
- The cell membrane controls what enters and leaves the cell.
- The **cytoplasm** is a jelly where many chemical reactions happen.

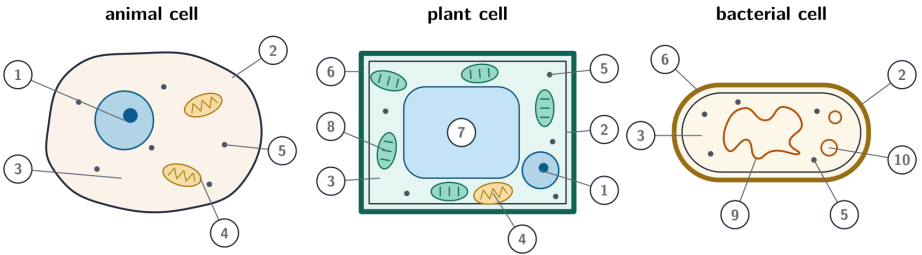
Cell structure (2)

- Each **mitochondrion** is where aerobic respiration releases energy.
- Each **ribosome** is where proteins are made.
- a cell wall made of cellulose, which supports the cell;

Cell structure (3)

- a permanent **vacuole** filled with cell sap, which keeps the cell firm;
- in the green parts of the plant, a **chloroplast** in which photosynthesis happens. Root cells are underground and have no chloroplasts.

Figure: Cell structure

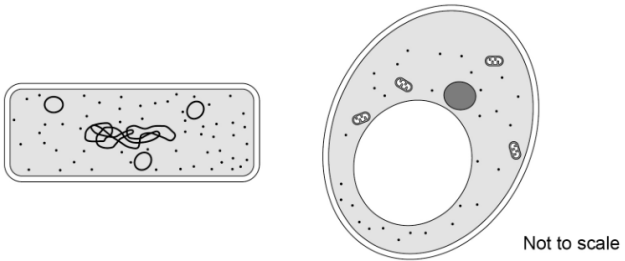


teacher models, not to scale: numbers match the structure key

- An animal cell, a plant cell and a bacterial cell, not to scale; the numbers are listed in the key below
- Match each part of the diagram to the text.

Figure: Cell structure (2)

Figure 10



- A bacterial cell and a yeast cell, not to scale (AQA GCSE Biology Paper 1H, June 2025, Figure 10)
- Match each part of the diagram to the text.

Specialised cells and differentiation

- **Specialised cells** have features that suit their jobs.
- In an answer, give the feature and then explain how it helps.
- **Differentiation** is the process by which a cell gains the special structures it needs to do one job.
- Most animal cells differentiate early in development and then keep their type; cell division in adult animals is mainly for repair and replacement.

Microscopy and magnification

- A **light microscope** uses light and lenses; it magnifies up to about 1500 times.
- An **electron microscope** uses a beam of electrons.
- Electron microscopes have a much greater **magnification** and **resolving power** (resolution), the ability to show two points close together as separate.
- This is why they revealed ribosomes and the inside of mitochondria, which light microscopes cannot show.

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

Culturing microorganisms (biology only)

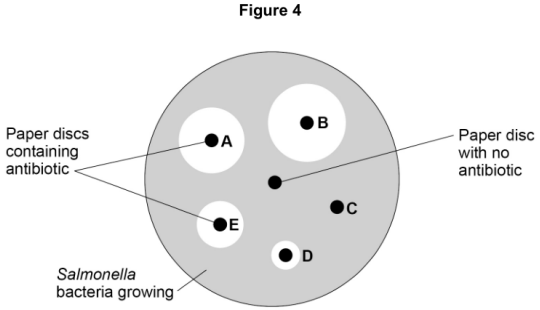
- **sterilise** the **Petri dishes** and **culture media** before use, to kill **microorganisms** already on them;
- pass the **inoculating loop** through a flame before use, to kill microorganisms on it;
- lift the lid only slightly, so that microorganisms from the air do not fall in;

$$\text{number of bacteria} = \text{starting number} \times 2^{\text{number of divisions}}$$

Culturing microorganisms (biology only) (2)

- secure the lid with tape (but do not seal it all round), so that oxygen can still get in and harmful anaerobic bacteria do not grow;
- store the dish upside down, so that drops of condensation do not fall onto the **agar**.

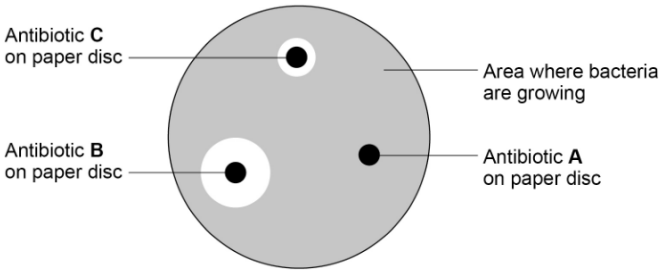
Figure: Culturing microorganisms (biology only)



- Five **antibiotics**, A to E, and a **control** disc with no antibiotic (AQA GCSE Biology Paper 1H, June 2023, Figure 4)
- Match each part of the diagram to the text.

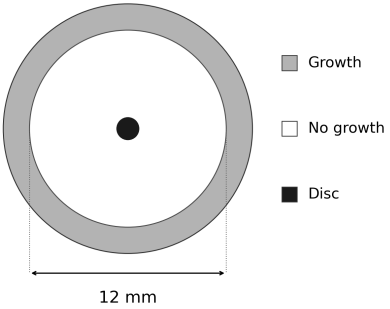
Figure: Culturing microorganisms (biology only) (2)

Figure 5



- Antibiotic A has no clear zone, B a large one and C a small one (AQA GCSE Biology Paper 1H, June 2024, Figure 5)
- Match each part of the diagram to the text.

Figure: Culturing microorganisms (biology only) (3)

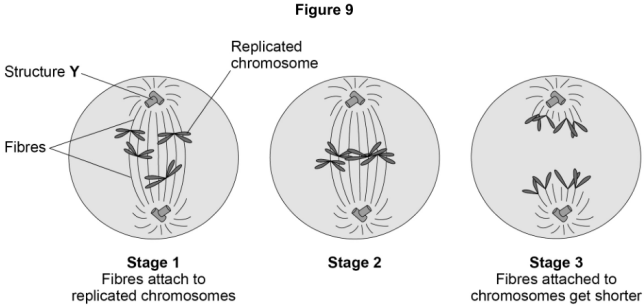


- A clear zone 12 mm across has a radius of 6 mm
- Match each part of the diagram to the text.

Cell division

- The **nucleus** contains **chromosomes** , long molecules of DNA.
- Each chromosome carries many **genes** .
- In body cells **chromosomes** are found in pairs: human body cells have 23 pairs, 46 chromosomes in all.
- **The cell cycle.** The **cell cycle** has three stages:

Figure: Cell division



- Fibres pull the copied **chromosomes** apart during **mitosis** (AQA GCSE Biology Paper 1H, June 2024, Figure 9)
- Match each part of the diagram to the text.

Stem cells

- A **stem cell** is **undifferentiated** : it can divide to make more stem cells and can differentiate into other kinds of cell.
- **Uses. Embryonic stem cells** might one day replace faulty cells, for example insulin-making cells in diabetes or nerve cells in paralysis.

Stem cells (2)

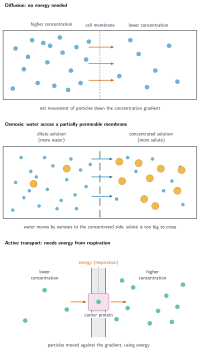
- In **therapeutic cloning** , an embryo is made with the same **genes** as the patient, so its stem cells are not **rejected** by the patient's immune system.
- **Meristem** cells are used to clone plants quickly and cheaply, to save rare species from extinction, or to produce many identical crop plants with useful features such as disease resistance.

Diffusion, osmosis and active transport

- **Diffusion** is the net movement of particles from an area of higher concentration to an area of lower concentration.
- Particles move in every direction, but more move down the **concentration gradient** than up it.
- Examples are oxygen and carbon dioxide in **gas exchange**, and urea moving from cells into the **blood plasma** to be taken to the kidneys.
- **Diffusion** is faster with a steeper **concentration gradient**, a higher temperature and a larger membrane surface area.

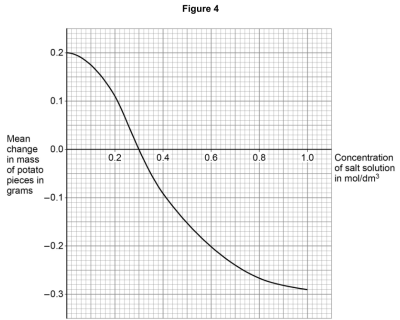
$$\text{percentage change} = \frac{\text{final mass} - \text{initial mass}}{\text{initial mass}} \times 100$$

Figure: Diffusion, osmosis and active transport



- **Diffusion**, **osmosis** and **active transport** compared in three panels.
- Match each part of the diagram to the text.

Figure: Diffusion, osmosis and active transport (2)

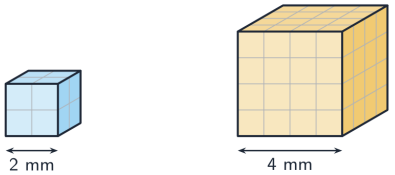


- Mean change in mass of potato in grams against solution concentration (AQA GCSE Biology Paper 1H, June 2024, Figure 4)
- Read the axes and units first.

Exchange surfaces and surface area to volume ratio

- a large surface area, so more substance crosses at once;
- a thin membrane, so the **diffusion** path is short;
- (in animals) a good blood supply, which carries substances away and keeps the gradient steep;
- (for **gas exchange**) **ventilation** , which brings in fresh air or water.

Figure: Exchange surfaces and surface area to volume ratio



surface area $= 6 \times 2^2 = 24$ mm^2
volume $= 2^3 = 8$ mm^3
SA : V = 24 : 8 = 3 : 1

surface area $= 6 \times 4^2 = 96$ mm^2
volume $= 4^3 = 64$ mm^3
SA : V = 96 : 64 = 1.5 : 1

double the side: area $\times 4$, volume $\times 8$, so SA : V halves

- Two cubes showing how doubling the side halves the surface-area-to-volume ratio.
- Match each part of the diagram to the text.

Sources for this lesson

- AQA, *GCSE Biology (8461) specification*, section 4.1 Cell biology, and the required practical handbook.
- R. Hooke, *Micrographia* (London, 1665), Observation XVIII, on cork.
- A. van Leeuwenhoek, letter to the Royal Society of 9 October 1676, *Philosophical Transactions* 12 (1677).
- AQA, *GCSE Biology* Paper 1 Higher (June 2023, 2024 and 2025), the antibiotic, cell division and **osmosis** questions, adapted.

Common errors

- Saying all plant cells have chloroplasts; root cells do not.
- Saying bacteria have no ribosomes or no cell wall; they have both.
- Dividing image size by real size without first changing to the same unit, or giving **magnification** a unit.

Common errors (2)

- Calling the water disc in RP2 a "**control** variable"; it is a control.
- Using the diameter instead of the radius in πr^2.
- Saying "water molecules stop moving" when there is no net **osmosis**.

Common errors (3)

- Writing that **active transport** moves substances down the **concentration gradient**.
- Saying a larger cube has a larger **surface area to volume ratio**.

Key terms

- **Eukaryotic cell**: a cell with its DNA inside a **nucleus**.
- **Prokaryotic cell**: a bacterial cell, with no nucleus.
- **Differentiation**: the process by which a cell becomes specialised.

Key terms (2)

- **Magnification**: how many times bigger the image is than the real object.
- **Aseptic technique**: methods that stop unwanted **microorganisms** contaminating a culture.
- **Mitosis**: the division of the **nucleus** that makes two identical nuclei.

Key terms (3)

- **Stem cell**: an **undifferentiated** cell that can make more stem cells and other cell types.
- **Diffusion**: the net movement of particles from higher to lower concentration.
- **Osmosis**: the **diffusion** of water across a **partially permeable membrane** from a dilute to a concentrated solution.
- **Active transport**: movement against a concentration gradient, using energy from respiration.

Check yourself

- 1.
- Name three structures found in plant cells but not in animal cells. 2.
- An image is 30 mm long and the **magnification** is $\times 500$.
- Find the real length in µm. 3.