B1: Cell Biology

AQA · GCSE Biology · Revision Notes

Specification reference: 4.1

Note: Sections marked ★ HIGHER TIER ONLY are for Higher tier students only. Foundation tier students should focus on the unmarked sections.

4.1.1 Cell Structure

4.1.1.1 Eukaryotes and Prokaryotes

All living organisms are made of cells. There are two types: eukaryotic cells (which have a nucleus) and prokaryotic cells (which do not have a nucleus).

- Eukaryotic cells include all animal cells, plant cells, fungal cells and algae.
- Prokaryotic cells include bacteria — they are much smaller than eukaryotic cells.

4.1.1.2 Animal and Plant Cells

Most animal and plant cells share some features, but plant cells have some extra structures.

- **Nucleus** — contains the genetic material (DNA) and controls the cell.
- **Cell membrane** — a thin, flexible layer that controls what enters and leaves the cell.
- **Cytoplasm** — a jelly-like substance where chemical reactions happen.
- **Mitochondria** — the site of aerobic respiration; they release energy (ATP).
- **Ribosomes** — tiny structures where proteins are made (protein synthesis).
- **Cell wall** (plant only) — made of cellulose; gives the cell a rigid shape.
- **Chloroplasts** (plant only) — contain chlorophyll; the site of photosynthesis.
- **Permanent vacuole** (plant only) — filled with cell sap; helps keep the cell firm (turgid).

Bacterial cells (prokaryotic) have: cell wall, cell membrane, cytoplasm, ribosomes, circular DNA (not in a nucleus), and sometimes plasmids (small extra rings of DNA).

Key Terms

Eukaryotic: Cell with a true nucleus (animals, plants, fungi)
Prokaryotic: Cell with no nucleus — DNA floats freely in cytoplasm (bacteria)
Plasmid: Small circular loop of extra DNA found in bacteria

Exam Tip: In exams, always remember bacteria have NO nucleus — their DNA is just a circular chromosome floating in the cytoplasm.

4.1.1.3–4 Cell Specialisation and Differentiation

Cells become specialised (differentiated) to carry out specific functions. The process of a cell changing to become specialised is called differentiation.

- Red blood cells — no nucleus, biconcave shape, carry oxygen using haemoglobin.
- Sperm cells — long tail for swimming, many mitochondria for energy, acrosome to penetrate the egg.
- Nerve cells (neurones) — very long, with many branches (dendrites) to receive signals.

- Root hair cells — large surface area to absorb water and mineral ions from the soil.
- Xylem cells — hollow tubes with thick walls to transport water up the plant.

4.1.1.5 Microscopy

Microscopes allow us to see cells and their structures in detail.

- **Light microscope** — uses light; maximum magnification ~×1500; maximum resolution ~200 nm. Can see living cells.
- **Electron microscope** — uses electrons; much higher magnification and resolution. Can see organelles like mitochondria and ribosomes in detail. Cannot view living cells.

Magnification formula: **Magnification = Image size ÷ Actual size**

Rearranged: Actual size = Image size ÷ Magnification

Exam Tip: Always check the units in magnification calculations. Convert to the same unit (usually mm or μm) before calculating.

Required Practical 1: Using a light microscope to observe and draw cells (e.g. onion cells, cheek cells).

4.1.2 Cell Division

4.1.2.1 Chromosomes

Chromosomes are thread-like structures made of DNA. Each chromosome contains many genes. Humans have 46 chromosomes (23 pairs) in most body cells.

Key Terms

Chromosome: A long strand of DNA carrying many genes
Gene: A section of DNA that codes for a specific protein
Diploid: Having two copies of each chromosome (e.g. 46 in humans)
Haploid: Having one copy of each chromosome (e.g. 23 in human gametes)

4.1.2.2 Mitosis and the Cell Cycle

Mitosis is cell division for growth, repair and asexual reproduction. It produces two genetically identical daughter cells, each with the same number of chromosomes as the parent cell.

- DNA replicates (copies itself) before the cell divides.
- Chromosomes line up in the middle of the cell.
- Chromosomes are pulled to opposite ends of the cell.
- The cell splits into two identical daughter cells.
- Each daughter cell has the same number of chromosomes as the original.

Cancer occurs when cells divide in an uncontrolled way. Malignant (cancerous) tumours can spread around the body (metastasis).

Exam Tip: Mitosis makes 2 identical cells. Meiosis makes 4 non-identical cells. Remember: **MI**tosis = **M**akes **I**dentical.

4.1.2.3 Stem Cells

Stem cells are undifferentiated cells that can divide and develop into many different specialised cell types.

- **Embryonic stem cells** — found in early embryos; can become any cell type (totipotent). Used in research and potentially in medicine.
- **Adult stem cells** — found in tissues like bone marrow; can only form a limited range of cell types. Used to treat blood diseases (e.g. leukaemia).
- **Meristems** — found at root and shoot tips of plants; can differentiate into any plant cell type. Used to clone plants quickly.

Therapeutic cloning: a cloned embryo is made with the same genes as the patient, then embryonic stem cells are taken from it to grow replacement tissues. This avoids rejection by the immune system.

Key Terms

Differentiation: The process by which a cell becomes specialised for its function

Totipotent: Able to develop into any type of cell

4.1.3 Transport in Cells

4.1.3.1 Diffusion

Diffusion is the movement of particles from an area of **high concentration** to an area of **low concentration** (down a concentration gradient). It is a passive process — no energy is needed.

- Oxygen diffuses into cells for respiration.
- Carbon dioxide diffuses out of cells.
- Glucose diffuses from the small intestine into the blood.

Rate of diffusion increases with: steeper concentration gradient, higher temperature, larger surface area, thinner membrane.

Exam Tip: Particles always move from HIGH to LOW concentration in diffusion — they move "down" the gradient, like rolling downhill.

4.1.3.2 Osmosis

Osmosis is the movement of **water molecules** from a dilute solution (high water potential) to a concentrated solution (low water potential) through a partially permeable membrane.

- Turgid plant cells — full of water; cell wall prevents bursting. Keeps plant firm.
- Plasmolysed plant cells — have lost water; cell membrane pulls away from cell wall.
- Animal cells in dilute solution — take in water and may burst (lysis).
- Animal cells in concentrated solution — lose water and shrink (crenation).

Required Practical 3: Investigating the effect of sugar/salt solutions of different concentrations on potato chips (mass change).

Exam Tip: Osmosis is just a special type of diffusion — it is ONLY water molecules moving, through a partially permeable membrane.

4.1.3.3 Active Transport

Active transport moves substances **against** the concentration gradient (from low to high concentration). It requires energy from respiration.

- Used by root hair cells to absorb mineral ions from the soil (even when soil concentration is lower than inside the root).
- Used in the small intestine to absorb glucose into the blood when its concentration in the blood is already high.
- Requires carrier proteins in the cell membrane.

Key Terms

Active transport: Movement against concentration gradient — requires energy (ATP)

Carrier protein: Protein in cell membrane that helps move substances by active transport