

- Triple Science Content only in purple
- Triple Science and Higher Content Only in blue

Topic 1 - Cell Biology - AQA Biology GCSE

1. Cell Structure and Types

1.1 Overview

- All living organisms are made up of cells.
- Cells are either **eukaryotic** (with a nucleus) or **prokaryotic** (without a nucleus).
 - **Animal and plant cells** → eukaryotic
 - **Bacterial cells** → prokaryotic

1.2 Eukaryotic Cells

- **Components of Eukaryotic Cells:**

Animal Cell:

- **Cell membrane** - controls what enters and leaves the cell
- **Cytoplasm** - jelly-like substance where chemical reactions happen
- **Nucleus** - contains DNA and controls cell activities
- **Mitochondria** - Produces energy through aerobic respiration
- **Ribosomes**- Makes Proteins (protein synthesis)

Plant Cell:

A plant cell contains everything an animal cell has, including the following:

Chloroplasts	Contains a green pigment called chlorophyll, which absorbs sunlight for photosynthesis
Vacuole	Stores cell sap
Cell Wall	Supports the cell and provides structure

1.3 Prokaryotic Cells

- **Components of Bacterial Cells:**
 - **Cell membrane** – controls entry/exit
 - **Cytoplasm** – site of chemical reactions (where chemical reactions take place).
 - **Cell wall** – supports the cell and provides structure
 - **Loop of DNA** – free-floating genetic material
 - **Plasmids** – small circular DNA,
 - **Flagellum** – allows to move
 - **Ribosomes** – protein synthesis (makes proteins)
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2. Subcellular Structures and Their Functions

Structure	Function
Nucleus	Stores DNA and controls cell activity
Cytoplasm	Site of chemical reactions and enzyme activity

Cell membrane	Regulates substances entering/leaving the cell
Mitochondria	Produces energy through aerobic respiration
Ribosomes	Synthesises (makes) proteins
Chloroplasts	Absorbs sunlight for photosynthesis
Vacuole	Stores cell sap
Cell wall	Strengthens the cell; made from cellulose (plants only)

3. Specialised Cells

- **Differentiation:** Process by which cells become specialised for specific functions.

Cell Type	Function	Key Features
Sperm Cell	Transfers male DNA to male egg cell for fertilisation	Streamlined head, tail for movement, many mitochondria, acrosome with digestive enzymes to enter the egg cell
Nerve Cell	Transmits electrical impulses in the body	<ul style="list-style-type: none"> - Long axon (can reach long distances) - Dendrites for connections with other nerve cells - Mitochondria for neurotransmitter production
Muscle Cell	Contracts/squeezes to move our bones	<ul style="list-style-type: none"> - 2 special proteins (Myosin & actin), slide

		<p>over each other for contraction</p> <ul style="list-style-type: none"> - A lot of mitochondria - Stores glycogen
Root Hair Cell	Absorbs water via osmosis and minerals ions through active transport	<ul style="list-style-type: none"> - Large surface area to take in more water/mineral ions. - Permanent vacuole to help water uptake. - Mitochondria for active transport.
Xylem Cell	Transports water/minerals ions up plants	<ul style="list-style-type: none"> - Lignin strengthens walls of the xylem cells, - Cells die to form tubes of xylem cells.
Phloem Cell	Transports food in plants	<ul style="list-style-type: none"> - Sieve plates allow food flow, - They have a companion cell that has mitochondria to provide energy

4. Microscopy

- **Light Microscope:** Uses light; magnification up to $\times 2000$; resolution ~ 200 nm; suitable for large organelles.
- **Electron Microscope:** Uses electron beams; much higher magnification and resolution; detailed view of cell structures.

Culturing Microorganisms (Triple Science)

Why Microorganisms are Cultured

- Microorganisms are tiny, so scientists grow many in the lab to study them.
- **Culture medium** provides nutrients: carbohydrates (energy), proteins, minerals, and vitamins.

Methods for Growing Microorganisms

1. In Liquid Nutrient Broth

- Bacteria are mixed with sterile nutrient broth in a flask.
- The flask is stoppered with cotton wool to keep out unwanted microbes.
- Shake the flask regularly to provide oxygen for growth.

2. On Agar Plates

- Agar jelly acts as a solid nutrient medium.
- Bacteria grow in **colonies** on the surface.

Steps for Preparing Agar Plates:

1. Pour hot, sterilised agar into a sterilised Petri dish; allow it to cool and solidify.

2. Use a sterilised inoculating loop to spread bacteria evenly over the agar surface.
3. Tape the lid loosely and store the dish **upside down** to prevent condensation dripping onto the colonies.
4. Incubate at **25°C**. This temperature is safe for students and prevents harmful bacteria (which grow best at 37°C) from thriving.

Important Safety Points

- **Sterilisation:** Petri dishes, culture media, and inoculating loops must be sterilised to prevent contamination.
 - **Partial sealing:** The lid should be taped lightly to stop airborne microbes but allow oxygen in for aerobic bacteria.
 - **Temperature control:** Avoid higher temperatures to prevent growth of potentially harmful human pathogens.
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Bacterial Growth

- Bacteria multiply by **binary fission**, roughly doubling every 20–30 minutes under ideal conditions.
 - To calculate population growth:
 1. Divide total time by mean division time → gives number of divisions.
 2. Multiply the starting number of bacteria by 2^n (n = number of divisions).
 - Populations can become very large, often expressed in **standard form** for simplicity.
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Testing Antibiotic Effectiveness

- Use **agar plates with bacterial cultures** and **antibiotic-soaked paper discs**:
 1. Soak discs in different antibiotics (include a control soaked in sterile water).
 2. Place discs on an evenly spread bacterial lawn.
 3. Incubate at 25°C for ~2 days.
 4. Measure the **zone of inhibition** (clear area around disc) – larger zones = more effective antibiotic.
- **Resistant bacteria** survive; non-resistant bacteria die, creating the clear zone.
- To quantify results, calculate **cross-sectional area** of the inhibition zone using:
Area= πr^2 where r = radius of the clear zone.

5. Cell Division

5.1 Chromosomes

- Chromosomes carry DNA.
- A gene is a section of DNA coding for a specific protein.
- Humans: 23 pairs (46 total) in body cells; 23 in gametes.

5.2 The Cell Cycle

1. **Interphase** – cell grows, DNA replicates
2. **Mitosis** – chromosomes align and are pulled apart
3. **Cytokinesis** – cell splits, forming two identical daughter cells

Mitosis is for **growth and development of cells**, and also **replacing damaged cells**.

5.3 Stem Cells

- **Stem cells:** Undifferentiated; can develop into multiple cell types.
 - **Embryonic stem cells** – can become any cell type
 - They can be used to replace insulin - producing cells for people with diabetes.
 - **Adult stem cells** – can differentiate to limited types (Found in bone marrow)
 - **Meristem cells (plants)** – can differentiate to any plant cell
 - Found in roots and shoots of plants
- **Uses of stem cells:**
 - Therapeutic cloning – growing tissues matching patient DNA
 - Replacing damaged or dead cells
 - Studying cell development

- **Advantages & Disadvantages:**

Advantage	Disadvantage
Can replace damaged tissue	Difficult to control cell development
Can study development processes	Ethical concerns (embryos)
Reduces risk of rejection	Possible viral transfer if they are contaminated

Very Expensive and Time
Consuming

6. Transport in Cells

6.1 Diffusion

- Movement of particles from **high** → **low concentration**
- No energy required
- Example: Oxygen/CO₂ across membranes

Factors affecting diffusion:

Factor	Effect
Concentration gradient	Greater difference → faster diffusion
Temperature	Higher temp → faster particle movement
Surface area of membrane	Larger surface → faster diffusion

6.2 Osmosis

- Diffusion of water through a **semi-permeable membrane** from a low concentration to high concentration.

6.3 Active Transport

- Moves substances **against concentration gradient** (low concentration → high concentration)
- Requires **energy** from respiration
- Examples:
 - Plant root uptake of minerals from soil

- Absorption of sugars from the gut into the bloodstream