# Cells and Organisation

Animal, plant and bacterial cells and the functions of their parts, using a microscope, specialised cells, tissues, organs and organ systems, and calculating magnification.

## 2.1 Cell structure and function

All living things are made of **cells**. A cell is the basic unit of life.

### Animal and plant cells

| Part | Found in | Function |
|---|---|---|
| **cell membrane** | animal, plant and bacterial cells | controls what enters and leaves the cell |
| **cytoplasm** | all cells | where most chemical reactions happen; a jelly-like liquid |
| **nucleus** | animal and plant cells | contains the DNA (genetic material) and controls the cell's activities |
| **ribosomes** | all cells | make proteins (protein synthesis) |
| **mitochondria** | animal and plant cells | release energy from glucose by aerobic respiration |
| **cell wall** | plant and bacterial cells | made of **cellulose** in plants; a strong layer that supports the cell and keeps its shape |
| **chloroplasts** | plant cells (the green parts) | contain **chlorophyll**; carry out photosynthesis |
| **sap vacuole** | plant cells | a large space filled with cell sap (a solution of sugars and salts); keeps the cell firm |

**Differences between plant and animal cells.** A plant cell has a **cellulose cell wall**, **chloroplasts** and a **large sap vacuole**. An animal cell has none of these, and is usually rounder and smaller. Both have a nucleus, cytoplasm, a cell membrane, mitochondria and ribosomes.

### Bacterial cells

A bacterium is a **single cell** with a simpler structure. It has:

- a **cell wall** (not made of cellulose) and a **cell membrane**,
- **cytoplasm** containing **ribosomes**,

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- **circular DNA** lying free in the cytoplasm (there is **no nucleus**),
- **plasmids**: small rings of DNA that carry extra genes.

### Using a microscope

Cells can be examined using a light microscope and a **temporary stain** that makes the parts easier to see.

- **Animal cells** (for example cheek cells scraped from the inside of the mouth) are stained with **methylene blue**.
- **Plant cells** (for example a thin layer of onion epidermis peeled from a bulb) are stained with **iodine solution**.

Method: place the thin sample on a slide, add a drop of stain, lower a **cover slip** at an angle (to avoid trapping air bubbles) and look under low power first. When you **draw** what you see: use a sharp pencil, draw clear single lines, make the drawing large, do not shade, and **label** the parts with straight, ruled label lines.

## 2.1 Specialised cells, tissues and organs

> **A specialised cell has a structure that is adapted to carry out a particular function.**

| Cell | Adaptation | Function |
|---|---|---|
| **root hair cell** | a long, thin extension that increases the surface area | absorbs water and ions from the soil |
| **palisade mesophyll cell** | many chloroplasts, packed at the top of the leaf | photosynthesis |
| **xylem vessel** | no cell contents, thick walls strengthened with lignin | carries water and supports the plant |
| **red blood cell** | no nucleus, biconcave disc shape, contains haemoglobin | carries oxygen |
| **sperm cell** | a tail (flagellum), many mitochondria, enzymes in the acrosome | swims to the egg and fertilises it |
| **egg cell** | large, with food stores and a jelly coat | gets fertilised, and provides nutrients for the early embryo |
| **ciliated cell** | hair-like cilia on the surface | moves mucus along the airways |

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## Levels of organisation

**A tissue is a group of similar cells that work together to do a job. An organ is made of different tissues working together. An organ system is a group of organs that work together. An organism is a living thing made of organ systems.**

**Example (the digestive system).** Muscle cells and gland cells (**cells**) form muscle tissue and glandular tissue (**tissues**). Together with other tissues they form the **stomach**, an **organ**. The stomach, small intestine, liver and pancreas are part of the **digestive system** (an **organ system**), and all the organ systems together make the **organism**.

**Example (the leaf).** Palisade cells form palisade tissue, and with xylem, phloem and epidermis they form the leaf (an organ).

## Magnification

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

Use the same units for both sizes. Rearranged: $\text{actual size} = \frac{\text{image size}}{\text{magnification}}$ and $\text{image size} = \text{magnification} \times \text{actual size}$.

TRY IT

A drawing of a cell is $45\ \text{mm}$ long. The magnification is $\times 300$. What is the actual length of the cell in micrometres?

$\text{actual size} = \frac{45}{300} = 0.15\ \text{mm} = 150\ \mu\text{m}$

($1\ \text{mm} = 1000\ \mu\text{m}$.)

NOTE

A common mistake is to mix units. Convert both measurements to the **same unit** before you divide.

# 1.1 Characteristics of living organisms

All living organisms show the same seven **characteristics of life**. A useful way to remember them is **MRS GREN**.

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- **M**ovement: an action by an organism or part of an organism that causes a change of position or place.
- **R**espiration: the chemical reactions in cells that break down nutrient molecules and release energy.
- **S**ensitivity: the ability to detect or sense stimuli in the internal or external environment and to make appropriate responses.
- **G**rowth: a permanent increase in size and dry mass by an increase in cell number or cell size or both.
- **R**eproduction: the processes that make more of the same kind of organism.
- **E**xcretion: the removal from organisms of toxic materials and substances in excess of requirements.
- **N**utrition: taking in of materials for energy, growth and development.

**Plants need light, water, carbon dioxide and mineral ions. Animals need organic compounds (carbohydrates, proteins, fats) and water, oxygen and minerals.**

**TRY IT**

A car moves, uses fuel to release energy and gets rid of waste gases. Why is it not a living organism?

It does not do **all seven** things. It does not grow, reproduce, respond to its environment on its own or take in nutrients. Being alive means showing every characteristic.

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