5 Cells

The **cell** is the basic structural and functional unit of living organisms. Some organisms are **unicellular**, being composed of a single cell; others are **multicellular**, being composed of many cells. Cells are so small that they can only be seen with a microscope and not with the naked eye.

Plant and animal cells

All plant and animal cells contain structures called **organelles** which are specialised to carry out one or more vital functions, e.g. the nucleus, mitochondria, chloroplasts and vacuoles. Organelles are found within the **cytoplasm** of the cells and most are surrounded by one or two **membranes**.

The following structures are found in **all** plant and animal cells:

- a **cell membrane** or **plasma membrane**
- **cytoplasm**
- a **nucleus**
- **mitochondria** (singular mitochondrion).

In addition to the above, **plant cells** also possess:

- a **cell wall**
- **chloroplasts**
- a large **vacuole**.

The cytoplasm and nucleus together are referred to as **protoplasm**.

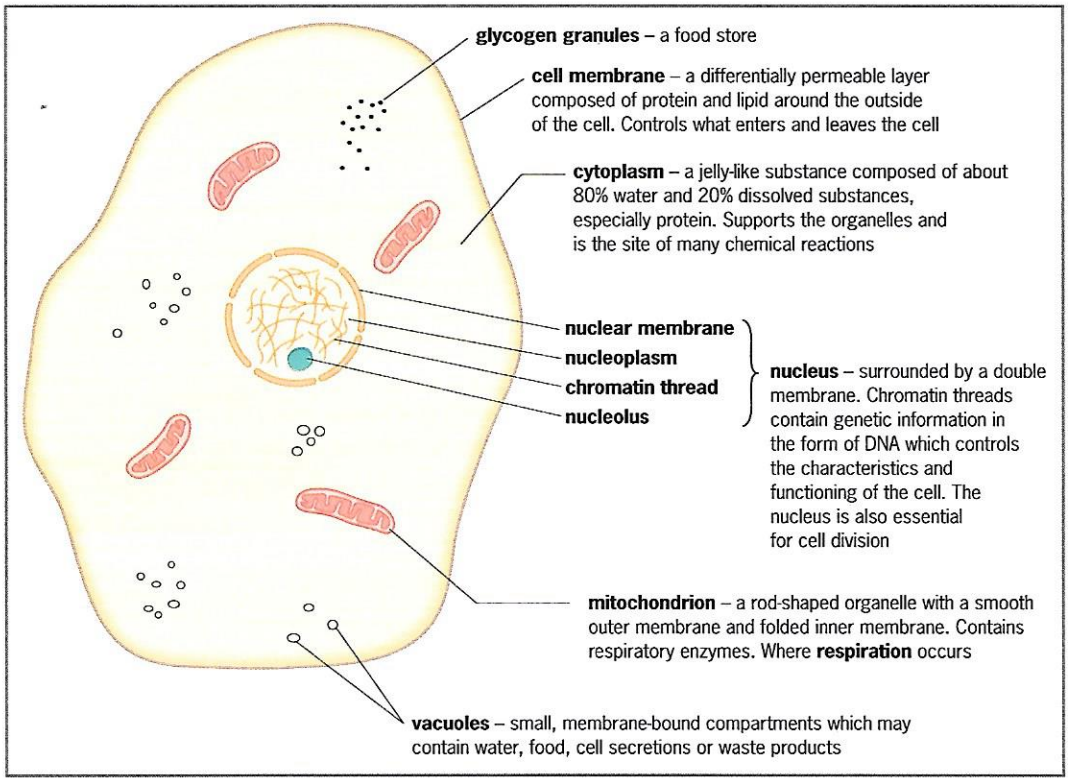


Figure 5.1 *Structure and function of the parts of a generalised animal cell*

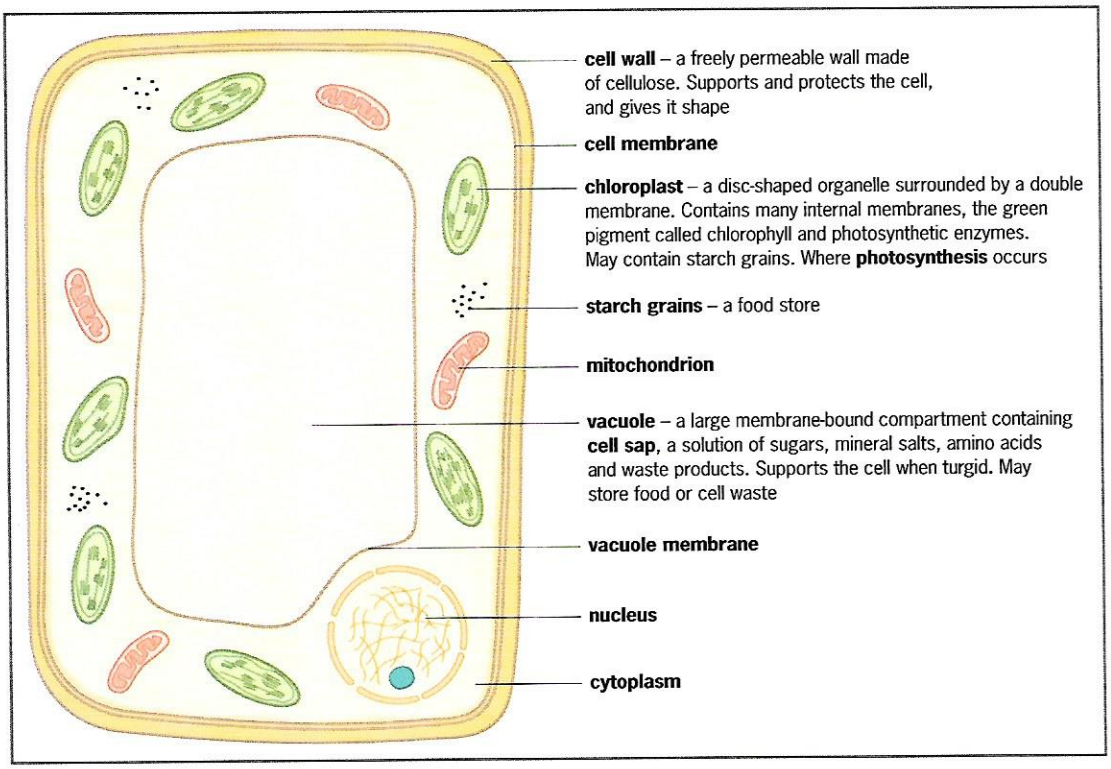
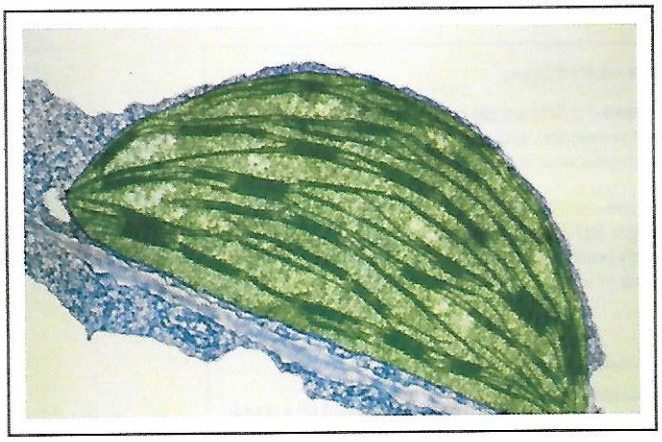


Figure 5.2 *Structure and function of the parts of a generalised plant cell*



An electron micrograph of a chloroplast

An electron micrograph of a mitochondrion

Table 5.1 *Plant and animal cells compared*

Animal cells	Plant cells
Do not have a cell wall.	Have a **cell wall** which is made of cellulose.
Do not have chloroplasts or chlorophyll.	Usually have **chloroplasts** which contain chlorophyll.
When present, the vacuoles are small and scattered throughout the cytoplasm and their contents vary.	Usually have one large, central **vacuole** which contains **cell sap**.
May contain **glycogen granules** as a food store.	May contain **starch grains** as a food store.
Can have a great variety of different shapes.	Have a regular shape, usually round, square or rectangular.

Microbe cells

Microbes or **micro-organisms** are extremely small organisms that include all members of the **Prokaryotae** kingdom, e.g. bacteria, many members of the **Protoctista** kingdom, e.g. amoeba, and some members of the **Fungi** kingdom, e.g. yeast.

The cells of **prokaryotes** lack a true nucleus and other membrane-bound organelles. Their DNA exists in a region called the **nucleoid**, which lacks a nuclear membrane, and also in smaller regions called **plasmids**.

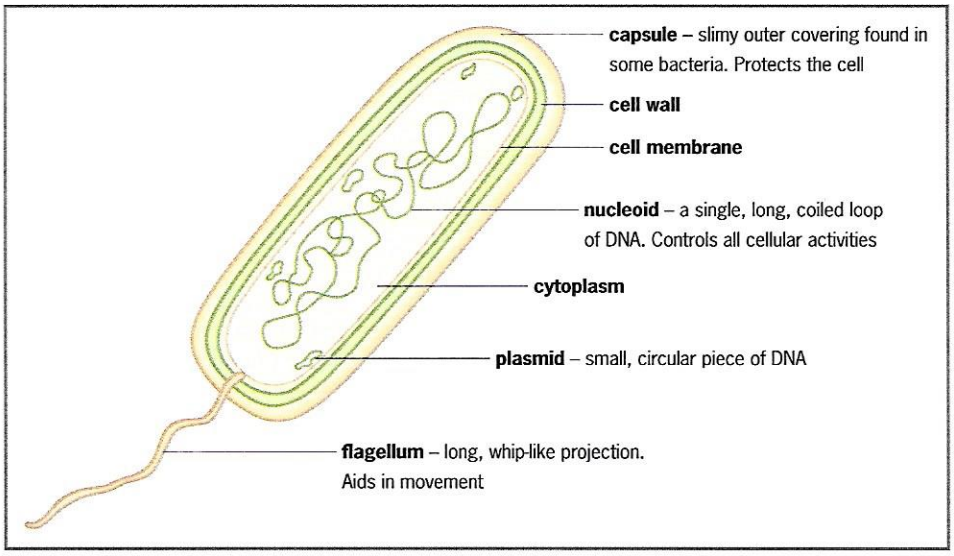


Figure 5.3 *A generalised bacterial cell*

The cells of **protoctists** and **fungi** all have true nuclei surrounded by nuclear membranes, and other membrane-bound organelles.

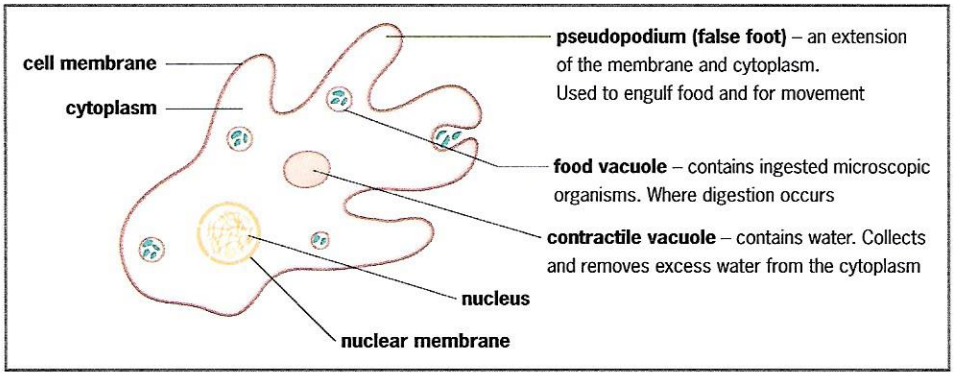


Figure 5.4 *An amoeba*

Cell specialisation

The body of a **unicellular organism** consists of **one unspecialised cell**. This cell can carry out **all** essential life processes.

The body of a **multicellular organism** is composed of **many cells**. To enable multicellular organisms to carry out all essential life processes **efficiently**, cells in their bodies become **specialised (differentiated)** to carry out specific functions, e.g. muscle cells in animals contract to bring about movement, mesophyll cells in leaves carry out photosynthesis. By becoming specialised, cells are **better able** to carry out their specific functions. Cells specialised to carry out a particular function then work together in groups called **tissues**. Tissues may contain one or, in some cases, more than one type of cell.

Table 5.2 *Some examples of plant tissues*

Name of tissue	What it is composed of	Where it is found	Functions
Epidermal tissue	Sheets of flattened epidermal cells.	Around the outside of leaves, young stems and roots.	• Protects the surfaces of leaves, stems and roots.
Packing tissue	Round or rectangular cells with large vacuoles called parenchyma cells.	Inside stems and roots.	• Fills spaces in stems and roots. • Supports non-woody plants when turgid. • Stores food.
Photosynthetic tissue	Round or rectangular cells containing chloroplasts called mesophyll cells.	Mainly in leaves.	• Makes food by photosynthesis.
Vascular tissue	Long tubes called xylem vessels and phloem sieve tubes with companion cells.	In leaves, stems and roots.	• Transports water and mineral salts. • Provides support. • Transports dissolved food substances.

Table 5.3 *Some examples of animal tissues*

Name of tissue	What it is composed of	Functions
Nerve tissue	Nerve cells or neurones.	• Conducts nerve impulses.
Muscle tissue	Muscle cells.	• Brings about movement on contraction.
Epithelial tissue	Sheets of cells.	• Covers and often protects inner and outer surfaces of the body, e.g. lines blood vessels and forms the outer layers of the skin.
Connective tissue	A variety of cells surrounded by extracellular material. Examples:	
	Blood tissue – red blood cells, white blood cells and platelets surrounded by plasma.	• Transports various substances around the body, e.g. food and oxygen. • Helps fight disease.
	Adipose (fat) tissue – fat cells surrounded by extracellular material.	• Insulates the body. • Serves as a food reserve. • Protects the body by acting as 'padding'.

Different tissues are then grouped together to form specialised **organs** which may perform one or more functions, e.g. the **skin** is composed of epithelial, connective and nerve tissues; the **leaves** of plants are composed of epidermal, photosynthetic and vascular tissues.

Organs work together in **organ systems**, e.g. the digestive, nervous and blood vascular systems in animals, and the transpiration and translocation systems in plants. Systems then work together in an organised way to form a **multicellular organism**.

i.e. cells ⟶ tissues ⟶ organs ⟶ organ systems ⟶ a multicellular organism

Revision questions

1. By means of a fully labelled and annotated diagram, describe the structure of a generalised animal cell.
2. State the function of any THREE of the structures you labelled in question **1**.
3. Give FOUR differences between the structure of an animal cell and that of a plant cell.
4. What features would enable a scientist to distinguish a bacterial cell from other cells when viewed under a microscope?
5. Why does cell specialisation occur in large multicellular organisms but not in small unicellular organisms?
6. What is a tissue?
7. Name TWO different tissues found in animals and TWO different tissues found in plants and give the functions of EACH.

Movement of substances into and out of cells

Substances can move into and out of cells, and from cell to cell, by **three** different processes:

- **diffusion**
- **osmosis**
- **active transport**.

Diffusion

Diffusion *is the net movement of particles from an area of higher concentration to an area of lower concentration until the particles are evenly distributed.*

The particles are said to move **down a concentration gradient**. Particles in gases, liquids and solutions are capable of diffusing. Diffusion is the way cells obtain many of their requirements and get rid of their waste products which, if not removed, would poison them.

The importance of diffusion in living organisms

- **Oxygen**, for use in **aerobic respiration**, moves into organisms through gaseous exchange surfaces and into cells by diffusion.
- **Carbon dioxide**, produced in **aerobic respiration**, moves out of cells and out of organisms through gaseous exchange surfaces by diffusion.
- **Carbon dioxide**, for use in **photosynthesis**, moves into leaves and plant cells by diffusion.
- **Oxygen**, produced in **photosynthesis**, moves out of plant cells and leaves by diffusion.
- Some of the **glucose** and **amino acids** produced in **digestion** are absorbed through the cells in the ileum and capillary walls and into the blood by diffusion.

Osmosis

Osmosis is a special form of diffusion.

*Osmosis is the movement of **water molecules** through a differentially permeable membrane from a solution containing a lot of water molecules, e.g. a dilute solution (or water), to a solution containing fewer water molecules, e.g. a concentrated solution.*

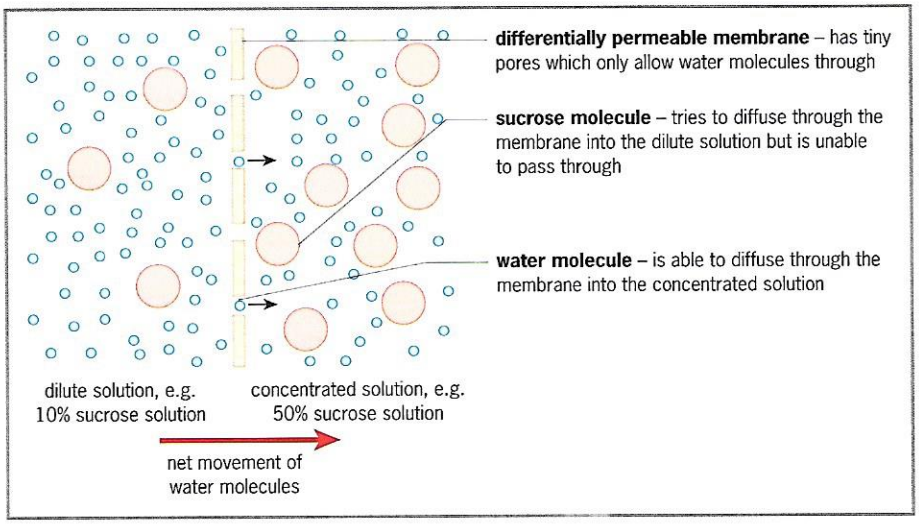


Figure 5.5 *Explanation of osmosis*

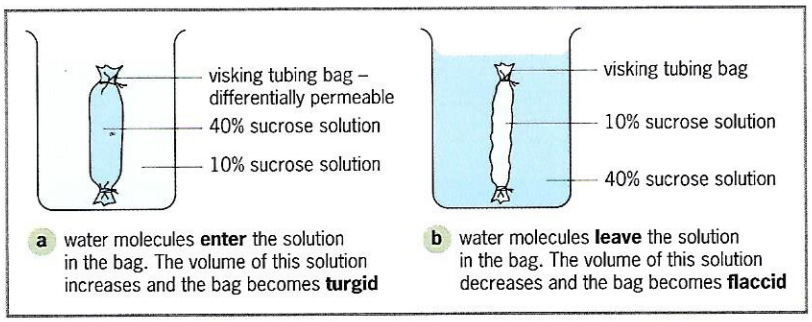


Figure 5.6 *Demonstrating osmosis*

In any cell, the **cell membrane** is differentially permeable. There is always **cytoplasm**, a solution of protein and other substances in water, on the inside of the membrane and usually a solution on the outside. **Water molecules**, therefore, move into and out of cells by **osmosis**.

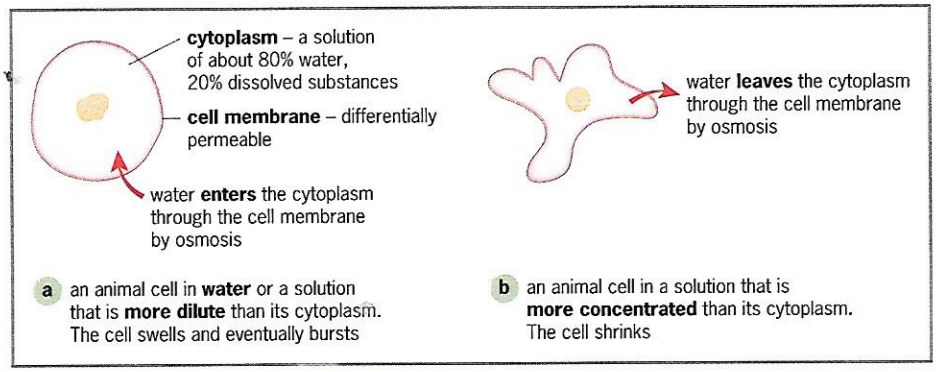


Figure 5.7 *The effect of different solutions on a single animal cell*

Plant cells are surrounded by strong, freely permeable **cell walls**. Because of this, they behave differently from animal cells when placed in different solutions.

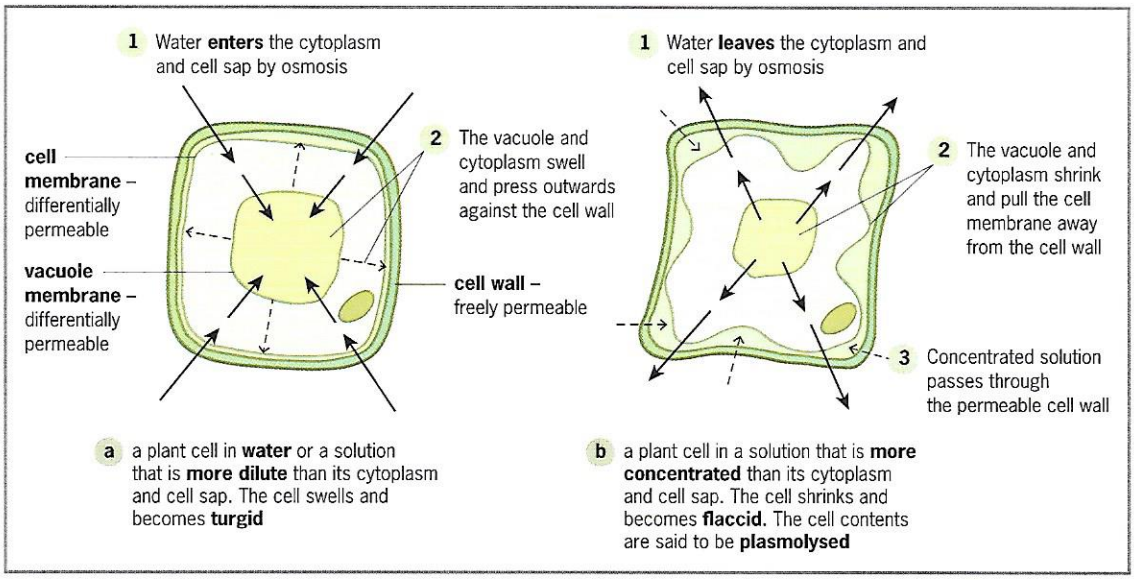


Figure 5.8 *The effect of different solutions on a single plant cell*

The importance of osmosis in living organisms

- All cells are kept **hydrated** by water moving into them by osmosis.
- Plant cells are kept **turgid** by water moving into them by osmosis. This causes non-woody stems to stand upright and keeps leaves firm.
- Water is kept **moving** through plants by osmosis occurring in the cells of roots and leaves. This ensures that leaves get water for photosynthesis.
- The **size** of stomatal pores is regulated by osmosis occurring in the guard cells. This controls the loss of water from the leaves of plants.
- Water is **reabsorbed** into the blood from the filtrate in the kidney tubules by osmosis. This prevents the body from losing too much water.

Active transport

During **active transport**, particles move through membranes **against** a concentration gradient. **Energy** produced in respiration is used to move the particles through the membranes from areas of lower concentration to areas of higher concentration. Active transport allows cells to accumulate high concentrations of important substances, e.g. glucose, amino acids and ions.

The importance of active transport in living organisms

- **Mineral ions** move from the soil into plant roots by active transport.
- **Sugars** produced in photosynthesis move into the phloem in leaves by active transport.
- Some of the **glucose** and **amino acids** produced in digestion are absorbed from the ileum into the blood by active transport.
- **Useful substances** are reabsorbed from the filtrate in the kidney tubules into the blood by active transport.

Revision questions

8. Define the term 'diffusion'.
9. Cite FOUR reasons to support the fact that diffusion is important to living organisms.
10. What is osmosis?
11. Explain what happens to a plant cell if it is placed in a solution that is more dilute than its cytoplasm and cell sap.
12. Give FOUR reasons why osmosis is important in the lives of living organisms.
13. Why is the root of a plant unable to absorb mineral salts from the soil if it is given a poison that prevents respiration?