

1 Cell Structure and Organisation

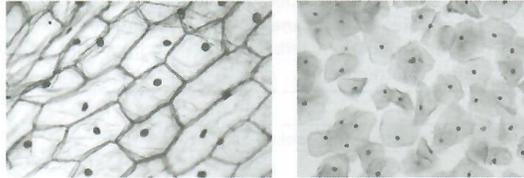
🔌 Study Station ▶▶

A Main Parts of a Cell

Learning Outcome

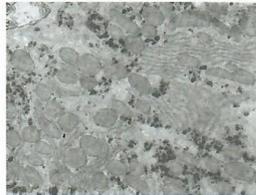
- Identify and state the functions of the following cell structures and organelles of typical plant and animal cells from diagrams and photomicrographs—cell wall, cell membrane, cytoplasm, nucleus, vacuole and chloroplast.

- A **cell** is the basic unit of life as it is the simplest unit which makes up a living thing.
- Cells take in raw materials and process them to make new molecules. They either use these new molecules or transport them to other parts of the body.
- Most cells are too small to be seen with our eyes alone.
- Light and electron microscopes allow us to see cells and their parts.
 - A **light microscope** magnifies an object up to 1000 times its original size and produces coloured **light micrographs**.



Light micrographs of plant cells and animal cells

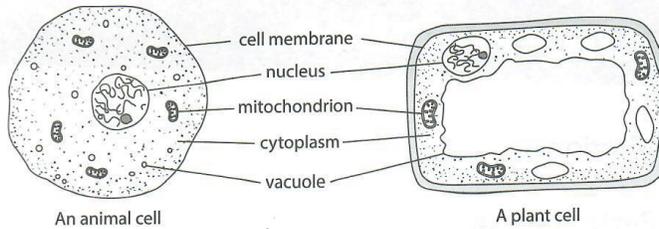
- An **electron microscope** magnifies an object up to 200 000 times its original size and produces black and white **electron micrographs**. Electron micrographs can be artificially coloured.



Electron micrograph of some parts of a cell

- Protoplasm** is the living material found in a cell. The protoplasm of a cell is made up of the **cell membrane, cytoplasm** and **nucleus**.

6. The diagrams show the main parts of an animal cell and a plant cell.



7. The table below summarises the functions of the cell parts.

Structure	Description	Function
Cell wall (present only in plant cells)	<ul style="list-style-type: none"> • Outermost part of the cell • Made up of cellulose • Fully permeable to small molecules 	<ul style="list-style-type: none"> • Protects the cell from injury • Gives the cell its shape
Cell membrane	<ul style="list-style-type: none"> • Partially permeable membrane that surrounds the cytoplasm • Made up of lipids and proteins 	Controls substances entering or leaving the cell
Cytoplasm	<ul style="list-style-type: none"> • Jelly-like substance embedded with specialised structures called organelles. 	<ul style="list-style-type: none"> • Each organelle is specialised for a particular function • Site where most cellular activities occur
Nucleus	<ul style="list-style-type: none"> • Surrounded by a membrane called the nuclear membrane • Contains genetic material in the form of chromosomes 	<ul style="list-style-type: none"> • Controls cell activities such as growth and repair • Important for cell division

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Tip

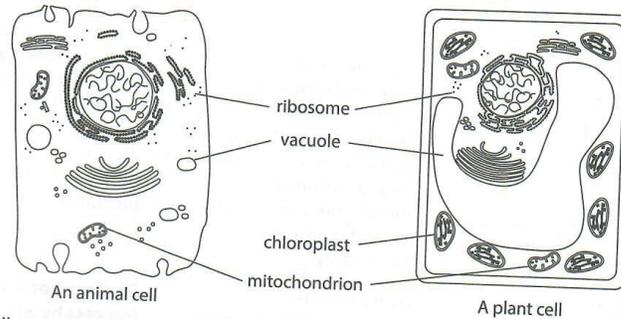
The cell wall, cytoplasm, nucleus, chloroplasts, mitochondria and vacuoles are visible with a light microscope.
The cell membrane and ribosomes are visible only with an electron microscope.

B Organelles in the Cytoplasm

Learning Outcomes

- Identify and state the functions of the mitochondria and ribosomes.
- Compare the structures of typical plant and animal cells.

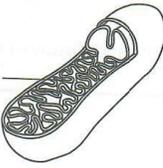
1. Organelles are tiny structures embedded in the cytoplasm that carry out different and specific functions.

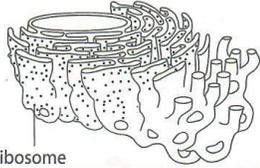
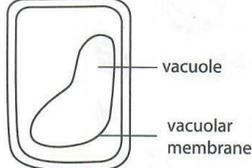


2. A plant cell contains most of the structures present in an animal cell with some key differences.

Structure	Animal Cell	Plant Cell
Cell wall	Absent	Present
Chloroplasts	Absent	Present
Vacuoles	Small and many	One large and central

3. The table below summarises the functions of organelles in the cytoplasm.

Organelle	Description	Function
<p>Mitochondrion</p>  <p>folded inner membrane</p>	<ul style="list-style-type: none"> • Small oval or sausage shaped structure • Enclosed by a double membrane • Inner membrane is highly folded 	<ul style="list-style-type: none"> • Site where aerobic respiration occurs • Provides energy for cell activities like growth and reproduction (when glucose is broken down in the presence of oxygen during aerobic respiration)

Organelle	Description	Function
<p>Ribosomes</p>  <p>ribosome</p>	<ul style="list-style-type: none"> • Small round structures • Found freely throughout the cytoplasm or attached to organelles in the cell 	<ul style="list-style-type: none"> • Synthesise proteins in the cell
<p>Vacuole</p>  <p>vacuole</p> <p>vacuolar membrane</p>	<ul style="list-style-type: none"> • Fluid-filled space • Large and central in plant cell; enclosed by a partially permeable membrane and contains cell sap • Small and numerous in animal cells; enclosed by a membrane and exist temporarily 	<ul style="list-style-type: none"> • Cell sap in plant vacuoles contains dissolved sugars, mineral salts, and amino acids • Vacuoles in animal cells store water and food substances
<p>Chloroplast (only in plant cells)</p> 	<ul style="list-style-type: none"> • Oval structure • Contains a green pigment called chlorophyll which is contained in stacks of membranes 	<ul style="list-style-type: none"> • Site for photosynthesis (process by which plants make food) • Chlorophyll is essential for photosynthesis

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Common Error

- Vacuoles contain air.
- Vacuoles contain a liquid.

Explanation

The vacuole accommodates dissolved substances — cell sap in plants and dissolved food substances in animals.

Worked Example 1.1

Insulin is a protein that is secreted by certain cells of the pancreas. Which of the following organelles are responsible for insulin production in pancreatic cells?

- A Mitochondria
- B Ribosomes
- C Vacuoles
- D Chloroplasts

 **Solution**

Option **B** is the correct answer.

Explanation

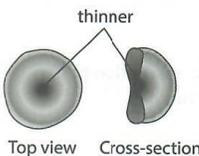
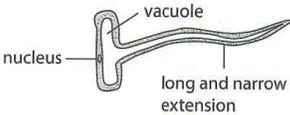
- The protein (insulin) is synthesised in the ribosomes.
- The protein is then packed and transported out of the cells for use outside the cell.

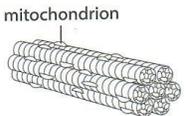
C Specialised Cells, Tissues, Organs and Systems

Learning Outcome

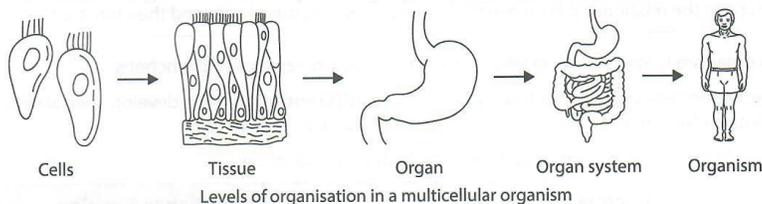
- Explain the relationship between the structures of specialised cells and their function.

1. An organism is made up of different types of cells which have specific functions.
2. Specialised cells are cells that have gone through **differentiation**. They develop special structures or lose certain structures to enable them to carry out specific functions.
3. The table below shows some specialised cells and their adaptations.

Cell Structure and Function	Adaptation to Function
<p>Red blood cell</p> <ul style="list-style-type: none"> • Transports oxygen to all parts of the body  <p style="text-align: center;">Top view Cross-section</p>	<ul style="list-style-type: none"> • Contains haemoglobin (a red pigment) <ul style="list-style-type: none"> - Transports oxygen • Circular, biconcave shape <ul style="list-style-type: none"> - Increases surface area-to-volume ratio of the cell which increases the rate of oxygen diffusion • Flexible and can squeeze through small blood vessels • Nucleus is absent <ul style="list-style-type: none"> - Increases amount of haemoglobin carried
<p>Root hair cell</p> <ul style="list-style-type: none"> • Absorbs water and mineral salts from the soil  <p style="text-align: center;">nucleus vacuole long and narrow extension</p>	<ul style="list-style-type: none"> • Long and narrow root hair extension <ul style="list-style-type: none"> - Increases surface area-to-volume ratio of the cell which increases the rate of absorption of water and mineral salts

Cell Structure and Function	Adaptation to Function
<p>Muscle cell</p> <ul style="list-style-type: none"> Causes muscle contractions to produce movement  <p style="text-align: center;">mitochondrion</p>	<ul style="list-style-type: none"> Contains many mitochondria which provide energy for muscle contractions

- A group of similar cells working together to perform a specific function is called a **tissue**.
 - A simple tissue consists of cells of the same type.
 - A complex tissue consists of more than one type of cell.
- Different tissues may combine to form an **organ**.
- Organs work together in **organ systems**. The digestive system is an example of an organ system which involves organs such as the mouth, oesophagus, stomach and intestines working together to digest food.
- A **multicellular organism** is made up of many organ systems working together.



Link → Discover Biology (3rd Edition) Textbook — Section 1.2

Tip !

In answering questions related to how cells are adapted for absorption or transport, recall the features that help to increase their surface area-to-volume ratio.

Checkpoint 1.1

- Which of the following is the earliest stage at which a living organism may differentiate to carry out a specific function?
 - Organ
 - Cell
 - Tissue
 - Organism

2. Complete the table by stating the correct organelle for each description.

Description	Organelle
Green in colour and is the site of photosynthesis	
'Powerhouses' of the cell	
Control centre of the cell	
'Factory' for protein production	



The functions of organelles have been asked in examination questions. One example can be found in **Q** GCE 'O' Level Science (Biology) Oct/Nov 2021 Paper 4 Q2 or **N** GCE N(A) Level Science (Biology) Sep/Oct 2015 Paper 6 Q1.

3. State the differences between plant and animal cells.



The differences between plant and animal cells have been asked in examination questions. One example can be found in **Q** GCE 'O' Level Science (Biology) Oct/Nov 2019 Paper 1 Q21 or **N** GCE N(A) Level Science (Biology) Sep/Oct 2020 Paper 5 Q2.

Test Station >>

1. What is the basic unit of life?
 - A Cell
 - B Carbohydrate
 - C Gene
 - D Protein
2. A muscle is considered a _____.
 - A tissue
 - B organ
 - C cell
 - D protein
3. (a) State the **two** types of ribosomes present in cells. [2]
 (b) State the functions of the ribosomes in (a). [2]
 (c) Insulin is a protein hormone which is secreted by certain cells in the pancreas. Explain if you will expect these cells to have many or few ribosomes. [2]

4. Figure 1.1 shows a unicellular organism.

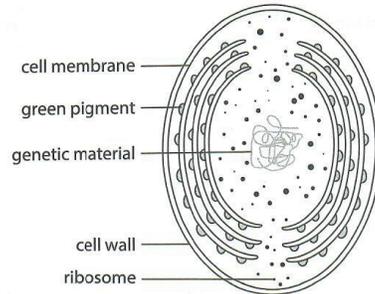


Figure 1.1

- (a) State **two** features found in this organism that make it similar to a plant cell. [2]
 - (b) Give **two** reasons why this organism cannot be considered a plant cell. [2]
 - (c) Suggest how this organism obtains energy. [2]
5. Cells undergo differentiation to give rise to different types of cells. Figure 1.2 shows a root hair cell and red blood cells.



Figure 1.2

- (a) Define the term *differentiation*. [2]
- (b) Explain how a root hair cell is adapted to carry out its specific function. [2]
- (c) Explain how a red blood cell is adapted to carry out its specific function. [3]