Cells:
The basic unit of life

Scope

Topic	Breakdown of topic
Cells as the basic unit of life **19 Marks**	Cell structure Molecular make-up: Cells are mostly made of proteins, carbohydrates, lipids, nucleic acids and water Cell structure and function: roles of organelles *Cell wall* – support structure in plant cells only. *Cell membrane* – fluid mosaic model, boundaries and transport: movement across membranes - diffusion -osmosis and -active transport. *Nucleus*, chromatin material, nuclear membrane, nucleopores, nucleolus: the control centre, heredity. *Cytoplasm*- storage, circulation of materials *Mitochondria* – release of energy during cell respiration *Ribosomes* – protein synthesis *Endoplasmic reticulum* (rough and smooth) transport systems *Golgi* –body – assemble secretion *Plastids* – production and storage of food, pigments *Vacuole*, lysosomes, vesicles – storage, digestion, osmoregulation Relate structure and location of organelles to their functions. Cells differ in size, shape and structure in order to carry out specialized functions Differences between plant and animal cells

Cells: The basic unit of life Notes

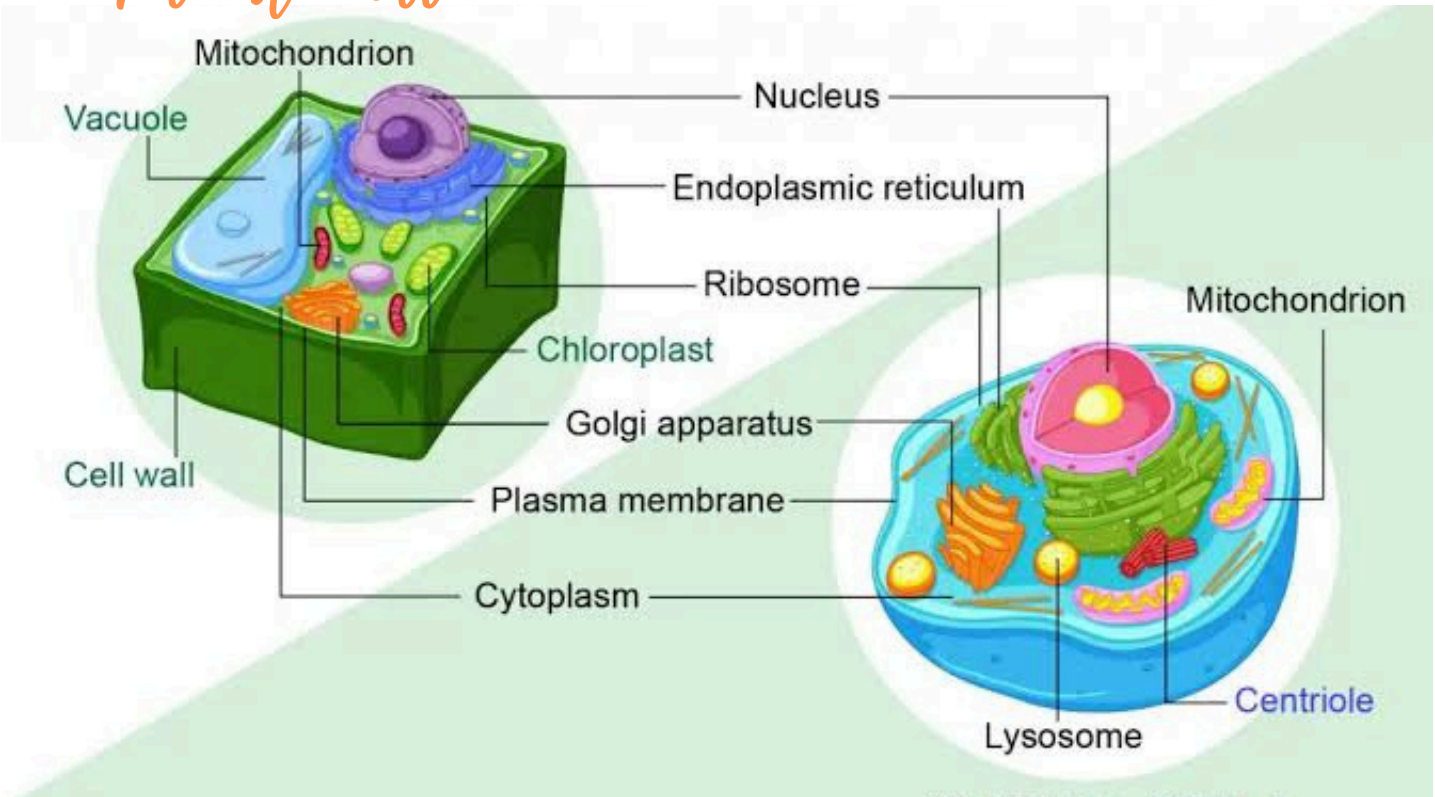
All living organisms consist of cells.

- Cells are the most basic and smallest building blocks (units) of life.
- All cells originate from pre-existing cells.
- Cells contain hereditary information that is passed from cell to cell during cell division.
- All cells show the same basic chemical composition.

Cell structure & functions

They contain a variety of organelles which perform specific functions. All cells have a cell membrane, cytoplasm, nucleus, mitochondria, endoplasmic reticulum, Golgi body and ribosomes. Plant cells have a cell wall, plastids and a large vacuole, not found in animal cells. Animal cells have vesicles, such as lysosomes, and centrosomes not found in plant cells. We will look at each of these structures in greater detail.

Plant cell



Animal cell

Cell structure & function

Cell wall

The cell wall is the rigid, outer, non-living part of the *plant cell*; it is **permeable** and allows free movement of all substances.

<u>The cell wall consists of three parts:</u>

1. Primary cell wall
2. Secondary cell wall
3. Middle lamella

Structure	Location	Composition	Function
Primary cell wall (found in all plant cells).	Occurs outside cell membrane.	Thin, made up of **cellulose** (a polysaccharide); has small openings: **pits** which contain **plasmodesmata:** cytoplasmic strands that connect adjacent cells. Elastic- it can stretch.	Protects living cell contents. Plasmodesmata facilitate transport of substances between cells.
Secondary cell wall (found in older cells).	Develops between the cell membrane and primary cell wall.	Consists of thick **cellulose fibres** with **lignin,** a woody substance, in between. Inelastic- it cannot stretch.	Provides support and gives rigidity(shape) to the plant cell.
Middle lamella(e)	Occurs outside the primary cell wall.	It is made up of **pectin,** a soluble jelly-like polysaccharide.	Connects the cell walls of adjacent (neighbouring) plant cells to each other.

<u>Functions of the cell wall</u>

- It protects the living cell contents (the cytoplasm and nucleus).
- It gives the plant cells a more uniform and regular shape – it provides rigidity.
- It provides support.

Cell structure & function

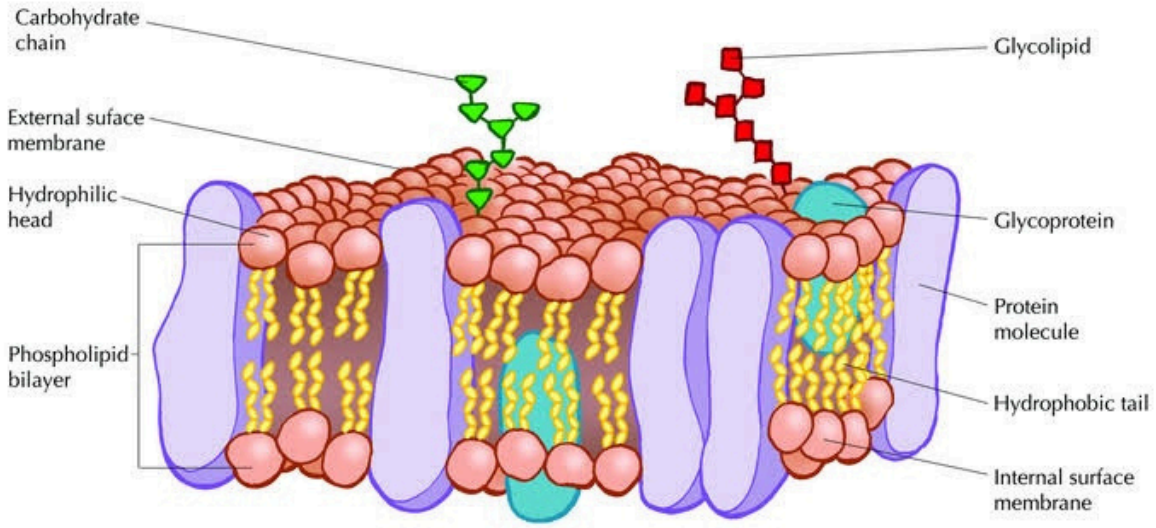
Cell membrane

A **cell membrane** (also known as the plasma membrane or plasmalemma) is found in all living cells. It is secreted by the cytoplasm and forms the outer living boundary of animal cells. In plant cells it is surrounded by the cell wall.

Structure	Location	Composition	Function
Cell membrane/plasma membrane/plasmalemma. Scientists use the **Fluid Mosaic Model** to describe the structure of the cell membrane.	Surrounds the cytoplasm.	It is made up of a **phospholipid bilayer** with large **protein molecules** (channel- and carrier proteins) embedded in between.	The cell membrane is **selectively permeable** and controls the movement of substances into and out of the cell. In animal cells it **encloses** and **protects** the cell contents.

Fluid mosaic model

The **fluid mosaic model** helps us understand the structure of a cell membrane



Fluid mosaic model explained: The cell membrane is made of a double phospholipid layer. Each phospholipid consists of a hydrophilic (water loving) head and a hydrophobic (water fearing) tail. In between the double phospholipid layer are protein molecules.

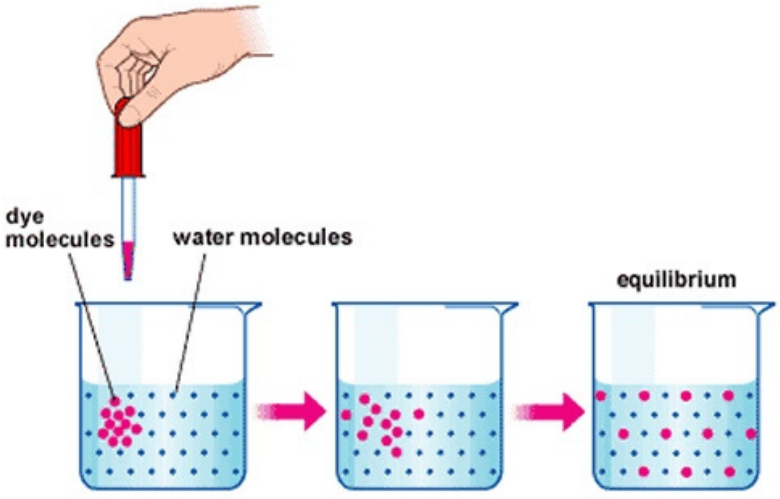
Transport
Across the cell membrane

Water and other substances such as gases, dissolved salts, amino acids and glucose continuously enter and leave the cell, through the selectively permeable cell membrane, by one of the following processes:

1. Diffusion
2. Osmosis
3. Activetransport

Diffusion

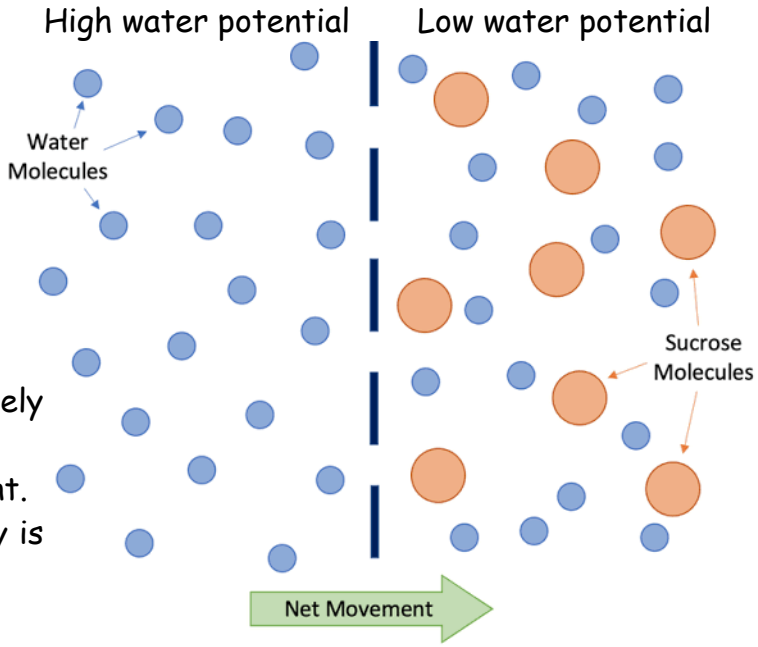
Diffusion is the spontaneous, random movement of the particles of a gas or a liquid from an area of higher concentration to an area of lower concentration until equilibrium is reached



The difference in concentration – higher concentration of particles in one area and lower concentration of the same particles in another area- is called the **diffusion gradient**.

Osmosis

Osmosis is the movement of water molecules from an area of high water potential to an area of low water potential, through a selectively permeable membrane, down a water potential gradient, until equilibrium is reached.



- Movement takes place through a selectively permeable membrane.
- Water (H_2O) molecules move down a gradient.
- an example of passive transport (no energy is required).

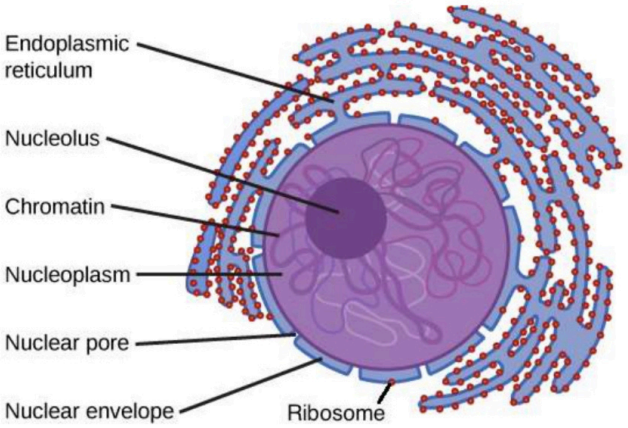
Active transport

The movement of substances across a selectively permeable membrane in living cells against a concentration gradient which therefore requires energy.

- Some organic molecules such as amino acids and glucose are too large to move easily through the selectively permeable cell membrane.
- These molecules often have to be moved/carried *against the concentration gradient* – from an area of lower to an area of higher concentration.

Cell structure & function

Nucleus



The nucleus is made up of four parts:

- nuclear membrane
- nucleoplasm
- nucleolus
- the chromatin network (chromosomes)

Structure	Location	Composition	Function
Nuclear membrane	**Surrounds**/ encloses the nucleoplasm	**Double** membrane with **nucleopores**- tiny/small openings	The **pores control** the movement of substances into and out of the nucleus
Nucleoplasm	**Fills** the **space** surrounded by the nuclear membrane	**Jelly-like** substance, made up of **water,** and dissolved **organic** and **inorganic** substances	Responsible for certain **metabolic** processes such as DNA- **replication** and **transcription** of mRNA
Nucleolus	Found **inside** the nucleoplasm	A **dark, dense round or oval** structure containing **RNA** and **proteins.** It is not surrounded by a membrane. There could be one or more present.	It **produces protein** and **stores RNA** for the processes of **mitosis** and **protein synthesis** and it is where **ribosomes** are assembled
Chromatin network	Found **throughout** the nucleoplasm	In a **non-dividing** cell it is an arrangement of **tangled threads** which are **folded** and **tightly packed** in the nucleus. In a **dividing** cell the threads form **chromosomes** made up of **DNA** and **proteins**	During **cell division** it forms **chromosomes**, made up of **genes,** which carry **genetic (hereditary) characteristics** from parents to offspring.

Functions of the nucleus of a cell:

- The nucleus controls all the activities of the cell, it is the control centre of the cell.
- The chromosomes carry hereditary characteristics from cell to cell and from one generation to the next generation (by means of the genes).

Cell structure & function

Cytoplasm

The cytoplasm is the fluid part of the cell found between the cell membrane and the nucleus. It is dynamic, constantly moving and changing and the different organelles are suspended in it.

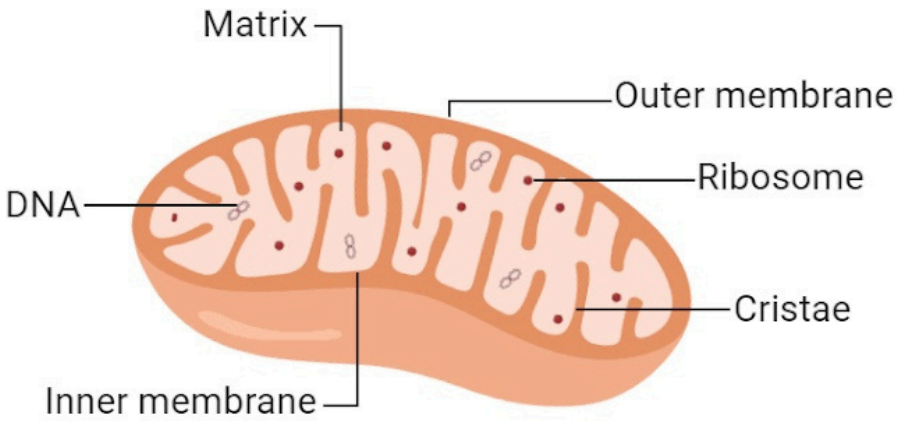
Structure	Location	Composition	Functions
Occurs in a **sol state:** a more fluid or liquid state **or** a **gel state:** a more jelly-like, less fluid state.	Occurs between the cell membrane and the nuclear membrane in the cell.	Made up of 90% water and dissolved organic and inorganic substances. It has a grey appearance due to the organelles suspended in it.	It is the site of all **metabolic and biochemical processes** that occur in a cell. It **stores** raw materials and/or reserve food needed by the cell. Substances **circulate** through the streaming movement of the cytoplasm called **cyclosis.** It brings about **exchange of materials** between organelles. It exchanges materials with the surrounding environment such as extra cellular fluid.

Role of organelles

Mitochondrion

Known as the 'power house' of a cell as it produces energy by cellular respiration

Structure	Location	Composition	Function(s)
It is a rod-shaped, cylindrical, hollow organelle.	It is found in the cytoplasm of almost all animal and plant cells. Some cells have a **single, large** mitochondrion, while other cells may contain **thousands.**	The mitochondrion is surrounded by a **double** membrane. The **outer** membrane is **smooth**, while the **inner** membrane is **folded inwards** to form finger-like projections called **cristae.** It encloses a granular, fluid-filled **matrix.** The matrix contains **ribosomes** and **enzymes.** Mitochondria contain their own **DNA** (mt-DNA).	The mitochondrion is responsible for **cellular respiration:** A process during which **energy** is released from **carbohydrates** such as **glucose** in the presence of **oxygen.** The **energy** that is released is used to form **ATP** (adenosine triphosphate), the **energy-carrier** in cells.

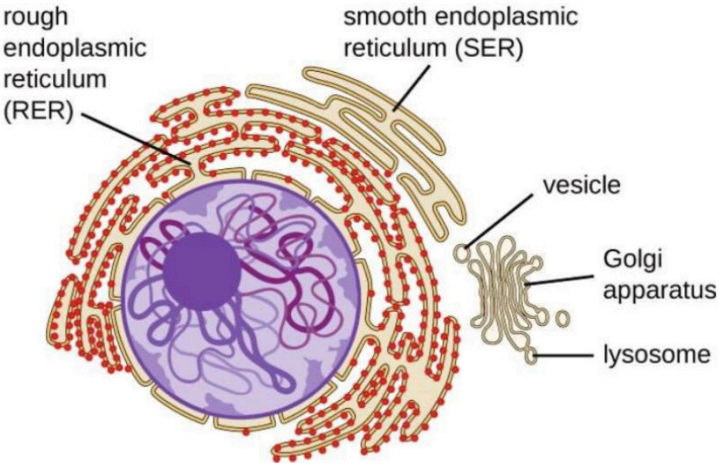


Role of organelles

Endoplasmic reticulum

It is a network of branching membranes. It forms a continuous system of canals throughout the cytoplasm.

Location	Composition	Function
It is found in the **cytoplasm** and is joined to the nuclear membrane and to the cell membrane	It is made up of membrane-bound sacs called **cisternae** that contain **fluid.** There are two types: **Rough ER:** has **ribosomes** on its outer surface. **Smooth ER:** has **no** ribosomes.	It **increases** the **internal** surface **area** of the cell. **Proteins** are made in the **ribosomes.** It **transports lipids** and **proteins** within the cell.



Ribosome

Structure	Location	Composition	Function
Ribosomes are small, round organelles that are found in plant and animal cells.	They are attached to the ER, found in groups in the cytoplasm, and occur in the mitochondria and chloroplasts.	Ribosomes are made up of protein and RNA	Ribosomes are the site of **protein synthesis.** (A protein is made when 51 or more amino acids are joined by peptide bonds).

Golgi body/apparatus

Structure	Location	Composition	Function
It consists of stacks of hollow, flat membrane-bound sacs in plant and animal cells.	It is found **near** the **nucleus** and **ER** in the cytoplasm of the cell.	The membrane-bound sacs are called **cisternae.** Small, rounded **vesicles,** carrying proteins, break off the ends of the cisternae.	It plays a role in producing and processing secretions such as saliva and mucus. It prepares proteins for storage or transport to other parts of the cell.

Role of organelles

Plastids

Plastids are small, disc-shaped organelles that occur in plant cells only.

There are three types of plastids:

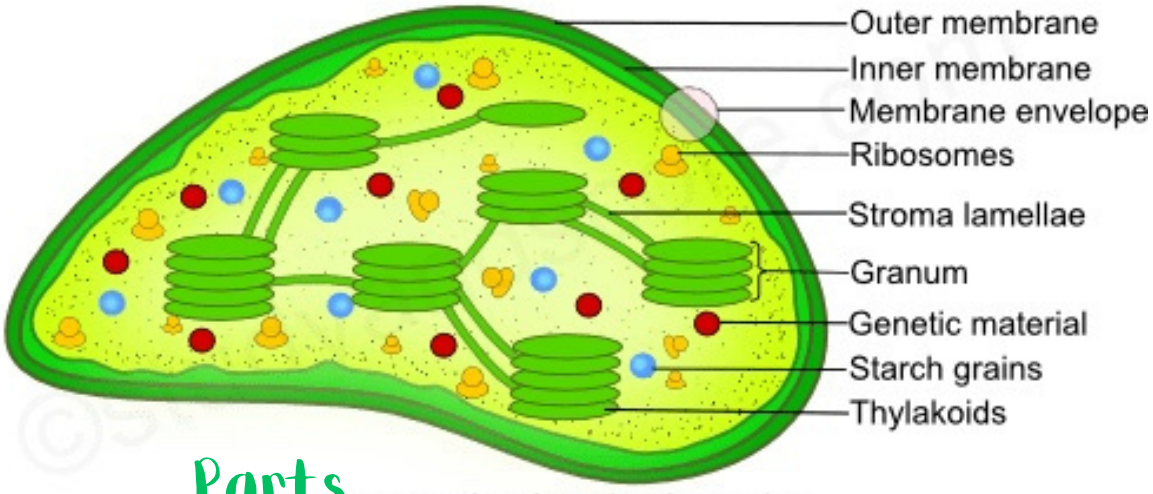
- Leucoplasts
- Chromoplasts
- Chloroplasts

Type	Location	Composition	Function
Leucoplasts	Found in the cytoplasm of the cells of **roots** and **tubers** and some **fruits** and **seeds**.	**Colourless**, contain starch, lipids or proteins. If leucoplasts are exposed to light, they can turn into chloroplasts.	Specialised to **store food** in an **insoluble** form such as **starch**
Chromoplasts	Found in the cytoplasm of the cells of **fruit**, **vegetables**, **leaves** and **flowers**	Contain pigments such as **carotenoids**- red, orange, or yellow	**Give colour** to fruit, vegetables, and flowers. Chloroplasts change into chromoplasts when autumn leaves change colour or when fruit ripens.
Chloroplasts	Found in the cytoplasm of the cells of **leaves** and **stems**	Contain the green pigment called **chlorophyll**	Responsible for the process of **photosynthesis**: When energy-rich carbohydrates (e.g glucose) are produced using radiant energy from the sun, CO_2 and H_2O. Oxygen is released as a by-product.

Role of organelles

Chloroplast

An oval shaped structure where photosynthesis takes place



Parts

• The selectively permeable, **double membrane** controls the movement of substances into and out of the chloroplast.
• Many **thylakoids** which contain many chlorophyll molecules to trap radiant energy from the sun.
• **Ribosomes** in the stroma make enzymes which control chemical reactions.
• **Starch granules** store starch, consisting of many glucose molecules, that is produced during photosynthesis.

Vacuole

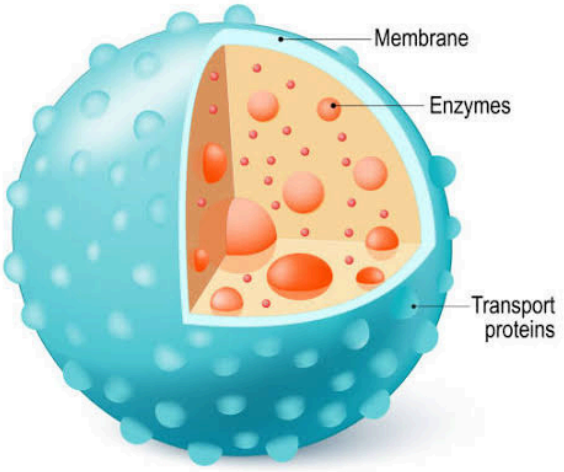
Vacuoles are fluid-filled, membrane-bound structures
Plant cells normally contain one, large, central vacuole which.
Animal cells contain numerous, small, vacuoles
A vacuole is surrounded by a single, selectively- permeable membrane, called the tonoplast.
Filled with cell sap and consists mainly of water and dissolved substances.

Functions of vacuoles in plant cells:
• Stores water and dissolved mineral salts.
• Transport of substances from one part of a cell to another.
• Responsible for movement of water from cell to cell via osmosis.
• Provides support (turgidity) for the cell:
If the vacuole is filled with water, it exerts a pressure called turgor pressure
on the cytoplasm and cell wall and the cell is described as being turgid(firm).

Role of organelles

Lysosome

Small vesicles found in all animal cells.



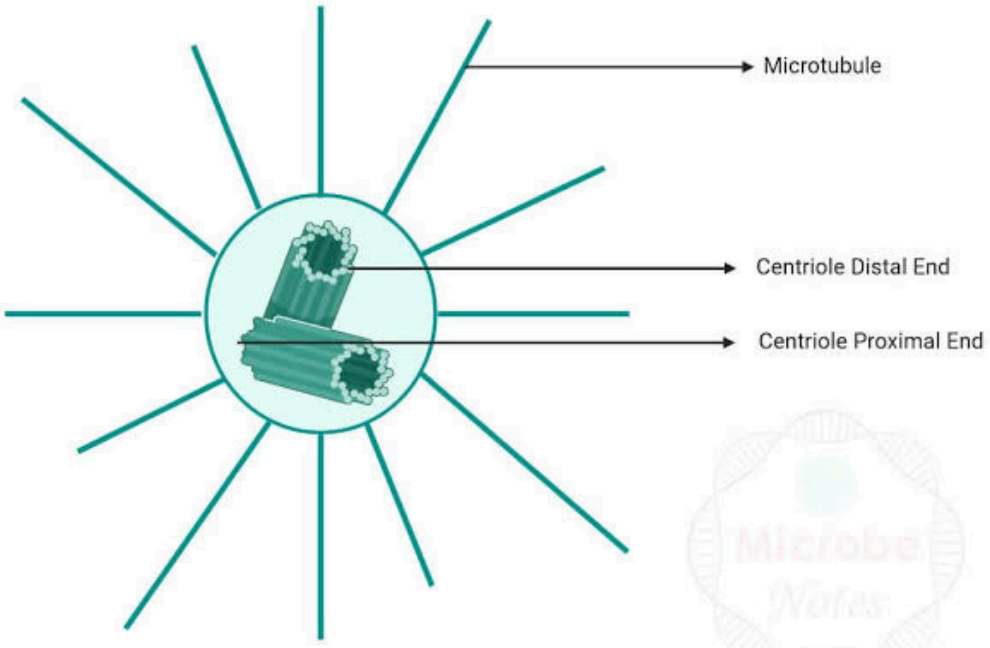
• Lysosomes are formed by the Golgi body or the ER.
• They are surrounded by a double membrane which ensures that the contents does not leak out into the cytoplasm as it would digest and destroy the cell.
• Lysosomes contain powerful, digestive (hydrolytic) enzymes.

Functions of lysosomes:

• In single-celled organisms, e.g .Amoeba, they play a role in the digestion of food inside the cell
• Lysosomes also digest dead cells, worn-out organelles and harmful bacteria.

Centrosome

A centrosome is a mass of specialised cytoplasm found near the nucleus in an animal cell.



Function of Centrosome:

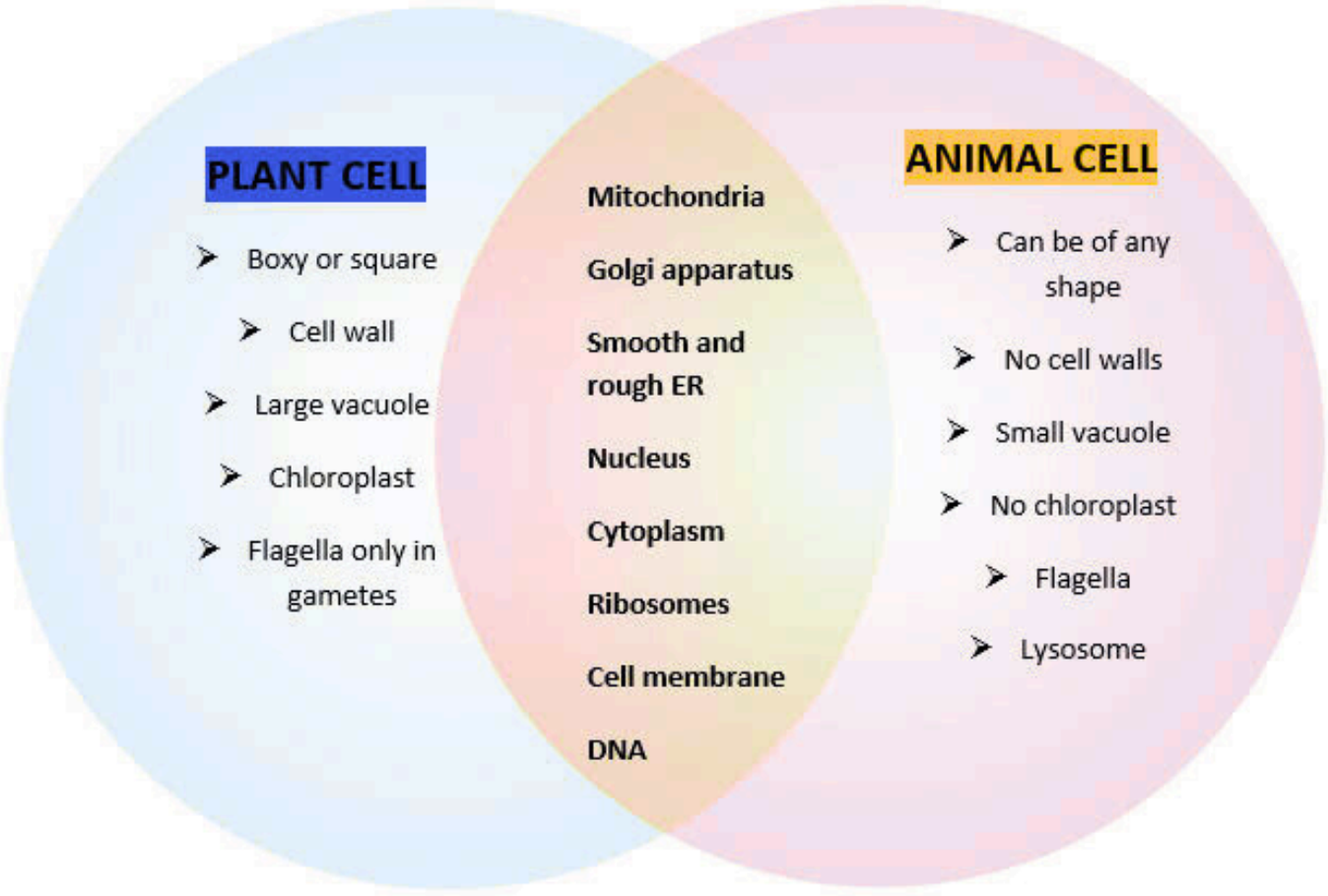
During mitosis (cell division) in animal cells, the centrioles form the spindle.

Plant cell vs Animal cell

Differences

Plant cells	Animal cells
Surrounded by a cell wall	No cell wall
Have a regular/fixed shape	Have more irregular and diverse shapes
Most contain plastids, e.g chloroplasts	No plastids
Usually one, large storage vacuole	No or a few small, specialised vacuoles
Lysosomes are absent	Lysosomes are present
*Centrosomes absent	*Centrosomes present

Similarities



Cells:
The basic unit of life
Terminology

Protoplasm	Living part of plant and animal cells.
Cytoplasm	Jelly-like transparent substance; between cell membrane and nucleus.
Cell membrane	Outer boundary of cytoplasm; a living, selectively permeable structure.
Organelles	Membrane-bound structures found in the cytoplasm; they perform specific functions.
Cell wall	Rigid, outer layer of plant cells made of cellulose; it is non-living and completely permeable.
Active transport	Movement of substances through a selectively permeable membrane against a concentration gradient; requires energy.
Passive transport	Movement of substances through a selectively permeable membrane down a gradient; does not require energy.
Diffusion	Movement of particles of a gas or a liquid, from a high- to a low concentration, down a concentration gradient, until equilibrium is reached.
Osmosis	Movement of particles of a liquid(water) from a high- to a low concentration through a selectively permeable membrane.
Selectively permeable	Allows certain substances to enter or leave the cell; controls movement of substances into and out of the cell.