1. CELL : THE BASIC UNIT OF LIFE

All living organisms are made up of microscopic units called cells. **Cell is the basic structural and functional unit of living organisms**. Cells are also called the **basic building units**. The living organisms such as Bacteria, *Amoeba*, *Chlamydomonas* and *Paramoecium* are made up of single cell (unicellular) whereas fungi, plants and animals are made up of many cells (multicellular).

1.1 HISTORY

The word cell is derived from latin word '***cellula***' which means 'a little room'. While examining thin slice of cork **Robert Hooke** in 1665 discovered small units called **Cells. Robert Brown** discovered nucleus in plant cell.

- **J.E. Purkinje** gave the term **protoplasm**.
- **J.M. Schleiden** gave the idea that all plants consist of cells.
- **Theodor Schwann** stated that all animals are made up of cells. **R. Virchow** said cells arise from pre-existing cells (*Omnis cellula-e cellula*). **Knoll** and **Ruska** designed first **electron microscope**.

1.2 CHARACTERISTICS OF CELL

1.2.1 They contain a limiting plasma membrane

(a) Every cell is bound by a plasma membrane which is living.
(b) This membrane permits controlled exchange of matter and energy with cell's external world (e.g. with aquatic environment in *Amoeba* or blood in WBC's).
(c) Therefore plasma membrane is called **semi-permeable** or **selectively-permeable**.

1.2.2 They contain metabolic machinery

(a) All cells contain cytoplasm suspended in which are various cell organelles such as mitochondria, chloroplasts, ribosomes, ER and golgi apparatus etc.

1.2.3 They contain set of genes

(a) Contain genetic material in the form of DNA which contain genes, RNA acts as genetic material where DNA is absent.
(b) Genes are self replicating units of chromosomes.
(c) They have coded information for regulation of cellular function (e.g. protein synthesis) and for production of new cells (cell division i.e. mitosis and meiosis).
(d) They are transmitted from generation to generation by chromosomes.

1.3 CELL THEORY

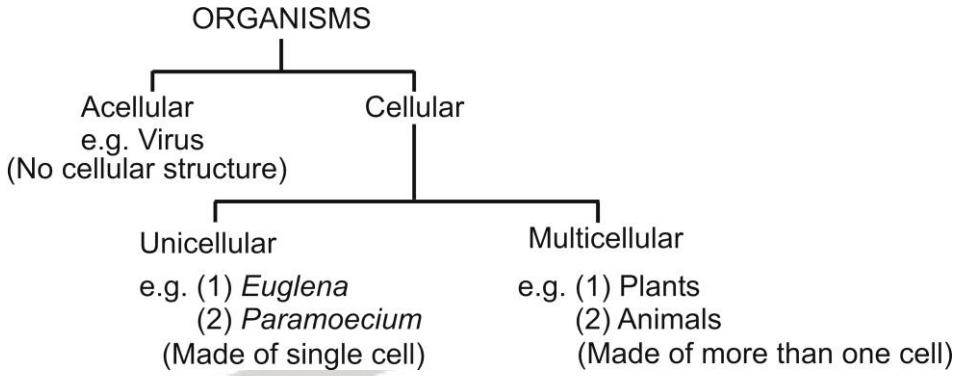
Cell theory was proposed by J.Matthias Schleiden (1838), a German botanist and Theodor Schwann (1839), a German zoologist.

The cell theory is as following :

(a) All organisms are composed of cell and cell products.
(b) All metabolic reactions take place in cells. Thus, cells are structural and functional unit of life.
(c) All cells arise from pre-existing cells only.
(d) Every organism start its life as a single cell.

1.4 TYPES OF CELLS (CLASSIFICATION)

1.4.1 On the basis of number of cells living organisms can be divided into



1.4.2 On the basis of complexity of organization, cells can be divided as **Prokaryotes** and **Eukaryotes**.

Difference between Prokaryotic cells and Eukaryotic cells

S.No.	Prokaryotic cell	Eukaryotic cell
1.	Size of cell is generally small (1-10 μm).	Size of cell is generally large (50 to 100 μm).
2.	Nuclear region is poorly defined, not surrounded by nuclear membrane and therefore called nucleoid and not nucleus.	Nuclear region is well defined, surrounded by a nuclear membrane. Therefore complete nucleus is present.
3.	Contains single chromosome.	Contains more than one chromosome.
4.	Nucleolus is absent.	Nucleolus is present.
5.	Membrane bound cell organelles absent.	Membrane bound cell organelles such as mitochondria, plastids, endoplasmic reticulum, golgi apparatus, lysosomes, peroxisomes etc. are present.
6.	Cell division takes place by fission or budding (no mitosis).	Cell division occurs by mitosis or meiosis.
7.	Centrioles absent.	Centrioles present in animal cells.
8.	Prokaryotic cells are found in bacteria and blue-green algae.	Eukaryotic cells are found in fungi, plant and animal cells.

1.5 SHAPE, SIZE, NUMBER, VOLUME OF CELL

The size, shape, number and volume of the cell is different among unicellular and multicellular organisms.

1.5.1 Cell Shape

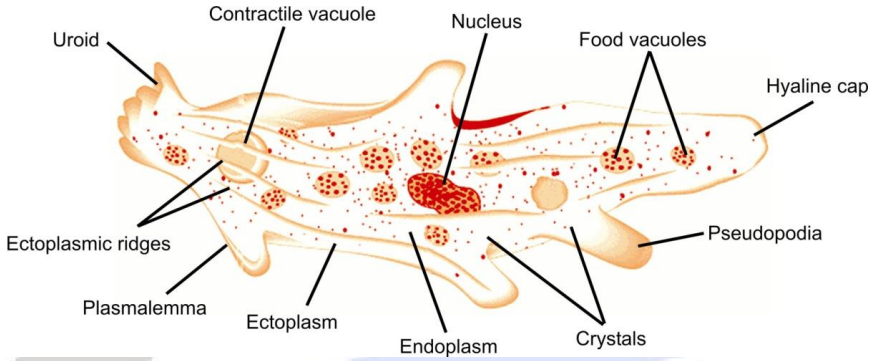
(a) Cell shape can be variable (e.g. *Amoeba*) or fixed (*Euglena* and *Paramoecium*).

(b) In multicellular organisms, the shape depends on functional adaptations and partly on the surface tension, viscosity of protoplasm, the mechanical action exerted by adjoining cells and rigidity of cell membrane.

(c) The various shapes are

S.No.	Shape	Example
1.	Spherical	Eggs of many animals

2.	Spindle shaped	Smooth muscle fibre
3.	Elongated	Nerve cells
4.	Branched	Chromatophores or pigment cells of skin
5.	Discoidal	Erythrocytes or RBC
6.	Polyhedral	with 8, 12 or 14 sides

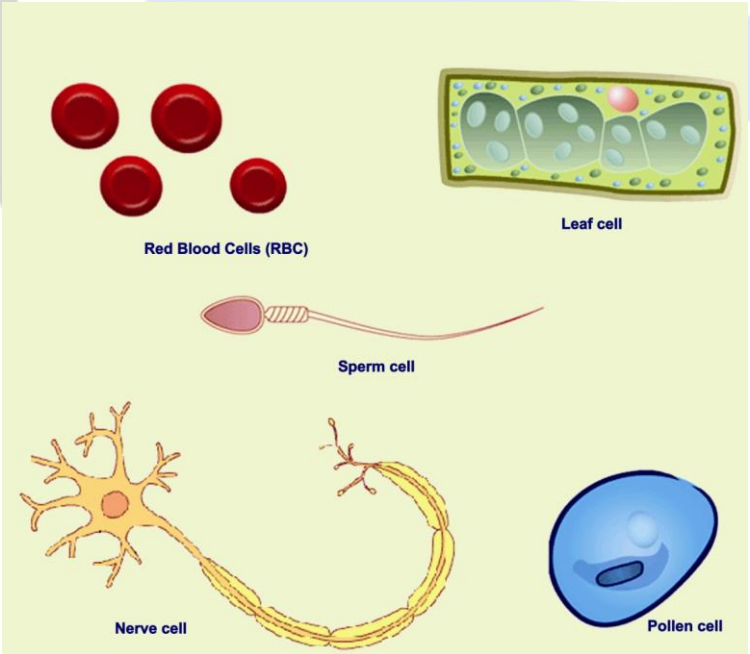


Amoeba showing its irregular body shape

1.5.2 Cell Size

Cell size vary. Some plant and animal cells are visible to the naked eyes but mostly seen with microscope since they are only few micrometers in diameter. The cells can be as small as 0.2 to 5 μm e.g. bacteria.

Largest Cell	Ostrich Egg
Smallest Cell	*Mycoplasma gallisepticum*
Longest Cell	Nerve cell
Largest cell (plant)	Ovule of *Cycas*



Different cells showing diversity in size and shape

1.5.3 Cell Volume

The volume of a cell

(a) Is fairly constant for a particular cell type.

(b) Is independent of the size of an organism.

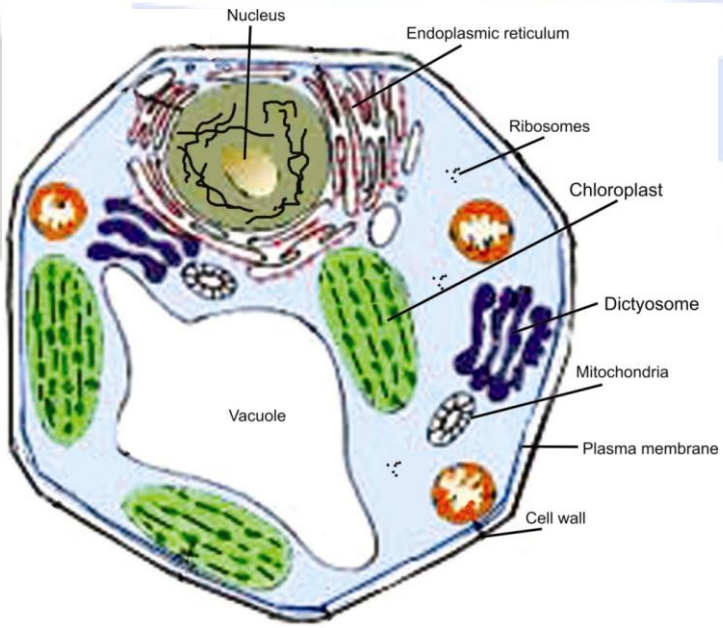
1.5.4 Cell Number

The number of cells in multicellular organism is indefinite.

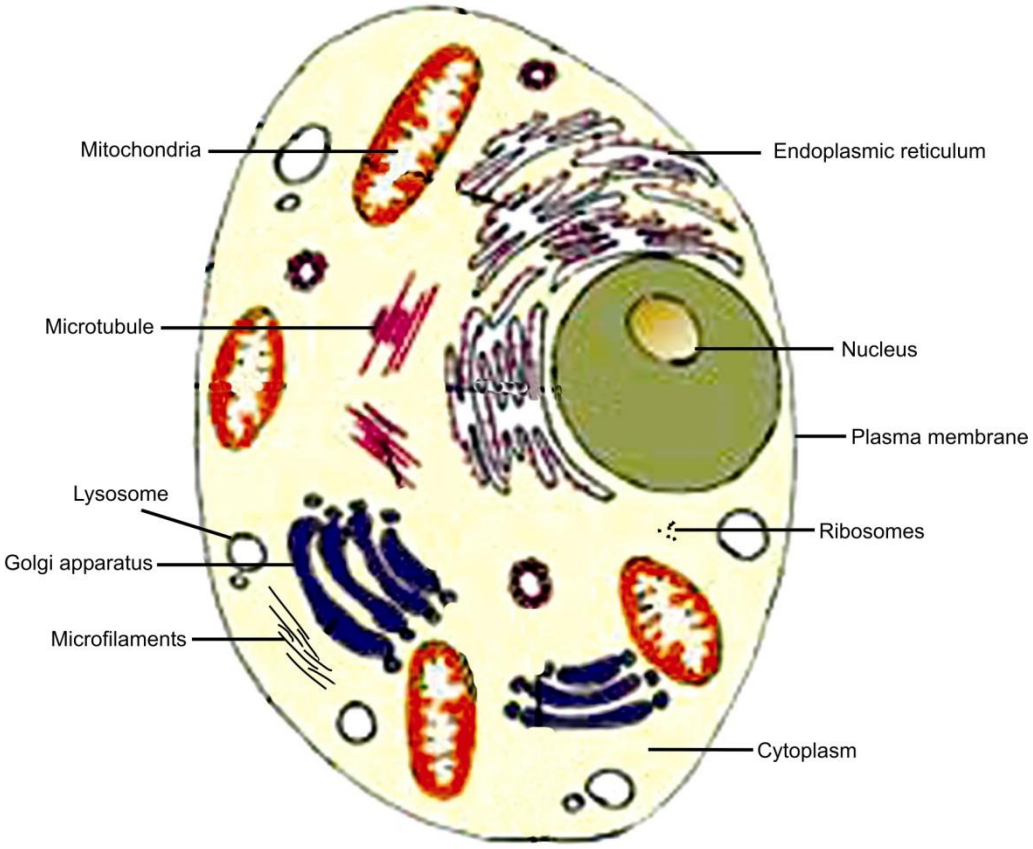
Newly born human infant has 2×10^{12} cells while an adult has 100 trillion (10^{14}) cells.

Difference between Animal and Plant Cell :

S.No.	Animal Cell	Plant Cell
1.	Animal cells are generally smaller in size.	Plant cells are larger than animal cells.
2.	Cell wall is absent.	The plasma membrane of plant cells is surrounded by a rigid cell wall of cellulose and hemicellulose.
3.	Except the protozoan (*Euglena*) no animal cell possesses plastids.	Plastids (Chloroplasts, Chromoplasts and Leucoplasts) are present.
4.	Animal cells have a single highly complex and prominent Golgi apparatus.	Plant cells have many simpler units called dictyosomes.
5.	Animal cells have centrosome and centrioles.	Plant cells lack centrosome and centrioles.
6.	Vacuoles are smaller but more in number.	Vacuoles are larger but less in number (1- 3)
7.	Nucleus is mostly in the centre.	Nucleus is mostly towards the periphery.

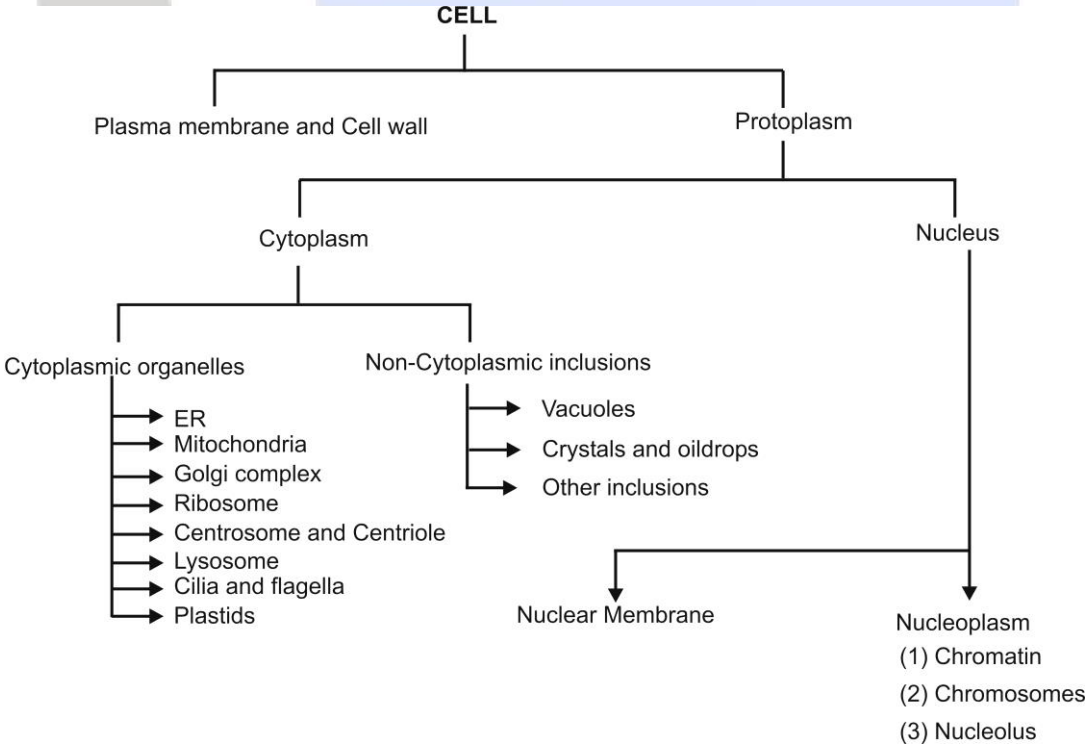


Ultrastructure of a generalized plant cell



Ultrastructure of generalized animal cell

1.6 DETAILED STRUCTURE OF CELL



Flow chart of cell

All cells have three major functional regions :

- Plasma membrane (cell membrane) and cell wall
- The Nucleus
- The Cytoplasm

1.6.1 Plasma membrane (Plasmalemma or Cell membrane)

(a) Nature and Occurrence : The cell membrane or plasma membrane is the outer covering of each cell. The cellular organelles such as mitochondria, chloroplast, lysosomes, peroxisomes, golgi apparatus and ER are all enclosed by this membrane.

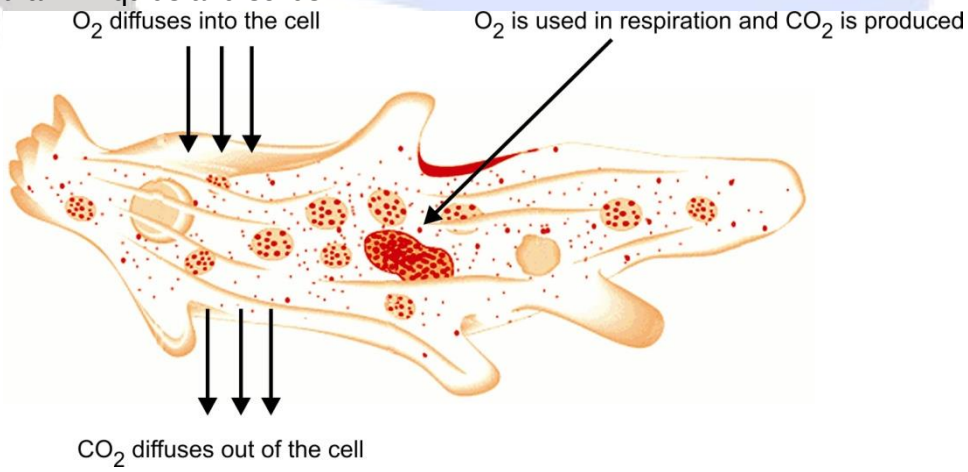
(b) Structure : Plasma membrane is a living, thin, delicate elastic, selectively permeable membrane made up of proteins, lipids and is present in both plant and animal cells. Phospholipids form the key element in structure of plasma membrane. Presence of proteins and lipids provide flexibility to plasma membrane. This property of flexibility of the plasma membrane helps in endocytosis. Proteins are formed by ribosomes present on rough endoplasmic reticulum. Lipids are formed by smooth endoplasmic reticulum. Formation of plasma membrane by proteins and lipids is known as **membrane biogenesis**.

(c) Functions

(i) It gives definite shape to the cell.
(ii) It separates the contents of a cell from its surrounding medium.
(iii) It provides mechanical barrier for the protection of internal contents of the cell.
(iv) It is selectively permeable membrane thus it regulates the movement of ions in and out of the cell.

1.6.2 Diffusion

It is the spontaneous movement of atoms or molecules from a region of higher concentration to a region of lower concentration leading finally to uniform concentration. It is faster in gaseous phase than in liquids and solids.



Diffusion of O_2 and CO_2 across the plasma membrane of Amoeba (unicellular organism)

(a) Importance of diffusion

(i) Intra Cellular Distribution : Diffusion helps in spreading of different substances throughout cytoplasm of cell without much delay.

(ii) Gaseous Exchange : Diffusion helps in exchange of respiratory gases (oxygen and carbon dioxide) between cells and their environment.

(iii) Transpiration : Loss of water in vapour form from aerial parts of the plants occurs through diffusion.

(iv) Aroma : Flowers spread aroma or odour through diffusion to attract insects and other animals for pollination.

1.6.3 Osmosis

It is the passage of water from a region of high water concentration through semi-permeable membrane to a region of low water concentration. It is pure mechanical diffusion process by which cells absorb water without spending any amount of energy.

(a) Types of Osmosis : Depending upon the entry or exit of the water molecules from the cell, osmosis is of 2 types.

(i) Endosmosis – is the osmotic entry of water into a cell or system.

(ii) Exosmosis – is the osmotic withdrawal of water from a cell or system.

1.6.4 Types of Solution

(i) Hypotonic Solution : If the medium surrounding the cell has a higher water concentration than the cell i.e. if the solution is very dilute, the cell will gain water by osmosis (endosmosis). Such a dilute solution is called hypotonic solution.

(ii) Isotonic solution : If the medium has exactly the same water concentration as the cell, there will be no net movement of water across the cell membrane. Such a solution is known as Isotonic solution.

(iii) Hypertonic solution : If the medium surrounding the cell has a lower water concentration i.e. if the solution is a very concentrated solution, the cell will lose water by osmosis (exosmosis). Such a concentrated solution is called hypertonic solution, resulting in shrinkage of cell.

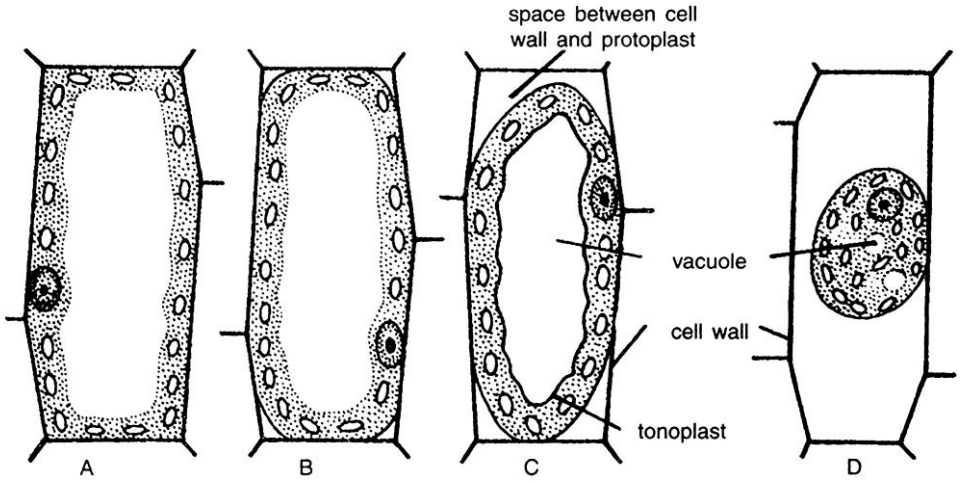
Differences between diffusion and osmosis :

S.No.	Diffusion	Osmosis
1.	Diffusion takes place in all mediums.	Osmosis occurs only in liquid medium.
2.	It is the movement of atoms and molecules from the area of higher concentration to the area of its lower concentration.	It is the movement of water from the area of its higher concentration to the area of its lower concentration.
3.	The diffusing molecules may be solid, liquid or gases.	It involves movement of solvent molecules only.
4.	It does not require a semi-permeable membrane.	It requires a semi-permeable membrane.
5.	An equilibrium in the free energy of diffusing molecules is achieved in the system.	Equilibrium in the free energy of solvent molecules is never achieved.

6.	It is dependant upon the free energy of the molecules of diffusing substance only, presence of other substances in the system is of no importance.	Though it is the diffusion of solvent molecules only, yet it is influenced by the presence of other substances (solutes) in the system.

1.6.5 Plasmolysis

When a living plant cell looses water through osmosis, there is a shrinkage or contraction of the protoplasm away from the cell wall. This phenomenon is called **plasmolysis**.



Plasmolysis : *A–A turgid or normal plant cell of Rheo*
B–D–Successive stages in the shrinkage of cell content (protoplasm) from the cell wall

1.6.6 Active Transport

It is the movement of molecules or ions from their lower concentration to higher concentration across the plasma membrane, i.e., it occurs against the concentration gradient. It often results in the accumulation of substances within the cell in higher concentrations than the outside concentration. It requires the utilization of energy in the form of ATP and also some membrane proteins acting as carrier molecules within the plasma membrane.

(a) Advantage of active transport

- It helps the cell to absorb many selective ions or molecules inside it even against concentration gradient.
- It is a very rapid process as compared to passive transport.
- It helps to maintain ionic and water balance between the cells and outside fluid.
- It helps to maintain action potential inside and outside the nerve membranes to enable the flow of stimulus across them.

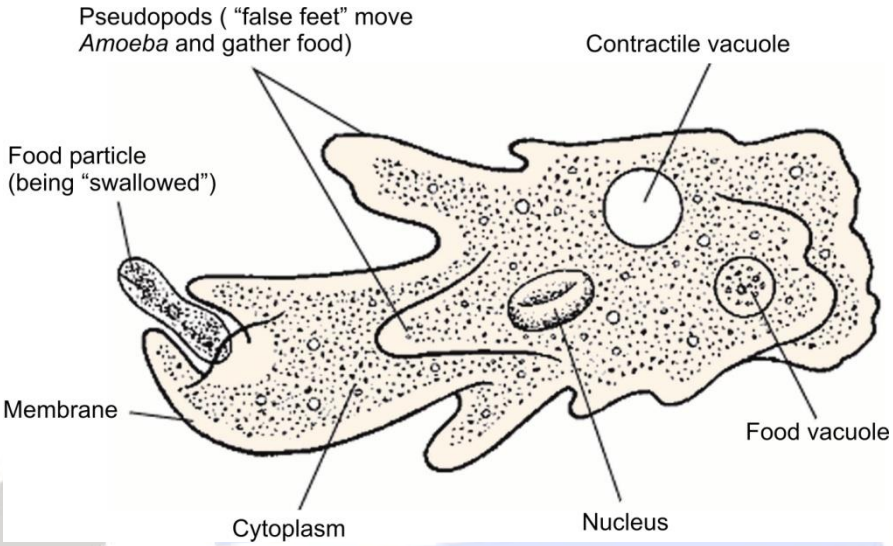
(b) Types of Active Transport

Active transport may occur by the following 2 modes

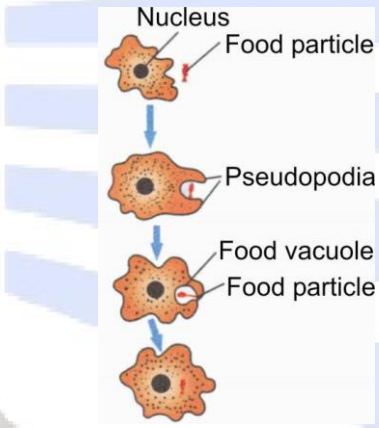
(i) Endocytosis
(ii) Exocytosis

(i) Endocytosis : It is a process of intake of materials inside the cell through the plasma membrane. According to the nature of substances taken in, it is of following two types :

(a) **Phagocytosis :** It is the process by which the cell takes in solid food material through its plasma membrane. Therefore, the process is also called as **cell-eating**. All protozoans take in their food by this process.

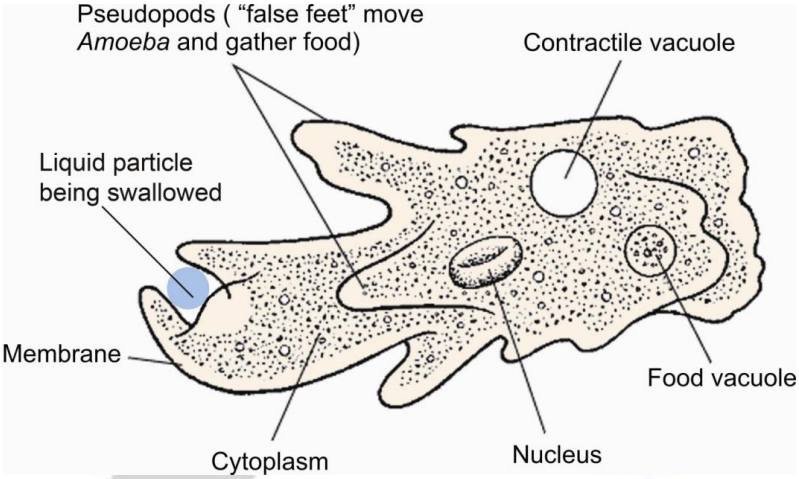


Phagocytosis in Amoeba : A closer view



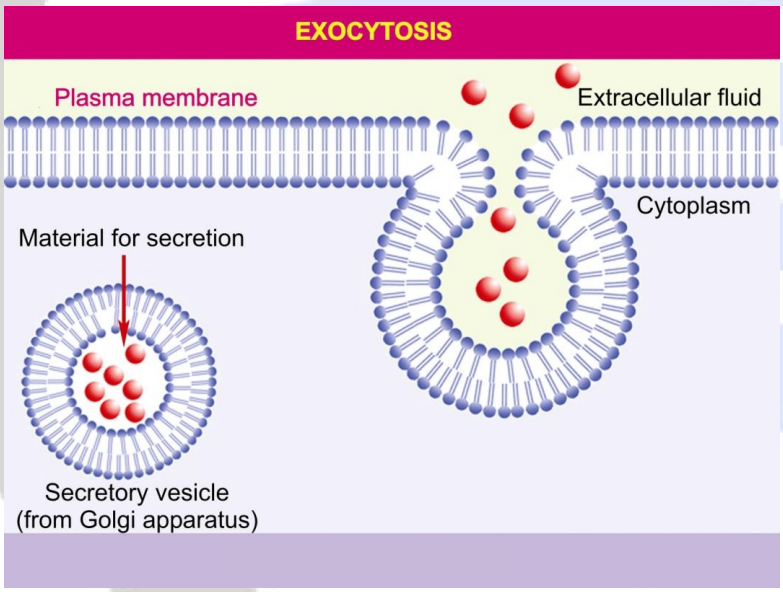
Different stages of phagocytosis in Amoeba

(b) **Pinocytosis :** It is the process by which the cells takes in the fluid matter through its plasma membrane, therefore the process is called **cell-drinking**. In this process an invagination occurs at any point in the plasma membrane near the fluid source and small-pocket like structure is formed. The fluid is then engulfed inside the cell via this invagination and it forms a pinosome. The digestion of pinosome is then brought about by various enzymes of the cell that are present in the lysosomes.



Pinocytosis in Amoeba : A closer view

(ii) Exocytosis : It is the process of exudation or secretion of the waste materials out of the cell through plasma membrane. It is opposite of endocytosis. Exocytosis occurs in the cells of pancreas where the vacuoles containing enzymes move towards the membrane to discharge their contents to the exterior.



Exocytosis

1.6.7 Cell Wall

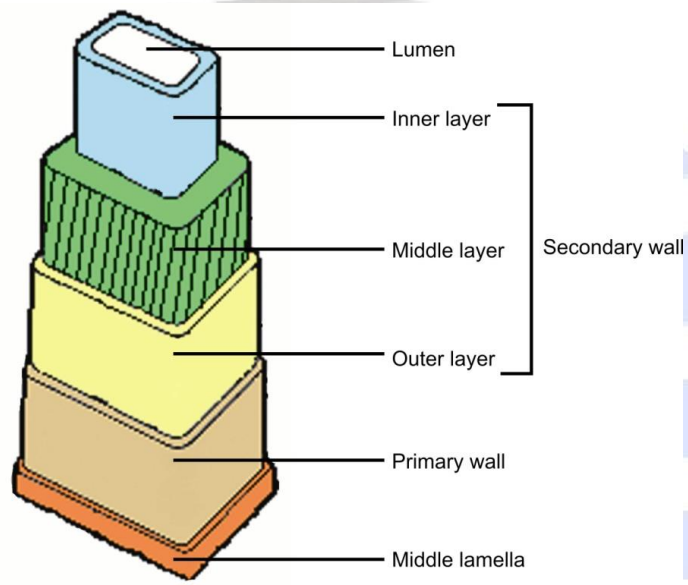
Plant cells have a rigid outer protective covering called the **cell wall** which lies outside the plasma membrane. The cell-wall is non-living, fully permeable and mainly composed of **cellulose.** The plant cell thus consists of tiny cellulose fibres called **microfibrils.** Microfibrils are bound together by pectins and hemicellulose.

(a) Functions of cell wall

(i) It provides structural strength to plant cells.

(ii) It permits the plant cell to become turgid. As water enters the vacuole by osmosis the plant cell expands.

(iii) It permits the cell of the plants, fungi, bacteria to withstand very dilute (hypotonic) external media without bursting.
(iv) It is freely permeable to water and substances in solution.
(v) Cell wall protects the cells against pathogens and mechanical injury.
(vi) It has narrow pores, called **pits**, through which fine strands of cytoplasm, called **plasmodesmata** are able to pass. These intercellular connections allow exchange of materials between living cell contents.
(vii) The cell walls of adjacent cells are glued together by the middle lamella. Middle lamella is made up of **calcium** and **magnesium pectate**.



3-dimensional view of cell wall showing its different layers

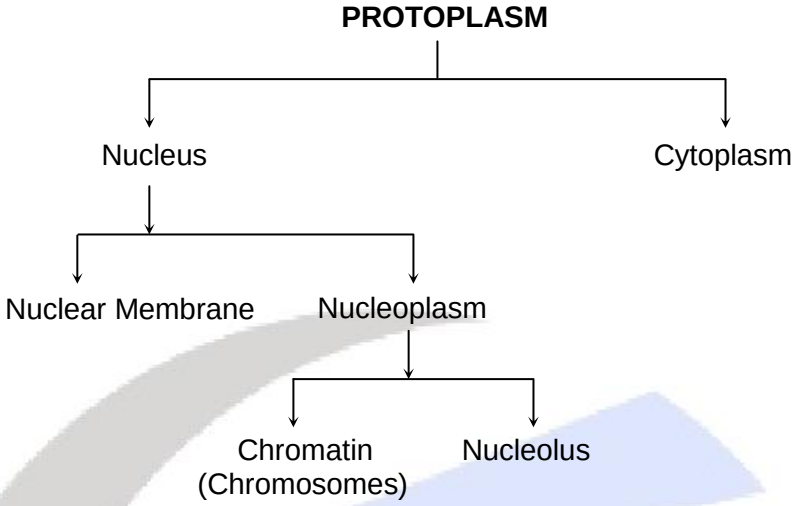
Difference between cell wall and plasma membrane :

S.No.	Cell wall	Plasma membrane
1.	It is present in plant cells only.	It is present in both animal and plant cells.
2.	It is the outermost covering of plant cells.	It is the outermost covering of the animal cells.
3.	It is present outside the plasma membrane.	It is present outside the cytoplasm.
4.	Cell wall is rigid and comparatively thick.	It is comparatively flexible and thin.
5.	It is made up of cellulose.	It is made up of lipids and proteins.
6.	It is non-living and fully permeable.	It is living and selectively permeable.

1.6.8 Protoplasm

(a) It is a colourless, transparent, viscous, base liquid in which all cell organelles are suspended. Every cell is made up of protoplasm.
(b) The chemical structure of protoplasm was discovered in 1880 by Rodwald. Huxley in 1898 discovered that it is the physical basis of life.
(c) Protoplasm consists of

(i) Nucleus
(ii) Cytoplasm



1.6.9 NUCLEUS (Karyon)

- **Robert Brown** in 1831 discovered nucleus in cell.
- It is the largest cellular structure.
- It is centrally located, spherical cell organelle.
- Nucleus is a dense protoplasmic body that contains hereditary information for controlling and regulating the cell activities.
- J. Hammerling (1953) proved hereditary role of nucleus on a green alga *Acetabularia*.

(a) **Distribution :** Present in all eukaryotic cells. In certain cells they get disintegrated when cells attains maturity e.g. RBC's in mammals.

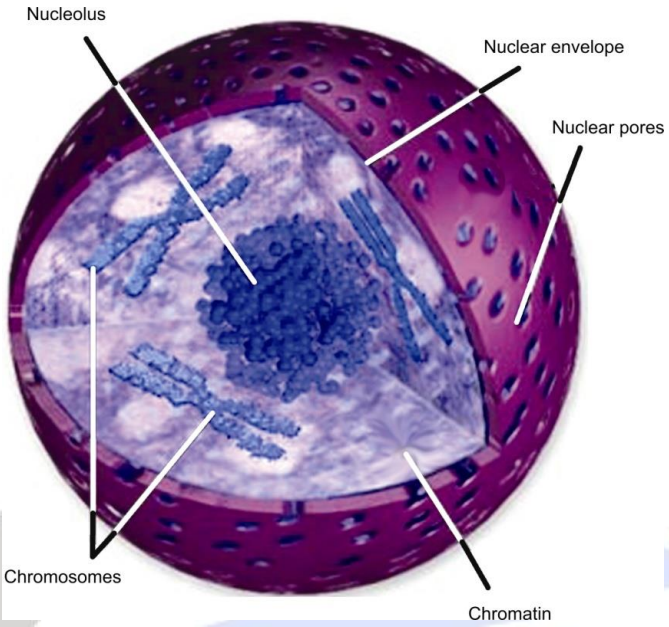
(b) **Number :** Generally a cell contains a single nucleus (mononucleated condition). Sometimes binucleated or multinucleated condition is also shown by cells.

(c) **Shape :** It is the largest cell structure which is usually oval or spherical in outline. The shape of the nucleus is variable and it depends on the functional state of cell. The shape may be discoid in case of flattened squamous epithelium cells, spherical in cuboidal or polyhedral cells, ovoid in case of columnar cells and bilobed or multilobed in case of leucocytes.

(d) **Position of Nucleus**

The nucleus is located in the cells as follows :

S.No.	Cells	Position
1.	Embryonic cells	Central position
2.	Adipose cells	Peripheral position
3.	Glandular cells	Basal position
4.	Mature plant cells	Peripheral position



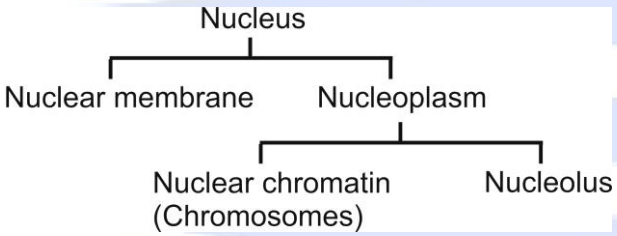
Structure of a nucleus

(e) Structure of Nucleus

Nucleus has the following important parts :

(i) Nuclear membrane

(ii) Nucleoplasm



(i) Nuclear Membrane

- Nucleus is bound by a double membrane structure called **nuclear envelope** or **karyotheca**. It separates the nucleus from the cytoplasm.
- The nuclear envelope contains many pores i.e. nuclear pores, which enclose the liquid ground substance, the **nucleoplasm**.
- Nuclear membrane is **semipermeable** and helps in the exchange of dissolved matter between cytoplasm and nucleus while nuclear pores are the pathway for the exchange of micromolecules / macromolecules.

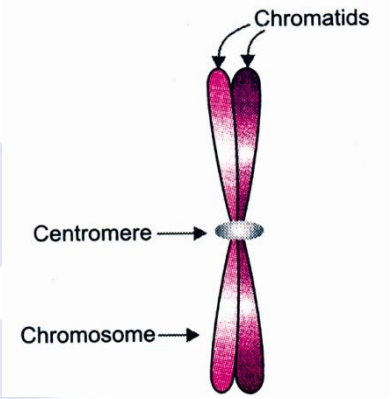
(ii) Nucleoplasm

- Inside the nucleus, a clear or **slightly acidophilic** mass is present, which is called **nucleoplasm** or **karyoplasm** or **nuclear sap** or **karyolymph**.
- It is transparent, homogeneous and granular dense fluid. It possesses high quantities of phosphorous and proteins.
- It contains nucleic acid i.e. genetic material.
- Many thread like structures are irregularly present in nucleoplasm. Their shape changes during cell division.
- It has following structures in it :

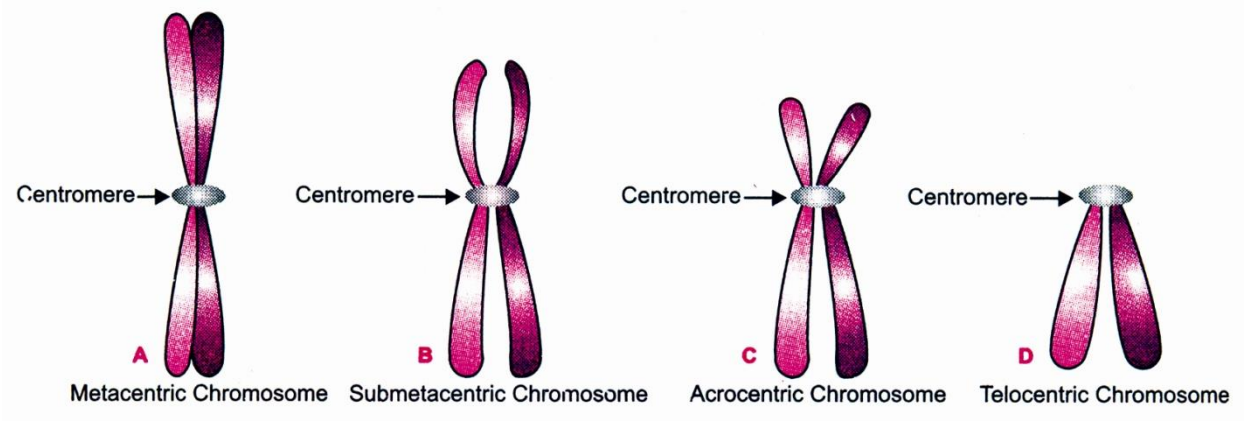
(a) Nuclear chromatin
(b) Nucleolus

(a) Nuclear chromatin or chromatin material :

- Is a thin, thread like intertwined mass of nucleic acids.
- The nucleoplasm contains much elongated structures known as **nuclear reticulum** and is made up of **chromatin**. It is also known as **chromatin net**.
- It is made up of two **chromonemata** and each chromonemata thread contains numerous small button shaped particles known as **genes**.
- Genes are made up of DNA and are responsible for the transfer of heredity characters from one generation to another.
- Chromosome number is constant for a particular species. It varies from 2n = 2 in *Ascaris* (round worm) to 1600 in radio-larian (protozoan).
- Human beings have 46 chromosomes in each cell. This chromosome number is diploid. The gametes or sex cells (sperm and ovum) are haploid. Thus haploid human sex cells have 23 chromosomes.



A chromosome



Types of chromosomes

S.No.	Types of chromosomes	Position of centromere
1.	Metacentric	At centre
2.	Sub-metacentric	Slightly away from center
3.	Acrocentric	Towards periphery
4.	Telocentric	At periphery

(b) Nucleolus

- Nucleus contains a large, spherical, dense, granular and stable structure known as nucleolus.
- These are one or more round structures which are not bound by a membrane.
- They are rich in RNA and proteins.

- It is known as factory of ribosomes.

(f) Functions of Nucleus

- **Control centre :** It controls all the metabolic activities of the cell. If it is removed the protoplasm dries up and dies.
- **Genetic information :** It is responsible for the transmission of hereditary traits.
- It regulates **cell cycle**.
- Ribosomes are formed by nucleolar part of nucleus.
- Division of nucleus is essential for **cell division**. It plays important role in mitotic division and meiotic division.

1.6.10 Cytoplasm

- The protoplasmic mass of cell excluding nucleus is called **cytoplasm**. This is colourless, transparent, homogenous mass which occurs between the plasma membrane and nuclear envelope.
- The inner granular mass of cytoplasm is called **endoplasm**, while the outer clear (glassy) layer is called **cortex** or **ectoplasm**.
- Cytoplasm consists of an aqueous substance called **cytosol**, containing various cell organelles.
- It also contains insoluble waste and storage products (starch, glycogen, lipids etc.)
- Membrane bound organelles are absent in prokaryotic cells.
- Cytoplasm contains :
  (i) Cytoplasmic organelles
  (ii) Non-cytoplasmic inclusions.

(a) Cytosol (Cytoplasm)

(i) It is the soluble part of cytoplasm.

(ii) It forms the 'background' material of cytoplasm and is located between cell organelles.

(iii) It contains system of protein fibres called **cytoskeleton**, which contain three types of protein fibres.

- Microtubules (tubulin protein)
- Microfilaments (actin protein)
- Intermediate filaments (keratin protein)

These filaments helps in (a) cellular movement (b) cells to maintain their shape.

(b) Functions

(i) Cytosol (cytoplasm) act as a store house of amino acids, glucose, vitamins etc.

(ii) Site of glycolysis, synthesis of fatty acids and nucleotides.

(iii) Living cytoplasm is always in a state of movement.

(c) Cytoplasmic Organelles

(i) These are living sub-cellular structures of the cytoplasm and are also called **protoplasmic bodies, organoids** or **trophoplasm**.

(ii) With the help of these organelles a cell performs different functions.

- It **synthesizes** substances e.g. protein synthesis by ribosomes, photosynthesis of food by chloroplasts.

- It **secretes** cell products e.g. enzymes, hormones, mucus etc. by Golgi bodies.
- It **digests** substances which are taken up by the cell during endocytosis by lysosomes.
- It **generate energy** e.g. synthesis of energy rich ATP by mitochondria.

(iii) On the basis of covering, cell organelles are of three types

- Double membrane bound e.g. mitochondria, plastids.
- Single membrane bound e.g. ER, golgi apparatus, lysosomes vacuoles.
- Membrane less e.g. ribosomes, nucleolus.

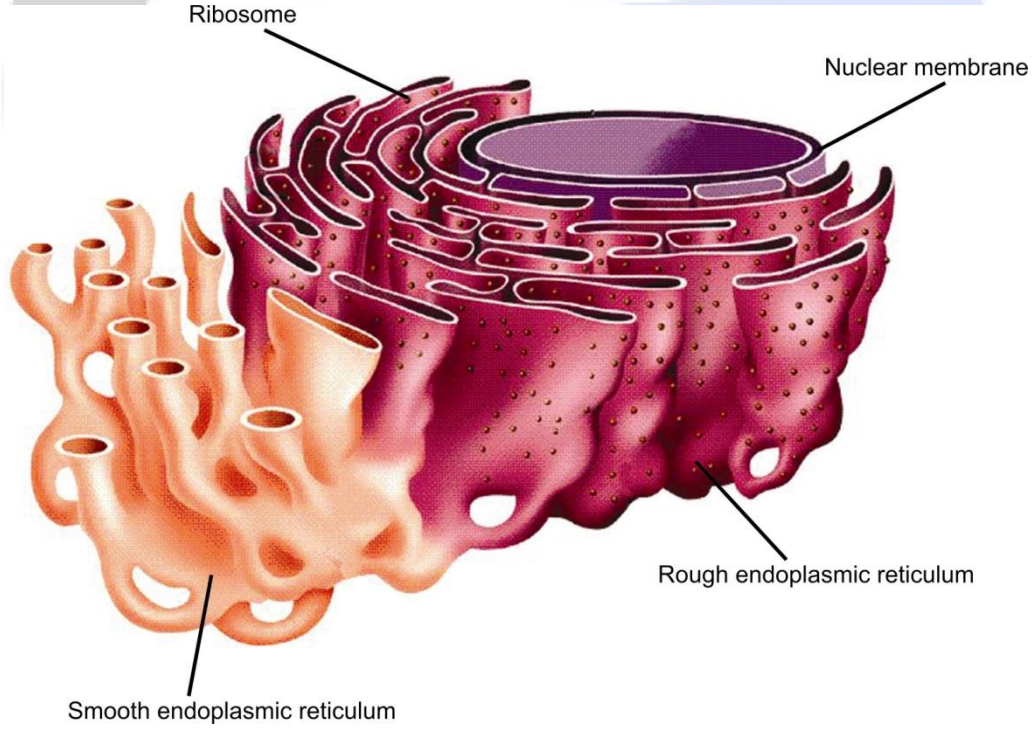
1.6.11 Endoplasmic Reticulum

(a) Nature and Occurrence

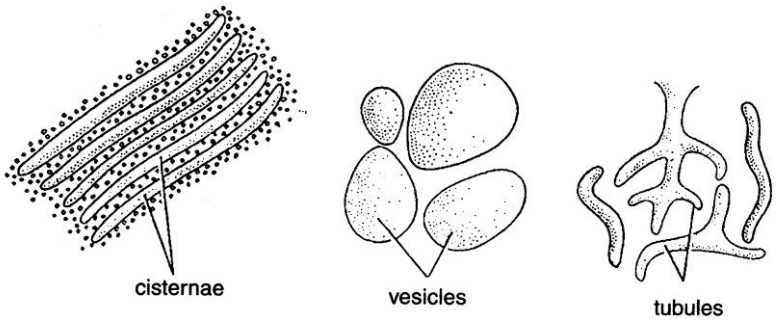
- It is only found in eukaryotic cells. It is also known as **ergastoplasm**.
- In 1945 K.R. Porter discovered it under electron microscope.
- It is a large network of membrane-bound tubes enclosing a fluid-filled lumen extending from outer nuclear membrane to plasma membrane.
- It occurs in three forms – cisternae, vesicles and tubules.
- Depending upon the presence or absence of ribosome on the surface of ER there are two types of E.R. in the cells.

(i) Smooth ER (SER) – devoid of ribosomes for secreting lipids.

(ii) Rough ER (RER) or granular ER – studded with ribosomes for synthesizing proteins.



Structure of Endoplasmic Reticulum



Various parts of ER

(b) Functions

(i) It forms supporting skeletal framework of the cell.
(ii) ER provides a pathway for distribution of nuclear material from one cell to another.
(iii) Enzymes present in smooth ER synthesize fats (lipids), steroids and cholesterol.
(iv) Rough E.R. is responsible for synthesis and transport of proteins.
(v) SER in liver cells takes part in detoxifying many poisons and drugs.
(vi) The nuclear membrane of nucleus is formed by ER in new cells.

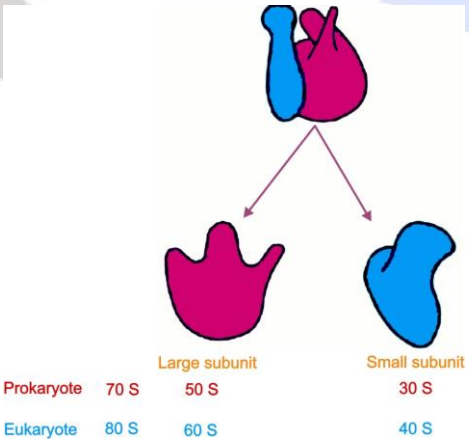
1.6.12 Ribosomes

(a) Nature and occurrence

(i) Discovered by **Palade** hence called **Palade granules**.
(ii) Smallest cell organelle (230 Å in diameter).
(iii) They are dense, spherical, granular particles occurring freely in cytosol (matrix) remaining attached to ER.
(iv) The main constituents of it are RNA and proteins.
(v) Two types of ribosomes are found 70S and 80S. 70S is found in prokaryotes which has two subunits (50S and 30S). 80S is found in eukaryotes which has two subunits (60S and 40S). Both the subunits of the ribosome remain attached when Mg^{2+} concentration increases but are separated when concentration decreases.

(b) Function

(i) Are sites of protein synthesis and hence are called **protein factories** or engines of cells.



Structure of Ribosome

1.6.13 Golgi Apparatus

Golgi body / Golgi Complex / Baker's body / Dalton complex / Golgisome / Lipochondria

(a) Nature and Occurrence

(i) First discovered by Camello Golgi described by the name **internal reticular apparatus**.

(ii) The apparatus lies near the nucleus. It is found in all eukaryotic cells except mammalian RBC's, bacteria, blue-green algae and mature sperms.

(iii) In plants Golgi complex are known as **dictyosomes**.

(iv) They are composed of

- **Cisternae :** They are flattened, plate like tubules.
- **Vesicles :** They are spherical tubules
- **Vacuoles :** Large spherical peripherally occurring vesicles.

(v) Golgi vacuoles are constantly and rapidly renewed.

(vi) Composed of lipids and fats mainly and that is why called **lipochondria**.

(b) Functions

(i) The main function of Golgi apparatus is secretory.

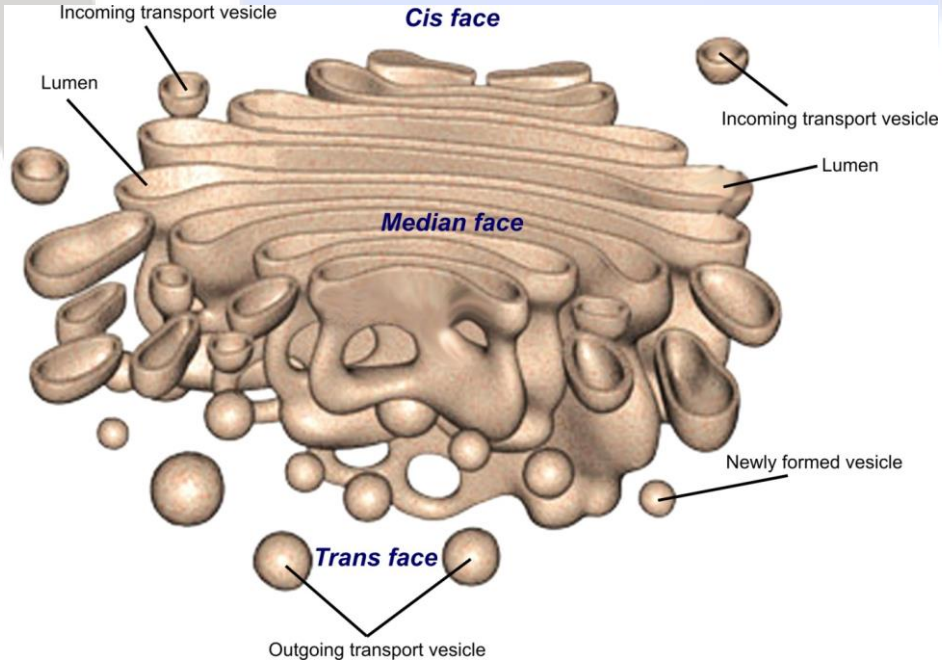
(ii) It **packages** materials synthesized in the cell and **dispatches** from cell across the plasma membrane.

(iii) It produces vacuoles or secretory vesicles which contain cellular secretions e.g. proteins, cellulose, melanin pigment, lactoprotein of milk, enzymes etc.

(iv) It is also involved in the synthesis of cell wall, plasma membrane and lysosomes.

(v) Responsible for the development and growth of the reproductive cells in mammals.

(vi) Anterior part of sperm i.e. acrosome is formed by them.



Golgi apparatus

1.6.14 Lysosomes (Enzymes packets)

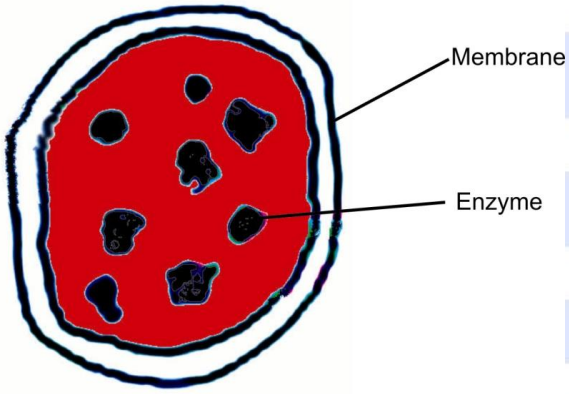
(a) Nature and occurrence

(i) Discovered by Christian de Duve (1955) in rat liver cells.

(ii) Are tiny spherical sac-like structures surrounded by a single, thin membrane of lipoproteins which contain digestive enzymes for intracellular digestion and waste disposal.
(iii) Lysosomal enzymes are made by RER.
(iv) It is abundant in digestive glands.
(v) The most important enzyme in lysosome is **acid phosphates**.

(b) Functions

(i) They serve as intracellular digestive system, hence, called **digestive bags**.
(ii) Destroy any foreign material in the cell.
(iii) Digestion of food, foreign material etc. by lysosome is called **heterophagy**.
(iv) Remove the worn out and poorly working cell organelles by digesting them, removing cell debris and are hence known as **demolition squad, scavengers, cellular housekeepers**. Thus, forming a **garbage disposal system** of the cell.
(v) During breakdown of cell structure, when the cell gets damaged, lysosomes may burst and eat up their own cells. Therefore also called **suicidal bags of cell**.



Structure of Lysosome

1.6.15 Mitochondria

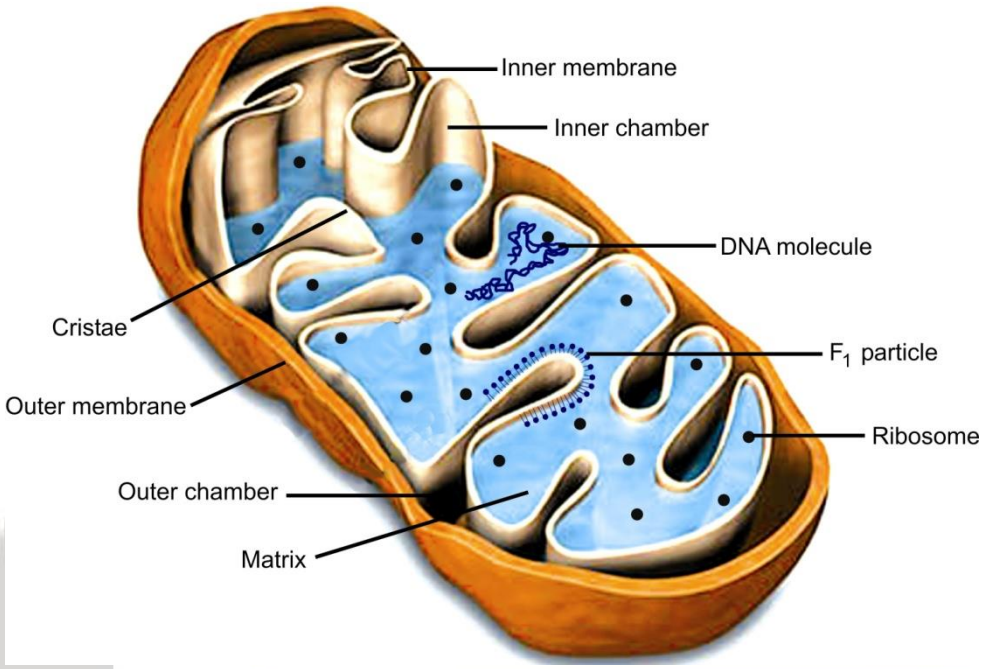
(a) Nature and occurrence

(i) 'Mitochondrion' was first coined by **Benda**.
(ii) Are tiny bodies of varying shapes and size (0.2 μm to 2 μm).
(iii) Each mitochondria is bound by a double membrane.
(iv) Outer membrane is porous, the inner membrane is thrown into folds called **cristae** and are studded with small round bodies known as F_1 particles or oxysomes.
(v) The interior is filled with gel like **matrix**. Matrix contains small sized ribosomes, circular DNA molecule and phosphate granule.
(vi) Mitochondria are absent in bacteria, RBC's of mammals.
(vii) Oxysomes – generate ATP by oxidative phosphorylation.

(b) Functions

(i) Are sites of cellular respiration.
- They synthesize energy-rich compounds (ATP) hence called '**power house of cell**'.
- ATP is known as **energy-carrier** or **energy-currency** of the cell. It is cellular-fuel.

- ATP is used for the synthesis of chemical compounds e.g. (DNA replication, transcription, protein, carbohydrates and lipid synthesis) mechanical work (contraction of muscles, movement of cilia and flagella).
- Mitochondria makes some of their proteins therefore it is a semiautonomous organelle.



Internal structure of mitochondria

1.6.16 PLASTIDS

(a) Nature and Occurrence

(i) Occur in most plant cells and are absent in animal cells.
(ii) They have their own genome (DNA) and ribosomes.
(iii) They are self-replicating organelles i.e. they have power to divide.
(iv) They are the largest cytoplasmic cell organelle in plant.
(v) Fungi (plants) lack plastids.

(b) Types of Plastids

- Plastids are of three types.

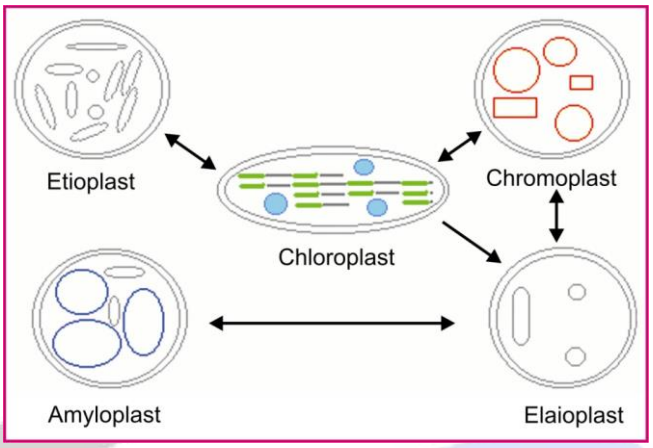
(i) Chromoplasts : Coloured plastids (except green) mostly present in flowers and fruits.

(ii) Chloroplasts : They are present in green algae and higher plants

- Have green pigment called **chlorophyll**, hence photosynthesis takes place in them. Therefore it is called '**kitchen of the cells**'.
- Chloroplast is bound by two unit membranes. It shows two distinct regions.

(a) **Grana :** They are the main functional units of chloroplast and are the site of light reaction during photosynthesis
(b) **Stroma :** It is a homogeneous matrix in which grana are embedded.
(c) Stroma contains variety of photosynthetic enzymes, starch grains, DNA and ribosomes and are the site of dark reaction during photosynthesis.

(iii) Leucoplast : They are colourless plastids and are mostly found in storage organs e.g. potato and nuts to store starch, fats and protein granules.



Different types of plastid : Inter-conversion

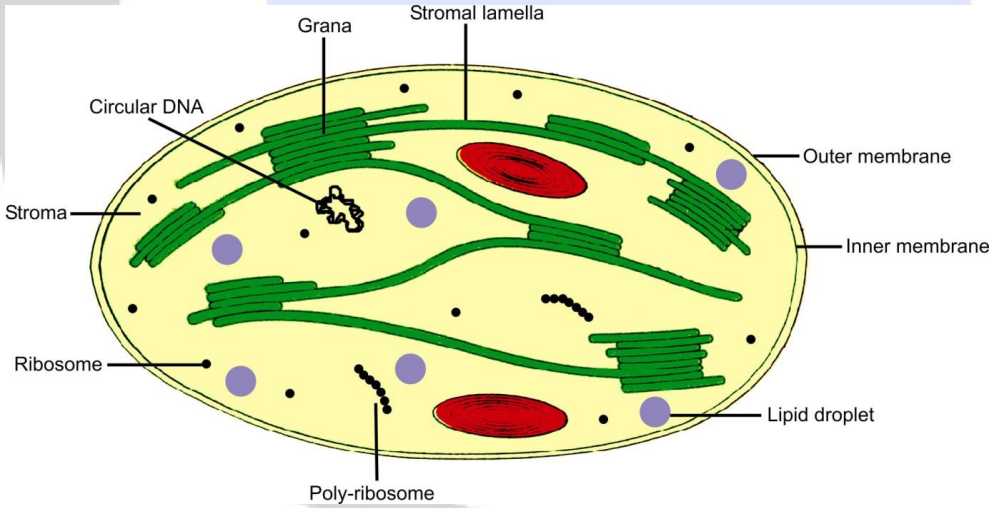
Elaiplast – Store fat ; Amyloplast – Store starch ;Etioplast-Chloroplast not been exposed to sun light

(c) Functions

Plastids perform following functions

(i) Chloroplasts trap solar energy and utilize it to manufacture food for the plant.

(ii) Chromoplasts impart various colours to flower to attract insects for pollination.



Internal Structure of Chloroplast

1.6.17 Vacuoles (Non-cytoplasmic inclusions)

(a) Nature and Occurrence

(i) Vacuoles are fluid filled or solid filled membrane bound spaces. They are storage sacs.

(ii) The vacuolar membrane is a single unit membrane and maintain water balance (osomoregulatory in protozoans).

(iii) In plant cells, a single prominent very large vacuole is present which occupies 50-90% of cell volume.

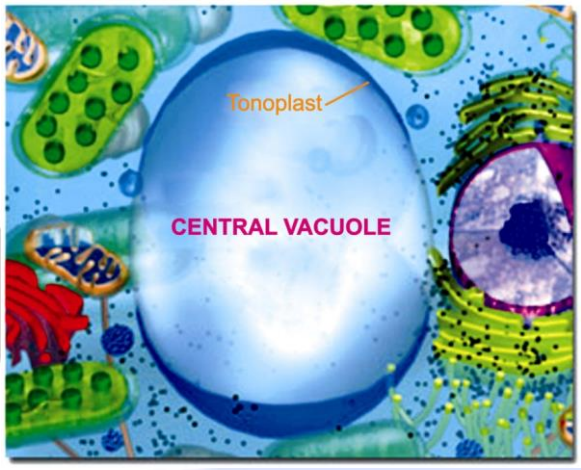
(iv) In plant cell, vacuole is bound by a membrane called **tonoplast**, filled with cell sap (a watery solution rich in sugars, amino-acids, proteins, minerals, metabolic wastes etc.

(b) Types of Vacuoles

- Vacuoles are of two types viz. food vacuoles and contractile vacuole.

(i) Food vacuoles : In *Amoeba* and amoeboid cells of higher animals the sacs containing ingested food particles fuse with lysosomes to form food vacuoles.

(ii) Contractile vacuole : Occur in some unicellular fresh water organisms e.g. *Amoeba*, *Paramoecuim*. They perform the function of osmoregulation.



Structure of Vacuole

(c) Functions

(i) Vacuoles play important role in expelling excess water and waste from the cell in unicellular organisms. This is called osmoregulation and excretion.
(ii) They store toxic metabolic by-products or end products of plant cells.
(iii) They provide turgidity and rigidity to the plant cells.
(iv) They are store houses of the cell.

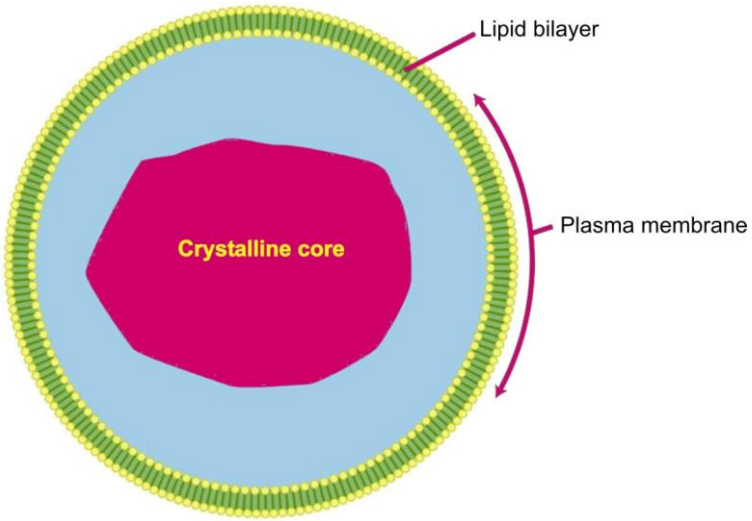
1.6.18 Peroxisomes

(a) Nature and occurrence

(i) They are small (0.3 to 1.5 μm in diameter) and spherical organelles containing powerful oxidative enzymes.
(ii) They are found in photosynthetic cell of plants, liver and kidney.
(iii) They are bound by single membrane. There is a crystalline core in the centre of peroxisomes.
(iv) The crystalline core is a crystallized protein called **catalase**.

(b) Functions

(i) They detoxify or remove toxic substances from cell.
(ii) In plant cells, they help in photorespiration.

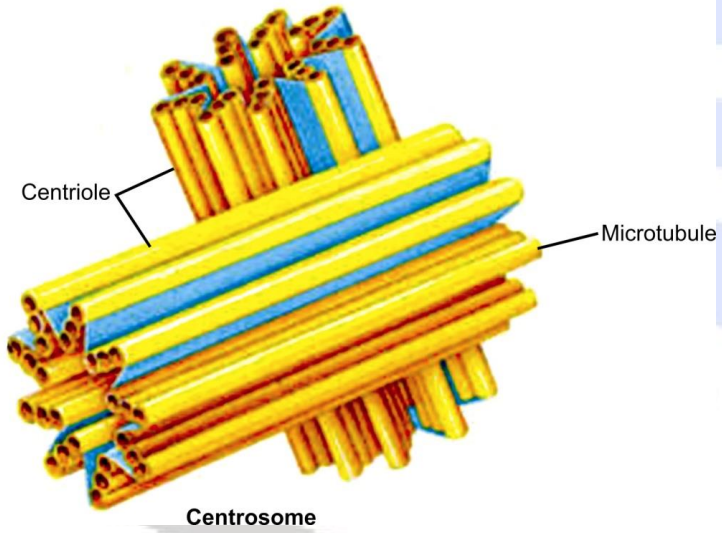


Structure of Peroxisomes

1.6.19 Centrosome

(a) Nature and occurrence

(i) Found only in animal cell.
(ii) It consists of two granules called **centrioles**.
(iii) Centrioles are hollow, cylindrical structures which are made up of microtubules.
(iv) In plant cells, polar caps perform the function of centrioles.



Structure of Centrosome

(b) Functions

(i) Centrosome helps in cell division in animal cells as they are involved in the formation of spindle fibers.
(ii) The microtubules of cilia and flagella originate and are borne by basal bodies or **kinetosome** formed by them.
(iii) It develops the axial fibers of sperms.

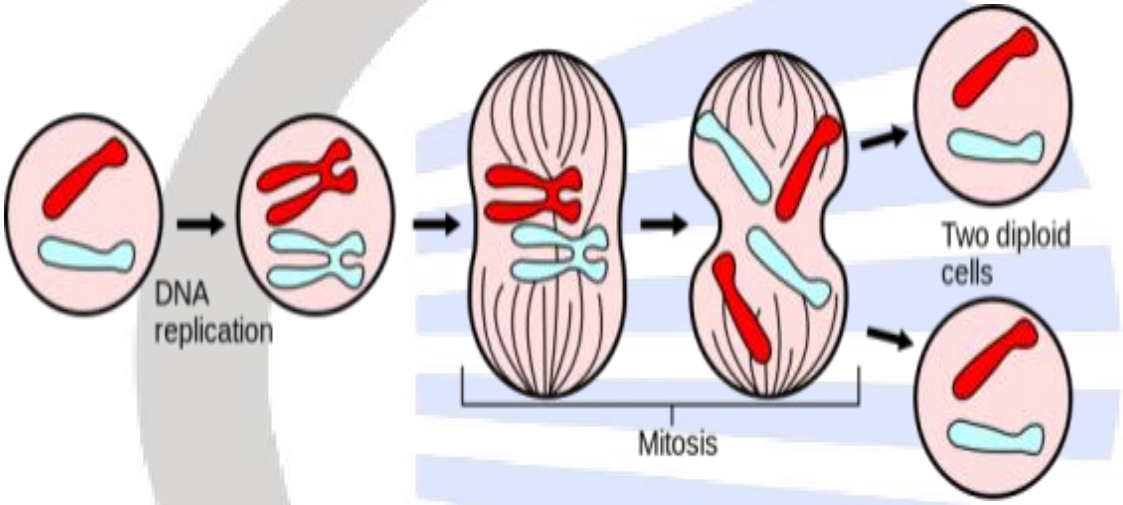
1.7 CELL DIVISION

There are two types of cell division: mitosis and meiosis. Most of the time when people refer to “cell division,” they mean mitosis, the process of making new body cells. Meiosis is the type of cell division that creates egg and sperm cells.

1.7.1 Mitosis

Mitosis is how somatic—or non-reproductive cells—divide. Somatic cells make up most of your body's tissues and organs, including skin, muscles, lungs, gut, and hair cells. Reproductive cells (like eggs) are not somatic cells.

In mitosis, the important thing to remember is that the daughter cells each have the same chromosomes and DNA as the parent cell. The daughter cells from mitosis are called diploid cells. Diploid cells have two complete sets of chromosomes. Since the daughter cells have exact copies of their parent cell's DNA, no genetic diversity is created through mitosis in normal healthy cells.

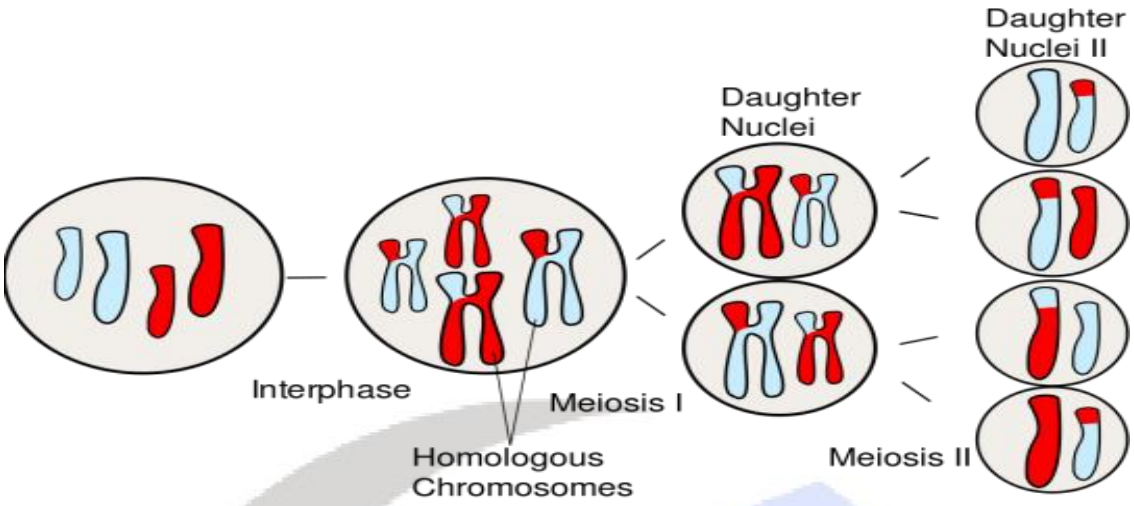


Mitosis cell division creates two genetically identical daughter diploid cells. The major steps of mitosis are shown here.

1.7.2 Meiosis

Meiosis is the other main way cells divide. Meiosis is cell division that creates sex cells, like female egg cells or male sperm cells. What is important to remember about meiosis? In meiosis, each new cell contains a unique set of genetic information. After meiosis, the sperm and egg cells can join to create a new organism.

Meiosis is why we have genetic diversity in all sexually reproducing organisms. During meiosis, a small portion of each chromosome breaks off and reattaches to another chromosome. This process is called "crossing over" or "genetic recombination." Genetic recombination is the reason full siblings made from egg and sperm cells from the same two parents can look very different from one another.



The meiosis cell cycle has two main stages of division -- Meiosis I and Meiosis II. The end result of meiosis is four haploid daughter cells that each contain different genetic information from each other and the parent cell.

1.7.3 Comparison

	Mitosis	Meiosis
Definition	A process of asexual reproduction in which the cell divides into two, producing a replica with an equal number of chromosomes in each resulting diploid cell.	A type of cellular reproduction in which the number of chromosomes are reduced by half producing two haploid cells.
Occurs in	All organisms	Reproductive cells of humans, animals, plants and fungi.
Type of reproduction	Asexual	Sexual
Genetically	Produces identical organisms or cells	Different cells or organisms.
Crossing over	No, crossing over cannot occur.	Yes, mixing of chromo somes can occur.
Pairing of Homologous chromosomes	No	Yes
Number of divisions	1	2
Number of daughter cells produced	2 diploid cells	4 Haploid cells