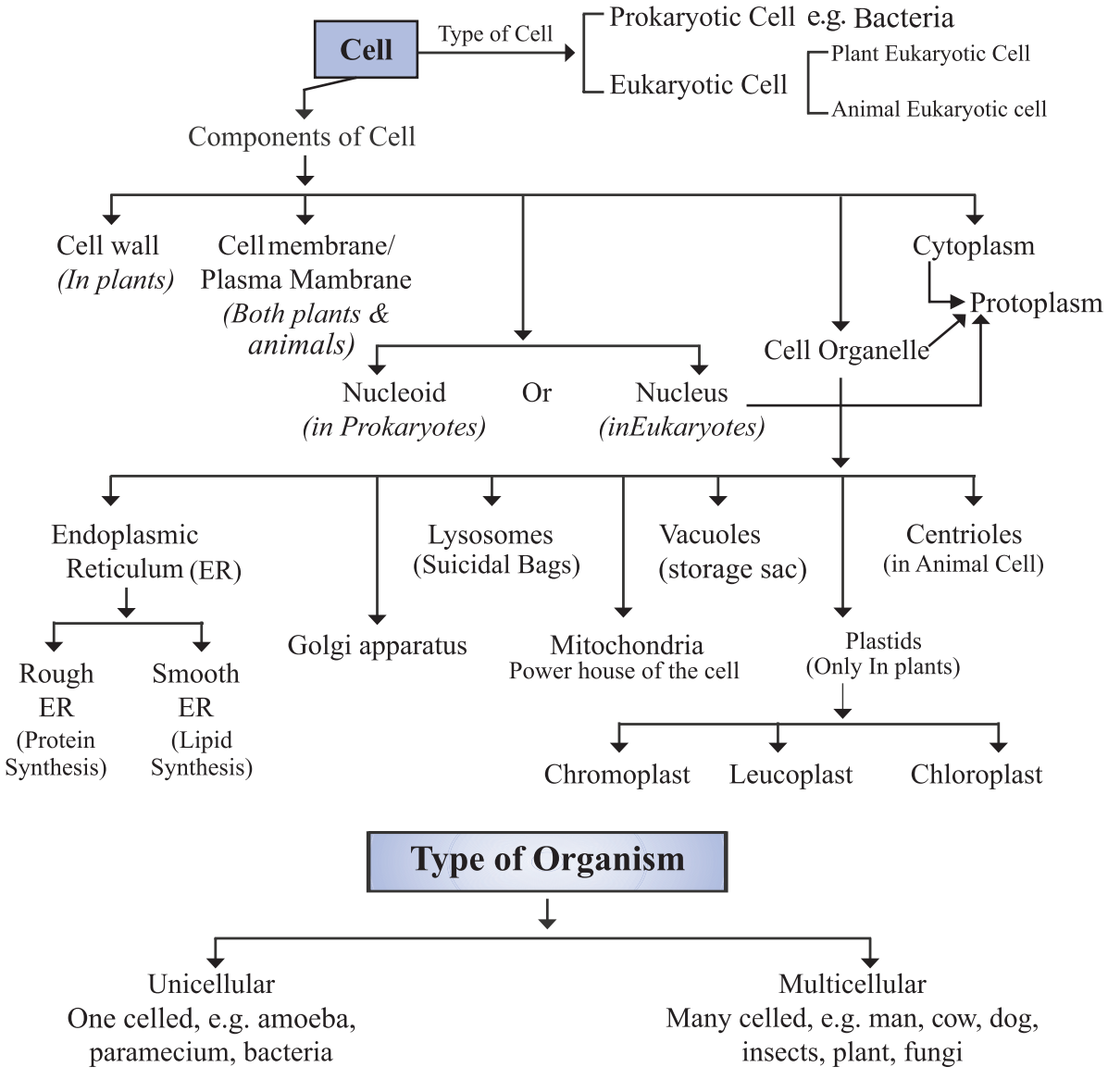
Chapter - 5

Fundamental Unit Of Life : Cell

CONCEPT MAPPING



Cell

- A cell is the basic structural and functional unit of all life forms.
- All living forms are composed of microscopic units called as 'Cells'.
- Study of structure and composition of cell is called Cytology'.
- Cell was first discovered and observed by Robert Hooke in a thin dead slice of cork in the year 1665.
- First free living cell was discovered by A. V. Leeuwenhoek. in 1674.
- Protoplasm is an aggregate of various chemicals such as water, ions, salts and other organic molecules like proteins, carbohydrates, fats, nucleic acids, vitamins etc. Present in cytoplasm along with cell organelles & nucleus that constitute a cell.
- It exists in sol-gel states.

Cell Theory :

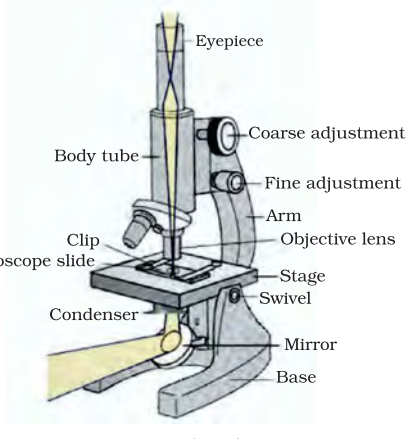
Two biologists, Schleiden and Schwann (1838) gave the Cell theory which states that :

(i) All plants and animals are composed of cells.

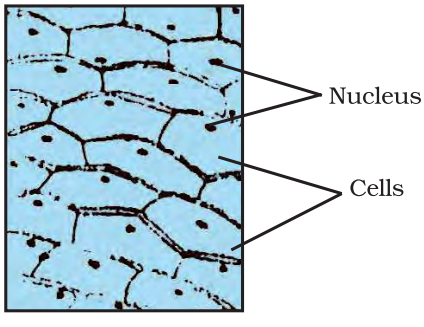
(ii) Cell is the basic unit of life.

(iii) All cell arise from pre-existing cells.

- Viruses are the exceptions of cell theory.

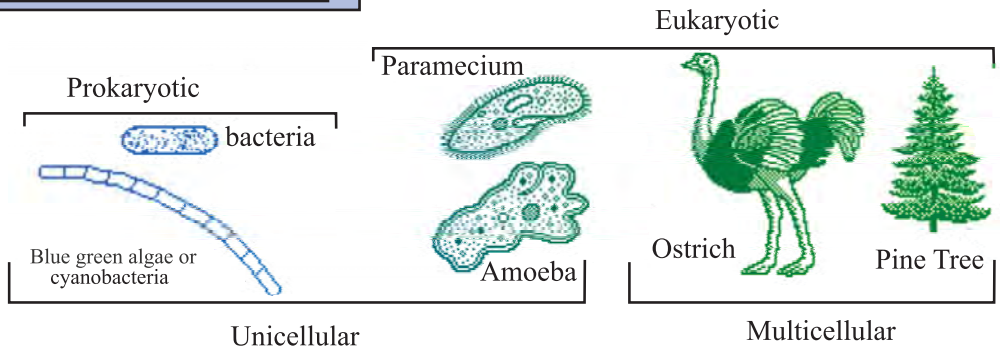


Compound microscope



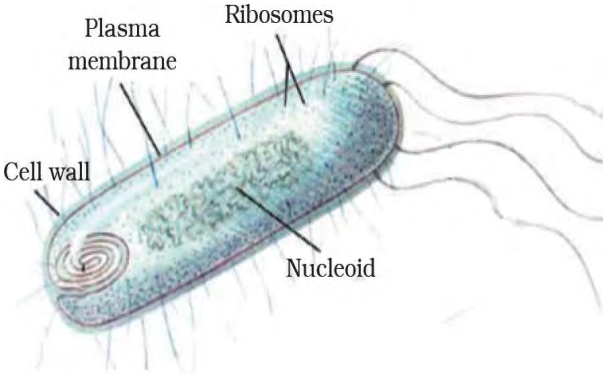
Onion Peel Cells

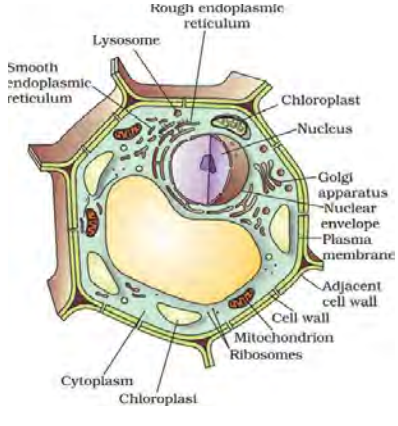
Types of Cell & Organism :



On the Basis of Type of Organization Cells are of two kind

Prokaryotic Cells	Eukaryotic Cells
• Very minute in size. (0.1-5 um)	• Fairly large in size. (5-100µm)
• Nuclear region (nucleoid) not surrounded by a nuclear membrane.	• Nuclear material surrounded by a nuclear membrane.
• Always Unicellular	• May be unicellular or multicellular
• Single Chromosome present.	• More than one chromosome present.
• Nucleolus absent.	• Nucleolus present.
• Cell division by fission or budding	• Cell division by mitosis or meiosis.
• Membrane bound cell organelles are absent.	• Membrane bound cell organelles are present.
Ex. Bacteria	Ex. All Plants, Animals, Amoeba etc.





Organism are of Two Type :

Characteristics	Unicellular organism	Multicellular organism
Cell number	Single cell, Simple	Large number of cells, Complex
Function	All functions are performed by single cell	Different cells perform different specific functions.
Division of labour	Not performed / Required	Cells specified to perform different functions.
Reproduction	Involves the same single cell	Specialised cells, (germ cells) take part in reproduction.
Life span ***Examples :***	Short Amoeba, Paramecium bacteria etc.	Long Plant, Fungi & Animals

Cell Shape : Cells are of variable shapes and sizes. That varies is according to their function position. Generally cells are spherical but they may be elongated (nerve cell). branched (pigmented), discoidal (RBC). Spindle- shaped (muscle cell) etc.

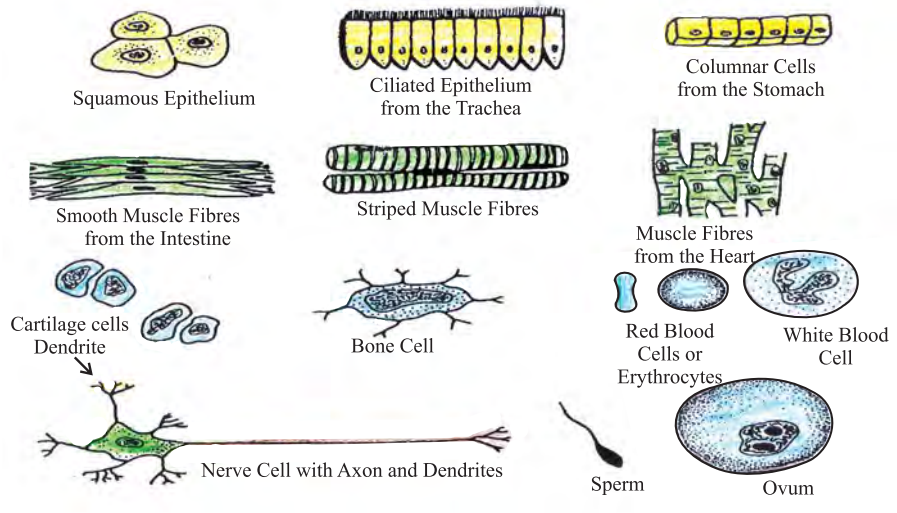


Fig: Different kinds of cell found in the human body

Cell Size : Size of cell is variable depending upon its position & function
Some are microscopic while some are visible with naked eyes. Their size may vary from 0.2 um to 18 cm.

- Size of typical cell in a multicellular organism ranges from 2-120 micron.
- The largest cell is ostrich egg (15 cm long 13cm wide & weight 1.4 kg)
- The longest cell is nerve cell (upto 1m).
- Smallest cells so far known are PPLOs e.g., mycoplasma

Components of Cell

There is an occurrence of division of labour within a Eukaryotic cell as they all got certain specific components called 'Cell organelles'. Each of them perform a specific function.

The three basic components of all the cells are :

(i) Plasma membrane (ii) Nucleus (iii) Cytoplasm

Cell Membrane/Plasma Membrane :

(a) Plasma membrane is selectively permeable in nature, means it allows or permits the entry and exit of some materials in and out of the cell.

(b) Cell membrane is also called plasma membrane or plasma lemma.

(c) It is the limiting boundary of each cell which separates cytoplasm from its surroundings. It is found in both plant as well as animal cells.

(d) It is the outermost covering of a cell in case of animals and lies below the cell wall in case of plants.

(e) As per the lipid model of plasma membrane, it is made up of proteins and lipids where proteins are sandwiched between bilayer of lipids.

(f) Singer and Nicholson gave the fluid mosaic model or lipid - bilayer model of plasma membrane.

(g) It is flexible and can be folded, broken and reunited.

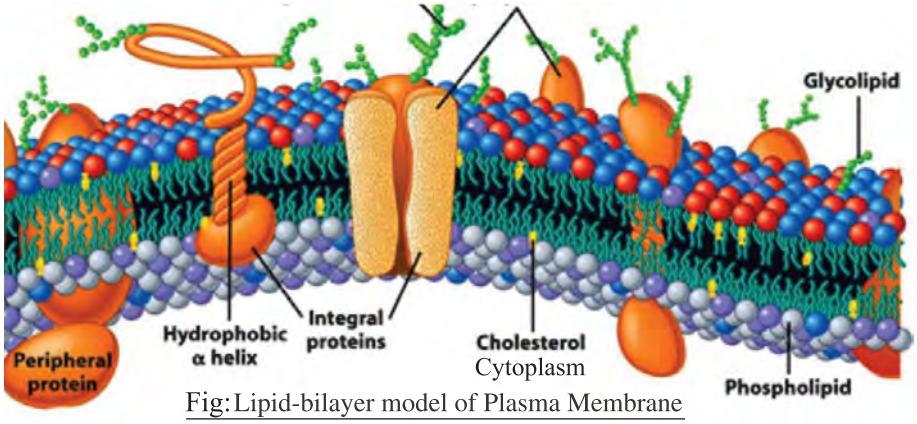


Fig: Lipid-bilayer model of Plasma Membrane

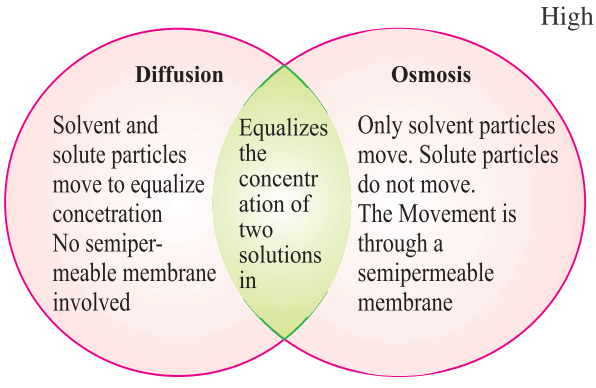
(i) ***Functions of Plasma Membrane :***

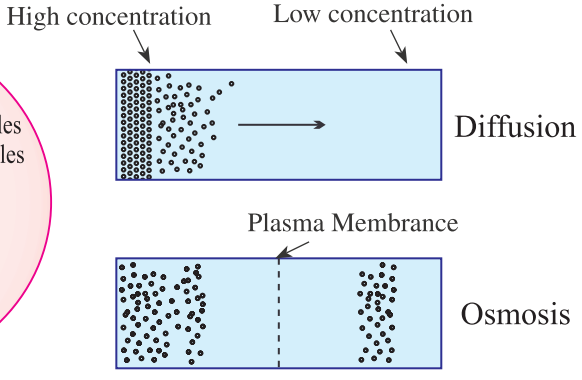
(a) It regulates the movement of molecules inside and outside the cell.

(b) It helps in maintaining the distinct composition of the cell.

(ii) ***Transportation of molecules across the Plasma Membrane :***

This can be done by following ways :





- **Diffusion :** Movement of solutes or ions from a region of higher concentration to a region of lower concentration is called diffusion. It does not require energy therefore, it is called passive transport.
- **Osmosis :** The movement of solvent or water from its higher concentration (solvent) to lower concentration (solvent) through a semipermeable membrane is called osmosis.

Or

The movement of water across semipermeable membrane is called as osmosis.

- **Osmosis can also be called 'Diffusion of solvents'.**
- **Endosmosis :** Movement of solvent into the cell is called Endosmosis.
- **Exosmosis :** Movement of solvent outside the cell is called Exosmosis.

Types of Solutions on the Basis of Concentration and its effect on cell :

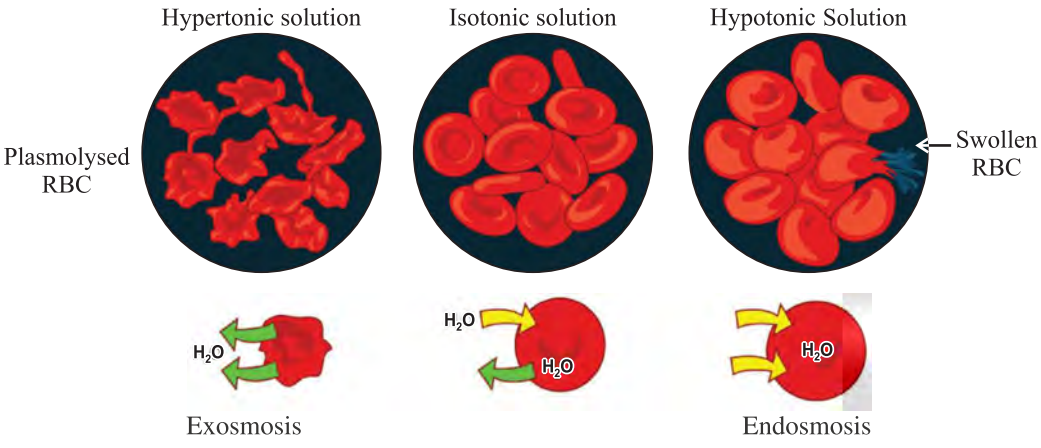


Fig. : Effect of different types of solution on RBC's placed in them.

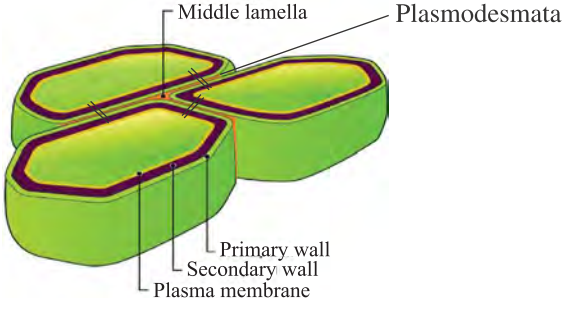
(a) ***Isotonic Solution :*** When concentration of a solution outside the cell is equal to the concentration of cytoplasm of the cell, it is called as isotonic solution.

(b) ***Hypertonic Solution :*** When concentration of a solution outside the cell is more than inside of the cell. Due to this, cell loses water and becomes plasmolysed. ***Plasmolysis:–*** Shrinking of the protoplasm away from the cell wall due to Excessive loss of water (Exosmosis) is called Plasmolysis

(c) ***Hypotonic Solutions :*** When the concentration of the solutions outside the cell is less than that of cytoplasm of cell, due to excessive endosmosis cell swells up and animal cell may burst.

Cell Wall

- It is the outermost covering of the plant cells and cells of fungi.
- It is absent in animal cells.
- Cell wall is rigid, strong, thick porous and non-living structure. In plant it is made up of cellulose and hemicelluloses. In fungi it is primarily made up of Chitin. Cell walls of two adjacent cells are joined by a layer called middle lamellae and microscopic channels called plasmodesmata for transport.



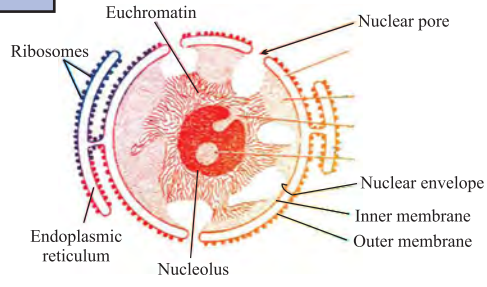
Functions of Cell Wall :

(a) It provides definite shape, structure, support and protection to the cell.

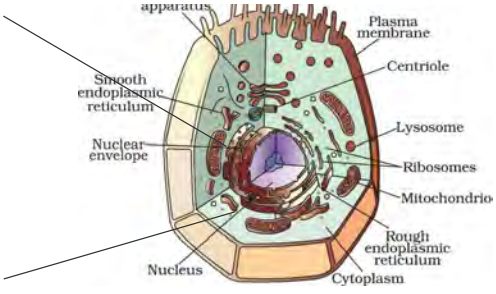
(b) It provides strength to the cell.

(c) It is permeable and allows entry of molecules of different sizes & thus control intercellular Transport.

Nucleus



Enlarged view of Nucleus



Eukaryotic Cell

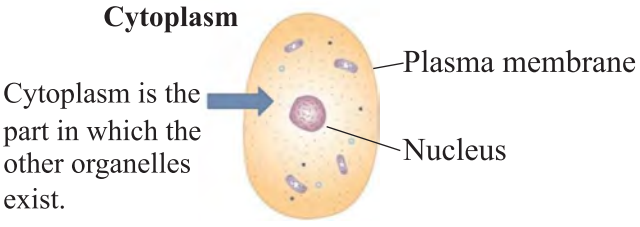
- Nucleus is the most important cell organelle which directs and controls all its cellular activities.
- It is called as 'Headquarter of the cell'/controller of cell.
- Nucleus was discovered by Robert Brown in 1831.
- In Eukaryotes, a well-defined nucleus is present while in Prokaryotes, a well-defined nucleus is absent.
- Prokaryotes contain a primitive nucleus called Nucleoid.
- It has double layered covering called nuclear membrane.
- Besides nuclear membrane, nucleus also contains nucleolus and chromatin material. Chromatin is made up of DNA (Deoxy ribonucleic acid) and Protein, that ultimately condenses and forms chromosome.
- Chromosomes or chromatin material consists of DNA which stores and transmits hereditary information for the cell to function, grow and reproduce.
- The functional segment of DNA is called Gene.

Functions of Nucleus :

(a) It directs and controls all the metabolic activities of the cell and regulates the cell cycle.

(b) It helps in transmission of hereditary characters from parents to their offsprings.

Cytoplasm

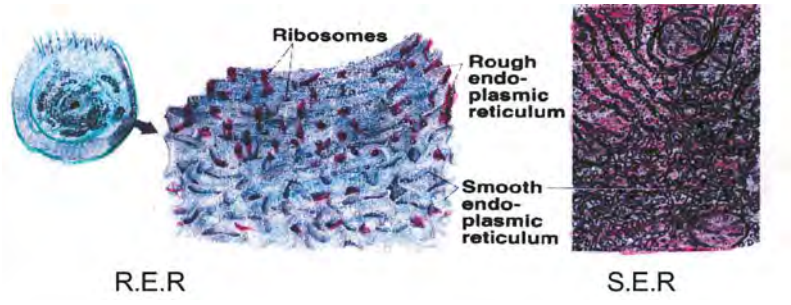


- Cytoplasm is the fluid content enclosed by the plasma membrane.
- Cytoplasm was discovered by Kolliker in 1862.
- It is the site of both biosynthetic and catabolic pathways (Metabolic activities)
- It can be divided into two parts :
  - ***(i)*** ***Cytosol :*** Aqueous soluble part contain various fibrous proteins forming cytoskeleton. It contain about 90% water, 7% Protein 2% carbohydrates & 1% etc.
  - ***(ii)*** ***Cell organelles :*** Living part of the cells having definite shape, structure and function bounded by plasma membrane.
- **There are single membrane bound, double membrane bound and non membrane bound Cell organelles.**

Single Membrane bound cell organelles	Double Membrane bound cell organelles	Non Membrane bound cell organelles
eg. ER, Lysosomes, Golgibodies & Vacuoles Peroxisomes	eg. Mitochondria, Plastids These 2 also have their own DNA material	eg. Ribosome, Centrosomes, Microtubules

Endoplasmic Reticulum

- It is the network of membrane bound tubules and sheet present in the cytoplasm.
- It was discovered by Garnier and structure given by Porter, Claude and fullum.
- These are present in all cells except prokaryotes and mammaliam erythrocytes.



Endoplasmic reticulum is of two types :

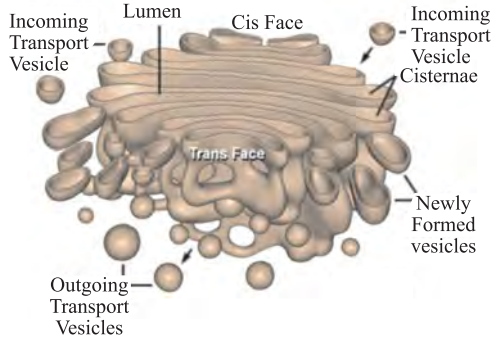
Smooth ER	Rough ER
• Made of tubules mainly.	• Made of Cisternae and vesicles.
• Helps in steroid, lipids and Polysaccharide synthesis.	• Helps in protein synthesis.
• Ribosomes are absent.	• Contains ribosome on its surface.

Function of ER :

(a) It is the only organelle which serves as a channel for the transport of materials between various regions of cytoplasm and between cytoplasm and nucleus.
(b) It also functions as a cytoplasmic framework to provide surface for some of the biochemical activities. It forms endoskeleton of cell.
(c) It helps in synthesis of fats, protien, steroids, cholesterol etc.
(d) SER plays a crucial role in detoxification of drugs and poisonous by products.
(e) Membrane biogenesis: Protein & Lipids produced by ER are used to produce cell membrane.

Golgi apparatus consists of a system of membrane bounded fluid filled vesicles arranged parallel to each other in stacks called Cisternae along with some large and spherical vesicles. It was discovered by Camillo Golgi. It is absent in prokaryotes, mammalian RBC's & sieve cells.

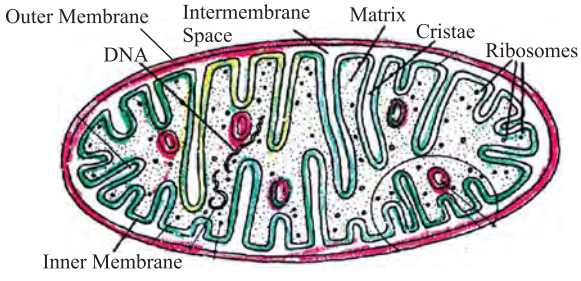
The Golgi Apparatus



Functions of Golgi apparatus :

(a) Its function include the storage, modification, Packaging & secretion of products in vesicles.
(b) It involves in the formation of lysosomes.
(c) It is secretary in nature. It helps in melanin synthesis.
(d) It also involves in the synthesis of cell wall & plasma membrane.

Mitochondria



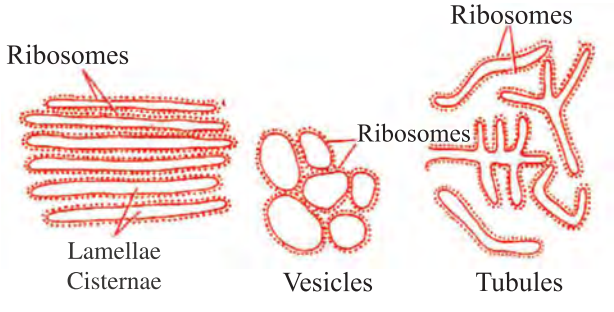
It is a rod shaped structure found in cytoplasm of all eukaryotic cells except mammalian RBC's.

- These are also absent in prokaryotes.
- It was first seen by Kolliker in insect cells in 1880.
- It is also called as 'Power House of the Cell' or the 'Storage Battery'.
- It is double membranous structure where outer membrane has specific proteins while inner membrane is folded inside to form chambers called Cristae.
- Mitochondria has its own DNA & Ribosomes

Functions of Mitochondria :

(a) Its main function is to produce, store and release the energy in the form of ATP (Adenosine Triphosphate) The energy currency of the cell.
(b) It is the site for cellular respiration (Kreb cycle) in which ATP are produced.

Ribosomes



(Ribosomes located on different cell organelles and their parts)

- Ribosomes are the sites of protein synthesis.
- All structural and functional proteins (enzymes) coded by the nuclear DNA are synthesized upon cytoplasmic ribosomes. The DNA codes are transcripted into messenger RNA (mRNA) (Ribonucleic Acid) molecules, Which comes out of the Nucleolus and translated (Protein synthesis) by ribosomes attached to RER in the form of proteins.

Functions of Ribosomes :

Ribosomes are the main site of protein synthesis. Synthesized proteins is transported by endoplasmic reticulum.

Plastids

- It is double membranous, discoidal structure, found mainly in algae and plant cells.
- Besides being discoidal or rhombic in plant cells, they occur in variable shapes like in (algae.) They can be 'U' - shaped, spiral, coiled, ribbon- shaped etc.
- They also have their own DNA and ribosomes.

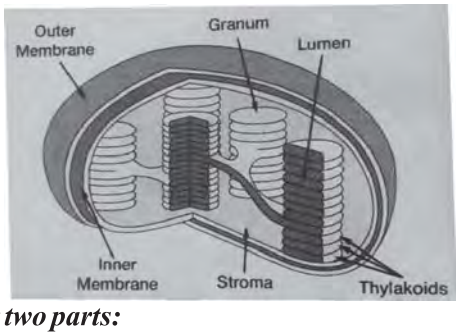
Depending upon the type of pigment present in them, they are of following three types :

(i) Leucoplast – These are white or colourless and found in non- photosynthesis tissue of plant such as Root, bulb, seeds, etc. They can change into other type of plastids. The primary functions is storage of starch, oil, proteins.

(ii) Chromoplast – These are coloured plastids except green, these impart colour to fruits & flowers.

(iii) Chloroplast – It contains chlorophyll which impart green colour to leaves and, found in aerial parts of plants. It helps in the process of photosynthesis so it is called the 'Kitchen of cell in plant.

Chloroplast :



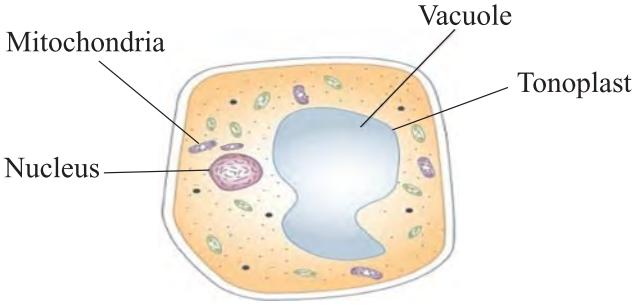
Chloroplast have following two parts:

(i) Grana : It constitutes the lamellar system. These are found layered on top of each other. These stacks are called Grana. Each granum of the chloroplast is formed by superimposed closed compartments called Thylakoids.

Function : They are the sites of light reaction of photosynthesis as they contain photosynthetic pigment chlorophyll, photosynthetic units.

(ii) Stroma : It is a granular transparent substance also called as matrix. Grana are embedded in it. Besides Grana they also contain lipid droplets, starch grains, ribosomes etc.

Vacuoles

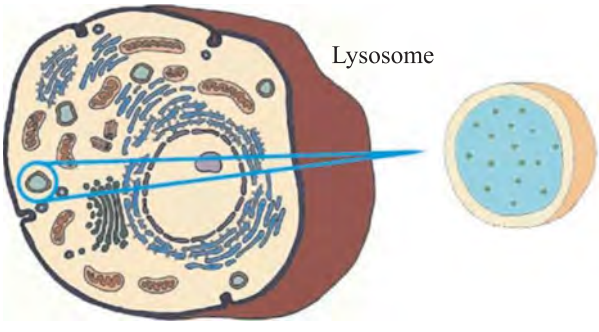


- These are membrane bounded regions in the cytoplasm containing water and other substances. They are bounded by a single membrane called Tonoplast.
- In animal cells vacuoles are absent or smaller in size. In plant cells a single large vacuole is found which occupies about 90% of the volume of cell.

Functions :

It helps in maintaining osmotic pressure in a cell & stores toxic metabolic products (Waste product) water, sugar, protein etc.

Lysosome (Suicidal Bag)



- They are tiny single membrane bound cell organelle containing powerful digestive enzymes for intracellular digestion.
- Lysosome absent in RBC's
- Lysosomes are synthesised by golgi body & enzymes present in it are synthesised by RER.

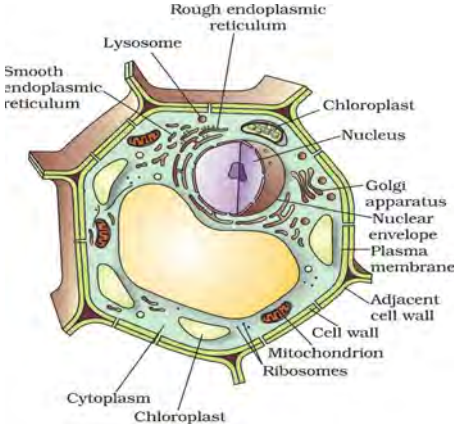
Functions :-

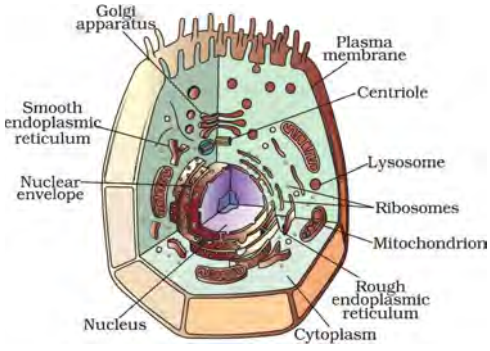
(a) Their main function is phagy (digestion). Means they breakdown worn out cell parts.
(b) They are kind of waste disposal system of the cell.
(c) They help in digesting foreign materials like invading viruses and bacteria in the cell.

Suicidal Bag : During disturbances in cellular metabolism (i.e., in case of cell damage), lysosomes burst and their enzymes are released into the cytoplasm which digest their own cell. Therefore they are also called 'Suicidal Bags'.

Difference between Plant cell and Animal cell

Plant Cell	Animal Cell
• Contain chloroplasts for Photosynthesis • Have a cell wall to maintain structure and rigidity. • Usually do not contain lysosomes and Peroxisomes. • Cells are square and rigid or geometric shaped. • Have one large central vacuole.	• No chloroplasts (plastids) • No cell wall • May Contain cilia and/or flagella • Cells are fluidic and flexible, many shapes. • Has small or no vacuoles. • Have lysosome



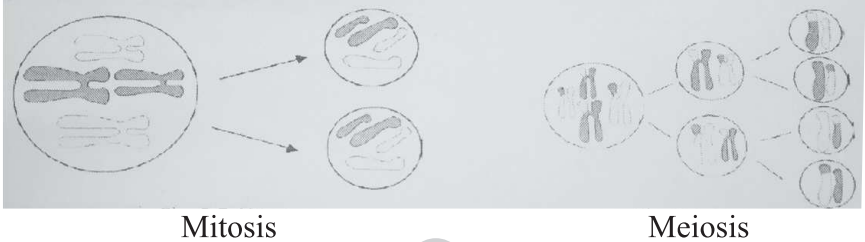


Cell Division : New cells are formed in organisms in order to grow, to replace old, dead and injured cells, and to form gametes required for reproduction. The process by which new cells are made is called cell division.

The two main types of cell division are :

i) **Mitosis :** The process of cell division by which most of the cells divide for growth is called mitosis. In this process, each cell called mother cell divides to form two identical daughter cells. The daughter cells have the same number of chromosomes as mother cell. It helps in growth and repair of tissues in organisms.

ii) **Meiosis :** Specific cells of reproductive organs or tissues in animals and plants divide to form gametes, which after fertilisation give rise to offspring. They divide by a different process called meiosis which involves two consecutive divisions. When a cell divides by meiosis it produces four new cells instead of just two. The new cells have only half the number of chromosomes than that of the mother cells. These new cells are Transformed into gametes.



Mitosis Meiosis