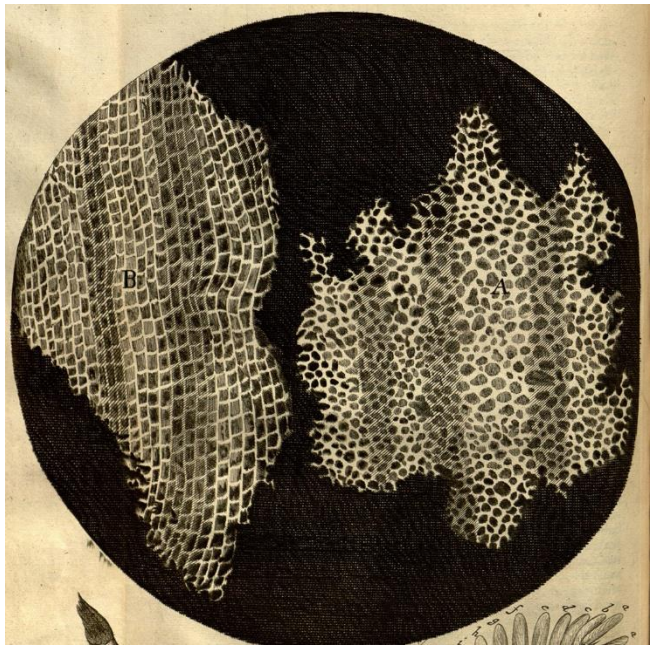
THE FUNDAMENTAL UNIT OF LIFE

- **Discovery of Cell:**

The credit of discovery of cell goes to Robert Hooke (1665) who observed honeycomb pattern in very thin slice of cork.



honeycomb like structure was made of enclosed box-like compartments

He used the Latin term 'cellulae' (cells) for little compartments with hollow space. Cell is a Latin word for little room.

Publication ➡ "Micrographia"

The Cell Theory

- Matthias Schleiden and Theodor Schwann proposed the cell theory
- All organisms are composed of one or more cells
- The cell is the smallest functional unit of life
- All cells are produced from other cells

Rudolf Virchow

Antonie van Leeuwenhoek

Dutch microscopist who was the first to observe bacteria and protozoa

- **Shape of the cells:**
- The shape of cells is determined by the cell environment and cell activities they perform.
- The cell shape could be more or less fixed and peculiar for a particular type of cell.
- Living cell has capacity to perform certain basic functions that are characteristic of all living forms.

- **<u>Organisms can have cells of different kinds.</u>**

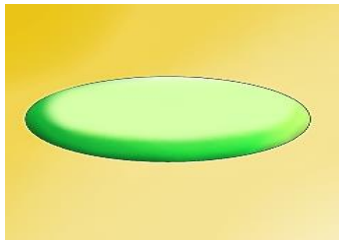
(i) Blood cells (Discoid shaped)

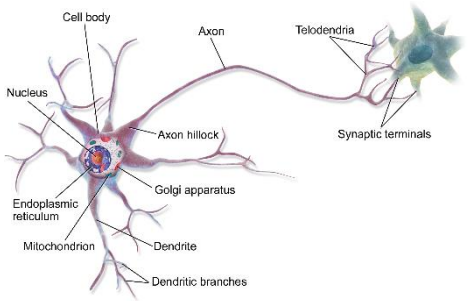
(ii) Nerve cells (Elongated shaped)

(iii) Sperm (Tadpole shaped)

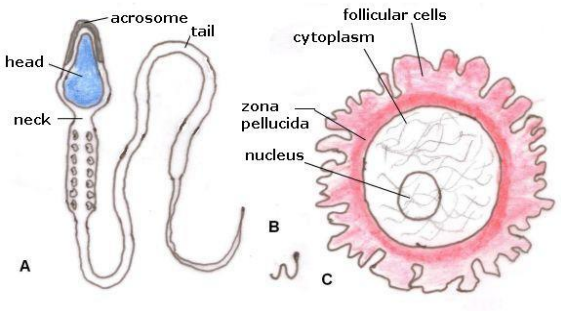
(iv) Ovum (Spherical shaped)

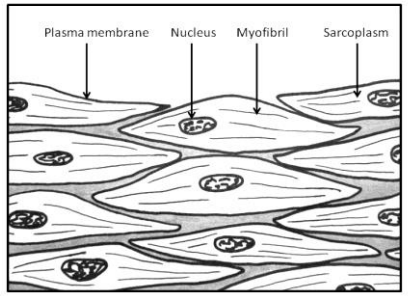
(v) Smooth muscles cells (Spindle shaped)





- **<u>Size of the cells</u>**
- The size of the cells is related to the specific functions they perform.
- It may vary from 1 micrometer to 100 micrometer (1 µm = 10^{-6} m)





- **Types of cells**

On the basis of number of cells

Unicellular organisms

The organisms made of single cell are called unicellular organisms

A single cell carries out all life process

Multicellular Organisms

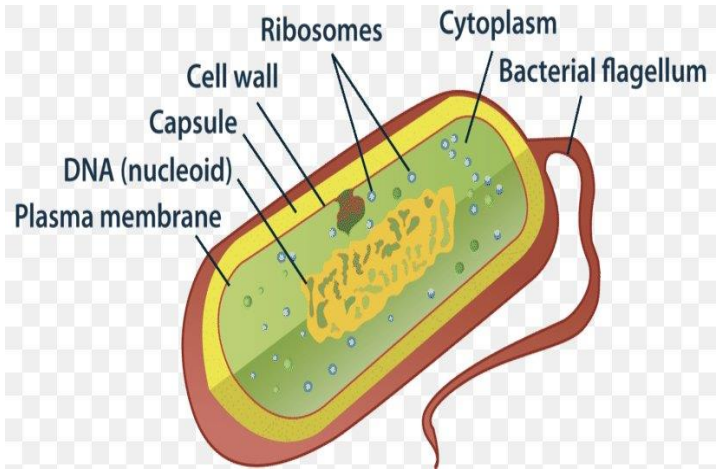
The organisms made of many cells are called multicellular organisms.

Multicellular organisms are more efficient and carry out number of activities.

- **Types of cells**

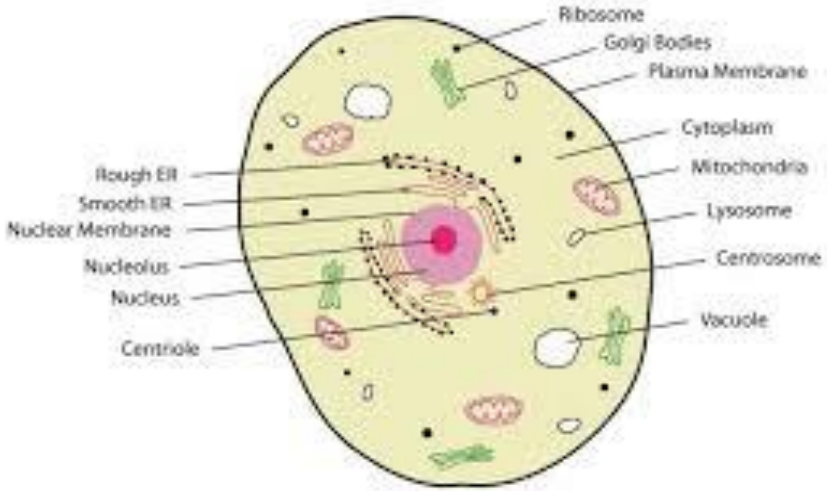
On the basis of nature of nucleus

Prokaryotic cells



- A cell does not possess membrane-bound organelles is called Prokaryotic cell.
- Even the chromosome is not enclosed in a membrane.
- The primitive nucleus lies freely in the cytoplasm.
- Examples: Bacteria and cyanobacteria (Blue green algae)

Eukarvotic cells



- A cell which possesses organelles, i.e., membrane bound structures like nucleus, mitochondria, chloroplasts is called Eukaryotic cell.
- The intracellular compartmentalisation is well reported. The eukaryotic cells further show diversities in plant cells and animal cells

- **Structure of the cell:**

If we study under the microscope, we would come across under three features in almost every cell.

(a) Plasma membrane

(b) Nucleus

(c) Cytoplasm

(a) Plasma membrane:

•Plasma membrane is thin, flexible, selectively permeable membrane, covering the cell.
•It is composed of lipid and protein.
•It separates the contents of the cell from its external environment.
•It is a selectively permeable membrane.

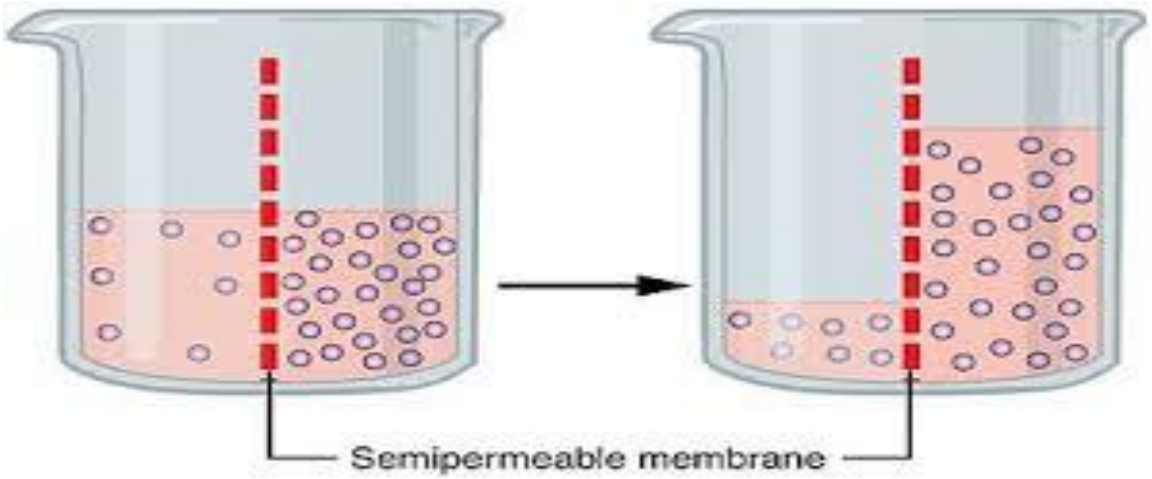
•**Diffusion:** A spontaneous movement of any substance from a region of high concentration to the region of lower concentration is called diffusion.

Atmosphere (O_2) ↑ body (O_2) ↓

Atmosphere(CO_2) ↓ body(CO_2) ↑

- In cellular respiration, oxygen diffuses into the cell from extracellular fluid because its pressure is higher in the extracellular fluid than in the cell.
- CO_2 diffuses out from the cell because its pressure is higher than in the extracellular fluid.

Osmosis: It is the passage of water from a region of higher water concentration to a region of lower water concentration through a semi-permeable membrane

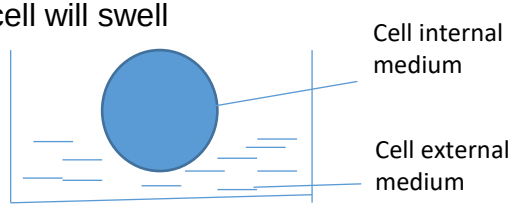


a

Hypotonic solution

If the concentration of water around the cell is more than that in the cell **(hypotonic condition)**, then water enters into the cell through osmosis.

The cell will swell

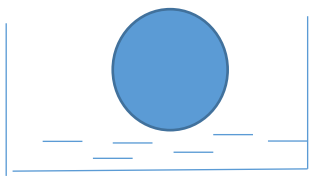


b

Hypertonic solution

If the concentration of water outside the cell is less than inside the cell **(hypertonic condition)** then water moves out of the cell.

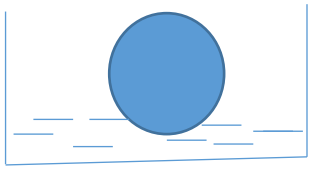
The cell shrinks.

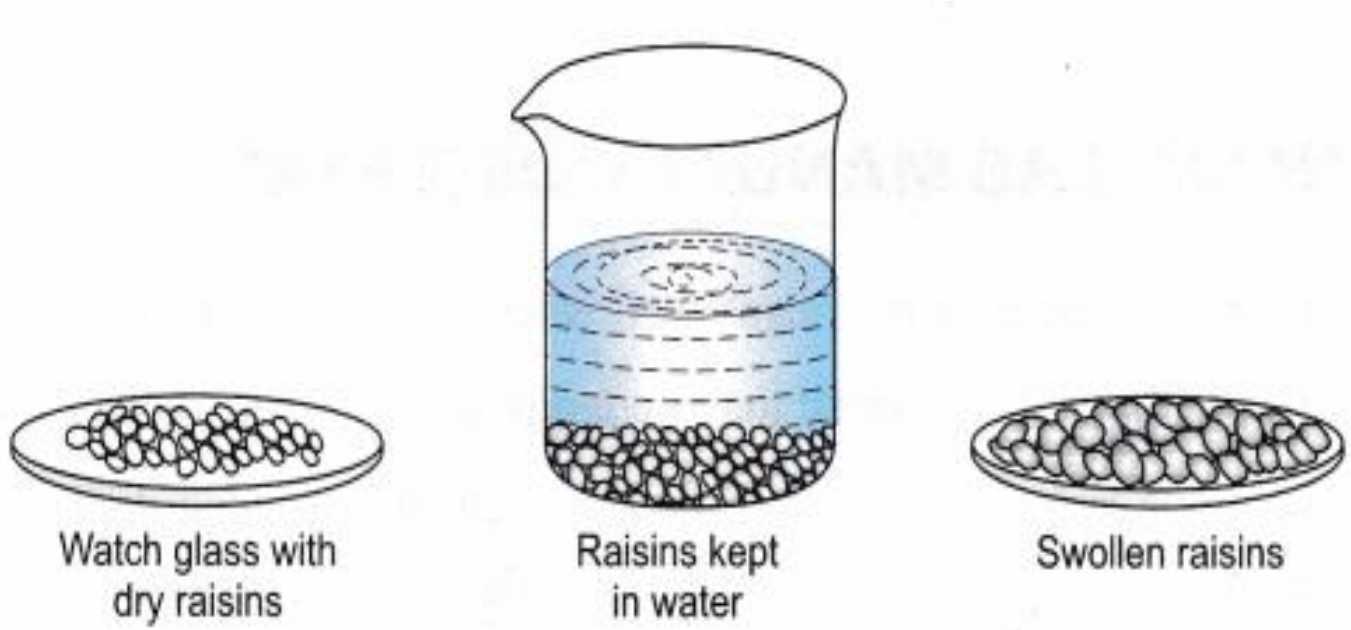


c

Isotonic solution

If the concentration of water is the same inside and outside the cell **(Isotonic condition)** then there will not be movement of water on the either side.





a) If kept in concentrated sugar solution ?
b) If kept in concentrated salt solution ?
c) If kept in diluted sugar solution ?
d) If kept in diluted salt solution ?

Cell wall

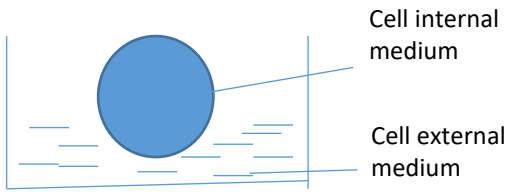
- It is non-living and freely permits the entry of substances.
- Apart from cell membrane, the cells of all plants and fungi have a rigid, protective covering outside the plasma membrane called cell wall.
- Cell wall is absent in animal cells.
- The plant cell wall is composed of cellulose.

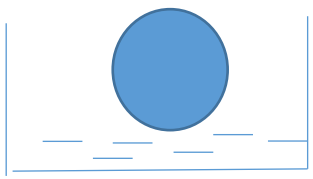
Function of cell wall:

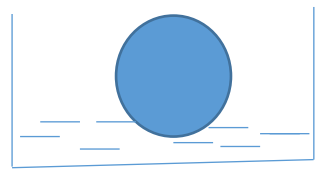
- It gives definite shape and rigidity to the cell.
- It protects the internal protoplasm against injury.
- It transports various substances in and out of the cells.

Remembering facts about cell wall:

- Cell wall permits cells of plants, fungi and bacteria to withstand hypotonic conditions by taking in water. By this the cell swells, building up pressure against the cell wall. The wall exerts an equal pressure against the swollen cell.

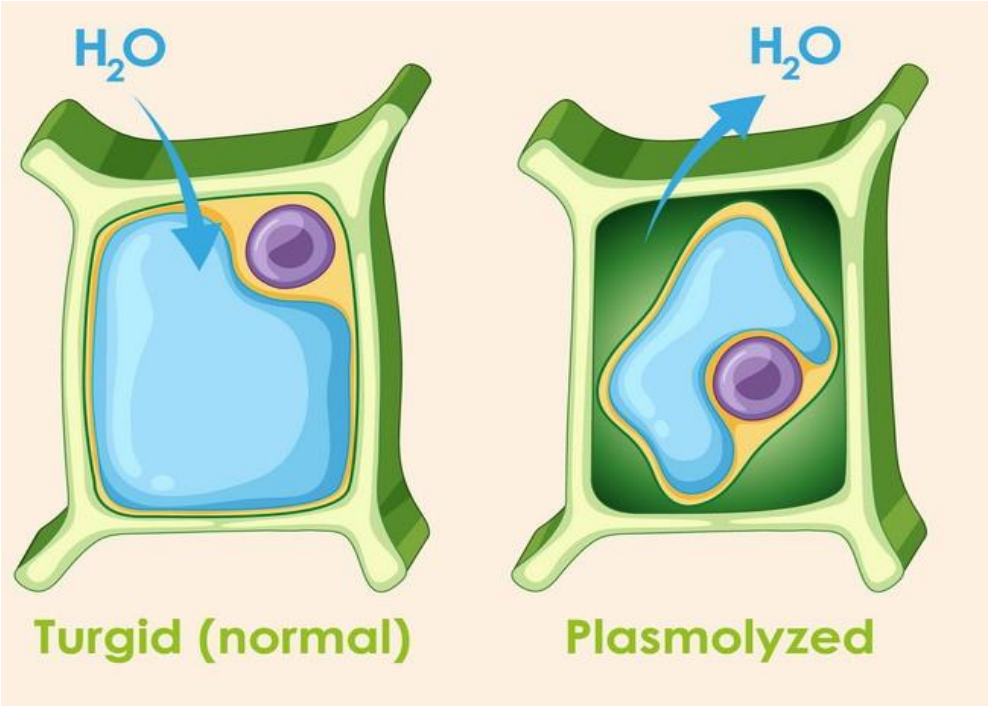




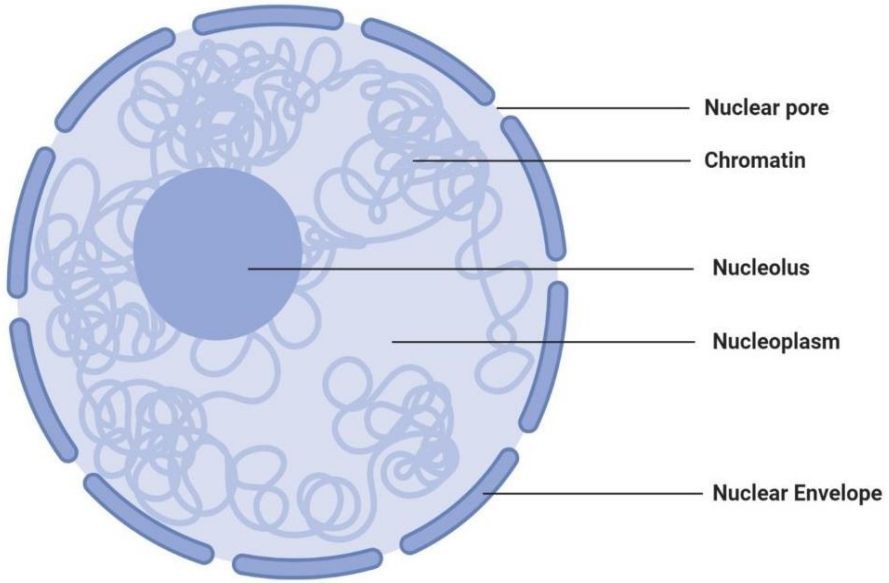


When a plant cell is placed in a hypertonic solution then a plant cell loses water through osmosis and there is a shrinkage or contraction of the contents of the cell away from the cell wall, this phenomenon is called **plasmolysis**

Endocytosis is a process by which cell takes in food from the outside by engulfing and fusing them with its plasma membrane.



nucleus



- Nucleus was first observed by Robert Brown in 1831.
- Nucleus has double layered covering called nuclear membrane.
- Nuclear membrane has pores which allow the transfer of materials from inside and outside the nucleus into the cytoplasm.
- Nucleus contains rod shaped structures called chromosomes (in dividing cells).
- Chromosomes contain information for inheritance of characters or traits from parents to next generation in the form of DNA (Deoxyribo nucleic acid).
- Genes: Genes are the functional segments of DNA.
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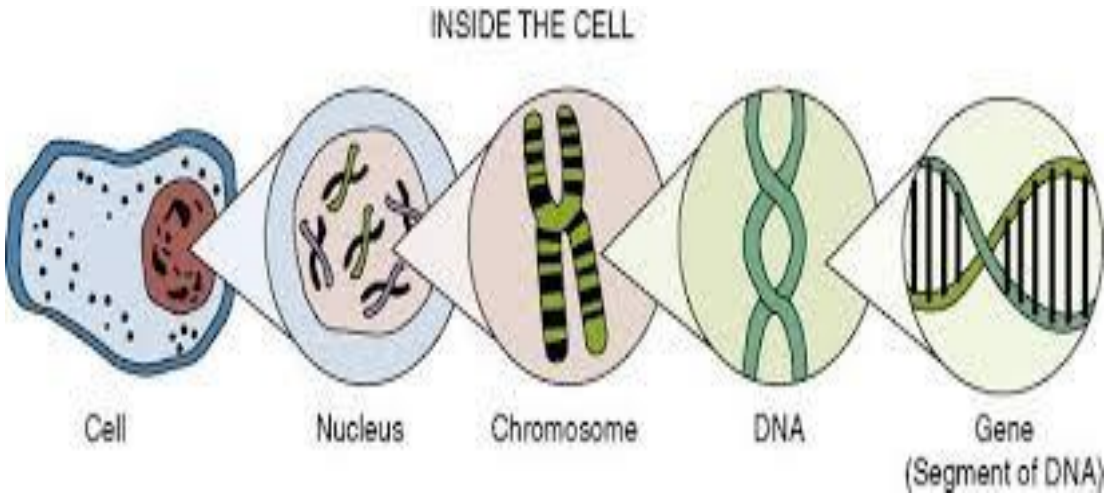
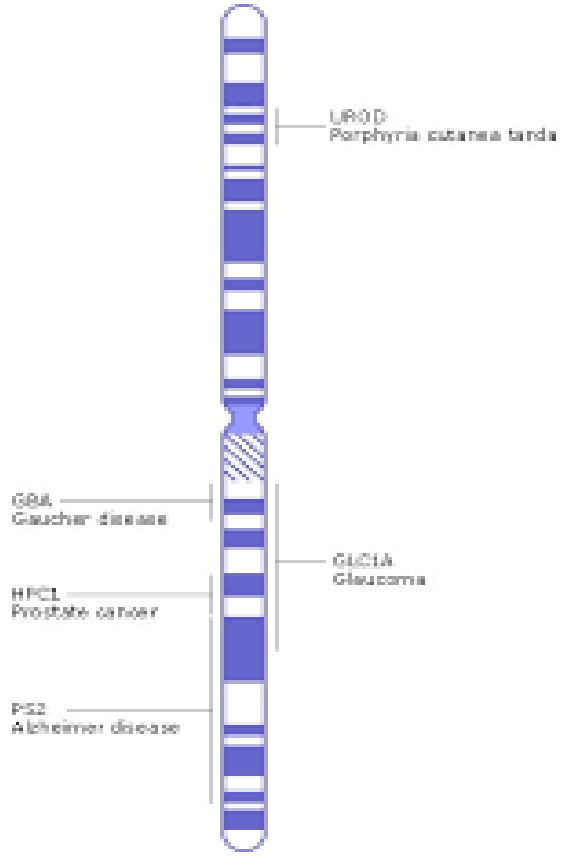
- In non-dividing cells DNA is present as chromatin material which is visible as an entangled mass of thread like structu
- Whenever the cell is about to divide, the chromatin material gets organized into chromosomes





Function of nucleus

- Nucleus plays important role in cellular reproduction, the process in which a single cell divides and forms two new cells.
- It also helps in determining the way the cell will develop and directing the chemical activities of the cell.

Remembering facts about nucleus:

- Nuclear membrane is absent in bacterial cells (Prokaryotic Cells)

An undefined nuclear region in prokaryotic cell containing only nucleic acids is called **nucleoid**

Cytoplasm:

- The term ‘cytoplasm’ is used for the fluid content inside the plasma membrane.
- The cytoplasm is jelly-like fluid covered by plasma membrane and contains the organelles.

Functions of cytoplasm:

- It is the active site of several metabolic processes like sugar, protein and fatty acid synthesis.
- It contains many specialized cell organelles.
- It helps in exchange of materials between cell organelles.

Cell Organelles:

- Every cell has a membrane around it to keep its own contents separate from the external environment.
- To perform various functions, the cell has organelles.
- In these organelles nucleus, mitochondria, chloroplast, Golgi body, Endoplasmic reticulum, plastids, vacuoles and ribosomes are included.
- These organelles do protein synthesis, photosynthesis and energy (ATP) synthesis.

Endoplasmic Reticulum

- The term ER was given by K. Porter.
- Endoplasmic Reticulum is a large network or reticulum of membrane bound tiny tubular structures in the cytoplasm.
- The ER network connects the nucleus with the cell membrane.
- ER are of two types:

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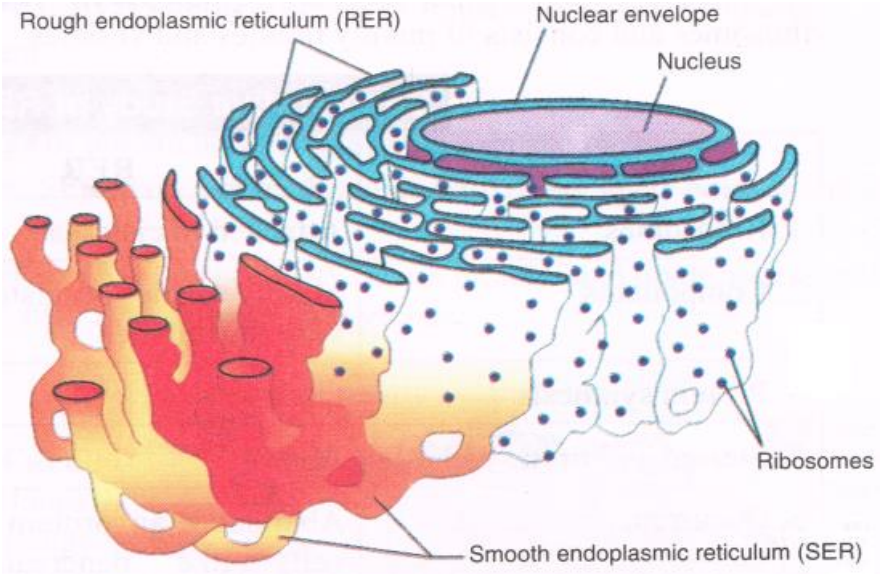


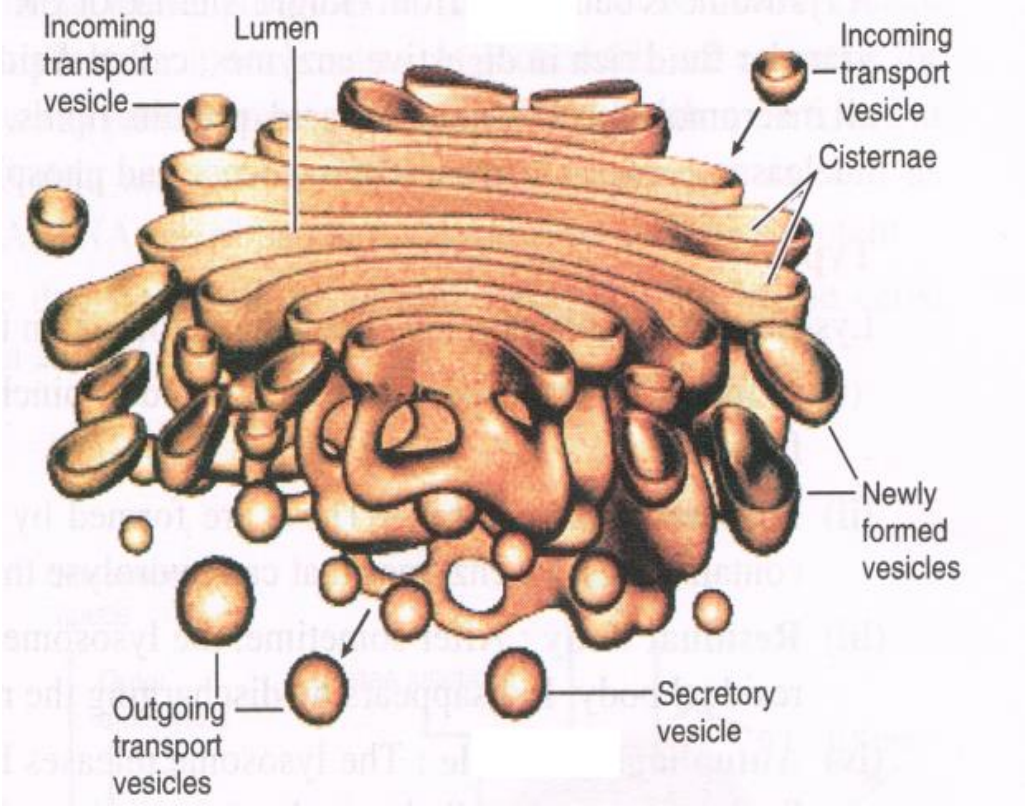
Rough Endoplasmic Reticulum (RER)	Smooth Endoplasmic Reticulum (SER)
When ribosomes are attached to the outer surface of ER, the endoplasmic reticulum is rough ER. Function: Ribosomes are the site of protein synthesis. So, it manufactures protein.	In the absence of ribosomes or when no ribosomes are attached to the surface of ER they appear smooth and are called smooth endoplasmic reticulum. Function: No ribosomes are present. So, SER manufacture lipid or fat molecules important for cell functioning

- The manufactured proteins are delivered to various places in the cell depending on need using the ER and lipid important for cell function.
- **Note:** The manufactured proteins and lipids help in building the cell membrane. This process is known as membrane biogenesis.

- **Function of ER:**
  - ♦ ER serves as channels for transport of proteins between different regions of the cytoplasm or between the cytoplasm and the vacuoles.
  - ♦ It also functions as cytoplasmic framework and provides a platform for some of the biochemical activities of the cell.

Golgi Body:

- Golgi apparatus was first observed by Camillo Golgi.
- These consist of membrane bound vesicles arranged parallel to each other in stacks called **cisterns.**
- These cisterns often have connections with the membranes of ER and therefore constitute another portion of a complex cellular membrane system.



Functions of Golgi Apparatus:

- Secretion is the main function of the Golgi complex.
- The material synthesized near the ER is packaged to various targets inside and outside the cell through Golgi apparatus.
- Its main functions include the storage, modification and packaging of products in vesicles.
- It also participates in the formation of lysosomes.

Lysosomes:

- Lysosomes were discovered by Christain de Duve.
- Lysosomes are membrane bound structures formed by the process of packaging in the golgi apparatus.
- Lysosomes contain powerful digestive enzymes which help to keep cell clean by digesting any foreign material such as bacteria or food, as well as old organelle, which break them up into small pieces.
- During the disturbance in cellular metabolism, when the cell gets damaged, lysosomes may burst and the enzymes digest their own cells. Therefore, lysosomes are called ‘suicidal bags’ of a cell.
- These enzymes are made by RER.

Functions of Lysosomes:

(i) Lysosomes act as waste disposal system of the cell.

(ii) These help to keep the cell clean by digesting any foreign material and worn out cell organelles.

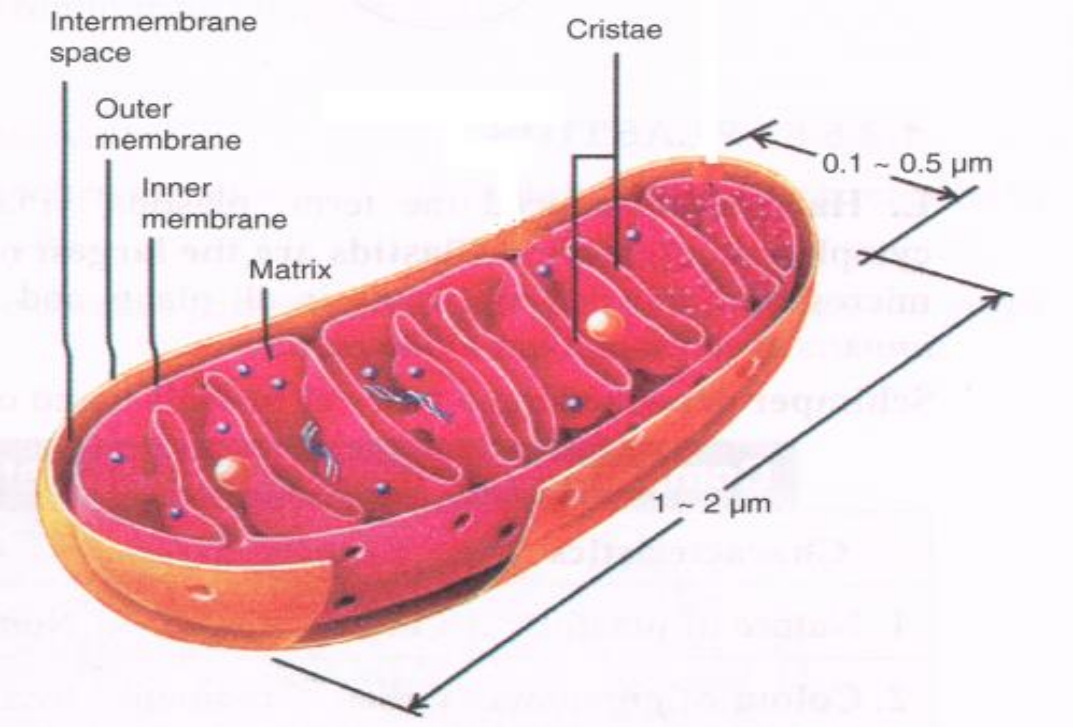
(iii) Lysosomes contain powerful digestive enzymes that can breakdown organic matter.

(iv) Lysosomes are defensive orgalelles.

Mitochondria

- Mitochondria were first discovered by Kolliker and then Benda coined the term mitochondria.
- Mitochondria are essential for aerobic respiration of eukaryotic cells.
  They are also known as powerhouse of the cell

Note: The energy required for various chemical activities needed for life is released by mitochondria in the form of ATP (Adenosine Triphosphate) molecules. ATP is known as energy currency of the cell. The body uses stored energy in the form of ATP for making new chemical compounds and for mechanical work.



Structure of Mitochondria

- Each mitochondrion is a double membrane structure.
- The outer membrane is very porous and forms continuous lining boundary of the organelles.
- The inner membrane is deeply folded.
- The inner membrane of mitochondria has many in foldings which create a large surface area for ATP generating chemical reactions.
- Mitochondria contains its own DNA and ribosomes. Therefore mitochondria are able to make some of their own proteins. So mitochondria are called semi-autonomous organelles.

Plastids

- E. Haeckel introduced the term “plastids”.
- Plastids are the plant cell organelle.

Plastids bear some specific pigments thus, imparting specific colours to the plants

Types of plastids based on its Pigments:

(i) Chloroplasts (green)

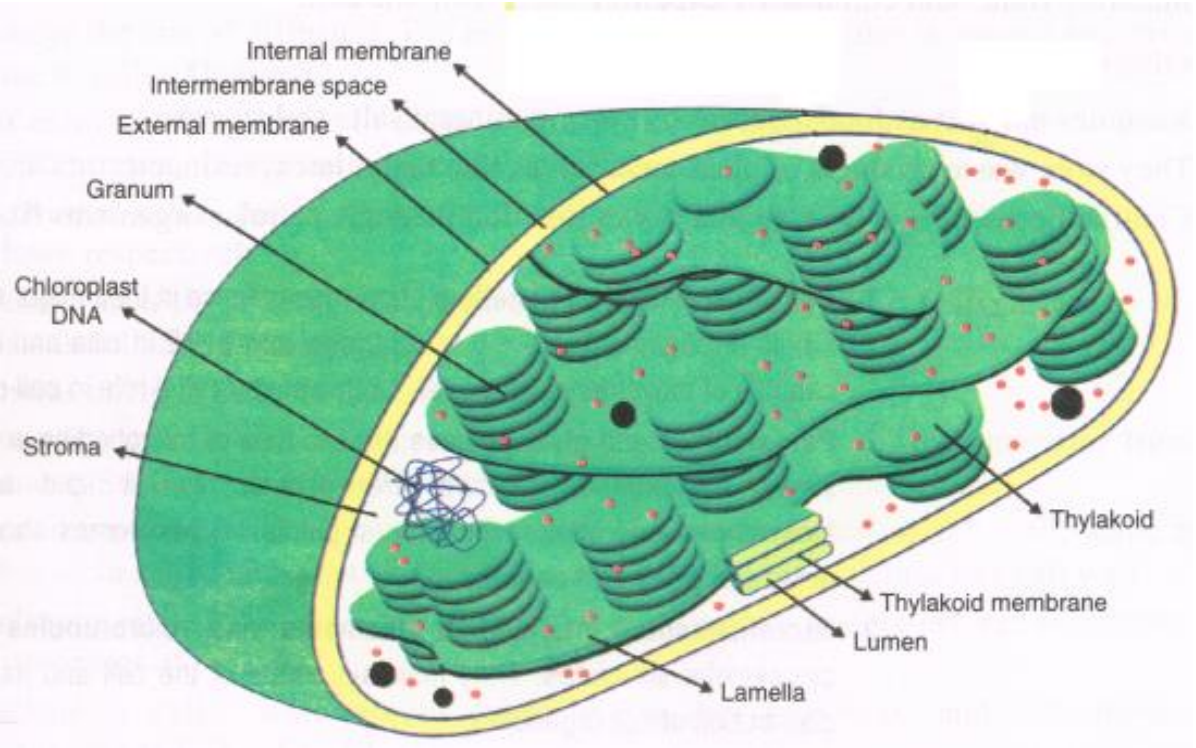
Chloroplasts contain chlorophyll pigments which impart green colour to the plants and are important for photosynthesis.

(ii) leucoplasts (colourless)

These are colourless pigments. They do not impart any colour but are important for storage of starch, oil, and proteins.

(iii) chromoplasts (coloured)

Impart other than green colour. Present in petals and fruits.



- Plastids consist of numerous membrane bound layers embedded in a material called the stroma.
- Plastids have their own DNA and ribosomes.

Vacuoles:

- The vacuole is single membrane-bound space found in the cytoplasm.
- Vacuoles are small sized.
- In plants cells, the vacuoles occupy upto 90% volume of a cell.
- In plant cells, vacuoles are full of cell sap and provide turgidity and rigidity to the cell.
- Its membrane is called tonoplast and it facilitates the transport of a number of ions and other materials (amino acids, sugars, various acids and proteins).
- It also contains water, sap, excretory product and other materials which are not useful for the cell.
- In single-celled organisms like Amoeba, the food vacuoles contain the food items.
- In some unicellular organisms, specialised vacuoles also play important roles in expelling water and some wastes from the cell.