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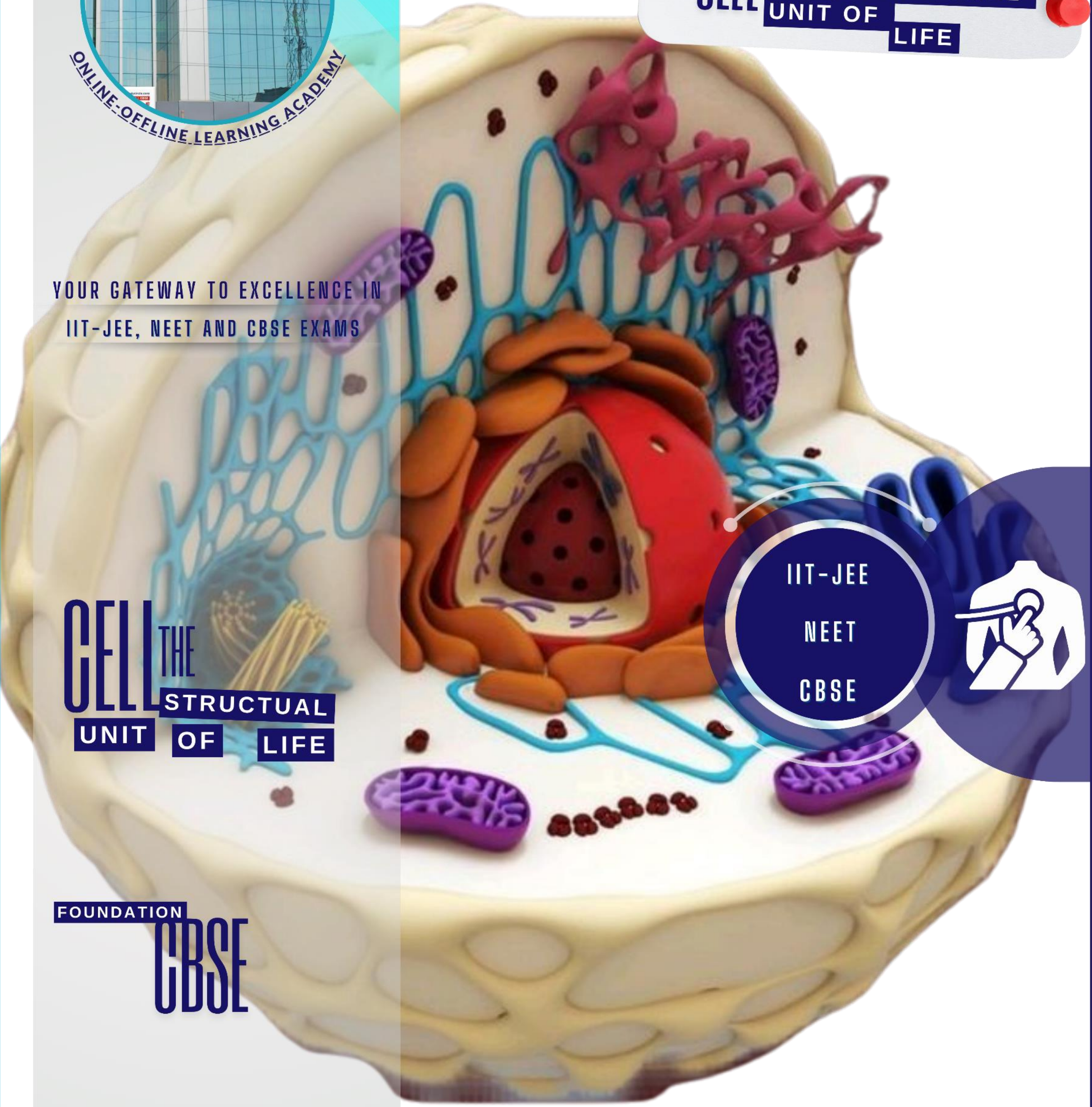

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## CELL THE STRUCTURAL UNIT OF LIFE

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# CELL THE STRUCTURAL UNIT OF LIFE

## The Fundamental Unit of Life

The body of all organisms from the simplest to the most complex one is made up of tiny microscopic units which carry out the processes that make the organisms a living entity. Such a structural and functional unit of living body is called a **cell.**

All living beings are composed of cells. **A cell is the structural and functional unit of every living organism,** capable of independent existence. Any function performed by the organism is the outcome of the activity of the cell.

Many types of organisms are **unicellular** with the whole body comprising a single, free living cell. These organisms are mostly microscopic bacteria. Amoeba, Euglena, Chlamydomonas, etc. Other organisms (animals from sponges to mammals, most algae, fungi, plants and trees) are **multicellular** (organisms comprising of more than one cell).

All these organisms differ in their structure, function and behaviour. Since all the activities of an organism are present in miniature form in each and every cell, therefore, it is called as the **basic unit of life.**

## DISCOVERY OF CELL

The invention of microscope helped in the discovery of the cell. The first microscope was constructed by Anton Von Leeuwenhoek (1632-1723). It consisted of a single biconvex lens and was known as the simple microscope. Cells were discovered by **Robert Hooke** in 1665. He studied the piece of cork under his microscope.

He observed that the cork piece had a large number of compartments joined together in a honey-comb like structure. He named these compartments as cells.

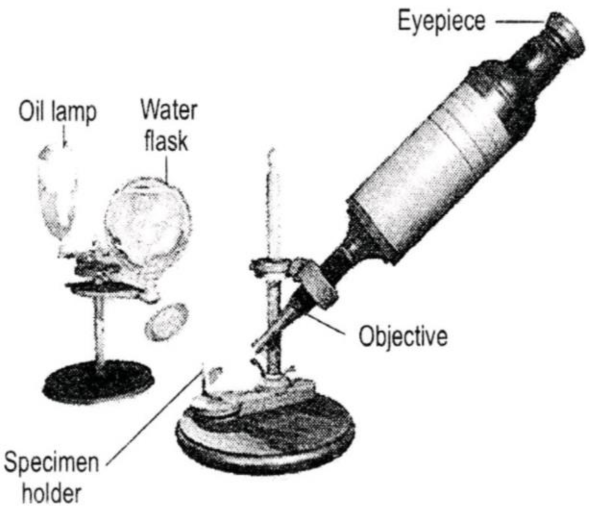



**Fig.:** Robert Hooke's microscope.

## Facts about cell discovery

- **Robert Hooke (1665),** an English botanist, observed thin sections of cork of bark of a tree under a self-designed compound microscope and noticed honey-comb like compartments. He coined them as cells. Term cell was derived from a Latin word *cella*= a little room. He explained his observation in a book namely, **Micrographia.** He actually observed the rigid cell walls of dead cells.
- **Anton Von Leeuwenhoek (1674),** a Dutch draper, was first to observe living cells like bacteria (from tartar of teeth), erythrocytes (of a fish), sperms (were called animalcules) and protozoans (e, g., Vorticella).
- **N. Grew (1682)** proposed cell concept which states that cell is a unit of structure of organ-isms.
- **Robert Brown (1831):** Discovered the nucleus in the root cells of orchid plant.
- **Purkinje (1839):** Gave the term protoplasm for the jelly –like semifluid material of the cell.
- **M.J. Schleidin (1838) and Theodore Schwann (1839):** Proposed the **cell theory** which states that the basic structural and functional unit of all the plant and animals is cell.
- **Rudolf Virchow (1855),** a German physiologist, proposed Theory of Lineage which states "omniscellula e cellula" which means that new cells are formed from the pre-existing cells.

- **Knoll and Ruska (1932)** of Germany' designed the electron microscope which was employed to study the ultrastructure (fine structure) of cell and various cell and various cell organelles in 1940s:
- In context of modern researches, the old **cell-theory** has been modified and it can be stated as follows:
  - All living organisms are composed of cells or cell products.
  - All new cells arise as a result of division of pre-existing cells.
  - All cells are basically alike in chemical composition and metabolic processes.
  - The function of an organism as a whole is the outcome of the combined activities and interactions of the constituent cells.
  - Cell is the structural and functional unit of- all living beings.

## COMPOUND MICROSCOPE

The ordinary **light or compound or optical microscope** is used extensively in laboratories these days. It is greatly-improved design of Hooke's microscope. It consists of two lenses, the **eyepiece lens** and the objective lens, which are combined to produce a greater magnification. These microscopes use light (generally sunlight) to illuminate the object. So, these compound microscopes are called light a **microscopes.** In these microscopes many lenses are combined together and their magnification power range from 300 to 1500 times, good enough to see cells, larger organelles and bacteria.

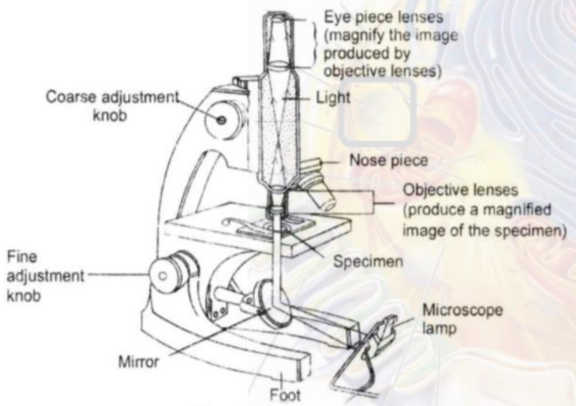



**Fig.:** A light microscope

As shown in figure, the object or specimen on a glass slide is kept on a stage under an objective piece (having lenses) almost in the middle of the microscope. Light is passed through the
Object, specimen with the help of a mirror (called reflector) and a condenser from below the stage. From the eyepiece on the top, a magnified image of the object, specimen can be seen easily a sharp image can be got by focussing the side knobs properly. The upper and large knob is meant for coarse adjustments and it is used for rapid and precise focussing of the object. The lower and small knob is used for fine adjustments (i.e., for getting perfect image of the object). The magnification of image can be increased or decreased by changing the objectives of high or low power (5 X, 10 X, 15 X, etc.) accordingly

## ELECTRON MICROSCOPE

The electron microscope (EM) has power of magnification and resolution much greater than that of an optical (light) microscope. An electron microscope can resolve points 1 nm apart. In this microscope, a beam of electrons is passed through the section of material to produce the image. The electron beam passing through the section is focused by electromagnets and is projected on to a fluorescent screen for direct view or on to a photographic plate for permanent recording. The resulting photograph is called an **electron micrograph.**

## UNICELLULAR AND MULTICELLULAR ORGANISMS

On the basis of number of cells, there are basically three types of organisms— non-cellular, unicellular and multicellular. Non-cellular organisms are those organisms that do not contain any cell in their body organization, e.g., virus. They do not have membrane and are non-living until they reach inside the body of a living organism. Unicellular organisms are those organ- isms that are made up of only one cell. In unicellular organisms, a single cell constitutes a whole organism. For example Amoeba, Chlamydomonas, Euglena, Paramecium, Trypanosoma and bacteria are unicellular organisms. **Multicellular organisms** are those organisms in which the body is made up of many cells which group together to perform many functions of the body. For example, fungi, plants and animals are multicellular organisms. All multicellular organ- isms have come from a single cell through cell division.

## PROKARYOTIC CELLS

The organisms whose cells lack a nuclear membrane are called prokaryotic cells. These cells have primitive organization of genetic material. The genetic material is equivalent to a single molecule of DNA. These cells do not have a well-organized nuclear region due to absence of nuclear membrane. These cells lack M several cytoplasmic organelles like mitochondria, lysosome, endoplasmic reticulum, chloroplast, nucleolus, etc. Many of the functions of these cells are performed by poorly organized parts of cytoplasm. The chlorophyll is found attached to membranous vesicles and not plastids as in eukaryotes. Bacteria and blue-green algae are example of prokaryotic cells.

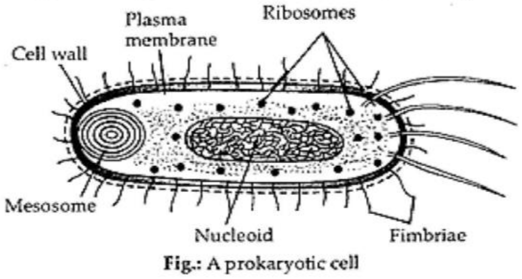


**Fig.:** A prokaryotic cell

## EUKARYOTIC CELLS

Organisms whose cells have a nuclear membrane are called eukaryotes. In these cells, the genetic material is made of two or more DNA molecules. The nuclear material is enclosed in a nuclear membrane. These cells have a well-organised nucleus. These cells have well-developed membrane-bound organelles, such as mitochondria, endoplasmic reticulum, lysosome, chloroplast,
Nucleolus, etc. Eukaryotic cells occur in plants, animals, fungi etc.

**Table: Differences between prokaryotic cell and eukaryotic cell**

| | Prokaryotic cell | Eukaryotic cell |
|---|---|---|
| **1.** | Size of the cells is generally small (1-10 $\mu m$) | Size of cell is generally large (5-100 $\mu m$). |
| **2.** | Nucleus is absent, (nuclear region or nucleoid is not surrounded by a nuclear membrane). | Nucleus is present (nuclear material is surrounded by a nuclear membrane). |
| **3.** | It contains single chromosome. | It contains more than one chromosome. |
| **4.** | Nucleolus is absent | Nucleolus is present. |
| **5.** | Membrane bound cell organelles are 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 mitotic or meiotic cell division. |

## CELL - SHAPE AND SIZE

Different organisms have cells of different kinds. The shape and size of cells are related to specific functions performed by organisms.

### Cell shape

Cells show a great variation in their shapes. Most cells have a definite shape. In human body, cells may be spindle-shaped—muscle cells, elongated—nerve cells, oval—red blood corpuscles, cuboidal—germ cells, branched—osteocytes and chromatophores and so on. Some cells may Fig.: Amoeba (changes shape) not have any definite shape, i.e., their shape changes e.g., Amoeba and leucocytes (white blood corpuscles).


*Amoeba* (changes shape)

### Cell size

The size of the cell also varies considerably

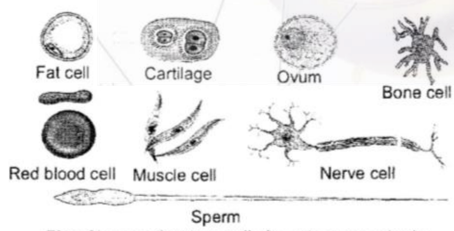


**Fig.:** Shapes of various cells from the human body

in different animals and plants. The average cell size varies from 0.5 to 20 p, in diameter. In human body, the **smallest cell is RBC** (7 $\mu m$ in diameter), and the **longest one are the nerve cells** which reach a length of about 90-100 cm. In plants, large cells occur in many algae. **Among the plants, the largest cell is the ovule of cycas.** The **smallest known cell is Mycoplasma or PPLO** (Pleu-ropneumonia-like organism). Its size is 0.1 to 0.5 $\mu m$ (micrometre). Amongst multicellular animals, the **largest cell is the egg of ostrich.** It measures about 15 cm and 8 cm in diameter with and without its shell respectively.

## CELL NUMBER AND VOLUME

**Cell number**

The number of cells in living beings differ from the one in unicellular organisms (e.g., bacteria, protozoa) to many in multicellular forms. The number of cells is not definite in multicellular organisms, and may increase along with the growth and volume of organism. However, green alga Pandorina contains 8-

32 cells. A human being weighing approximately 80 kg is estimated to have 60 thousand billion cells, whereas a newly born human infant has 2 x $10^{12}$ cells. The number of cells in most multicellular organisms is indefinite, but the number of cells may be fixed in some multicellular organisms such as rotifers and nematodes. In the nematodes (e.g., Ascaris), the number of cells in various organs is fixed and it is attained by the time hatching takes place. Most growth in size of a nematode results from an increase in cell size. The phenomenon of having a constant and genetically fixed number of cells is called **eutely.** In eutelic animals mitosis stops following embryonic development.

## Cell volume

The volume of a cell is fairly constant for a particular cell type and is independent of the size of the organism. For example, kidney or liver cells are about the same size in the bull, horse and mouse. The difference in the total mass of the organ or organism depends on the number, not on the volume of the cells. Thus, the cells of an elephant are not necessarily larger than those of other tiny animals or plants. The large size of the elephant is due to the larger number of cells present in its body.

## Dimensions of cell size

(i) Millimetre (mm) 1mm = 1000 $\mu$

(ii) Micrometry ($\mu m$) or micron ($\mu$)*

(iii) Nanometre (nm) or millimicron ($m\mu$) $1\mu = 1000\ m\mu$

(iv) Angstrom (A°) 1A° =$10^{-1}\ m\mu$ =$10^{-7}$mm *Micron ($\mu$) is a unit of length in the CGS system, equal to one millionth of a metre. In SI units it is replaced by the micrometer ($\mu m$)



## ILLUSTRATION

**1. Name the smallest sized organism.**

**Ans.** The smallest cells are of pleuropneumonia like organism (PPLO), Mycoplasma gallisepticum. Its size is found around 0.1 $\mu m$

**2. Who discovered cells and how? (NCERT)**

**Ans.** Robert Hooke in 1665 discovered the cells. He examined thin slices of cork under a self-designed primitive microscope and saw that the cork resembled the structure of a honey, comb. The latter consisted of may tiny compartments. He called them cellulae (singular cellula), now termed cells Cellula is a Latin name which means 'a little room'.

**3. Why is the cell called the structural and functional unit of life?**

**Ans.** All living organisms are made up of cells. Thus, cell is the structural unit of life. Each cell acquire distinct structure and function due to the organization of its membrane and cytoplasmic organelles in the specific way. Such an organization enables the cell to perform basic functions such as respiration, obtaining nutrition, clearing of wastes material, forming new proteins etc. The cell is, therefore, the basic functional unit of living organisms.

## STRUCTURAL ORGANISATION OF A CELL

Although the structure of the cell and its components may vary to a certain extent in plants and animals, the basic structure and functions of specific organelles remain the same.

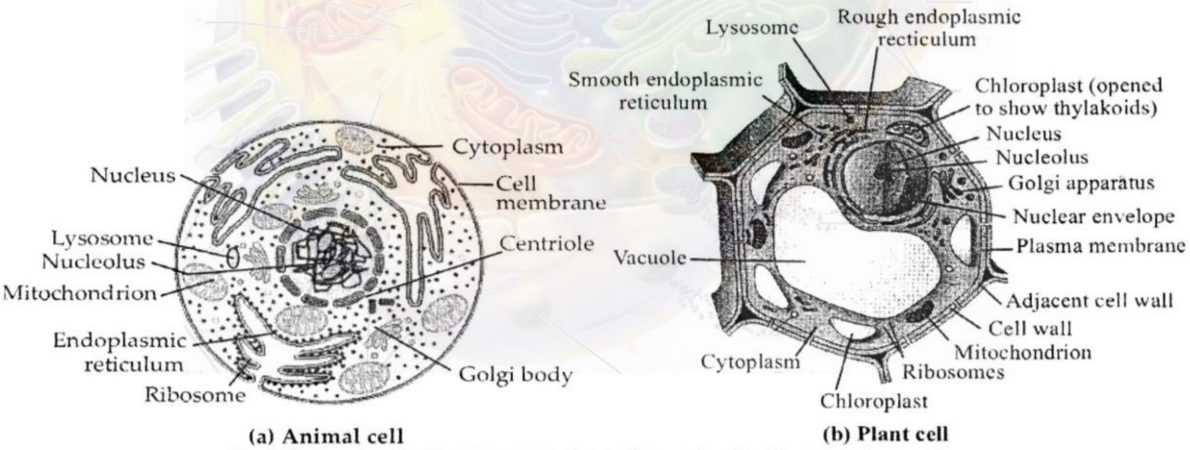



**Fig. :** Generalised ultrastructure view of an animal cell and a plant cell

## PLASMA MEMBRANE (CELL MEMBRANE)

Every cell is bound by a thin delicate membrane called cell membrane or plasma membrane or plasma lemma. It is a transparent, electron microscopic, elastic, regenerative and semi permeable membrane present in both prokaryotic and eukaryotic cells outside the protoplasm. In 1972, Singer and Nicolson suggested a model, called fluid mosaic model. According to them, plasma membrane is made up of a bilayer of phospholipids. Two types of protein molecules 'floated about' in the fluid phospholipid layer: Intrinsic proteins, which completely span the lipid bilayer and extrinsic proteins, which occur either on the outer surface or on the inner surface of the lipid membrane. Plasma membrane is a selectively permeable membrane which regulates the exchange of materials between the cytoplasm and extra-cellular fluid (ECF). It allows the movement of selected quantities of selected materials across it.

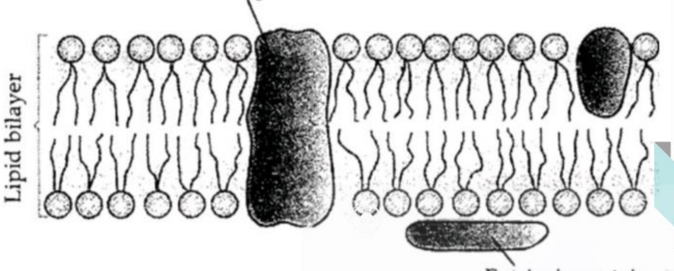


Fig.: Structural details of plasma membrane according to Fluid Mosaic Model

## ACTIVITY CORNER

Preparation of a temporary stained slide of squamous epithelium cells of cheek of man.

**Materials required:** A tooth pick or ice-cream coverslip, watch glass, needle, blotting paper, 1% methylene blue, normal saline, glycerine and microscope.

**Procedure:** Rinse your mouth with warm water. With the help of a toothpick ice-cream spoon, gently scrape the inner surface of the cheek. Place the scrapping in a watch glass containing a very small quantity of normal saline. After cleaning put the scraping on a clean glass having a drop of water. Spread out the scraping and separate the cells with the help of a needle. Remove the excess .water and put a drop of methylene blue stain or iodine solution on the scraping. Wipe off the extra stain with a blotting paper, put a drop of glycerine on the stained material. Place a clean coverslip gently over it to avoid the entry of air bubbles. Gently press the coverslip with the needle so as to spread the cells uniformly under the coverslip. Examine the Slide under the microscope.

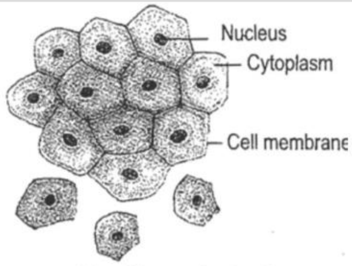


Fig.: Human cheek cells

**Observations**: A large number of cells are observed. Each cell is bounded by a thin cell membrane as shown in the figure. A dark stained distinct nucleus is observed in each cell. Cytoplasm is granular; Cells lack cell wall, large vacuoles and plastids.

**Inference:** The cells observed under microscope are animal cells as each cell has a cell membrane only as outer boundary. Cell wall, central prominent vacuole arid plastids are absent.

## Movement of substances across the plasma membrane

Movement of substances across the cell membrane occurs through a number of mechanisms like: Diffusion, osmosis, active transport and endocytosis etc.

## Diffusion

It is the process of movement of molecules of a substance from a region of their higher concentration to a region of their lower concentration. Waste material like carbon dioxide moves out of the cell through diffusion. Similarly, oxygen enters the cell through diffusion. Significance of diffusion

- Helps in uniform distribution of materials in the cytoplasm.
- Helps in exchange of gases during respiration.
- Odoriferous chemicals of flowers attract the pollinating agents.

# ACTIVITY CORNER

To understand the principle of diffusion.

**Materials required:** Beaker, copper sulphate, crystal, water.

**Procedure:**

- Half-fill a beaker with water.
- Put a crystal of copper sulphate into it.

**Observation:** After some time, the water around the crystal becomes blue and finally the whole water becomes uniformly blue.

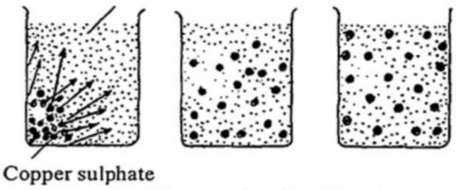



**Fig.:** Diagram showing diffusion.

**Inference:** The molecules of copper sulphate slowly diffuse on all the sides until these are uniformly distributed in the beaker of water. This proves that molecules of copper sulphate move along their concentration gradient. On the other hand, the gases always diffuse along their pressure gradient i.e., from the region of higher partial pressure to the region of lower partial pressure e.g., exchange of oxygen and carbon dioxide in tissue respiration. In this, oxygen always diffuses from the blood (where $PO_2$=95 mm Hg) into the cells (where $PO_2$=20 mm Hg), While carbon dioxide always diffuses from the cells (where $PCO_2$=52 mm Hg) into the blood (where $PCO_2$=40 mm Hg).

## Osmosis

Osmosis is the passive movement of water or any other solvent molecules from a region of higher water concentration to a region of lower water concentration- through a semi permeable membrane. Plasma membrane or cell membrane is selectively permeable membrane. How- ever, in case of the movement of solvent or water, it acts as a semi-permeable membrane because it allows the free diffusion of water molecules, A dilute solution has more concentration of water molecules in contrast to a concentrated solution which has low concentration of water. Hypotonic, isotonic and hypertonic are relative terms, i.e., a solution is known as hypotonic, isotonic or hypertonic only when it is compared with some other solutions. Let us take an example of each one of these terms.

(i) If a cell is placed in such a solution which has lower concentration of solute and higher concentration of water as compared to the concentration of cell sap (i.e., the solution inside the cell), the water molecules move from external solution into the cell sap. Such an external solution is known as **hypotonic solution**.

(ii) If a cell is placed in such a solution which has exactly the same concentration as that of cell sap, there will be no net movement of water across the cell membrane. Such an external solution is known as isotonic solution.

(iii) If a cell is placed in such a solution which has higher concentration of solute and lower concentration of water as compared to the concentration of cell sap the water molecules move from cell sap to the external solution so that the cell shrinks. Such a solution is known as **hypertonic solution.**

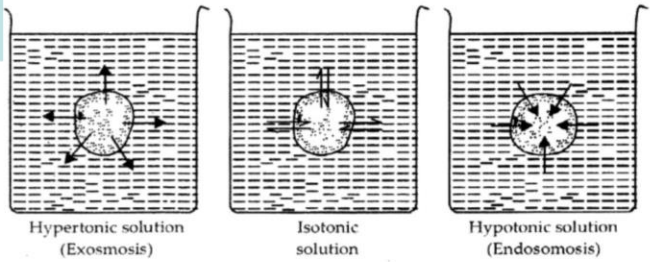



**Fig.** Diagrammatic explanation of hypertonic, isotonic and hypotonic solutions

**Explanation:** The cell membrane is semipermeable that allows water molecules to pass through it in both directions. When a cell is placed in hypotpnic solution, the water molecules move from external solution into the cell by osmosis so that the cell swells up. This shows the phenomenon of endosmosis (i.e., water enters into the cell). On the other hand, when a cell is placed in a hypertonic solution/ the water leaves the cell and moves outside so that the. Cell shrinks. This shows the phenomenon of **exosmosis.** However in case of isotonic solution the amount of water that enters into the cell is same as the amount of water moves outside so that there is no net movement of water.

## Significance of osmosis

- It helps in **absorption of water** from the soil by root hair.
- It helps in **opening and closing of stomata** on the leaves.
- It induces the **movement of leaflets** of touch-me-not.
- It also helps **in growth of embryo during seed germination.**

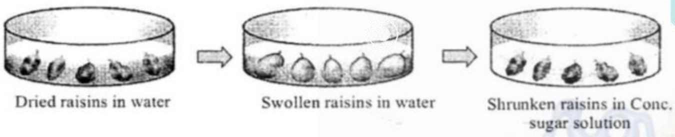
## ACTIVITY CORNER

To study the osmosis in raisins.

**Materials required:** Dried raisins, petridish, concentrated sugar or salt solution.

**Produce:** half-fill a petridish with water and place 4-5 dried raisins in it. Observe after few minute. Now place these raisins in concentrated sugar or salt solution

**Observations and Conclusion:** Dried raisins, when put in pure water for sometimes, swell up. When these swollen raisins are put in concentrated sugar solution (or salt-solution), they again shrink after sometime. Pure water has lesser concentration of solutes and greater concentration of water than inside the dried raisins. Therefore, due to endosmosis, more water molecules move inside the dried raisins. Consequently, dried raisins swell up. Concentrated sugar or salt solution is a hypertonic solution which has higher concentration of solutes and lesser concentration of water than inside the swollen raisins. Therefore, when swollen raisin are put in concentrated sugar or salt solution, they quickly lose water to the surrounding medium. Consequently, due to exosmosis, swollen raisins again shrink.



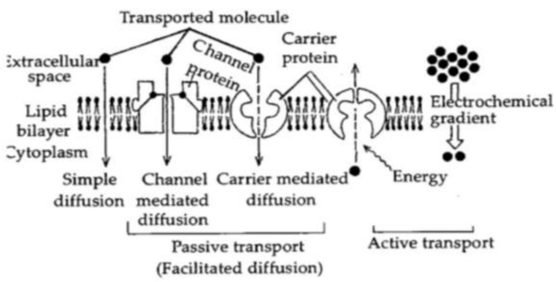

### Mediated Transport

As the cell/plasma membrane is an effective barrier to the free diffusion of most molecules of biological significance, yet it is essential that some materials enter and leave the cell. Nutrients such a sugars and materials of growth such as amino acids must enter the cell, and the wastes of metabolism must leave. Such molecules are moved across the membrane by special proteins called transport proteins or permeases. Permeases form a small passageway through the membrane, enabling the solute molecule to cross the phospholipid bilayer. Permeases are usually quite specific, recognizing and transporting only a limited group of chemical substances or perhaps even a single substance.

### Types of mediated transport

**Facilitated transport**

In this case, the permease assists a molecule to diffuse through the membrane that it cannot otherwise penetrate. It differs from active transport in that it promotes movement in a downhill direction (i.e., in the direction of concentration gradient) only and requires no metabolic energy to drive the transport system. In many ani- mals facilitated transport (or facilitated dif- fusion) aids in the transport of glucose fusion) aids in the transport of glucose (blood sugar) into the body cells that oxidise it to get ATPs. The concentration of glucose is greater in the blood than in the cells that consume it, favouring inward diffusion, but glucose is a water soluble molecule that does not by itself penetrate the membrane rapidly enough to support the metabolism of many cells. The carrier system (i.e., mediated transport) increases the inward flow of glucose.




### Active transport

In this case, the energy is supplied to the system (called pump) to transport molecules in the direction opposite to concentration gradient. In active transport, molecules are moved uphill against the forces of passive diffusion. Active transport always involves the expenditure of energy (from ATP)

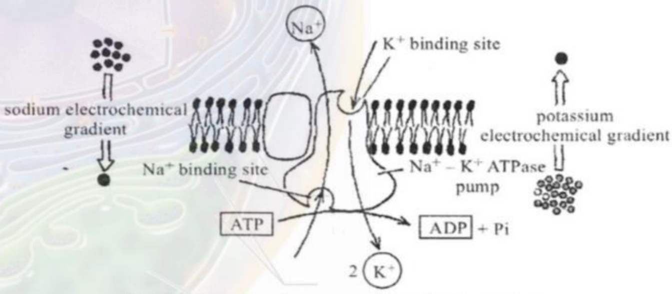



**Fig.:** Sodium-potassium pump of the plasma membrane

Because materials are pumped against the concentration gradient. Among the most important active transport system in all animals are those that maintain sodium and potassium gradients between cells and the surrounding extracellular fluid or external environment. Most animal cells require a high internal concentration of potassium ions for the protein synthesis at the ribosomes and for certain enzymatic functions. The potassium ion concentration may be 20 to 50 times greater inside the cell than outside. Sodium ions, on the other hand, may be 10 times more concentrated outside the cell than inside. Both of these ionic gradients are maintained by the active transport of potassium ions into and sodium ions out of the cell. There is evidence that 10 per cent to 40 per cent of all energy produced by some cells is used to power the **sodium- potassium pump. Significance:** It helps in muscle contraction, nerve impulse conduction, intestinal absorption of glucose, maintaining ionic balance, etc.

## Endocytosis

Endocytosis is the ingestion of material by the cells through the plasma membrane. It is a collective term that describes two similar processes: **phagocytosis** (cell eating), **potocytosis** or pinocytosis (cell drinking). Both require energy, so may be regarded as different forms of active transport

**(i) Phagocytosis:** It literally means **"cell eating".** It is a common method of feeding among the protozoa (Amoeba) and lower metazoa (e.g., sponges). White blood cell (leucocytes) engulf cellular debris and uninvited microbes (viruses, bacteria) in the blood by phagocytosis. By phagocytosis, an area of the plasma membrane, forms a pocket that engulfs the solid material. The membrane-enclosed vesicle, phagosome, then detaches from the cell surface (plasma membrane) into the cytoplasm where its contents are digested by lysosomal enzymes.

**(ii) Pinocytosis or Potocytosis:** It is the bulk transport of fluid matter and substances dissolved in it (e.g., ions, sugars, amino acids) across the cell membrane by forming minute detachable vesicles. Pinocytosis is also called cell drinking. As soon as the fluid particles attaches the plasma membrane, the latter invaginates at that site. The invagination deepens and gets pinched off as a vesicle called pinosome. The pinosome migrates towards the interior where it liberates the materials into the cytoplasm or vacuole. Lysosomes are required if digestion of solutes is involved.

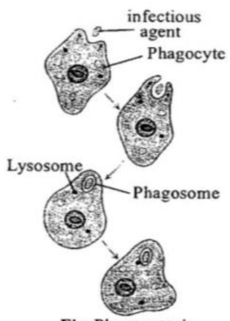


Fig. Phagocytosis.

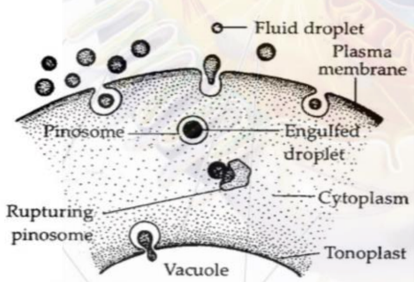


Fig.: Bulk transport of fluid substances by pinocytosis

## Exocytosis

Just as materials can be brought into the cell by invagination and formation of a vesicle, the membrane of a vesicle can fuse with the plasma membrane and extrude its contents to the surrounding medium. This is the process of exocytosis. Exocytosis occurs in various cells to remove undigested residues of substances brought in by endocytosis, to secrete substances such as hormones, enzymes, and to transport a substance completely across a cellular barrier. In the process of exocytosis, the undigested waste-containing food vacuole or the secretory vesicle budded from Golgi apparatus, is first moved by cytoskeleton from the interior of the cell to the surface. The vesicle membrane comes in contact with the plasma membrane. The lipid molecules of the two bilayers rearrange themselves and the two membranes are, thus, fused. A passage is formed in the fused membrane and the vesicle discharges its contents outside the cell.

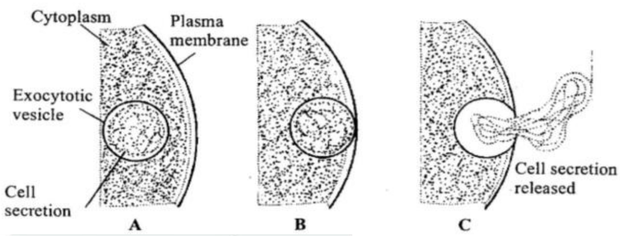


Fig.: Exocytosis by a cell.

## CELL WALL

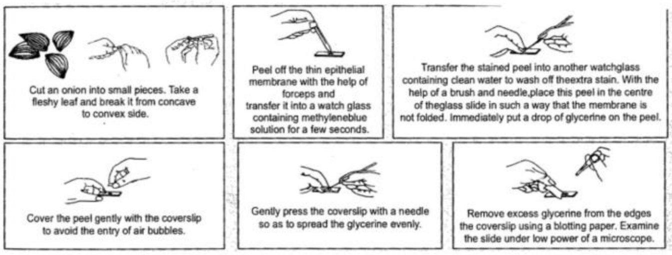
Cell wall was first seen in cork cells by Robert Hooke in 1665. Cell wall is present in plant cells, bacteria and fungi. It is an additional protective wall present outside plasma membrane. Cell wall is a thick, non-living, rigid and permeable covering made up of cellulose. Cellulose is a kind of carbohydrate (polysaccharide). It provides structural strength to the plant. Cell wall is formed of **peptidoglycan** in bacteria and blue-green algae cells but is formed of chitin in most of fungi. Young growing cells, meristematic cells, photosynthesizing cells, some storage cells, all parenchymatous cells and some other plant cells possess only a primary cell wall made up of cellulose. The primary cell walls of adjacent cells are cemented through middle lamella. However, many mature plant cells especially dead cells of xylem, cork and sclerenchyma possess an additional secondary wall inner to the primary wall. Functionally, the primary cell wall provides mechanical strength and protection to the protoplast. This wall is porous and considered as permeable membrane which allows both solvent as well as solute molecules to pass through it. The secondary wall deposited on the inner face of the primary wall, is composed of lignin and suberin substances. Due to presence of lignin and suberin the secondary wall becomes impermeable to the substances so that the cell becomes dead.

## ACTIVITY CORNER

**Preparation of a temporary stained mount of an anion peel and its observation on under a microscope.**

**Materials required:** One small piece of an onion, brush, needle, watch glass, glass slide, glycerine, and water, cover slip, staining reagent (iodine solution or methylene blue), blotting paper and a microscope.

**Produce:**




**Observation:** There are a large number of brick shaped (rectangular) cells lying side by side as shown in the figure. Each cell has a distinct cell wall. A distinct darkly stained nucleus is present in each cell which is spherical or oval shaped dot like structure. A prominent vacuole is seen in the centre, and cytoplasm is present in every cell.

**Inference:** The cells observed under microscope are plant cells as each has a distinct cell wall and a large vacuole is present in the centre of each cell.

**Precautions:**

(i) Immediately put the peel of onion bulb in a water containing watch glass to avoid its folding and drying

(ii) Spread the peel uniformly on the slide.

(iii) Excess of stain should be drained off.

(iv) There should be no air bubble under the coverslip.

Similar observations are found in the peel taken from the undersurface of a leaf of tradescantia or Rheo or temporary mounts of peels of onions of different sizes.

## Plasmolysis

A plant cell placed in a hypotonic solution receives water by osmosis. It does not burst because it is surrounded by a rigid cell wall which can withstand the hydrostatic or turgor pressure of the turgid (distended) cell contents. The cell wall counters the turgor pressure by exerting wall pressure. If a living plant cell is immersed in a concentrated sugar solution, the concentration of water molecules inside the cell will be higher than outside. As a result, water will move by osmosis from the higher water potential inside the cell to the lower water potential outside. The cytoplasm along with the plasma membrane shrinks and separates from the cell wall. This process of shrinkage of protoplast from the cell wall due to exosmosis caused by a hypertonic solution is called plasmolysis. , Thus, because of the presence of cell wall, the plant cells can withstand much greater changes in the external medium as compared to animal cells.

## ACTIVITY CORNER

To show with the help of Rheo leaf that only living cells undergo plasmolysis.

**Materials required:** Rheo leaf, glass slides, concentrated sugar or salt solution, water petri dish and microscope.

**Procedure:** Take a Rheo leaf and break it to take out a peel. Mount this peel of Rheo leaf in wafer on a glass slide and examine under high power of microscope.

**Observation 1:** We will observe that the leaf peel contains cells having small green granules, i.e., the chloroplasts containing chlorophyll pigments. These cells are turgid, i.e., the plasma membrane is in complete contact with the cell wall in these cells. Now, put a drop of strong or concentrated solution of sugar or salt on the leaf peel. Wait for a minute and observe.

**Observation 2:** We observe that the cell contents are separated from the cell wall, i.e., the cytoplasm along with plasma membrane has come to lie on one side of cell wall in the leaf cells and a clear space is seen between the cell wall and protoplast of the cells The observed change in the condition of Rheo cells is due to plasmolysis phenomenon, Now, place the leaf peel in boiling water for a few minutest This will kill the cells. Put a drop of stronger concentrated solution of sugar or salt on the leaf peel. Wait for a minute and observe.

**Observation 3:** We will observe that the boiled leaf peel does not lose any water due to exosmosis and hence no plasmolysis. This shows that only living cells show plasmolysis and not the dead cells.

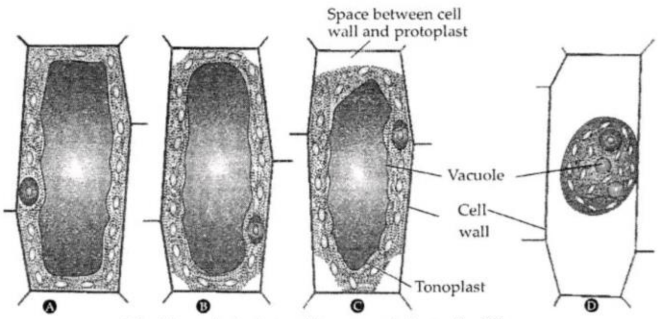



Fig.: Plasmolysis. A. turgid or normal plant cell of *Rheo*
B-D. Successive stages in the shrinkage of cell content (protoplasm) from the cell wall.

## ILLUSTRATION

**4. Why is the plasma membrane called a selectively permeable membrane? (NCERT)**

**Ans.** Plasma membrane permits the entry and exit of selected materials in the cells. It also prevents movement of selected materials. Therefore, the plasma membrane is called a selectively permeable membrane.

**5. Give the chemical nature of plasma membrane?**

**Ans.** Plasma membrane is made up of a bilayer of phospholipids in which protein molecules 'float about'.



**6. What is a semi-permeable membrane?**

**Ans.** A semi-permeable membrane is a membrane that allows the movement of solvent molecules (e.g. water molecules) through it but prevents the movement of solute particles (e.g. sugar or salt molecules). For example, egg membrane, parchment membrane, cellophane paper, etc. are semi-permeable membrane.

**7. What is endosmosis and exosmosis?**

**Ans.** The inward diffusion of water through a semi-permeable membrane when the surrounding solution is less concentrated is called endosmosis (endo: inward). Endosmosis leads to swelling up of the cells. The outward diffusion of water through a emi-permeable membrane when the surrounding solution is more concentrated is called exosmosis (exo: outward). Exosmosis leads to the shrinking up of cells.

**8. What is the difference between diffusion and osmosis?**

**Ans.** The differences between diffusion and osmosis are:

| | Diffusion | Osmosis |
|---|---|---|
| 1. | It is the movement of molecules or ions of a substance from a region of their higher concentration to a region of their lower concentration. | It is the diffusion of water molecules from a dilute solution to a concentrated solution through a semipermeable membrane. |
| 2. | Diffusion can operate in any medium like solid, liquid, gas etc. | Osmosis operates only in a liquid medium. |
| 3. | It does not require any semi-permeable membrane. | It requires a semi-permeable membrane. |
| 4. | It is a rapid process in gases and slow process in liquids | It is a slow process. |
| 5. | It helps in equalizing the concentration of the diffusing substances on the two sides of the system. | It does not equalize the concentration of x solvent on the two sides of the system. |

**9. What is the difference between active transport and diffusion**

**Ans.** **Table: Difference between active transport and diffusion**

| | Active transport | Diffusion |
|---|---|---|
| 1. | It is a rapid process. | It is a slow process. |
| 2. | It can move materials through a biological (cellular) membrane against the concentration gradient. | It can move materials across a biomembrane down the concentration gradient. |
| 3. | It takes place in one direction only. | It takes place in both directions. |
| 4 | It needs carrier (or transport) proteins to occur. | It occurs without the help of carrier proteins. |
| 5 | It uses energy of ATP. | It does not use energy. |
| 6. | It brings about selective uptake of materials. | It allows all transmissible molecules to pass through membrane. |

## ILLUSTRATION

**10. How do substances like $CO_2$ and water move in and out of the cell? Discuss.(NCERT)**

**Ans.:** $CO_2$ moves in and out of the cells by the process of diffusion which involves movement of molecules from higher concentration to lower concentration across the cell membrane. Water moves in and out of the cells by osmosis is the movement of water or solvent through a semipermeable membrane from a solution of lower concentration of solutes to a solution of higher concentration of solutes to which the membrane is relatively impermeable.

**11. Give the chemical nature of cell wall.**

**Ans.:** Cell-wall of plant cell is formed of a fibrous polysaccharide called cellulose.

## NUCLEUS

**A true nucleus is absent in prokaryotes. It is present in all the eukaryotic cells except mammalian RBCs, sieve tube cells of phloem and tracheids and vessels of xylem.** Generally it is centric in position and oval or spherical in shape. It was discovered by **Robert Brown** (1831). Nucleus is the most conspicuous and the largest organelle of a eukaryotic cell. It directs and controls all the cellular activities, so is called director of cell. Nucleus is formed of **four components:**

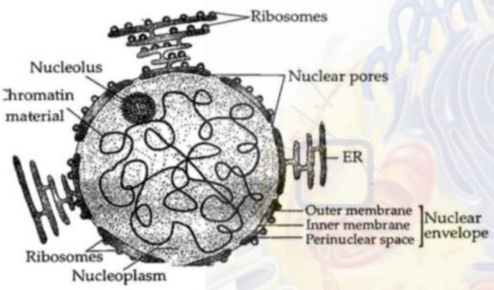



Fig.: Organization of nucleus

**(i) Nuclear membrane or Karyotheca:** It is a two-layered envelope around the nuclear sap. It is porous (with nuclear pores) and semipermeable membrane. Outer membrane is studded with ribosomes and may be continuous with RER. It regulates the **exchange of materials** between nucleoplasm and cytoplasm.

**(ii) Nucleoplasm** or **nuclear sap:** It is a transparent, semifluid, colloidal ground substance in which nucleoli and chromatin fibres are present.

**(iii) Nucleolus:** It is dense, spherical, naked (membrane less) and darkly stained structure and is the site of formation and storehouse of rRNAs so helps in the synthesis of ribosomes.

**(iv) Nuclear chromatin:** It is a darkly stained network of long and fine threads called chromatin fibres which, during cell division, condense by dehydration and spiralling to form a species specific number of rods, called chromosomes. The chromosome term was given by Waldayer in 1888. Chromosomes are made up of DNA and proteins. The DNA possesses all the necessary information for the cell to function, grow and divide properly. The specific segments of DNA are termed genes. These are the hereditary units.

### Functions

(i) The nucleus controls cell metabolism and other activities of the cell, hence, it is also called **Master or Director of the cell.**

(ii) Chromatin part of the nucleus possesses all the genetic information that is required for growth and development of the organism, its reproduction, metabolism and behaviour.

(ii) Nucleus plays a central role in the cellular reproduction (division of single cell to form two cells).

(iii) Along with environment, nucleus also directs the chemical activities of the cell. This deter- mines the development and future form of the cell.



## Prokaryotic and eukaryotic cells

### Prokaryotic cells

The cells of some most primitive organisms lack nuclear membrane around their genetic material (i.e., DNA). The nuclear region of such organisms is poorly defined and contains only nucleic acids. Such an undefined nuclear material is called nucleoid. The organisms whose cells lack a nuclear membrane, are called prokaryotes (G. Pro = primitive or primary; Karyote = nucleus). Prokaryotes also do not contain membrane bound organelles in the cytoplasm. Ribosomes are, however, present. Examples of prokaryotic organisms (Prokaryotes) are - bacteria and cyanobacteria, etc.

## Eukaryotic cells

The cells of higher organisms possess true nucleus bounded by nuclear membrane. Such organisms which possess cells having a nuclear membrane are called eukaryotes. They have membrane bound organelles in the cytoplasm. Examples of eukaryotes are protists, fungi, plants and animals

# ILLUSTRATION

**12. Fill in the gaps in the following table illustrating difference between prokaryotic and eukaryotic cells.**

| | Prokaryotic cell | Eukaryotic cell |
|---|---|---|
| 1. | Size: Generally small (1-10 $\mu m$). | Size: generally large (5-100 $\mu m$). |
| 2. | Nuclear region: ______________ ____________________________ and known as ______________ | Nuclear region: well defined and Surrounded by a nuclear membrane |
| 3. | Chromosome: single | More than one chromosome |
| 4. | Membrane-bound cell organelles absent. | ________________________________________ ________________________________________ |

**Ans.:** The differences between prokaryotic cell and eukaryotic cell is given below:

| | Prokaryotic cell | Eukaryotic cell |
|---|---|---|
| 1. | Size: generally small (1-10 $\mu m$). | Size: generally large (5-100 $\mu m$). |
| 2. | Nuclear region: poorly defined due to the absence of membrane, and known as nucleoid. | Nuclear region: well defined and surrounded by a nuclear membrane, |
| 3. | Chromosome: single | More than one chromosome. |
| 4. | Membrane bound cell organ Cells absent. | Membrane bound cell organelles, such as mitochondria, lysosome, endoplasmic reticulum, Golgi complex, etc. are present. |

## PROTOPLASM

All cells contain living substance called protoplasm. It is a jelly-like, viscous, colourless semi-fluid substance in which various cell organelles and inclusions remain in colloidal form. Protoplasm includes all the components of the cell including cell membrane. However, protoplasm does not include cell wall and the contents of the vacuole. Protoplasm can be distinguished in two forms - cytoplasm, is that part of protoplasm which surrounds the nucleus and **nucleoplasm,** that part of protoplasm which is located inside the nucleus.

## CYTOPLASM

The space between the plasma membrane and the nucleus is filled by an amorphous, translucent, homogeneous, colloidal liquid called cytoplasm. It consists of various inorganic molecules, such as water, salts, organic compounds, proteins, nucleic acids, and a variety of enzymes. Chemically, cytoplasm contains about 90% water, 7% proteins, 2% carbohydrates and lipids and 1% inorganic materials, minerals/ vitamins, etc.

Cytoplasm contains many specialized membrane bound living parts called cell organelles. Each of the cell organelle has a characteristic shape and specific function. Presence of cell membrane and membrane bound cell organelles is the characteristic feature of living organisms. The membranes and membrane bound cell organelles are absent in viruses. Therefore, the viruses do not show characteristics of life.

## CELL ORGANELLES

Large and more highly evolved cells, or cells of the multicellular organisms have a great deal of biochemical activities to support their complicated structure and function. Such cells possess specific membrane-bound subcellular components within themselves to keep different kinds of cellular activities separate from each other. These membrane bound sub-cellular components are called organelles (i.e., small organs). Presence of organelles is one of the important features of the eukaryotic cells which distinguishes them from prokaryotic cells. We have already discussed plasma membrane, cell wall and nucleus. Now we will discuss some common cell organelles such as **endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, plastids and vacuoles.**

## Endoplasmic reticulum

The endoplasmic reticulum is a complex network of membranous system in the cytoplasm of eukaryotic cells. It is connected with plasmalemma as well as

nuclear envelope. Endoplasmic reticulum is absent in prokaryotic cells and matured RBCs of mammals.
ER occurs in three forms: These are cisternae (i.e., closed, fluid-filled sacs), vesicles and **tubules.** ER is of two types:

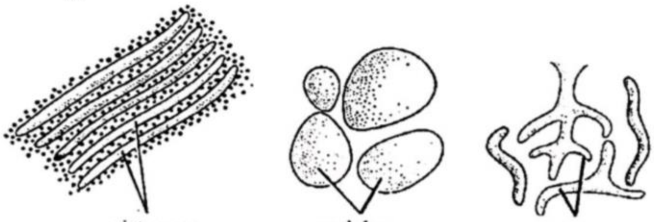



**Fig.:** Various parts of ER.

**(i) Rough endoplasmic reticulum** (RER) with ribosomes attached on its surface for synthesizing proteins. Thus, RER is engaged in the synthesis and transport of proteins. Some of proteins and lipids, which are synthesized in the cell with the help of ER, are utilized in building the cell membrane. This process is known as membrane biogenesis.
**(ii) Smooth endoplasmic reticulum** (SER) which is without ribosomes and is meant for synthesis of fat or lipids.

## Functions

(i) The network of ER separates cytoplasm of the cell into several small compartments. This compartmentalization of cytoplasm helps a cell to perform specific functions within specific chambers excluding others.
(ii) The ER gives mechanical support to the cytoplasm by providing a kind of cytoskeleton to maintain the shape of cell.
(iii) The ER offers extensive surface for the synthesis to proteins and lipids. It also helps in the transport of materials (especially proteins) from one part of the cell to another or between the cytoplasm and the nucleus.
(iv) The SER brings about detoxification in the liver of vertebrates, i.e., it converts harmful poisons and drugs into harmless substances for excretion by the cell.

## Golgi apparatus

Golgi apparatus (Golgi complex) was discovered by Nobel Laureate **Camillo Golgi** (1898) while he was examining the nerve cells of barn owl

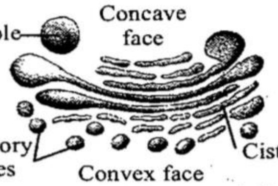



**Fig.:** Golgi apparatus

The Golgi complex occurs in almost all eukaryotic cells. It is not found in prokaryotic cells like bacteria. The Golgi complex is a membranous structure which originates from the smooth endoplasmic reticulum. It is formed of interconnected stacks of flattened membranous sacs called cisternae. Besides cisternae the complex also bears large vacuoles but cluster of small vesicles. In plant cells, Golgi complex exists as freely distributed sub-units of Golgi apparatus and are called dictyosomes. Secretory materials reach the Golgi apparatus from the SER by way of transport vesicles which bud off from the SER and fuse with the Golgi cisternae on one end. The secretory materials are processed in the Golgi apparatus and then arises as secretory vesicles from the other end of the Golgi apparatus that carry them to their destination (i.e., inside and outside the cell). Golgi apparatus has a convex forming face and a concave maturing face. The forming face receives vesicles from endoplasmic reticulum. The maturing face produces secretory vesicles and lysosomes.

## Functions

(i) Golgi apparatus helps in the secretion of mucus, enzymes and hormones. The material synthesized near the endoplasmic reticulum is transported to various targets inside and outside the cell through the Golgi apparatus.
(ii) It helps in the storage, modification and packaging of secretory products in the vesicles.
(iii) In some cases Golgi apparatus also helps in the manufacture of complex sugars from simple sugars.
(iv) The Golgi apparatus also helps in the formation of lysosomes.
(v) It is involved in the synthesis of cell wall and plasma membrane.
(vi) It is also involved in the formation of cell plate during cell division.

## Ribosomes

Ribosomes are the smallest membrane-less, ribonucleoproteins particles which can be seen only through electron microscope. They are found in both prokaryotic as well as eukaryotic cells, except in mature sperms and RBCs. These are dense, round bodies which occur freely in cytoplasm or may remain attached to the surface of endoplasmic reticulum. Chemically, ribosomes are made up of ribonucleoprotein (in eukaryotic cells, the constituent of ribosomes is 50% protein and 50% ribosomal RNA). In prokaryotic cells, they are found floating freely in the cytoplasm.

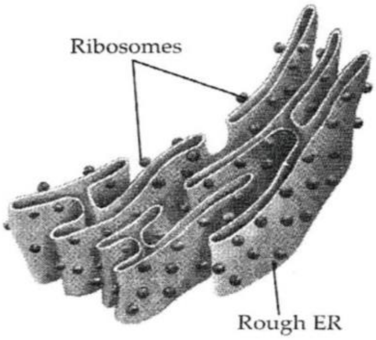



**Fig.:** Ribosomes attached on the surface of endoplasmic reticulum

RER increases the rate of protein synthesis by the ribosomes. These proteins may be used in the formation of new cell membranes (membrane biogenesis) or act as enzymes or hormones. Two types of ribosomes are present on the basis of their sedimentation coefficient: 70 S (in prokaryotes) and 80 S (in eukaryotes). Each ribosome is formed of two unequal components. 70S ribosome is formed of 50 S and 30 S subunits, while 80S ribosome is formed of 60S and 40 S subunits.

**Function:** Ribosomes are sites of protein synthesis so are called as **protein factories.**

## Lysosomes

Lysosomes are electron microscopic spherical sac like structures found in the cytoplasm of all the eukaryotic animal cells except mammalian RBCs. Lysosomes contain several digestive enzymes. More than 40 enzymes present in lysosomes are synthesized in rough endoplasmic reticulum (RER), and are brought to the lysosome through Golgi complex. These enzymes are capable of breaking down almost all types of organic substances. Lysosomes pass through various stages in the same cell.

## Functions

(i) Lysosomes serve as intracellular digestive system, hence, called digestive bags. They destroy any foreign material which enter the cell such as bacteria and virus. In this way they protect the cells from bacterial infection.

(ii) Lysosomes also remove the worn out and poorly working cellular organelles by digesting them to make way for their new replacements. In this way, they remove the cell debris and are also known as demolition squads, scavengers and cellular housekeepers. Thus, lysosomes form a kind of garbage disposal system of the cell.

(iii) During breakdown of cell structure, when the cell gets damaged, lysosomes may burst and the enzymes eat up their own cells. Therefore, lysosomes are also known as 'suicide bags' of a cell.

(iv) When a cell is destined to die, the lysosomal enzymes digest the whole cell/ a process called autolysis.

## Significance of lysosomes

(i) In WBCs or leucocytes: Lysosomes in leucocytes digest foreign proteins, bacteria and viruses.

(ii) **In autophagy:** During starvation, the lysosomes digest stored food contents such as fats and glycogen of the cytoplasm and supply the necessary amount of energy to the cell.

(iii) In metamorphosis (Frog), the embryonic tissues such as gills and tail are digested by the lysosomes and utilized by other body cell.

(iv) In fertilization: The lysosomal enzymes present in the acrosome of sperm cells digest the limiting membrane of the ovum (egg).Thus, the sperm is able to enter the ovum and start the fertilization.

## Mitochondria

Mitochondria were first seen by Kolliker (1880) in muscle cells but it was Benda (1898) who named them as mitochondria. They are present in all aerobic eukaryotic cells. However, they are absent in prokaryotic cells. Typically, mitochondria are sausage-shaped, but these may be granular, filamentous, rod-shaped, spherical or thread-like also.

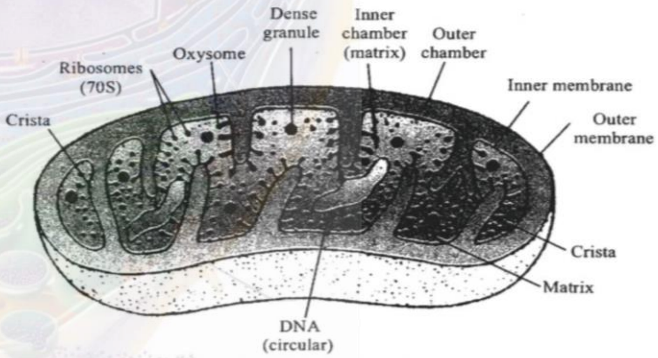



**Fig.:** Mitochondrion in section.

Mitochondrion is a thermos bottle like structure and has two mitochondrial membranes. Outer mitochondrial membrane is smooth, porous and freely permeable while inner mitochondrial membrane is selectively permeable and is deeply folded into finger-like processes, called cristae, to increase the surface area. The cristae are arranged in characteristic patterns in different cells and bear ATP-generating assemblies called oxysomes or elementary particles. The two membranes of each mitochondrion are separated by a narrow space called inter-membrane space or outer chamber. It contains a clear, homogeneous fluid. The space between the cristae is called inner chamber. Inner chamber of mitochondria is filled with circular and denser proteinaceous mitochondrial matrix having respiratory enzymes of Krebs cycle. It also has 70 S ribosomes and a number of circular and naked DNA molecules and RNA molecules.

Inner membrane folds create a large surface area for the generation of ATP during respiration. This energy is required for various chemical activities needed for life. Hence, mitochondria are also known as the powerhouses of the cell. ATP is known as the energy currency of the cell. Our body uses energy stored in ATP for manufacturing new chemical compounds and for mechanical work.

## Functions

(i) Mitochondria are miniature biochemical factories where food is oxidized and energy is released. This energy is stored in the form of ATP (Adenosine triphosphate). Hence, mitochondria are called the powerhouses of the cell.

(ii) They provide important intermediates for the synthesis of several biochemical like chlorophyll cytochromes, steroids, etc.

(iii) Synthesis of many amino acids' occurs in mitochondria.

(iv) Mitochondria are capable of self-duplication (replication). They have DNA, RNA, ribosomes and enzymes. They are able to synthesize some of their own proteins. Hence, they are regarded as **semi-autonomous organelles.**

## Plastids

The term 'plastid' was given by Haeckel in 1866. They are spherical or discoidal in shape and are enclosed in double membrane. They are present only in plant cells. These are absent from the prokaryotes, fungi and animal cells. Plastids are also self-replicating bodies. They contain their own DNA, RNA and ribosomes, i.e., they have their own protein synthesizing machinery hence are called **semiautonomous bodies.** On the basis of the colour, plastids may be of the following types:

- **Chloroplasts:** Green-coloured plastids containing chlorophyll.
- **Leucoplasts:** Colourless plastids, which store starch, protein and lipids in them.
- **Chromoplast:** These plastids are yellow or reddish in colour and are present in flowers and fruit

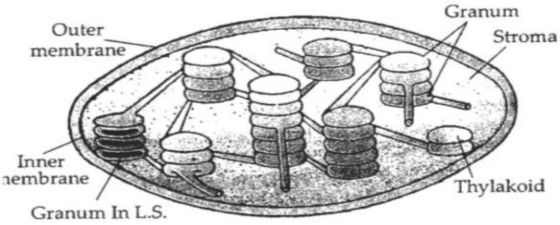



**Fig.:** Ultrastructure of chloroplast

Structure of chloroplasts: The chloroplasts of higher plants are usually spherical, ovoid, on of: discoidal or lens shaped. Each chloroplast is a vesicle bounded by double membrane envelope and filled with fluid matrix like the mitochondrion. The outer membrane is smooth and freely permeable to small molecules. Inner membrane is, however, selectively permeable. It has carrier proteins that control the passage of molecules. It is greatly infolded but the infolds become free in the mature chloroplast to lie as lamellae in the matrix. Lamellae are closed, flattened, membrane-bound ovoid sacs called thylakoids which lie closely packed in piles, the grana (singular granum). These contain green chlorophyll pigment molecules. Matrix is a colourless, granular, colloidal ground substance called **stroma**. It contains proteins, lipids, ribosomes, circular DNA, RNA molecules, enzymes, lipid droplets, and certain metal ions.

Granum is the site of light reaction during photosynthesis whereas stroma is the site of dark reaction during photosynthesis Chloroplasts trap the solar energy which is used for manufacturing the food. They are, therefore, the sites of photosynthesis and are commonly called 'kitchen of the cell'.

## Functions

**(i)** Leucoplasts store the reserve food in the form of starch grains or oil droplets or proteins

**(ii)** Chromoplasts help in pollination and dispersal of seeds and fruits.

**(iii)** Chloroplasts are sites of photosynthesis.

## Vacuoles

Vacuoles are fluid-filled and membrane bound spaces in the cytoplasm. They are small in size but more in number in animal cells but in plant cells, they are larger in size and lesser in number. Vacuoles are storage sacs for liquid or solid contents. They are bound by a membrane know as **tonoplast.** The fluid present inside vacuole is called cell sap which is watery and contains substances, like sugar, amino adds, proteins, minerals and metabolic wastes. The central vacuole of some plant cells may occupy 50-90% of the cell volume. Since the plant vacuole is large and occupies the central part of the cell, the nucleus and other cell organelles are pushed to the periphery. In single-celled organisms such as Amoeba or Paramecium, the food vacuole contains the food item that the animal has ingested and subsequently consumed. Many unicellular organisms, in addition, possess specialized vacuoles that serve as osmoregulatory organelles, i.e., they are associated with the maintenance of water balance of the body.

## Functions

(i) Vacuoles are meant for the storage of food, water and other substances.

(ii) They help in the elimination of excess water from the cell (osmoregulation), and maintains internal pressure of the cell.

**Table: Differences between animal and plant cells**

| | Animal cell | Plant cell |
|---|---|---|
| 1. | Animal cells are generally small in size. | Plant cells are generally larger than animal cells |
| 2. | It is enclosed by a thin, flexible, living plasma membrane only. Cell wall is absent. | It is enclosed by a thick, rigid, dead cell wall in addition to plasma membrane. |
| 3. | Plastids are absent. | Plastids are present. |
| 4. | Single Golgi apparatus generally near the nuclear envelope. | Many Golgi complex scattered in the cytoplasm. |
| 5. | Vacuoles are many but small-sized. | Vacuoles are fewer but large-sized. |
| 6. | Nucleus is generally near the centre of the cell. | Nucleus is often pushed to one side in the periphera cytoplasm by the central vacuole containing cell sap. |

## ILLUSTRATION

**13. Give an example of a membrane less organelle (non-membranous).**

**Ans.** Ribosome.

**14. Name the organelle, which is known as "kitchen of the cell".**

**Ans.** Chloroplast.

**15. Which organelle is known as powerhouse of the cell?**

**Ans.** Mitochondria.

**16. Can you name the two organelles we have studied that contain their own genetic material. (NCERT)**

**Ans.** (i) Mitochondrion (ii) Plastid

**17. If the organization of a cell is destroyed due to some physical or chemical influence, what will happen? (NCERT)**

**Ans.** If **the organization of** a cell is destroyed by any reason, lysis of the whole cell will occur due to the enzymes released by lysosomes.

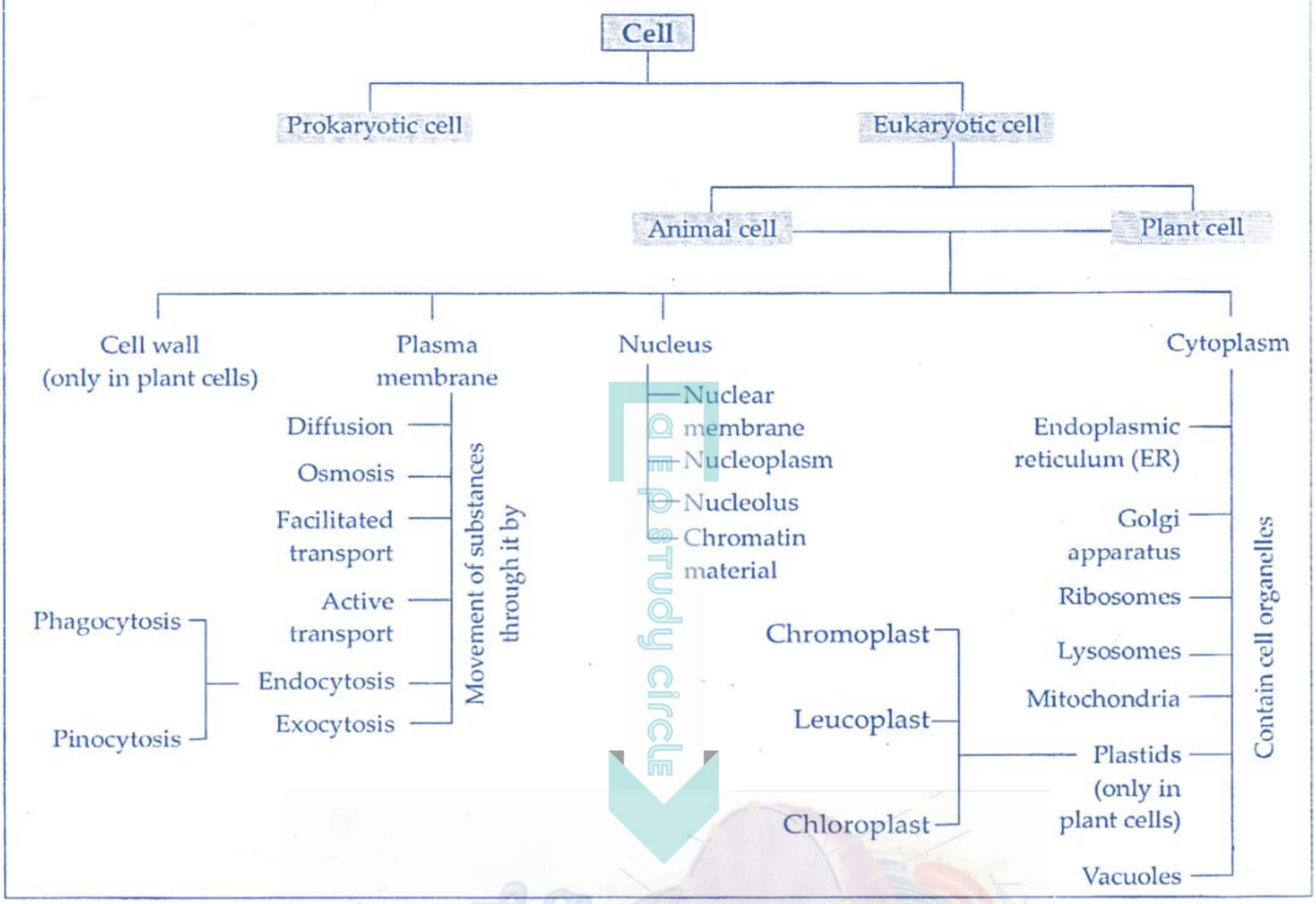
**18. Why are lysosomes known as "suicide bags"? (NCERT)**

**Ans.** Lysosomes are known as the suicide bags of the cell because they contain digestive enzymes capable to digest the whole cell when the situation so demands. Since a cell in itself contains an organelle through which it can kill itself, it is called suicide bag of the cell.

**19. Where are proteins synthesized inside the cell?**

**Ans.** The ribosomes attached to endoplasmic reticulum as well as present freely in the cytoplasm of all active cells are the site for the synthesis of proteins.

# CONCEPT MAP




## ESSENTIAL POINTS For COMPETITIVE EXAMS

- The **cell theory** states that-
  - **(i)** All living things are composed of minute units, the cells, which are the smallest entities that can be called "living";
  - **(ii)** A cell is a mass of protoplasm containing a nucleus and bounded by a cell membrane, and in many cases by a cell wall also;
  - **(iii)** All cells are basically alike in structure and metabolic activities;
  - **(iv)** The function of an organism as a whole is the result of the activities and interactions of the constituent cells.
  - **(v)** New cells arise from pre-existing cells.
- The **cell principle** states that-
  - **(i)** Life exists only in cells.
  - **(ii)** Living objects are composed of cells and cell products, or are multinucleate mass of protoplasm, or are like a single free cell.
  - **(iii)** A cell is a small mass of protoplasm usually containing a nucleus or nuclear material and some other organelles, and is bounded by a cell membrane. A cell organelle does not survive alone.
  - **(iv)** Cell is also a unit of function, reproduction, heredity and disease, besides being a unit of structure.
  - **(v)** Cells always arise from the preexisting living cells by division.
- The **cell principle is better than cell theory** as-
  - **(i)** It applies almost to all the living things: plants, animals and microorganisms.
  - **(ii)** It incorporates nearly all the modem findings about a cell.
- **Totipotency** (L. totus all, potens -powerful) or cellular totipotency is the ability of a living somatic nucleated cell to form the complete organism. Totipotency can be easily demonstrated in plant cells. In higher animals it has not yet been experimentally proved. It is because the cells do not undergo independent

tissue differentiation. Cellular totipotency was first proposed by German botanist Haberlandt in 1902.

- **Pits** are unthickened areas in the secondary walls of plant cells. They, therefore, appear as depressions.
- **Modifications of cell membrane**
  - **Microvilli** are finger like evaginations of 0.6-0.8 $\mu m$ length and 0.1 $\mu m$ diameter which are found on the free surface of cells engaged in absorption, e.g., intestinal cells, hepatic cells, mesothehal cells, uriniferous tubules. Microvilli increase the surface area several times.
  - **Mesosomes** are plasmalemmainfoldings found in bacteria. One type of mesosome is attached internally to the nucleoid. It is required for nucleoid replication and cell division.
  - **Junctional complexes** are contacts between adjacent cells which in case of animal cells are separated by spaces of 150-200A filled with tissue fluid. The important ones are: interdigitations, intercellular bridges, tight junctions, gap junctions, plasmodesmata, desmosomes, hemi desmosomes and terminal bars.
- A chromosome consists of two identical and spirally coiled threads, called sister chromatids, joined at a lightly stained constriction called centromere or primary constriction. On the basis of position of centromere, the chromosomes are of four types: Telocentric (centromere is at the end of chromosome); Acrocentric (sub terminal centromere); Sub metacentric (near the centre) and Metacentric (at the centre). Some chromosomes have additional sub terminal constriction called secondary constriction. The part of chromosome from secondary constriction to end of chromosome is called satellite and such chromosomes are called SAT-chromosomes. Chemically, each chromatid of chromosome is formed of DNA and proteins (especially histones).

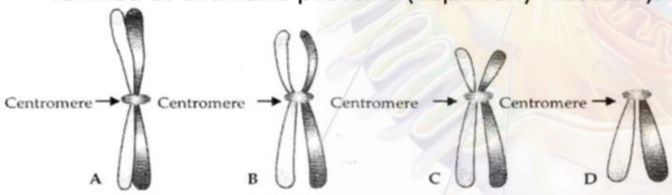



Fig.: A. Metacentric chromosome, B. Submetacentric chromosome, C. Acrocentric chromosome, D. Telocentric chromosome.

- Number of chromosome is species specific but it varies from species to species. Among the animals, it is 2 in Ascarismegalocephala (minimum number), 8 in fruitfly, 26 in frog, 46 in human beings, 48 in apes while largest number of chromosomes is found in a protozoan Aulocantha (2N = 1600).
  Among the plants, the chromosome number is 4 in Haplopappusgracilis (plant with minimum chromosome number), 14 in garden pea, 18 in cabbage and radish, 24 in rice, 42 in wheat while largest number of chromosomes are found in Adder's tongue fern (2N = 1262).
  Both chromatids of a chromosome are identical, having identical genes. During cell division, the two sister chromatids separate and each chromatid becomes an independent daughter chromosome.
- **Cytoplasm** is differentiated into two parts:
  **(i) Matrix or Cytosol (Hyaloplasm):** It is the ground substance which is again differentiated into outer, denser and non-granular ectoplasm (plasmagel) and inner fluidy and granular endoplasm (plasmasol), two being interconvertible. Matrix shows streaming movements, called cyclosis, which helps in uniform distribution of materials.
  **(i) Cytoplasmic structures:** These lie in the cytoplasm and are of two types: cell organelles and cell inclusions.
- There are three types of special leucoplasts:
  (i) Amyloplasts: They are the starch containing leucoplasts e.g., potato tuber, rice, wheat,
  (ii) Elaioplasts (Lipidoplasts, Oleoplasts): The colourless plastids store fat, e.g., tube rose.
  (iii) Aleuroplasts, Proteoplasts or Proteinoplasts: The plastids contain protein in the amorphous, crystalloid or crystallo-globoid state (e.g., aleurone cells of maize grain, endosperm cells of Castor).
- About 40 enzymes have been recorded to occur in lysosomes. All the enzymes do not occur in the same lysosome but there are different sets of enzymes in different types of lysosomes. The important enzymes are acid phosphatases, sulphatases, proteases, peptidases, nucleases, lipases and glycosidases. They are also called acid hydrolases because these digestive enzymes usually function in acidic medium or pH of 4-5. Acidic conditions are maintained inside the lysosomes by pumping of H"'" or protons into them. Lysosomes pass through various stages in the same cell. The phenomenon is called polymorphism or existence of more than one morphological form. Depending upon their morphology and function, there are four types of lysosomes - primary, secondary, residual bodies and autophagic vacuoles.

- **Sphaerosomes** (= spherosomes) are small cell organelles bounded by single membrane which take part in storage and synthesis of lipid. They arise from endoplasmic reticulum. They are considered to have lysosomic activity.
- **Microbodies** are small cell organelles bounded by single membrane which absorb molecular oxygen and take part in oxidations other than those involved in respiration. Micro bodies are of two types- peroxisomes and glyoxysomes.
- Feroxisomes are electron microscopic, vesicular structures found in photosynthetic cells of plants and liver and kidney cells of the vertebrates. They are bounded by a single membrane. Each peroxisome contains two types of oxidative enzymes (oxidase and catalase) bounded by a unit membrane. Inner contents of peroxisomes are finely granular. Peroxisomes are specialized for carrying out some oxidative reactions; such as detoxification or removal of toxic substances from the cell.
  (i) Peroxisomes are self-replicating organelles which selectively import proteins (enzymes) from the cytosol.
  (ii) Leaf peroxisomes, which are present in cells of a plant's leaf, are associated with ER, chloroplasts and mitochondria and are involved in photorespiration.
- **Glyoxysomes**are microbodies which contain enzymes for P-oxidatior of fatty acids and glyoxylate pathway. They are considered to be special peroxisomes. The microbodies appear transiently in germinating oil seeds and the cells of some fungi till the stored fat is consumed. β-oxidation of fatty acids produces acetyl Co A which is metabolized in glyoxylate cycle to produce carbohydrates. After completion of their function, glyoxysomes are believed to be changed into peroxisomes.
- **Ribosomes** may occur singly as monosomes or in rosettes and helical groups called polyribosomes or polysomes (Gk. poly - many, soma - body). The different ribosomes of a polyribosome are connected with a 10 - 20 A thick strand of messenger or mKNA. Polyribosomes are formed during periods of active protein synthesis when a number of copies of the same polypeptide are required.
- **Cytoskeletal structures** are extremely minute, fibrous and tubular structures which form the structural frame-work inside the cell. Cytoskeletal structures occur only in eukaryotic cells. They maintain shape of the cell and its extensions, regulate orientation and distribution of cell organelles. They are of three types - microfilaments, intermediate filaments and microtubules.
- **Flagella and cilia** are fine hair like movable protoplasmic processes of the cells which are capable of producing a current in the fluid medium for locomotion and passage of substances. Flagella are longer (100 - 200 $\mu m$) but fewer. Only 1 - 4 flagella occur per cell, e.g., many protists, motile algae, spermatozoa of animals, bryophytes and pteridophytes, choanocytes of sponges, gastrodermal cells of coelenterates, zoospores and gametes of thallophytes. Cilia are smaller (5 - 20 $\mu m$) but are numerous. They occur in group ciliata of protista, flame cells of worms, larval bodies of many invertebrates, epithelium of respiratory tract, renal tubules, oviducal runnel, etc. Cilia present on the tracheal and bronchial epithelial cells are specialized to send back dust particles into the pharynx so that the lungs remain unharmed. Both cilia and flagella are structurally similar and possess similar parts - basal body, rootlets, basal plate and shaft.
- Cilia and flagella help in locomotion in flagellate and ciliated organisms. They create current for obtaining food from aquatic medium. It is also called food current. In some protists and animals, the organelles take part in capturing food. In aquatic organisms cilia create currents in water for renewal of oxygen supply and quick diffusion of carbon dioxide. In land animals the cilia of the respiratory tract help in eliminating dust particles in the incoming air. Internal transport of several organs is performed by cilia, e.g., passage of eggs in oviduct, passage of excretory Ssubstances in the kidneys, etc. Being protoplasmic structures they can function as sensory organs.
- **Centrioles** are minute - submicroscopic microtubularsubcylinders with a configuration of nine triplet fibrils and ability to form their own duplicates, astral poles and basal bodies, without having DNA and a membranous covering. Usually two centrioles are found associated together but at right angles to each other. The pair of centrioles is often called diplosome. Diplosome lies in a common specialized part of cytoplasm called centrosphere or kinoplasm (= cytocentrum). Centrosphere is devoid of any other cell organelle. The complex, formed of centrioles and centrosphere, is called centrosome (Boveri, 1888) or central apparatus. Centrioles are found in almost all eukaryotic animal cells, protozoan protists (except some forms like

Amoeba), some fungi and the cells of all those eukaryotic plants where flagellate structures are present in the life cycle (many green algae, bryophytes, pteridophytes and cycads). They are absent in angiosperms, higher gymnosperms, some algae and fungi.

- A centriole possesses a whorl of nine peripheral fibrils. Fibrils are absent in the centre. The arrangement is, therefore, called 9+0. Centrioles help in cell division by forming spindle poles or microtubule- organizing centres (MTOCs).
- Cell inclusions are non-living substances present in the cells. They are also called ergastic bodies. They may be present in soluble or insoluble state and can be organic or inorganic in nature. The cell inclusions belong to three categories - reserve food, excretory or secretory products and mineral matter.