CELL: THE FUNDAMENTAL UNIT OF LIFE

- The story of life is the story of cells. The bodies of living organisms are made up of microscopic units called cells. They are the smallest part of the living organism that can lead an independent existence.
- *Cell is the basic structural and functional unit of living organisms*. There is no known form of life that does not depend on the cell.

- ***Robert Hooke*** in 1665 observed in a thin slice of cork many compartment like structures with a primitive and self designed microscope. He named these structures as cells. Cell is a Latin word for "a little room".

UNICELLULAR AND MULTI-CELLULAR ORGANISMS

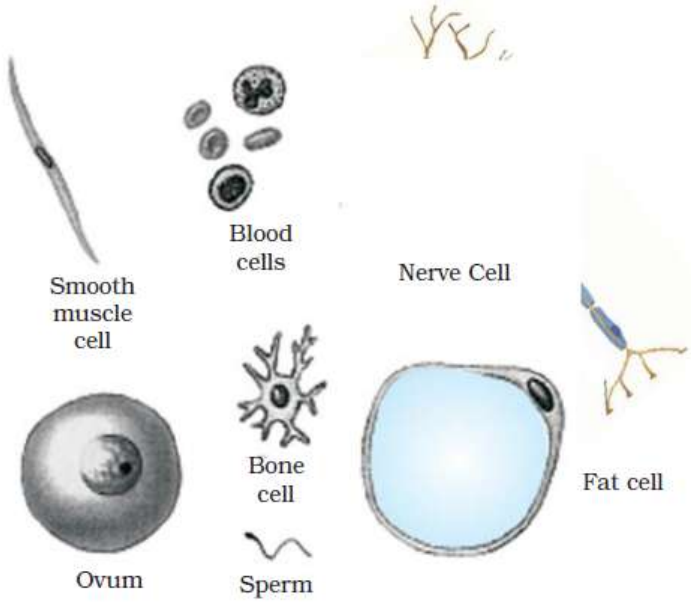
- Most of the organisms that we see around consist of so many of calls. These organisms are known as **Multi-cellular Organisms**. As a human body contains more than 50 million cells.

- The body of a multi-cellular organism consists of cells of different shapes and sizes which perform different functions. However, a multi-cellular organism begins its life as a single cell. This cell by repeated cell division produces body of the multi-cellular organism.

- Invention of microscope led to the discovery of world of microscopic organisms. These are generally made up of single cell and known as **Unicellular Organism**. Such as Bacteria, Amoeba, Paramecium, Chlamydomonas, etc.

SHAPE AND SIZE OF CELLS

- Cells vary considerably in shape and size. They vary not only different organisms but also in different part of the same organism.
- Unicellular organisms also differ in shape and size. Amoeba has no fixed shape while Euglena and Paramecium have fixed shape.
- In multi-cellular organisms cell shape is generally fixed. The shape of a cell depends mainly on the functional adaptations. It is related to the specific function they perform.



DIVISION OF LABOUR

- Different part of a multi-cellular body performs different functions and all these functions are vital to maintain any life form. This is called 'Division of labour'.

- Similarly division of labour is also present within a single cell. Each cell has different cell organelles which perform specific functions.

- A cell able is able to live and perform all its functions because of these organelles. These organelles together constitute the basic unit called the cell.

STRUCTURAL ORGANIZATION OF CELL

- Cells vary in shape, size and function. However a generalized pattern of cell is there, for, all the cells have three major functional regions, Plasma membrane, Cytoplasm and Nucleus.
- Nucleus control all the activities inside the cells where as Plasma membrane play major role in interaction of the cell with it environment.

PLASMA MEMBRANE

- All animal or plant cells are bounded by a living, delicate, elastic selectively permeable membrane called Plasma membrane.
- It separates the cell contents from the external environment. It determines the substances which can pass in or out of the cell hence called selectively permeable.
- It is made up of organic molecules called Lipids and Proteins. Structure of plasma membrane can only be observed through an electron microscope.

- **Functions of Plasma Membrane:**
  - It binds the semi fluid cytoplasmic contents of the cell.
  - It functions as a barrier between the protoplasm and the external environment of the cell.
  - It regulates the movement of molecules in and out of the cell.
  - The elasticity of the cell membrane enables the cell to engulf in particles of food and other materials from the external environment. (such process is known as endocytosis. Amoeba acquires its food by this process by using pseudopodia.

- **Transport across the plasma membrane:**
  - **Diffusion:** It is the movement of a substance from a region of its higher concentration to the region where its concentration is low.
  - Substances like CO_2 or O_2 can move across the plasma membrane by diffusion.

  - **Osmosis:** The movement of water from a region of its higher concentration to a region where its concentration is low, through a selectively permeable membrane is called osmosis.
  - In fact, osmosis is a special case of diffusion through a selectively permeable membrane.

- Animal cell or plant cell placed in solution of sugar or salt will behave in one of the following ways depending upon the concentration of the surrounding solution.
  - If the solution surrounding the cell has a higher water concentration as compared to cell contents i.e. outside solution is very dilute, the cell will gain water by osmosis and such a dilute solution is called **hypotonic solution**. And cell will swell up due to endo-osmosis.

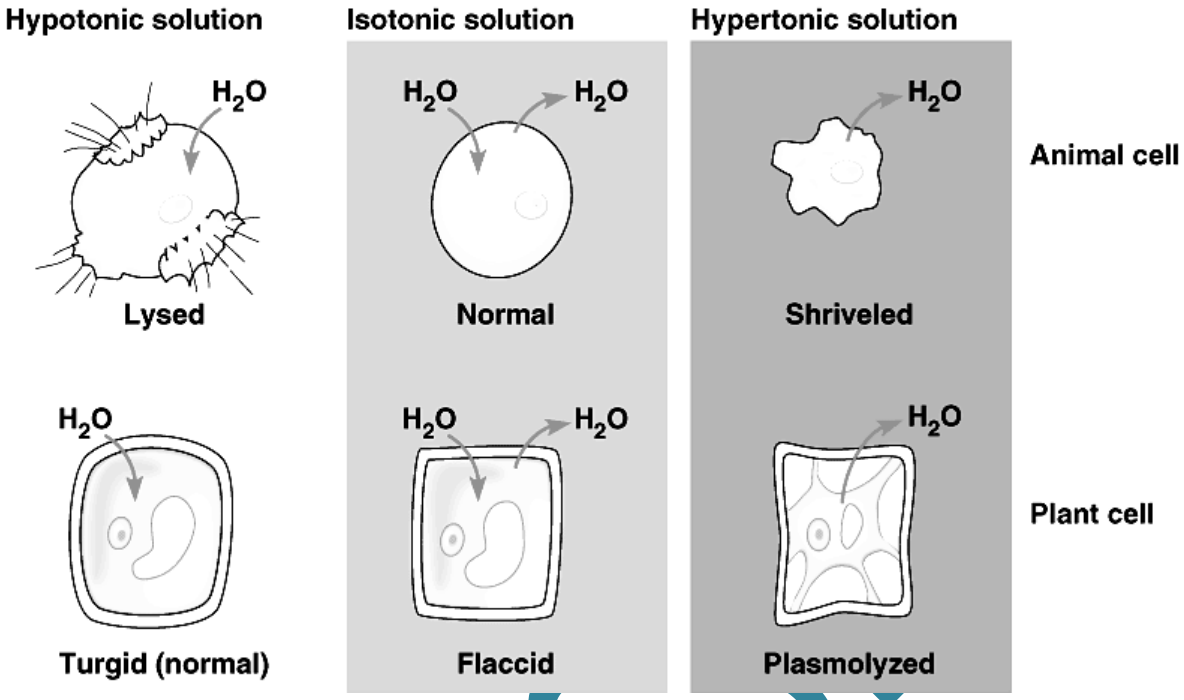


FIGURE: EXOSMOSIS AND ENDOSMOSIS IN CELL

- If the solution surrounding the cell has exactly the same concentration as that of the cell contents (**isotonic solution**), there will be no net movement of water across the plasma membrane. Water will cross the cell membrane in both directions, but the amount going in is the same as the amount going out, so there is no overall movement of water. The cell size will remain same.

- If the solution surrounding the cell has a lower water concentration as compared to cell content i.e. the outside solution is very concentrated solution or **hypertonic solution**, the cell will lose water. Water crosses the cell membrane in both directions, but this time more water leaves the cell than enters it. This process is called exosmosis. Therefore cell will shrink in size.

CELL WALL

- A plant cell in addition to plasma membrane has a rigid, non-living and freely permeable cell wall which lies outside the plasma membrane. It is made up mainly of cellulose.
- Cell wall performs the following functions:
  - It provides mechanical strength and determines the shape of the plant cell.
  - It prevents bursting of the cell due to hypotonic external media.

- When a plant cell is placed in strong hypertonic solution, it loses water through osmosis and content of the cell (protoplast) shrink away from the cell wall. This phenomenon is known as **Plasmolysis**.
- Phenomenon of osmosis occurs only in the living cells. The dead cells cannot perform osmosis.

NUCLEUS

- Nucleus may be located at different positions in the cytoplasm but generally it is centric in position and spherical or oval in shape. It consists of four parts-

(i) Nuclear membrane or Nuclear envelop
(ii) Nucleoplasm or Nuclear sap
(iii) Chromatin material
(iv) Nucleolus

- **Nuclear membrane:** It bounds the nucleus on the outside so it separates the nucleus from the cytoplasm. Nuclear membrane is made up of two membranes. It has large number of pores. The nuclear pores allow exchange of materials between nucleoplasm and cytoplasm.

- **Nucleoplasm:** It is semifluid, transparent, colloidal ground substance in which nucleoli and chromatin material is present. It contains raw materials for the synthesis of nucleic acid and proteins.

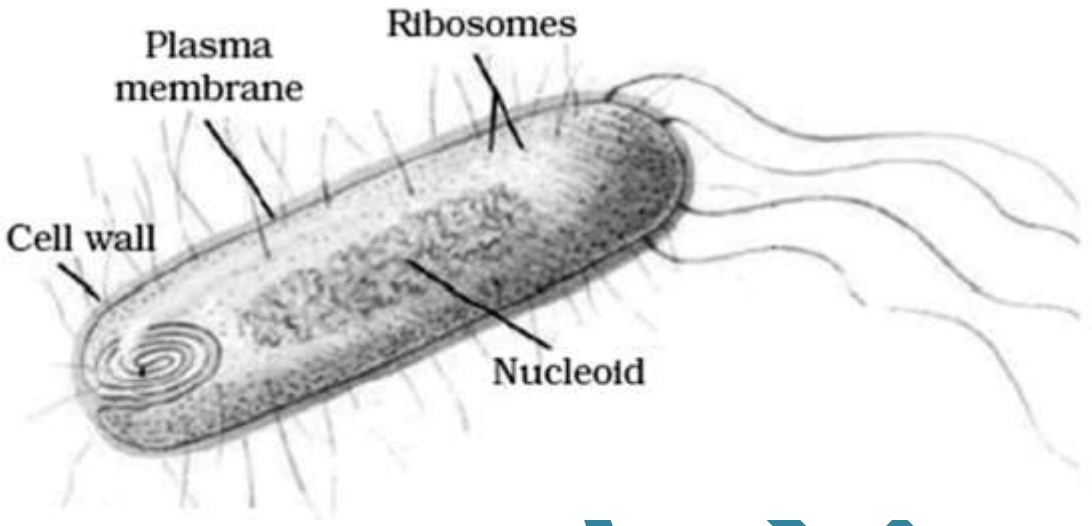
- **Chromatin Material:** chromatin occurs in the form of elongated fibres, which overlap one another to form a network called chromatin reticulum. Chromatin fibres are mainly made up of DNA (Deoxyribo Nucleic Acid). DNA is the genetic material and forms the genes. At the time of cell division chromatin fibres condensed into compact rod like structure called chromosomes. The number of chromosomes is fixed for a species. A gene is a functional unit of chromosome. It acts as the units of heredity and variations.

- **Nucleolus:** It is rounded or slightly irregular structure which is attached to the chromatin. It is devoid of any limiting membrane. Commonly 1 to 4 nucleoli are found in nucleus.

- **Functions of Nucleus:**
  - Nucleus plays a central role in cellular reproduction i.e. cell division.
  - It directs and controls all the cellular metabolic activities by directing chemical activities of the cell.
  - Along with the environment, it determines the cell differentiation and from it will exhibit at maturity.
  - It is responsible for the transmission of hereditary traits from the parent to the offspring.

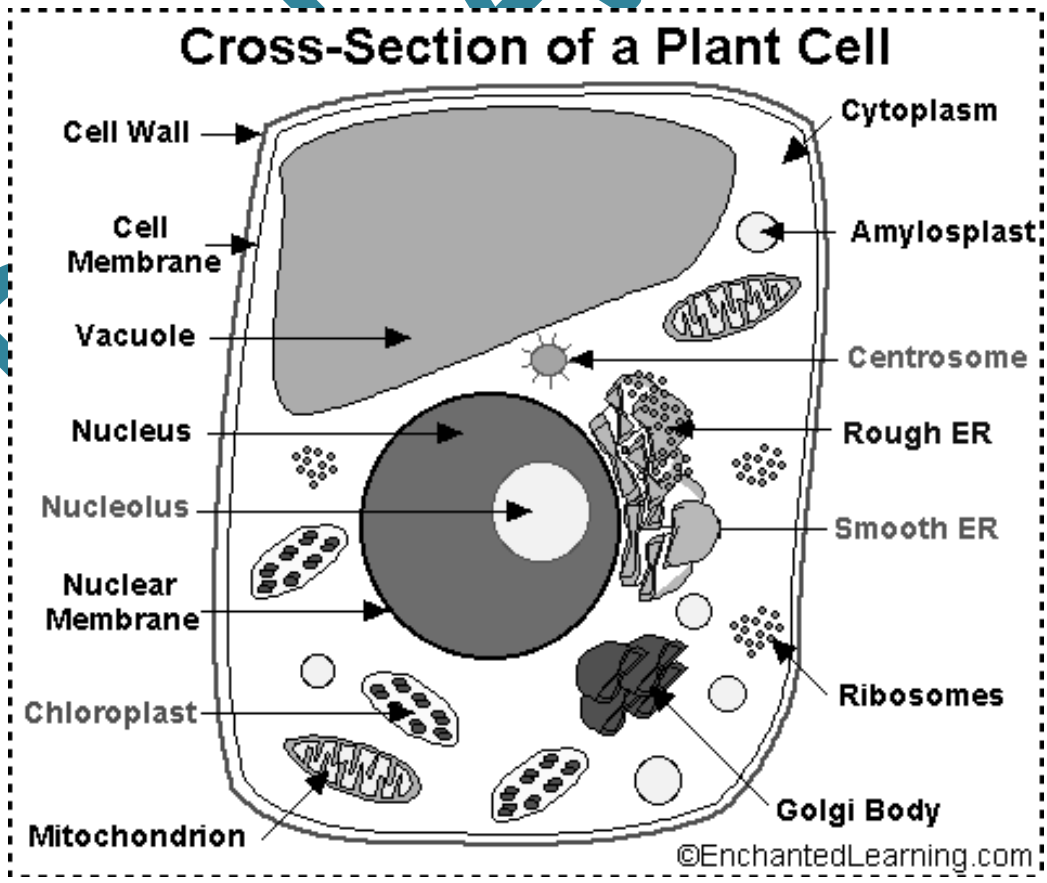
- In some organisms like bacteria, the nuclear region of the cell is poorly defined due to absence of a nuclear membrane. Such an undefined nuclear region containing only nucleic acid is called a nucleoid. Such organisms, whose cell lacks a nuclear membrane,

are called **prokaryotes.** Organisms with cells having a nuclear membrane are called **eukaryotes.**



CYTOPLASM

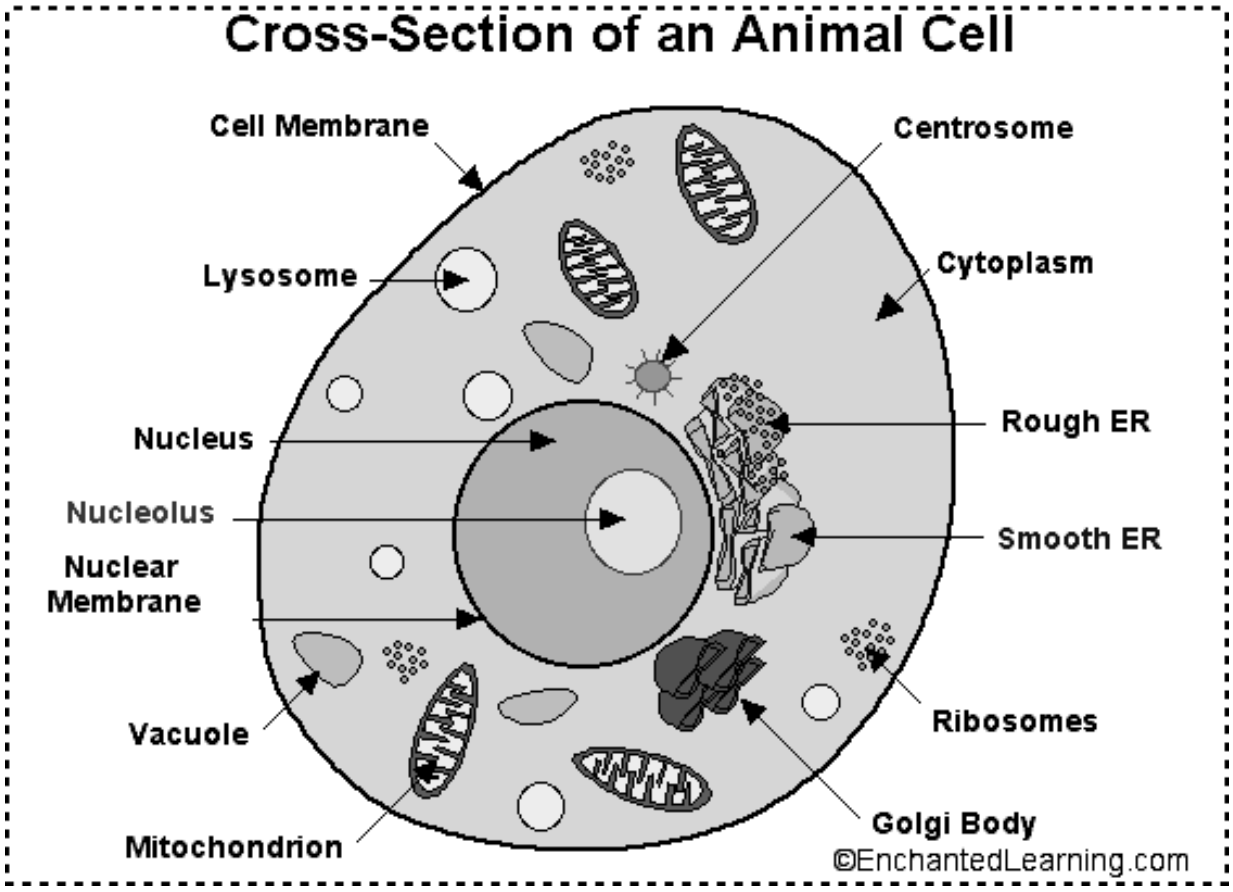
- Homogeneous, colloidal ground substance present between the plasma membrane and nuclear membrane is called cytoplasm.
- It contains certain non-living inclusions and living cell organelles suspended in it.



CELL ORGANELLES

- More evolved cells or cells of multicellular organisms need a lot of metabolic activities to support their complicated structures and functions. These calls use membrane bound cell organelles to keep the different types of activities going on in them separate from each other.
- So, the cell organelles are living, sub cellular, membrane bound structures.
- The importance of membrane can be illustrated with the example of viruses. Viruses do not have any membrane and hence do not show characteristic of life until they enter any living cell.
- The various cell organelles are:

(i) Endoplasmic Reticulum
(ii) Golgi Apparatus
(iii) Lysosomes
(iv) Mitochondria
(v) Plastids (In plant cells)
(vi) Vacuoles



ENDOPLASMIC RETICULUM

- Endoplasmic Reticulum is a complicated system of interconnected membrane bound tubes and sheets found in cytoplasm.
- It may lie freely in cytoplasm or connected with nuclear envelope and plasma membrane.
- The membrane of ER is similar in structure to the plasma membrane.

- There are two types of ER- Rough Endoplasmic Reticulum (RER) & Smooth Endoplasmic Reticulum (SER).
- **SER:** It has smooth membrane which does not bear ribosomes.
- **RER:** It has rough membranes because a number of ribosomes are attached to its outer surface.

- **Functions of Endoplasmic Reticulum:**
  - ER provides supporting skeleton framework and shape to cells.
  - It acts as a cell circulatory system for quick intracellular transport. It also helps in intercellular transport of substances.
  - ER provides increased surface area for the biochemical activities to take place.
  - SER helps in the synthesis of lipids.
  - RER is concerned with the synthesis of proteins and enzymes in association with ribosomes.
  - Some proteins and lipids synthesized by ER are used for producing new cellular parts e.g. membranes. This process is termed as membrane biogenesis. Some other proteins and lipids function as enzymes and hormones.
  - SER in liver cells of vertebrate plays a very significant role in the detoxification of many poisonous substances such as drugs, insecticides, pollutants etc.

GOLGI APPARATUS

- It is consists of a system of membrane bounded, fluid filled, smooth, flattened sac like structures called cisternae, tubules and vesicles.
- The cisterns are usually arranged parallel to each other in stalks. Membranes of ER and cisternae are continuous with each other.
- It is absent in bacteria, mature sperms and RBC.

- **Functions of Golgi apparatus:**
  - The main function of Golgi apparatus is storage, modification and packaging of products in vesicles. The various chemicals produced in the cell pass in to cisternae of the Golgi apparatus through ER. Here they are concentrated and modified and then passed out to the secretion vesicles which separate and proceed towards the plasma membrane. They fuse with the plasma membrane and throw out their products.
  - It is also involve in the systhesis of plasma membrane, cell wall, lysosome etc.

LYSOSOME

- Lysosomes are small, spherical or irregular in shape, single membrane bound vesicles which contain hydrolytic enzyme.
- These enzymes are made by RER.

- Lysosomes are found in all animal cells except mammalian RBCs.
- Digestive enzyme of lysosome can break down or digest all organic materials. If their covering membrane breaks, the released digestive enzyme can cause the breakdown of cellular constituents too. Lysosome is called **suicide bag** as they can kill the cell possessing them, during the disturbance in cellular metabolism.

- **Functions of Lysosomes:**
  - Lysosomes serve as intracellular digestive system hence called digestive bags.
  - Lysosomes of WBC devour foreign particles, bacteria and other organisms.
  - By digesting any foreign material as well as worn out, poorly working, ageing and useless dead cells, Lysosomes work as a kind of waste disposal system of the cell.

MITOCHONDRIA

- Mitochondria are double membrane bounded cytoplasmic organelle of aerobic eukaryotic cells which take part in the production of **ATP** (Adenosine Tri-Phosphate).
- Since it is associated with extraction of energy in the form of ATP, it is called **power house of the cell**.
- It is absent in mammalian erythrocytes or RBC.
- Outer membrane of mitochondrion is smooth and porous. The inner membrane is thrown up into deep folds inside the cavity of the mitochondrion. The folds are called cristae.
- The cristae increase the surface area of the inner membrane thereby providing more area for ATP generating chemical reactions.
- ATP is used to drive many energy requiring processes of the cell. The body or organisms uses energy stored in ATP for synthesis of chemical compounds and for mechanical work. ATP is known as energy currency of the cell.
- Mitochondria are self replicating semiautonomous body. They contain DNA, RNA and ribosomes, and synthesize some of their own proteins.

- **Functions of mitochondria:**
  - Mitochondria contain enzymes for cellular respiration. They are called power house of the cell where organic compounds are broken down to release chemical energy which is further converted into usable energy and stored as ATP molecules. Hence ATP is known as energy currency of the cell.
  - They help in the synthesis of phospholipids.
  - They synthesis amino acids from organic acids.

PLASTIDS

- Plastids are double membrane bounded, large cytoplasmic organelles found only in plant cells.

- They are self replicating semiautonomous organelles like mitochondria as they also have DNA and ribosomes.
- Depending upon presence and absence of pigments, the plastids are divided into following two groups:

(i) **Leucoplasts:** They are white or colourless plastids found in those cells which do not receive light e.g. underground parts like roots, tubers, rhizomes etc. In leucoplasts materials such as starch, oils and proteins granules are stored.

(ii) **Chromoplasts:** The plastids which are coloured due to presence of some pigments are called chromoplasts.

- Plastids containing the pigments chlorophyll are known as **chloroplasts**. It is important for photosynthesis in plants.
- Outer membrane of plastid is smooth whereas the inner membrane layer embedded in the matrix called stroma.
- **Functions of Plastid:**
  - Chloroplasts utilize solar energy and synthesise organic food from inorganic raw materials by the process of photosynthesis and liberate oxygen.
  - Chromoplasts impart characteristic colours to flowers and ripe fruits.
  - Leucoplasts are concerned with storage of food in the form of starch, fats and proteins.

VACUOLES

- Vacuoles are non-living, fluid filled membrane bound spaces present in cytoplasm of the cell.
- In animal cells, these are temporary, small sized and many in number. Plant cells have very large vacuoles.
- Because of the central position of vacuole in plant cell, the nucleus and other cell organelles in plant cell are pushed towards the cell wall.
- The vacuole is filled with liquid called cell sap.

- **Functions of vacuoles:**
  - Vacuoles provide turgidity and rigidity to the plant cells.
  - It stores toxic metabolic by-products or end products of plant cells.
  - In amoeba the **food vacuole** contains food particle captured by pseudopodia.
  - Specialized vacuoles known as **contractile vacuole** in some organisms helps in expelling excess of water and some wastes from the cell as in amoeba.