THE FUNDAMENTAL UNIT OF LIFE

CELL

Cell is called the fundamental unit of life. A cell is capable of independent existence and can carry out all the functions which are necessary for a living being. A cell carries out nutrition, respiration, excretion, transportation and reproduction; the way an individual organism does. Unicellular organisms are capable of independent existence which shows a cell's capability to exist independently. Due to this, a cell is called the fundamental and structural unit of life. All living beings are composed of the basic unit of life, i.e. cell.

CELL THEORY (Schleiden, Schwann and Virchow):

Cell theory was presented by Schleiden (1838) and Schwan (1839)

• All living organisms are composed of one or more cells.
• The cell is the basic unit of structure, function, and organization in all organisms.

Later it was modified by R. Virchow (1858) by presenting the idea *'Omnis Cellula e Cellula'* which means that all living cells arise from pre-existing cells.

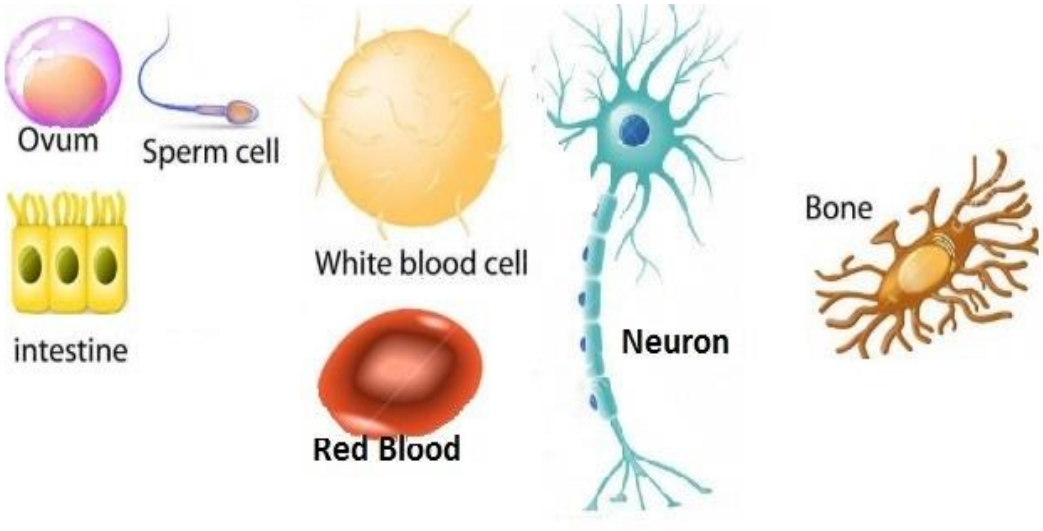
CELL SIZE, SHAPE AND NUMBER

There is much variation in size, shape and number of cells in different organisms, and also in various parts of the body. Most of the cells are only a few micrometres in diameter and are visible only with the help of a microscope.

Cells may be spherical, spindle shaped, elongated, polyhedral or irregular in shape. The shape of the cells is determined by the specific function they perform.

The number of cells is related to the size of the organ or body. Thus, small organisms have limited number of cells, while the larger ones such as elephant, whale or banyan tree have a countless number of cells.

Some organisms can also have cells of different kinds. Look at the following picture. It depicts some cells from the human

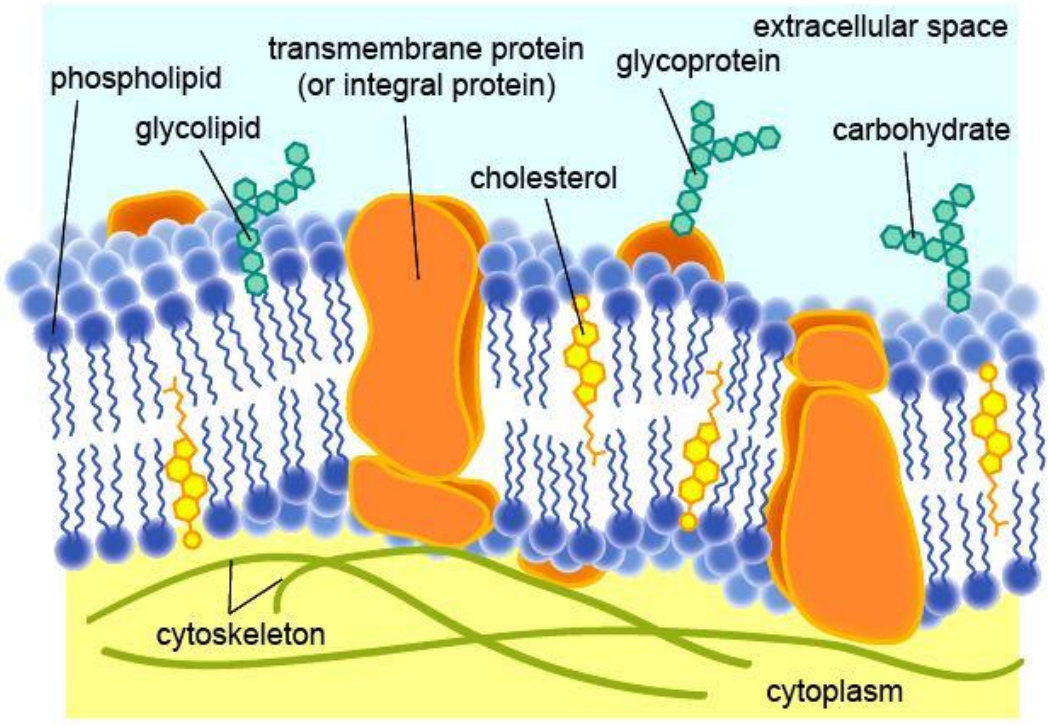


PROTOPLASM

A cell is made of life giving substance called protoplasm. The protoplasm is a highly organised jelly like, viscous, semifluid, composed of molecules of various chemicals. Most of these are organic molecules such as proteins, carbohydrates, fats, nucleic acid etc. Protoplasm is commonly called the " physical basis of life " .
A plant cell consists of a cell wall and protoplast. Cell wall is absent in animal cells. Protoplast denotes the whole of protoplasm present in a cell. It is differentiated into plasma membrane, nucleus and cytoplasm.

PLASMA MEMBRANE

Plasma membrane is a semi-permeable membrane. It is composed of bilayer of lipid and protein. This is the outermost covering of the cell that separates the contents of the cell from its external environment. The plasma membrane allows or permits the entry and exit of some materials in and out of the cell. It also prevents movement of some other materials. The cell membrane, therefore, is called a selectively permeable membrane.



Functions of Plasma Membrane

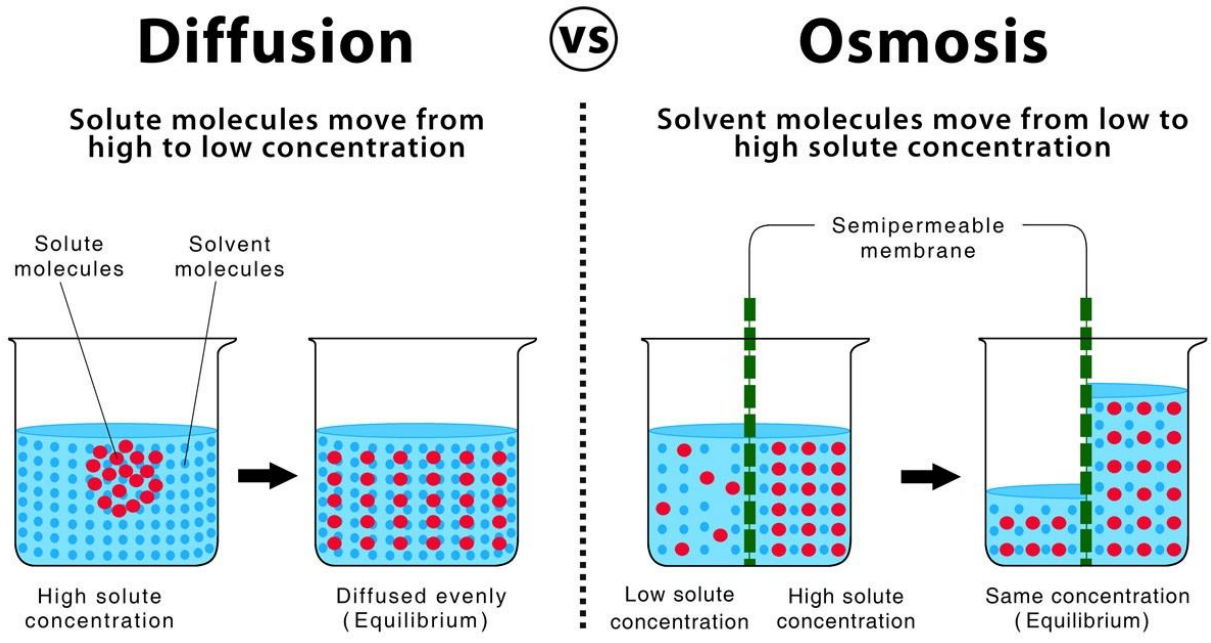
- Plasma membrane selectively regulates the entry and exit of the substances into and out of the cell. Therefore, it is called a selectively permeable membrane or semipermeable membrane.
- It provides an outer boundary to the cell and protects the cell from injury.
- It allows the flow of materials and information between different organelles of the same cell, as well as between the adjacent cells.
- It provides some organic connections between the adjacent cells.

DIFFUSION

Diffusion is the movement of a substance from an area of high concentration to an area of low concentration. Diffusion happens in liquids and gases because their particles move randomly from place to place. Diffusion is an important process for living things; it is how substances move in and out of cells.

OSMOSIS

Osmosis is the movement of a solvent across a semipermeable membrane toward a higher concentration of solute (or lower concentration of solvent). In biological systems, the solvent is typically water, but osmosis can occur in other liquids, supercritical liquids, and even gases



Movement of substances like CO_2 and water

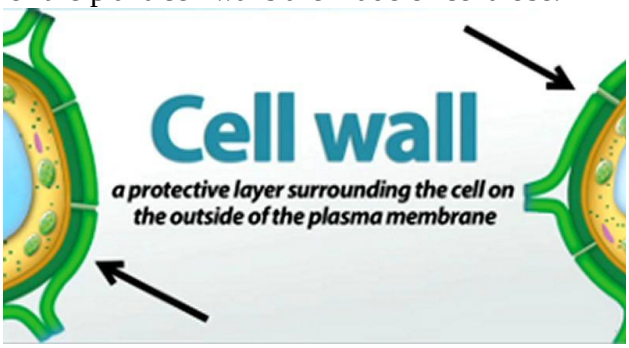
The cell membrane is selectively permeable and regulates the movement of substances in and out of the cell.

Movement of CO_2: CO_2 is produced during cellular respiration. Therefore, it is present in high concentrations inside the cell. This CO_2 must be excreted out of the cell. In the cell's external environment, the concentration of CO_2 is low as compared to that inside the cell. Therefore, according to the principle of diffusion, CO_2 moves from a region of higher concentration (inside the cell) towards a region of lower concentration (outside the cell). Similarly, O_2 enters the cell by the process of diffusion when the concentration of O_2 inside the cell is low as compared to its surroundings.

Movement of water: Water moves from a region of high concentration to a region of low concentration through the plasma membrane. The plasma membrane acts as a semi-permeable membrane, and this movement of water is known as osmosis. However, the movement of water across the plasma membrane of the cell is affected by the amount of substance dissolved in water.

CELL WALL

Cell wall is made of cellulose. Cell wall is present only in plant cells. It is a rigid protective covering outside the plasma membrane. Presence of cell wall in plant cells distinguishes them from animal cells. Most of the plant cell walls are made of cellulose.



The cell wall consists of three layers namely, middle lamella, primary wall and secondary wall. The middle lamella is a thin amorphous cement like layer between two adjacent cells. Primary wall is the first formed wall of the cell and is produced inner to the middle lamella. The secondary wall is a thick layer found inner to the primary wall.

Functions of Cell Wall:

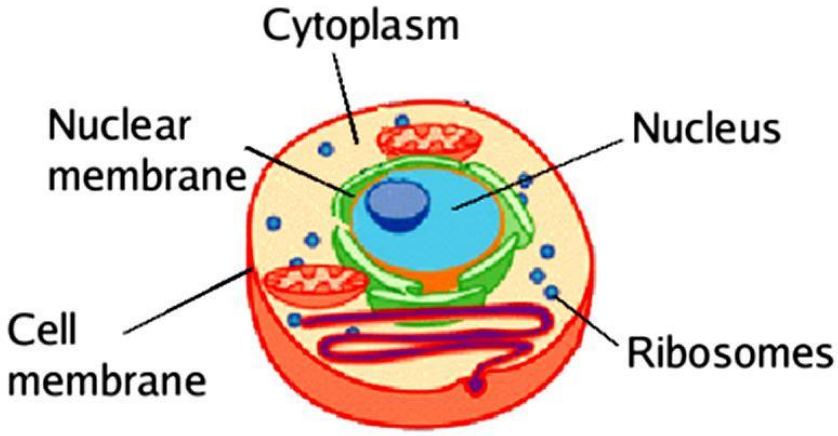
- Cell wall gives a definite shape to the plant cells.
- It provides mechanical strength to the cell.
- It protects the protoplasm against injury.
- It gives rigidity to the cell.

CYTOPLASM

A cell is enclosed in a membranous casing and is filled with a liquid substance which is called the cytoplasm. There are many cell organelles in a typical cell. Some of the main structures of a cell are as follows: The cytoplasm is the fluid content inside the plasma membrane. It also contains many specialised cell organelles. Each of these organelles performs a specific function for the cell.

Functions of Cytoplasm

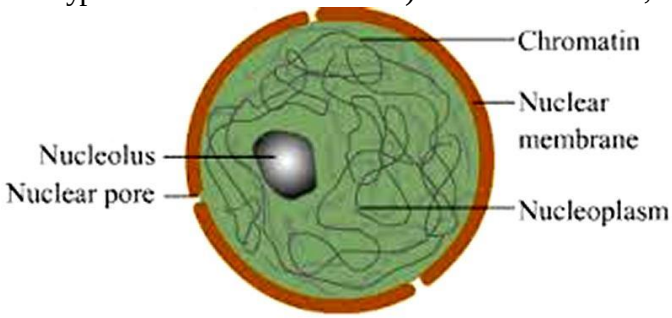
- Cytoplasm helps in intracellular distribution of enzymes, nutrients and other biomolecules within the cell.
- Synthesis of different types of biomolecules such as proteins, nucleotides, fatty acids etc., takes place in the cytoplasm.



NUCLEUS

Nucleus is the major central structure in the cell. It is a dense spherical structure embedded in the cytoplasm. Nucleus has a double membraned envelope called nuclear envelope. Nuclear envelope encloses a ground substance called nucleoplasm or karyolymph. The nuclear envelope possesses many pores called nuclear pores.

The nucleoplasm has two types of nuclear structures i) the nucleolus and, ii) chromatin.



Structure of a Nucleus

The nucleolus is a spherical body rich in protein and RNA. It is the site of ribosome formation. There may be one or more nucleoli in the nucleoplasm. The chromatin is a network of fine threads composed of genetic material DNA (Deoxyribo nucleic acid) and proteins. During cell division chromatin is condensed into thick cord like structures called Chromosomes. The chromosomes contain genes and each gene is responsible for one hereditary character of the organism. Genes contain information for inheritance of features from parents to next generation in the form of DNA molecule.

Functions of Nucleus:

i) Nucleus controls all the metabolic activities of the cell.
ii) It controls the inheritance of characters from parents to off-springs.
iii) It controls cell division.

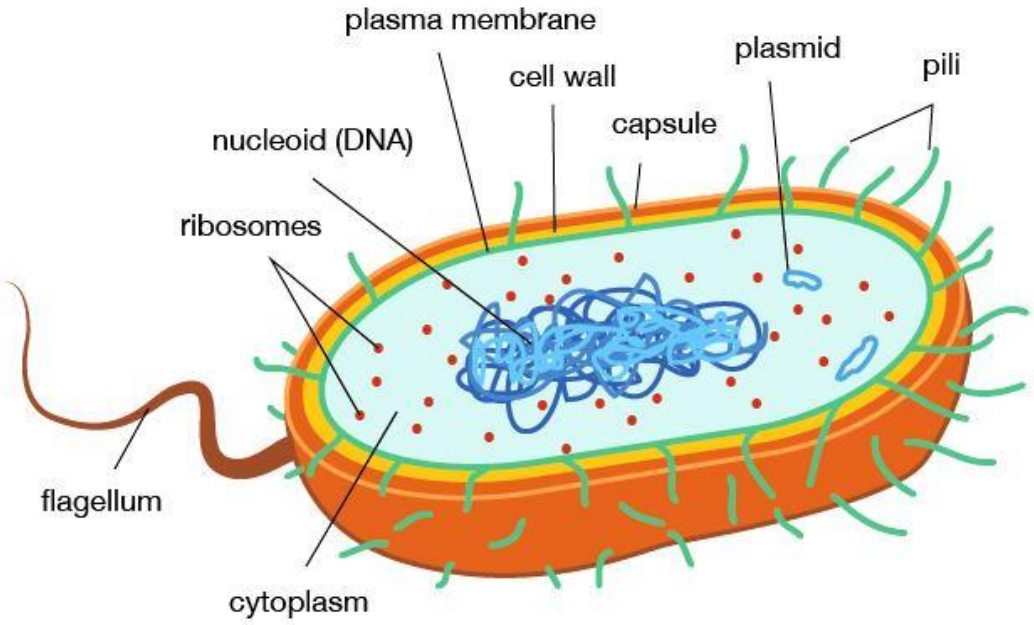
PROKARYOTES AND EUKARYOTES

Based on the complexity of organization, especially nuclear organization, the cells are classified into two types.

i) Prokaryotic cells.
ii) Eukaryotic cells.

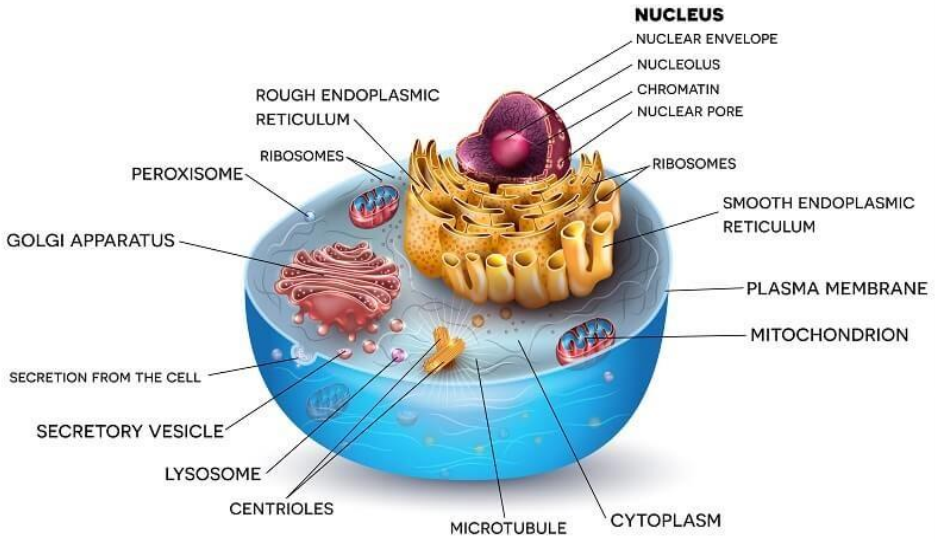
PROKARYOTIC CELLS

The cells of Bacteria and Cyano Bacteria (blue green algae) lack a well organised nucleus and are called prokaryotic cells. Their DNA (Deoxyribo Nucleic Acid) is not enclosed by a nuclear membrane. They also lack membrane bound organelles. The organisms which possess prokaryotic cells are called prokaryotic organisms or prokaryotes. They are considered to be primitive organisms.



EUKARYOTIC CELL

The cells of all plants (except bacteria and cyano bacteria) and animals possess a well organised nucleus and are called Eukaryotic cells. Their genetic material is enclosed by a nuclear membrane. They possess membrane bound organelles like Endoplasmic reticulum, golgi body, mitochondria, plastids and vacuoles. The organisms which possess eukaryotic cells are called Eukaryotic organisms or eukaryotes.



CELL ORGANELLES

A cell performs a variety of functions such as i) Synthesis of complex molecules and their breakdown, ii) Production of energy, iii) Secretion of certain substances, etc.. These activities of the cell are performed by different cell organelles. These organelles are enclosed by membranes. To understand the functioning of the cell, it is necessary to know briefly about the structure of cell organelles.

ENDOPLASMIC RETICULUM

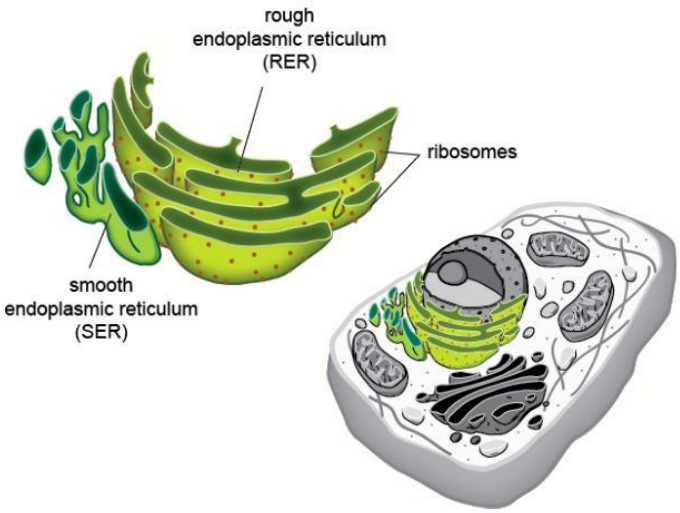
Endoplasmic reticulum is a complicated and interconnected system of membrane bound channels and tubules.

It is spread throughout the cytoplasm and is continuous with the plasma membrane and nuclear membrane.

There are two types of Endoplasmic Reticulum.
a) Rough Endoplasmic Reticulum. (RER)
b) Smooth Endoplasmic Reticulum. (SER)

Rough endoplasmic reticulum (Granular endoplasmic reticulum)
They are found in cells which synthesize proteins. This type of endoplasmic reticulum possesses rough walls because the ribosomes remain attached with membrane of endoplasmic reticulum.

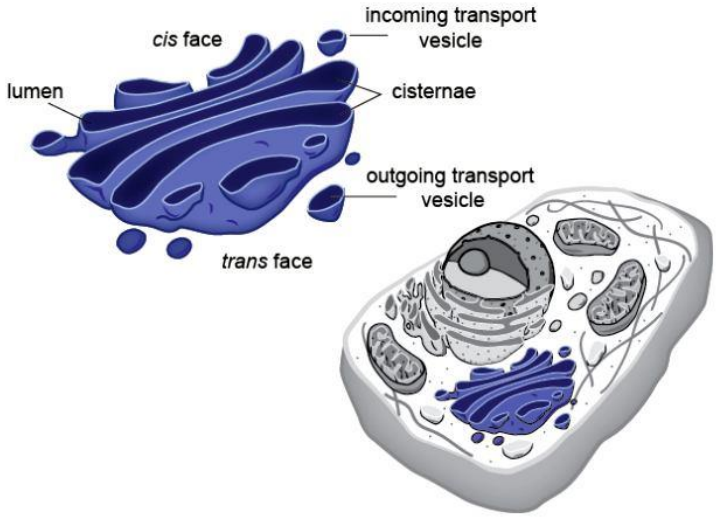
Smooth endoplasmic reticulum (Agranular endoplasmic reticulum)
They are found in cells which synthesize lipid. The walls are smooth and ribosomes are not attached to its membrane.



Functions of Endoplasmic Reticulum
- Endoplasmic Reticulum (E.R) provides large surface area for the metabolic activities of the cell.
- Rough endoplasmic reticulum plays an important role in protein synthesis.
- Smooth endoplasmic reticulum is involved in the synthesis of steroid, hormones and lipids.

GOLGI COMPLEX OR GOLGI APPARATUS

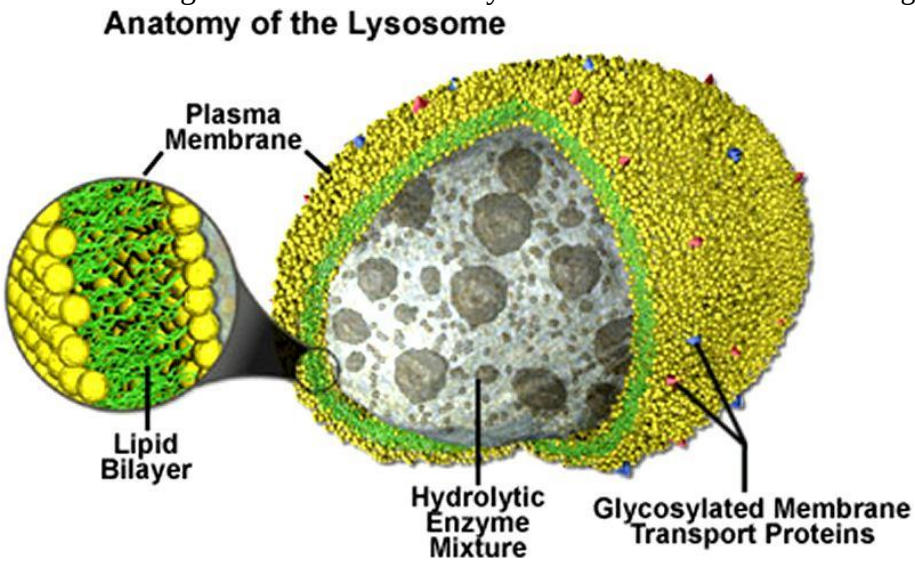
The Golgi apparatus was first described by Camillo Golgi. Golgi complex consist of saucer-like compartments called cisternae, network of interconnecting tubules, vesicles and vacuoles at the peripheral regions. In plant cells, Golgi apparatus is referred to as dictyosomes.



Functions of Golgi Complex
- Golgi apparatus is involved in the formation of lysosomes.
- It is also responsible for the synthesis of cell wall and cell membrane.

LYSOSOMES

Lysosomes are small membrane bound vesicles which contain various types of digestive enzymes. These serve as intracellular digestive system, hence they are called digestive bags.
They are produced by the joint activity of Endoplasmic reticulum and Golgi apparatus. If the membrane of Lysosome happens to get ruptured, the enzymes of Lysosome would digest the entire cellular structure causing death of the cell. So Lysosomes are called " suicide bags " .

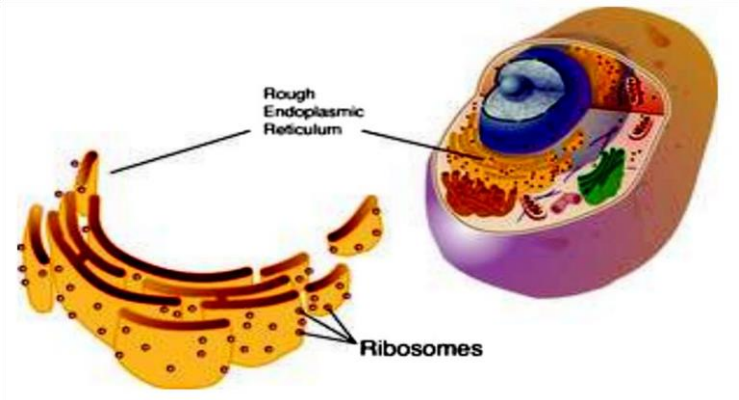


Functions of Lysosomes

- Lysosomes are involved in the intracellular digestion of food particles ingested by the cell through endocytosis.
- The lysosomes of WBCs (White blood cells) destroy pathogens and other foreign particles and thus take part in natural defence of the body.

RIBOSOMES

Ribosomes are small granular structures made up of ribo nucleic acids (RNA) and proteins. They occur free in the cytoplasm as well as attached to the outer surface of the rough endoplasmic reticulum. Each ribosome consists of two subunits – a small subunit and a large subunit. At the time of protein synthesis many ribosomes get attached to messenger RNA and form a structure called polyribosome or polysome.



Functions of Ribosomes

Ribosomes play an important role in protein synthesis. So they are called, " protein factories " of the cell.

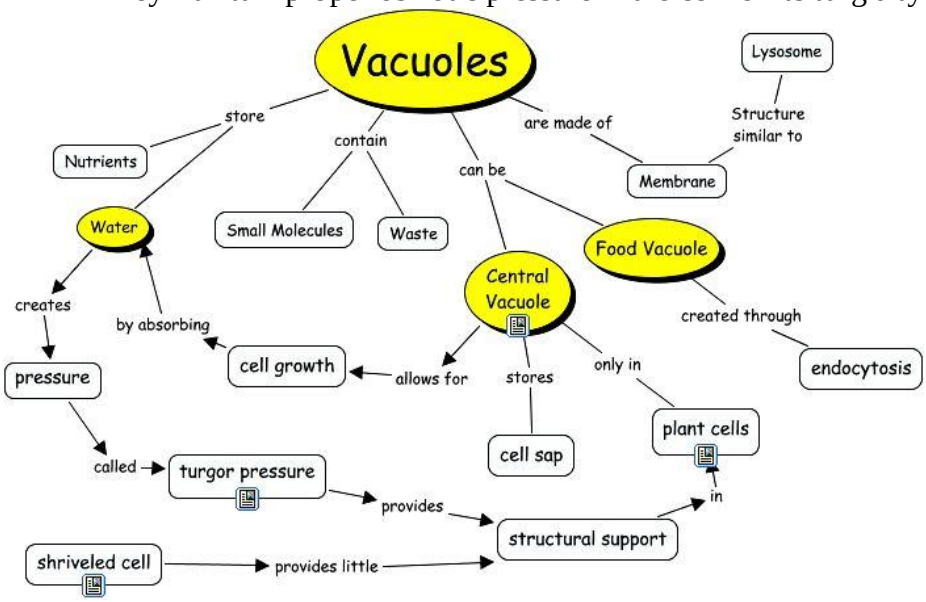
VACUOLES

Vacuoles are fluid– filled sacs bound by a single membrane and are present in plant cells as well as in certain protozoans as food vacuoles and contractile vacuoles. In plant cells, major portion of the cell is occupied by vacuoles and are bound by the definite membrane called tonoplast.

Vacuoles of plants are filled with cell sap containing minerals, sugars, amino acids and dissolved waste products.

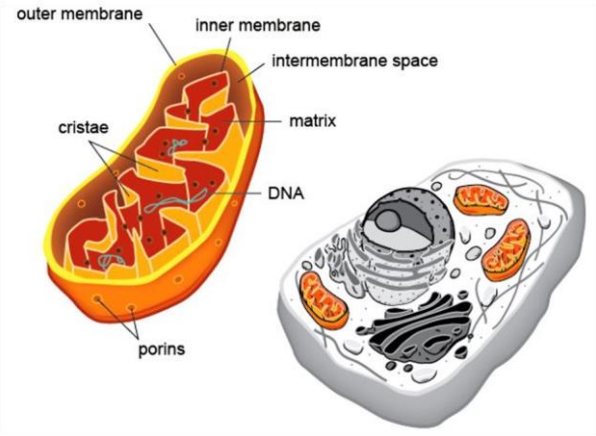
Functions of Vacuoles

- Vacuoles store and concentrate mineral salts as well as nutrients.
- They maintain proper osmotic pressure in the cell for its turgidity and absorption of water.



MITOCHONDRIA

Mitochondria are globular or cylindrical organelles. Each mitochondrion is bound by two membranes – an outer continuous membrane and an inner membrane thrown into folds called cristae. These cristae divide the inner chamber incompletely. The inner chamber is filled with homogenous dense material called the matrix. The cristae have pin headed bodies called F1 particles or Oxysomes which play an important role in respiration.



The matrix of mitochondria contains enzymes necessary for the oxidation of food during respiration and release of energy in the form of ATP molecules. Therefore mitochondria are called power houses of the cell. The mitochondria contain proteins, lipids and a small amount of DNA.

Functions of Mitochondria

- Mitochondria synthesize energy rich compounds such as ATP.
- Mitochondria provide important intermediates for the synthesis of several biochemicals like chlorophyll, cytochromes, steroids, aminoacids etc.

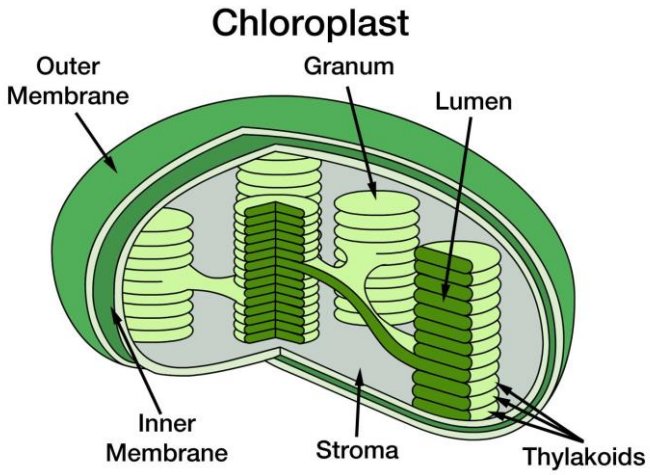
PLASTIDS

Plastids are disc or oval shaped organelles which occur in plant cells only. Plastids are of three types. They are Leucoplasts, Chromoplasts and Chloroplasts.

i) **Leucoplasts:** These are colourless plastids which store food in the form of starch, lipids and proteins

ii) **Chromoplasts:** These are yellow or reddish in colour due to the presence of pigments other than chlorophyll. Chromoplasts provide colour to many flowers and fruits.

iii) **Chloroplasts:** These are green coloured plastids which possess the photosynthetic pigment chlorophyll.



Each chloroplast consists of a double membraned envelope and a matrix. The inner membrane is arranged along the length of the plastids as lamellae. At certain regions, the lamellae are thickened and appear like pile of coins. These are called the grana. Each granum consists of disc shaped membranous sacs called thylakoids. Inside these grana, the chlorophyll is located. The non-thylakoid portion of the matrix is called stroma. It contains a number of enzymes involved in photosynthesis.

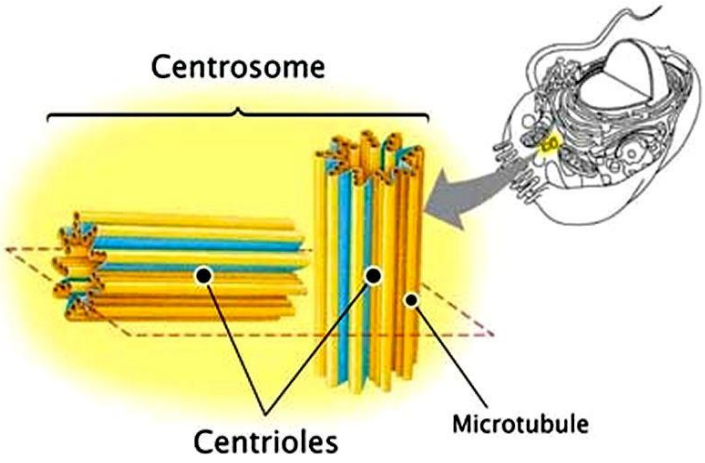
Functions of Plastids: Leucoplasts are responsible for storing food; such as carbohydrates, protein and lipid. Chromoplasts impart various colours to the plant parts. A leaf of a plant is green in colour because of chloroplast. Chloroplast is the site of photosynthesis.

CENTROSOME

Centrosome is present in animal cells and in certain lower plants. It is absent in prokaryotic cells and in higher plant cells. It is located near one pole of the nucleus. It contains a pair of small, hollow granules called centrioles.

Functions of Centrioles

Centrioles play an important role in the formation of spindle fibres during cell division.

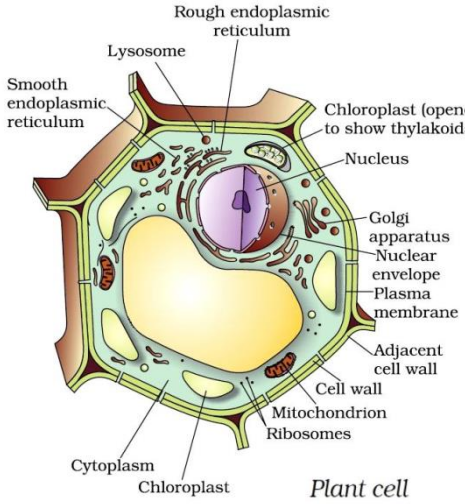


HISTORY OF DISCOVERY OF CELLS

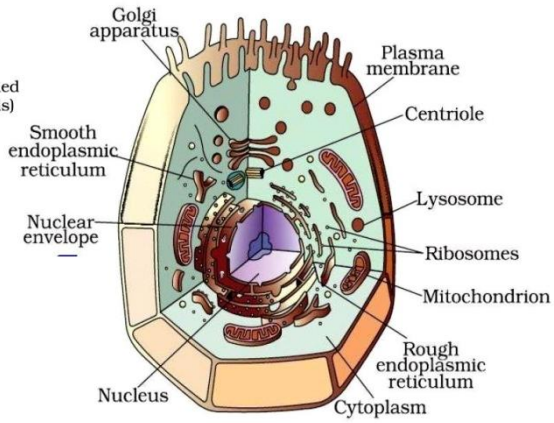
- Robert Hooke was the first to discover cell (1665).
- Leeuwenhoek was the first to discover free living cells in pond water (1674).
- Robert Brown discovered the nucleus (1831).
- Purkinje coined the term ‘protoplasm (1839).
- Schleiden (1838) and Schwann (1839) proposed the Cell Theory. Virchow (1855) made further addition to the cell theory.
- The discovery of electron microscope (1940) made it possible to study the structures of cell organelles.

Differences between Plant cell and Animal cell

S.No.	Plant cell	Animal cell
1.	Plant cell has an outer rigid cell wall which is made up of cellulose.	Animal cell lacks a cell wall.
2.	Plant cell is larger than animal cell.	Animal cell is comparatively smaller in size.
3.	Plant cell has large vacuoles which occupy more space in the cell.	Animal cell usually lacks vacuoles. Even if they are present, they occur in minute sizes.
4.	Centrosome is present only in the cells of some lower plants.	All the animal cells have centrosomes.
5.	Lysosomes are found only in the eukaryotic plant cells.	Lysosomes are found in all animal cells.
6.	Plant cell contains plastids.	Plastids are absent
7.	Mostly, starch is the storage material.	Glycogen is the storage material.



Plant cell



Animal cell

Differences between Prokaryotic cell and Eukaryotic cell

Prokaryotic Cell		Eukaryotic Cell	
1.	It is generally smaller (1-10 micro metre) in size	1.	It is comparatively larger (5-100 micro metre) in size.
2.	It lacks a well organised nucleus as its nuclear material is not surrounded by a nuclear membrane.	2.	It contains a well organized nucleus as its nuclear material is surrounded by a nuclear membrane.
3.	It has a single chromosome	3.	It has more than one chromosome.
4.	Nucleolus is absent	4	Nucleolus is present
5.	It lacks membrane bound cell organelles.	5.	It possess membrane bound cell organelles.
6.	Cell division occurs by fission or budding. Mitotic and meiotic divisions are absent	6.	Cell division takes place by mitosis and meiosis.
7.	Ribosomes are smaller	7.	Ribosomes are larger