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CHAPTER – 5

FUNDAMENTAL UNIT OF LIFE

Cells were first discovered by Robert Hooke in 1665. He observed the cells in a cork slice with the help of a primitive microscope. Leeuwenhoek (1674), with the improved microscope, discovered the free living cells in pond water for the first time. It was Robert Brown in 1831 who discovered the nucleus in the cell. Purkinje in 1839 coined the term 'protoplasm' for the fluid substance of the cell.

The cell theory, that all the plants and animals are composed of cells and that the cell is the basic unit of life, was presented by two biologists, Schleiden (1838) and Schwann (1839). The cell theory was further expanded by Virchow (1855) by suggesting that all cells arise from pre-existing cells.

CELL

the cell is the fundamental structural and functional unit of living matter and that the organism is composed of autonomous cells with its properties being the sum of those of its cells.

Unicellular organisms

Unicellular organisms are composed of single cell.
The single cell constitutes the structure and entire function of the organism.
single cell may constitute a whole organism as in Amoeba , Chlamydomonas, Paramoecium and bacteria.These organisms are called unicellular organisms.

Multicellular organisms

many cells group together in a single body and assume different functions in it to form various body parts in multicellular organisms (multi = many) such as some fungi, plants and animals

organelles

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

Structural Organisation of a Cell

study a cell under a microscope, we would come across three features in almost every cell; plasma membrane, nucleus and cytoplasm. All activities inside the cell and interactions of the cell with its environment
are possible due to these features

Prokaryotic & Eukaryotic cells

Two types of cell; Prokaryotic and Eukaryotic cells. Prokaryotic cells are primitive and lack well defined nucleus. Eukaryotic cells are more advanced and have well defined nucleus.

PLASMA MEMBRANE OR CELL MEMBRANE

Plasma membrane is the outermost layer in cells. It separates the content of cell from their external environment. ... It also allows the movement of water in and out of the cell depending upon the concentration outside the cell by the process of osmosis

OR

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.

Cell Membrane :

(a) Cell membrane is also called as plasma membrane or plasma lemma.
(b) It is the limiting boundary of each cell which separates the cytoplasm from its surroundings.
(c) It is found in both plant as well as animal cells.
(d) It is the outermost covering of a cell in case of animals and lies below the cell wall in case of plants.
(e) It is made up of proteins and lipids where proteins are sandwiched between bilayer of lipids.
(f) Plasma membrane is selectively permeable in nature. It allows or permits the entry and exit of some materials in and out of the cell.

Diffusion

Some substances like carbon dioxide or oxygen can move across the cell membrane by a process called diffusion.
Diffusion : Movement of solutes or ions from higher concentration to lower concentration is called as diffusion. It does not require energy therefore, it is called as passive transport

osmosis.

The movement of water molecules through such a selectively permeable membrane is called osmosis.

OR

osmosis is the passage of water from a region of high water concentration through a semi-permeable membrane to a region of low water concentration.

Unicellular freshwater organisms and most plant cells tend to gain water through osmosis. Absorption of water by plant roots is also an example of osmosis.

Osmosis can also be called as 'Diffusion of solvents'.

• Endomosis : Movement of solvent into the cell is called as Endomosis.

• Exosmosis : Movement of solvent outside the cell is called as Exomosis.

<u>Isotonic, hypotonic solutions, hypertonic solutions</u>

- **Isotonic solutions are those which have the same solute and pH concentration as the surrounding body fluid or the cytoplasm.**
- **Hypotonic solutions contain lesser amount of solute concentration compared to the surrounding fluid and can force the cell to rupture due to excess input of water into the cell.**
- **Hypertonic solutions contain higher concentration of solute compared to the surrounding fluid and thus push water out of cell, shrinking it.**

Endocytosis

The plasma membrane is flexible and is made up of organic molecules called lipids and proteins. However, we can observe the structure of the plasma membrane only through an electron microscope. The flexibility of the cell membrane also enables the cell to engulf in food and other material from its external environment. Such processes are known as endocytosis.

Types of Solutions on the Basis of Concentration

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

(b) Hypertonic Solution : When the concentration of the solution outside the cell is more than the inside the cell. Due to this, cell looses water and becomes plasmolysed.

(c) Hypotonic Solution : When the concentration of the solution outside the cell is lesser than that of cytoplasm of cell. Due to this, cell swells up and bursts.

CELL WALL

Plant cells, in addition to the plasma membrane, have another rigid outer covering called the cell wall.
The cell wall lies outside the plasma membrane.
The plant cell wall is mainly composed of cellulose.
Cellulose is a complex substance and provides structural strength to plants.

Plasmolysis

When a living plant cell loses water through osmosis there is shrinkage or contraction of the contents of the cell away from the cell wall. This phenomenon is known as plasmolysis.

NUCLEUS

The nucleus has a double layered covering called nuclear membrane. The nuclear membrane has pores which allow the transfer of material from inside the nucleus to its outside, that is, to the cytoplasm.

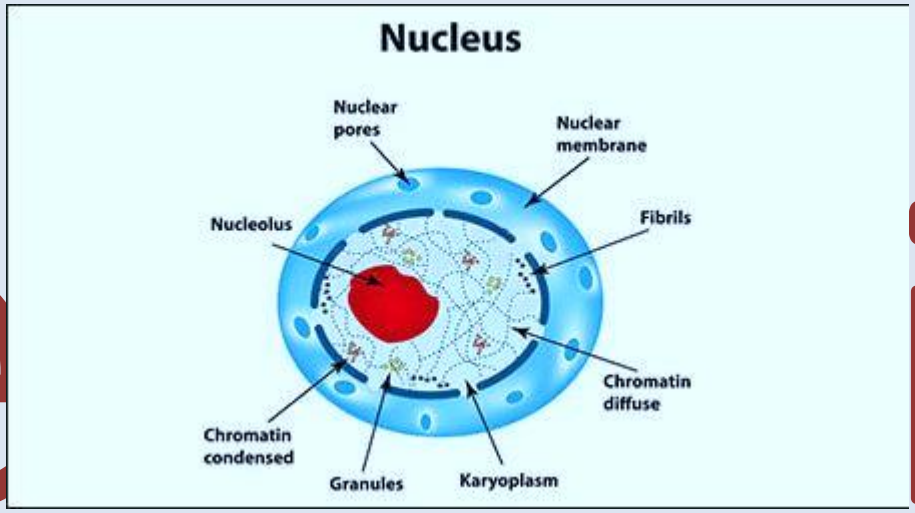
The nucleus contains chromosomes, which are visible as rod-shaped structures only when the cell is about to divide. Chromosomes contain information for inheritance of features from parents to next generation in the form of DNA (Deoxyribo Nucleic Acid) molecules. Chromosomes are composed of DNA and protein. DNA molecules contain the information necessary for constructing and organising cells. Functional segments of DNA are called genes.

In a cell which is not dividing, this DNA is present as part of chromatin material. Chromatin material is visible as entangled mass of thread like structures. Whenever the cell is about to divide, the chromatin material gets organized into chromosomes.

Nucleus is the most important cell organelle which directs and controls all its cellular activities.

- It is called as 'Headquarter of the cell'.
- It was discovered by Robert Brown in 1831.
- In Eukaryotes, a well-defined nucleus is present while in Prokaryotes, a well-defined nucleus is absent.
- Prokaryotes contain a primitive nucleus.

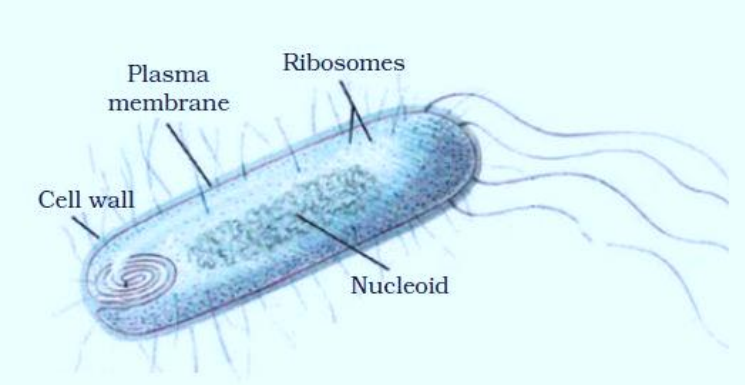
• It has double layered covering called as nuclear membrane.
• Nuclear membrane has pores which regulate the movement of materials in & out of the cell.
• Besides nuclear membrane, nucleus also contains nucleolus and
chromatin material and the substance filled inside the nucleus is nucleolus.



Prokaryotes

organisms like bacteria, the nuclear region of the cell may be poorly defined due to the absence of a nuclear membrane. Such an undefined nuclear region containing only nucleic acids is called a nucleoid. Such organisms, whose cells lack a nuclear membrane, are called prokaryotes (Pro = primitive or primary; karyote ≈ karyon = nucleus).

Organisms with cells having a nuclear membrane are called eukaryotes

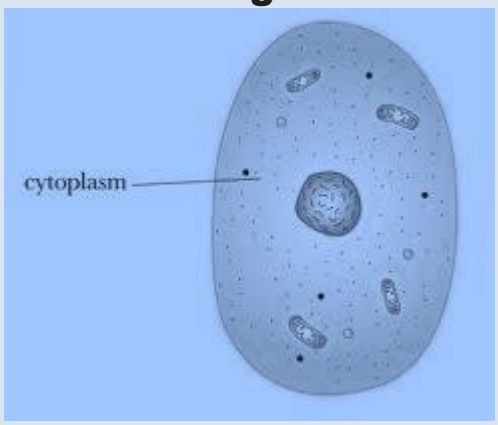


Prokaryotic cell

CYTOPLASM

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.

Cell organelles are enclosed by membranes. In prokaryotes, beside the absence of a defined nuclear region, the membrane-bound cell organelles are also absent. On the other hand, the eukaryotic cells have nuclear membrane as well as membrane-enclosed organelles.



It can be divided into two parts :

(i) Cytosol : Aqueous soluble part contains various fibrous proteins forming cytoskeleton.

(ii) Cell organelles : Living part of the cells having definite shape, structure and function bounded by plasma membrane.

CELL ORGANELLES

The basic structure of cell consist of nucleus, plasma membrane and cytoplasm. Other than this different structures like Endoplasmic Reticulum(ER), Golgi body, Lysosomes, Mitochondria, Plastids and Vacuoles are also present. All of these are cell organelles.

ENDOPLASMIC RETICULUM

The endoplasmic reticulum (ER) is a large network of membrane-bound tubes and sheets. It looks like long tubules or round or oblong bags (vesicles). The ER membrane is similar in structure to the plasma membrane.
There are two types of ER– rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER).

Rough endoplasmic reticulum (RER)

ER looks rough under a microscope because it has particles called ribosomes attached to its surface. The ribosomes, which are present in all active cells, are the sites of protein manufacture.The manufactured proteins are then sent to various places in the cell depending on need, using the ER.

smooth endoplasmic reticulum (SER).

The SER helps in the manufacture of fat molecules, or lipids, important for cell function. Some of these proteins and lipids

help in building the cell membrane. This process is known as membrane biogenesis. Some other proteins and lipids function as enzymes and hormones.

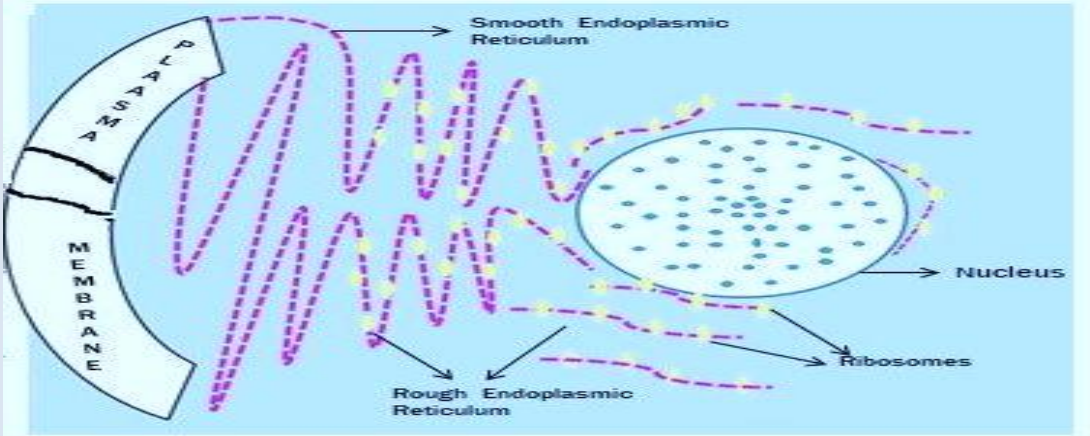
Functions of ER :

ER is to serve as channels for the transport of materials (especially proteins) between various regions of the cytoplasm or between the cytoplasm and the nucleus.

It also functions as a cytoplasmic framework to provide space for some of the biochemical activities. It forms endoskeleton of cell.

It helps in synthesis of fats, steroids, cholesterol etc.

SER plays a crucial role in detoxification of drugs and poisonous by-products.



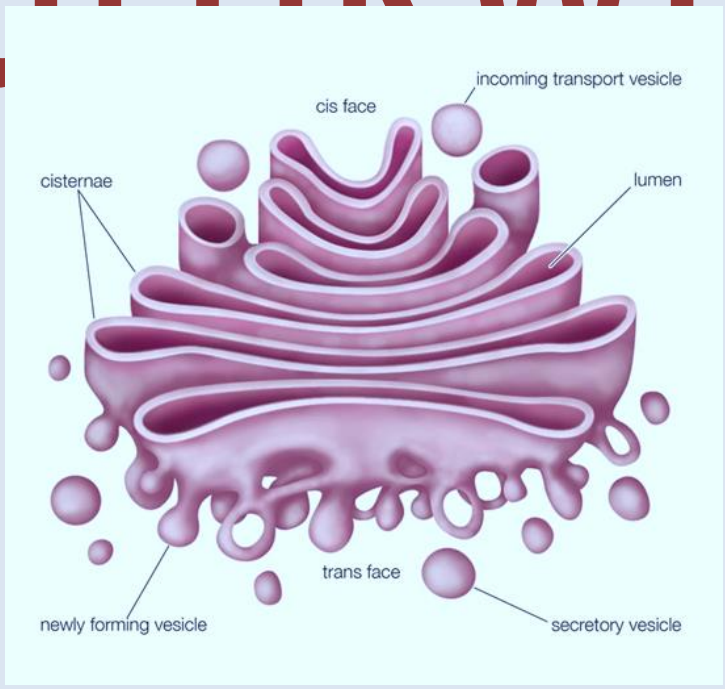
GOLGI APPARATUS

The Golgi apparatus is an organelle present in most eukaryotic cells. It is made up of membrane-bound sacs, and is also called a Golgi body, Golgi complex, or dictyosome. The job of the Golgi apparatus is to process and bundle macromolecules like proteins and lipids as they are synthesized within the cell.

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

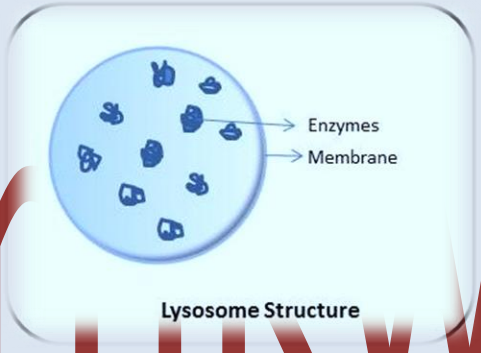
Functions of Golgi apparatus *:*

(a) It helps in formation of lipids.
(b) It helps in formation of middle lamellae.
(c) It is secretary in nature.
(d) It helps in melanin synthesis.
(e) Lipids and proteins synthesized in endoplasmic reticulum are packed at Golgi complex. They provide the site for assembly of new membrane material.



LYSOSOMES

Lysosomes are a kind of waste disposal system of the cell. Lysosomes help to keep the cell clean by digesting any foreign material as well as worn-out cell organelles. Foreign materials entering the cell, such as bacteria or food, as well as old organelles end up in the lysosomes, which break them up into small pieces. Lysosomes are able to do this because they contain powerful digestive enzymes capable of breaking down all organic material.
when the cell gets damaged, lysosomes may burst and the enzymes digest their own cell. Therefore, lysosomes are also known as the 'suicide bags' of a cell.



MITOCHONDRIA

Mitochondria are known as the powerhouses of the cell. The energy required for various chemical activities needed for life is released by mitochondria in the form of ATP (Adenosine triphopshate) molecules. ATP is known as the energy currency of the cell. The body uses energy stored in ATP for making new chemical compounds and for mechanical work.
Mitochondria have two membrane coverings instead of just one. The outer membrane is very porous while the inner membrane is deeply folded. These folds create a large surface area for ATP-generating chemical reactions.

Functions of Mitochondria :

(a) Its main function is to produce and store the energy in the form of ATP.

(b) It is the site of Kreb cycle of respiration.

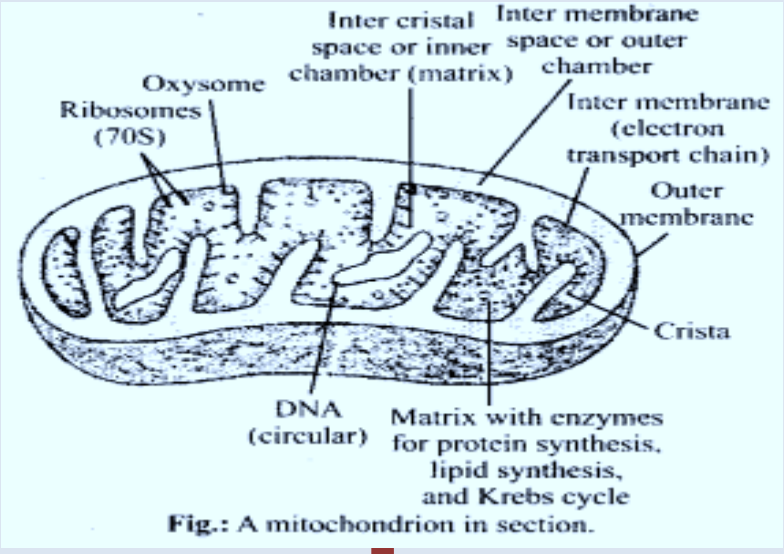


Fig.: A mitochondrion in section.

PLASTIDS

Plastids are present only in plant cells. There are two types of plastids – chromoplasts (coloured plastids) and leucoplasts (white or colourless plastids).

Plastids containing the pigment chlorophyll are known as chloroplasts.

Chloroplasts are important for photosynthesis in plants.

Chloroplasts also contain various yellow or orange pigments in addition to chlorophyll.

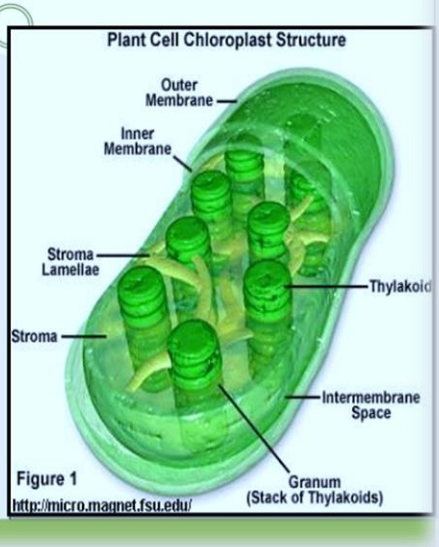
Leucoplasts are primarily organelles in which materials such as starch, oils and protein granules are stored.

It is double membranous discoidal structure, found only in plant cells.

Besides being discoidal of rhombic in plant cells, they occur in variable shapes like in algae. They can be 'U'-shaped, spiral, coiled, ribbon shaped etc.

Structures:

1. Grana
2. Thylakoids
3. Stroma
4. Inner Membrane
5. Outer Membrane



VACUOLES

Vacuoles are storage sacs for solid or liquid contents. Vacuoles are small sized in animal cells while plant cells have very large vacuoles. The central vacuole of some plant cells may occupy 50-90% of the cell volume.

Functions :

It helps in maintaining osmotic pressure in a cell & stores toxic metabolic products of plant cell.

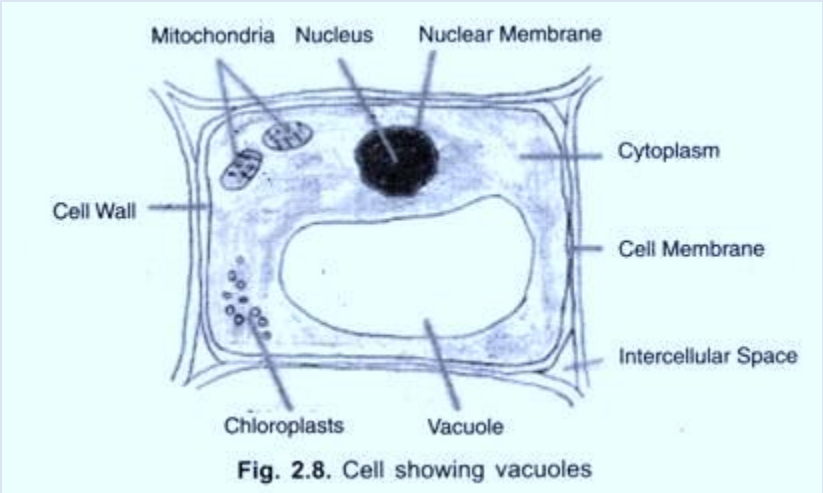


Fig. 2.8. Cell showing vacuoles

Ribosomes

The ribosome is a complex molecular machine found inside the living cells that make proteins from amino acids in the process called protein synthesis or translation. Protein synthesis is a major task performed by living cells. Ribosomes are special organelles as they are found in both prokaryotic and eukaryotic cells.

The Function Of Ribosomes.

The function of ribosomes is to synthesize proteins as directed in the messenger RNA. Ribosomes are organelles and help produce proteins with many different functions in the body, they can be found within the cytoplasm or the endoplasmic reticulum

Differences between Animal cell and Plant cell

Plant Cell	Animal Cell
• Contain chloroplasts for photosynthesis.	• No cell wall.
• Have a cell wall to maintain structure and rigidity.	• No chloroplasts.
• Usually do not contain lysosoms and Peroxisomes.	• Contain cilia and/or flagella
• Cells are square and rigid or geometric shaped. many shapes.	• Cells are fluid and flexible,