Chapter 5:- The Fundamental Unit of Life

Part-1:

Cell

It is the structural and functional unit of life.

- **Cell is termed as the structural unit of life as it** provides structure to our body.
- **Cell is considered as the functional** unit of life as all the functions of the body take place at cell level.

Discovery of cell:

- Discovered by Robert Hooke in 1665.
- Robert Brown in 1831 discovered the nucleus in the cell.

Cell Theory:

Cell theory states that:

- All living organisms are composed of cells.
- Cell is the fundamental unit of life.
- All new cells come from pre-existing cells.

Types of Organisms on the Basis of Number of Cells

There are two kinds of organisms on the basis of cells:

(i) Unicellular Organisms: The organisms that are made up of single cell and may constitute a whole organism, are named as unicellular organisms.

For example: Amoeba, Paramecium, bacteria, etc.

(ii) Multicellular Organisms: The organisms which are composed of a collection of cells that assume function in a coordinated manner, with different cells specialized to perform particular tasks in the body, are named as multicellular organisms.

For example: Plants, human beings, animals, etc.

Shape and Size of Cells

- Cells vary in shape and size. They may be oval, spherical, rectangular, spindle shaped, or totally irregular like the nerve cell.

- The size of cells also varies in different organisms. Most of the cells are microscopic in size like red blood cells (RBC) while some cells are fairly large like nerve cells.

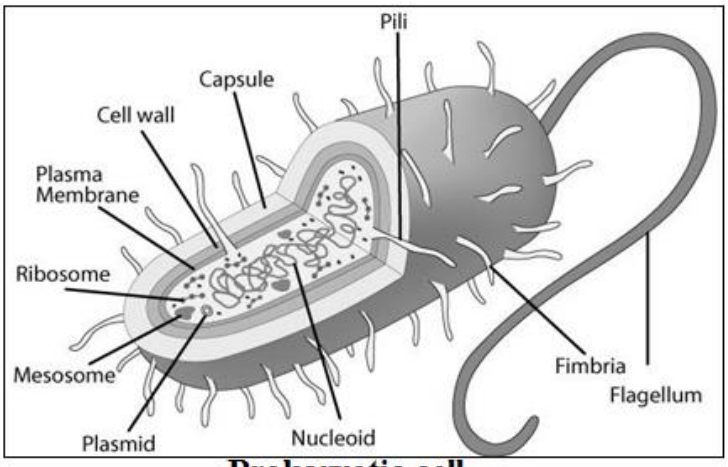
Types of Cells

The cells can be categorized in two types:

1. Prokaryotic Cell 2. Eukaryotic Cell

1. Prokaryotic cell

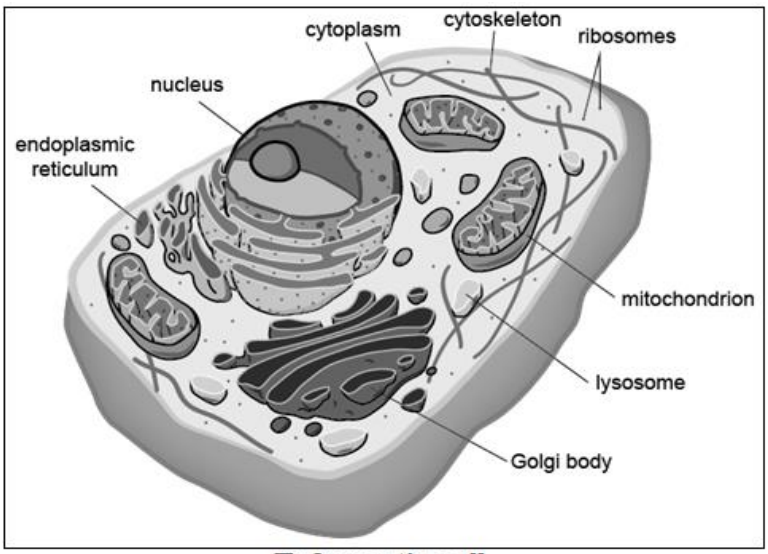
Prokaryotic cells are cells in which the true nucleus is absent. They are primitive and incomplete cells. Prokaryotes are always unicellular organisms. For example, archaebacteria, bacteria, blue green algae are all prokaryotes.



Prokaryotic cell

2. Eukaryotic Cell

Eukaryotic cells are the cells in which the true nucleus is present. They are advanced and complete cells. Eukaryotes include all living organisms (both unicellular and multicellular organisms) except bacteria and blue green algae.



Eukaryotic cell

Difference Between Prokaryotic and Eukaryotic Cells:

S. No.	Prokaryotic cell	Eukaryotic cell
1.	Size of the cell is generally small (1-10 mm).	Size of the cell is generally large (5-100 mm).
2.	Nucleus is absent.	Nucleus is present.
3.	It contains a 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, etc., are present.
6.	Cell division takes place by fission or budding.	Cell division takes place by mitotic or meiotic cell division.

Structure of Cell

Cell is generally composed of three basic components:

(i) Cell wall and cell membrane

(ii) Nucleus

(iii) Cytoplasm

(i) Cell membrane or Plasma membrane:

Plasma membrane is the covering of the cell that separates the contents of the cell from its external environment.
It is a living part of the cell and is present in cells of plants, animals and microorganisms.
It is a very thin, delicate, elastic and selectively permeable membrane.
It is composed of lipid and protein.

Function:

As it is a selectively permeable membrane, it allows the flow of limited substances in and out of the cell.

(ii) Cell wall:

the cell wall is non-living, thick and freely permeable covering made up of cellulose.
It is present in eukaryotic plant cells and in prokaryotic cells.

Functions:

- It determines the shape and rigidity to the plant cell.
- It protects the plasma membrane.
- It prevents desiccation or dryness in the cell.
- It helps in the transport of various substances in and out of the cell.

(iii) Nucleus:

Nucleus is dense and spherical organelle.
Nucleus is bounded by two membranes, both forming a nuclear envelope. Nuclear envelope contains many pores known as nuclear pores.
The fluid which is present inside the nucleus is called nucleoplasm.
Nucleus contains chromosomes and chromosomes contain genes which are the centres of genetic information.

Functions:

- Nucleus controls all the metabolic activities of the cell.
- It regulates the cell cycle.
- Nucleus is the storehouse of genes.It is concerned with the transmission of hereditary traits from the parent to offspring.

(iv) Cytoplasm:

It is a jelly-like, viscous, colourless semi-fluid substance that occurs between the plasma membrane and the nuclear membrane.
The aqueous ground substance of cytoplasm is called cytosol that contains a variety of cell organelles and other insoluble waste products and storage products, like starch, glycogen, lipid, etc.

Functions:

• Protoplasm acts as a store of vital chemicals like amino acids, proteins, sugars, vitamins, etc.

• It is the site of certain metabolic reactions, like glycolysis, synthesis of fatty acids, nucleotides, etc.

Cell organelles:

Inside the cell there are different parts performing different activities to keep the cell alive and functionable. These part are called Cell organelles. They are explained below:

1. Golgi Apparatus:

Golgi apparatus consists of a set of membrane bound, fluid filled vesicles, vacuoles and flattened cisternae (closed sacks).
Cisternae are usually arranged parallel to each other.

Functions:

- Its main function is to store, modify, package and dispatch the substances.
- It is also involved in the synthesis of cell walls, plasma membrane and lysosomes.

2. Endoplasmic Reticulum:

It is a membranous network of tube-like structures extending from nuclear membrane to plasma membrane.
It is absent in prokaryotic cells and matured RBCs of mammals.
There are two types of endoplasmic reticulum: (i) Rough Endoplasmic Reticulum (RER): Here ribosomes are present on the surface for the synthesis of proteins. (ii) Smooth Endoplasmic Reticulum (SER): Here ribosomes are absent and is meant for secreting lipids.

Functions:

- It gives internal support to cell.
- It helps in transport of various substances from nuclear membrane to plasma membrane or vice versa.
- RER helps in synthesis and transportation of proteins.
- SER helps in synthesis and transportation of lipids.

3. Ribosomes:

These are extremely small, dense and spherical bodies which occur freely in the matrix (cytosol) or remain attached to the endoplasmic reticulum.
These are made up of ribonucleic acid (RNA) and proteins.

Function:

They play a major role in the synthesis of proteins.

4. Mitochondria:

They are small rod-shaped organelles.
It is a double membrane structure with outer membrane being smooth and porous whereas inner membrane being thrown into a number of folds called cristae.
They contain their own DNA and ribosomes.
They are absent in bacteria and red blood cells of mammals.

Functions:

- They are the sites of cellular respiration, hence provide energy for the vital activities of living cells.
- They store energy releases during reactions, in the form of ATP (Energy currency of the cell). Therefore, they are also called ‘power house’ of the cell.

5. Centrosome and Centrioles:

Centrosome is found only in eukaryotic animal cells. It is not bounded by any membrane but consists of centrioles.
Centrioles are hollow cylindrical structures arranged at right angle to each other and made up of microtubules.

Function:

Centrioles help in cell division and also help in the formation of cilia and flagella.

6. Plastids:

Plastids are present in most of the plant cells and absent in animal cells.

They are usually spherical or discoidal in shaped and double membrane bound organelles.

They also have their own DNA and ribosomes.

Plastids are of three types:

(a) Chloroplasts: These are the green coloured plastids containing chlorophyll. Chloroplasts aid in the manufacture of food by the process of photosynthesis.

(b) Chromoplasts: These are the colourful plastids (except green colour).

(c) Leucoplasts: These are the colourless plastids.

Function:

- Chloroplasts trap solar energy and utilise it to manufacture food for the plant.
- Chromoplasts impart various colours to flowers to attract insects for pollination.
- Leucoplasts help in the storage of food in the form of starch, proteins and fats.

7. Lysosomes:

Lysosomes are small, spherical, sac like structures which contain several digestive enzymes enclosed in a membrane.

They are found in eukaryotic cells mostly in animals.

Functions:

- Lysosomes help in digestion of foreign substances and worn-out cell organelles.
- They provide protection against bacteria and viruses.
- They help to keep the cell clean.

- During the disturbance in cellular metabolism, for example when the cell gets damaged, lysosomes may burst and the enzymes digest their own cell. Therefore, lysosomes are also known as **suicide bags** of a cell

8. Vacuoles:

Vacuoles are liquid/solid filled and membrane bound organelles.
In plant cells, vacuoles are large and permanent. In animal cells, vacuoles are small In size and temporary.
In mature plant cell, It occupies 90% space of cell volume.
Due to its size, other organelles, including nucleus shift towards plasma membrane.

Function:

- They help to maintain the osmotic pressure in a cell.
- They provide turgidity and rigidity to the plant cell.

9. Peroxisomes:

They are small and spherical organelles containing powerful oxidative enzymes.
They are bounded by a single membrane.
They are found in kidney and liver cells.

Function:

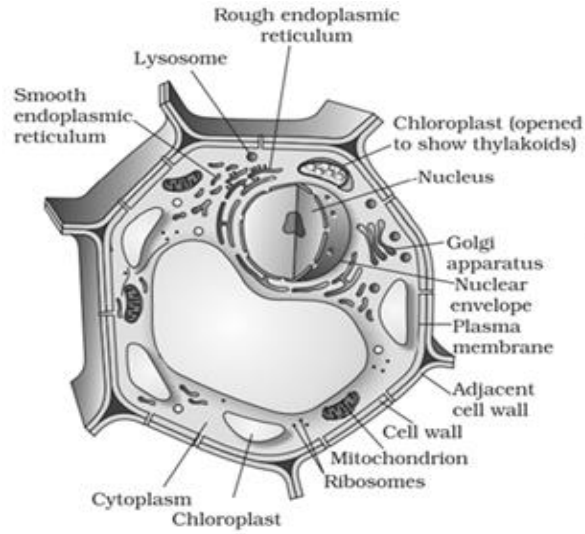
- They are specialized to carry out some oxidative reactions, such as detoxification or removal of toxic substances from cells.

Difference Between Animal Cell and Plant Cell:

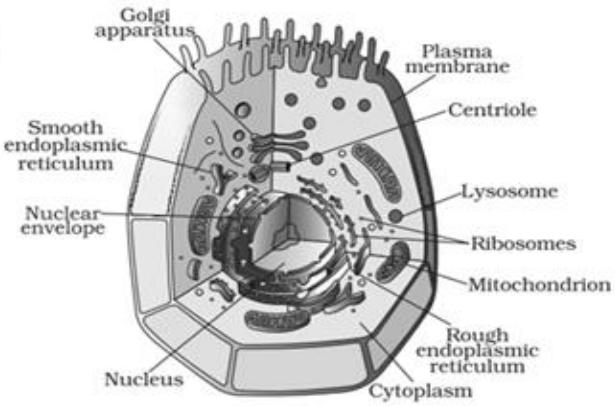
S. No.	Animal cell	Plant cell
1.	Animal cells are generally small in size.	Plant cells are larger than animal cells.

2.	Cell wall is absent.	Plasma membrane of a plant cell is surrounded by a rigid cell wall of cellulose.
3	Plastids are absent except in the case of protozoan Euglena.	Plastids are present.
4.	Here vacuoles are many, small and temporary.	They have a permanent and large central sap vacuole.
5.	They have centrosomes and centrioles.	They lack centrosomes and centrioles.

Structure of Plant cell and Animal cell:



Plant cell



Animal cell

Try the following questions:

Q1. What is the characteristic of nuclear envelope?

Q2. Where does ATP synthesis occur in mitochondria?

Q3. What would happen if the plasma membrane ruptures or break down?

Q4. Why are lysosomes known as suicide bags?

Q5. Which cell organelle is also known as the 'Power house of the cell' and why?

Part-2:

Transport of Substances through Plasma Membrane

Selectively Permeable Membrane:

Plasma membrane permits the entry and exit of certain materials in the cells. Therefore, it is named as a selectively permeable membrane.

Substances can pass through the plasma membrane by two processes:

1. Diffusion

2. Osmosis

Diffusion

It is the process of movement of substances from a region of high concentration to the region of low concentration until uniform concentration is finally acheived.

For example:

- During respiration, due to the difference of the concentration of carbon dioxide (CO_2), inside and outside of the cell, CO_2 is given out a waste product, moving out from region of high concentration to region of low concentration.
- Similarly, oxygen (O_2) enters the cell by the process of diffusion when level of concentration of O_2 inside the cell decreases.

Osmosis

It is the process of movement of water from its high concentration region to its low concentration region through semi-permeable membranes.

Different types of solutions exhibiting osmosis are:

(i) Hypotonic Solution:

If the medium surrounding the cell has a higher water concentration than the cell, i.e., if the solution is a very dilute solution, then the cell will gain water by osmosis. Such a dilute solution is called a Hypotonic solution.

Endosmosis: Though water molecules are free to pass across plasma membranes on both sides but more water will enter inside the cell. The cell will therefore swell up and increase in volume. This process is called **Endosmosis.**

(ii) Isotonic Solution:

If the medium surrounding the cell is of exactly the same water concentration as inside the cell, there will be no net movement of water across the membrane resulting in no change in size of cell. Such a solution is called Isotonic solution.

(iii) Hypertonic solution:

If the medium surrounding the cell has a lower water concentration than inside the cell, i.e., if the solution is highly concentrated, then the cell will lose water through osmosis. Such a concentrated solution is called Hypertonic solution.

Exosmosis: When the water moves out of the cell placed in a highly concentrated solution, it wall causes the cell to shrink. This process is known as Exosmosis.

Plasmolysis and Cytolysis:

The biological phenomena of exosmosis when a cell or tissue is placed into a strong hypertonic solution, is termed as plasmolysis, whereas the reverse process is **cytolysis**, which occurs if the cell is placed in a hypotonic solution resulting in a lower external osmotic pressure and a net flow of water into the cell.

Difference between Diffusion and Osmosis:

S. No.	Diffusion	Osmosis
1.	It can take place in any medium.	It can take place only in liquid medium.
2.	Semipermeable membrane is not required.	Semipermeable membrane is required.
3.	Here the diffusing molecules may be solids, liquids or gases.	It involves the movement of solvent molecules only.

4.	It is dependent on the free energy of the molecules of the diffusing substance only.	Here the diffusion of the solvent molecules is affected by the presence of other substances (solute) in the system.
5.	An equilibrium in the free energy of the diffusing molecules is achieved.	Equilibrium in the free energy of the solvent molecules is never achieved.

Mediated Transport:

Plasma membrane renders the transport of many molecules of biological significance. Such essential molecules are moved across the membrane by special proteins called transport proteins or permeases. This process of forced diffusion of certain substances through the plasma membrane is called mediated transport.

Note: Permeases used in the process are quite specific to the substance they transport.

Types of Mediated Transport:

It is of the following two types:

(i) Facilitated transport/diffusion: Here, the permeases assists a molecule to diffuse through the membrane that it cannot otherwise penetrate.

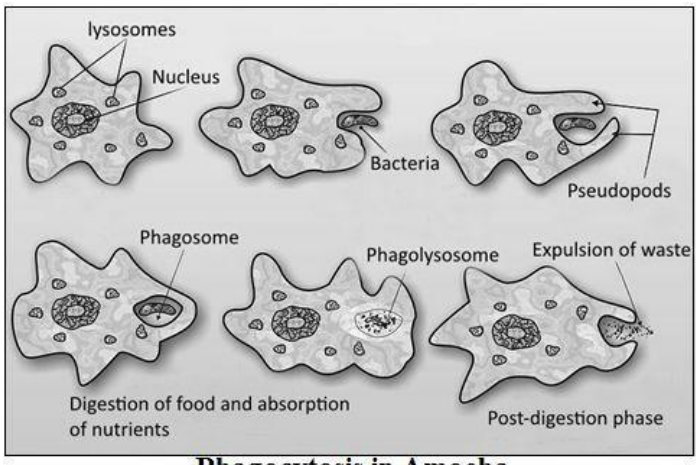
(ii) Active transport: In this case, the energy is supplied to the system to transport the molecules in a direction opposite to a concentration gradient.

Endocytosis:

It is the process of ingestion of materials by the cells through the plasma membrane.

It describes all three similar processes: phagocytosis (cell eating), potocytosis (cell drinking) and receptor-mediated endocytosis.

Phagocytosis: It is a method of intake of food materials by certain organisms like protozoa (Amoeba). The flexibility of the cell membrane enables the cell to engulf the solid particles of food and other materials from its external environment.



Phagocytosis in Amoeba

Exocytosis:

In this process the membrane of a vesicle can fuse with plasma membrane and extrude its contents to the surrounding medium. This process is also named as cell vomiting.

Cells exhibit exocytosis to:

- Remove the undigested residues od=f substances brought in by endocytosis.
- Secrete substances such as hormones, enzymes
- Transport a substance completely across a cellular barrier.

Try the following questions:

Q1. Why is the plasma membrane called a selectively permeable membrane?

Q2. How do substances like CO_2 and water move in and out of the cell? Discuss.

Q3. How does an Amoeba obtain its food?

Q4. What is Plasmolysis?

Q5. Differentiate between endocytosis and exocytosis.

Q6. Why does the skin of our hands shrink when we wash clothes for a long time?