Chapter 5 - The Fundamental Unit of Life

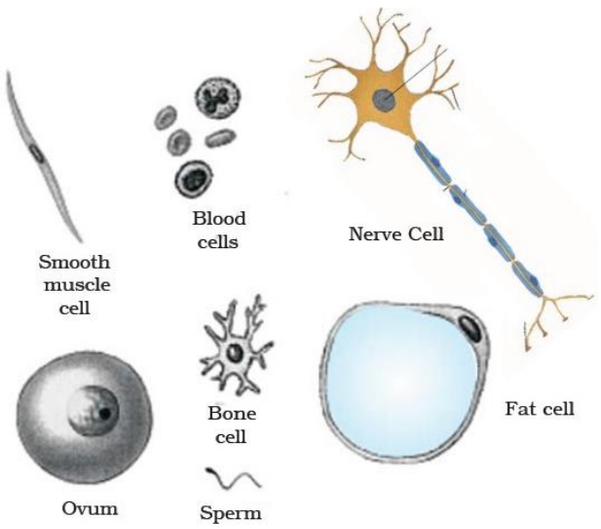
What are Living organisms made up of?

All living organisms are made up of cells. Cell is the basic structural and functional unit of complex organisms.

History of cell:

Cells were first discovered by Robert Hooke in 1665 with the help of a primitive microscope.
Leeuwenhoek, in 1674, with the improved microscope, discovered free-living cells in pond water for the first time.
Robert Brown in 1831 discovered the nucleus in the cell.
Purkinje in 1839 coined the term 'protoplasm' for the fluid part of the cell.
Schleiden in 1838 and Schwann in 1839 proposed the cell theory which stated that all plants and animals are composed of cells.
Rudolf Virchow in 1855 further expanded the cell theory by suggesting that all cells arise from pre-existing cells.

The invention of magnifying lenses led to the discovery of the microscopic world. Unicellular organisms are the organisms in which a single cell performs all the functions like nutrition, respiration, excretion and reproduction. Eg. Amoeba, Chlamydomonas, Paramecium and Bacteria possess single cells constituting the whole organism.
Multicellular organisms are the organisms which possess many cells to perform different functions. Multicellular organisms represent themselves as a member of a group of cells or as an individual.
Eg. Fungi, plants and animals have many cells that group together to form tissues. Every multi cellular organism has come from a single cell. All cells thus come from pre existing cell.
Some organisms can also have cells of different kinds.



The shape and size of cell are related to the specific function they perform. Some cells change their shapes. Eg. Amoeba. In some cases the cell shape could be more or less fixed and the peculiar for a particular type of cell. Eg: nerve cells

Each living cell has the capacity to perform certain basic functions that are characteristic of all living forms. There is a division of labour in multicellular organism such as human beings. This means that different parts of the human body perform different functions. Similarly division of labour is also seen within a single cell. In fact each such cell has got certain specific components within it known as **cell organelles**. Each kind of cell organelle performs a special function. 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.

What is a cell made up of? What is the structural organization of a cell?
Every cell would have three features- plasma membrane, nucleus and cytoplasm. All activities inside the cell and interactions of the cell with its environment are possible due to these features.

Plasma membrane or cell membrane:
This is the outermost covering of the cell that separates the contents of the cell from its external environment. It is flexible and made up of organic molecules called lipids and proteins. 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. Eg: Amoeba

It allows the movement of some substances into and out of the cell. It also prevents movement of some other materials. Therefore it is called a selectively permeable membrane. Movement of substances through this semi-permeable membrane can be by the process of diffusion, osmosis etc.

Difference between diffusion and osmosis

OSMOSIS	DIFFUSION
It involves movement of solvent molecules	It involves movement of solute molecules
Molecules move from lower concentration of solute to higher concentration of solute	Molecules move from higher concentration of solute to lower concentration of solute
It occurs only across a semi-permeable membrane	It does not require semi-permeable membrane
Example: Shrinking of Potato slice when kept in concentrated sucrose solution	Example: Spreading of ink when a drop of it is put in a glass of water.

If we put an animal cell or a plant cell into a hypotonic solution the cell is likely to swell up. The cell will stay in the same size if it kept it in isotonic solution. If the solution is hypertonic then the cell will shrink.
Unicellular fresh water organism and most plants tend to gain water through osmosis.

Cell wall:
It is present only in plant cells. The cell wall is composed of cellulose and is permeable. It separates the contents of the cell from the surroundings. It gives shape and protection to the cell. Cell walls permit the cells of plants, fungi and bacteria to withstand very dilute external media without bursting.

Plasmolysis: It is the process in which cells lose water in a hypertonic solution.

Nucleus:
The nucleus has a double layered covering called nuclear membrane. The nuclear membrane has pores which allow the transfer of material from inside to outside. The nucleus contains chromosomes which are composed of Deoxyribonucleic acid (DNA) and proteins. Nucleus controls all the activities of the cell.
As the nucleus carries genetic information in the form of DNA, it plays a major role in cell division and cell development. The functional segments of DNA are called genes. Nucleus plays an important role in protein synthesis and transmission of characters from one generation to another generation. It plays a central role in cellular reproduction. In some organisms nuclear membrane is absent and nuclear region contains only nucleic acids called nucleoid. Such organisms called prokaryotes. Eg. Bacteria. Organisms with cells having a nuclear membrane are called eukaryotes.

Prokaryotic Cells	Eukaryotic Cells
Very minute in size	Fairly large in size
Nuclear region (nucleoid) not surrounded by a nuclear membrane	Nuclear material surrounded by a nuclear membrane
Single chromosome present	More than one chromosome present
Nucleolus absent	Nucleolus present
Membrane bound cell organelles are absent	Membrane bound cell organelles are present
Cell division by fission or budding (no mitosis)	Cell division by mitosis or meiosis

Cytoplasm:
The cytoplasm is the fluid content inside the plasma membrane. It is a jelly like viscous substance occupying entire cell except the nucleus. It also contains many specialized cell organelles that perform a specific function for the cell.

Cell organelles:
Cell organelles include endoplasmic reticulum, Ribosomes, Golgi apparatus, Mitochondria, Plastids, Lysosomes, and Vacuoles. They are important because they carry out some very crucial functions in cells.

Endoplasmic reticulum (ER):
The ER is a large network of membrane bound tubes and sheets. It serves as channels for the transport of materials especially proteins between various organs of the cytoplasm or between the cytoplasm and nucleus. It also functions as a cytoplasmic framework providing a surface for some of the biochemical activities of the cell. There are two types of ER- Rough endoplasmic reticulum and smooth endoplasmic reticulum.

RER: These are rough at surface and are associated with ribosomes. These are responsible for the synthesis of proteins.

SER: These are smooth at surface and are not associated with ribosomes. It helps in the manufacture of fat molecules or lipids. It also plays a crucial role in detoxifying many poisons nd drugs.

Membrane biogenesis: Some of the proteins and lipids synthesized by EF help in building the cell membrane. This process is known as membrane biogenesis.

Golgi Apparatus:
These cell organelles are named after the biologist, Camillo Golgi, who first described it. The Golgi consists of a stack of membrane-bound cisternae. These membranes often have connections with the membranes of ER and therefore constitute another portion of a complex cellular membrane system. Its functions include the storage, modification and packaging of products in vesicles. It is also involved in the formation of lysosomes.

Lysososmes:
Lysosomes are membranous sacs filled with enzymes. These enzymes are made by RER. They are a kind of waste disposal system of the cell. They help to keep the cell clean by digesting any foreign material as well as worn out cell organelles. Lysosomes contain hydrolytic enzymes which are capable of digesting cellular macromolecules. When the cell gets damaged, the lysosome may burst and its enzymes may digest thecell itself. Hence, lysosomes are called as ‘suicidal bags’.

Mitochondria:
These are cellular organelles termed as ‘power houses of the cells’. These are bounded by a double membrane. The outer membrane is smooth while the inner membrane is thrown into folds

called as cristae. The cristae increase the area of cellular respiration. Mitochondria releases energy in the form of ATP molecules. ATP is known as the “energy currency of the cell”. Mitochondria have its own DNA DNA ribosomes and are able to make some of their own proteins.

Plastids:

Plastids are present only in plant cells. These are of two types- chromoplasts (coloured plastids) and leucoplasts (white or colourless plastids). Plastid contains pigment called chlorophyll are known as chloroplasts. These are important for photosynthesis in plants. Chromoplasts are the organelles which provide bright colours to the plant structures like buds, flowers etc. Leucoplasts are the organelles which store starch, oils and protein granules. Plastids consist of numerous membrane layers embedded in a material called the stroma. Plastids also have their own DNA and ribosomes.

Vacuoles:

Vacuoles are membrane bound compartments present in both plant and animal cells. These are storage sacs for solid or liquid contents. These are small sized in animal cells while bigger in plant cell. In plant cells vacuoles are full of sap and provide turgidity and rigidity to the cell. These organelles store water, waste products, and substances like amino acids, sugars and proteins. In some unicellular organisms specialized vacuoles also play important roles in expelling excess water and some wastes from the cell.

Difference between plant cells and animal cells

PLANT CELLS	ANIMAL CELLS
Plant cells possess cell wall.	Animal cells do not possess cell wall.
Chloroplasts are present in plant cells.	Animal cells do not possess chloroplasts.
Plant cells possess large vacuoles.	Animal cells have many small vacuoles.
Higher plants do not possess centrioles.	Animal cells do contain centrioles.