The Fundamental Unit of Life

Cell: It is the smallest unit of life capable of performing all living functions.
Properties of cell

- The Cell is the smallest living unit of life.
- It is so small that it is not visible to the naked eye.
- The shape of the cell varies in different organisms and within an organism.
- Size of cells also differs.
- All living cells exhibit certain basic properties like respiration, growth, metabolism etc.
- Cells originate from a pre-existing cell. A mother cell divides to produce daughter cells. Hence, cells exhibit cell division.

Milestones in Cell Biology

Biologists	**Major contributions**
Robert Hooke	Discovered cell
Leeuwenhoek	Discovered microscope
Robert Brown	Nucleus
Purkinje	Coined term protoplasm
Schleiden and Schwann	Presented Cell theory
Camillo Golgi	First described Golgi apparatus

Invention of Microscope

- The first, simple microscope was constructed by Antony van Leeuwenhoek. He used biconvex lens to make the microscope.
- The invention of compound microscope was done by Robert Hooke. These compound microscopes consisted of concave lens.
- The modern compound microscopes are a modification of one made by Robert Hooke. Their magnification power has been improved up to 2,000 times.
- Electron microscopes are the one that use electronic beams to magnify the objects. Their magnification power is over 2,00,000 times.

Cell theory

- All plants and animals are composed of cells
- The cell is the basic unit of life.
- This was further expanded by Virchow by suggesting that all cells arise from pre-existing cells.

Classification of Cell on the basis of their cellular complexity

- **Prokaryotic cell -**

1. The nuclear region is poorly defined; membrane-bound organelles are absent. The undefined nuclear region containing only nucleic acid called nucleoid.
2. Prokaryotes are unicellular organisms, while eukaryotes are usually multicellular organisms. Yeast is exceptionally a unicellular eukaryote.

- **Eukaryotic cell**

1. Nuclear region is well defined, bounded by nuclear membrane. Other membrane-bound organelles are also present.

Structural Organization of cell

Cell wall – It is the outermost membrane present in plant, fungal, and some bacterial cells; it is absent in animal cells. The main component providing structural strength to the cell wall is **cellulose**. However, the bacterial cell wall is mainly composed of **peptidoglycan**.

Functions of Cell Wall

- It protects intracellular organelles from the outside environment.
- It can withstand dilute hypotonic media and prevents bursting of cells.

Plasma membrane or cell membrane –It is the outermost covering of all animal cells and next to cell wall in plant cells. It separates the contents of the cell from the external environment.
Functions of cell membrane

- It protects intracellular organelles from the outside environment.
- It selectively allows the molecules to move in and out of the cell.
- It can also engulf or expel substances in and out of the cell through **endocytosis** or **exocytosis** respectively.
- It establishes communication between cells.

Process of Diffusion and Osmosis

- **Diffusion –** It is the spontaneous movement of molecules from a region of high concentration to a region of low concentration

- **Osmosis –**It is the movement of water molecules from a region of high concentration to a region of low concentration, through a selectively permeable membrane

Cytoplasm

The **cytoplasm** is the inner content of the cell membrane, which is separated from the nucleus. It includes cytosol, organelles, and inclusions. Cytosol is a soft and sticky, semi-transparent fluid in which various cell organelles are suspended.

Functions of Cytoplasm

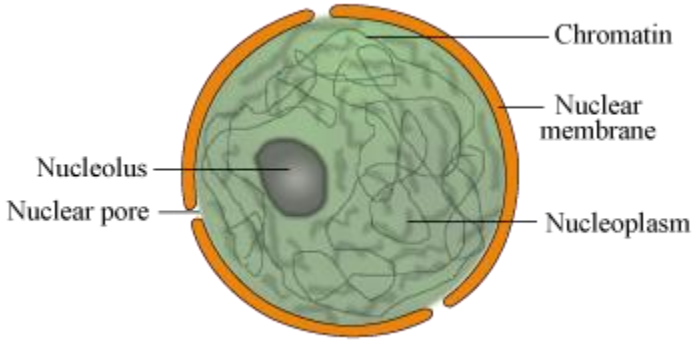
- It is the region where many cellular activities take place.
- It mostly consists of water and it balances the water content in the cell.
- It contains **cytoskeleton**, which maintains the shape and movement of cells.
- Cytoplasmic streaming or circulation of the cytoplasm helps in the proper distribution of cellular organelles during cell division, growth, etc

Nucleus

- It is one of the most important cell organelle which controls all the cellular activities of the cell.

Structure

- Nucleus is enclosed by double membrane known as nuclear membrane.
- The nuclear membrane has pores for the selective transport of different materials.
- It contains a nuclear sap, enclosed by the nuclear envelope, known as the nucleoplasm containing nucleoli and chromatin.



Role of Nucleus- The nucleus plays an important role in cellular reproduction as it divides and passes the genetic material to the offspring. It also directs all the chemical activities of the cell hence also known as director of cell.

- **Nucleus**

- It controls all the cellular activities of cell.

- It consists of the following.

1. **Nuclear membrane** – It has perforations called nuclear pores.
2. **Nucleoplasm**
3. **Nucleolus**

- Nucleolus is the site of ribosomal RNA formation.

- Network of nucleoprotein fibres are called the chromatin.

- Chromatin contains DNA, histones (basic proteins), non-histone proteins, and RNA.

- Chromatin threads condense and organize to form chromosome.

- The primary constriction in the chromosome is called centromere.

- Based on the position of centromere, chromosomes are of four types:

1. **Metacentric:** Centromere is located at the middle of chromosome.
2. **Sub-metacentric:** Centromere is slightly away from the middle of chromosome.
3. **Acrocentric:** Centromere is situated close to the end of chromosome.
4. **Telocentric:** Centromere is located at the terminal end.

- A small chromosomal segment separated from the main body of the chromosome by a secondary constriction is called satellite.

- **Vacuole**

  - It is found in both plant and animal cells. It is single and large in plant cells while it is small and numerous in animal cells. It is enclosed by a membrane known as tonoplast.

- **Important functions of vacuoles**:

  - Provide turgidity and rigidity to plant cells.
  - Stores some useful substances such as amino acids, sugars, various organic acids etc.
  - In some organisms specialized vacuole performs the function of expelling waste material and excess of water.

Endoplasmic reticulum - It **is an interconnected network of membranous structures like** tubules, vesicles, and cisternae.

Cisternae are the flattened disk-like membranous structures. Tubules are tubular in shape, while vesicles are sac-like structures.

Types of Endoplasmic reticulum- There are two types of ER:

- SER - Smooth endoplasmic reticulum(due to absence of ribosomes)
- RER - Rough endplasmic reticulum (due to presence of ribosomes)

Functions of SER:- It is involved in the synthesis of fats and lipids, in detoxification of drugs, in metabolism of carbohydrates

Functions of RER**:-** It is involved in the transportation of proteins and is the main site of glycosylation.

Golgi Apparatus

- Discovered by Camillo Golgi in 1898.
- These are membrane-bound, sac-like structures called cisternae which are arranged parallel to each other in stacks.

Important functions of Golgi apparatus:

- Helps in the storage, modification and packaging of products in vesicles
- Involved in the formation of lysosomes

Lysosome- It keeps the cell clean by acting as the waste disposal system of the cell.

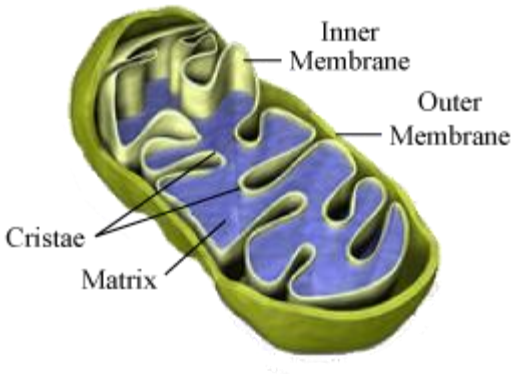
- It contains digestive enzymes that can destroy any foreign organic material.
- Also known as the '**suicidal bag**' of a cell because enzymes can digest own cell, when lysosomes gets burst.

Mitochondria-

- Also known as the 'Powerhouse of the cell'
- It is a double membrane bound organelle that has its own DNA; hence they are able to make some of their own proteins.

Important functions of Mitochondria:

- Involved in cellular respiration
- Produce energy in the form of ATP (Adenosine triphosphate).



Plastids- These cell organelles are present in plants and absent in animals. Plastids have their own DNA and ribosomes.

Types- Chromoplasts and leucoplasts

Chromoplasts- These contain color pigments like chlorophyll, carotene , xanthophyll hence responsible for the colour of plants.
Leucoplasts are the colourless plastids.

Functions of plastids:

- They carry out the process of photosynthesis.
- They contribute to the colour of leaves, flowers etc.