Biology NCERT Class 6-12 compilation for UPSC CSE Prelims by Pmfias.com

Biology is a **Low Gain – High Pain topic** (not of much use for mains; many topics to be covered, subject is complicated for a non-science student, weightage is not significant in prelims).

So, you should prepare Biology only after finishing Indian Polity, Economy, Modern History, Geography, Environment..... which have good weightage in both prelims and mains.

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**Cell - Cell Organelles: Plasma Membrane, Cell Wall, Cytoplasm, Nucleus, Mitochondria. Prokaryotic Cells vs. Eukaryotic Cells. Plant Cell vs. Animal Cell.**

## Cell

| | |
|---|---|
| **Robert Hooke** | Discovered and coined the term cell in 1665 |
| **Robert Brown** | Discovered Cell Nucleus in 1831 |
| **Schleiden and Schwann** | Presented The cell theory, that all the plants and animals are composed of cells and that the cell is the basic unit of life. Schleiden (1838) and Schwann (1839). |

- With the discovery of the electron microscope in 1940, it was possible to observe and understand the complex structure of the cell and its various organelles.

## Cell Organelles

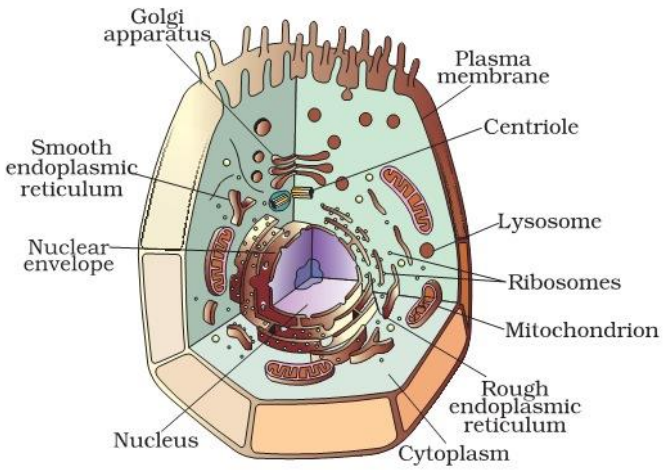


***Fig. 5.5:*** *Animal cell*

## Plasma Membrane or Cell Membrane

- **Cell membrane** is also called the plasma membrane.
- It can be observed only through an electron microscope.
- Plasma membrane is the **outermost** covering of the cell that separates the contents of the cell from its external environment.

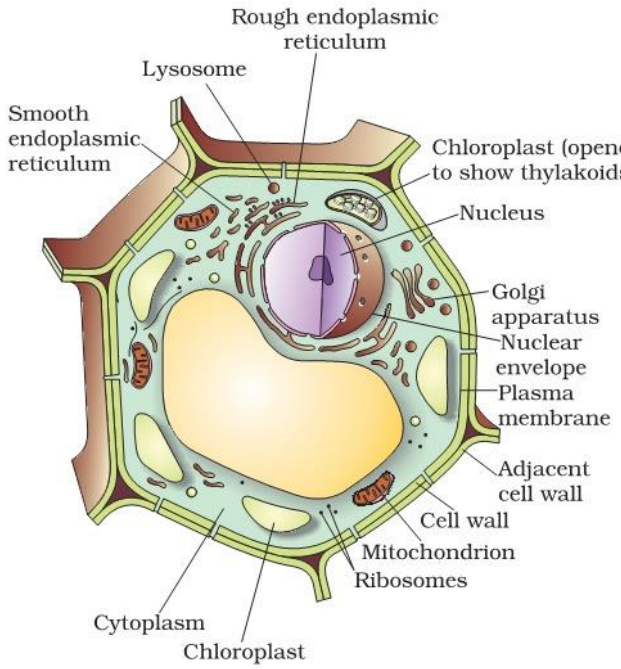


***Fig. 5.6:*** *Plant cell*

## Endocytosis

- The plasma membrane is flexible and is 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 (endo → internal; cyto → of a cell). **Amoeba** acquires its food through such processes.

## Diffusion

- Plasma membrane is a selectively permeable membrane [The plasma membrane is porous and allows the movement of substances or materials both inward and outward].
- Some substances like carbon dioxide or oxygen can move across the cell membrane by a process called **diffusion** [spontaneous movement of a substance from a region of high concentration (hypertonic solution) to a region where its concentration is low (hypotonic solution)].
- Thus, diffusion plays an important role in gaseous exchange between the cells as well as the cell and its external environment.

## Osmosis

- Water also obeys the law of diffusion. The movement of water molecules through a selectively permeable membrane is called osmosis.
- 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. Thus, **osmosis is a special case of diffusion** through a selectively permeable membrane.
- 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.
- Thus, diffusion is important in exchange of gases and water in the life of a cell. In additions to this, the cell also obtains nutrition from its environment.
- Different molecules move in and out of the cell through a type of transport requiring use of energy in the form of **ATP.**

## Reverse Osmosis (RO)

- Reverse osmosis (RO) is a **water purification technology** that uses a semipermeable membrane to remove larger particles from drinking water.
- In reverse osmosis, an **applied pressure** is used to overcome osmotic pressure.
- Reverse Osmosis is a phenomenon where pure water flows from a dilute solution [hypotonic] through a semi permeable membrane to a higher concentrated solution [hypertonic].
- **Semi permeable** means that the membrane will allow small molecules and ions to pass through it but acts as a barrier to larger molecules or dissolved substances.

## Cell Wall

- Cell wall is **absent in animals**.
- 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 (plasma → fluid; lysis → disintegration, decomposition).
- **Only living cells**, and not dead cells, are able to absorb water by osmosis. Cell walls permit the cells of **plants, fungi** and **bacteria** to withstand very dilute [hypotonic] external media without shrinkage.
- In such media the cells tend to lose water by osmosis. The cell shrinks, building up pressure against the cell wall. The wall exerts an equal pressure against the shrunken cell.
- Cell wall also prevents the bursting of cells when the cells are surrounded by a hypertonic medium (medium of high concentration).
- In such media the cells tend to gain water by osmosis. The cell swells, building up pressure against the cell wall. The wall exerts an equal pressure against the swollen cell.
- Because of their walls, plant cells can withstand much greater changes in the surrounding medium than animal cells.

## Cytoplasm

- It is the jelly-like substance present between the **cell membrane** and the **nucleus**.
- The cytoplasm is the **fluid** content inside the plasma membrane.
- It also contains many specialized **cell organelles [**mitochondria, golgi bodies, ribosomes, etc**]**.
- Each of these organelles performs a specific function for the cell.
- Cell organelles are enclosed by **membranes**.
- The significance of membranes can be illustrated with the example of viruses.
- **Viruses lack any membranes** and hence do not show characteristics of life until they enter a living body and use its cell machinery to multiply.

## Nucleus

- It is an important component of the living cell.
- It is generally spherical and located in the center of the cell.
- It can be stained and seen easily with the help of a microscope.
- Nucleus is separated from the cytoplasm by a **double layered** membrane called the **nuclear membrane**.

- This membrane is also porous and allows the movement of materials between the cytoplasm and the inside of the nucleus [diffusion].
- With a microscope of higher magnification, we can see a smaller spherical body in the nucleus. It is called the **nucleolus**.
- In addition, nucleus contains thread-like structures called **chromosomes**. These carry genes and help in **inheritance** or transfer of characters from the parents to the offspring. **The chromosomes can be seen only when the cell divides**.
- Gene is a **unit of inheritance** in living organisms. It controls the transfer of a hereditary characteristic from parents to offspring. This means that your parents pass some of their characteristics on to you.
- Nucleus, in addition to its role in inheritance, acts as **control center** of the activities of the cell.
- The entire content of a living cell is known as **protoplasm [cytoplasm + nucleus]**. It includes the cytoplasm and the nucleus. Protoplasm is called the **living substance** of the cell.
- The nucleus of the bacterial cell is not well organized like the cells of multicellular organisms. There is **no nuclear membrane**.
- Every cell has a membrane around it to keep its own contents separate from the external environment.
- Large and complex cells, including cells from multicellular organisms, need a lot of chemical activities to support their complicated structure and function.
- To keep these activities of different kinds separate from each other, these cells use membrane-bound little structures (or 'organelles') within themselves.

## Chromosomes

- 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)**
- Chromosomes are composed of **DNA and Protein**.
- DNA molecules contain the information necessary for constructing and organizing 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 **organised into chromosomes**.
- The nucleus plays a central role in **cellular reproduction**, the process by which a single cell divides and forms two new cells.
- It also plays a crucial part, along with the environment, in determining the way the cell will develop and what form it will exhibit at maturity, by directing the chemical activities of the cell.

## Prokaryotic Cells vs. Eukaryotic Cells

- 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 cells also **lack most of the other cytoplasmic organelles** present in eukaryotic cells.
- Many of the functions of such organelles are also performed by **poorly organised parts of the cytoplasm**.
- The chlorophyll in photosynthetic prokaryotic bacteria is associated with **membranous vesicles (bag like structures) but not with plastids** as in eukaryotic cells.

**Prokaryotes** → defined nuclear region, the membrane-bound cell organelles are absent.

**Eukaryotic Cells** → have nuclear membrane as well as membrane-enclosed organelles.

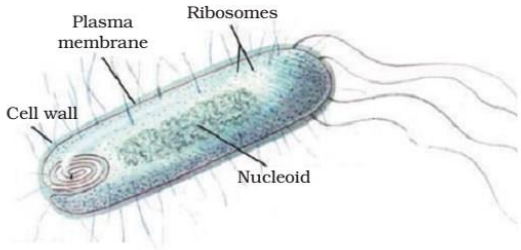


***Fig. 5.4:*** *Prokaryotic cell*

| | Prokaryotes | Eukaryotes |
|---|---|---|

| | | |
|---|---|---|
| **Organisms** | Monera: Eubacteria and Archebacteria | Protists, Fungi, Plants and Animals |
| **Meaning of name** | Pro = before<br><br>Karyon = nucleus | Eu = after<br><br>Karyon = nucleus |
| **Evolution** | 3.5 billion years ago (older type of cell) | 1.5 billion years ago |
| **Uni-/multicellular** | Unicellular (less complex) | Multicellular (more complex) |
| **Cell wall** | almost all have cell walls (murein) | fungi and plants (cellulose and chitin): none in animals |
| **Organelles** | usually none | many different ones with specialized functions |
| **Metabolism** | anaerobic and aerobic: diverse | mostly aerobic |
| **Genetic material** | single circular double stranded DNA | complex chromosomes usually in pairs; each with a single double stranded DNA molecule and associated proteins contained in a nucleus |
| **Location of genetic information** | Nucleoid region | Nucleus |
| **Mode of division** | binary fission mostly; budding | mitosis and meiosis using a spindle: followed by cytokinesis |

## Nucleoid

- In some 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

## Vacuoles

- Empty structure in the cytoplasm is called vacuole. It could be single and big as in an onion cell (plant cell). Cheek cells (animal cells) have smaller vacuoles.
- **Large vacuoles are common in plant cells. Vacuoles in animal cells are much smaller.**
- Vacuoles are **storage sacs** for solid or liquid contents.
- The central vacuole of some plant cells may occupy 50-90% of the cell volume.
- In plant cells vacuoles are full of cell sap and provide **turgidity** [swollen and distended or congested] and **rigidity** to the cell.
- Many substances of importance in the life of the plant cell are stored in vacuoles. These include amino acids, sugars, various organic acids and some proteins.
- In single-celled organisms like amoeba, the food vacuole contains the food items that the amoeba has consumed.
- In some unicellular organisms, specialized vacuoles also play important roles in expelling excess water and some wastes from the cell

## Endoplasmic Reticulum (ER)

- The endoplasmic reticulum (ER) is a large network of membrane-bound tubes and sheets. It looks like long tubules or round or long 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 – Ribosomes

- RER 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