CHAPTER

1 Cell: The Unit of Life

Cell

- Cell is the fundamental structural and functional unit of all living organisms.
- **Anton Von Leeuwenhoek** first saw and described a live cell.

Cell Theory

- Cell theory was given by two scientists **Schleiden** and **Schwann.**
- It states that all plants or animals are composed of cells and their products.
- **Rudolf Virchow** explained that new cells arise from pre-existing cells (*Omnis cellula-e cellula*) and finally modified the cell theory as:
  (*i*) All living organisms are composed of cells and products of cells.
  (*ii*) All cells arise from pre-existing cells.

An Overview of Cell

- Cells differ greatly in size, shape and activities for example, **Mycoplasma** is smallest cell (0.3µm), Egg of an ostrich is the largest isolated single cell.
- **Cytoplasm** is main arena of cellular activities in both plant and animal cells.

Prokaryotic Cells

- Lack membrane bound nucleus and cell organelles.
- Represented by bacteria, blue-green algae, mycoplasma and PPLO (0.1µm).
- In addition to genomic DNA, many bacteria have small circular DNA outside the genomic DNA called **plasmids**.
- All prokaryotes have a cell wall surrounding the cell membrane (except mycoplasma).
- Most prokaryotic cells have cell envelope which is tightly bound three layered structure i.e., the outermost **glycocalyx** followed by the **cell wall** and then the **plasma membrane.**
- **Mesosomes are** extensions of plasma membrane into the cell. It helps in cell wall formation, DNA replication, distribution of daughter cells, respiration, secretion process and increase the surface area of plasma membrane.
- In cyanobacteria, chromatophores contain pigments.
- Prokaryotic cells have surface structures - **Flagella**, **pili** and **fimbriae**.
- Bacteria may be motile or non-motile. If motile they have flagella, composed of three parts: **Filament** (longest portion), **hook** and **basal body**.
- Bacteria, on the basis of the staining, can be **Gram positive** or **Gram negative.**
- Ribosomes are non-membrane bound organelles.
- Ribosomes are 70S, has subunits 50S and 30S. Several ribosomes may attach to a single mRNA and form a chain called **polyribosome** or **polysome**.
- **Reserve material** is stored in the form of inclusion bodies in prokaryotic cytoplasm. Eg. phosphate granules, cyanophycean granules and glycogen granules.
- **Gas vacuoles** are found in blue-green, purple and green photosynthetic bacteria.

Eukaryotic Cells

- The eukaryotes include all the protists, plants, animals and fungi.
- Besides the nucleus, eukaryotic cells have other membrane bound structure called **organelles** like **ER**, **Golgi complex** etc.
- Cell membrane is mainly composed of proteins and lipids (**mainly phospholipids**).
- Membrane proteins can be **integral** or **peripheral**.
- Most accepted model for structure of cell membrane is **fluid mosaic model** given by **Singer and Nicolson** (1972).
- Membrane is **selectively permeable.**
- The **quasi-fluid** nature of lipid enables **lateral** movement of proteins within the overall bilayer. This ability to move within the membrane is measured as its fluidity.
- The fluid nature of membrane is important for cell growth, formation of intercellular junctions, secretion, endocytosis, cell division etc.
- Cell wall is a non-living rigid structure forms an outer covering of the plasma membrane in fungi and plants.
- **Primary wall:** Cell wall of a young plant cell is capable of growth which gradually diminishes as the cell matures.
- **Secondary wall:** As cell matures, it is formed on inner side (towards membrane) of the cell.
- **Middle lamella:** It is a layer mainly composed of calcium pectate that holds the different neighbouring cells together.

- **Cell wall of Algae:** Cellulose, galactans, mannans and calcium carbonate.
- **Cell wall of plants:** Cellulose, hemicellulose, pectin and proteins.
- Endomembrane system is made up of ER, GC, lysosomes and vacuole.
- **RER** (Rough endoplasmic reticulum) is involved in protein synthesis and **SER** (Smooth endoplasmic reticulum) is involved in lipid synthesis.
- **Golgi apparatus** has cisternae that perform processing, packaging and transporting the materials for secretions.
- **Lysosomes** contain hydrolytic enzymes
- **Vacuole** is a single membrane (called **tonoplast**) bound organelle found in the cytoplasm containing water, sap, excretory product and other material not useful for the cell and thus occupy 90% of volume of plant cell.
- Plant cells have large central vacuole.
- Ribosomes are non-membrane bound organelles (80S - cytoplasm and 70S - Mitochondria and chloroplast), involved in protein synthesis.
- Mitochondria is the site of aerobic respiration and produce cellular energy in the form of **ATP**, hence called 'power house of the cell'.
- Each mitochondria is a **double membrane** bound structure
- It contain single circular DNA molecule, a few RNA molecules, ribosomes (70S) and the components required for the synthesis of proteins.
- Plastids are found in all plant cells and in euglenoids.
- **Chloroplast** contain chlorophyll and carotenoid pigments.
- **Leucoplast** are colourless plastids.
- **Amyloplasts** store carbohydrates e.g. Potato, **Elaioplasts** store oils and fats whereas the **aleuroplast** store proteins.
- **Chloroplast** are double membrane bound structure
- The stroma of chloroplast contains small, double stranded circular DNA molecules and ribosomes (70 S).
- Cytoskeleton is an elaborate network of filamentous proteinaceous structures present in the cytoplasm. It involves in many functions such as mechanical support, motility and maintenance of the shape of the cell.
- Cilia and Flagella are hair-like outgrowths of the cell membrane.
- The central core in cilia and flagella is **axoneme** having **9 + 2** array of microtubules.
- Both cilium and flagellum arise from centriole like structure called **basal bodies**.
- Centrosome is an organelle usually containing two cylindrical structures called **centrioles**, having 9 + 0 array of microtubules.
- Centrioles form the basal body of cilia or flagella, and spindle fibres that give rise to spindle apparatus during cell division in animal cells.
- Nucleus was discovered by **Robert Brown** and given the name **chromatin** by **Flemming**.
- **Interphase nucleus** has chromatin, nuclear matrix and nucleolus. Nucleus has the membranes and the space between two membranes is perinuclear space.
- The nuclear matrix or the nucleoplasm contains nucleolus and chromatin.
- **Chromatin** contains DNA, some basic histones, some non-histones and some RNA.
- Every chromosome has **primary constriction** called centromere on the sides of which disc-shaped structures called **kinetochores** are present.
- Micro bodies are membrane bound minute vesicles which contain enzymes and are present in both plant and animal cells.