9. Organization of Cell

- **Cell**
  - Cells are the basic structural units and the building blocks of all living organisms.
- **Discovery of the Cell**
- Cell was discovered by Robert Hooke in 1665 after observing a piece of cork under a magnifying device.
- Robert Hooke coined the term “cell”.

1. Schleiden and Schwann proposed the cell theory. According to cell theory-

   Cells are the basic structural and functional units of life.

   All living organisms are made up of one or more cells.

   New cells arise from pre-existing cells.

- **Number of Cells**
- Organisms made of only a single cell are called unicellular organisms.
- For example: *Amoeba* and *Paramecium*
- Single cell in these organisms performs all the basic functions such as digestion, respiration, excretion, etc.
- Organisms made up of more than one cells are called multicellular organisms.
- For example: Humans, cow, rose, etc.
- In these organisms, the cells show division of labour as particular set of cells are involved in performing a specific body function.
- **Shape of the Cells**
- Most of the cells have a definite shape.
- Some cells such as that in *Amoeba* have no definite shape.
- The human red blood cell (RBC) is spherical-shaped.
- The muscle cells in humans are spindle-shaped.
- The human nerve cells have elongated branched structure.
- In plants and bacteria, the cell is enclosed in a protective covering called cell wall, which gives shape and rigidity to the cells.
- **Size of the Cells**

- The smallest cell is 0.1 to 0.5 micrometre in bacteria.
- The largest cell is of size 170 mm x 130 mm, which is the egg of an ostrich.
- Size of a cell has no relation with the size of an organism.
- **Cell Structure and Functions**
- In multicellular organisms, each organ system is made up of several organs.
- Organs are further made up of tissues.
- Tissues are groups of similar cells performing a specific function.

Cell

- It is the basic structural and functional unit of life.

Discoveries

- **Anton Von Leeuwenhoek** saw and described a live cell.
- **Robert Brown** discovered nucleus.
- The name chromatin was given by **Fleming.**
- **Schleiden and Schwann** formulated the cell theory.
- **Rudolf Virchow** gave the concept *Omnis cellula-e cellula* i.e., all cells arise from pre-existing cells.
- According to present day cell theory:

  - All living organisms are made up of cells.
  - All cells arise from pre-existing cells.

Prokaryotic cell

- It includes bacteria, blue-green algae, mycoplasma, and PPLO.
- Nuclear region is poorly defined. Nuclear material is naked.
- They lack membrane-bound cell organelles such as plastids, mitochondrion, endoplasmic reticulum, etc.
- Along with genomic DNA, they also have smaller circular DNA called plasmids.
- Mesosome, a specialised membranous structure formed by infolding of cell membrane, is characteristic feature of prokaryotic cell. It helps in cell wall formation, increasing the surface area of the plasma membrane, DNA replication, respiration, secretion, etc.
- Based on the differences in the staining procedure of cell membrane, bacteria is divided into two types:

  - **Gram positive** which take up gram stain
  - **Gram negative** which do not take up gram strain

- The outermost covering of bacterial cell is known as cell envelope. It is composed of three layers – outer glycocalyx, middle cell wall, and innermost cell membrane.
- Prokaryotic cell contains non-membrane bound organelle called ribosome.
- Ribosome in prokaryotes is 70S, which is made up of two subunits – 50S and 30S.

- **Eukaryotic cells**

  - It includes all protists, plants, animals, and fungi.
  - In all eukaryotic cells, nuclear region is well-defined and is surrounded by nuclear membrane.
  - They have membrane-bound cell organelles such as mitochondrion, plastids, endoplasmic reticulum, etc.

- **Cell membrane**

  - Cell membrane is made up of protein and lipid bilayer.
  - **Fluid mosaic model** of cell membrane was proposed by **Singer and Nicolson.**
  - According to this model, the fluid nature of lipid bilayer enables the lateral movement of proteins.
  - Plasma membrane is selectively permeable that regulates entry and exit of substances in and out of cell.
  - Movement of molecules across membrane without requirement of energy is **passive transport.**
  - Movement of water molecules from a region of higher concentration to lower concentration through a selectively permeable membrane is known as **osmosis.**
  - Movement of ions or molecules from lower to higher concentration across a semi-permeable membrane with an expenditure of energy is known as **active transport**.

- **Cell wall**

  - It is the outermost rigid structure present in the plant cell.
  - The cell wall of algae is made up of cellulose, galactans, mannans and minerals like calcium carbonate while the cell wall of plant is made up cellulose, hemicellulose, pectins, and proteins.
  - Middle lamella is made of calcium pectate and serves the function of holding different cells.
  - Plasmodesmata are perforations in the middle lamella and cell wall which connect the cytoplasm of neighbouring cells.

Endomembrane System

- The functions of certain organelles are interconnected. Such interconnected organelles together are known as **endomembrane system.** For example, the function of endoplasmic reticulum, golgi complex, lysosome, and vacuoles are interconnected.

  - **Endoplasmic reticulum (ER)**

    They are of two types:

  - **Rough endoplasmic reticulum (RER)** is important for synthesis and packaging of proteins.
  - **Smooth endoplasmic reticulum (SER)** acts as storage organelle. It also helps in lipid (fat) synthesis.

- **Golgi apparatus**

- It is made up of parallel arranged membrane-bound vesicles called cisternae.
- It helps in storage, modification, and packaging of products in vesicles.
- It helps in formation of glycoproteins and glycolipids.

- **Lysosomes**

- It is a membrane-bound structure that holds variety of enzymes.
- It is rich in all types of hydrolytic enzymes, which are active at acidic pH
- It is involved in digestion of carbohydrate, proteins, lipids, and nucleic acids.

- **Vacuoles**

- These are the storage sacs found in both plant and animal cells.
- The outermost layer of vacuole is known as tonoplast.
- Tonoplast helps in transport of substances into the vacuole against concentration gradient.

- **Ribosomes**

- First observed by George Palade
- These are non-membranous organelles found in both plant and animal cells.
- These are composed of RNA and proteins.
- Ribosomes in eukaryotes are 80S whose two subunits are 60S and 40S.

- **Mitochondria**

- It is a double membrane-bound structure.
- The inner membrane of mitochondria is deeply folded to form **cristae.**
- **Cristae** increase the surface area in the organelle.
- It is the site of cellular respiration and hence known as 'power house of cell'.
- They have their own single circular DNA.
- They divide by fission.

- **Plastids**

It is the organelle present only in plant cell and euglenoids.
On the basis of pigments, plastids are divided into three types.

- **Chloroplasts** – contain chlorophyll
- **Chromoplasts** – contain carotenoid pigments such as carotene, xanthophylls etc.
- **Leucoplasts** – colourless plastids

They store nutrients and are called amyloplasts (when storing carbohydrate), elaioplasts (when storing oils and fats), and aleuroplasts (when storing proteins).

- **Chloroplasts**

- It is a double membrane-bound structure.
- It is divided into **stroma** (site of dark reaction of photosynthesis) and **grana** (site of light reaction of photosynthesis)**.**
- The individual flattened membranous sacs of grana are called thylakoids.

- **Cytoskeleton**

- They are filamentous proteinaceous structures.
- They give mechanical support and shape to cell.

- **Cilia and flagella**

- These are the outgrowths of the cell membrane.
- These emerge from basal body.
- They help in cell movement.
- Axonemal microtubules have 9+2 arrangement i.e., nine pairs of doublets of radially arranged peripheral microtubules and a pair of centrally located microtubules.

- **Centrosome and Centrioles**

- Fibrils of these organelles are made up of protein tubulin.
- It helps in the formation of spindle apparatus in animal cells.
- It forms the basal body of cilia and flagella.

- **Microbodies**

- Microbodies are membrane bound minute vesicles. They are present in both animal and plant cells. They contain various enzymes.

- **Nucleus**
  - It controls all the cellular activities of cell.
  - It consists of the following.
    a. **Nuclear membrane** – It has perforations called nuclear pores.

b. **Nucleoplasm**
c. **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:
  - **Metacentric:** Centromere is located at the middle of chromosome.
  - **Sub-metacentric:** Centromere is slightly away from the middle of chromosome.
  - **Acrocentric:** Centromere is situated close to the end of chromosome.
  - **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.
- **Structure of DNA**
  - It has a double-helix structure, similar to ladder.
  - It is made up of nucleotides.
  - Nuclotides are made of sugar, phosphate groups and nitrogen bases
- **Components of DNA**
  - Sugar
  - Phosphate groups
  - Nitrogen bases
- **Genes**
  - It is a unit of DNA.
  - Located on Chromosomes.
  - Controls the development of one or more traits.
  - It is the basis of Inheritrance.
  - It can acquire mutation leading to variation.