

CELL : THE UNIT OF LIFE

- Unicellular Organism: Composed of Single Cell.
- Multicellular Organism: Composed of many Cells.

* CELL: It is the fundamental structural and functional unit of all living Organism.

- Anton Von Leeuwenhoek discovered living Cell.
- Robert Brown discovered the Nucleus.

* CELL THEORY:

→ Formulated by ~~Sett~~ Schleiden and Schwann

- Matthias Schleiden, German Botanist Examined plant's Cell.

- Theodore Schwann, British Zoologist, Examined Animal Cells.

→ They proposed that "The Bodies of animal and plant are Composed of Cells and product of Cells".

- Did not - Explained how new cell formed
- **Rudolf Virchow** first explained that cell's divide and new cells are formed from pre-existing cells.
- **Cell theory** : also known as Modern Cell theory.

- [i] All living Organism are composed of cell's and product of cells.
- [ii] All cell's arise from pre-existing cells.

* OVERVIEW OF CELL

- Cell's that have membrane bound nuclei are called **Eukaryotic**.
- Cell's that lack a membrane bound nucleus are **prokaryotic**.
- **Cytoplasm** occupies the Volume of both Cell.
- Eukaryotic Cell have other membrane bound distinct structure called **Organelles** like Endoplasmic reticulum, golgi Complex etc.
- Prokaryotic Cells lack such Organelles.

→ **Ribosomes** are non-membrane bound Organelles found in both prokaryotic and Eukaryotic Cells.

→ They also found within the two Organelles **Chloroplast** and **Mitochondria** and on rough ER.

→ Animal Cell contain another Non-membrane bound Organelle called **Centriole**

↓
Help in Cell division.

→ **Mycoplasmas** : Smallest Cell [0.3 μm]

→ largest isolated single cell is egg of an **Ostrich**

→ **Nerve cells** → longest Cell.

→ Shape of Cell may be disc-like, polygonal, Columnar, Cuboid, thread like or even irregular.

* PROKARYOTIC CELLS

- Represented by bacteria, blue-green algae, mycoplasma and PPLO [Pleuro Pneumonia Like Organism].
- Vary in shape and size. Four basic shapes of bacteria are Bacillus [rod like], Coccus [spherical], Vibrio [comma] and Spirillum [spiral].
- Prokaryotes have a Cell wall surrounding Cell membrane.
- No well-defined Nucleus.
- genetic material is Naked and not enveloped by a nuclear membrane.
- Addition to genomic DNA many bacteria have smaller Circular DNA outside the genomic DNA.
- This smaller DNA are called Plasmids.
- No Organelles found in prokaryotic cell.
- A specialised differentiated form of Cell membrane, called Mesosome, is characteristic of prokaryotic cell.

* Cell Envelope And It's Modification

- Most prokaryotic cells, particularly the bacterial cell have complex cell envelop.
- Cell envelop consist three layer i.e the Outermost glycocalyx, middle cell wall, Inner most plasma membrane.
- Act together as a single protective unit.
- Bacteria Classified into two group on the basis of manner in which they respond to staining procedure developed by Gram.
 - Gram positive bacteria: that take up gram stain
 - Gram negative bacteria: that do not take up gram stain.

① Glycocalyx differ in composition and thickness

- It could be loose sheath called Slime layer. or may be thick and tough called Capsule.
- Determine shape of cell.
- Provide strong structural support to prevent bacterium from bursting or collapsing.

① plasma membrane: Semi-permeable in nature

② Mesosomes: Formed by the extension of plasma membrane into cell.

→ These extensions are in form of Vesicles, Tubules and lamellae.

→ Help in cell wall formation, DNA replication and respiration and secretion process.

→ Also help to increase the surface area of plasma membrane.

→ In some prokaryotic like Cyanobacteria there are other membrane extensions into cytoplasm called Chromatophores -

↓
Contain pigment.

③ Bacterial cell may be motile or non-motile.

→ If motile have flagella extend from their cell wall.

→ flagella is composed of three parts - Filamentous, hook and basal body

→ Pili and fimbriae are also surface structures but do not play any role in motility.

① Pili: Elongated tubular structure made of a special protein.

② fimbriae: They are small bristle like fibres sprouting out of cell wall.

→ Help to attach bacteria on rocks or host tissue.

* Ribosomes And Inclusion Bodies

① Ribosomes: Site for protein synthesis

→ Made up of two sub-units - 50s and 30s unit which when present together form 70s prokaryotic ribosomes.

→ Several ribosomes attach to single mRNA and form a chain called polysome or polyosome.

② Inclusion bodies:

→ Reserve food material in prokaryotic cell stored in cytoplasm in form of inclusion bodies

→ lie freely in cytoplasm.

→ Gas vacuoles are found in blue green and purple and green photosynthetic bacteria.

* EUKARYOTIC CELLS

- include all protists, plants, animals and fungi
- have Nucleus with a nuclear envelope
- genetic material is organised into the chromosomes.
- Plant's cell has cell wall, plastids and large central vacuole which are absent in animal cell.
- Animals cell have centrioles which are absent in almost all plants.

* CELL MEMBRANE

- Composed of lipids that are arranged in bilayer.
- also possess protein and carbohydrates.
- lipids are arranged within membrane with polar head towards outer side and hydrophobic tail toward inner part to protect hydrocarbon from aqueous environment.

→ Lipid Component mainly consist phosphoglycerides.

→ Membrane protein are classified as
[i] **Integral**: Integral protein are partially or totally buried in membrane

[ii] **Peripheral**: peripheral protein lie on surface of membrane.

* **Fluid mosaic model**: proposed by Singer and Nicolson.

→ According to this, The quasi-fluid nature of lipids enable lateral movement of protein within the Overall bilayer.

→ The ability of protein to move within the membrane is measured as its fluidity.

* **PASSIVE TRANSPORT**: Many molecule can easily ~~cross~~ move across the membrane without any requirement of Energy. This is called passive transport.

→ Movement is from high Concentration to low Concentration.

eg: Neutral solute and water.

→ Osmosis : Movement of water from high Concentration to Low Concentration by diffusion.

* ACTIVE TRANSPORT : Some molecule cannot move across the membrane and required energy for movement. This is called Active transport.

→ Movement is from high Concentration to Low Concentration.

eg : Na^+/K^+ Pump.

* CELL WALL

→ It is non-living rigid structure.

→ Protect cell from mechanical damage and infection and provide barrier to Undesirable Macromolecules.

→ In algae It consist, Cellulose, galactose and minerals like Calcium Carbonate.

→ In Plant it consist Cellulose, hemicellulose, pectins and proteins.

→ Middle lamella is layer composed of Calcium pectate which holds or glues the different neighbouring cell together.

* ENDOPLASMIC RETICULUM [ER]

→ It is the network or reticulum of tiny tubular structure scatter in cytoplasm.

→ Divide intracellular space into two distinct compartment i.e. luminal [inside ER] and Extra luminal [cytoplasm].

→ Endoplasmic reticulum bearing ribosomes on their surface is called rough endoplasmic reticulum [RER].

→ Endoplasmic reticulum having no ribosome on their surface is called smooth endoplasmic reticulum [SER].

→ RER involved in protein synthesis and secretion.

→ SER is major site for synthesis of lipid.

• In animal cell lipid-like steroidal hormone are synthesised in SER.

* GOLGI APPARATUS

- Discovered by Camillo Golgi
- Consist of many disc-shaped sacs or Cisternae of $0.5\mu\text{m}$ to $1.0\mu\text{m}$ in diameter
- The golgi Cisternae are arranged near the nucleus with distinct Convex ~~Cis~~ or the forming face and Concave ~~trans~~ or Maturing face
- Performs the function of packaging of material
- Material is packed in form of Vesicles from the ER fuse with ~~Cis~~ face of golgi apparatus and move toward maturing face
- Protein Synthesised by ribosome on Endoplasmic reticulum are modified in the Cisternae of golgi apparatus before they are released from its ~~trans~~ face.
- Important site of formation of glycoproteins and glycolipids.

* LYSOSOMES

- formed by the process of packaging in golgi apparatus.
- Rich in all type of hydrolytic Enzymes [Hydrolases - lipases, proteases, Carbohydrase]
- Active at Optimal Acidic pH.
- Enzymes are Capable of digesting Carbohydrates, protein, lipids and Nucleic acids.

* VACUOLES

- Membrane bound space found in Cytoplasm
- Contain water, Excretory product and materials not useful for cell.
- Vacuoles is bound by Tonoplast.
- In plant, tonoplast facilitates the transport of ion and other material against Concentration gradient.
- In Amoeba the Contractile Vacuole is important for excretion.
- In some cells, as in protists food Vacuoles are formed by engulfing the food particle.

MITOCHONDRIA

- It is a Sausage-shaped or Cylindrical having diameter of $0.2 - 1.0 \mu\text{m}$ and length $1.0 - 4.1 \mu\text{m}$.
- Double membrane-bound structure with the outer membrane and the inner membrane divide its lumen into two compartments.
 - Inner compartment is called Matrix.
 - Outer membrane forms a no. of infolding called Cristae.
 - Cristae increase the surface area.
- It is site of Aerobic respiration.
- They produce Energy Cellular Energy in form of ATP. Hence are called 'power house' of cell.
- The matrix also possesses single circular DNA molecule, a few RNA molecules, ribosomes (70S).
- The components required for the synthesis of protein. The mitochondria divide by fission.

PLASTIDS

→ found in all plants and in ~~e~~ euglenoides

→ Bear some specific pigment, imparting specific colour to plants.

→ Based on type of pigment plastid can be classified into Chloroplast, Chromoplasts and leucoplast

* Chloroplast: Contain Chlorophyll and Carotenoid pigments

→ Carotenoid pigment are responsible for trapping light energy.

* Chromoplast: Contain fat soluble Carotenoid pigment like Carotene, ~~Xanto~~ Xanthophylls.

→ gives part of plant a yellow, orange or red colour.

* Leucoplast: Colour less plastids of varied shapes and size with stored nutrients.

- * Amyloplasts : store Carbohydrates [starch]
- * Elaioplasts : store Oils and fats
- * Aleuroplasts : store protein

* Structure of Chloroplast.

- found in mesophyll cells of leaves
- lense shaped, Oval, Spherical, discoid or Even ribbon like.
- Number Varies from 1 per cell of Chlamydomonas a green algae to 20-40 per cell in mesophyll
- Chloroplast has double membrane
- Space limited by inner membrane of Chloroplast is called stroma.
- Flattened membranous sac called the thylakoids are present in stroma.
↓
Arranged in stacks like the piles of coins called grana.

→ Stroma lamella : It is flat membranous connect thylakoids of different grana.

→ Stroma contain Enzymes required for Synthesis of Carbohydrates and protein.

• also contain small, double stranded Circular DNA molecules and ribosomes.

→ Chlorophyll pigment are present in thylakoids.

* RIBOSOMES

→ Discovered by George Palade
→ Composed of RNA and protein.

Eukaryotic ribosome $\Rightarrow$ 80 S

Prokaryotic ribosome $\Rightarrow$ 70 S

S - stands for Sedimentation Coefficient.

* CYTOSKELTON

→ Network of filamentous proteinaceous Structure present in Cytoplasm.

→ Provide mechanical Support, motility and maintain shape of Cells.

* CILIA AND FLAGELLA

- They are hair-like outgrowths of the cell membrane.
- Cilia are small and cause the movement of either cell or surrounding fluid.
- Flagella are longer and responsible for cell movement.

Axoneme : Core of cilia or flagella covered with plasma membrane

- Axoneme has nine pairs of doublets of radially arranged peripheral microtubules and a pair of doublets centrally located microtubule.
- Such an arrangement of axonemal tubules is referred to as 9+2 array.

* CENTROSOME AND CENTRIOLES

- Centrosome is an organelle containing two cylindrical structures called centrioles.

- Centrioles in a Centrosome lie perpendicular to each other.
- Made up of nine ~~sets~~ evenly spaced peripheral fibrils of tubulin protein.
- Central part of proximal region of Centriole is proteinaceous and called Hub.
- Hub is connected with tubules of peripheral triplet's by radial spoke made of protein.

* NUCLEUS

- Cell Organelle discovered by Robert Brown
- Material of ~~the~~ Nucleus Chromatin discovered by Flemming.
- Interphase nucleus has Chromatin, nuclear matrix and one or more spherical bodies called Nucleoli.
- Perinuclear Space: Space between two membranes of Nuclear Envelope.
- Normally there is one nucleus per cell. Variations are also observed.

* Some Cells Even lacks nucleus

eg: Erythrocytes of many mammals
Sieve tube cells.

* Nuclear matrix or Nucleoplasm Contains nucleolus and Chromatin

• It is a site for active Ribosomal RNA Synthesis.

* Chromatin Contains DNA and some basic protein called Histone

→ Every Chromosome has Centromere on which disc shaped structure called kinetochores are present.

* Based on Chromosome position of Centromere Chromosome can be classified into four types.

[i] Metacentric : Chromosome has middle Centromere forming two equal arms of chromosome.

[ii] Sub-metacentric : Chromosome has Centromere slightly away from middle of chromosome.

[iii] Acrocentric : Centromere is situated close to its end forming one extremely short and one very long arm

[iv] Telocentric : Chromosome has terminal Centromere.

* Satellite : few chromosome have non-staining secondary constriction at a constant location. This gives the appearance of a small fragment called Satellite.