



# The Cell

## CHAPTER – 4

### CELL

It is the basic structural and functional unit of life, which is able to carry out all the life processes.

### CELL THEORY

The cell theory was collectively proposed by

“Schleiden(1838), Schwann(1839) and Virchow (1858).

### IMPORTANT POSTULATES

The fundamental points of the cell theory are:

(a) The cell is the structural and functional unit of all living organism.

(b) All organisms are composed of one or more cells.

(c) New cells can arise only by division of pre-existing cells.

Thus cell theory established the concept that the function of an organism is the result of activities and interaction of the cell units.

### MICROSCOPE

### DEFINITION

An instrument with the help of which we see small, tiny and minute objects which can't be observe by naked human eye.

### TYPES OF MICROSCOPE

There are three main types of microscope.

#### 1. LIGHT MICRO SCOPE

In this microscope visible light is used as source of illumination.

#### 2. X-RAY MICROSCOPE

X-Rays are used as source of illumination.

#### 3. ELECTRON MICROSCOPE

Electron beam is used as source of illumination.

There are further two sub-types of electron microscope which are:

#### (A)TRANSMISSION ELECTRON MICROSCOPE

In this type resultant image is obtained on a fluorescent screen or photographic film.

#### (B)SCANNING ELECTRON MICROSCOPE

In this type resultant image is obtained on a television screen.

### MAGNIFICATION OF MICROSCOPE

Ability of microscope to increase the shape and size of the objects image. It can be calculated by multiplying the power of its eye pieces with its magnifying power of its objective.

### RESOLUTION OF MICROSCOPE

The capacity of microscope to separate adjacent forms or object. Also known as "Minimum Resolved Distance".

### CONTRAST

It is important to distinguishing one part of cell from another. (Difference between light and electron microscope – From Text page #57)

Prokaryotes and eukaryotes – From Text page #58)

### CELL MEMBRANE

Each cell is covered by an asymmetrical, porous, thin, semi permeable sheet called cell membrane or plasmalemma.

## *CHARACTERISTICS OF CELL MEMBRANE*

Living part of the cell, consist of lipid + protein.

- 1.5 micron in thickness.
- Consist of two layers of lipid.
- Lipid of plasma membrane are,
  1. Phospho-lipids
  2. Glycolipids
  3. Sterol
  4. Cholesterol.

## *STRUCTURE OF CELL MEMBRANE*

Cell membrane made up of phospho-lipids bilayer and each layer consists of ,

1. Head (hydrophilic end)
2. Tail (hydrophobic end)

### 1. HEAD (HYDROPHILIC/POLAR END)

Present towards the surface and formed of phosphates.

### 2. TAIL (HYDROPHOBIC/NON-POLAR END)

Present towards the center and formed of fatty acids.

The non-polar ends of phospho lipids face each other, whereas their polar ends are in association with protein or carbohydrates between every two phospho lipids molecule lies a molecule of "Cholesterol".

## *FLUID MOSAIC MODEL*

### INTRODUCTION

The fluid mosaic, bilayer model was proposed by "Singer and Nicolson (1972).

### *POSTULATES OF FLUID MOSAIC MODEL*

Important postulates of this model are,

- (a) The cell membrane consists of lipid bilayer, in which a variety of proteins are present.
- (b) These proteins float in the fluid matrix of lipid (as ice bergs in the sea)

(FIGURE 4.4 Page #61)

### ARRANGEMENT OF PROTEINS

According to the fluid mosaic model proteins are:





### *1. INTRINSIC/INTEGRAL PROTEINS*

These proteins penetrate the membrane surface and enter the lipid layers (partially or wholly)

### *2. EXTRINSIC/PERIPHERAL PROTEINS*

These are located adjacent to outer and inner surface of membrane and float like ice-berg in the sea.

### ARRANGEMENT OF LIPIDS

The non-polar end face each other while their polar ends are towards the surface.

### SIGNIFICANCE OF MODEL

- Cell membrane is flexible.
- Can change shape (because the protein and lipid of the membrane can move).

### *FUNCTION OF MEMBRANE PROTEIN*

- Certain proteins themselves act as enzymes.
- Some protein act as carrier for active transport.
- Provide elasticity to membrane.
- Pores are lined by the proteins.

### *FUNCTION OF LIPIDS PRESENT IN MEMBRANE*

- The lipids give rigidity to cell membrane.
- They lower the surface tension.

### *FUNCTIONS OF CELL MEMBRANE*

- It performs the two main function.
- Protection of Protoplasm.
- Regulation of material (In and Out of cell) through its permeability.

### *PERMEABILITY OF MEMBRANE*

The permeability of membrane is regulated by two processes.

(1) Passive Transport (Osmosis and Diffusion)

(2) Active Transport (Endocytosis, Exocytosis)

### 1. PASSIVE TRANSPORT

Such type of molecules transport which does not require energy. It is further divided into,

## *DIFFUSION*

Spreading and free movement of molecules (or ions) from the region of higher concentration to the region of lower concentration (till equilibrium state)

### *SIGNIFICANCE*

- Movement of oxygen and digested food (glucose, amino acids, fatty acids) into the cell.
- Movement of excretory waste out of cell.

## *OSMOSIS*

Diffusion of water by semipermeable membrane or the movement of solvent molecules from higher to lower concentration across semi permeable membrane.

### *SIGNIFICANCE*

- Liquids, primarily water molecules enter and leave the cell by Osmosis.
- It helps to maintain a balance (osmotic pressure) in and out of cell.

## 2. ACTIVE TRANSPORT

Such type of molecule transport which require energy. Or Movement of molecules against the concentration by the expenditure of energy through a carrier (i.e. movement of molecules from the region of lower concentration to higher concentration by protein using ATP as energy).

### *SIGNIFICANCE*

Absorption of excess food (glucose), ions ( $K^+$  and  $Na^+$ ) takes place by Active transport.

### *CONDITIONS*

- It is unidirectional.
- ATP provides energy.
- Protein act as carrier.

Active transport is further subdivided into,

- (1) Phagocytosis and Pinocytosis (Endocytosis).
- (2) Exocytosis.

## PHAGOCYTOSIS

Process of picking and ingestion of large solid particle by



plasma membrane (which can not enter by diffusion, osmosis or active transport).

### *SIGNIFICANCE*

Ingestion of solid food particles.

WBCs pick foreign particles (certain bacteria)

### PINOCYTOSIS

Process of fluid intake, for absorbing fluid by forming pinocytic vesicle (the fluid which cannot be absorbed by osmosis, enters through it)

### *SIGNIFICANCE*

Helps in absorption of hormones, lipids etc.

### CELL WALL

The cell wall is the outer most covering of a plant cell. It is composed of cellulose (a carbohydrate) and some other chemical substances.

This hard covering gives form, firmness and strength to the plant cell.

In a young cell it is thin and delicate but in a mature cell it becomes thick due to the deposition of various chemical substances on its inner surface.

There are three layer of cell wall.

### 1. MIDDLE (LAMELLA)

- First formed cell plate.
- Cementing layer between two daughter cells.
- Composed of  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  pectate.
- Cells are separated when this layer is dissolved.

### 2. PRIMARY WALL

- First product of cell synthesized by protoplast.
- In young cells it is thin and elastic while it becomes thick and rigid on maturity.
- Made up of Hemicellulose (50%), cellulose (25%) and pectate substances.

### 3. SECONDARY WALL

- Composed of cellulose.
- Present inside the primary wall.

- Can be modified through the deposition of lignin and other substances.

## NUCLEUS

It control all the activities of the cell and was discovered by Robert Brown in 1831.

It consist of the following parts,

- (1) Nuclear Membrane.
- (2) Nucleoplasm or Karyoplasm.
- (3) Nucleolus.
- (4) Chromatin Network.

### 1. NUCLEAR MEMBRANE

The nucleus is bounded by a double layered membrane which bears pores and is known as "Nuclear Membrane"

### 2. NUCLEOPLASM

Inside the nuclear membrane is a structure less fluid called "Nucleoplasm" and highly rich with proteins.

### 3. NUCLEOLUS

It is a patch work of granules rich in R.N.A formed in the nucleus. They may be more than one in a single nucleus. It contains mRNA formed from DNA, later mRNA comes out of nucleus to control protein formation.

### 4. CHROMATIN NETWORK

There is a network of threads dispersed in the karyoplasm called (Chromatin network)

Each individual thread is called (Chromosomes).

These are made up of DNA and are carrier of genes.

NOTE:(Types of Chromosomes from Book Page# 66)

## MEMBRANE BOUND ORGANELLES

### (1) ENDOPLASMIC RETICULUM

It is a complex series of tubules in the cytoplasm.

Endoplasmic reticulum are of two types,

- (1) Agranular or Smooth EPR.
- (2) Granular or Rough EPR.

### SMOOTH EPR

- It has no attached ribosome's.





- Function is to synthesis lipid.

### ROUGH EPR

- It has ribosome's attached to its outer surface.
- Synthesize protein and also transport material within the cell.

### (2) MITOCHONDRIA

An oval body bounded by a double membrane. The inner membrane is folded to form shelves/incomplete partitions. Which are known as "Crista", here oxidative enzyme are present. They are sites for aerobic cellular respiration and the energy is produced. Therefore also known as "Power house of cell"

### (3) GOLGI APPARATUS(DICTYOSOMES)

These are thin, plate like structures and are usually located near the nucleus. These are the site of formation of lysosomes and also conjugate protein, modify structure of substances, synthesized by EPR to form lysosomes and secretory vesicles. Golgi bodies of plants and lower animals (mostly invertebrates) are known as "Dictyosomes".

### (4) LYSOSOMES

They are large, some what irregular structure formed in the cytoplasm formed by golgi-bodies. They contain hydrolytic enzymes which destroys foreign particles. They are also known as "Suicide Sacs" because after secreting the enzymes they digese their own proteins (Autophagy).

NOTE:(Lysosomal Storage Diseases From Text Page # 71)

### (5) PLASTIDS

They are specialized organelles of plant cell that contain pigment or they synthesize reserve substances.

They are of three kinds,

#### (A) LEUKOPLAST

leuco = white

Leukoplast are colourless and store nutrient material.



### (B) CHLOROPLAST

Chloroplast are green having chlorophyll that performs photosynthesis.

### (C) CHROMOPLAST

Chromo = Colour

Chromoplast contain different coloured (red, yellow, orange or other than green) pigments. They are found in the cells of different coloured flowers and fruits.

### (6) MICRO BODIES

It includes peroxisome and glyoxysome.

#### (A) PEROXISOME

These are the single membrane bounded microbodies contain enzymes for transferring hydrogen atom to oxygen i.e. forming hydrogen peroxide.

Hydrogen peroxide is very toxic to the cell therefore it is immediately break down to water by enzyme catalyst.

These microbodies help in detoxification of alcohol and mostly present in liver cells.

#### (B) GLYOXYSOME

It is a single layered membrane bound structure containing enzymes which metabolize some molecules in photosynthesis and respiration.

They also cause oxidation of fatty acids.

### CYTOSKELETON

Cytoskeleton means skeleton of the cell, which is mostly composed of microtubules, microfilaments and intermediate filaments.

#### (A) MICRO TUBULES

- Microtubules are hollow cylinders with an outer diameter of 25nm.
- They are made up of a special type of globular protein tubulin.
- In single microtubule consist of hundredth of thousands of tubulin sub units, which are usually arranged in 13 columns called Protofilaments.



- Microtubules are arranged in assemble and disassemble manner.
- In animal cells and lower plants they also form centriole, cilia and flagella.

#### *(B) MICROFILAMENTS*

- Microfilaments are solid structures, thread like with a diameter of 7nm.
- They are also composed of globular proteins.
- Each microfilament consist of two actin (Protein) chains that inter wing in a helical fashion.

#### *(C) INTERMEDIATE FILAMENTS*

- They are intermediate in size having a diameter of 8nm to 11nm.
- They are rope like polymers of Fibrous protein.
- In skin and hair these filaments are made up of protein keratin.
- They provide mechanical strength to the cell and support the nuclear envelope.

### NON MEMBRANE BOUND CYTOPLASMIC ORGENELLE

#### *(1) RIBOSOMES*

- These are small structures concerned with protein synthesis in all type of the cells i.e. Prokaryotic as well as Eukaryote.
- They are freely dispersed in cytoplasm of Prokaryotic cell but in Eukaryotic cells they may be free or attached with endoplasmic reticulum.
- More than 50 type of proteins are present in ribosome structure and they contain high quantity of RNA.
- Under the direction of Nucleus ribosome produce the protein made it by the cell.
- Each Ribosome consist of two unequal parts.
- These are the smallest and most vital cellular components, manufactured in the nucleolus.

#### *(2) CENTRIOLE*





- They are only present in animal cells and certain lower plants.
- Mostly near the nucleus.
- Each centriole consist of two cylinders lying perpendicular to one another.
- Each cylinder consist of nine parallel triplets of hollow cylindrical microtubules.
- During the cell division they replicate and move towards opposite poles of the cell.
- In mitosis and meiosis they form thread like fibers which radiate from each centriole are known as mitotic apparatus.

### (3) VACUOLES

- These are non-protoplasmic fluid filled cavities in the cytoplasm.
- Their membrane is known as Tonoplast.
- They are more prominent in mature cells.
- In plant cells vacuoles are filled with cell sap and act as store, house.
- They also play an important role in plant defence.
- In animal cells vacuole contain hydrolytic enzymes (i.e. lysosomes)