

Unit No. 03

CELL STRUCTURE

& FUNCTION

UNIT # 03 CELL STRUCTURE & FUNCTION

CELL (Gr: Kytos = Hollow space, Lt: Cella = Empty room):

- Cell is the basic structural and functional unit of life.
- Robert Hook discovered dead cell.
- Antonie Van Leeuwenhoek discovered the living cell.
- Cell theory was given by Schleiden and Schwann.
- "OMINUS - CELLA - E - CELLA" (Latin) means that new cells arise by the division of pre-existing cells. This statement was given by Rudolf Virchow (Pathologist).

→ EUKARYOTIC CELL

- It consists of four components but three parts:
 - 01- Cell wall → Non-living (Not present in every cell)
 - 02- Plasma membrane
 - 03- Cytoplasm
 - 04- Nucleus
- } Living (Present in every eukaryotic cell)

CELL WALL

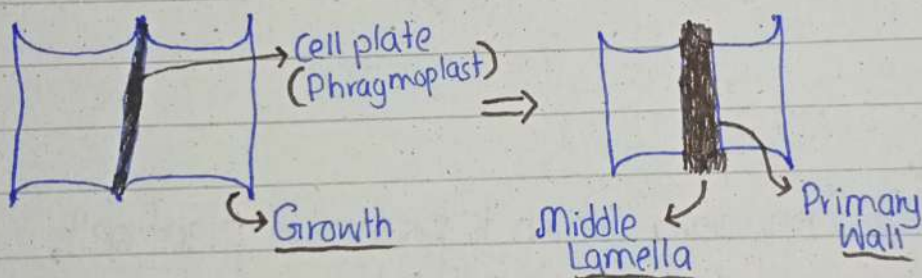
- It is the outer boundary which is present in plant cell, fungal cell, algal cell and bacterial cell.
- It is non-living and is secreted by the living material of the cell (Protoplasm).
- Plant cell wall is composed of 'cellulose' and 'pectin'.
- Fungal cell wall is composed of 'chitin'.
- Algal cell wall is composed of 'cellulose'.
- Bacteria cell wall is composed of 'peptidoglycan' (murein).
- Peptidoglycan and murein are two different things.
- Cell wall of plant cell consists of three layers:
 - 01- Middle lamella

02- Primary wall

03- Secondary wall

a) MIDDLE LAMELLA

- It is the first formed cell plate that acts as a cementing layer between two daughter cells.
- It is composed of Calcium (Ca^{++}) and Magnesium (Mg^{++}) pectate.
- Middle lamella between two cells in the absence of primary and secondary walls is called cell plate (Phragmoplast).
- Plant cell without cell wall is called protoplast.
- Plant cell always divide vertically not horizontally



b) PRIMARY WALL

- It is the first product of protoplast. It is deposited side by side of middle lamella.
- It is elastic and found in young stem cells, leaf cells etc.
- Chemically, it is composed of 50% hemicellulose, cellulose and pectin.
- Hemicellulose makes matrix and microfibrils are arranged in that matrix in criss cross manner. Hemicellulose (Half cellulose) is a fluid.

c) SECONDARY WALL

- It is deposited on the primary wall.

- It is made of cellulose.

- It consists of cellulose products.

- It provides strength to the cell.

- They don't break.

- It has adjacent cells.

- It provides support to the cell.

- It is made of cellulose.

- It is made of cellulose.

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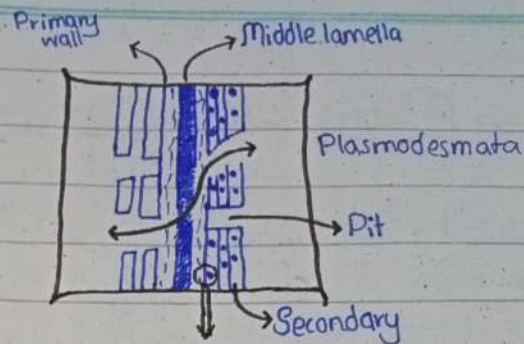
- It is made of cellulose.

- It is made of cellulose.

- It is made of cellulose.

c) SECONDARY WALL

- It is deposited inside the primary wall.
- It is mostly found in dead cells.
- It consists of three layers of cellulose and in that cellulose, lignin and pectin (waste products) are deposited by plant.
- It provides mechanical support to the cell.



Pectin
OR
Pectate

Hemicellulose matrix
(where microfibrils are
present in criss cross manner
& are attached by pectin)

→ PLASMODESMATA

- They are the minute pores on cell wall where deposition doesn't occur.
- It helps to communicate and exchange materials with adjacent cells.

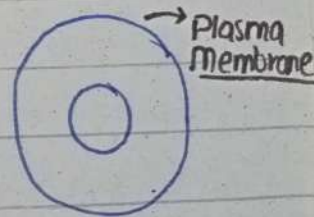
→ FUNCTIONS OF CELL WALL

- It gives definite shape to plant cell.
- It provides mechanical support to plant cell.
- It has the ability to absorb ~~the~~ water (due to cellulose, which is hydrophilic) and prevent from bursting.
- It is permeable.

tc.

PLASMA MEMBRANE (CELL MEMBRANE)

- It is the outer boundary of cytoplasm.
- It is living in nature (can repair itself).
- It is selectively permeable.
- It is composed of phospholipid bilayer.



→ MODELS ON THE STRUCTURE OF PLASMA MEMBRANE :

There

are two models given on the structure of plasma membrane.

01- Sandwich model OR Unit model

02- Fluid mosaic model

→ COMPOSITION OF PLASMA MEMBRANE

- It is composed of phospholipid bilayer
- The arrangement of phospholipid molecules is like hydrophobic ends face each other and hydrophilic ends are arranged at the opposite side and are associated with carbohydrates ~~and proteins~~ as glycoprotein and glycolipid.
- Plasma membrane consists of 50% lipids, 50% proteins and 5-10% carbohydrates
- Plasma membrane also contains lipid derivatives such as cholesterol and sterol. The role of cholesterol is to hold the molecules of plasma membrane at one place while sterols are the third lipid class which also regulate biological processes and sustain the domain structure of cell membranes where they are considered as membrane reinforcers.
- Animal cells possess 50% cholesterol and some plant cell membranes lack cholesterol
- Plasma membrane and cell membrane are different. Cell membrane has same structural composition in every cell ~~which~~ while plasma membrane has minor changes in cell by cell. So, the membrane of plant cells is cell membrane while the membrane of animal cells is plasma membrane due to the minor changes in the structure of this membrane in

every cell

01 - SANDWICH

- It was

- It was

- It still

sandwich

present

02 - FLUID

PLASMA

- It was

- According

membrane

protein

- Lipid

of plant

in plant

that

show

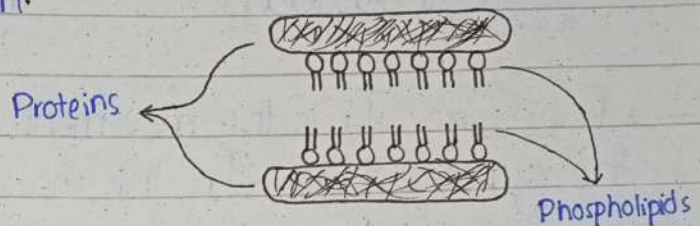
→ LATER

mol

every cell.

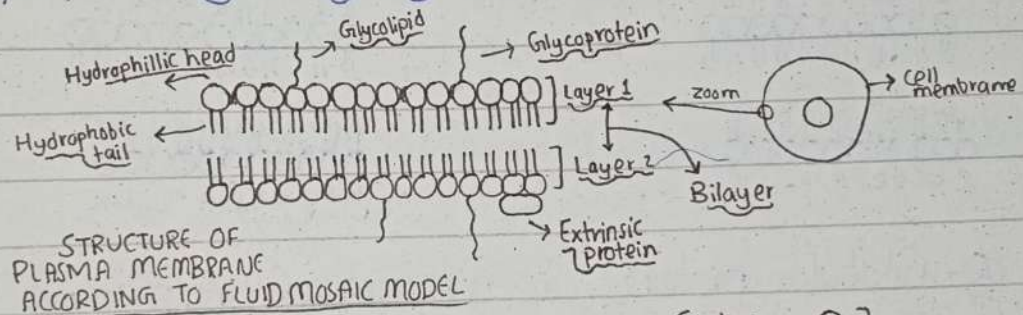
01 - SANDWICH MODEL OF PLASMA MEMBRANE

- It was given by Danielli and Davson.
- It was a popular model before fluidmosaic model.
- It states that, "the plasma membrane looks like a sandwich." According to this model, phospholipids were present between the protein.



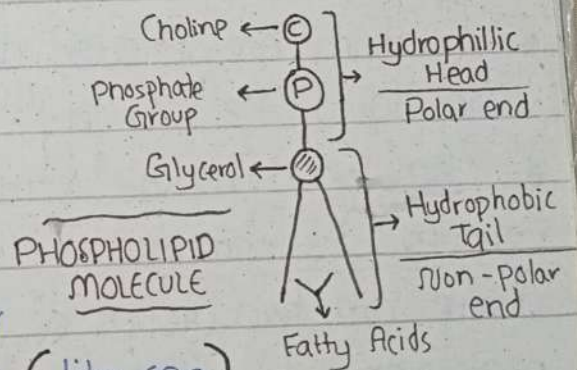
02 - FLUID MOSAIC MODEL OF PLASMA MEMBRANE

- It was proposed by Singer & Nicholson in 1972.



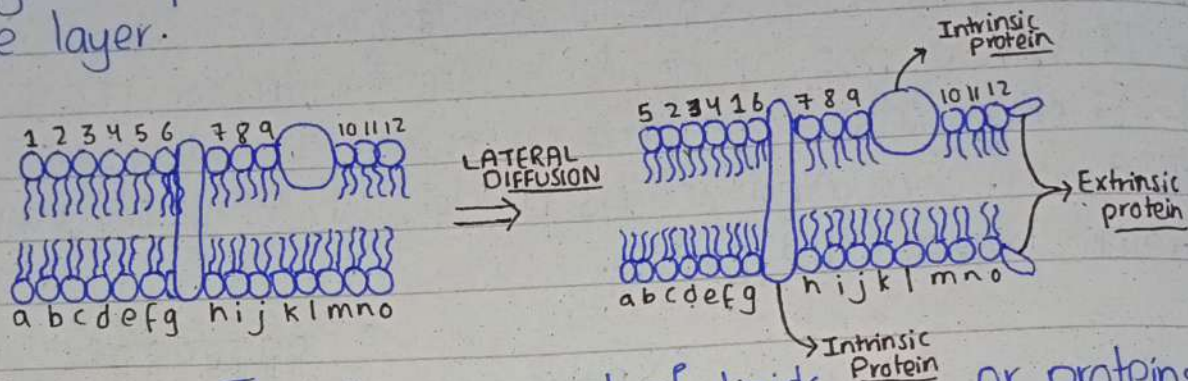
- According to this model, plasma membrane is composed of lipids and proteins.

- Lipids are retained in the core of plasma membrane. Lipids appear in plasma membrane in fluid state (like sea) that rotates, translates (translatory motion), vibrates and shows movement (~~transit~~^{translatory} and flip flop).

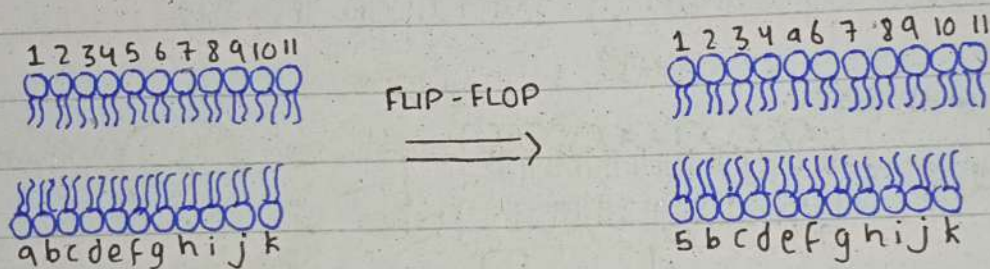


→ LATERAL DIFFUSION :- It is the movement of lipids or protein molecules in the same layer / along ~~same~~^{lateral} direction. It is also

called transient movement. In this movement, molecules change or replace their positions with other molecules of the same layer.



→ FLIP FLOP :- It is the movement of lipids or proteins in the opposite layer. In this movement, molecules change or replace their positions with other molecules of the opposite layer.



- α - Globular proteins are also present in plasma membrane.
- Proteins are inserted deeply in lipid sheet and float in lipid liquid like 'ice-berg'.
- The word 'mosaic' is used for different layers of proteins.

GROUPS OF PROTEINS

There are two groups of proteins associated with plasma membrane.

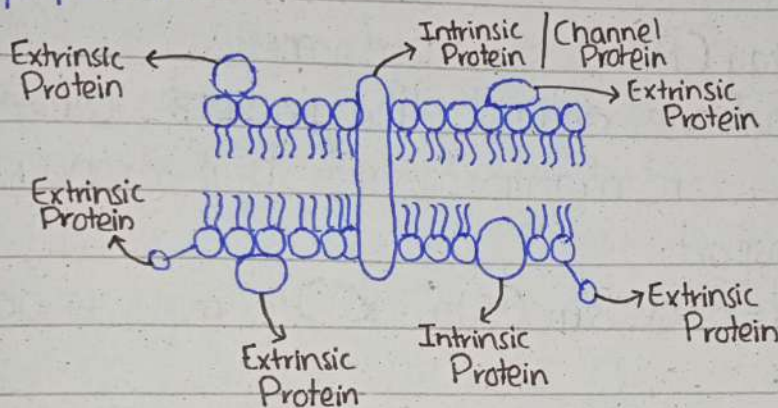
- INTRINSIC PROTEIN
- EXTRINSIC PROTEIN

a) INTRINSIC PROTEIN (INTEGRAL PROTEIN OR CHANNEL PROTEIN)

- They are fully or partially inserted in the lipid bilayer.
- They help in facilitated diffusion (movement of ions).

b) EXTRINSIC PROTEIN (PERIPHERAL PROTEIN OR MOSAIC PROTEIN)

- They are present at the outer or inner surface of lipid bilayer.
- They combine with glucose and lipids to form glycoprotein and lipoprotein.



- Enzymes such as ATPase, NADP reductase and Adenylate cyclase are extrinsic proteins.

FUNCTIONS OF PLASMA MEMBRANE

- Its primary function is to protect the cytoplasm.
- It regulates the chemical substances in and out from the cell (maintains pH, ionic concentration).
- It acts as an enzyme as it provides site for the attachment of hormones.

TRANSPORT ACROSS THE PLASMA MEMBRANE

a) PASSIVE TRANSPORT

- No energy (ATP) required to perform it.
- Movement of molecules from the region of higher concentration towards the region of lower concentration is called

passive transport.

ci) DIFFUSION

- Movement of gas molecules.

cii) OSMOSIS

- Movement of water molecules through semi-permeable membrane.

ciii) FACILITATED DIFFUSION

- Movement of ions through channel proteins.

cb) ACTIVE TRANSPORT

- It requires energy (ATP) to be performed.
- Movement of molecules against the ~~gradient~~ concentration gradient (from lower concentration towards higher concentration) is called active transport.

Examples :- Sodium-Potassium ($\text{Na}^+ - \text{K}^+$) pump, endocytosis and exocytosis etc.

ci) ENDOCYTOSIS (ENDO = Inside, CYTOSIS = Process)

- The process in which substances are brought into the cell is called endocytosis.

01- PHAGOCYTOSIS (PHAGO = Eat, CYTOSIS = Process)

- It is the process in which cell intakes solid particle or a bulk of solid. It is also known as eating process of the cell.

Example:- WBCs pick up bacteria from the bloodstream.

02- PINOCYTOSIS (PINO = Drink, CYTOSIS = Process)

- It is the process in which cell intakes/absorbs liquid substance. It is also known as drinking process of the cell.

Example:- Cells absorb hormones.

cii) EXOCYTOSIS (EXO = Outside, CYTOSIS = Process)

- The process in which cell secretes hormones, waste products,

enzymes etc is called exocytosis.

Examples: Pancreas secrete gastric juice, Stomach secrete HCl, etc

FLUIDITY OF PLASMA MEMBRANE

brane. The fluidity of plasma membrane is affected by the decrease in temperature. The fluid starts to freeze so at that time, cell starts to produce unsaturated fatty acids to maintain the fluidity of plasma membrane.

ROLE OF GLYCOLIPIDS & GLYCOPROTEIN ON PLASMA MEMBRANE

→ GLYCOLIPIDS :- It is formed on the outer surface of plasma membrane when oligosaccharides combine with phospholipid.

- It maintains the stability of plasma membrane, helps in cell to cell communication, provides adhesive force at tissue level, helps in immune responses etc.

- Glycolipids on RBCs make ~~antigen~~ antigen which are responsible for blood grouping. If the cell has no antigen, then the blood group will be 'O'.

→ GLYCOPROTEINS :- They are formed when glucose combines with protein.

- They form receptors (such as 'HLA' present in WBCs or MHC → Major Histo Compatibility Complex)

- Both glycolipids and glycoprotein form cell coat.

- Every cell has a slight difference in its cell coat.

CYTOPLASM

- It was first seen by Schwann.
- The term 'cytoplasm' was coined by Von Wolliker.
- It is the region between plasma membrane and nuclear membrane. It is translucent (Some light can pass through it).
- In unicellular organisms, cytoplasm is divided into two regions. Near the plasma membrane, the cytoplasm is more viscous and is called cytogel (previously called ectoplasm). Near the nucleus, the cytoplasm is less viscous and is called cytosol (previously called endoplasm).

COMPOSITION OF CYTOPLASM

- It is composed of 90% water & 10% organic & inorganic substances.
- Micro-organic molecules are amino acids, fatty acids, glucose, nucleotides etc.
- Macro-organic molecules are proteins, carbohydrates, lipids etc (Colloid form).
- The observations in electron microscope reveal that cytoplasm has granular structures called organelles.
- Organelles are the sub-cellular structures that perform particular functions.
- Cyclosis :- The streaming movement of cytoplasm is called cyclosis. It helps to exchange and transport materials.
- Cytoplasm is the site of metabolic activities.
- The main metabolic activity that occurs in the cytoplasm is glycolysis.

CYTOPLASMIC ORGANELLES

- 01- Endoplasmic Reticulum (E.R) → Import & Export of cell
- 02- Golgi Apparatus → Cell secretions
- 03- Lysosomes → Cellular digestion
- 04- Peroxisome → Detoxification of Alcohol
- 05- Glyoxisome → Conversion of fatty acids into sugar
- 06- Mitochondria → Power house of the cell
- 07- Plastids → Manufacturers, Storage
- 08- Ribosomes → Protein factories
- 09- Centrioles → Help in cell division
- 10- Vacuoles → They are cell sap

- E.R, Golgi Apparatus, Lysosomes, Peroxisomes and Glyoxisomes are single membrane bound organelles

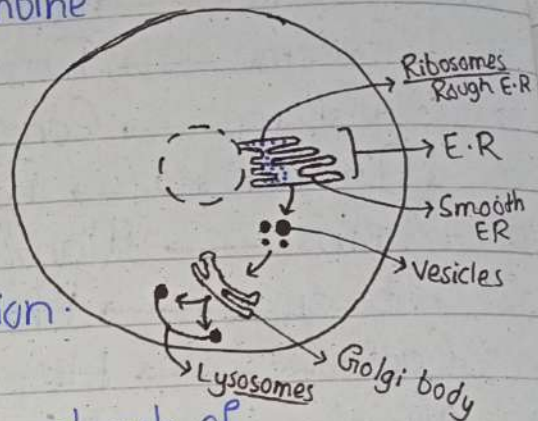
- Mitochondria and Plastids are double membrane bound.

They are basically not true organelles rather they are individual cells such as prokaryotic cells which have their own D.N.A and don't have membrane bound organelles due to the absence of nucleus.

- Ribosomes and Centrioles are non-membrane bound organelles. Vacuole is also a single membrane bound organelle in both plant & animal cells but in animal cell, it is produced by E.R and Golgi Apparatus while in plant cell, it is synthesized by the cell.

ENDOMEMBRANE SYSTEM (GERL)

- It is the set of three organelles which work together such as Endoplasmic Reticulum, Golgi Apparatus & Lysosomes.
- E.R synthesizes vesicles which combine and form another membrane bound structure called as the golgi apparatus which synthesizes vesicles as well & those vesicles are called lysosomes which are responsible for cellular digestion.



ENDOPLASMIC RETICULUM

- Electron microscope revealed that a network of tubules extend from nuclear membrane to plasma membrane and those tubules are called endoplasmic reticulum.
- E.R is a single membrane bound organelle.
- It's membrane is made up of lipoprotein.
- There are two types of E.R:

- ci) Granulated E.R OR Rough E.R (R.E.R)
- cii) Agranulated E.R OR Smooth E.R (S.E.R)

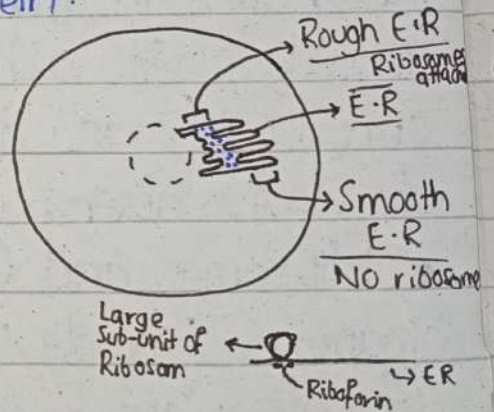
- ROUGH E.R

ROUGH E.R

- It is highly coated with ribosomes.
- It is present near the nucleus.
- It is more concentrated tubule in protein producing cells such as gland cells i.e. ~~salivary~~ salivary glands etc.

SMOOTH E.R

- Its surface is not associated with ribosomes.
- It is away from nucleus.
- It is more concentrated tubule in lipid storing and releasing cells.



i.e. Adipose cells.

→ Generally, both types of E.R are found in cells.

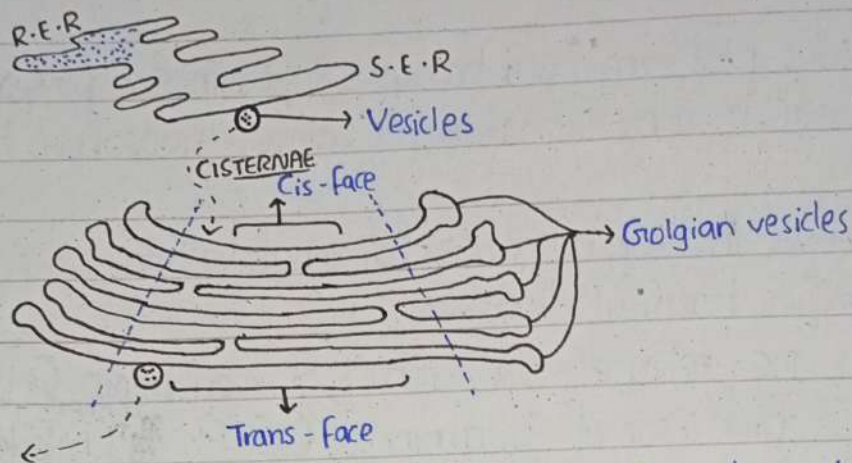
FUNCTIONS OF E.R

- It provides platform for ribosomes to synthesize protein. Riboforin protein helps to attach the large subunit of ribosome to attach with E.R.
- It increases the surface area for metabolism.
- It detoxifies harmful drugs.
- It stores and releases Ca^{++} ions (Sarcoplasmic Cells)
- It is the precursor of Vitamin D (S.E.R ^{converts} Cholesterol to Vitamin D)

GIOLGI-APPARATUS

- It was discovered by Camillo Golgi in 1898.
- Basically, it is developed by Smooth E.R.
- It is canalicular system which consists of interconnected tubules like E.R but lie in parallel.
- It is single membrane bound organelle.
- All biological membranes are made up of lipoprotein which include the membrane of Golgi body as well.
- The morphology / external structure of Golgi body is same in both plant cell and animal cell.
- It consists of central disc shaped flattened structure called Cisternae, and peripheral flattened stalk have vesicles called golgian vesicles.
- Cisternae has convex region towards the nucleus which is called cis-face. It recieves vesicles from S.E.R.
- Cisternae has concave region away from the nucleus which is called trans-face or shipping face.

- In lower invertebrates and plants cells, it is called dictyosome.



Here, R.E.R produced protein and and sent it to S.E.R which secreted it in the form of vesicle. The cis-face of cisternae of golgi-complex recieved it, modified it and then sent it out through the trans-face of cisternae.

* FUNCTIONS OF GOLGI COMPLEX

- It is more present or prominent in glandular cells because it is concerned with cell secretions.
- It collects and modifies the vesicles and then packs them and send them to their destination which is why they are also called finishers of cell.
- They synthesize lysosomes, peroxisomes, glyoxisomes etc.
- They synthesize macromolecules such as cellulose (for plant cell wall), chitin, lignin, cell plate (Phragmoplast).
- They form conjugated molecules (Glycoprotein, Lipoprotein etc)
- They help in cytokinesis in only plants cells. In animal cells, cytokinesis (division of cytoplasm) is done is centrioles.
- Because of all these functions of golgi apparatus, they are

also called post office of the cell and traffic police of the cell.

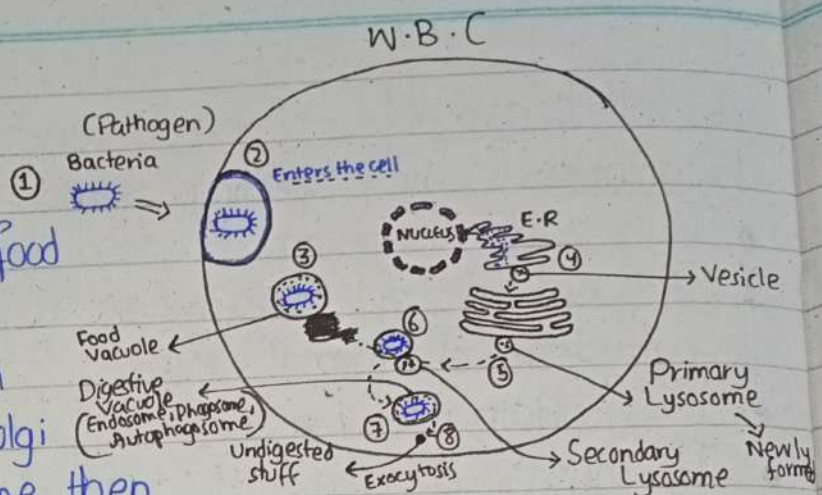
LYSOSOMES (Lyso = Splitting, Soma = body)

- It is single membrane bounded organelle.
- It is only a few micrometers in diameter and is found in cytoplasm of animal cells.
- It is originated / ~~is~~ secreted from golgi body.
- It consists of about 40 types of hydrolytic / digestive enzymes.
- It is also called garbage collector of cell.

* FUNCTIONS OF LYSOSOMES

- It is concerned with cellular digestion.
- It wears out old cell organelles or the organelles which are present in excess.
- It performs apoptosis (pre-programmed cell death).
- During destruction of own cell organelle (lysosome), its membrane ruptures and the hydrolytic enzymes of it are released which perform the chemical breakdown of their own cell (lysis). This phenomenon is called Autophagy. Hence, lysosomes are also known as suicidal sacs.
- The whole body of a fetus is fused within itself. Lysosomes give it structure by ~~breaking down~~ killing certain cells after the gene information which is passed from it.

- Here, bacteria is engulfed by the cell and trapped inside the food vacuole. Then, the cell synthesizes lysosome with the help of E.R & Golgi Apparatus. The lysosome then



goes toward the food vacuole and binds to it. It then releases its hydrolytic enzymes in the food vacuole which kill the bacteria. After killing the bacteria, the digested minerals are used by the cell and the undigested waste products are excreted by the cell.

- Primary & secondary lysosomes are not the types of lysosomes
- Lysosomes consists of hydrolytic enzymes. If cell becomes unable to synthesize any one of these enzymes due to heredity or congenital reasons then the substrate will start to accumulate (being produced in excess) and will cause lysosomal storage diseases. Over 30 types of lysosomal storage diseases are reported. Some of them are as follows:
 - 01 - TAY SACH'S DISEASE → Mental retardation, blindness, death by age of 3.
 - 02 - GAUCHER'S DISEASE → Liver and Spleen enlargement, erosion of long bone, mental retardation in infantile only. Death by age of 5 for infantile only while adults can expect normal life with enzyme replacement therapy.
 - 03 - KRABBE'S DISEASE → Loss of myelin sheath, mental

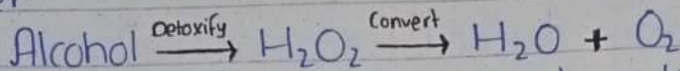
retardation, death by the age of 2.

- The first lysosomal storage disease (Pompe disease) was reported by L. Hers. He reported the cause of the disease as a deficiency of α -glucosidase. He also suggested that other lysosomal storage diseases might be caused by enzyme deficiencies as well.

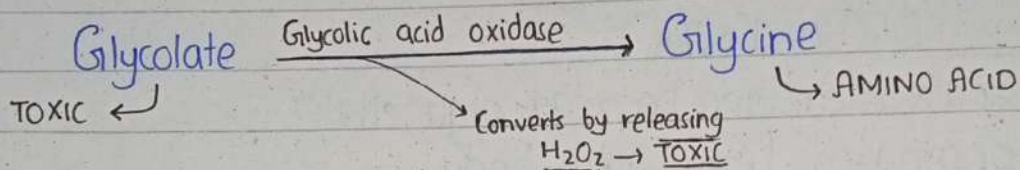
PEROXISOMES (Micro bodies)

- It is single membrane bounded organelle.
- It is originated from golgi body.
- It is smaller in size than lysosomes.
- It is found in both plants and animals.
- It is concerned with the formation & decomposition of H_2O_2 (Hydrogen Peroxide).
- It consists of catalase enzymes (LYASE class of enzymes) i.e. Peroxidase, Glycolic acid oxidase etc. These enzymes do not belong to oxidoreductase group of enzymes because ~~in~~ they only perform oxidation and not reduction. They belong to Lyase group of enzymes because they are also responsible for the breakdown of substances without adding water. Oxidoreductase enzymes perform redox reactions (both oxidation and reduction).
- It is responsible for the oxidation of lipids.
- It either synthesizes phospholipid or plasmalogen (Plasmalogen are the class of phospholipids which are responsible for the formation of membranes of brain, tissue of heart, isoprenoid units, cholesterol etc).
- It detoxifies alcohol into H_2O_2 and then release O_2 in

liver.



- It is present in high amount in liver cells in animals / humans.
- In plant cell, it helps in photorespiration (wasteful process)

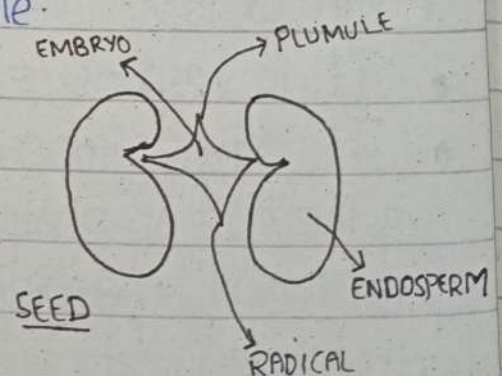


GLYOXISOMES : (A body that adds oxygen & forms glucose)

- It is single membrane bounded microbody originated from Golgi body.
- It acts as an alternate of ~~lysosome~~ ^{peroxisome} in plant cells (functions like ~~lysosome~~ ^{peroxisome} in plant cell).
- It is mostly found in fat storing cells i.e. seed endosperms (plant cells).
- Structurally, it is single membranous. Inside that membrane, granular stroma ^{present} which consists of enzymes.
- These enzymes are responsible to convert fatty acids of endosperm into sugar (mostly glucose) in cyclic manner and cycle is called glyoxalate ~~cycle~~ cycle.

• Here in the seed, fatty acids are present in the endosperms. In plant cells, glyoxisomes are present in excess which convert fatty acids into sugar. So in the endosperms,

~~glyoxisomes~~ glyoxisomes convert fatty acids into sugar

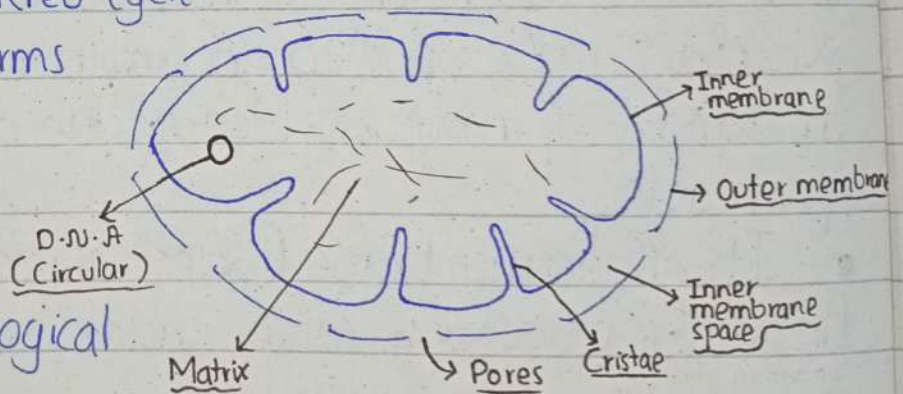


by adding oxygen with the help of its enzymes (LYASE class of enzymes). This sugar then deposited to plumule and radical and provides energy (ATP) to them. With this energy, plumule forms shoot and radical forms root. This process is called Germination.

MITOCHONDRIA OR CHONDRIOSOMES (SELF REPLICATING ORGANELLE)

- It is universally found in cytoplasm of eukaryotic cells.
- It is spherical, vesicle, rod-like but normally bean shaped.
- Its diameter ranges from 0.1 to 1 μm while its length is 1-2 μm .
- It is double membrane bounded. Both membranes are composed of lipids and proteins (lipoproteins).
- Its outer membrane is smooth and has slit like pores which are made up of porin protein. These pores allow the movement of molecules. Hence, the outer membrane is permeable.
- Its inner membrane (Selectively Permeable) has irregular finger like projections called cristae, which increase the surface area.
- Cristae consist of many complexes like ATPase (F_0-F_1 particles), many types of cytochromes, NAD reductase, FAD reductase, ubiquinone etc. These molecules act as electron carriers and are responsible for oxidative phosphorylation (process in which ATP is formed, when electrons are transferred by electron carriers from NADH or $FADH_2$ to oxygen) $\rightarrow$ such as Electron transport chain.

- Inside the mitochondria, a gel like substance is present called matrix. Matrix consists of enzymes, co-enzymes, D.N.A, all types of R.N.A and 70s ribosomes.
- Mitochondria is the seat of aerobic respiration (respiration in which oxygen is used), it oxidizes carbohydrates (glucose), proteins (amino acids), fatty acids and release CO_2 , H_2O and energy (A.T.P).
- Due to the production of high ~~en~~ concentration of energy in cell through mitochondria, it is known as power house of the cell.
- It is semi-autonomous (it has its own D.N.A).
- It can reproduce by itself by simple cell division (binary fission).
- The matrix performs Krebs cycle.
- ~~Matrix~~ Cristae performs Electron transport chain.
- No. of mitochondria vary in every cell according to the physiological functions of the cell.



- Skeletal muscles have largest no. of mitochondria.
- Cytoplasm, mitochondria and chloroplast all three form A.T.P but only mitochondria is known as the power house of the cell because it form more energy than others.
- Mitochondria is absent in red blood cells and sieve tube cells.
- Mitochondria is the seat of cellular respiration.

PLASTIDS

- It is special ~~proplasmic~~ protoplasmic double-membrane bounded organelle which is found in plant cell and in algal cell.

- It is chemical synthesizer and storage organelle.

- Plastids are developed from proplastids (which are found in meristematic cells) → Dividing cells

- Proplastids are immature, colourless, double membrane bounded ~~struc~~ structure with granular stroma. They can be divided when ~~meristematic~~ meristematic cells divide. Their distribution depends upon the availability of light.

- Plastids are of following types :

ci) Chloroplast cii) Chromoplast ciii) Leucoplast

→ CHLOROPLAST :

- It consists of green pigment (Chlorophyll).

- It is found in mesophyll cells and plant like protists (algae).
↳ leaf cells

- It helps in photosynthesis.

→ CHROMOPLAST :

- It consists of various pigments i.e. Xanthophyll, carotenes etc and different pigments other than green.

- It gives different colours to fruits and flowers.

- When chloroplast is destroyed, it converts into chromoplast.

- It helps in pollination.

→ LEUCOPLAST :

- It is colourless plastid and is found in underground parts of plants and storage stem.

- It stores the photosynthetic products.
- ~~Amilo~~ **AMYLOPLAST** :- It converts glucose into starch and then stores it.
- **ELAIOPLAST** :- It converts glucose into lipids and then stores it.
- **PROTEIOPLAST** :- It converts glucose into protein and then stores it.

Proplastids

↓
Plastids

where light is present ←

→ where light is absent

- Chloroplast
 - Chromoplast
- } are available

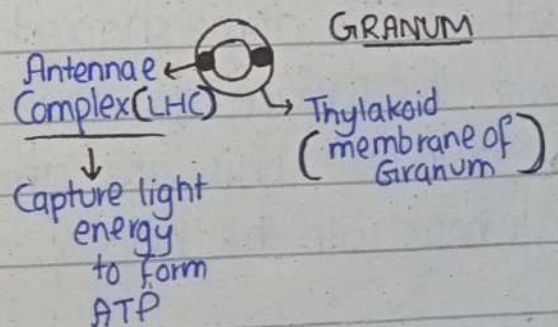
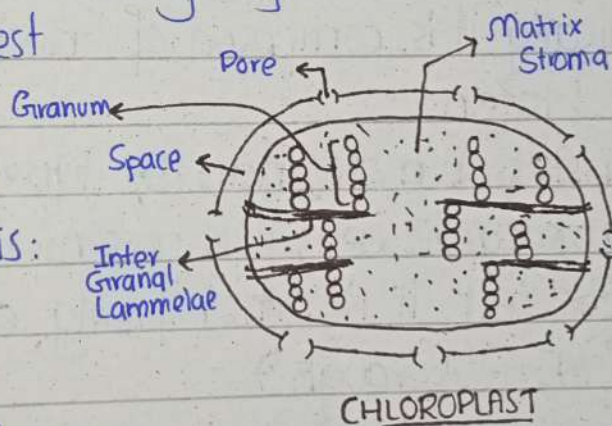
- Leucoplast is available

→ STRUCTURE OF CHLOROPLAST

- It is double membrane bound plastid which is found in mesophyll cells and protists.
- No. of chloroplast vary in mesophyll cells.
- The outer membrane of chloroplast is permeable and has pores (like mitochondria) which is made up of porin protein.
- The inner membrane is differentially permeable.
- Inner membrane has hollow sac like structures called granum (Pl: Grana).
- Each granum consists of 50 or more sacs called thylakoid.
- Each chloroplast consists of 40 - 60 grana.
- Thylakoid consists of pigments like chlorophyll, xanthophyll, carotenoids etc.
- These pigments make Antennae complex or Light

Harvesting Complex (LHC).

- Grana are interconnected with intergranal lamellae (which is colourless).
- Chloroplast is filled with matrix called stroma.
- Stroma consists of many enzymes (i.e. Rubisco etc), D.N.A., 70s ribosomes and all types of R.N.A.
- Rubisco is the most abundant protein in nature.
- Chloroplast is self-replicating organelle (Semi-autonomous).
- Chloroplast has its own D.N.A.
- Chloroplast is also known as energy converting organelle because it captures light energy and converts it into chemical (food) energy by the process of photosynthesis. Hence, chloroplast is the site of photosynthesis.
- Chloroplast is oxygen releasing organelle.
- Chloroplast is the largest organelle of plant cell.
- Two types of reactions occur during photosynthesis:
 - Light reaction
 - Dark reaction

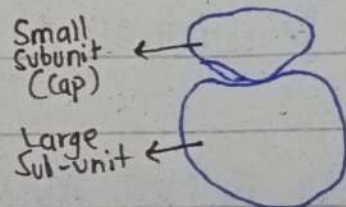


- Light reaction takes place in thylakoid to form O_2 , ATP & $NADPH_2$.
- Dark reaction takes place in stroma to ~~fix~~ synthesize glucose by fixing CO_2 .
- Chloroplast is not true organelle.

- Chloroplast is from symbiotic origin (means it was once a photosynthetic bacteria and now it lives in eukaryotic cell).

RIBOSOMES

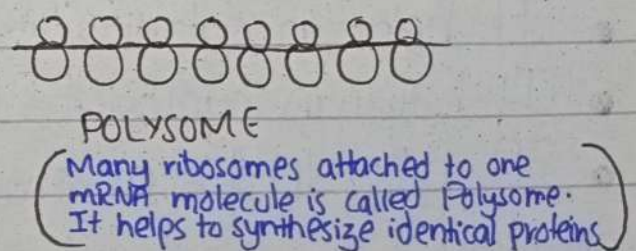
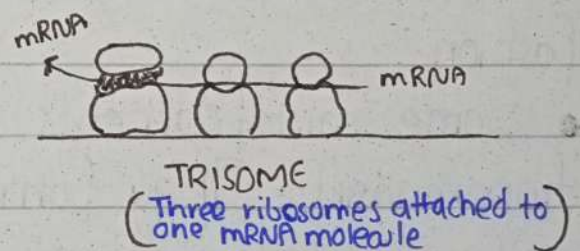
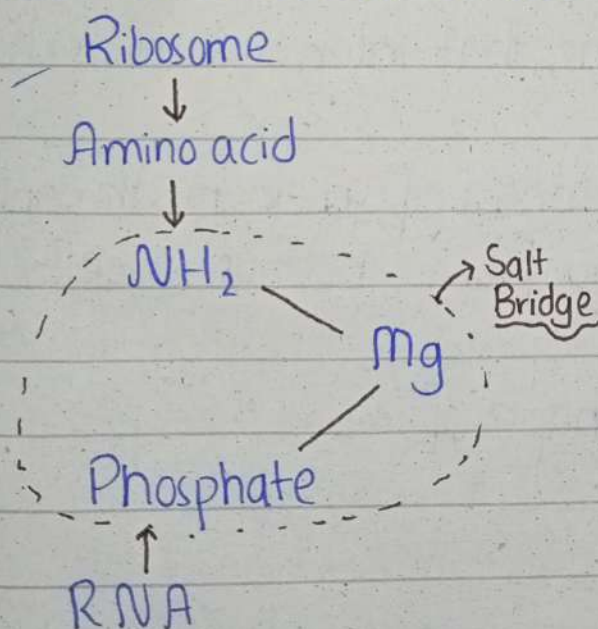
- It is also known as Palady's particle.
- It is named due to high concentration of Ribonucleic acid (R.N.A) $\rightarrow$ λ R.N.A.
- It is non-membrane bounded structure found in both types of cells (prokaryotic and eukaryotic) and is responsible for protein synthesis. Hence, it is known as protein factory of the cell.
- It is also found in the matrix of mitochondria (70s) and stroma of chloroplast (70s). Hence, it is an organelle within the organelle.
- Chemically it is composed of nucleoprotein, 40% RNA and 60% Protein.
- It consists of more than 50 types of proteins.
- In prokaryotic cell, it is present freely in cytoplasm while in eukaryotic cell, it is either freely or attached with the surface of E.R (rough)
- Ribosomes consist of two unequal sub-units. Larger sub-unit is dome shaped while smaller sub-unit is attached with the surface of larger sub-unit and forms a cap.
- Both sub-units are attached only at the time of protein synthesis with the help of Mg^{++} ions.



- In prokaryotic cell,
- | | | |
|-------------------|------------------|----------|
| Larger Sub-unit | Smaller Sub-unit | Ribosome |
| 50s | + 30s | → 70s |
| S → Svedberg unit | | |
- ∴ 10s are lost

- In eukaryotic cell,
- | | | |
|-----------------|------------------|----------|
| Larger Sub-unit | Smaller Sub-unit | Ribosome |
| 60s | + 40s | → 80s |
- ∴ 20s are lost

- Larger sub-unit of ribosome is attached with the surface of E.R with the help of Riboforin protein to synthesize proteins from mRNA. After the larger sub-unit is attached with E.R, the smaller sub-unit of ribosome is attached with the larger sub-unit with the help of Mg^{++} ions.
- mRNA is attached to the ribosome through salt bridge.



● CYTOSKELETON (Cyto = cell, Skeleton = frame work)

● A network of different protein fibres which provide three dimensional shape to cell is called cytoskeleton.

● It maintains and changes the shape of the cell.

● It secures some organelles at their specific position.

● It enables movement of cytoplasm and vesicles within the cell and cell to move in response of stimuli.

● There are three types of cytoskeletal elements found in cell.

● (i) Microfilament

● (ii) Microtubules

● (iii) Intermediate filaments

→ MICROFILAMENT

● It is a solid strand, about 7nm in diameter.

● It consists of two actin chains, that intertwine in a helical fashion.

● Some microfilaments also consist of myosin, troponin, tropomyosin. They form myofibril in muscle cell, perform muscle contraction.

● It helps to change the shape of cell.

● It helps in cytokinesis.

● It helps in cyclosis.

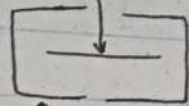
● It helps in the movement of pseudopodia (false feet of amoeba)

● It assembles and deassembles during cell division.

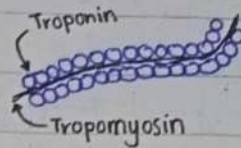
• Skeletal muscle → Muscle fibre

↓
Myofibril

myosin

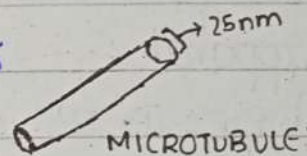


Actin
SARCOMERE is a microfilament
(Functional unit of muscle)



→ Microtubules (They assemble and deassemble)

- It is a hollow tube with an outer diameter about 25 nm.
- It is composed of tubulin protein.
- It is a single microtubule that consists of hundreds of thousands of tubulin sub-units that are arranged in 13 columns called protofilament.
- Cilia and flagella are microtubules composed of tubulin protein.

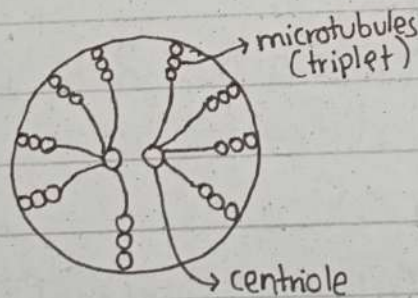


→ INTERMEDIATE FILAMENTS

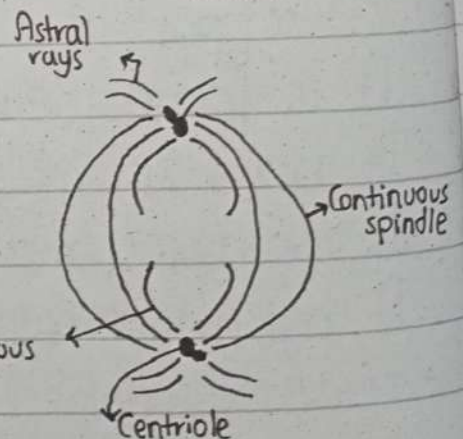
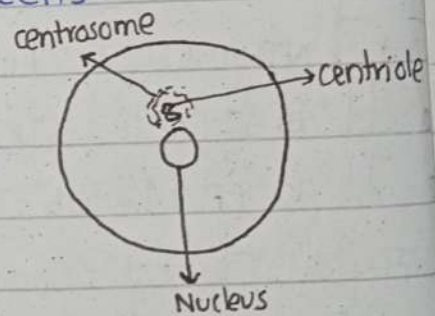
- It is a solid strand that is about 8 to 12 nm in diameter.
- It is made up of five different types of proteins that are collectively called vimentin.
- It supports the cell membrane and nuclear membrane.
- It is found between the microfilament & microtubules.
- It never assembles and deassembles (book point).
- It assembles and deassembles (Sir's point).
- It maintains cell shape, muscle attachment and neuron processes extension.

CENTRIOLES

- It is short ~~barrel~~ barrel shaped.
- It is non-membranous.
- It has two microtubules in number that lie perpendicular to each other.
- It is found in animal cell and fungi-like protists.
- Each centriole consists of triplet filaments of microtubules arranged in 9 columns and form rounded structure.
- The region of cytoplasm where centrioles are present is called centrosome.
- During cell division, centrioles duplicate and form a pair. One pair goes to the opposite pole and forms mitotic apparatus.
- It helps in cell division in animal cells.



- This arrangement is called 9 + 2 arrangement.



MITOTIC APPARATUS

Vacuole

- It is non-protoplasmic organelle except food vacuole because its membrane is made up of tonoplast, not lipoprotein.
- In immature plant cell, many vacuoles are present. At maturity, all the vacuoles unite to form a central vacuole. Central vacuole has tonoplast membrane (double membrane).
- Tonoplast is selectively permeable. (Tono = Tension)
- In the vacuole, a fluid is present that makes cell sap. Cell sap contains minerals, organic compounds, hydrolytic enzymes etc. Due to the presence of hydrolytic enzymes, vacuoles act as alternate lysosome in plant cells.
- Tonoplast maintains internal turgor pressure, that helps to maintain cell shape.
- It is concerned with store house of the cell.

NUCLEUS OR KARYON

- In 1831, Robert Brown discovered it from orchid plant cell. Bird's nest is composed of orchid plant cells. Orchid plant is saprotrophic.
- In plant cell, it is placed at one side (peripheral) due to the presence of central vacuole and in animal cell, it is present at centre.
- It is normally spherical in shape.
- Some cells possess more nuclei such as skeletal muscle cells.

● STRUCTURE OF NUCLEUS :- Nucleus consists of :

- a) Nuclear membrane
- b) Nucleoplasm
- c) Nucleolus

→ NUCLEAR MEMBRANE :

- It is outer boundary of nucleus.
- It is double membrane bounded and made up of lipoprotein.
- Between both membranes, a fluid is present.
- Outer membrane is not a complete barrier, it has minute pores called nucleopores. Nucleopores are made up of nucleoporin protein.
- Outer membrane is also associated with ribosomes and E.R.

→ NUCLEOPLASM (KARYOLYMPH) :

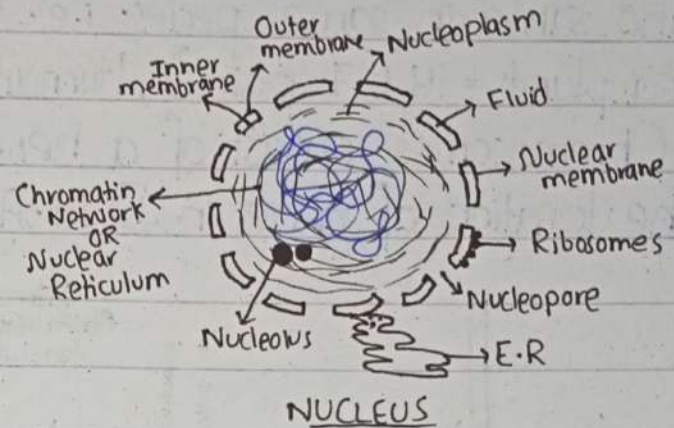
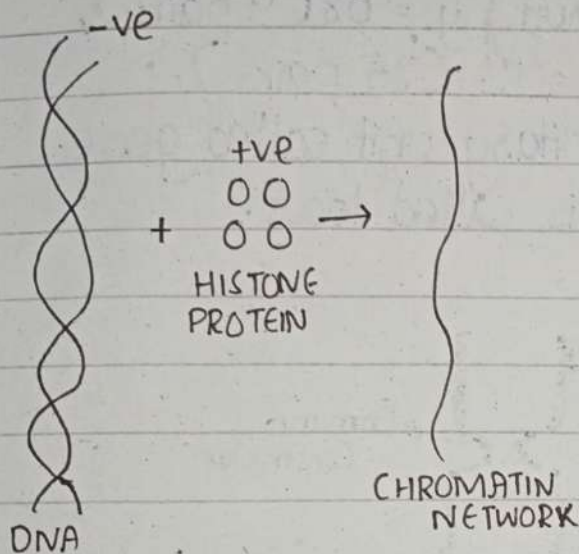
- Inside the nucleus, a protein rich gel like structure is present known as nucleoplasm.
- Nucleoplasm consists of proteins (histones, non-histones, etc), D.N.A, R.N.A, enzymes, nucleotides and some metal ions i.e. Mg^{++} .
- Main enzymes in nucleoplasm are D.N.A polymerase and R.N.A polymerase (help in synthesis of DNA & RNA).

→ NUCLEOLUS :

- It is non-membranous spherical structure.
- Some nuclei consist more than one nucleolus.
- It disappears during cell division and reappears afterwards. The reason for which it disappears during

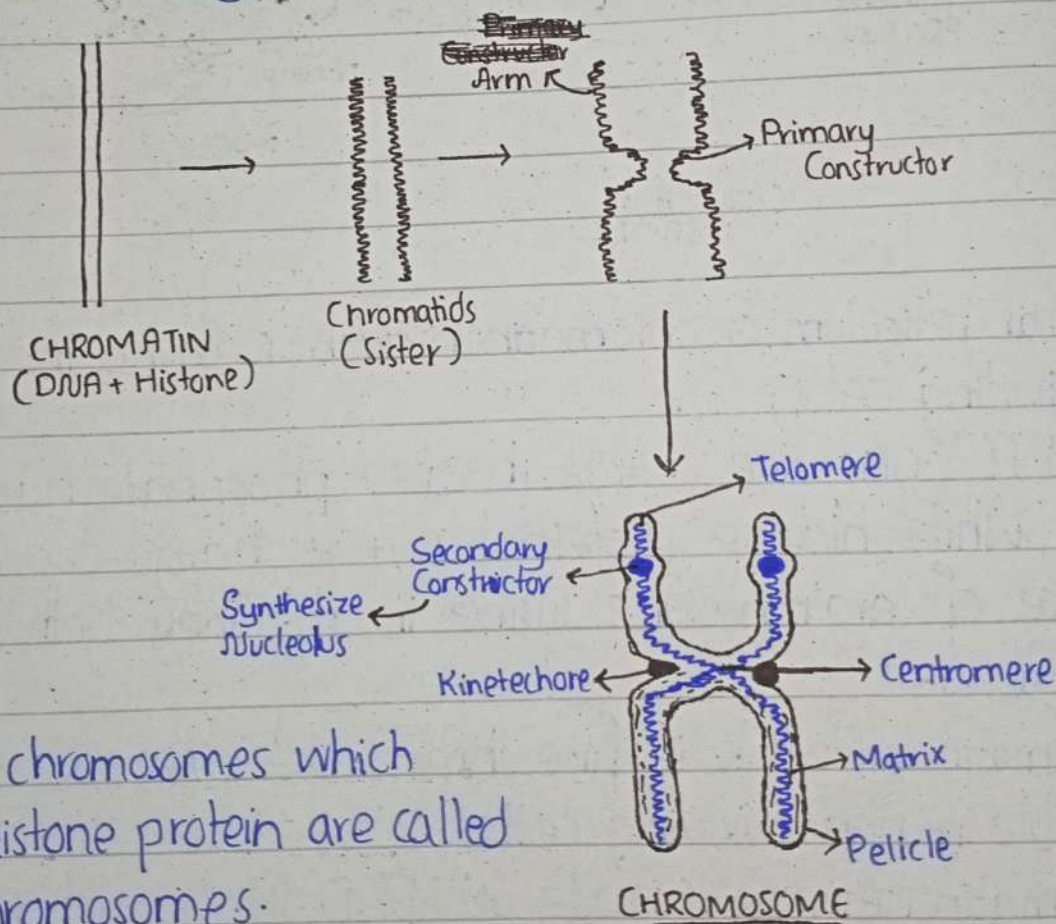
cell division is because it makes all the ribosomes that synthesize the necessary proteins for cell division. It disappears because it becomes empty.

- It is the site of rRNA and ribosome synthesis.
- It is known as the ribosome factory of the cell.



- Nuclear reticulum or chromatin network is found in non-dividing cells.
- D.N.A has -ve charge because phosphate has free radical while histone protein has +ve charge due to the presence of arginine and lysine in it. They both are amino acids.
- Chromatin network is fine thread-like structure which is only visible in non-dividing cells.
- Chromatin network is made up of D.N.A and histone protein. During cell division, chromatin network breaks into specific number and start to condense to form chromosomes.

- Chromosomes consist of two identical threads called sister chromatids. Chromatids are highly condensed form of chromatin.
- Two sister chromatids are joined together by a centromere.
- Number of chromosomes are different in different species and same in same species. i.e. fruit fly = 08 (4 pairs), pea plant = 14 (7 pairs), human = 46 (23 pairs).
- Chromosomes consist of a hereditary unit called gene. The location of gene in D.N.A is called locus.



- The chromosomes which have histone protein are called true chromosomes.

TYPES OF

on the b
visible d

01- M.E

02- Su

03- Ac
huge.

04- T

TYPES OF CHROMOSOMES :

There are four types of chromosomes on the basis of centromere. These chromosomes are only visible during metaphase and anaphase of cell division.

01- METACENTRIC :- Both arms are equal.



OR



(V-shaped)

02- SUB-METACENTRIC :- Both arms are unequal.



OR



(L-shaped)

03- ACROCENTRIC :- One arm is very small and the other is huge.

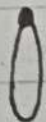


OR

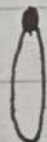


(J-shaped OR Rod)

04- TELOCENTRIC :- One of the two arms is absent.



OR



(I-shaped)

DIFFERENCE B/W PROKARYOTIC & EUKARYOTIC CELLS

PROKARYOTIC CELL: (Pro = Before, Karyon = Nucleus)

- It is a primitive cell (oldest and simplest cell).
- Its nucleus is incomplete or absent.
- Its nucleoplasm and nucleolus are absent.
- It has no true chromosomes (lack histone protein).
- It has no membrane bound organelles.
- Non-membrane bound organelles are present.
- 70s ribosomes are present.
- They are always in unicellular or colonial form.

Examples:- Bacteria, Archaea, Cyanobacteria etc.

- First colonizers of earth are cyanobacteria.
- Cyanobacteria is the first organism which released oxygen in the atmosphere by fixing CO_2 for the first time. At that time, there was no oxygen present in the atmosphere of earth.

- Prokaryotic cell was formed 3.5 billion years before. It has no paired chromosomes (unpaired chromosomes are present).

EUKARYOTIC CELL (Eu = True, Karyon = Nucleus)

- It is true nucleus cell.
- It has complete nucleus.
-  Nucleolus and Nucleoplasm are present.
- It has true chromosomes (have histone protein).
- Membrane bound organelles are present.
- Non-membrane bound organelles are present.

• 80s
• It c
Examp

- 80s ribosomes are present.

- It can be in unicellular as well as multicellular form.

Examples :- Animal cell, Plant cell etc.