ARIHANT COLLEGE OF ARTS,COMMERCE AND SCIENCE, BAVDHAN PUNE-21

T.Y.B.Sc

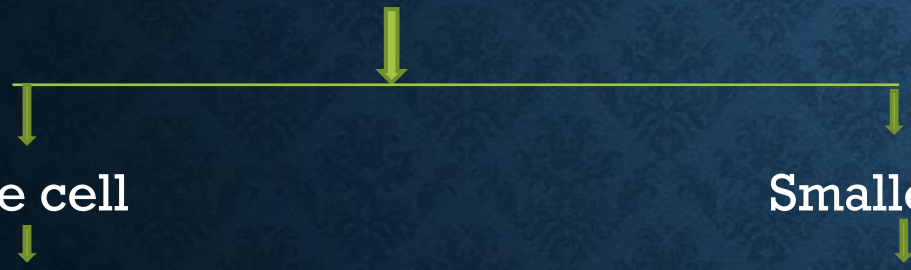
Cell Structure And Organisation.

Prof. Megha Pawal.

CELL STRUCTURE AND ORGANISATION.

CELL THEORY WAS PROPOSED BY SCHWANN AND SCHLEIDEN.

- Cell : Cell is a structural and functional unit of life.
- 2 types of cell present



Simple microscope
Magnifying image 50 – 100 times

Compound Microscope
Magnifying image 1000 times or more

- Electron Microscope : Used for seen interior of cell magnify 50,0000 times.
- Cell size various in plant & Animal cell. Some of cell not visible to naked eyes.
- There is no typical shape of a cell.
- Cell may be spherical, rectangular, polygonal, flattened, oval, triangular, conical, columnar etc.

SIZE OF CELL

- Mycoplasma – 0.3 µm
- Bacterial cell – 3-5 µm
- Ostrich egg – 15 cm (Largest size of cell)
- Nerve cells – 3-18 micron/mm (Longest Cell)
- Small cell is very active.
- Totipotency : Capacity of forming new cell.
- Cell is totipotent because it has genetic information of the organism in its nucleus.
- Embryonic animal cell are totipotent it is called stem cells.
- Stem cell have great medical application including cure for disease.

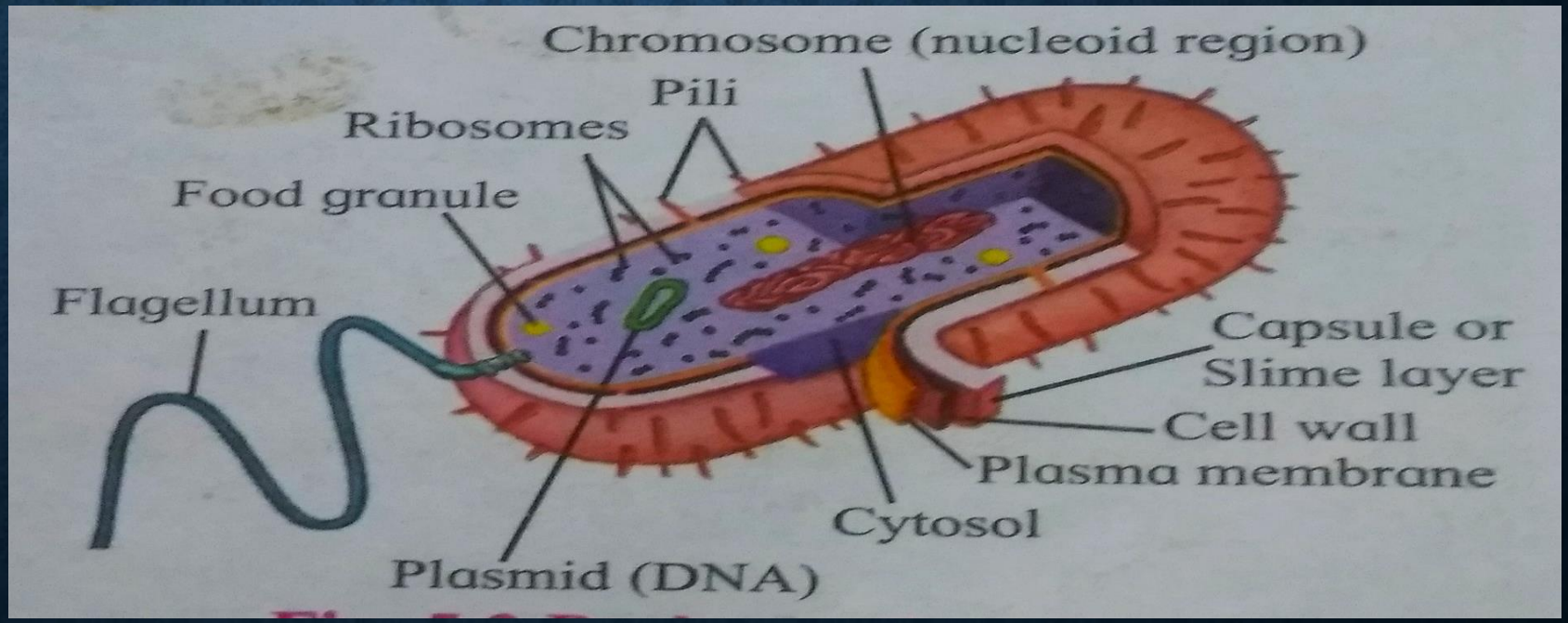
POSTULATES OF MODERN CELL THEORY

Postulates of modern cell theory,

- All living organisms are made up of cells.
- Living cells arise from pre-existing cells.
- A cell is the structural and functional unit of life.
- Total activities of cells are responsible for activity of an organism.
- Cells show transformation of energy.
- Cells contain nucleic acids; DNA and RNA in the nucleus and cytoplasm.

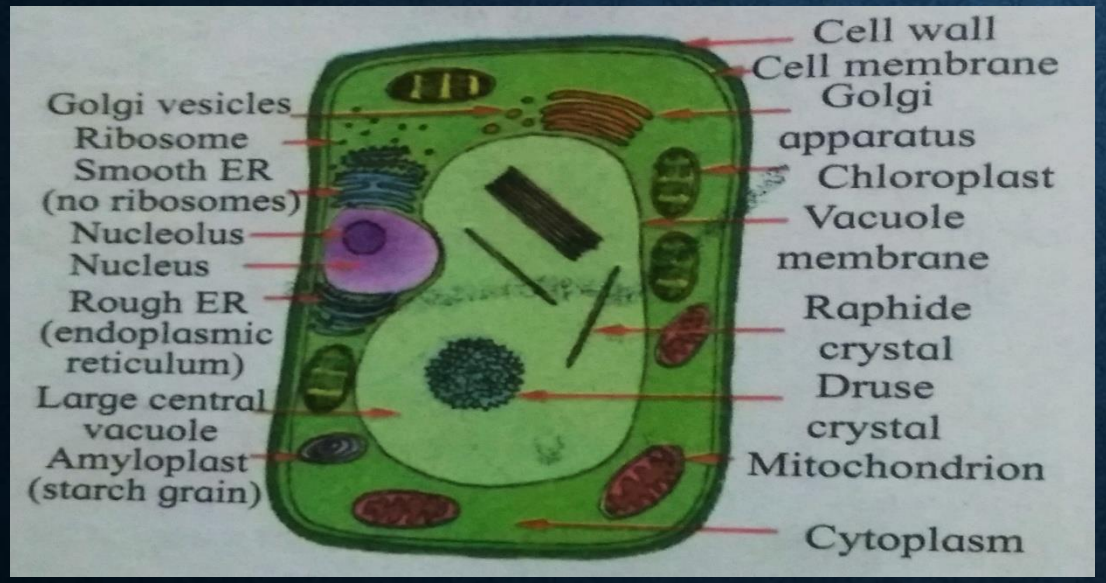
PROKARYOTIC CELL

- Prokaryotic cells may be represented by Bacteria, Blue green algae and Mycoplasma
- They multiply rapidly and vary in size.
- Bacterial cell may be Bacillus (rod shaped),Coccus (spherical).
- Cell organelles like Mitochondria
- Prokaryotic cell does not have well defined nucleus and other membrane bound cell organelles.
- Cell developed in 3 layer:
- 1) Outer glycocalyx
- 2) Middle cell wall
- 3) Inner plasma membrane.

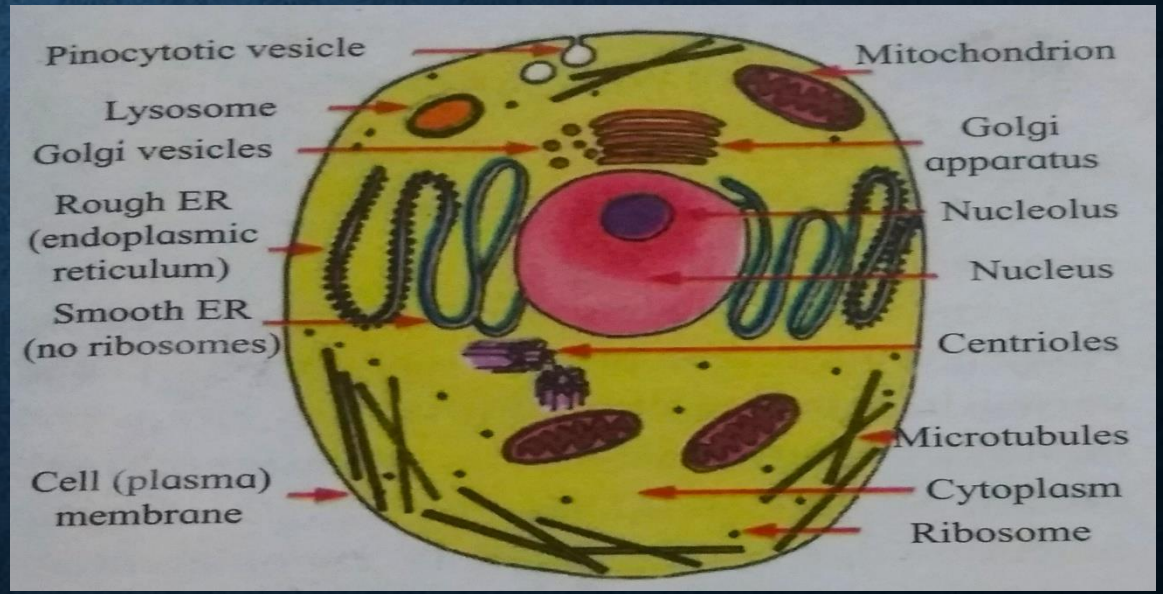


EUKARYOTIC CELL

- The nucleus has a definite nuclear membrane I such cells it is called eukaryotic cell.
- Membrane bound cell organelles are present.
- E.g. : Plant, animal, Fungi.
- Eukaryotic cell have different shape size and physiology but all the cells are typically composed of plasma membrane ,Cytoplasm and Mitochondria, E.R ,Ribosomes, Golgi complex etc.



Plant cell



Animal cell

PROKARYOTIC CELL	EUKARYOTIC CELL
The prokaryotic cell is the primitive cell.	The eukaryotic cell is the evolved cell.
Nucleus is not well defined i.e. nuclear membrane is absent	Nucleus is well defined i.e. nuclear membrane is present
The cell wall made of peptidoglycan.	The cell wall made of cellulose in plant cell and chitin in fungal cells.
The membrane bound cell organelles such as Mitochondria, Golgi Complex, ER etc are absent in prokaryotic cell	The membrane bound cell organelles such as Mitochondria, Golgi Complex, ER etc are present in eukaryotic cell
The genetic material occurs in n the form of a circular chromosome.	The genetic material occurs in n the form of a linear chromosome.
The ribosome are 70S type.	The ribosome are 80S type.

COMPONENTS OF EUKARYOTIC CELLS

1) Cell Wall
2) Cell membrane/ plasma membrane/ Biomembrane
3) Cytoplasm
4) Endoplasmic Reticulum (ER)
5) Golgi complex
6) Lysosomes
7) Vacuoles
8) Gloxysomes
9) Mitochondria
10) Plastid
11) Ribosome
12) Nucleus
13) Cytoskeleton

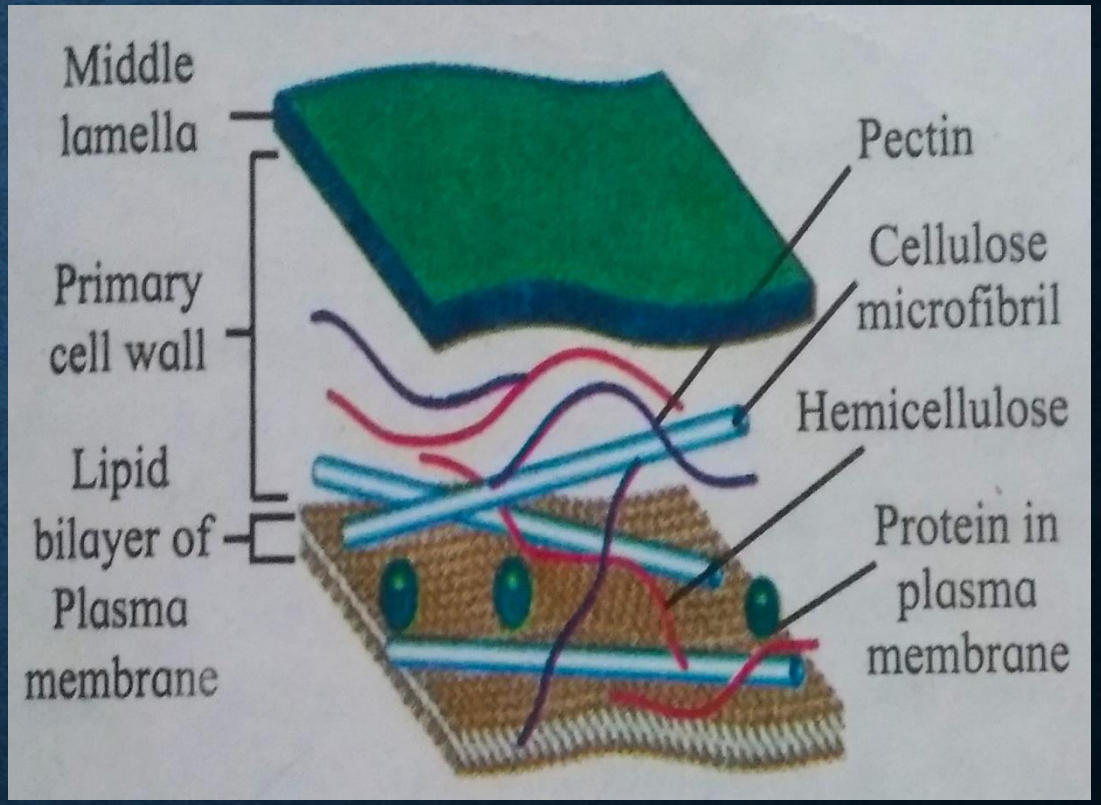
1) CELL WALL

- Outermost, rigid layer present in cells of plants, fungi and protista.
- Algal cell wall made up of cellulose , galactons, mannans and minerals like calcium carbonate.
- Plant cell wall consists of cellulose, hemicellulose, pectin, lipids and proteins.
- Cell wall of plants also contains Silica, cutin, subrin, wax and lignin.
- Cell wall divided into 3 part : 1) Middle lamella
  2) Primary wall
  3) Secondary wall

- **Function of cell wall :**
- Gives shape to the cell.
- Protect cell from mechanical injury and infections.

- In plants, cell wall shows middle lamella, Primary wall and secondary wall.

- Middle lamella :
- It is thin and lies between two adjacent cells.
- It is made up of pectin, calcium and magnesium pectate.
- Softening of ripe fruit is due to solubelization of pectin.



- Primary wall :
- Thin and capable of growth.
- It is situated to inside to middle lamella.
- It is only seen in meristematic tissue, Mesophyll, pith etc.

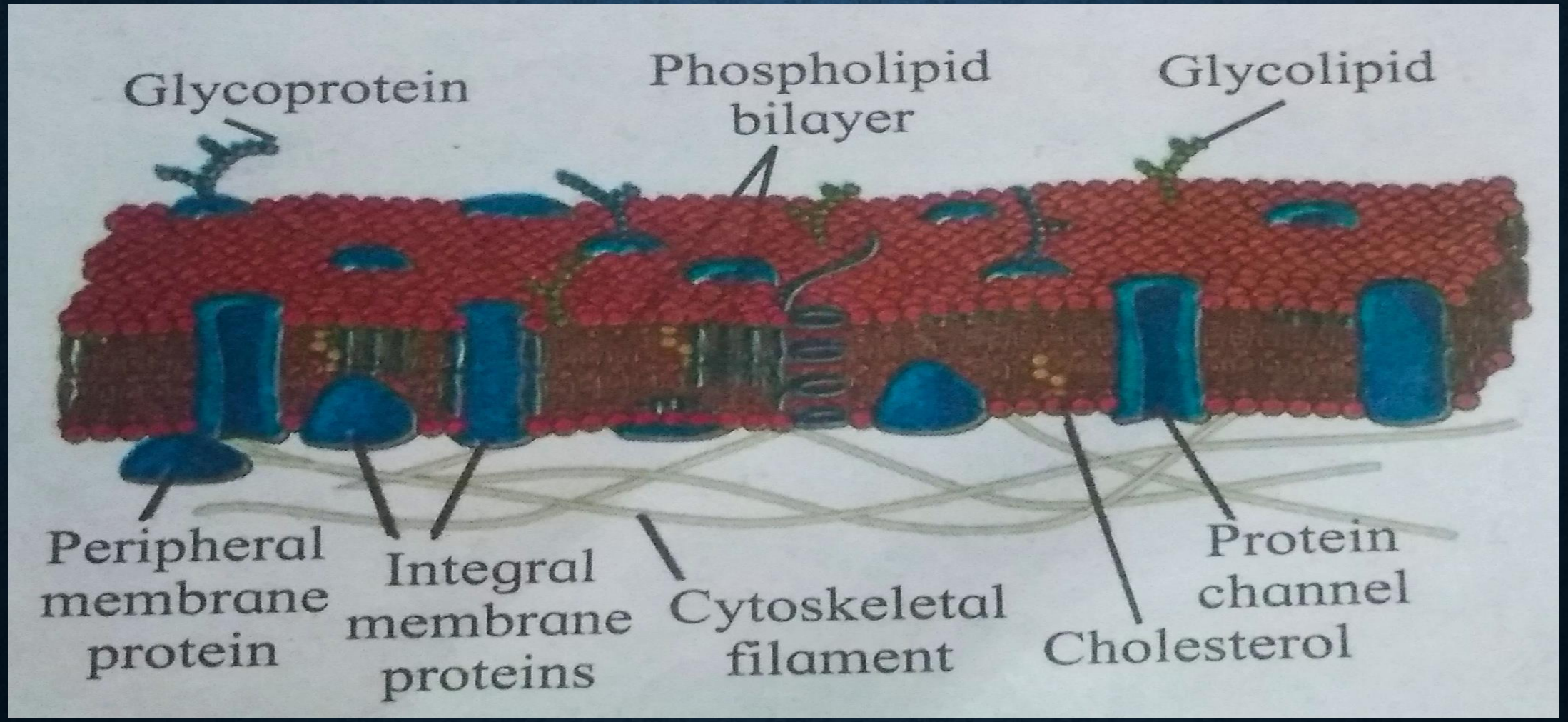
- Secondary wall :
- Thick and located on inner side of primary wall.
- Once primary growth of a wall stopped secondary wall is laid.
- Plasmodesmata are cytoplasmic bridges between cell wall and middle lamella.

CELL MEMBRANE

- It is thin and quasifluid structure present.
- Extracellularly present around protoplast and interacellulary around most cell organelles.
- It separate cell organelles from cytosol.
- Thickness of biomembrane is 75Å under electron microscope.
- Cell membrane appears trilaminar.
- It shows presence of lipids arranged in bilayer.
- Lipid posses are hydrophilic polar head and 2 non hydrophobic polar tail.
- Lipids molecule arranged in 2 layers (bilayer) in such way that tails are sandwitched in between heads. That’s why tail not directly contact with aqueous surrounding.
- Cell membrane in RBCs consist of about 52% proteins and 40% lipids.

- Fluid mosaic model, proposed by singer and Nicholson (1972).
- According to this model, cell membrane consists of fluid matrix of phospholipid bilayer and extrinsic and intrinsic proteins.
- Quasifluid nature of lipids enable lateral movement of proteins.
- This ability to move within the membrane is measured s fluidity.
- Each phospholipid molecule has a hydrophilic head and 2 hydrophobic tail.
- The hydrophilic heads are oriented inwards and tails from lipid bilayers face each other.
- The hydrophilic head are on the outer side of the membrane.
- The protein are extrinsic and intrinsic types.
- The extrinsic or peripheral proteins are found on surfaces of phospholipid bilayer.
- The intrinsic or integral proteins occur at different depths of bilayer.
- Transmembrane proteins span the entire thickness of the membrane and they form channels for passage of water.

FLUID MOSAIC MODEL



CYTOPLASM

- The cell contain ground substance called cytoplasmic matrix or cytosol.
- Cytoplasmic matrix colloidal jelly like material is not static.
- Streaming movement called cyclosis.
- Cytoplasm contain – water as major component along with organic and inorganic molecules like sugars, amino acid, vitamins, enzyme nucleotides, minerals and waste products.
- It contain various cell organelles like endoplasmic reticulum (E.R.), Golgi complex, Mitochondria, plastids, nucleus, microbodies and cytoskeleton element like microtubules.
- Cytoplasm act as source of raw materials.
- What is mean by cell organelles ?

Ans : Cell organelles are compartment in the cell and they carry out specific functions. Some of coordinate with each other and complete specific task for the cell. Nuclear membrane, endoplasmic reticulum, lysosome and various type of vesicle and vacuoles form such a group of and are toghather considered as endomembrane system of cell.

ENDOPLASMIC RETICULUM (E.R.)

- ER system that forms a series of flattened sacs within the cytoplasm of eukaryotic cells and serves multiple functions, being important particularly in the synthesis , folding modification and transport of proteins.
- Location :
- Present in almost all eukaryotic cell.

Present in all Eukaryotic cells except ova and mature red blood corpuscles.

The ER occupies most of the cytoplasm.

Physical Structure :

The ER is 3- dimensional network of intracellular.

It is formed of 3 types of element :

1) Cisternae

2) Tubules

3) Vesicle

1) Cisternae :

- These are flattened, Unbranched, Sac- like element.
- They lie in stacks parallel to one another.
- Ribosomes present on the surface that therefore, appears rough.

2) Tubules :

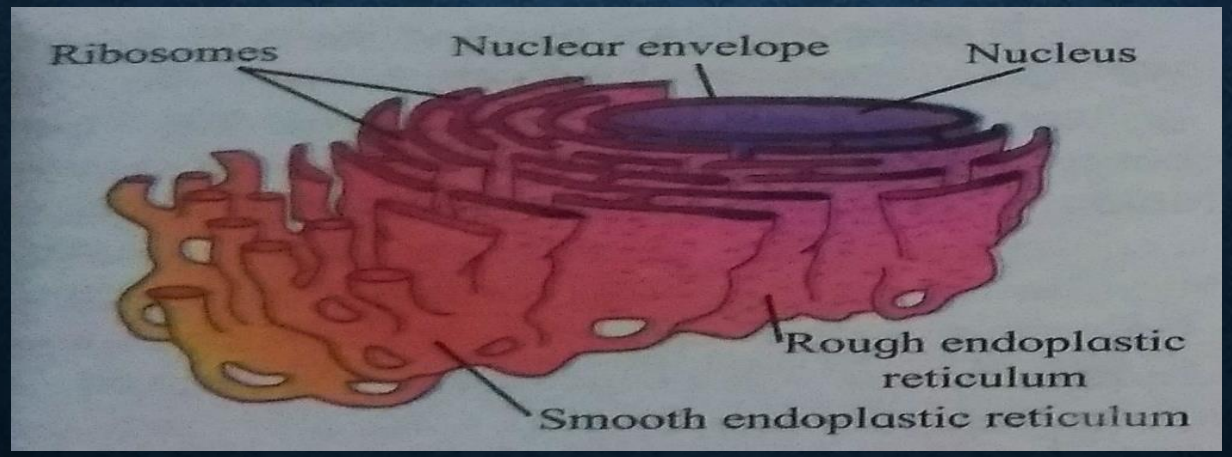
- These are irregular branching element which form a network along with other element.
- These are often free of ribosome.

3) Vesicles :

- These are oval and rounded, vacuole like element.
- These are also free of ribosome.
- All the element of ER freely communicates with one another and contain a fluid called endoplasmic matrix in the ER lumen.

ENDOPLASMIC RETICULUM : 2 TYPES

Smooth ER	Rough ER
Smooth ER does not have ribosome	Rough ER does have ribosome
Found near the cell membrane	Found near the cytoplasm
Mainly composed of tubules	Mainly composed of cisternae
Synthesis of lipids	Synthesis of protein
Mainly present in lipid forming cell	Mainly present in protein forming cell



- Functions of Endoplasmic reticulum:

1. Intracellular supporting framework.
2. Helps in maintaining position of cell organelles in the cytoplasm.
3. SER stores calcium ions in muscle cells, detoxifies drugs and poisons in liver cells and also synthesizes lipids and steroidal hormones (in testis, ovaries, adrenal gland means they produce hormone).
4. RER is involved in protein synthesis and formation of membranes.

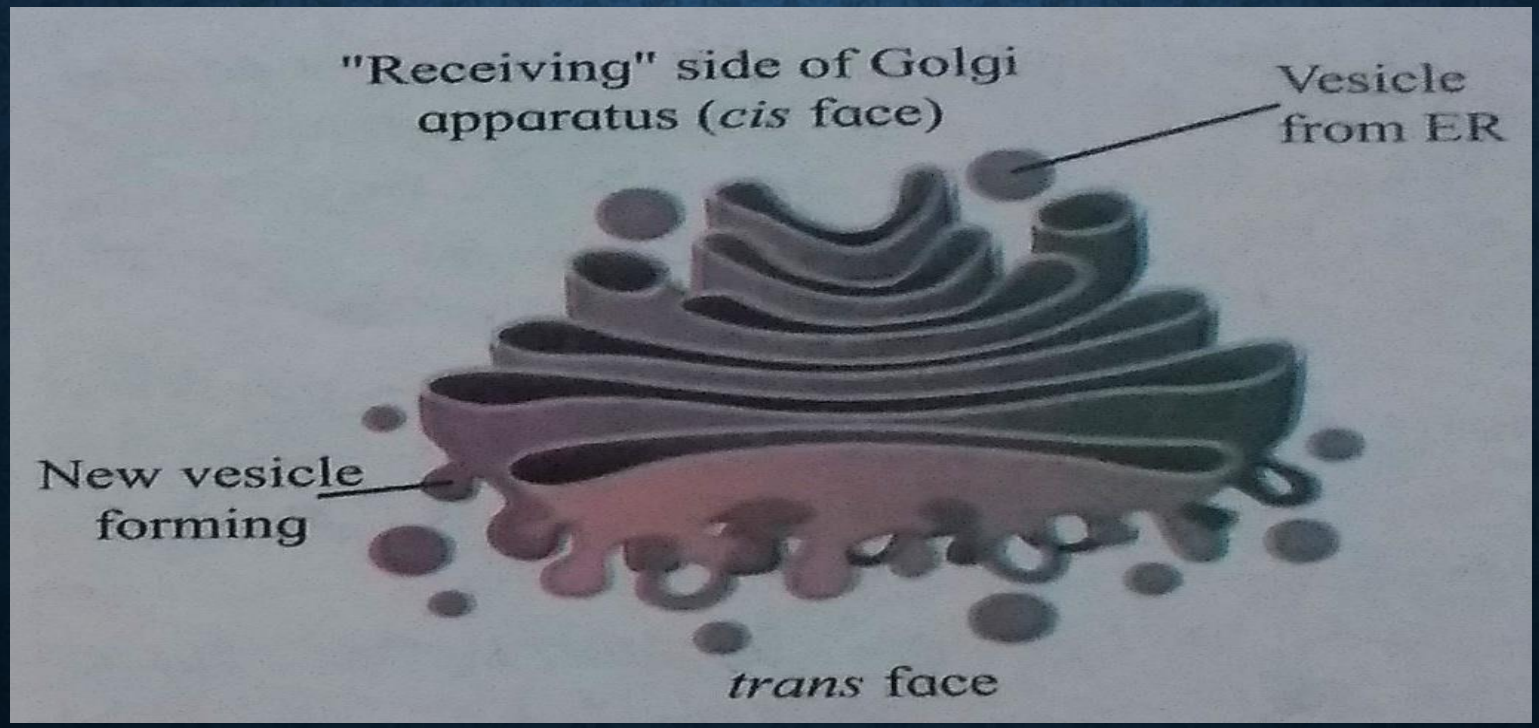
GOLGI COMPLEX

- Also knows as Golgi body or Golgi.
- Found in cytoplasm of most eukaryotic cells and absent in prokaryotes, Mammalian RBCs and Sperm cells of bryophytes.
- Golgi complex essentially consists of stacks of membranous sacs called cisternae.
- Diameter of cisternae varies from 0.5 to 1 μm.
- A cell may have few to several cisternae depending on its functions.
- Thickness and molecular composition of 2 membranes of golgi sac different from each other.
- The golgi sacs show specific orientation in the cell.
- Each cisterna has *cis* face (same side) and *trans* (opposite side) face.
- Cisternae of Golgi body themselves mature moving from *cis* to *trans* face it is called Cisternal maturation model.
- It is responsible for transporting, modifying and packaging proteins and lipids into vesicle.

- Golgi body also manufacture their own product.
- Golgi bodies in many plant cells produce non cellulose polysaccharides like pectin.

Function

- It is concerned with the synthesis and secretion of enzymes and hormones in the cell.
- Golgi apparatus carries materials synthesized by the endoplasmic reticulum to different parts of the cell the material is stored and packaged in vesicle.
- It forms Glycoprotein and complex sugar from simple sugar.



LYSOSOME

- Single membrane bound polymorphic organelles present only in animal cells, except RBCs.
- Lysosomal Enzyme :
- Contain hydrolytic enzymes such as acid phosphatases, sulphatases, proteases, lipases, nucleases etc.
- 3 dimensional shape of these proteins probably protects the membrane.
- Accidental release of lysosomal enzymes in limited amount does not harm the cell because pH of cytosol is near neutral.
- Types of lysosome :

1) Primary lysosome – Contain hydrolytic enzymes in an inactive state.
2) Secondary lysosome/ Hybrid lysosome – Formed by fusion of lysosome with endocytic vesicle containing materials to digested.
3) Residual bodies – Vesicles which contain undigested remains.
4) Autophagic vesicles/ Suicide bags - Digest damaged cells or damaged organelles.

FUNCTIONS OF LYSOSOMES

- Dismantling and restructuring units of a cell .
- Digestion of old or dead cell organelles (autophagy).
- Digestion of foreign materials by secondary lysosome (Heterophagy).
- Destruction of malignant cells e.g. T- lymphocytes.

VACUOLES

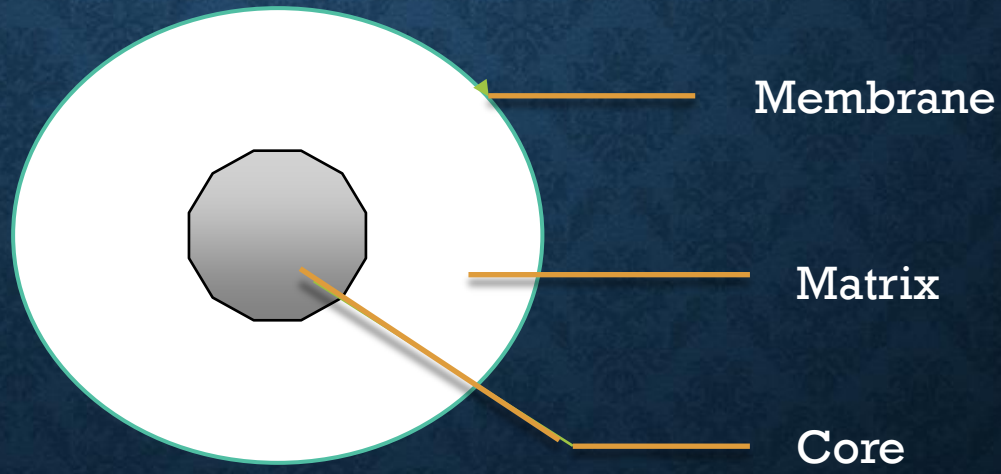
- Vacuoles are present in plant and animal cell.
- In animal cell vacuole present in few in number and smaller in size.
- In Plant cell permanent 2 or3 vacuoles are present.
- In large plant cell a single large vacuole occupies the central part of the cell, It is called central vacuole.
- Central vacuole occupy as much as 90% of the total volume of the cell.
- The vacuole are bound by semipermeable membrane called tonoplast membrane.
- Tonoplast membrane helps in maintaining the composition of vacuole fluid; the cell sap different form that of the cytosol.

- # Functions of Vacuole :

1. Vacuoles store ions, protein (in seed) pigment and excretory product.
2. Protection of the plants from herbivores by storing harmful or unpalatable compounds.
3. Attractive colours of the petals are due to storage of such pigment in vacuoles.
4. Phagocytosis involves formation of food vacuole.
5. Helps in excretion and osmoregulation contractile vacuole in *Paramoecium*.
6. Maintain turgidity of the cell.

GLYOXYSOMES .

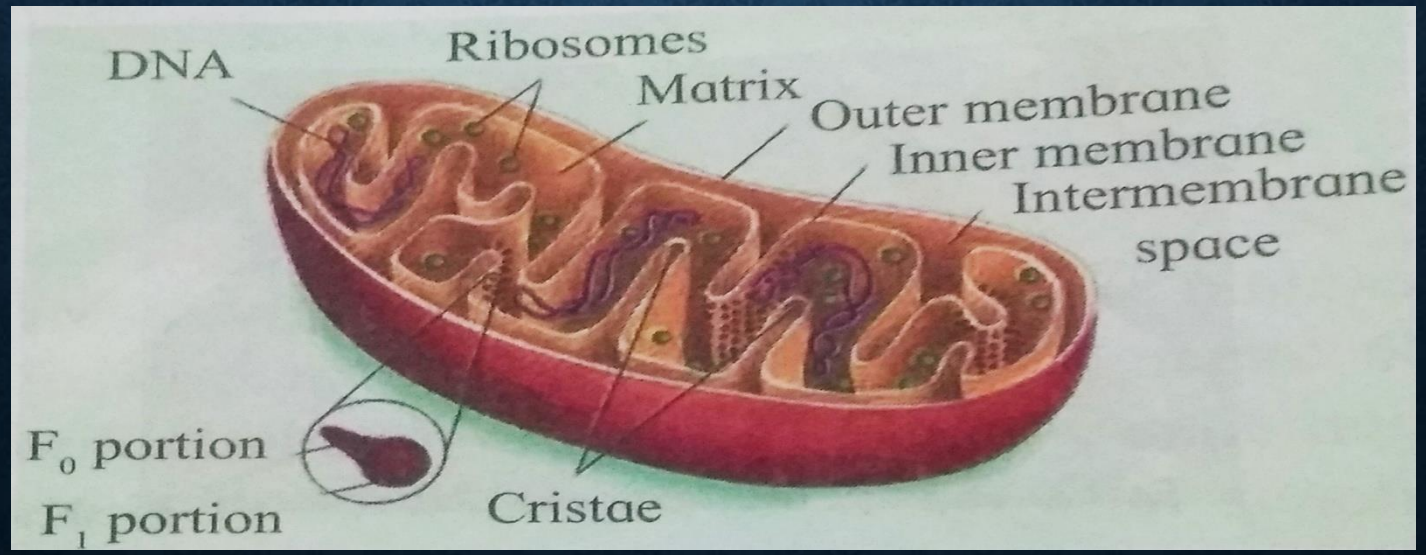
- Glyoxysomes membrane originated bound organelles which contain enzymes that converted into fatty acid to sugar.
- Fatty acid ⟶ Sugar
- They are found in cells of germinating seed which in stored fats are used as source of sugar till photosynthesis starts.



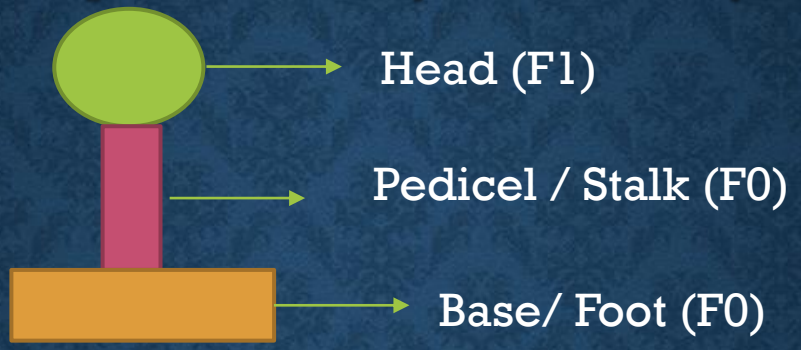
Glyoxysomes

MITOCHONDRIA

- Mitochondria are absent in prokaryotic cell.
- Mitochondria is double membrane bound structure with the outer and inner membrane.
- Outer membrane is permeable to various metabolites due to presence of protein.
- Inner membrane is selectively permeable to few substances only.
- Both membranes are separated by a space- outer chamber.
- Inner member shows finger like projection or plate like folds – cristae.



Inner membrane bears numerous particles – Oxysomes and cytochromes/ electron carriers.



- Oxysomes (F1-F0 / Fernandez- Moran / Elementary particles/ Mitochondrial particles).
- Each particle consist of head, stalk and foot.
- Head (F1) head faces towards matrix and foot (F0) is embedded in inner membrane.
- Head act as enzyme ATP synthase and foot as proton channel.

- Inner membrane encloses a cavity- inner chamber, containing a fluid- matrix.
- Matrix contains few coils of circular DNA,RNA,70S types of ribosomes, lipids and various enzymes of krebs cycle and other pathways.

PLASTID

- Types of Plastid :

1) Leucoplast (Colourless plastid)

2) Chromoplast (Contain carotene and Xanthophylls)

3) Chloroplast (Contain chlorophyll and carotenoid)

1) Leucoplast

Leucoplast do not contain any pigment.

These are meant for storage of nutrients.

For EX :

1. Amyloplasts that store starch.
2. Elaioplasts store Oil .
3. Aleuroplasts store protein.

2) Chromoplast

- Contain pigment like carotene (Orange) and Xanthophyll (Yellow).
- They impart red, yellow or orange colour to flowers and fruits.

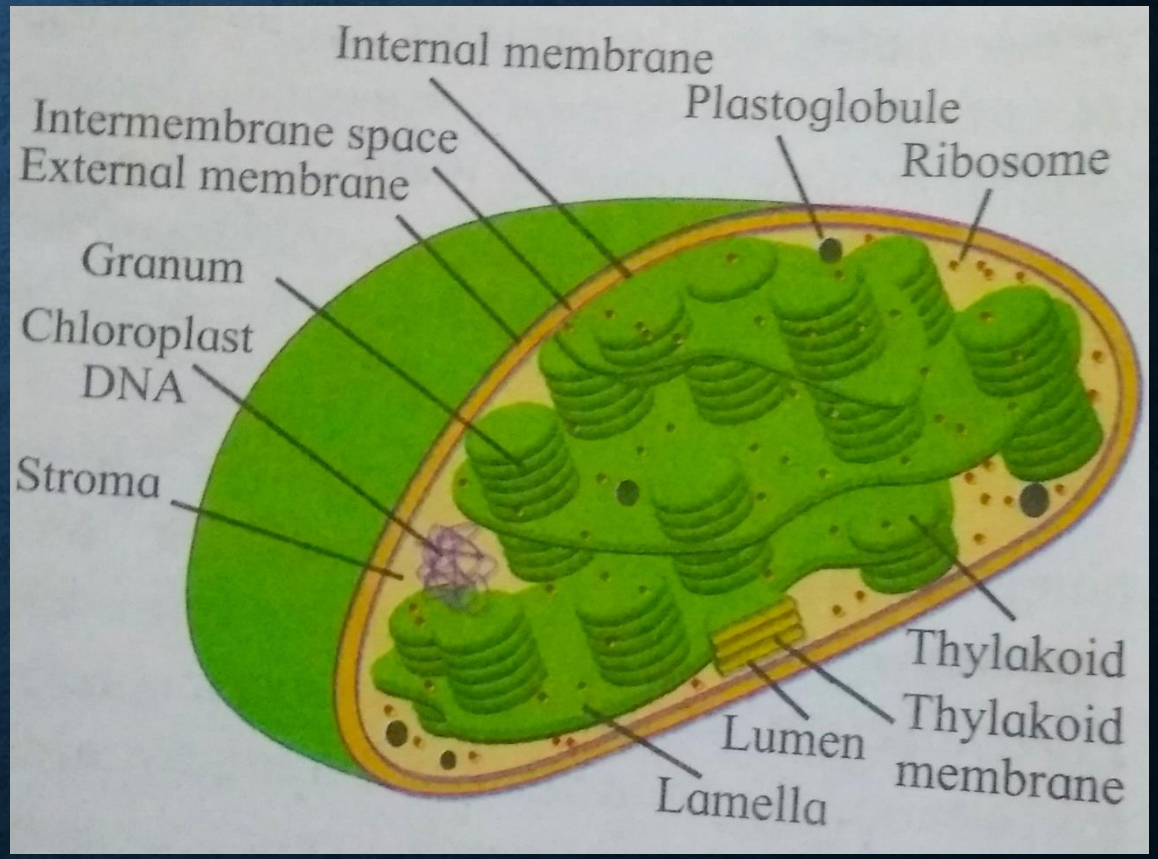
3) Chloroplast

- Chloroplast contain green pigment chlorophyll along with other enzyme that help in production of sugar by photosynthesis.
- Contain chlorophyll that traps solar energy for photosynthesis.

Chloroplast is lens shaped. But it can also be oval, spherical discoid or ribbon like.

EX: *Spirogyra* is ribbon shaped.

- Chloroplast are double membrane structures.
- The space limited by inner membrane is called stroma.
- Thylakoids are arranged in the form of stacs called grana. (singular : granum).
- The grana are connected to each other by means of membranous tubules called stroma lamellae.
- Space outside thylakoids is filled with stroma.
- The stroma and the space inside thylakoids contain various enzymes essential for photosynthesis.
- Stroma of chloroplast also contains DNA and ribosomes.



RIBOSOMES

- Cell have tiny granular structures known as ribosomes.
- Ribosomes are Ribonucleo- Protein Particles.
- Ribosomes do not have any membrane.
- Consist of ribosomal RNA and proteins.
- Eukaryotic cell has 80s ribosomes (in cytoplasm, attached to RER & nuclear membrane) and 70s ribosome (in mitochondria, chloroplast).

Function:

- Main function of ribosomes is the translation of genetic information encoded in nucleotide bases of DNA into amino acid sequence of proteins.
- Ribosome basically a protein factory. Subunit each have role in making of proteins.
- Proteins that are transported outside the cell are generally synthesized by bound ribosomes whereas enzymatic proteins which are used in cytoplasm are synthesized by free ribosome.
- Free ribosome form chains called polyribosomes for protein synthesis.

- **Svedberg unit :**
- The particle size of ribosomes is measured in terms of sevdberg unit (S).
- It is a measure of sedimentation rate of a particle in ultracentrifuge.
- It is a measure of density and size of particle.
- $1S = 10^{-13}$ sec

NUCLEOLUS

- Structure of nucleus of a eukaryotic cell becomes distinct in a non – dividing cell or during interphase.
- Interphase nucleus is made up of nuclear envelope, Nucleoplasm, nucleolus and chromatin network.

I) Nuclear envelop :

- Nuclear envelop is a double walled delimiting membrane of nucleus.
- 2 membrane are separated from each other by perinuclear space (10 to 50 nm).
- Consists of outer membrane (connected to ER at places.) inner membrane lined with nuclear lumina which maintains shape of nucleus), nuclear pores (guarded by pore complex) and perinuclear space (space between nuclear membranes).
- Nuclear envelope separates nucleoplasm from cytoplasm .
- Transport of substances between nucleus and cytoplasm is controlled by nuclear pore complex.

II) Nucleoplasm:

Nucleoplasm also called karyolymph.

- It contains chromatin network, nucleolus and various substances like nucleic acids, protein molecules, minerals and salt.

III) Nucleolus :

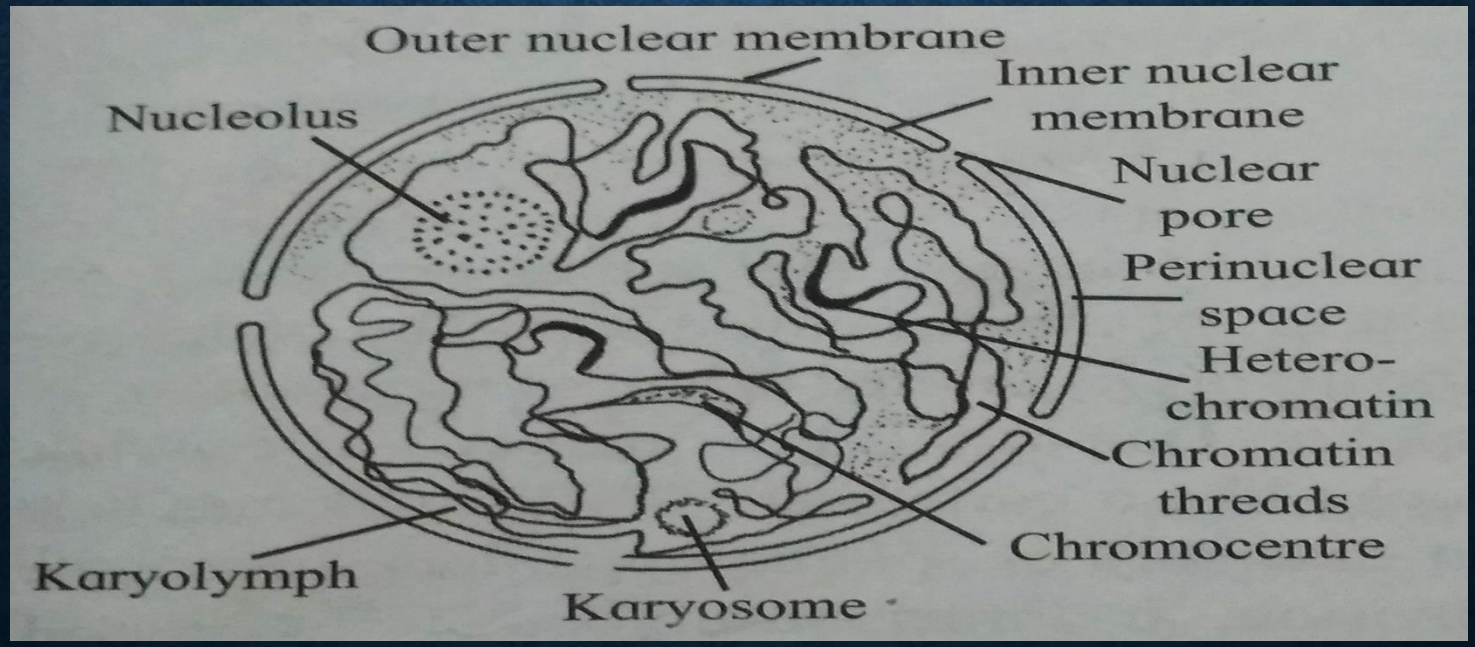
- Dense spherical body which is not bound by membrane.
- Consists of rRNA and ribosomal proteins it is known as site of ribosome biogenesis.
- Depending on synthetic activity of cell, there are one or more nucleoli present in the nucleoplasm.

IV) Chromatin material :

- Nucleus contains genetic information in the form of chromosomes which are nothing but DNA molecules associated with proteins.
- Nucleus in a nondividing cell shown a network of chromatin fibes which consist of DNA, histones, non- histone protein and RNA.
- DNA is genetically active called euchromatin.
- More of proteins and less DNA and are genetically inactive are called heterochromatin.

FUNCTIONS OF NUCLEUS

- Important role in heredity and variation.
- Chromosomes in the nucleus contain entire genetic information.
- Site of synthesis of DNA, RNA & ribosomes.
- Important role in photosynthesis.
- Chromosome no. are constant for a species, it is imp in phylogenetic studies.
- The controlling centre of all the cellular activities.



CYTOSKELETON

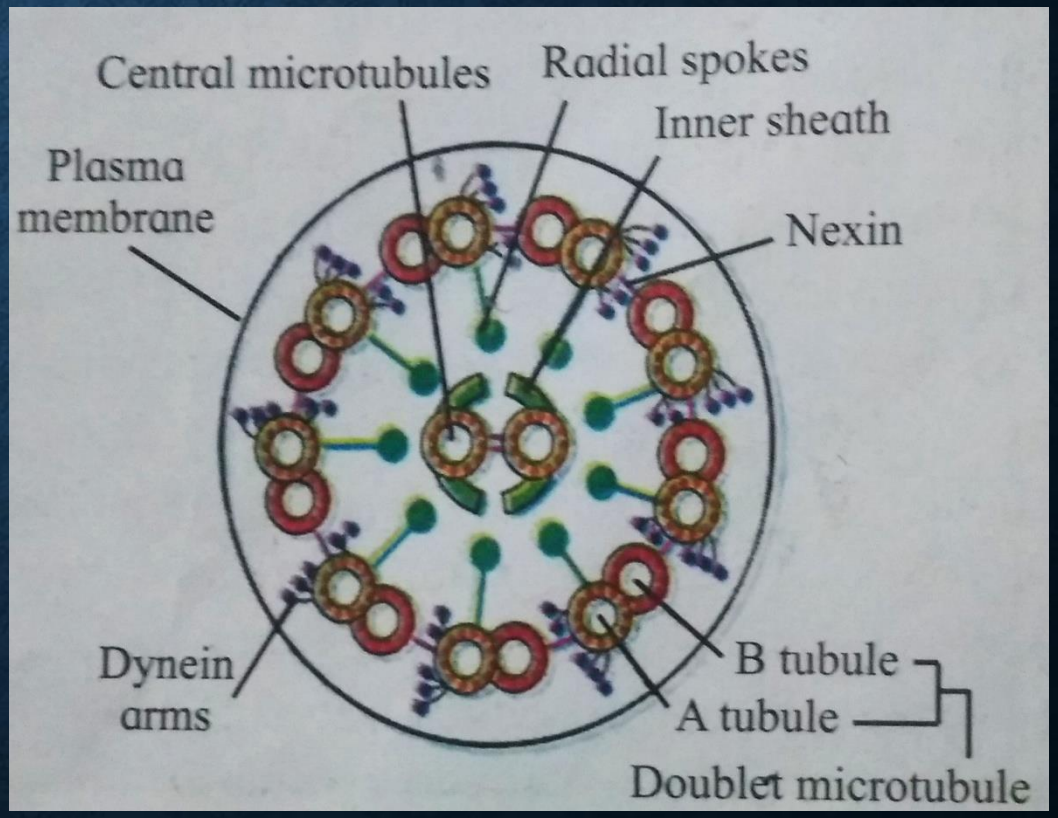
- Cytoskeleton consists of microtubules, microfilaments and intermediate filaments.
- Microtubules – made up of protein – tubulin.
- Microfilaments – made up of actin
- intermediate filaments are composed of fibrous proteins.
- Cytoskeleton helps in maintenance of shape of cell, contraction of cell, mobility of cell and cell organelles, changes in shape cells and cell division.

DIFFERENCE BETWEEN CILIA AND FLAGELLA

Cilia	Flagella
Cilia are short hair like structure.	Flagella are long whip like structure.
Around 5 – 10 µm in length.	Around 150 µm in length.
Only found in eukaryotic cell.	Found in eukaryotic & prokaryotic cell
Occurs throughout the cell.	Occurs at one end of a cell
Involved in processes like locomotion, feeding and circulation.	Involved in locomotion
Found in the lining of the body tubes	Found in most Bacteria, Archaea and Eukaryotes.

SIMILARITIES OF CILIA AND FLAGELLA

- Cilia and Flagella are both auxiliary parts of living cells.
- They can both be used for movement.
- Cilium or Flagellum consists of basal body, basal plate and shaft.
- Basal body is placed in outer part of cytoplasm.
- It derived from centriole.
- It has 9 peripheral triplet (3) of fibrils.
- Shaft is exposed part of cilia or Flagella.
- It consists of two part – Sheath and axoneme.
- Sheath is covering membrane of cilium or flagellum.



CENTRIOLES AND CENTROSOMES

- Centrosome contain a pir of cylindrical centrioles.
- The centrioles are perpendicular to each other and are surrounded by amorphus pericentriolar material.
- Each centriole consist of 9 set of triplet microtubules and there is a proteinaceous hub at the centre.
- The proximal end of centriole there is set of tubules called hub.
- Hub is connected with the peripheral triplets by 9 radial spokes.

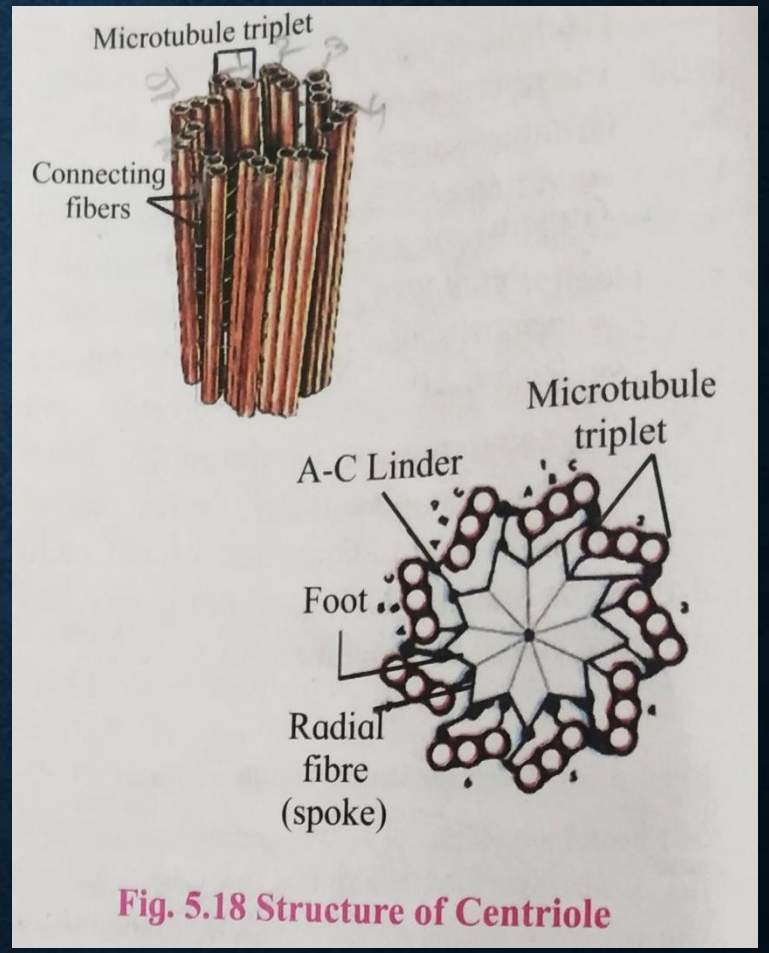


Fig. 5.18 Structure of Centriole

- **Functions :**
- The centrosomes help in assembly of spindle apparatus during cell division.
- It forms basal body of cilia and flagella.

THANK YOU…….