Cell Structure and Function

Cell : the basic structural and functional units of an organism.

Eukaryotic cells
cell membrane
membrane-enclosed nucleus
cytoplasm, containing organelles and cytoskeleton.

In contrast, the smaller prokaryotic cells of bacteria typically have a cell wall and lack nuclei and membranous cytoplasmic structures.

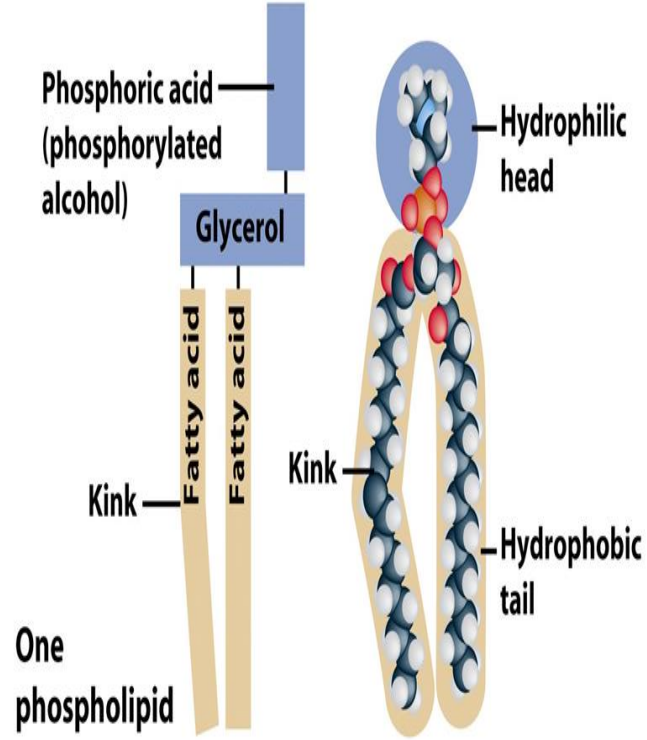
PLASMA MEMBRANE (CELL MEMBRANE)

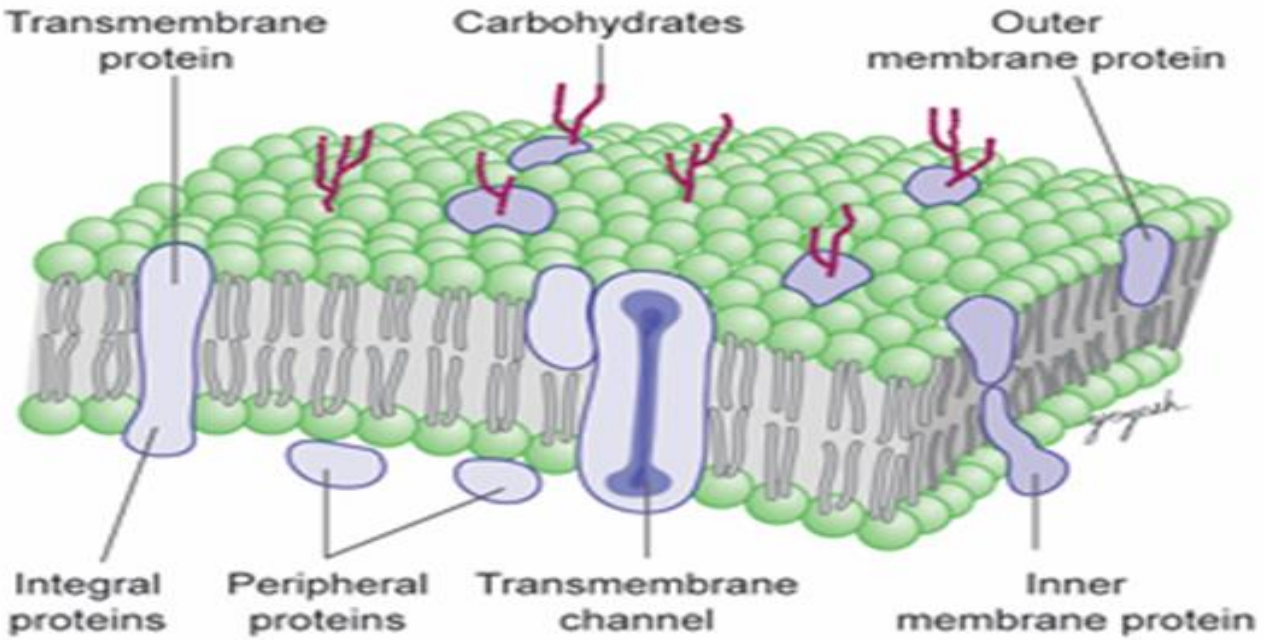
- It separates intracellular compartment from extra cellular compartment of the tissue.

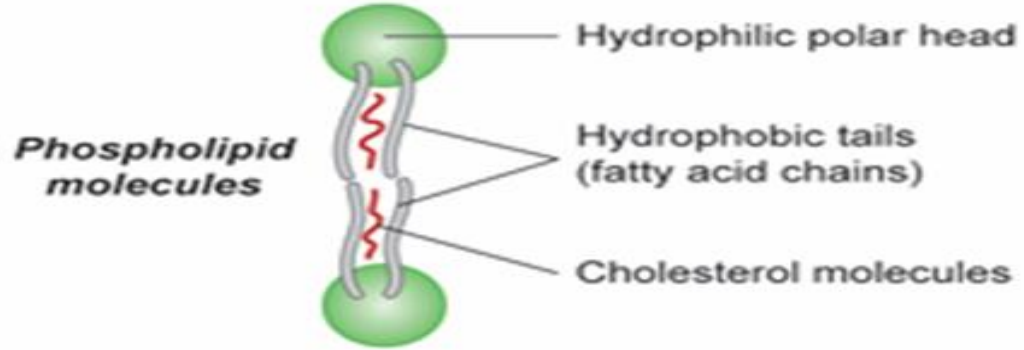
- It consists of a lipid bilayer, membrane proteins, and carbohydrates.

Plasma membrane has three types of lipids: phospholipids, cholesterol, and glycolipids.

- Phospholipid molecules have polar hydrophilic head and nonpolar hydrophobic tail.


Phosphoric acid (phosphorylated alcohol)
Glycerol
Fatty acid
Fatty acid
Kink
Kink
Hydrophilic head
Hydrophobic tail
One phospholipid


Transmembrane protein
Carbohydrates
Outer membrane protein
Integral proteins
Peripheral proteins
Transmembrane channel
Inner membrane protein


Phospholipid molecules
Hydrophilic polar head
Hydrophobic tails (fatty acid chains)
Cholesterol molecules

Plasma membrane proteins:

- integral membrane proteins
- peripheral membrane proteins.

Carbohydrates of plasma membrane

- attached to proteins > glycoproteins
- to lipids of the bilayer > glycolipids.

FLUID MOSAIC MODEL FOR MEMBRANE STRUCTURE

Membrane proteins comprise a moveable mosaic within the fluid lipid bilayer.

Movement of molecules through the plasma membrane.

- Lipid-soluble and uncharged molecules, (oxygen, carbon dioxide, glycerol, water, ammonia) cross plasma membrane freely from higher to lower concentration.
- Water-soluble molecules require membrane transport proteins .

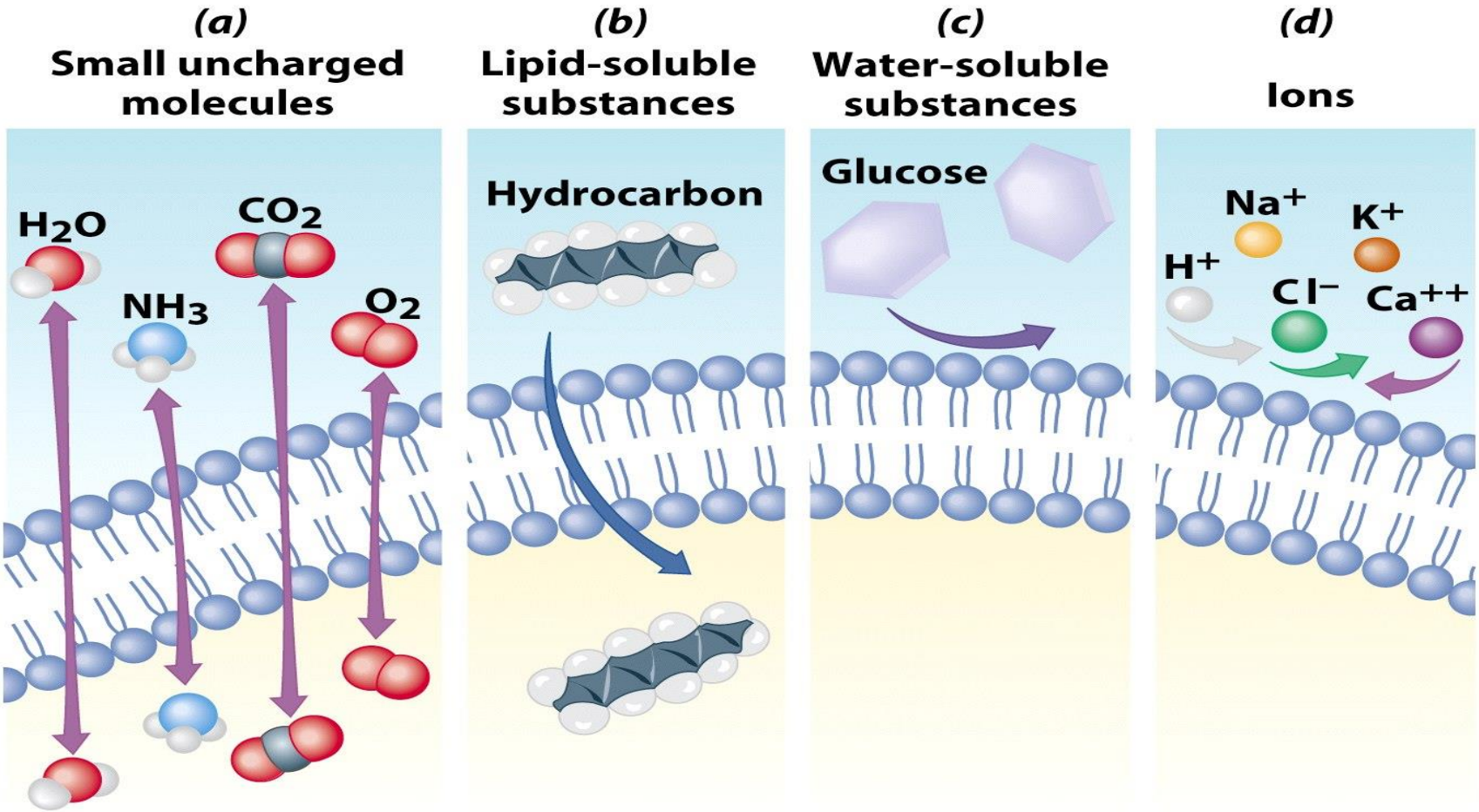
  If the process requires energy, it is called active transport (e.g., transport of H ions)

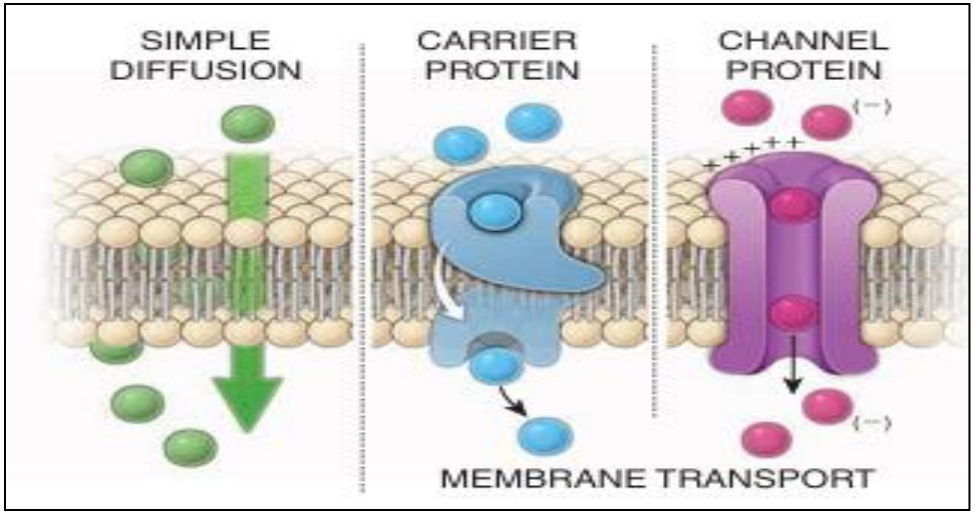
  If energy is not required, the process is called passive transport (e.g., glucose transport).

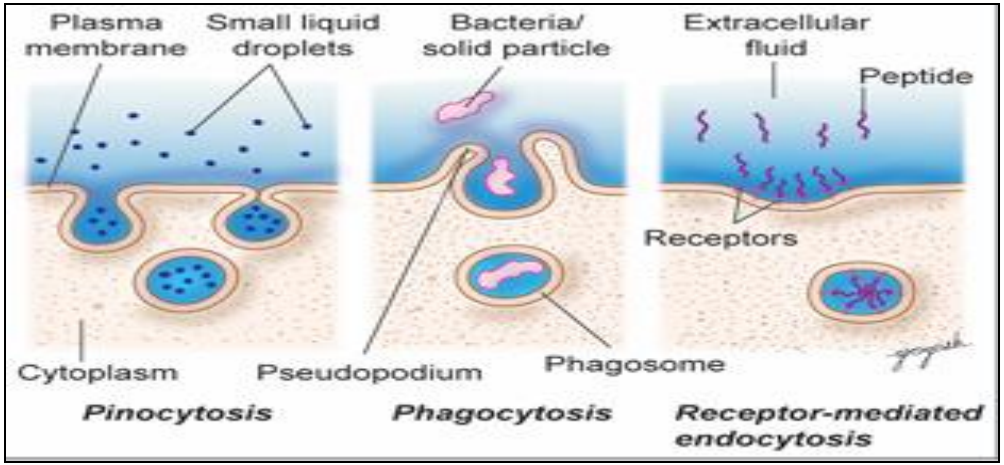
Movement of molecules through the plasma membrane

- Ions and other small charged molecules are transported through the plasma membrane by ion-selective channel proteins.

- Vesicular Transport
  - ✓ Large molecules
  - ✓ Endocytosis and exocytosis.


(a)
Small uncharged molecules
(b)
Lipid-soluble substances
(c)
Water-soluble substances
(d)
Ions
H2O
CO2
NH3
O2
Hydrocarbon
Glucose
Na+
K+
H+
Cl−
Ca++


SIMPLE DIFFUSION
CARRIER PROTEIN
CHANNEL PROTEIN
(−)
+ + + + +
(−)
MEMBRANE TRANSPORT


Plasma membrane
Small liquid droplets
Bacteria/ solid particle
Extracellular fluid
Peptide
Receptors
Cytoplasm
Pseudopodium
Phagosome
Pinocytosis
Phagocytosis
Receptor-mediated endocytosis

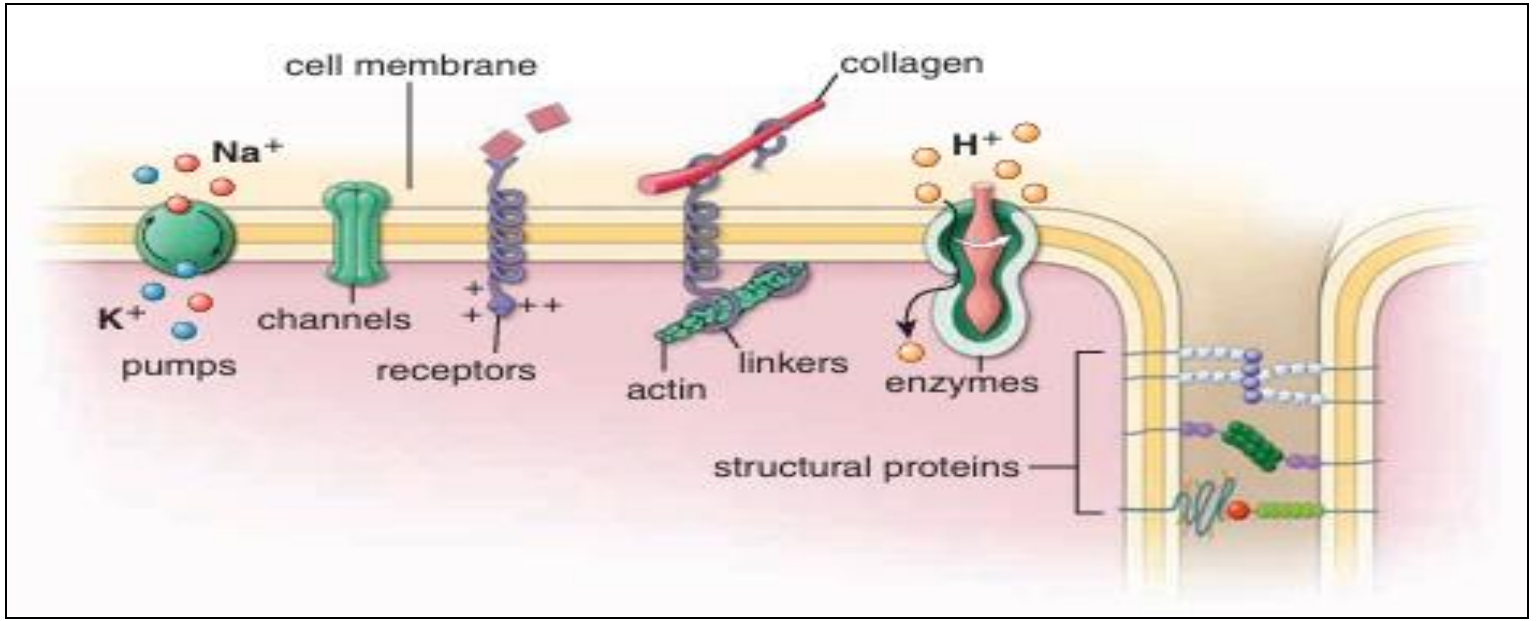
Membrane Proteins

- pumps (Na+ pump)
- channels (passage of small ions, molecules, and water across the plasma membrane in either direction).
- receptor proteins(recognize certain molecules (hormones, antibody).

Membrane Proteins

- linker proteins (anchor cytoskeleton).
- enzymes (ATPase, ATP synthase and digestive enzymes).
- structural proteins (cell-to-cell junctions).

Membrane Proteins



Cytoplasm

is the part of the cell located out side the nucleus, consists of gel-like matrix called cytosol

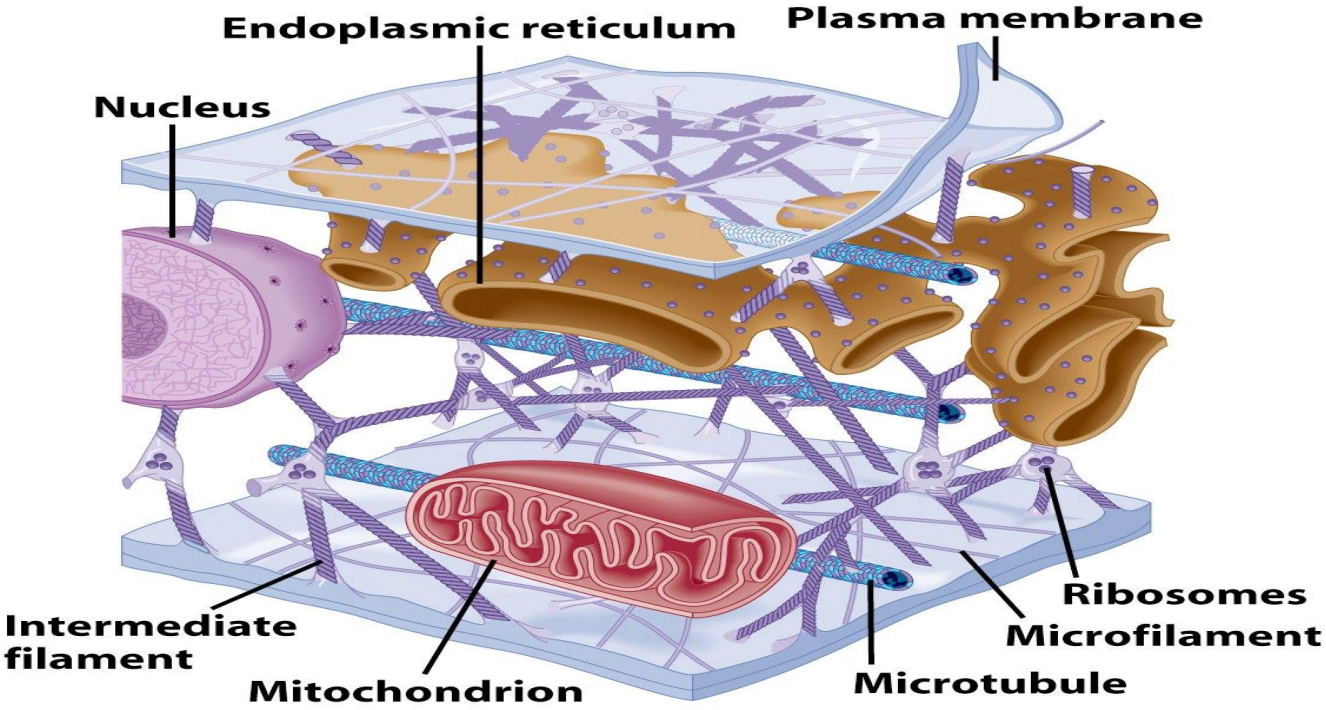
- contains organelles
- cytoskeleton
- The matrix consists of solutes, including inorganic ions (Na^{+}, K^{+}, Ca^{+2}) and organic molecules such as lipids, proteins, and RNAs.

Cell Organelles

Structures that perform various functions.

Within cytoplasm

- rough endoplasmic reticulum (rER), smooth-surfaced endoplasmic reticulum (sER), Golgi apparatus, lysosomes, pinocytic vesicles, endocytic vesicles, and mitochondria.
- microtubules, filaments (actin and intermediate filaments), centrioles, ribosomes, and proteasomes.


Endoplasmic reticulum
Plasma membrane
Nucleus
Intermediate filament
Mitochondrion
Microtubule
Ribosomes
Microfilament

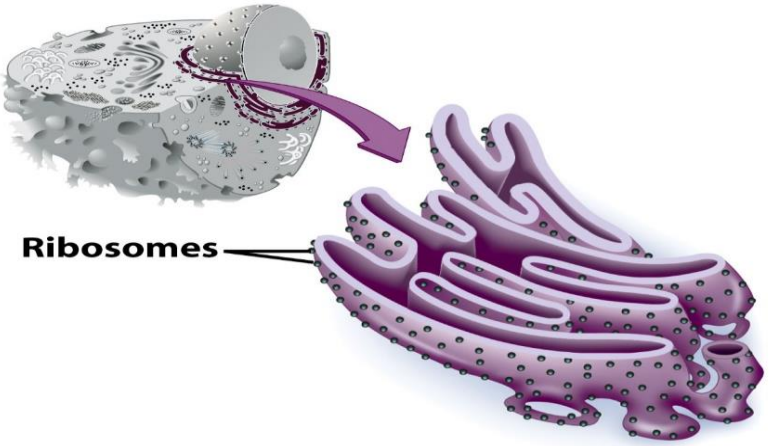
Endoplasmic Reticulum

- Network of interconnected membranes

- Two types
  - Rough endoplasmic reticulum
  - Smooth endoplasmic reticulum

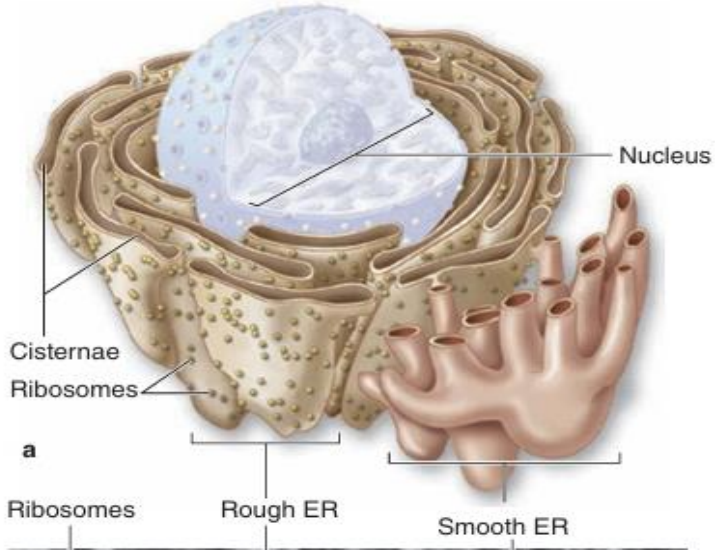
Rough Endoplasmic Reticulum

- Ribosomes attached to surface
  - Modifies, transports, and stores proteins produced by attached ribosomes.
  - Free ribosomes synthesize cytoplasmic structural and functional elements(hemoglobin synthesis in precursor cells of RBCs).



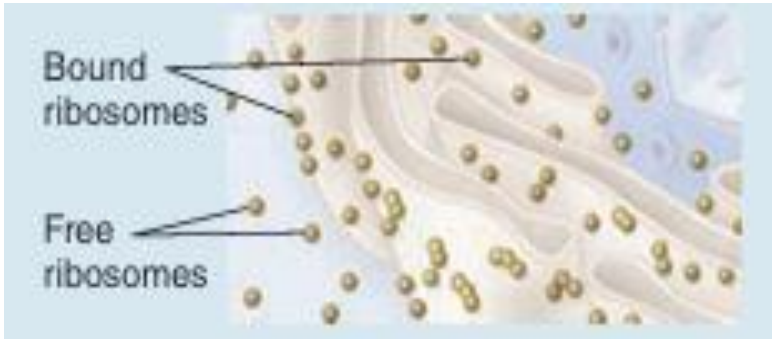
Smooth Endoplasmic Reticulum

- No attached ribosomes
- Synthesizes, transports, and stores lipids (eg, steroids).
- Carbohydrates metabolism.
- Detoxification of drugs, alcohol.



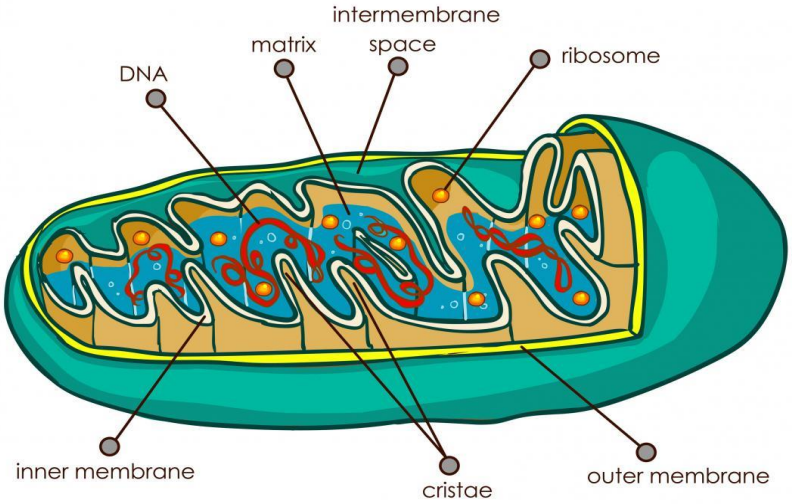
Ribosomes

- Small cytoplasmic particles (protein and ribosomal RNA ,rRNA)
- Ribosomes lie in association with rER or in free in the cytoplasm.
- Free ribosomes produce structural proteins of a cell
- Membrane-bound ribosomes (rER) produce secretory proteins.



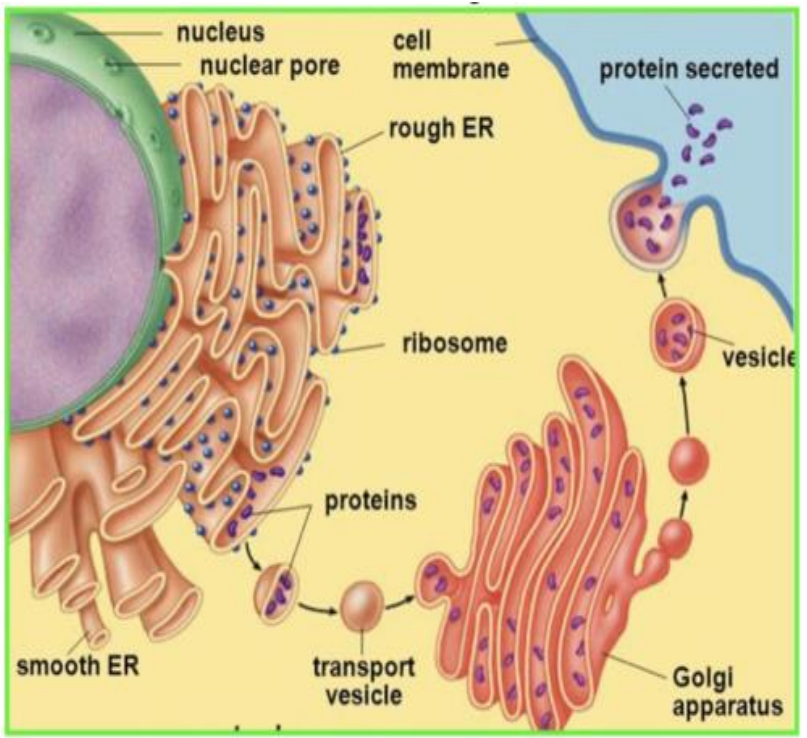
Mitochondria powerhouse

- Double membrane-bound organelles containing a circular strand of DNA (mitochondrial DNA)
- Generate ATP during aerobic cellular respiration
- contains enzymes for β-oxidation of fatty acids and the citric acid (Krebs) cycle.
- Mitochondria of stressed cells may release cytochrome c (cell death (apoptosis).



Golgi apparatus

- Saclike membranous structures, in most cells located near the nucleus.
- Receives proteins from rER for posttranslational modification and packaging.
- Delivers enzymes to lysosomes

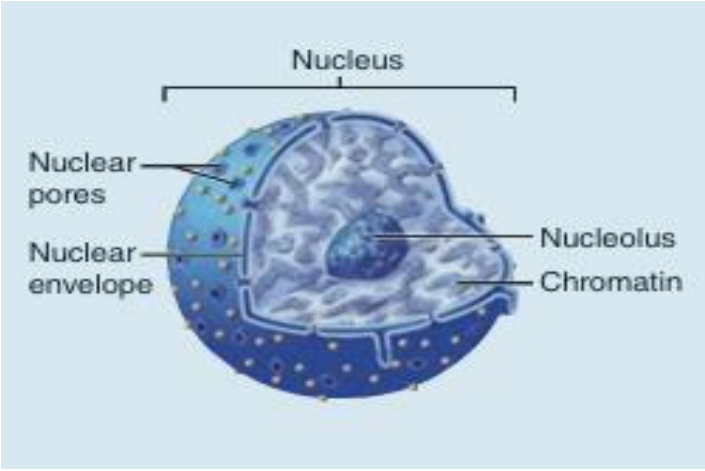


Nucleus

- Large rounded or oval structure
- double membrane
- contains chromatin, nucleolus, nuclear membrane, and nucleoplasm

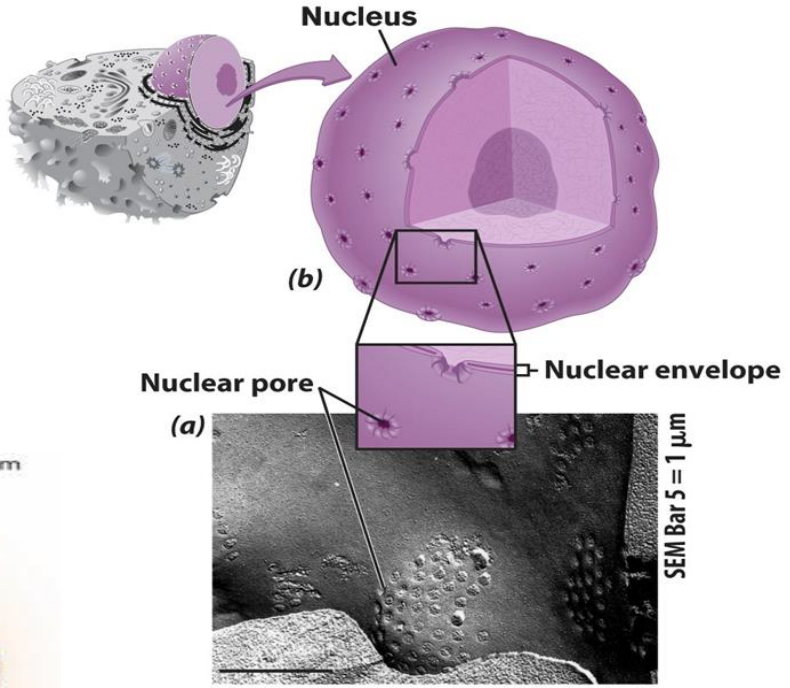
Nuclear envelope

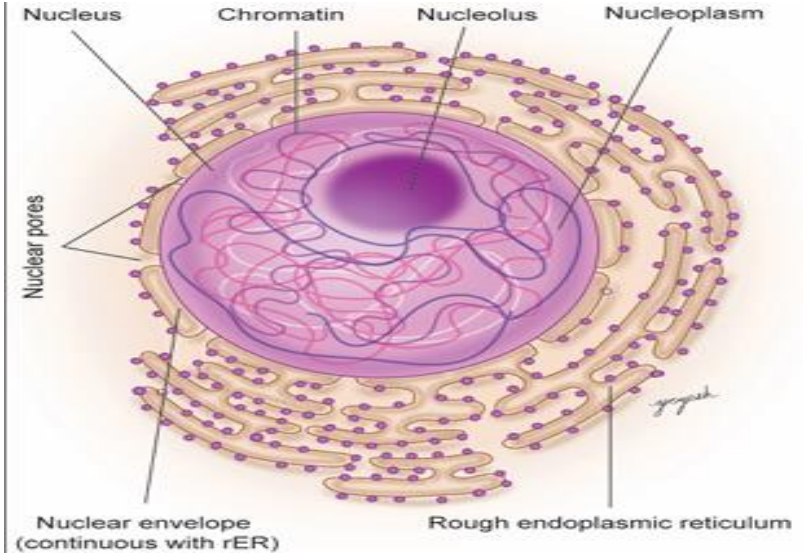
- Double membrane
- Separates nucleus from cytoplasm
- Nuclear pores



Chromatin: Genetic material consist of:

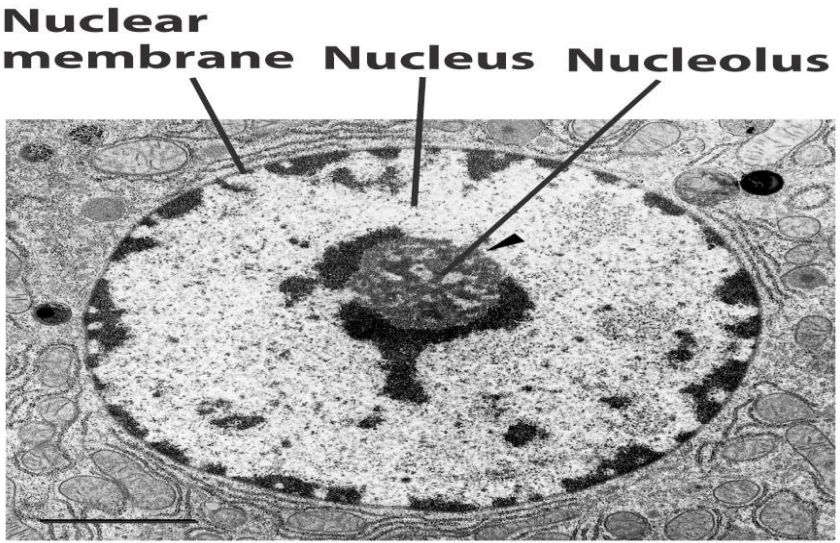
- DNA
- 46 chromosomes
- billions base pairs of nucleotides
- protein-coding genes





Nucleolus

- Generally spherical
- Most cells have 2 or more
- Directs synthesis of rRNA
- Forms ribosomes



Cytoskeleton

- Supporting network of protein filaments in cytoplasm.

Components of cytoskeleton:

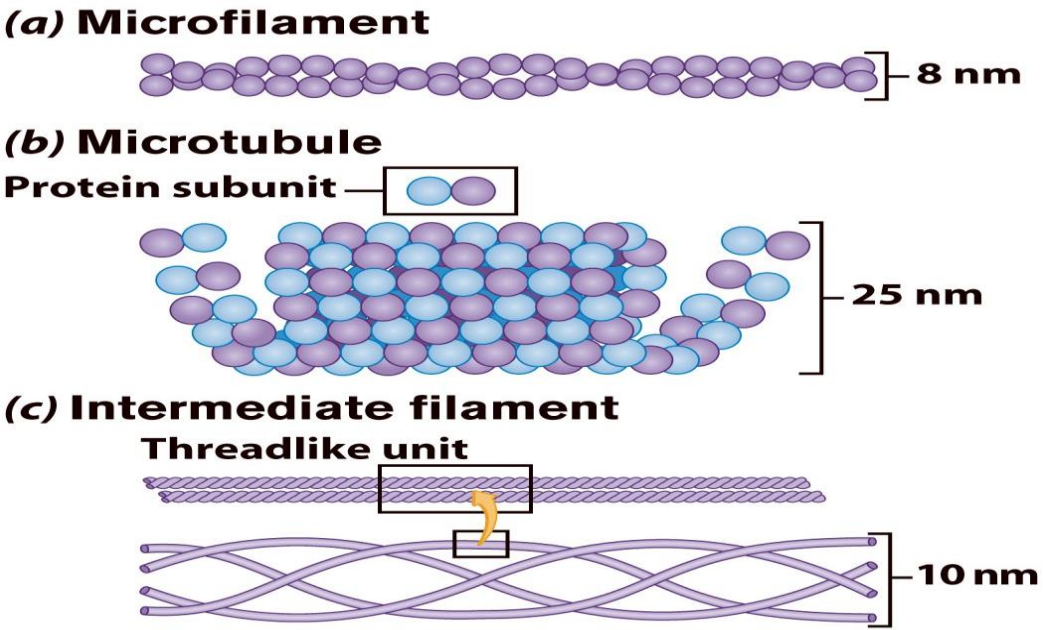
- 1. Microtubules
- 2. Microfilaments (Actin Filaments)
- 3. Intermediate filaments

Cytoskeleton

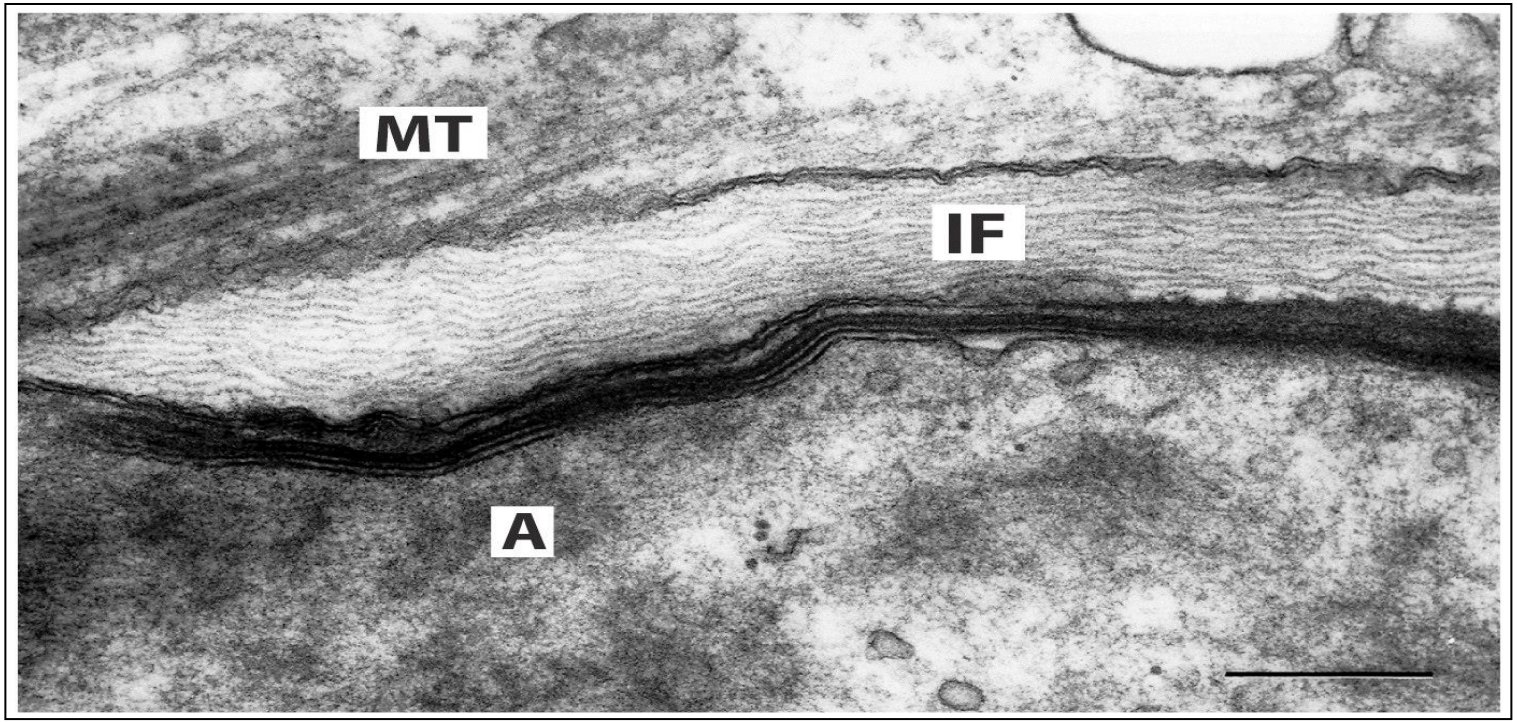
Functions

1. Determine the shapes of cells.
2. Cellular mobility
3. Movements of organelles and materials throughout cell.
4. Movement of cilia, microvilli, tail of sperms
5. Movement of chromosomes during cell division.
6. Structural support ,stabilizes junctions between cells.

Cytoskeleton



Cytoskeleton



A = actin, IF = intermediate filament, MT = microtubule

Cilia

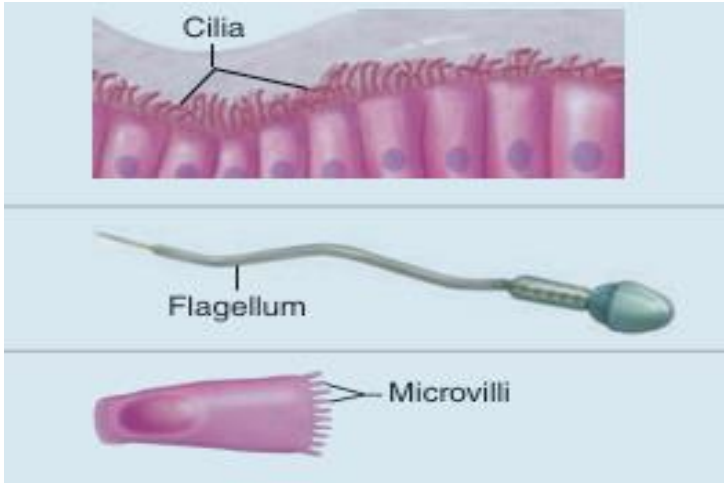
- Short, numerous membrane extensions
- Move substances over the cell surface(mucus)

Flagellum

- Long, singular membrane extension
- present on sperm cells

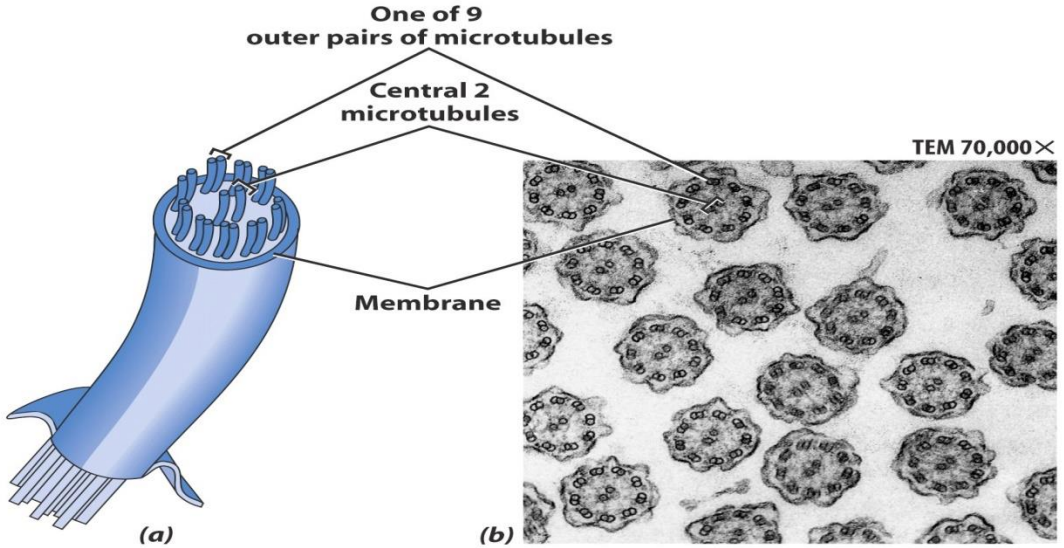
Microvilli

- Numerous membrane folds projecting from the cell surface;
- supported by microfilaments
- Increase membrane surface area for absorption



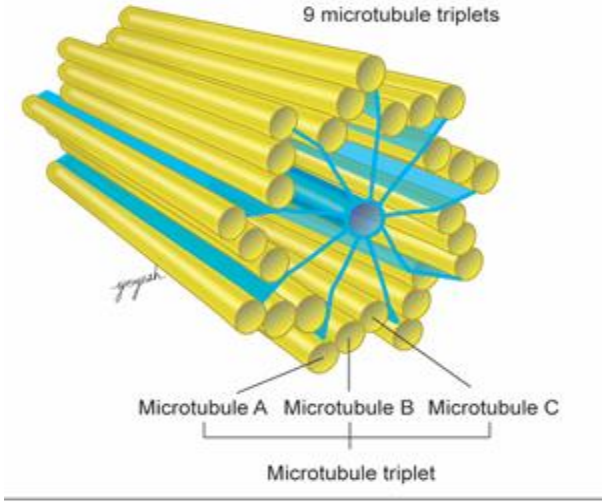
Cilia & Flagella Structure

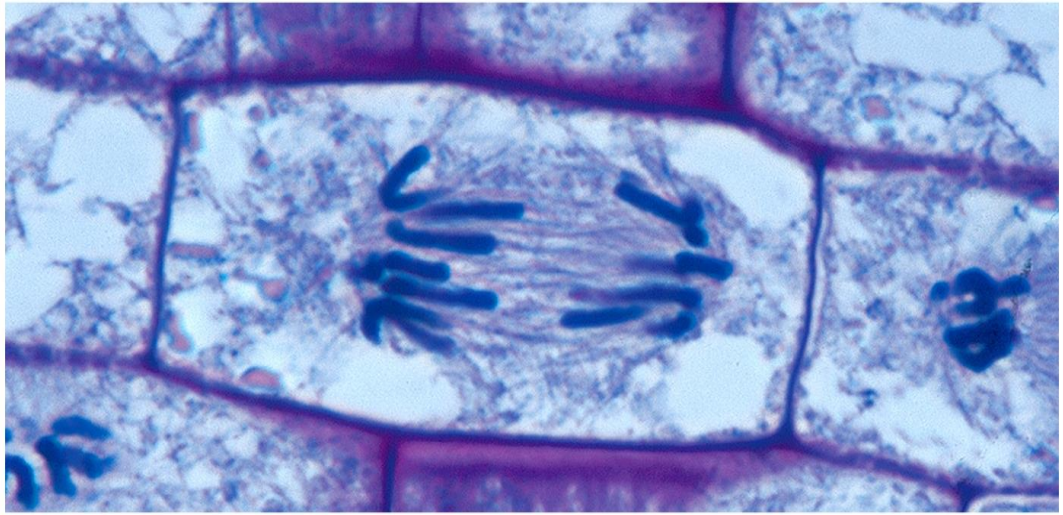
- Bundles of microtubules
- With plasma membrane



Centrioles

- Two centrioles in a cell near the nucleus.
- Forms mitotic spindle.
- basal bodies for cilia and flagella.





Thank You