CELL AND CELL ORGANELLES

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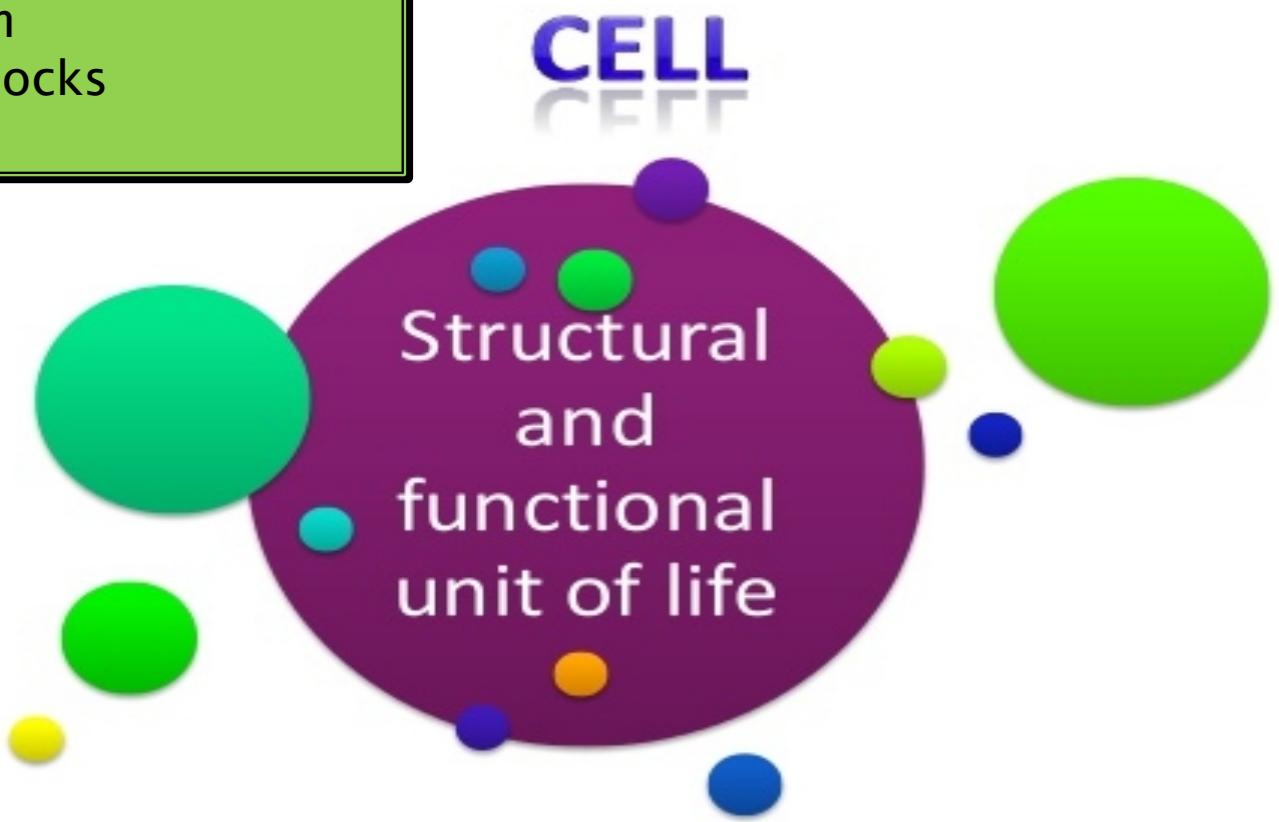
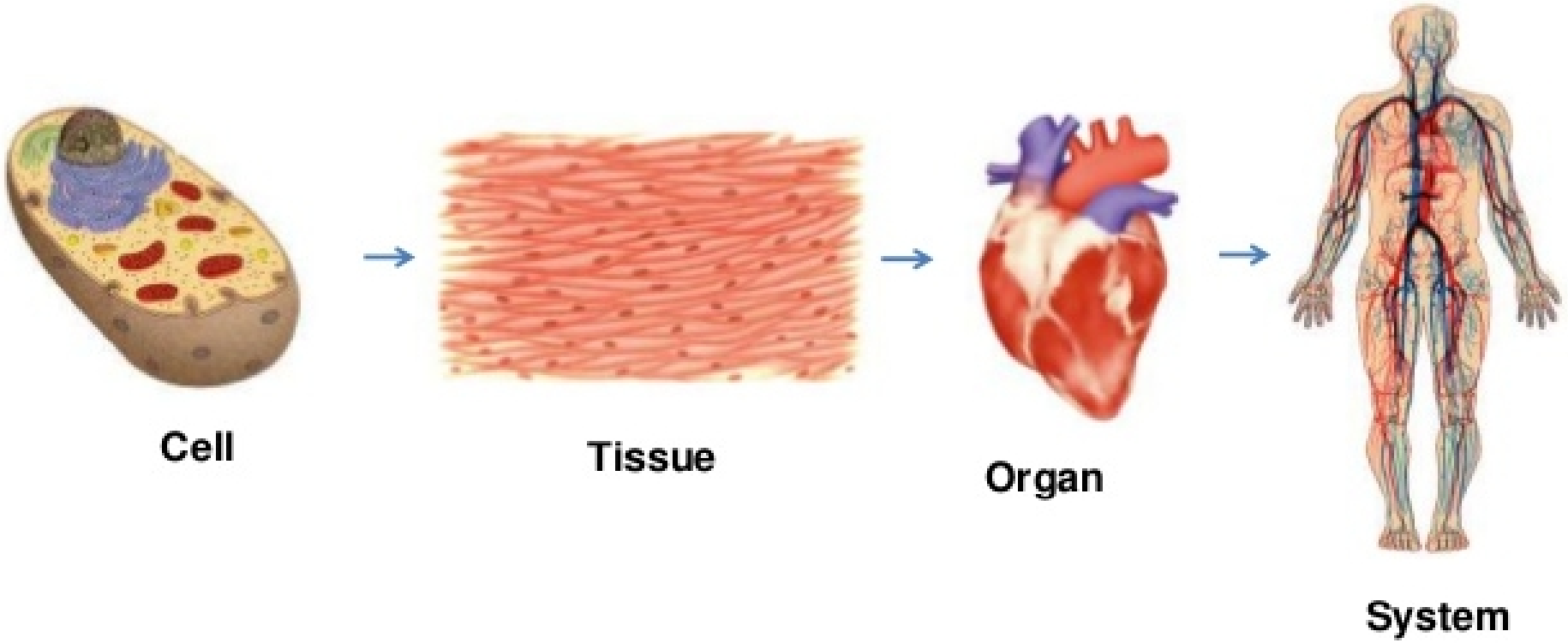
INTRODUCTION TO CELL

Latin word ‘cella’ means
small room
Building blocks



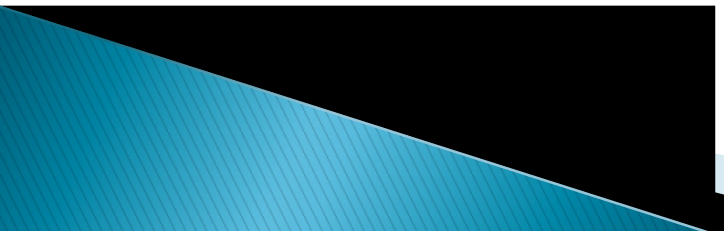


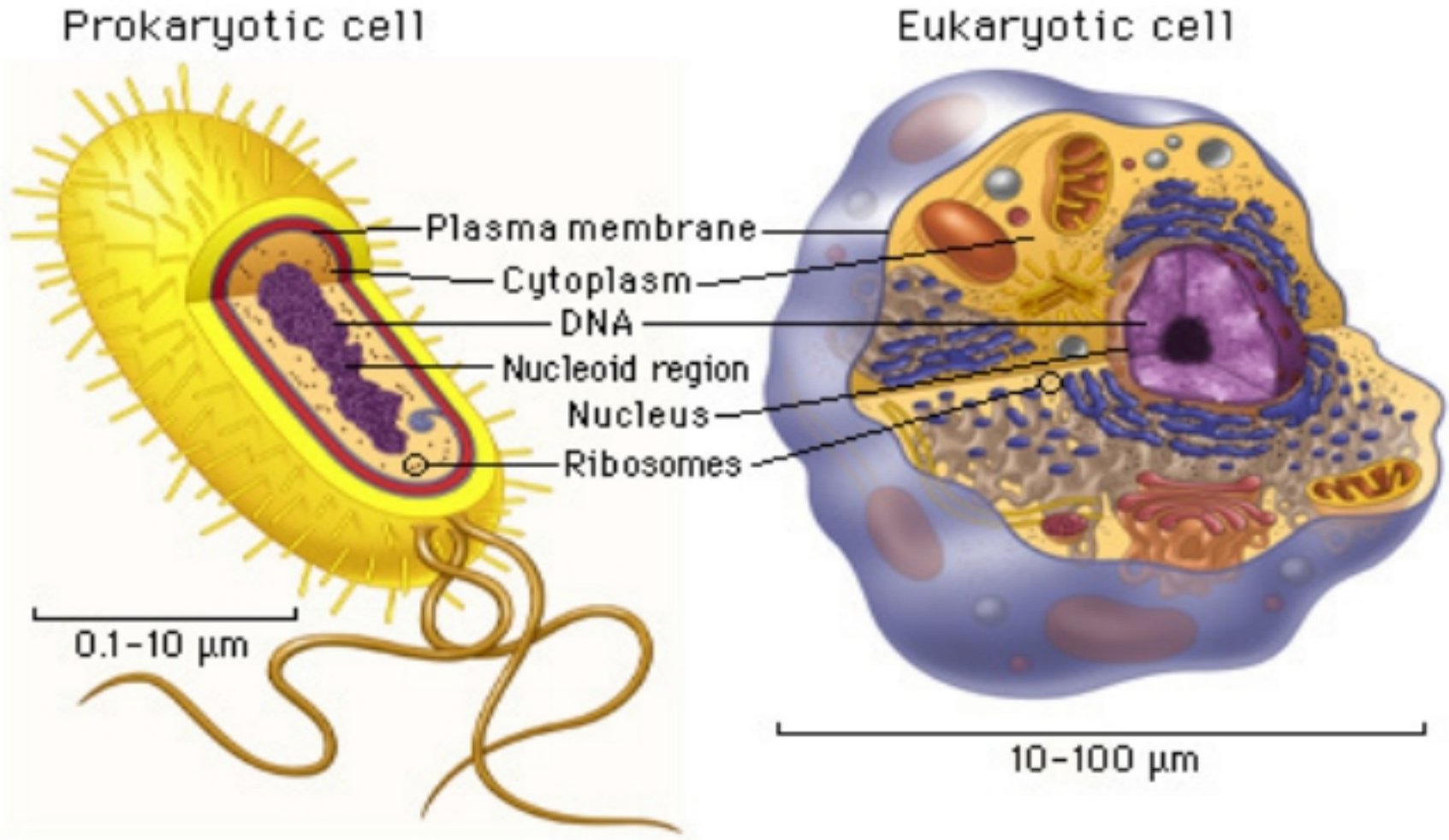
Similar cells join together to form tissues. Different tissues join together to form organs. Organs work together to form systems.

HISTORY:

SCIENTIST	YEAR	DISCOVERY
Robert Hooke	**1655**	CELL
Brown	1831	NUCLEUS
Jakob Schleiden and Schwan	1838	CELL THEORY
Virchow	1858	***"OMNIS CELLULA E CELLULA"(cell theory)***
Miescher	1871	*DNA*
James Watson & Francis Crick	1953	**Double helix model of DNA.**
Singer & nicholson	1972	**Fluid Mosaic model**

CLASSIFICATION





eg. :
Bacteria, blue

eg.:
animals, plants, protozoa, and fungi.

DIFFERENCES BETWEEN PROKARYOTES AND EUKARYOTES

Prokaryote	Eukaryote
Small; unicellular	Larger; multi or unicellular
No nucleus; circular DNA	Nucleus; linear DNA
Small ribosomes (70s)	Large ribosomes (80s)
No mitochondria- respiration in mesosomes and cell membrane	Mitochondria for aerobic respiration
Binary fission- division	Meiosis/Mitosis- division
Asexual reproduction	Sexual and asexual reproduction

Based on cell

Size &shape

- Spindle shaped
- Small & disc shape
- Long & branched

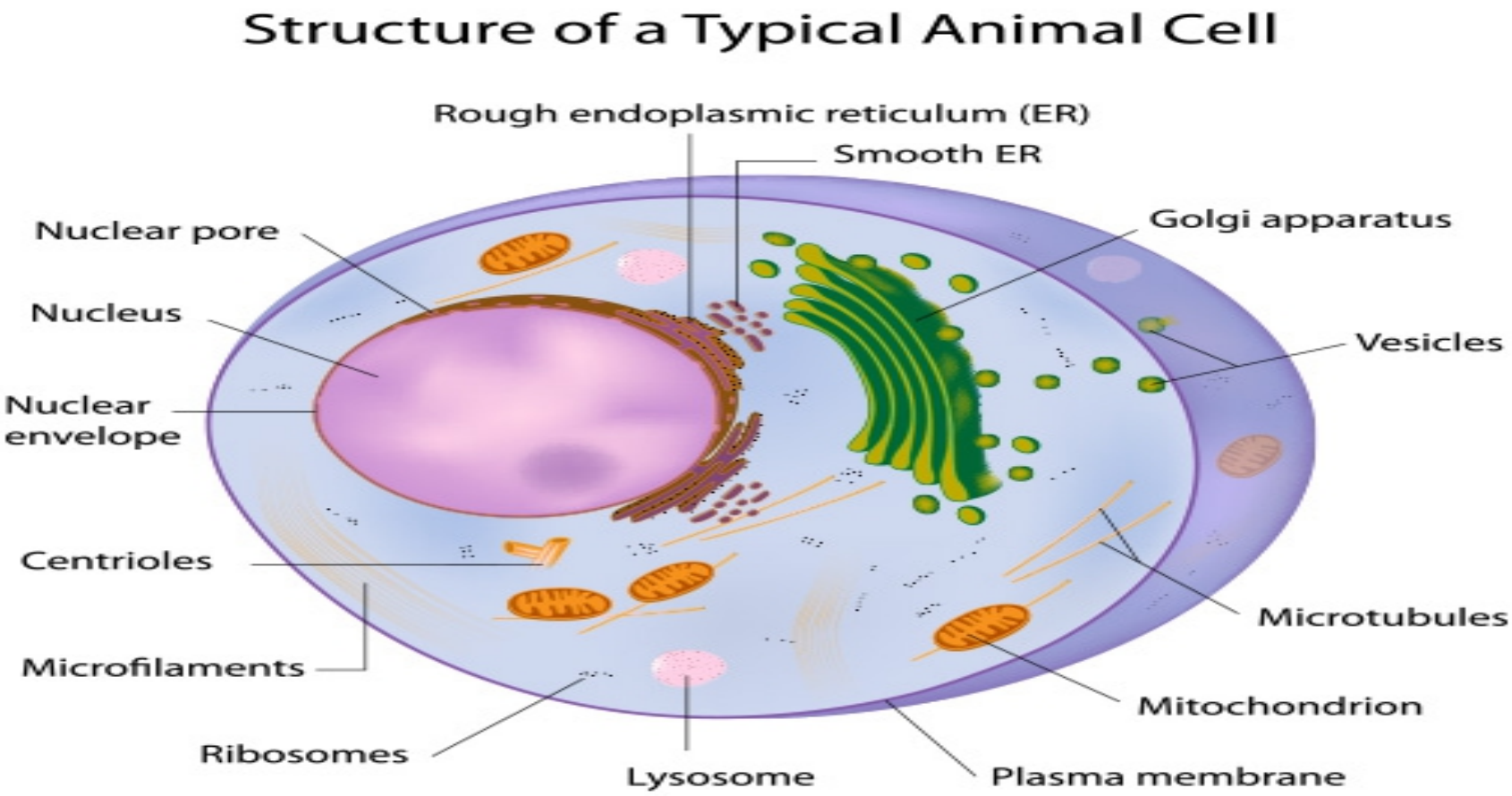
number

- Unicellular
- Multicellular

function

- Movement
- Synthesis & secretion
- Transport
- Digestion
- Absorption
- Growth, repair

CELL STRUCTURE



CELL

CYTOPLASM

- CYTOSKELETON
- CYTOSOL
- CELL ORGANELLES
- CELL INCLUSIONS

CELL MEMBRANE

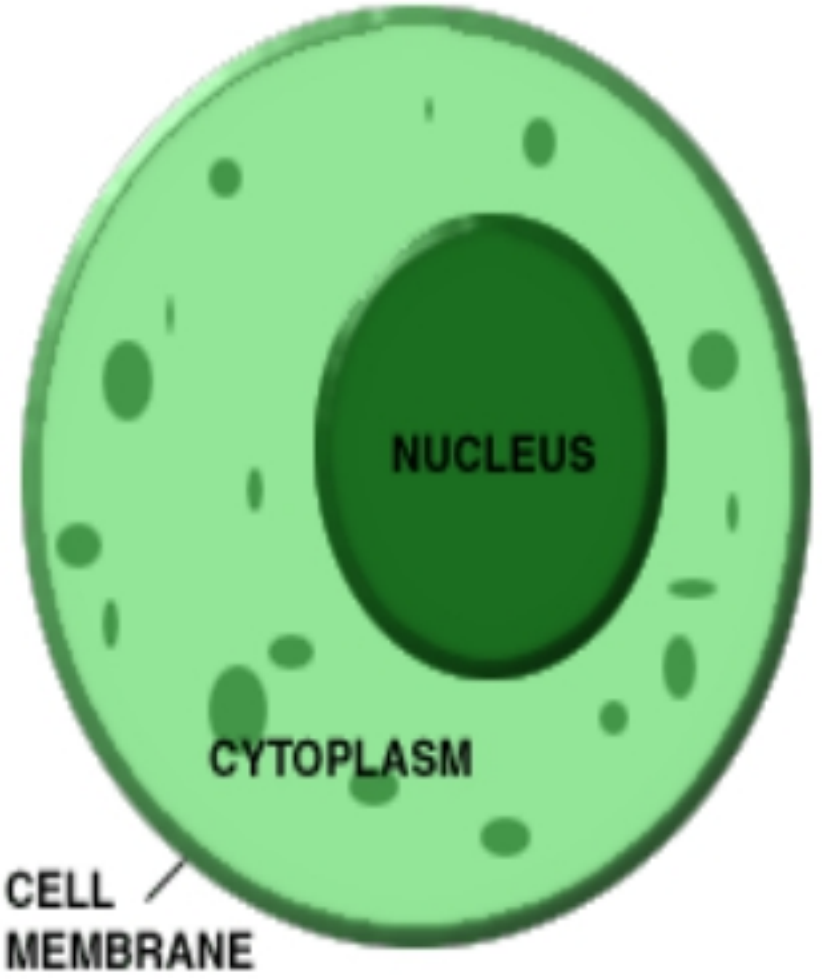
NUCLEUS

- NUCLEAR MEMBRANE
- NUCLEOLUS
- CHROMATIN
- NUCLEOPLASM

CYTOPLASM

- It is everything that is present between the cell membrane and the nuclear envelope.
- consists primarily of water.
- It includes:

membrane bound cell



CYTOSOL

- Organelle free sap is called as cytosol.
- The cyoplasmic matrix is a concentrated aqueous gel consisting of electrolytes, metabolites, RNA, and synthesised proteins.
- A major role of cytosol is to support synthesis of protein on the RER by [redacted] factors & energy.

Cytoplasmic cell Organelles

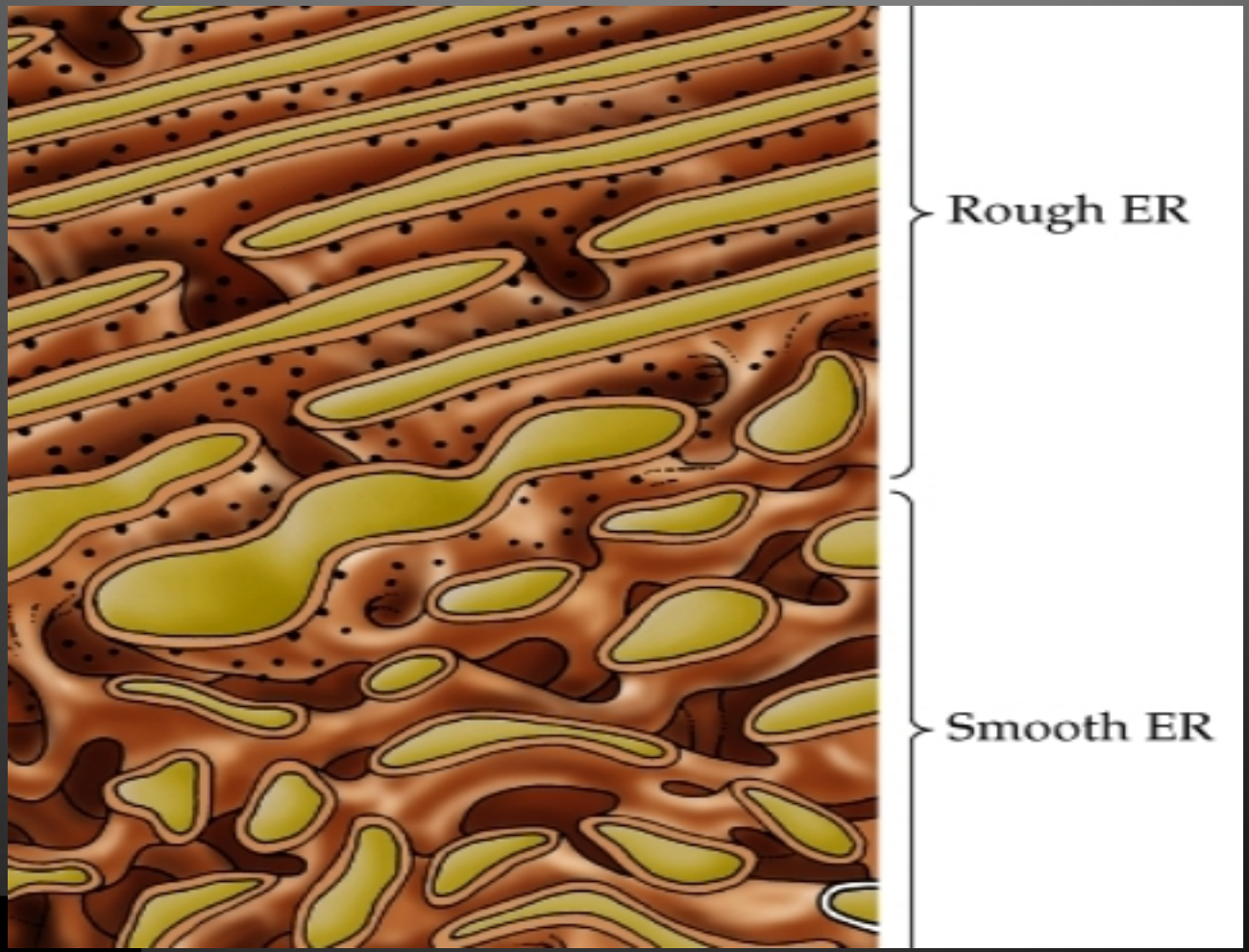
- **Membranous organelles**
  - Mitochondria
  - Golgi apparatus
  - Rough surfaced endoplasmic reticulum
  - Smooth surfaced endoplasmic reticulum

  - Coated vesicle
  - Secretory vesicles
  - Lysosomes
  - Endosomes / Peroxisomes

- **Non Membranous organelles**
  - Ribosomes
  - Microtubules
  - [illegible]

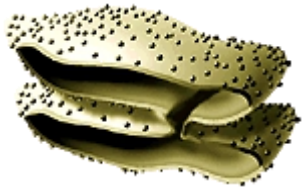
ENDOPLASMIC RETICULUM

- CISTERNAE
- Two types:
  r ER
  s ER
- Present as a system of double mem. Involved in the synthesis of transported proteins.
- R E R and Ribosomes are concerned with p r o t e i n synthesis.



Rough endoplasmic reticulum

- Also known as **'Ergastoplasm'.**



- It is rough because imbedded in the membrane are ribosomes the site of the synthesis of secretory proteins.

- Ribosomes in the rough ER synthesize protein that then are converted to glycoprotein and packaged in transport vesicles for secretion.

Figure 4.8A Rough endoplasmic reticulum

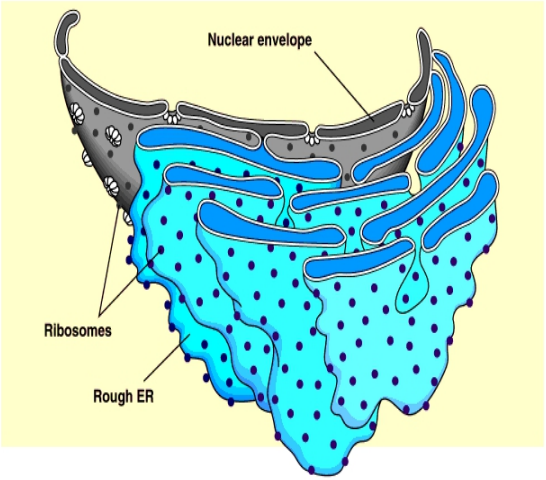
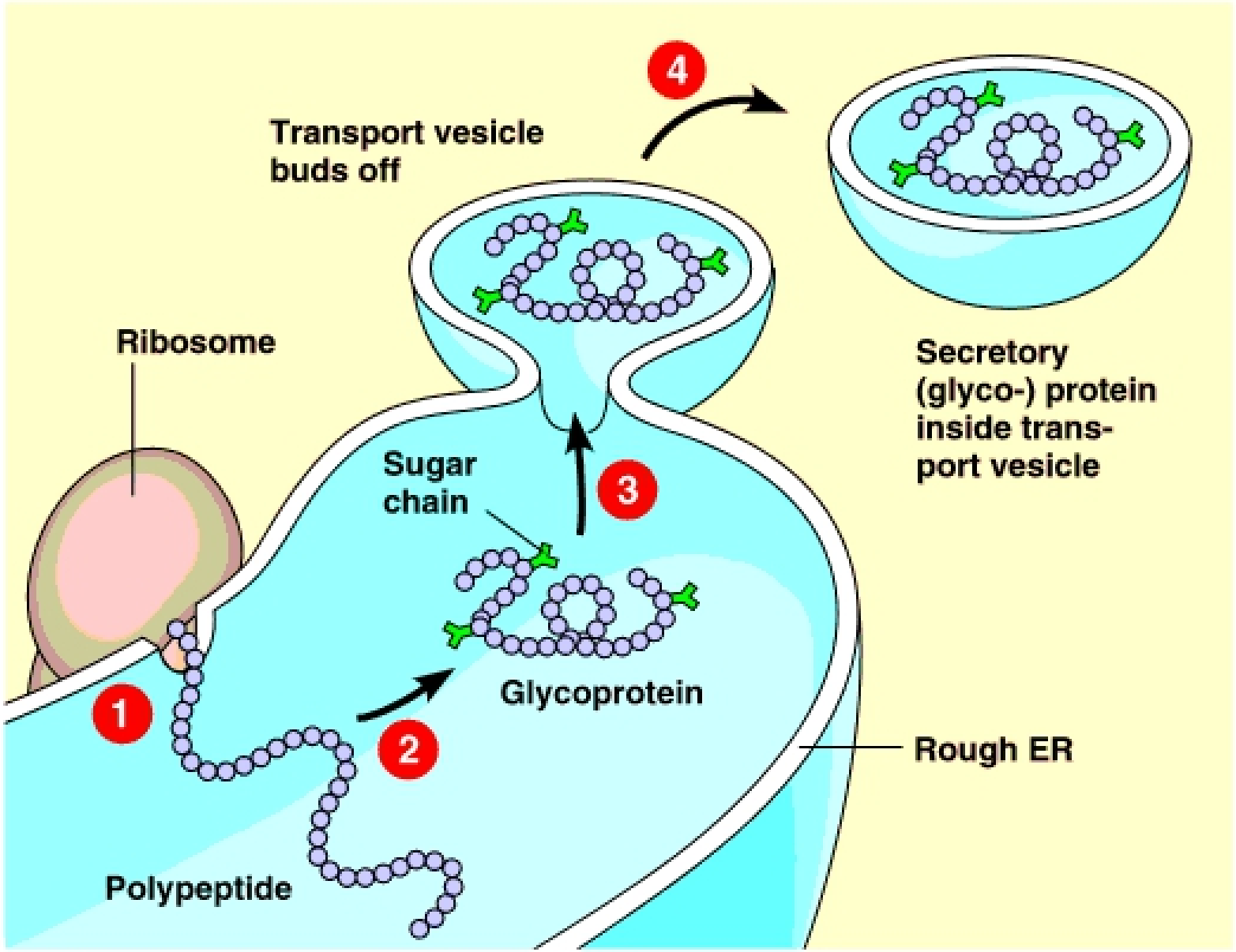
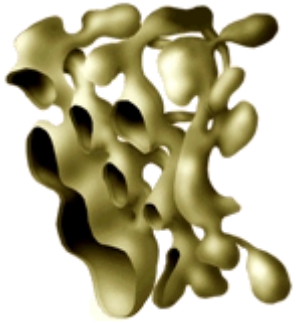


Figure 4.8B Synthesis and packaging of a secretory protein

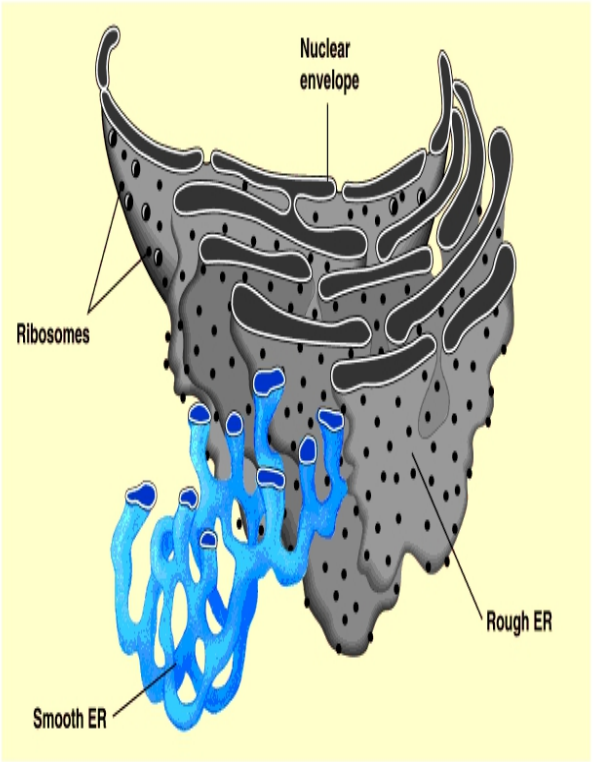


Smooth endoplasmic reticulum



- The smooth ER is the site for the synthesis of lipids, phospholipids and steroids
- Note that the production of steroid hormones occurs in specific tissues for example, the ovaries and testes that synthesize the sex hormones.
- It is involved in modification & transport of proteins [redacted] e RER.

Figure 4.9 Smooth endoplasmic reticulum



Smooth endoplasmic reticulum

- Enzymes in the smooth ER regulate the release of sugar into the bloodstream.
- Other enzymes break down toxic chemicals.
- Detoxification action :If the liver is exposed to high doses of a drug, the liver increases the amount of smooth ER to handle it.
- The smooth ER functions to store calcium ions.

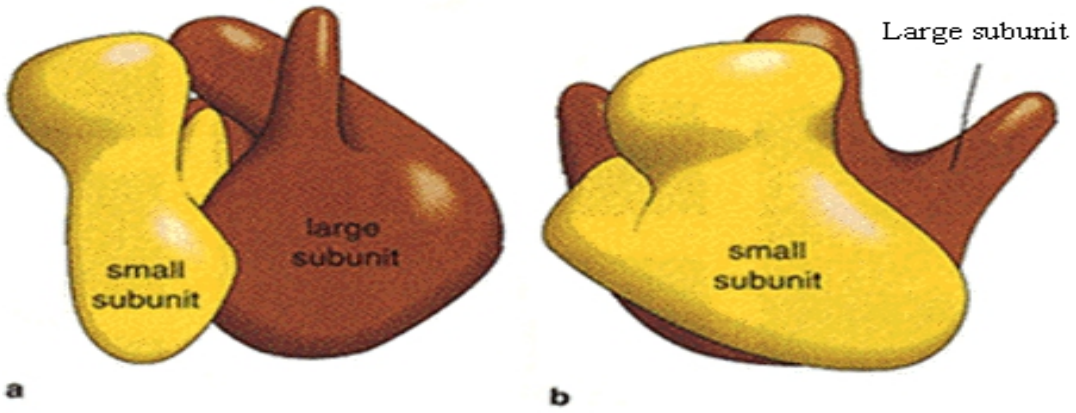
Functions of rER:

- Segregation of proteins.
- Helps in initial glycosylation of glycoproteins.
- The assembly of multi chain protein

Functions of sER:

- Lipid and
- steroid synthesis
- Detoxification of drugs
- Modification & transport of proteins synthesized in the RER
- Major reservoir of ca^{++} ions.

RIBOSOMES



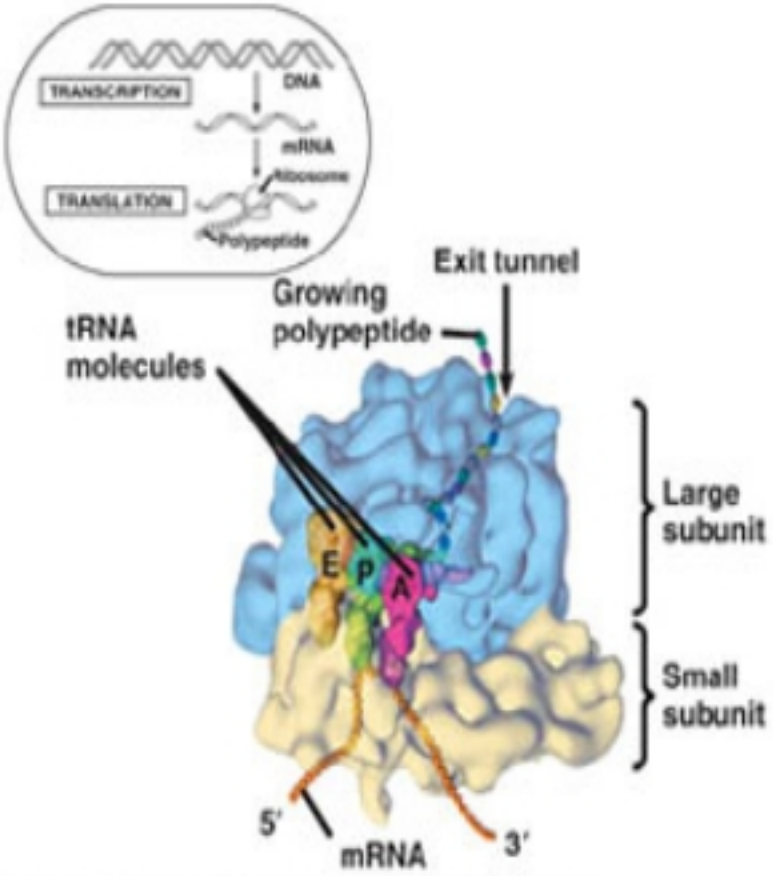
- Made up of a large and a small subunit.
- Ribosomes are seen in
  1.bound form
  2.free form
- Mainly involved in protein synthesis

Ribosomes

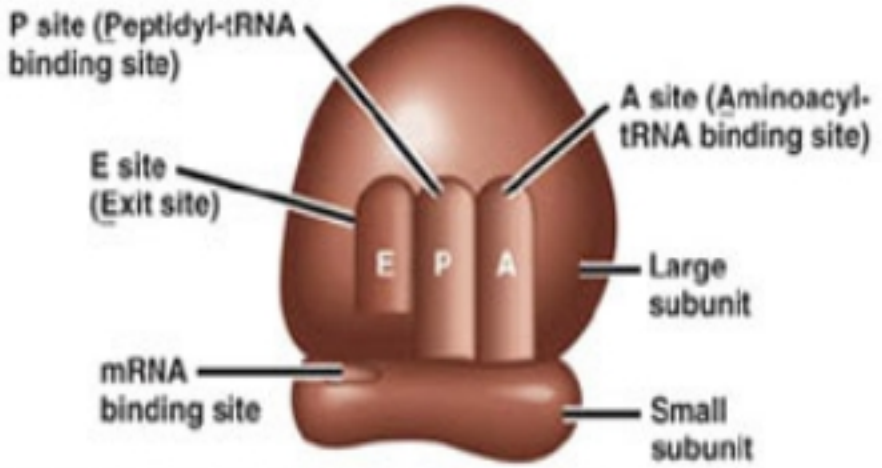
- Protein synthesis takes place on ribosomes which is a nucleoprotein and contain 65% r-RNA and 35% protein
- The two subunits in prokaryotes are 50s and 30s and in eukaryotes are 60s and 40s
- A polysome or polyribosome is a beaded string like linear cluster of 5-8 ribosomes on mRNA
- Each ribosome has peptidyl (P), amino acyl (A) and exit (E) site

STRUCTURE

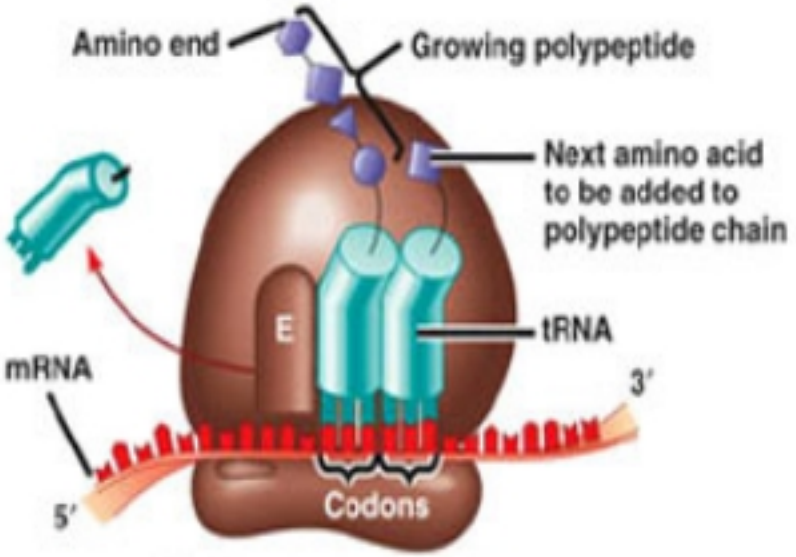
- RNA molecules of both subunits are synthesized with in the nucleus.
- The individual ribosomes held together by strand of mRNA to form poly ribosomes.
- The message carried by mRNA is a code for the amino acid sequence of proteins being synthesized by a cell and the ribosomes play a crucial role in decoding or translating this message during protein synthesis.



(a) Computer model of functioning ribosome



(b) Schematic model showing binding sites



(c) Schematic model with mRNA and tRNA

GOLGI COMPLEX

- Camillo Golgi.
- Usually composed of 4 or more stacked layers of thin, flat, enclosed vesicles lying one side of nucleus.
- The Golgi apparatus, like the ER, is a series of folded membranes
- Prominent in secretory cells.
- [redacted]sociation with ER.

Golgi apparatus

- Its function is in processing enzymes and other products of the ER to a finished product
- It is the source of the production of lysosomes
- Receives proteins & lipids in membrane-bound vesicles from ER
- Modifies those proteins & lipids
- Sorts and ships the proteins & lipids away in membrane-bound vesicles

STRUCTURE

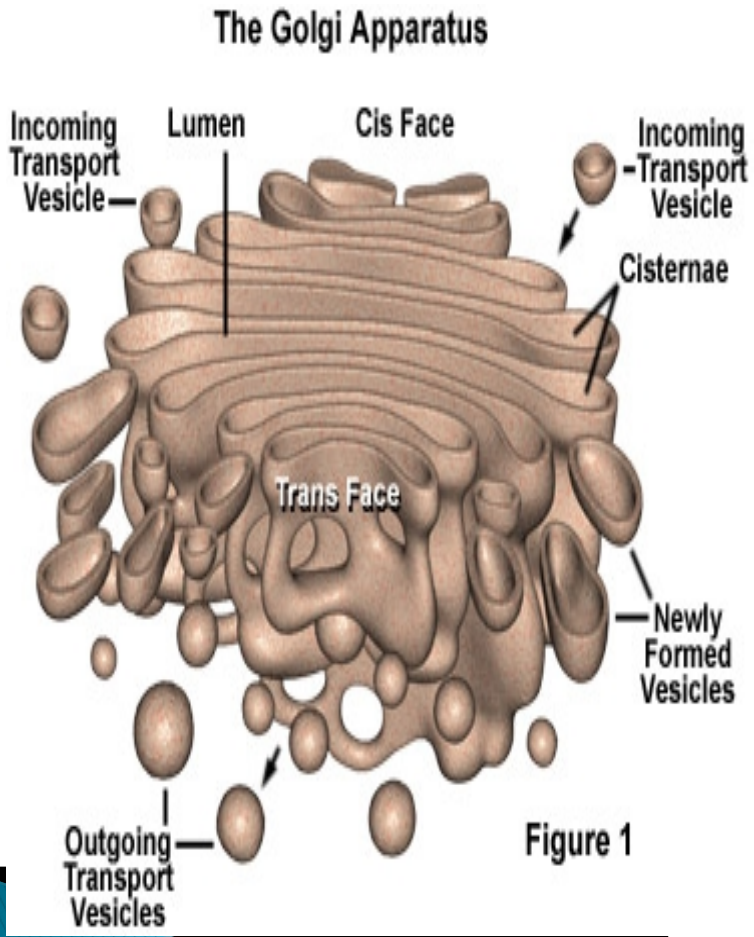
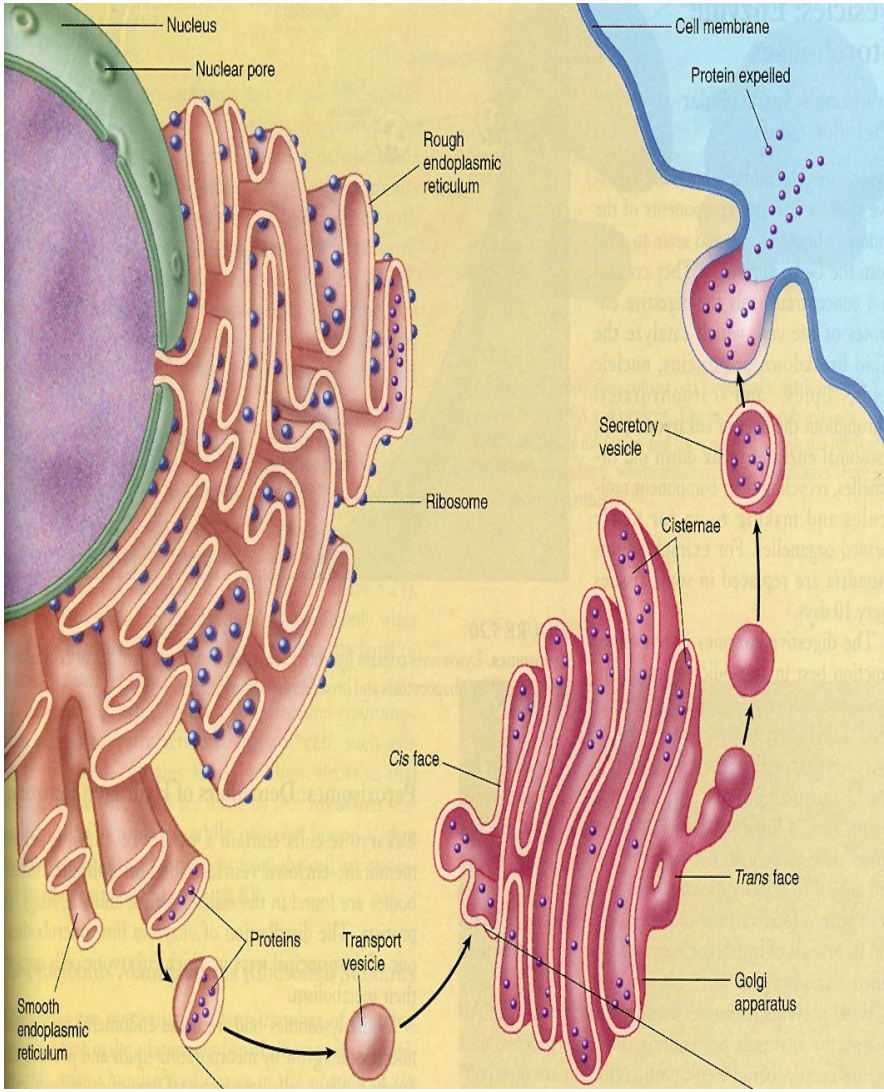


Figure 1

- Functionally Golgi complex is divided into 3 regions

1. The region nearest the nucleus is cis-face
2. The opposite face, nearest to cell membrane is trans-face
3. The intermediate part is medial Golgi.

- Cis face: proteins are phosphorylated
- Medial golgi : protein – carbohydrate complexes formed
- Trans face : Inactive forms to active forms
- Sugar residues are added and then
- Sorting & packing into vesicles is done.



Main function of the Golgi apparatus is protein sorting , packing and secretion .

- The finished products may have one of the
- following destinations
- a They may pass through plasma membrane
- to the surrounding medium . This forms continuous secretion , e. g secretion of immunoglobulins by plasma cells .
- b They reach plasma membrane and form an
- Integral part of it .
- c They are formed into a secretory vesicle
- Where these products are stored for a longer
- time .Under appropriate stimuli the contents are
- Secreted

Release of trypsinogen by pancreatic acinar cells and release

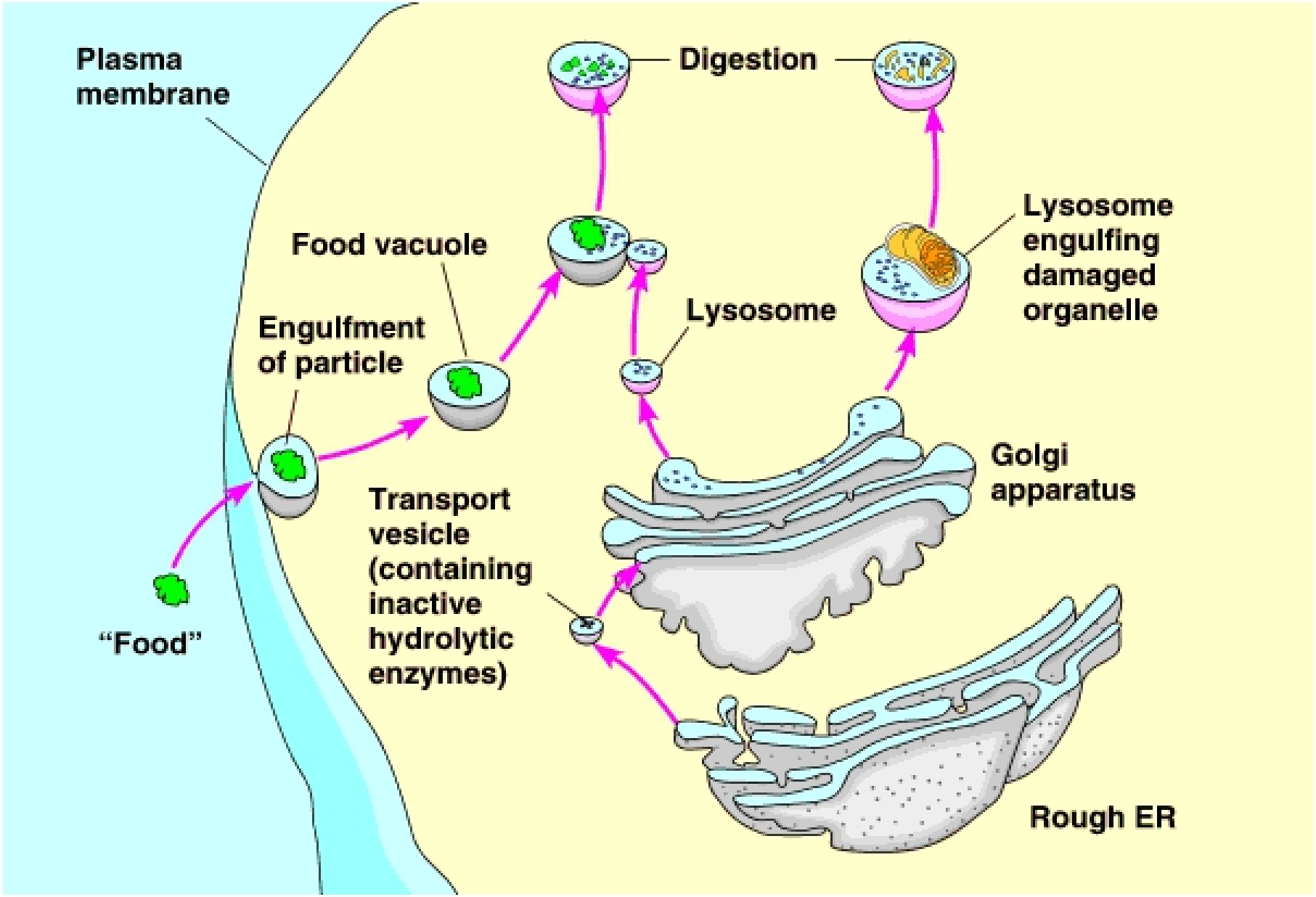
- Of insulin by beta cells of Langerhans are cited as examples
- d The synthesized products may be collected
- Into lysosome packet .

LYSOSOMES

(Digestive bags, suicide sacks)

- Lysosomes have unique membrane that is resistant to acidic internal PH.
- They are formed from region of golgi complex.
- They are membrane limited vesicles and contain large variety of hydrolytic enzymes.
- They are abundant in cells exhibiting phagocytic activity
- Digestive organ of cell

Figure 4.11B Lysosome formation and functions



Important Lysosomal Enzymes

Proteolytic Enzymes	**1.Cathepsins**	**2.Collagenases**	**3.Elastases**	
Lipolytic Enzymes	**1.Lipases**	**2.Phospholipase**	**3.Fatty acyl Esterases**	
Carbohydrate splitting enzymes	**1.α-glycosidase**	**2. β-galactosidase**	**3.Hyaluronidase**	**4.Aryl Sulphatase**
Nucleic acid Hydrolysing enzymes	**1.Ribonuclease**	**2.Deoxy Ribonuclease**		
Other enzymes	**1.Acid Phosphatse**	**2.Catalase**		

Functions:

- Contains enzymes essential for intracellular digestion.
- Kill and remove foreign bodies.
- Acrosome located at the head of spermatozoa is a specialized lysosome

Gout and Rheumatoid Arthritis

- ***Gout*** is deposition of **uric acid crystals** of the joints often from over consumption of meat.
- These crystals are phagocytosed by the lysosomes causing physical damage & rupturing them.
- These ruptured lysosomes release enzymes that **degrade the components of the synovial membrane in the joints**, causing great pain and joint deformation.

- ***Tay-Sachs* Disease**

- **I-cell disease**

Inclusion cell disease

- It is a rare condition in which lysosome lack
- Enzymes but they are seen in blood.
- This means that the enzymes are synthesized
- but are not able to reach the correct site .
- The disease is characterized by severe progressive psychomotor retardation with death occurring in first decade.
- It is shown that mannose 6 phosphate is the
- marker to target the nascent enzymes to
- Lysosome

- In these persons the carbohydrate units are
- Not added to the enzymes .
- Mannose 6 phosphate deficient enzymes
- cannot reach their destination .

PEROXISOMES

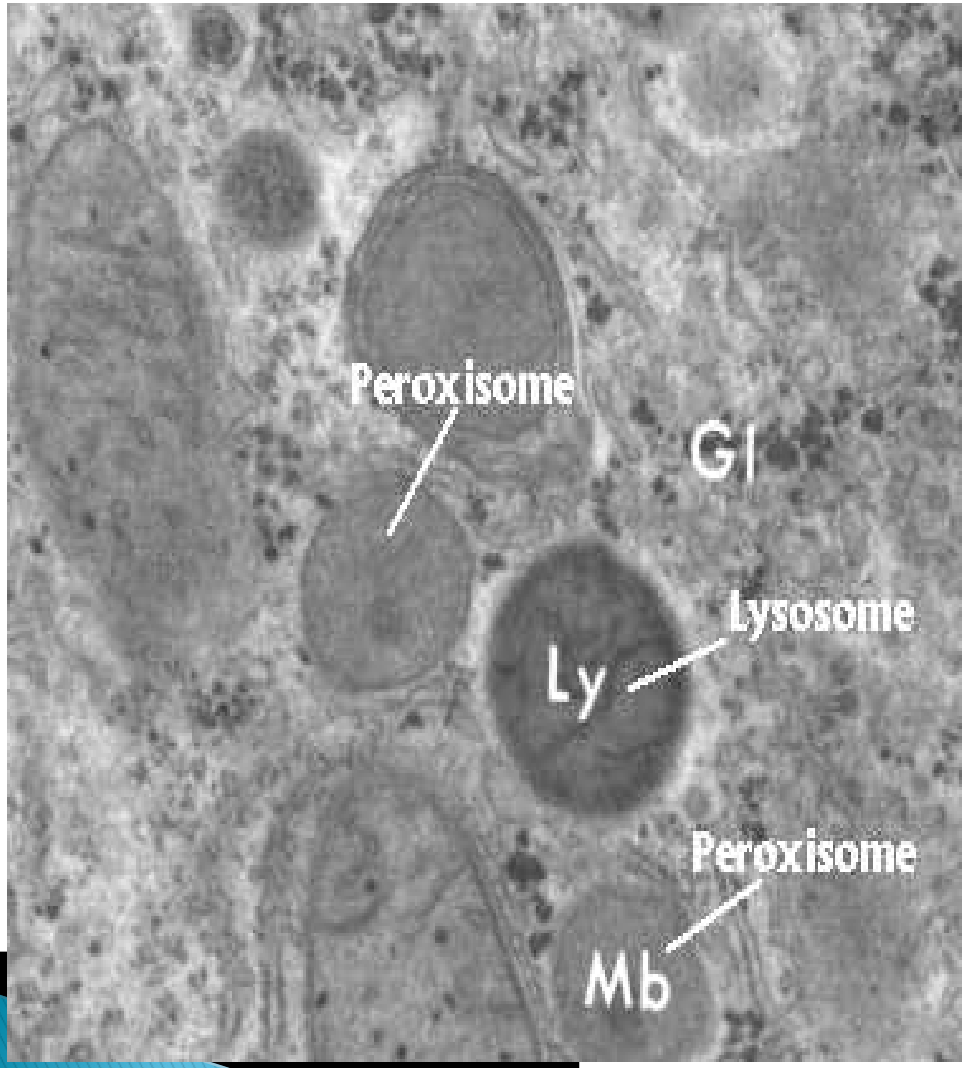
- single membrane bounded organelles with oxidative enzymes ,also known as **‘microbodies’**
- Structure similar to lysosomes
- Formed by self replication or by budding off from sER
- **Detoxifying organs of cell**
- Lipid metabolism, myelin synthesis
- [redacted]epatocytes

Peroxisomes or Microbodies

- For **oxidation of fatty acids and toxicants, it contains oxidative enzymes.**
- E.g. **catalase** in peroxisomes can decompose hydrogen peroxide into water.
- Abundant in hepatocytes (liver cells), where oxidation of fatty acids (and other organic matters) takes place and produces hydrogen peroxide.
- Life span is short and the numbers of peroxisome vary.
- They replicate like mitochondria.

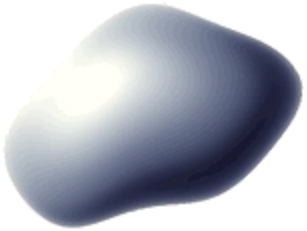
ZELLWEGERSYNDROME

(hepato renal syndrome)



- There is inherited absence of peroxisomes in all tissues.
- Failure to oxidize long chain FA in peroxisome.
- Accumulation in brain ,liver & kidneys.

Vacuoles

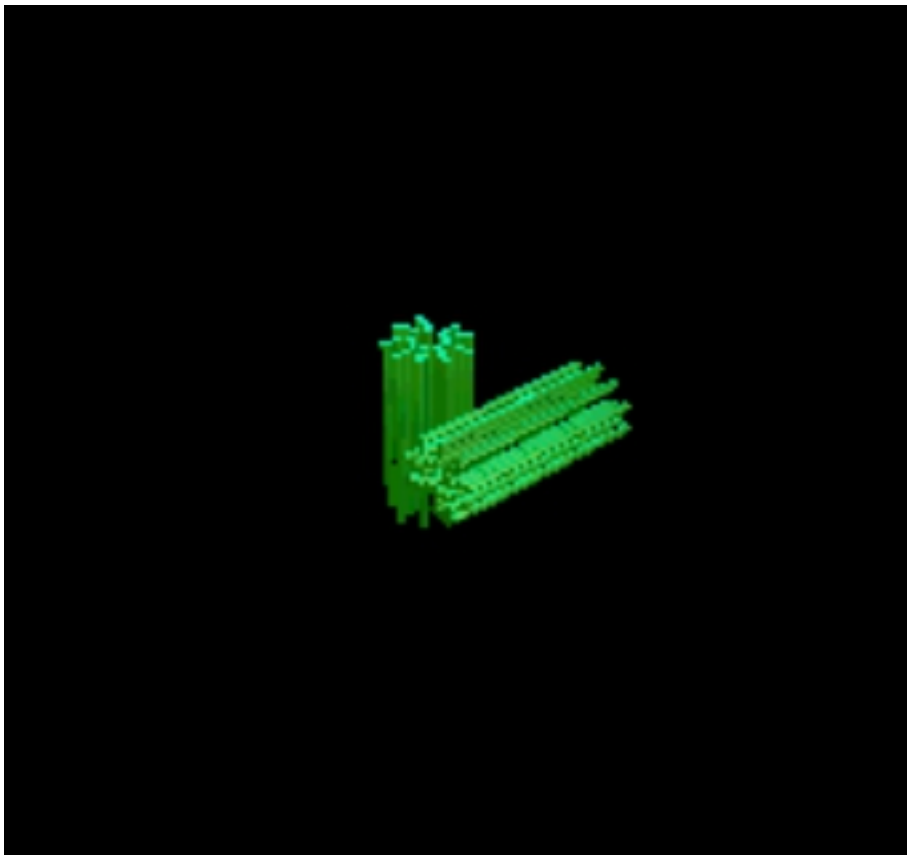


- These are membrane-bound sacs that have many different functions.
- It may also function in absorbing water.
- The central vacuoles of flower petal cells may hold the pigments that give the flower its color

Centrosome:

- Centrosome is the area located near nucleus.
- The two centrioles are located perpendicular to each other in the centrosome.
- Each centrioles consists of nine bundles of tiny microtubules arranged in a circle.
- Functions:

1. Basal body formation
2. [redacted]tion

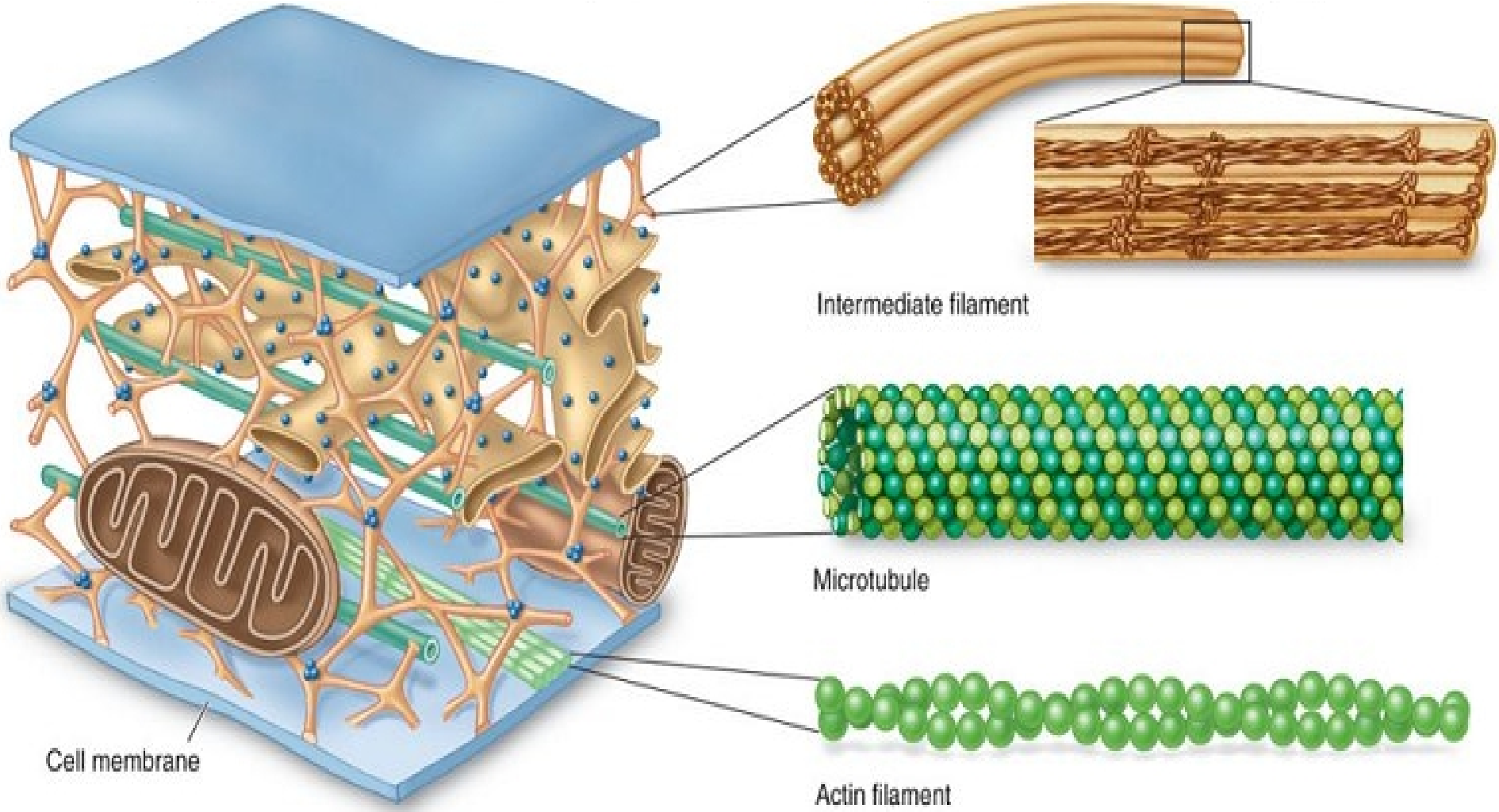


Cytoskeleton

The cytoplasm is permeated by a number of fibrillar elements that collectively form a supporting network called the cytoskeleton.

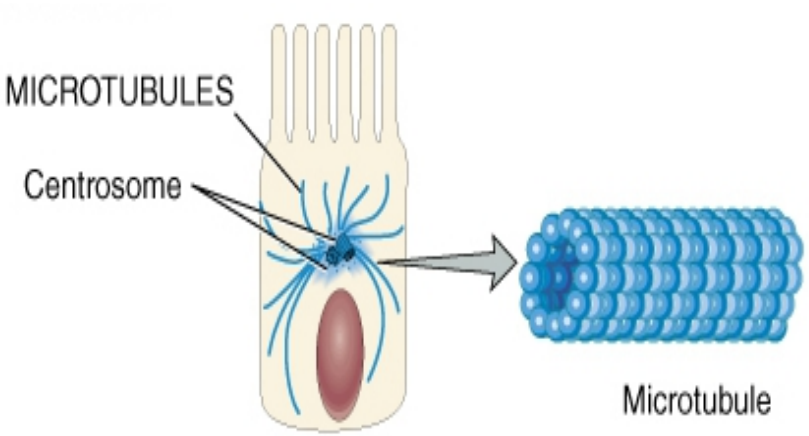
Functions of cytoskeleton:-

- Maintains the cellular architecture
- Cell motility
- Divides cytosol into functionally discrete areas
- Anchoring cells to each other.


Intermediate filament
Microtubule
Actin filament
Cell membrane

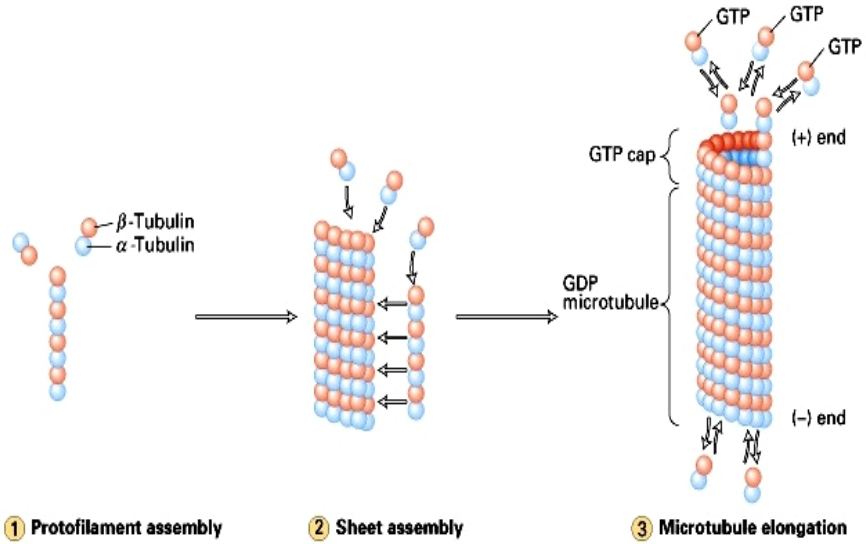
Microtubules

- 25nm
- Protein is *tubulin dimer*(α and β subunits).
- Polymerisation of microtubles in centrioles constitute the microtubule organising centre (MTOC).
- Act as conveyor belts



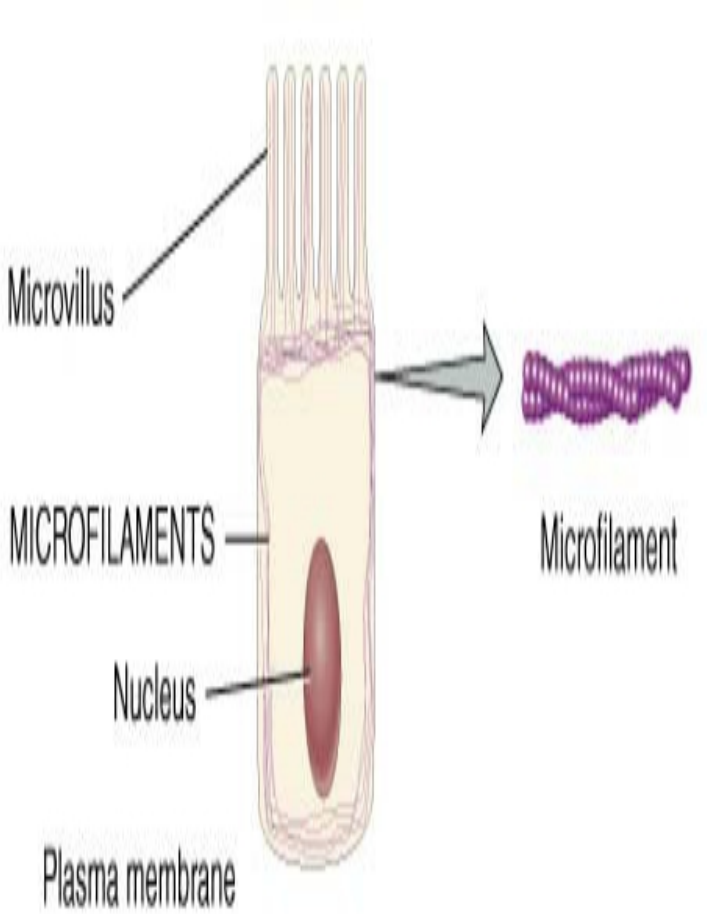
ROLE:

- Intra-cellular vesicular transport.
- Movement of cilia and flagella.
- Mitotic spindles
- [redacted]nd mo[redacted]



Microfilaments

- **Diameter is 5 nm.**
- **It is composed of actin filaments.**
  Free actin = G –actin
  polymerised actin = F-actin.



FUNCTIONS:

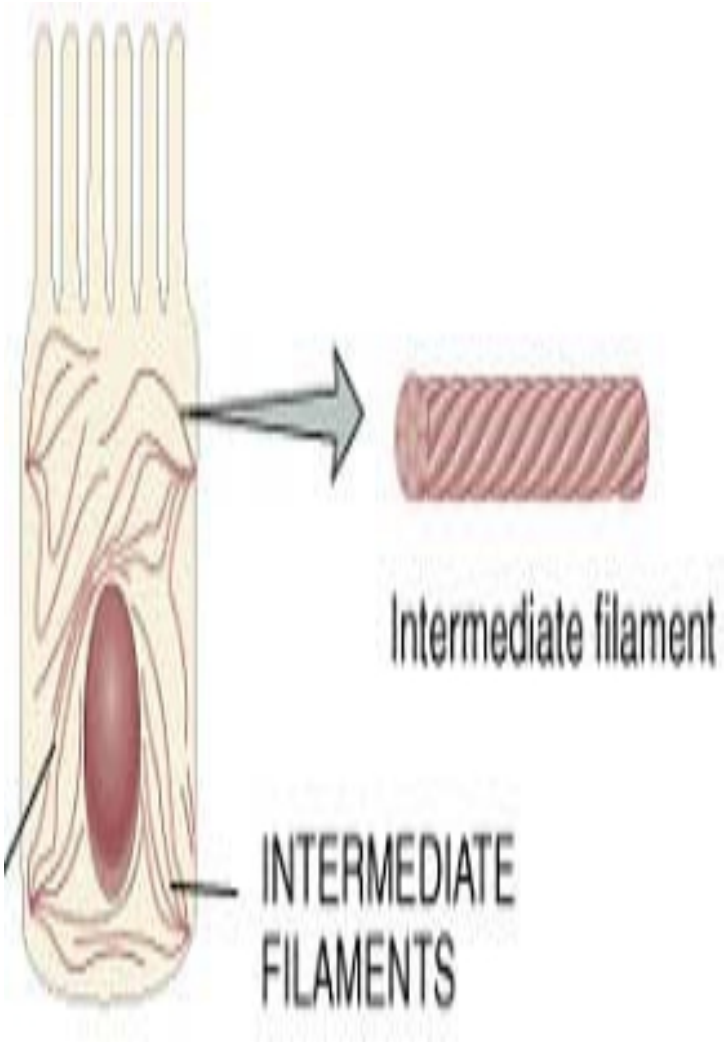
- **Anchorage and movement of membrane protein**
- **Formation of core of microvilli.**
- **Cell division, locomotion.**
- **Extension of cell processes.**

Intermediate filaments

- Diameter: 10nm
- Connects adjacent cells through desmosomes
- Made of fibrous proteins.

Proteins:

Cytokeratin in epithelial cells
Neurofilament proteins in neurons
Desmin in muscle
Glial fibrillary acidic protein in astrocytes
Laminin in nuclear lamina
Vimentin in various cells



CELL INCLUSIONS

Cytoplasmic Inclusions

1) **Stored foods**
a) Glycogen
b) Fats

2) **Pigments**

Exogenous
Carotene
Carbon pigments

Endogenous
Hemoglobin
Hemosiderin
Bilirubin
Melanin

Commonly seen inclusions are

- Lipofuscin
- Hemosiderin
- Glycogen
- Lipid inclusions
- Crystalline inclusions

LIPOFUSCIN:

- Brownish gold pigment .
- A cluster of lipids, metals & organic molecules.
- wear and tear pigment.

HEMOSIDERIN :

- Iron storage complex found in cytoplasm.
- [illegible]le.

GLYCOGEN:

- Highly branched polymer.
- may not be stained in H & E.
- Liver and striated muscle cells shows unstained regions where glycogen is present.
- In EM clusters of granules of 25 to 30nm.

LIPID INCLUSIONS:

- Are usually nutritive inclusions that provide energy for cellular metabolism.
- May appear in cell for very short time but in Adipocytes they constitute most of cytoplasmic volume and compress other organelles into thin rim at margin of the cell.

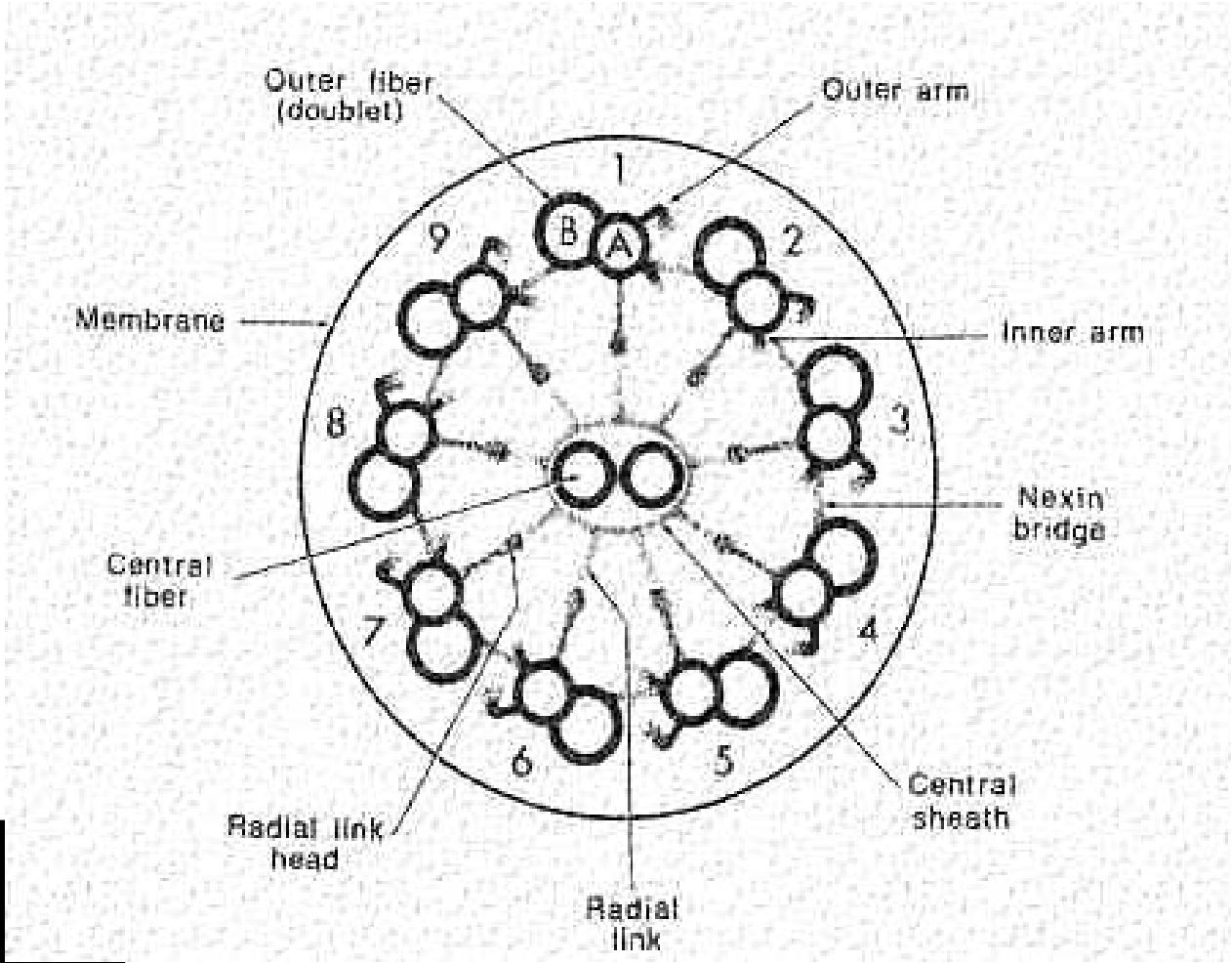
CRYSTALLINE INCLUSIONS:

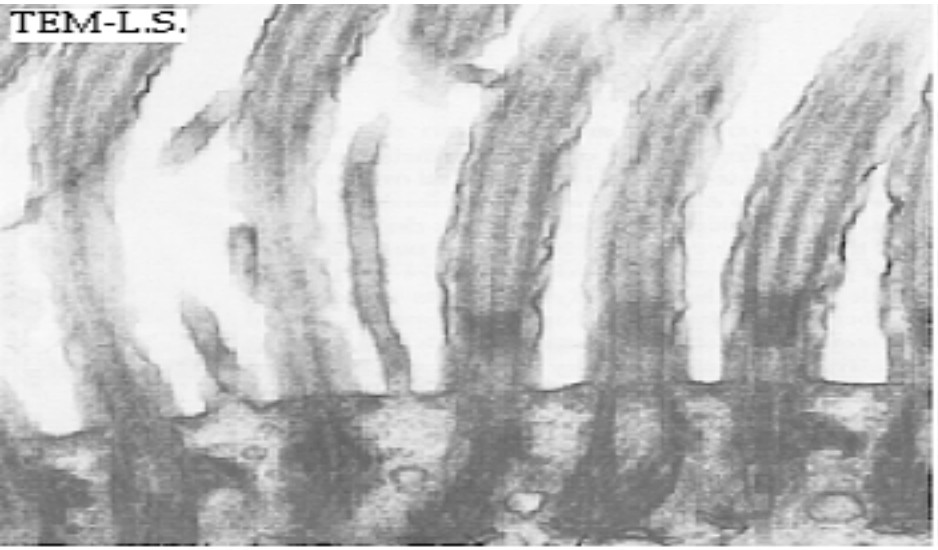
- These contained in certain cells are recognized in light microscope. In humans are found in sertoli and leydig cells of testis may contain storage material or cellular metabolite.
- Significance is not clear.

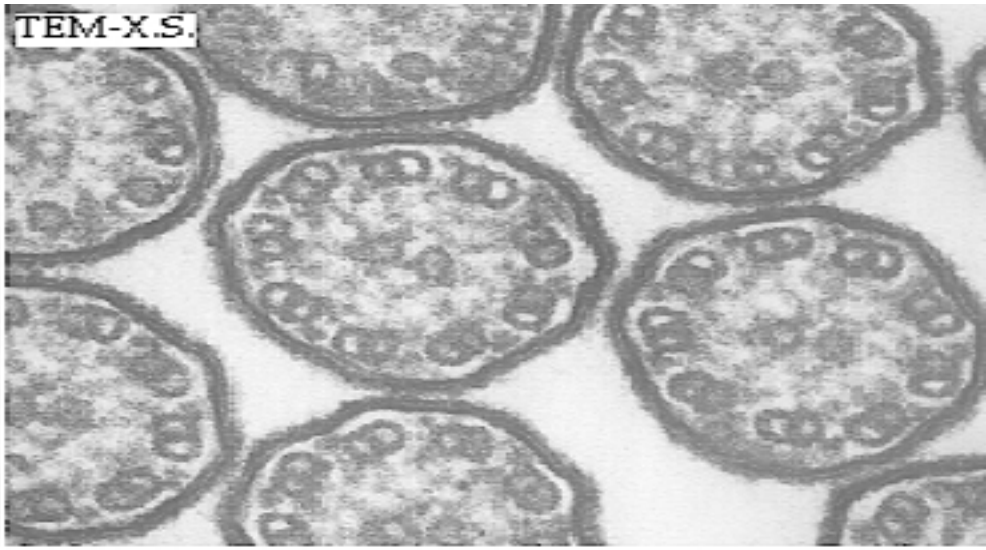
PROJECTIONS FROM CELL SURFACE

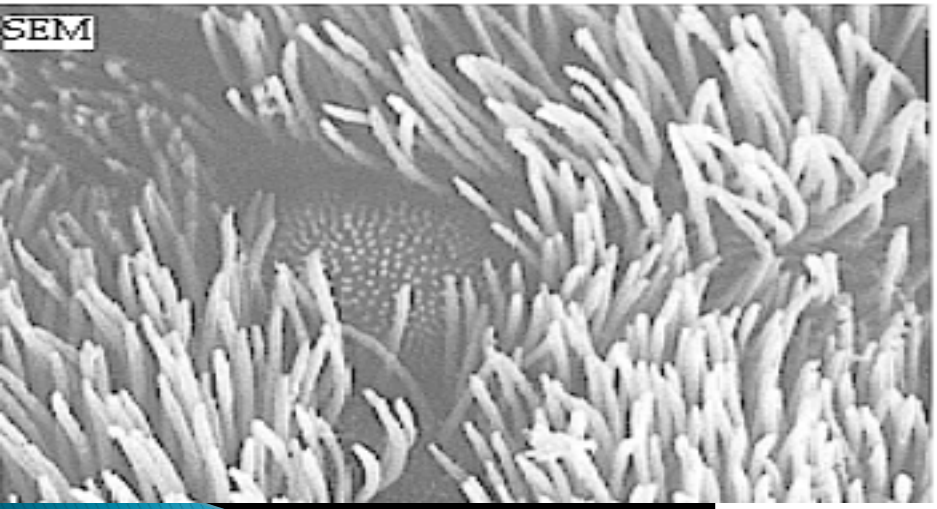
1. CILIA:

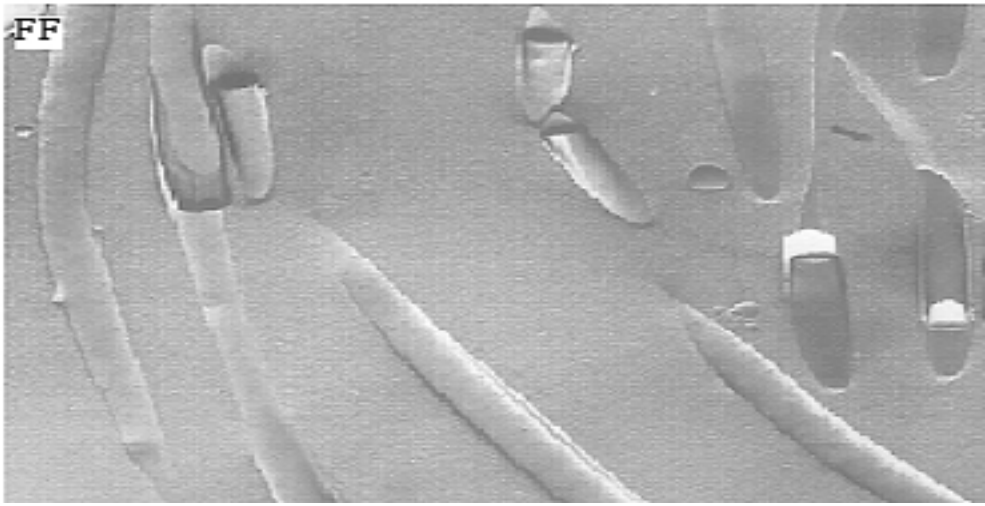
- These are minute hair-like projections from free surface of some cells.
- 0.25µm in diameter.
- They are made up [illegible] microtubules.




TEM-L.S.


TEM-X.S.


SEM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FUNCTIONS:

Ciliary action moves :-

-Secretions in the respiratory tract

-Ova through the uterine tube.

-Spermatozoa through the male genital tract

-Cells in embryogenesis

2) FLAGELLA

- Similar in structure to cilia but longer.

  Eg; tail of spermatozoan.

- Movement starts at base of flagellum.

  nearest segment--- one direction.

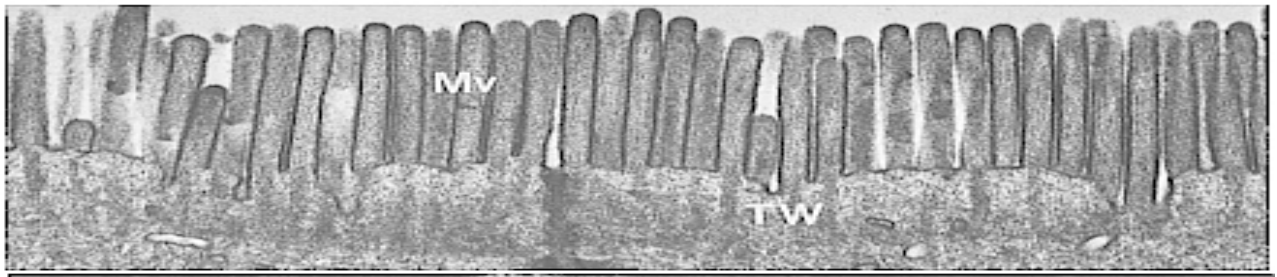
  succeding segements--- opposite direction .

  wave like motion passes down the flagellum.

3) MICROVILLI:

- With EM: Finger like extensions of cell membrane.
- plasma memebrane and numerous actin filaments in it.
- Increases the surface area for absorption of materials

Microvilli
Transmission Electron Microscopy
(sectioned tissue)



Microvilli
Scanning Electron Microscopy

Microvilli
Transmission Electron Microscopy
(freeze-fracture replica)

- Inclusions contain products of metabolic activity of the cell
- Consists of pigment granules, lipid droplets and glycogen.
- Considered as nonmoving and nonliving components of the cell.
- characteristic staining properties


Thank
you!