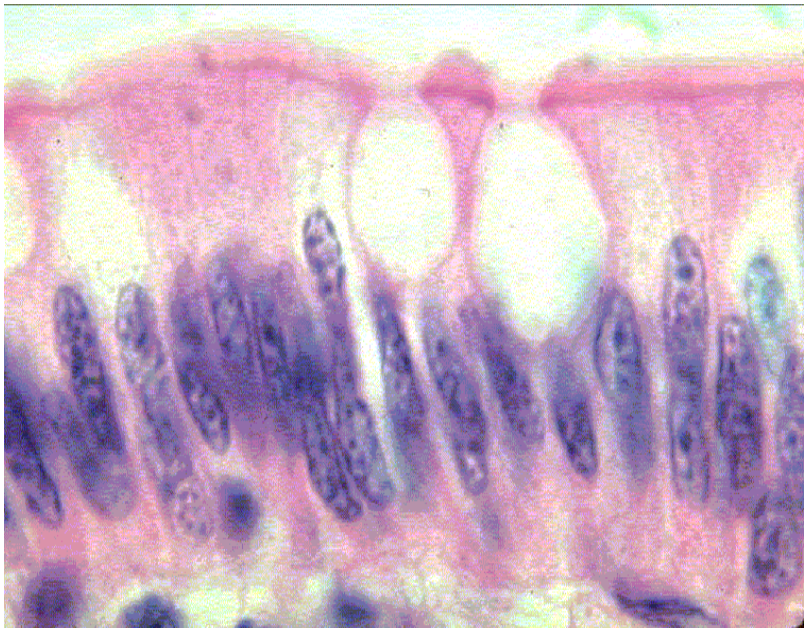
Cell Overview

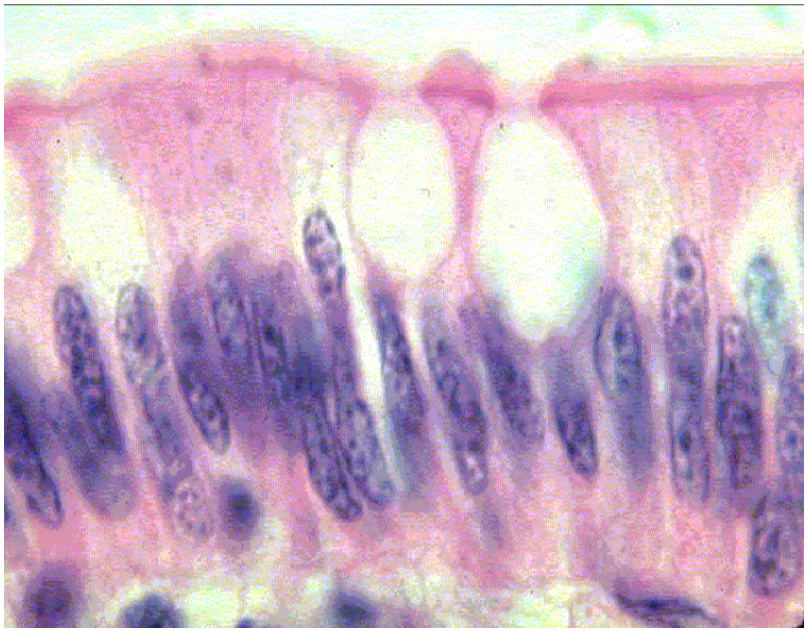
Basophilic



- Basophilic structures are stained by basic dyes:
  - Basic dyes are **positive**
  - Basophilic structures are **negative** (ex. DNA, RNA, ribosomes, RER)
- Mnemonic:

  Basophilic = **B**lue

Acidophilic (Eosinophilic)



- Acidophilic structures are stained by acid dyes:
  - Acid *dyes* are **negative**
  - Acidophilic structures are **positive** (ex. Proteins, collagen, cytoplasm)
- Eosinophilic = Pink

Sections cut through a curved tube

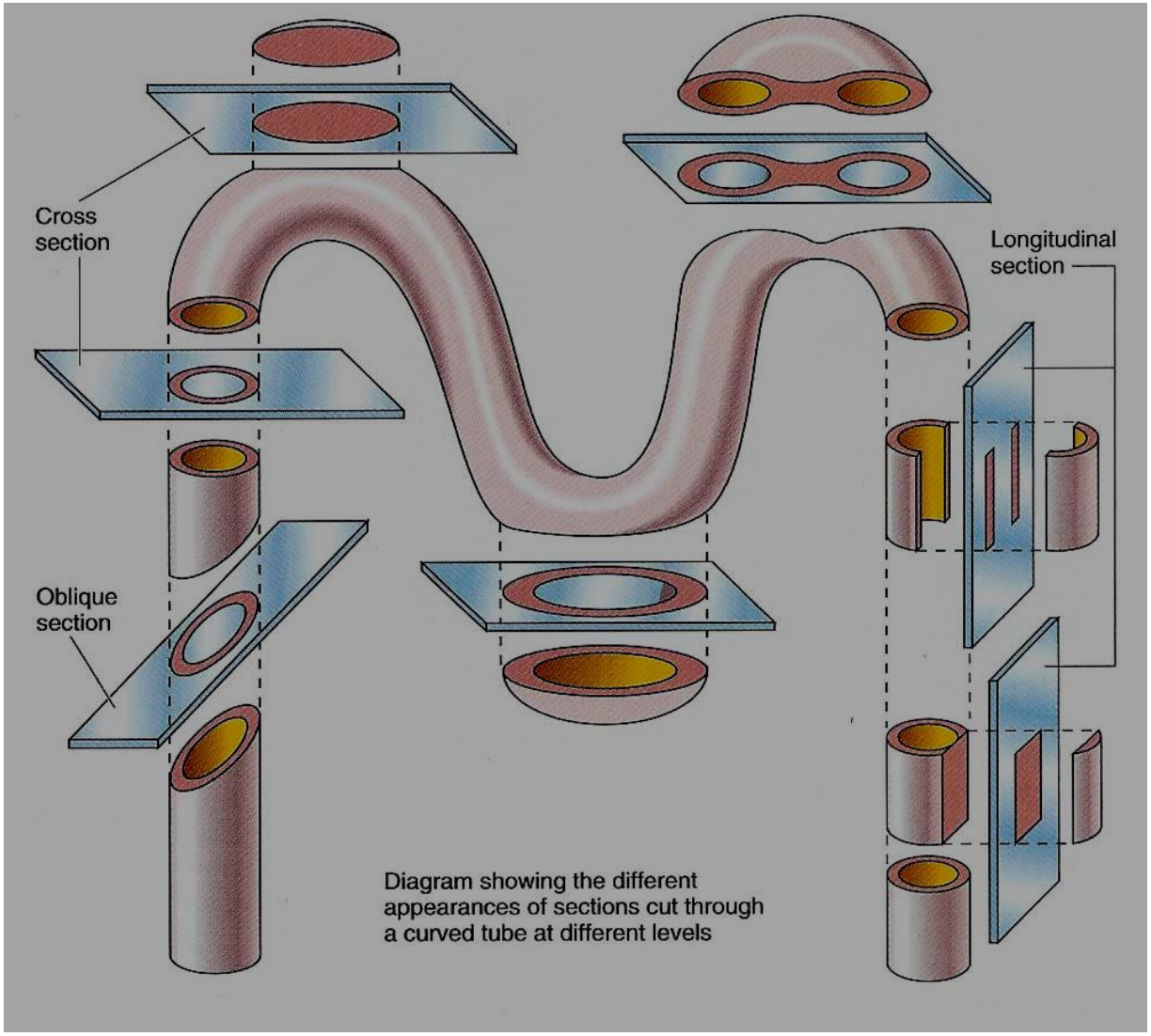
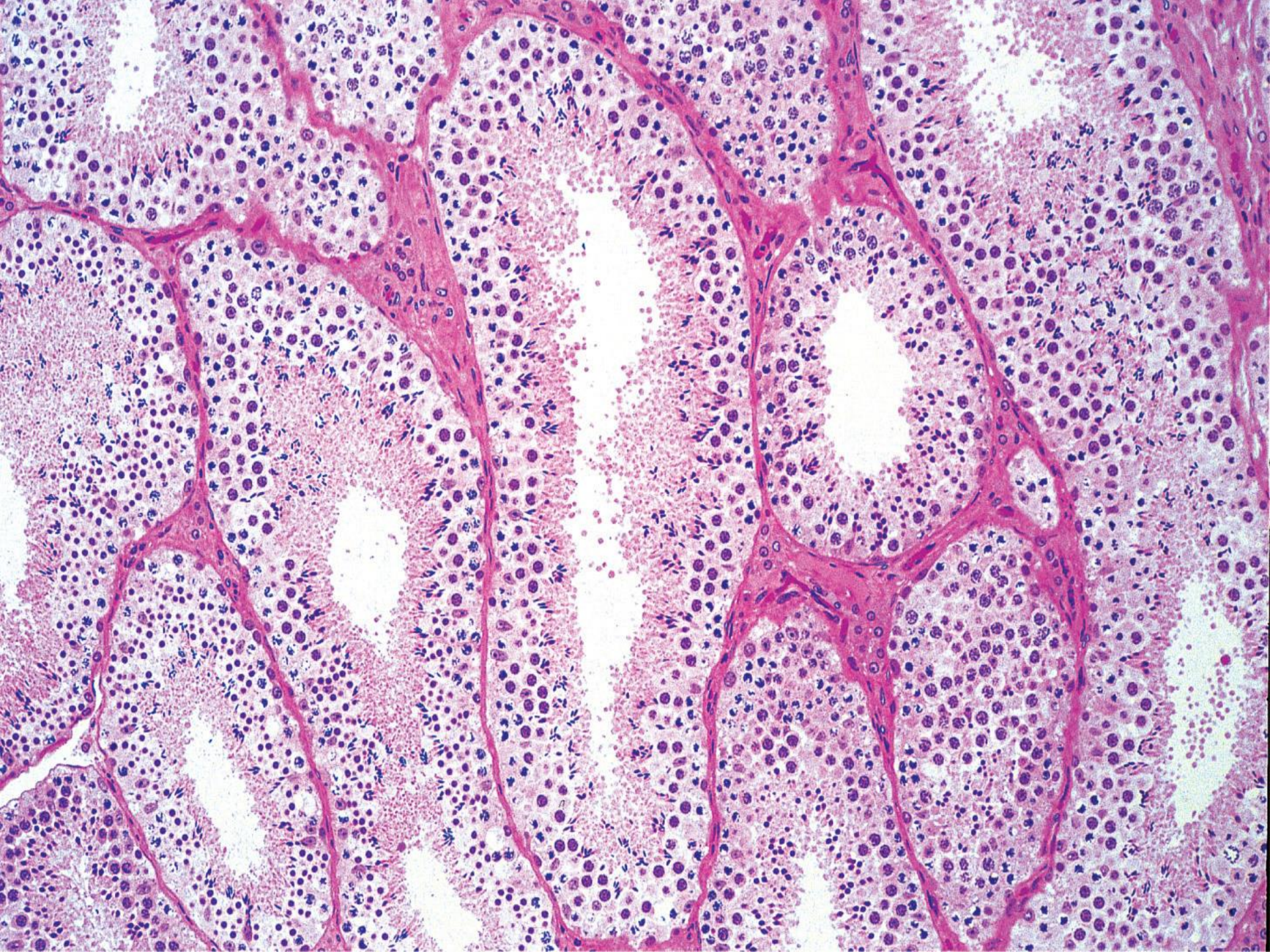
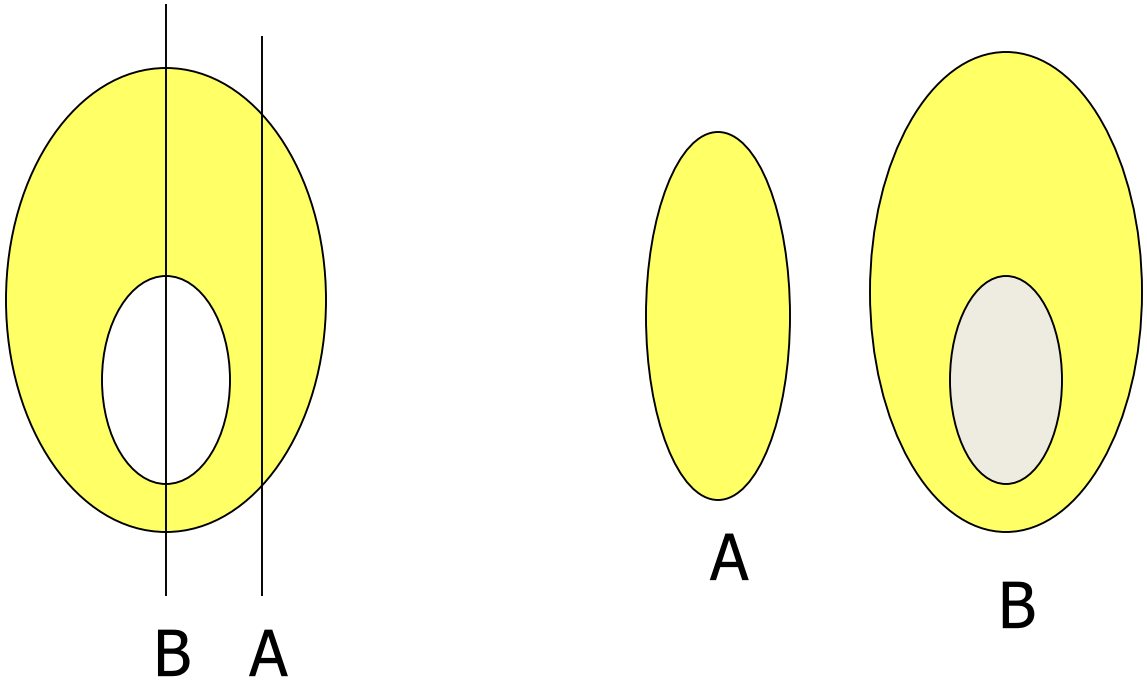


Diagram showing the different appearances of sections cut through a curved tube at different levels



Section of Round Solid Object

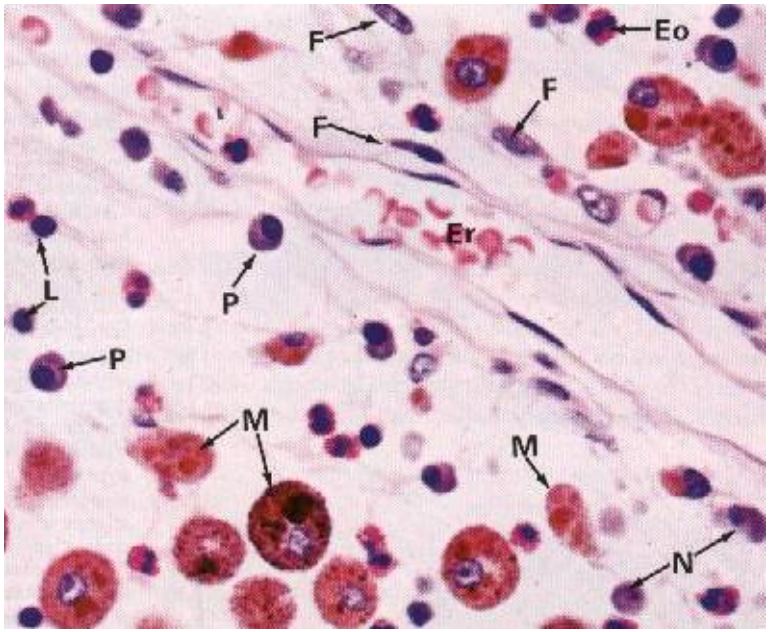


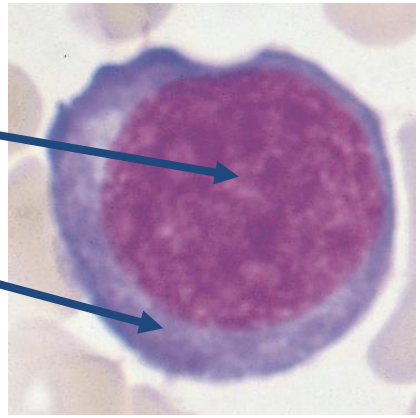
THE CELL

- **It Is the structural & functional unit of all living tissues.**
- **Cells have different shapes & sizes.**
- **<u>THE CELL</u> is made of:**

  1- Nucleus

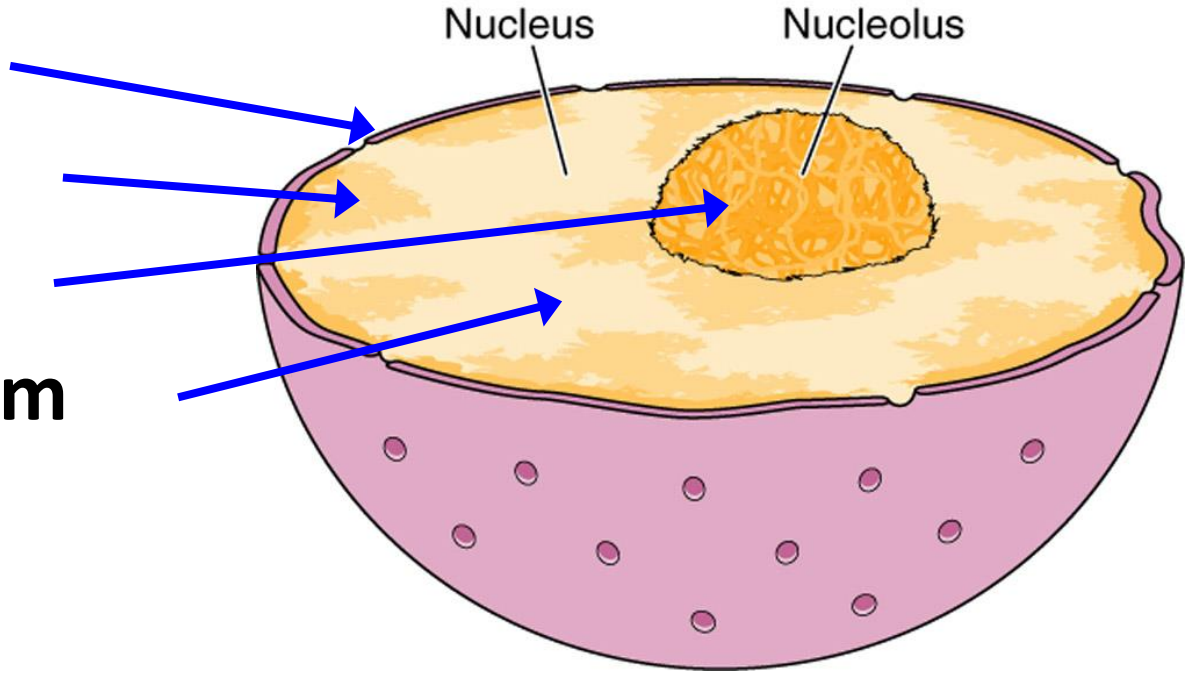
  2- Cytoplasm





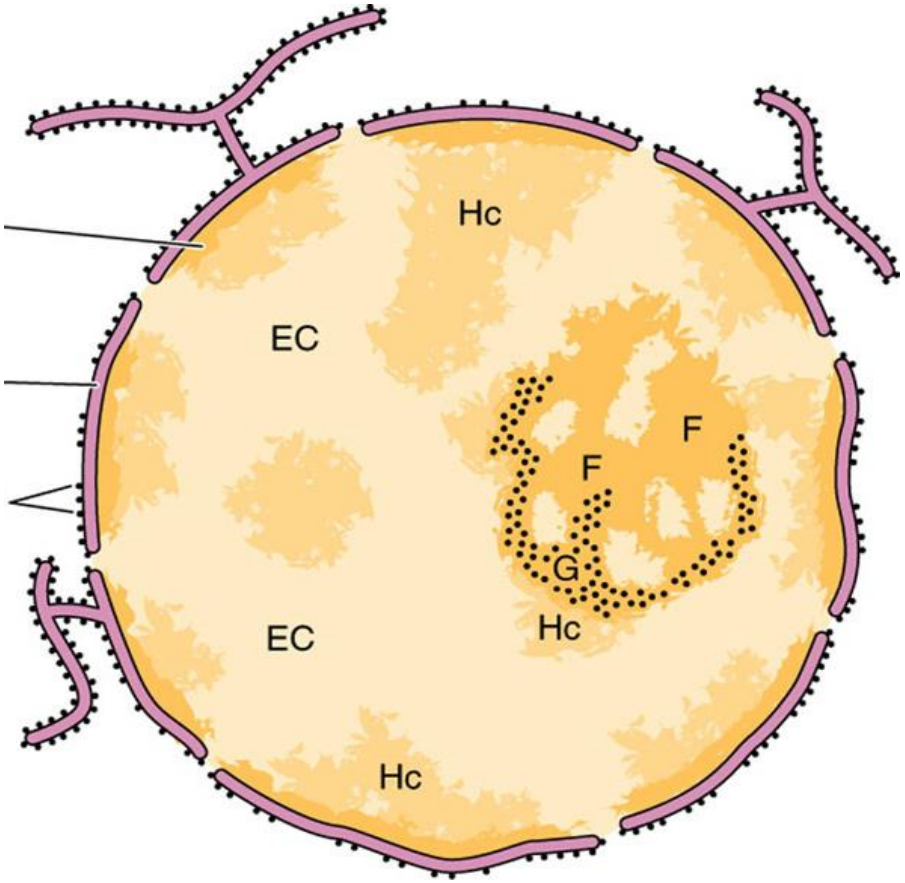
NUCLEUS

- **Formed of:**
  1. **Nuclear envelope**
  2. **Chromatin**
  3. **Nucleolus**
  4. **Nucleoplasm**



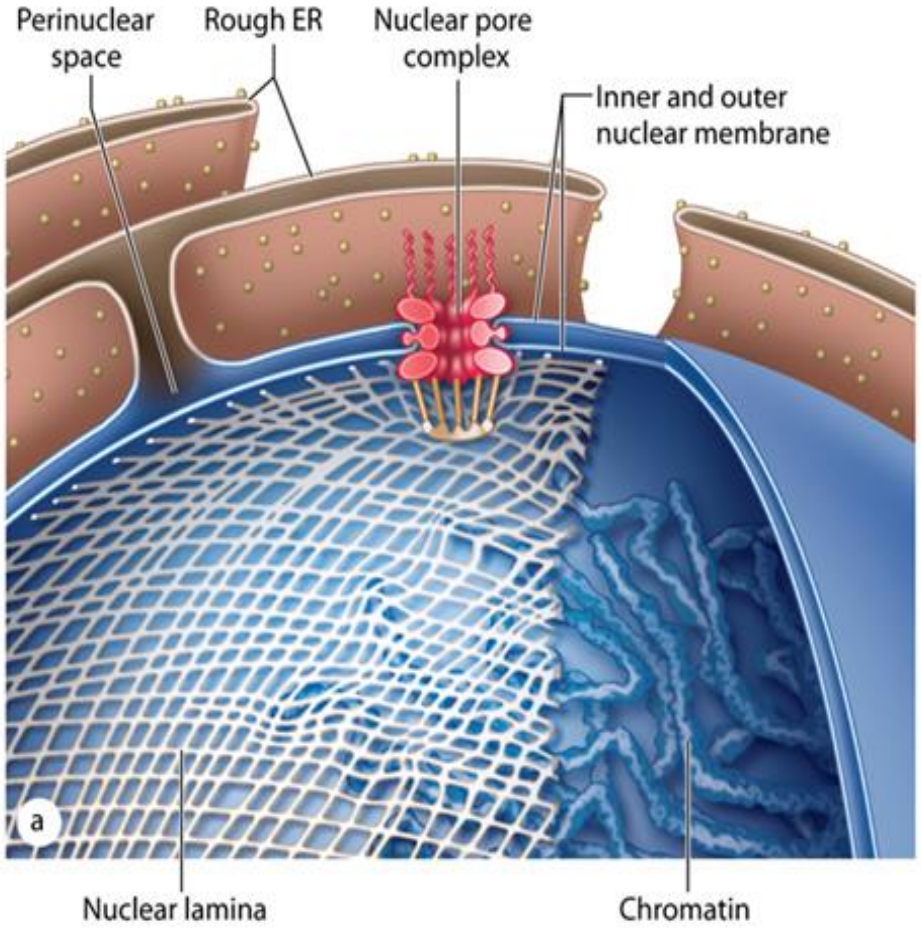
1. Nuclear Envelope

- A double membrane with many pores.
  a) **<u>Outer membrane</u>**.
  b) **<u>Inner membrane</u>**.
  c) **<u>Perinuclear space</u>**
  d) **<u>Nuclear pores</u>**: provide communication between nucleus and cytoplasm.



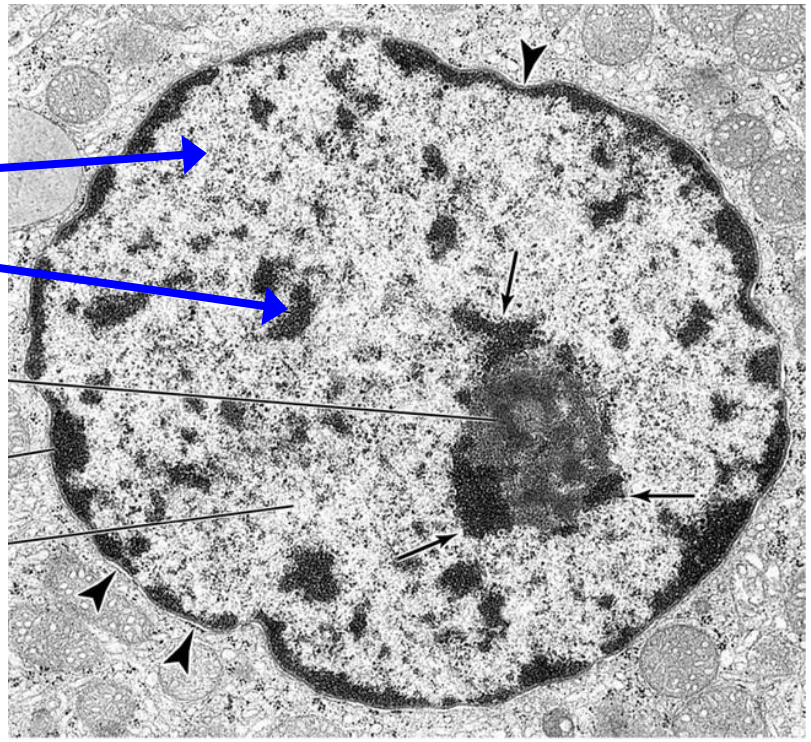
Nuclear lamina is a meshwork of intermediate filaments proteins Called lamins

Nucleoporins is a protein complex associated with the nuclear envelope, make up the nuclear pore complex

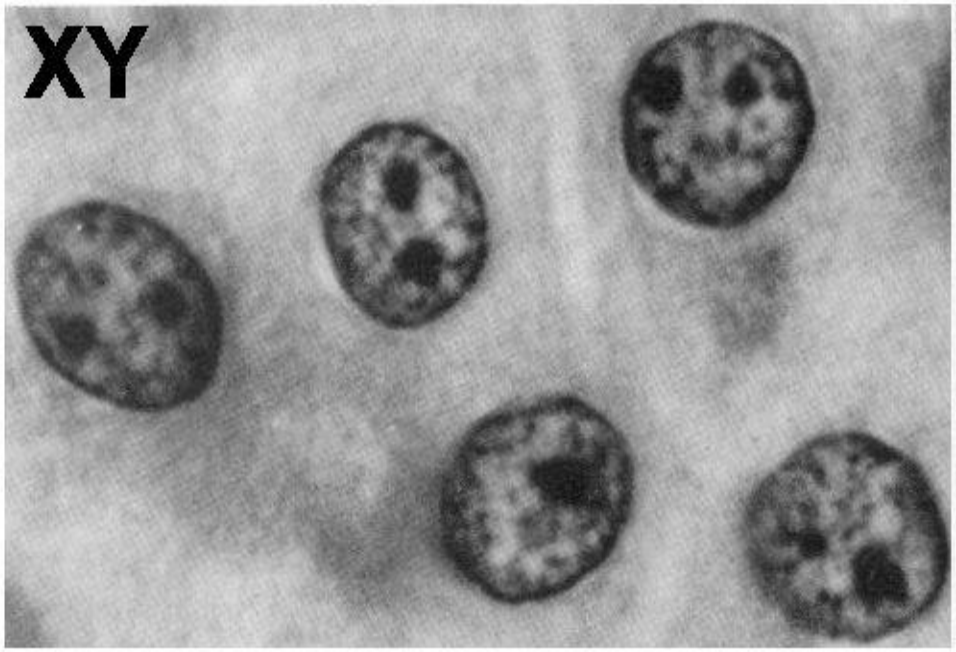


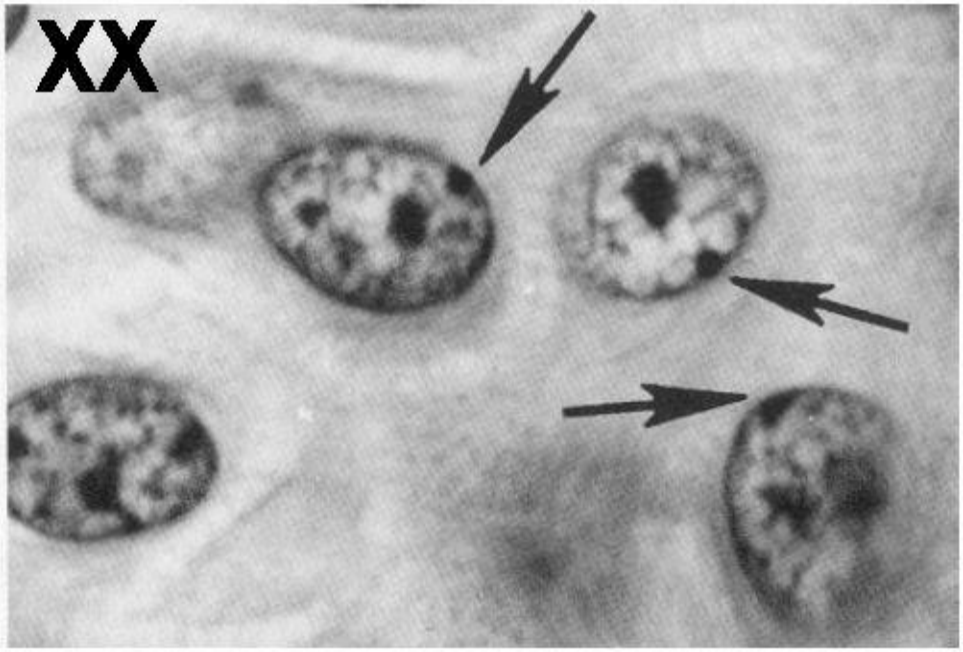
2. Chromatin

- Formed of **DNA**.
- **2 Forms:**
  - **Euchromatin**: extended active chromatin (pale).
  - **Heterochromatin:** condensed inactive chromatin (dark)
- **Functions:**
  - Carries genetic information.
  - Directs protein synthesis.



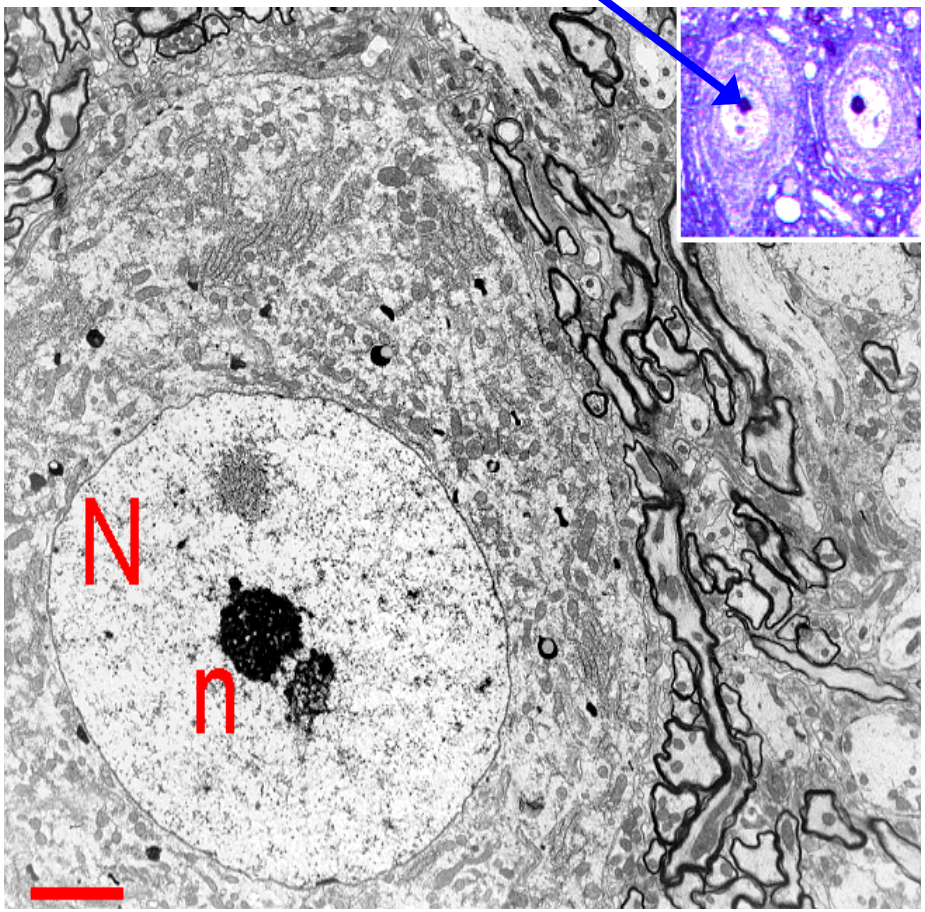
Barr body or sex chromatin : inactive X chromosome in a female somatic cell appears as small dense mass of heterochromatin





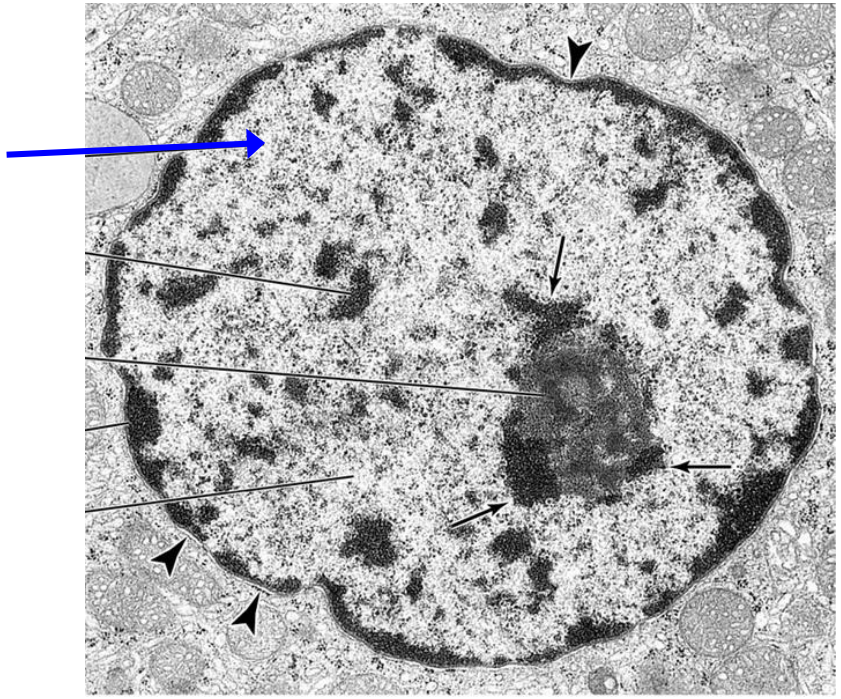
3. Nucleolus

- It is a spherical dark basophilic mass not surrounded by a membrane.
- Usually one.
- **Function:** formation and assembly of ribosomal RNA (rRNA), which is responsible for protein synthesis in the cytoplasm.



4. Nucleoplasm

- It is a clear fluid medium in which all the contents of the nucleus are embedded.



Function:

- Provides a medium for movement of 3 types of RNA (ribosomal, messenger and transfer RNA) from the nucleus to the cytoplasm.

Functions of the Nucleus

1- It is essential for the **vitality** and **division** of the cell.

2- It is the site of storage of **genetic information**.

3- It is the site of formation of the **three types of RNA**.

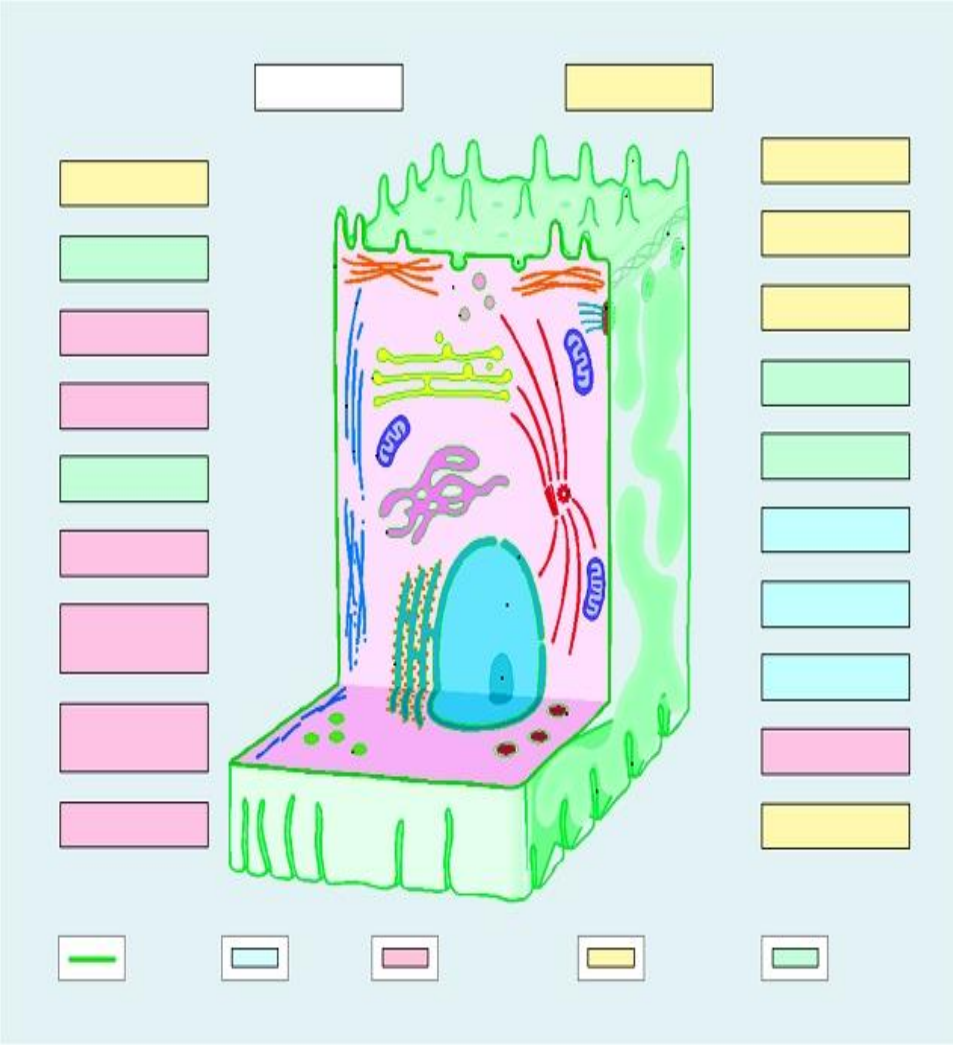
CYTOPLASM

is formed of:

1- **ORGANELLES:** They are specialized structures, **ESSENTIAL** for vital processes of the cell.

2- **INCLUSIONS:** They are **not essential** for vitality of cells. may be present or absent. Examples are lipids, glycogen and pigments like melanin & lipofuscin.

3- **CYTOSKELETON**



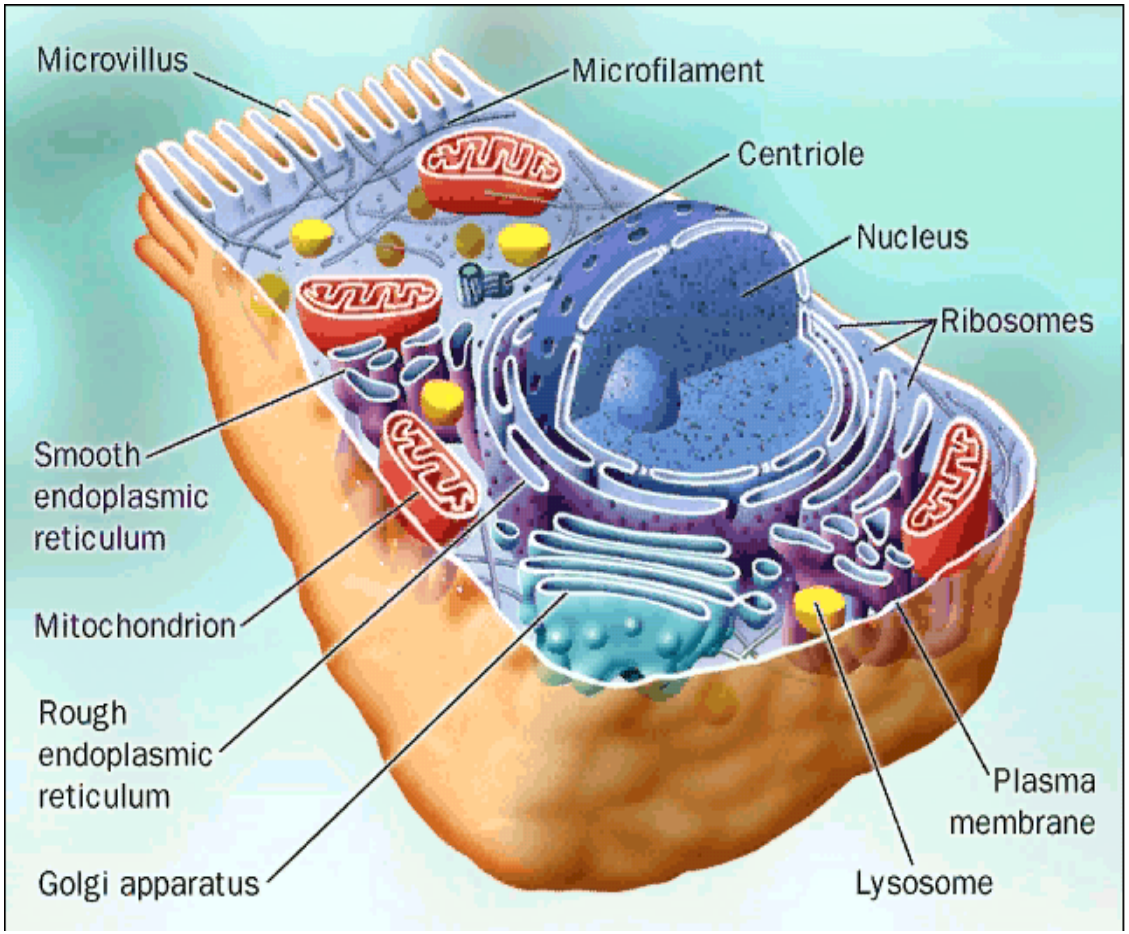
CYTOPLASMIC ORGANELLES

A. Membranous:

1. Cell membrane.
2. Mitochondria.
3. Endoplasmic reticulum (rough & smooth).
4. Golgi apparatus.
5. Lysosomes.
6. Secretory vesicles.

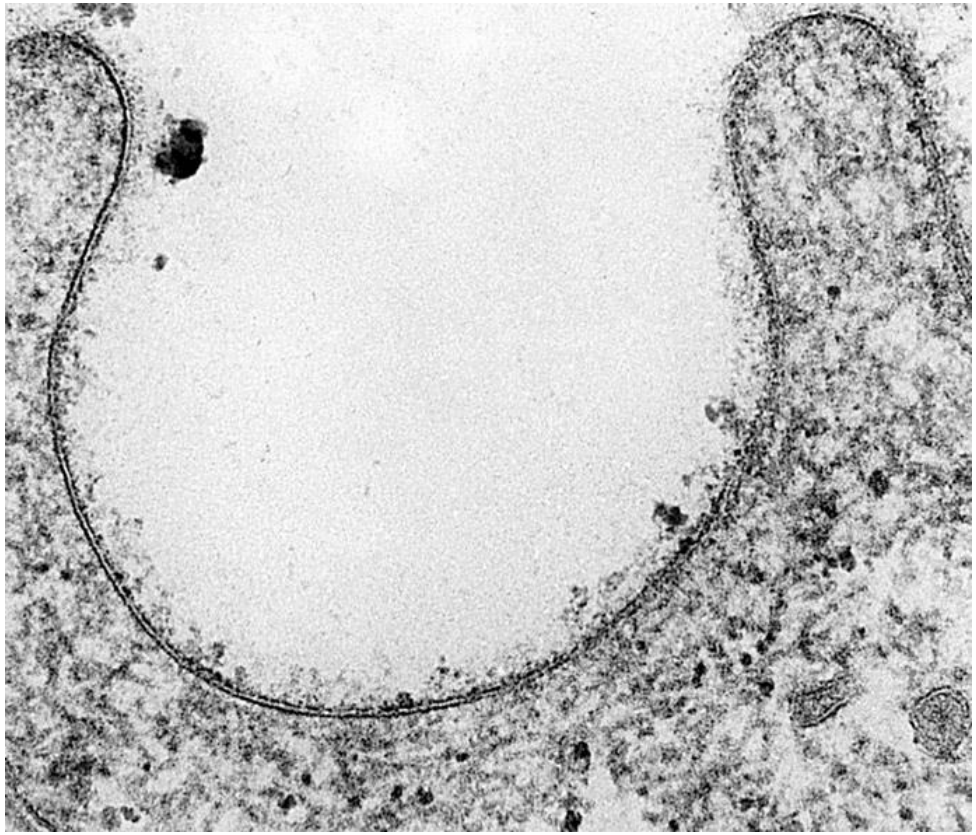
B. Non-membranous:

1. Ribosomes.
2. Centrioles.

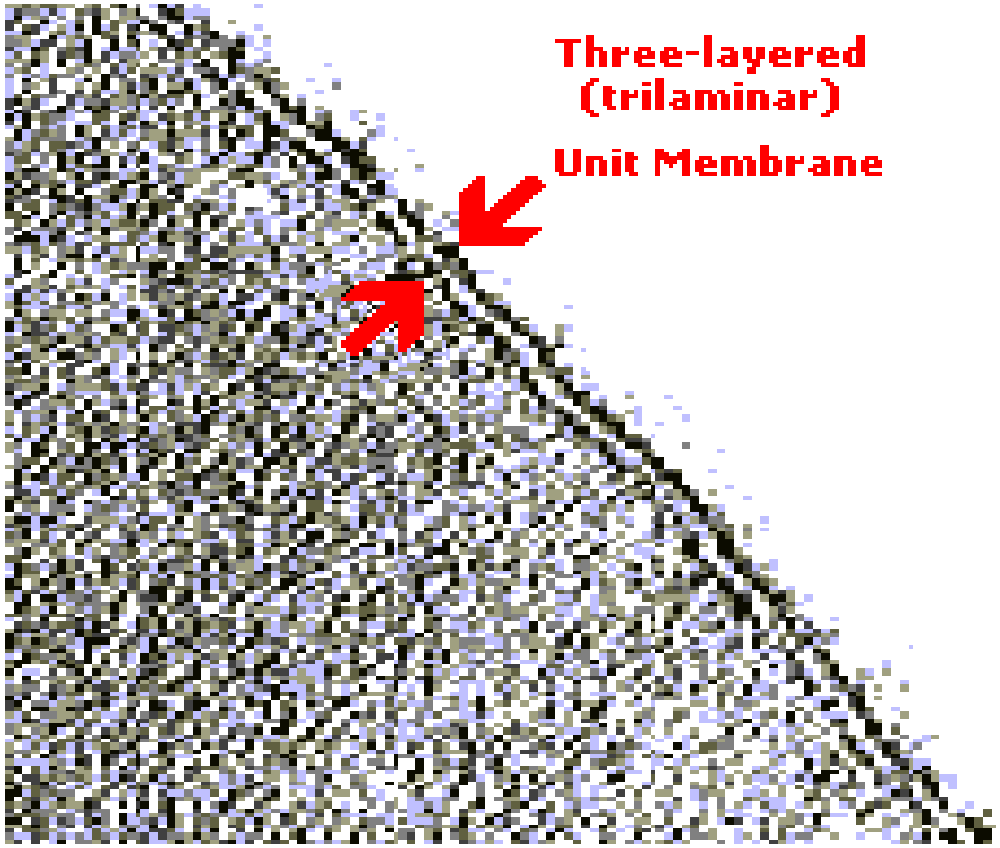


Cell Membrane

- A very thin membrane that surrounds the cell.
- **LM:** Not visible.
- **EM:** appears as 2 dark lines, separated by a light one (trilaminar appearance).
- **Function:** selective barrier.



7.5-10 nm in thickness


Three-layered
(trilaminar)
Unit Membrane

Cell Membrane

Chemical Structure:

1- **Phospholipid molecules**:

arranged in 2 layers.

2- **Protein molecules**:

a) **Peripheral protein**

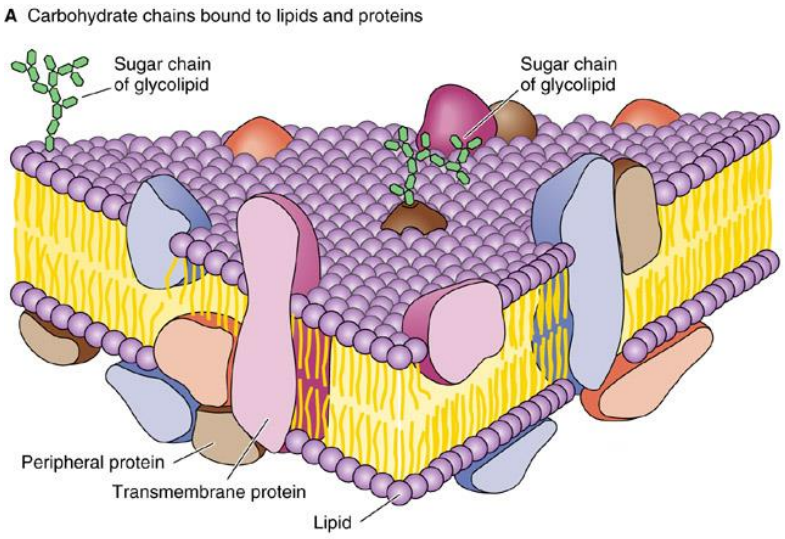
b) **Integral protein**

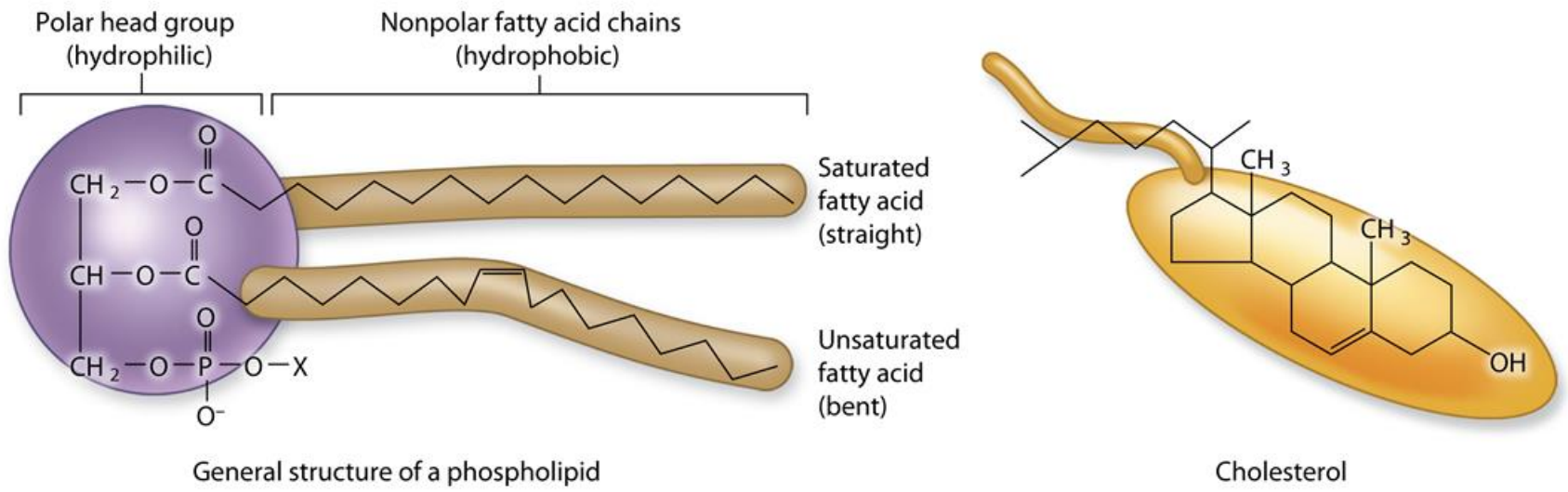
3- **Carbohydrate molecules**:

attached to either proteins or lipids **(glycoproteins** and **glycolipids)**, forming the **surface or cell coat (Glycocalyx)**:

a) Protection of the cell.

b) Cell recognition and adhesion.





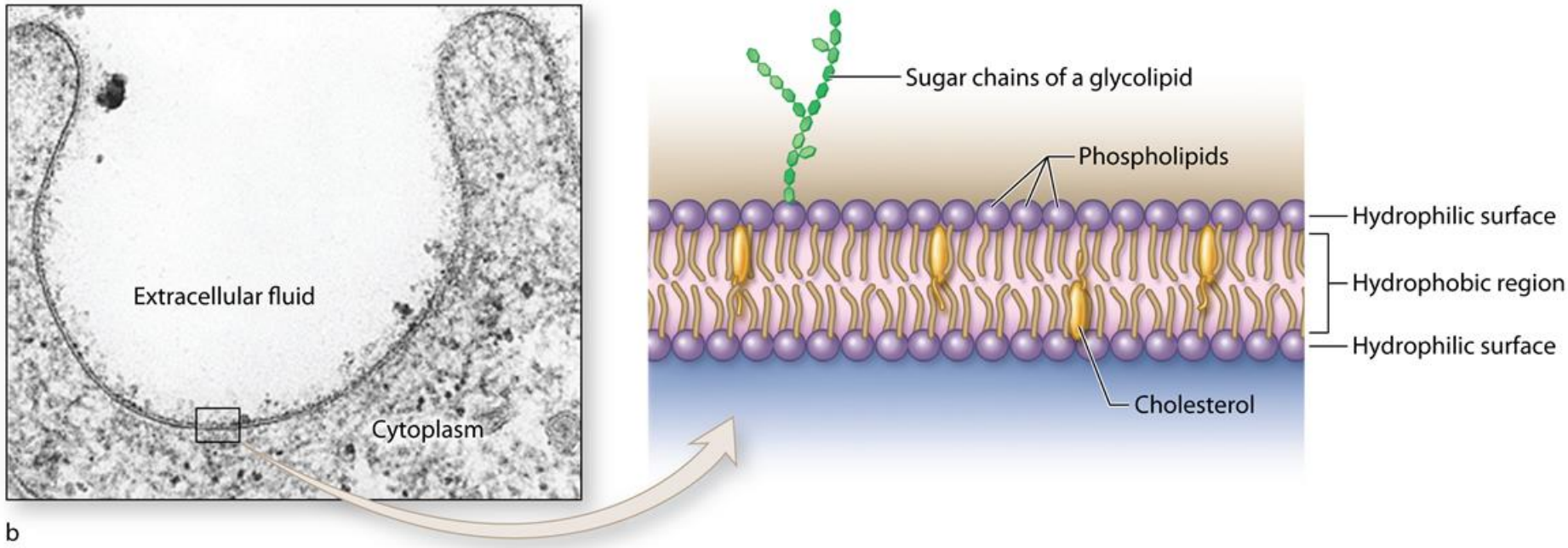
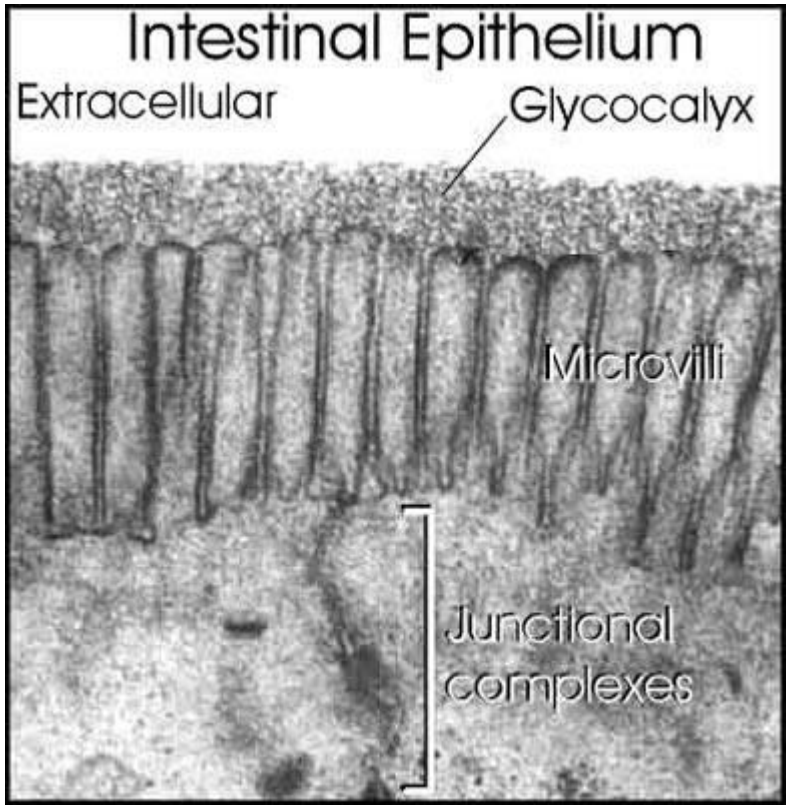


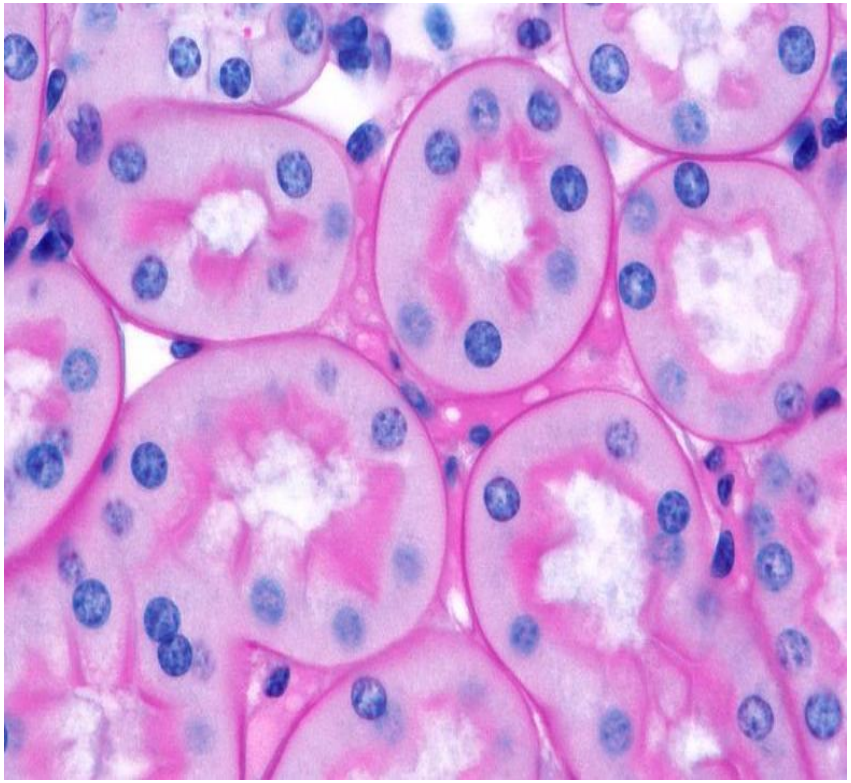
Figure 2-1

Cell Membrane (glycocalyx)

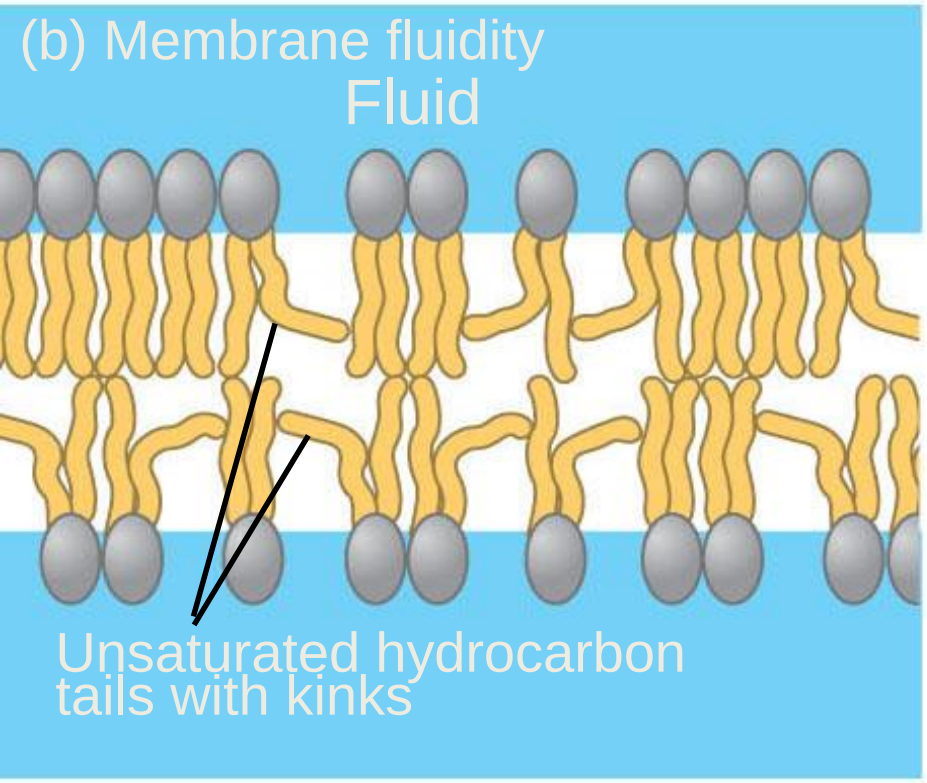
EM

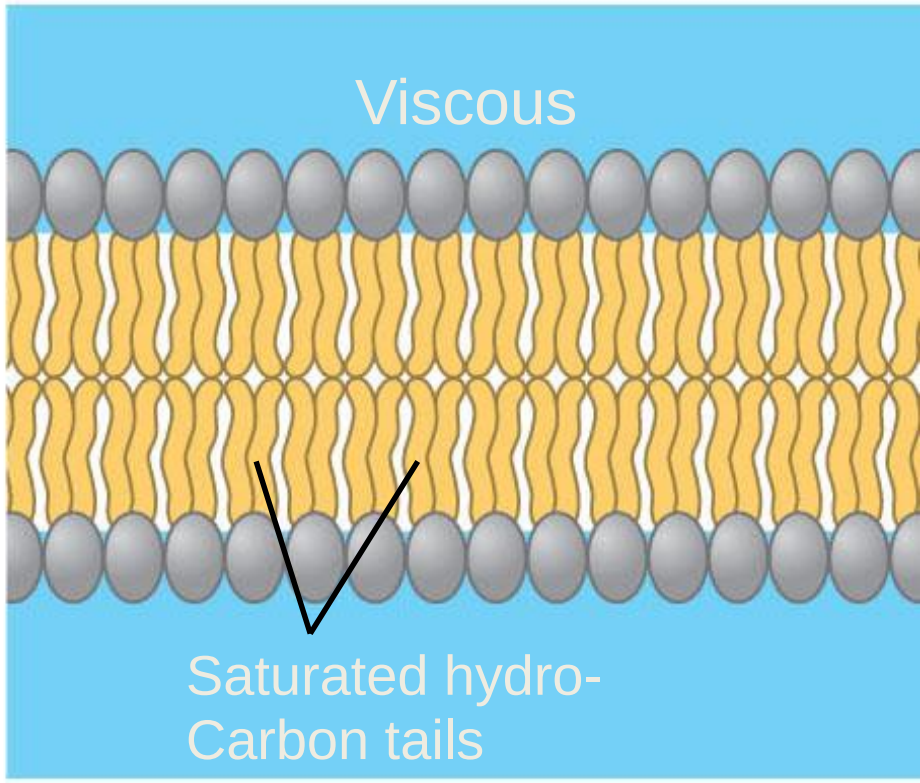


LM (PAS stain)



- The type of hydrocarbon tails in phospholipids
  - Affects the fluidity of the plasma membrane

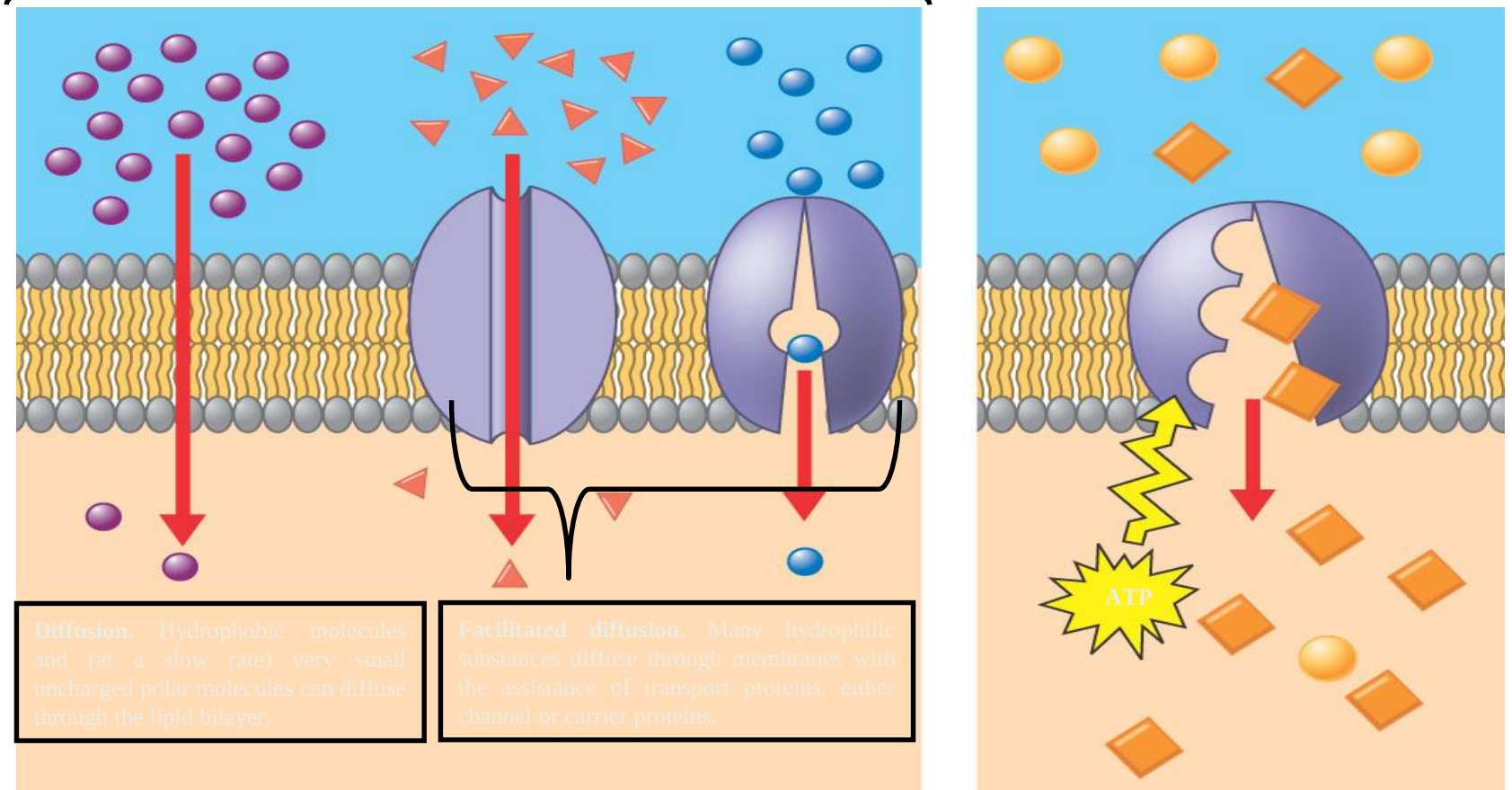


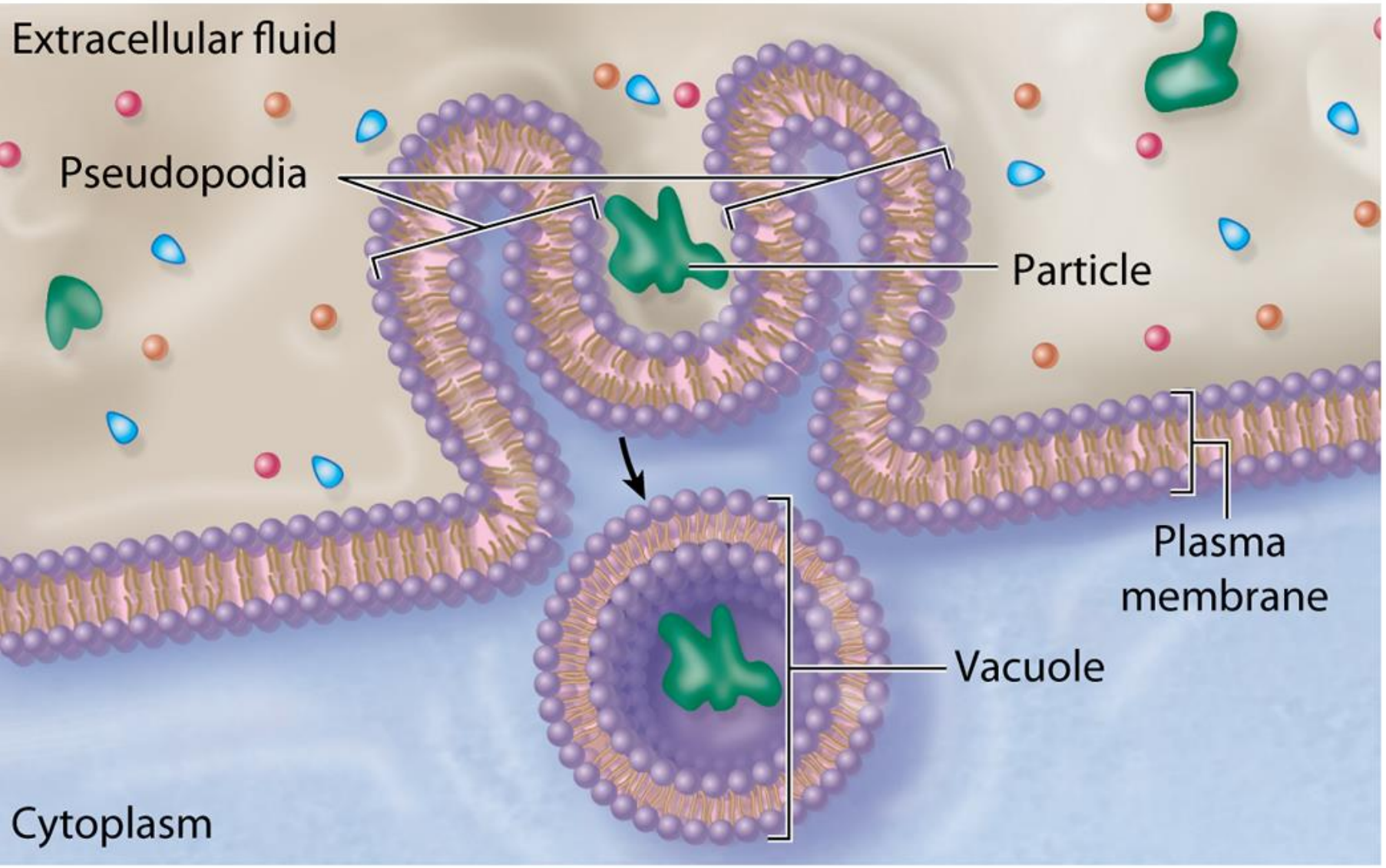


- Review: Passive and active transport compared

Passive transport. Substances diffuse spontaneously down their concentration gradients, crossing a membrane with no use of energy by the cell. The rate of diffusion can be greatly increased by transport proteins in the membrane.

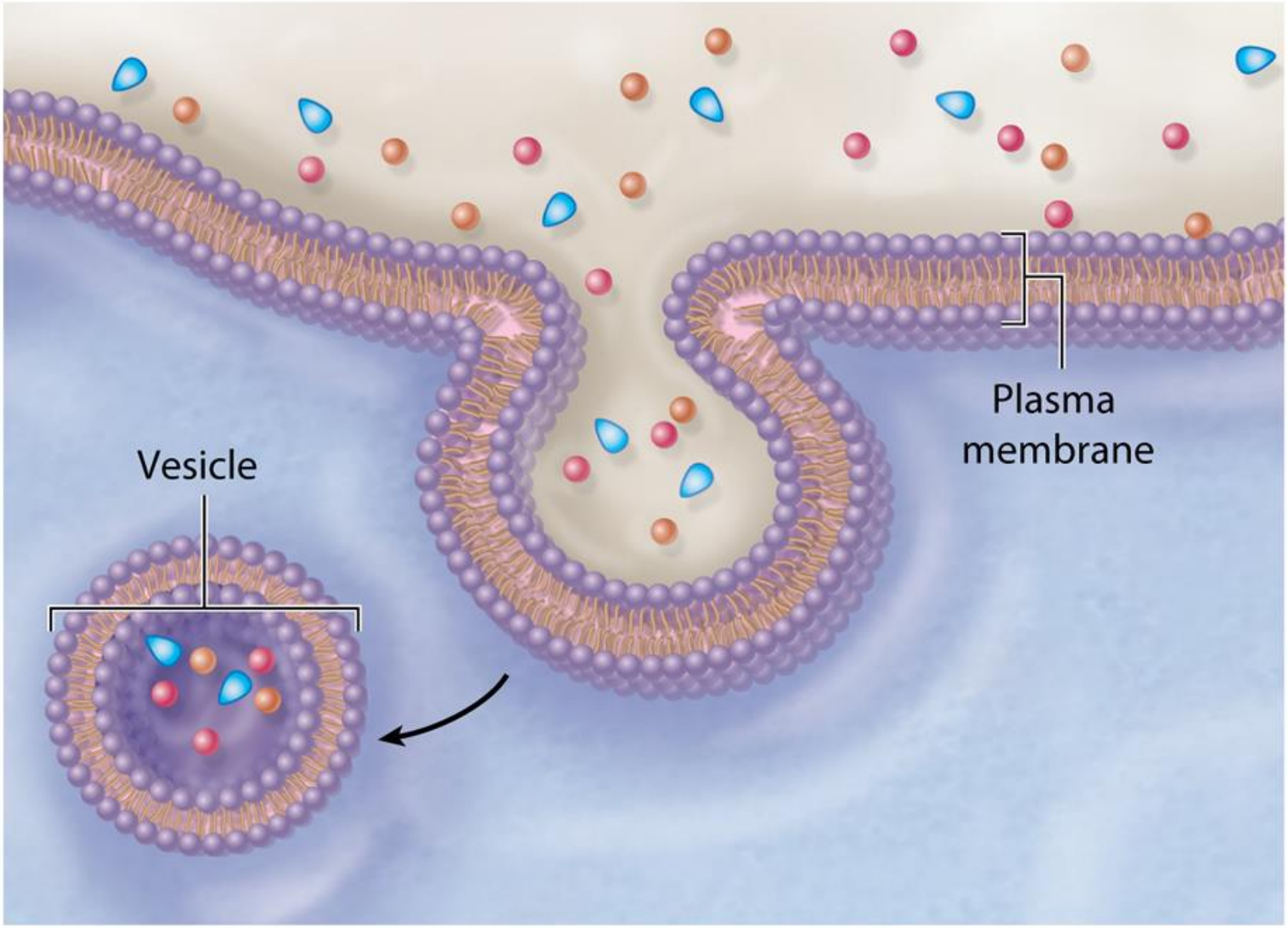
Active transport. Some transport proteins act as pumps, moving substances across a membrane against their concentration gradients. Energy for this work is usually supplied by ATP.





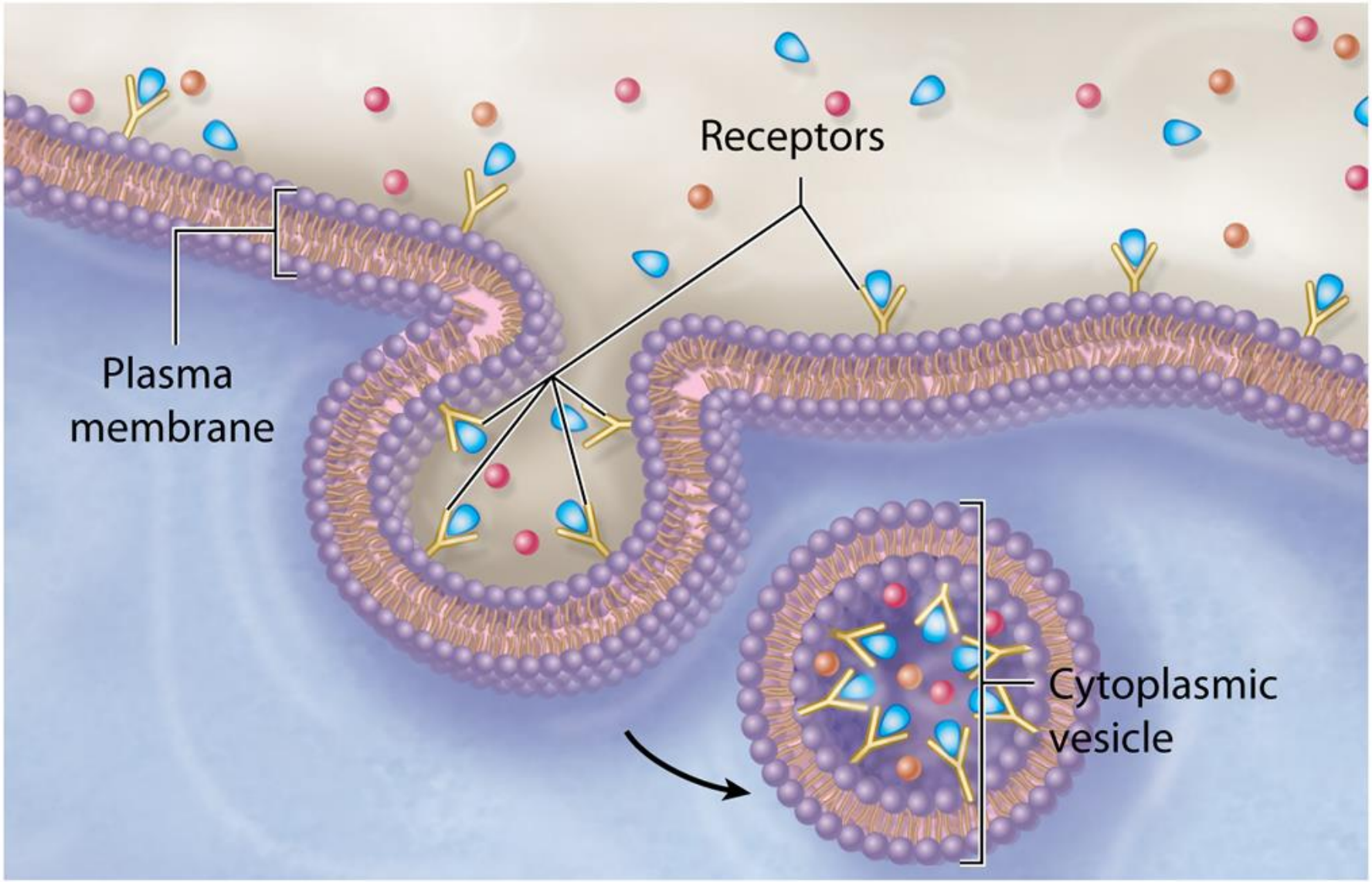
a Phagocytosis

Figure 2-6



b Pinocytosis

Figure 2-6

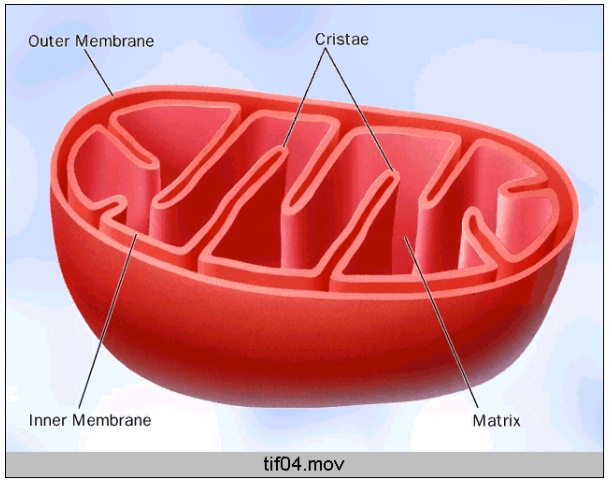


c Receptor-mediated endocytosis

Figure 2-6

Mitochondria

- Each mitochondrion is rod-shaped .
- The wall is composed of 2 membranes.
- The outer is smooth, the inner is folded to form **cristae**.
- The cavity is filled with mitochondrial matrix, which contains enzymes. Also contains its own **DNA**.



Functions:

1- **Generation of ATP** which is the source of energy for the cell. They are called **the power-house** of the cell.

2- They can form their **own proteins** and undergo **self replication**.

Mitos: thread
Chondros: granule

Mitochondria

- LM

Can not be seen under LM (except by special stains to its enzymes)

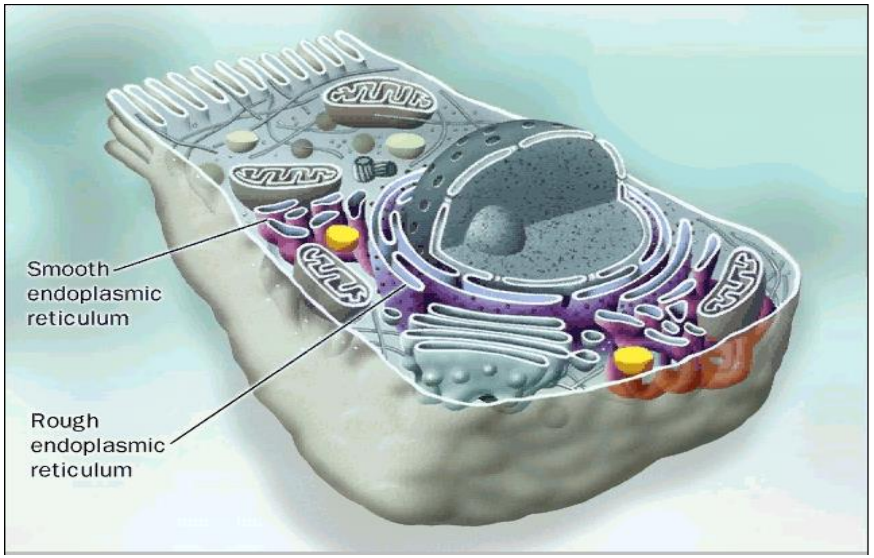
If the cells have a high number of mitochondria, it appears as acidiophilia of the cytoplasm

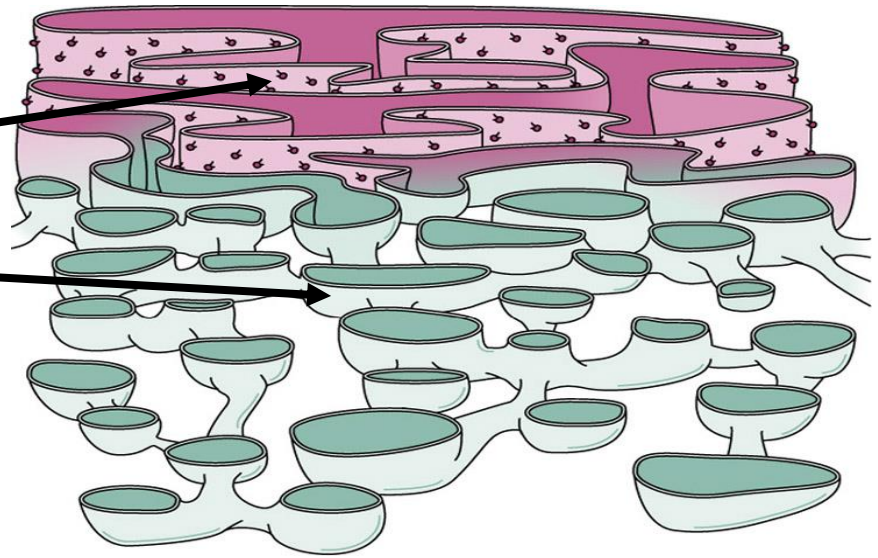
- EM

It has two membranes, outer smooth and inner folded into cristae

Endoplasmic Reticulum (ER)

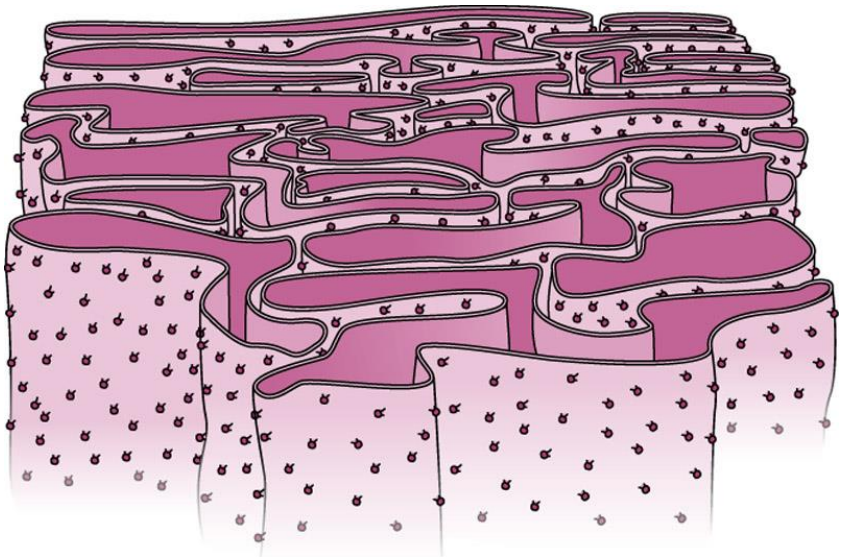
- It is a system of communicating membranous tubules, vesicles, and flattened vesicles (cisternae).
- There are 2 types:
  - Rough (rER).
  - Smooth (sER).





Rough Endoplasmic Reticulum

- Membranous sheets of flattened tubules & vesicles with ribosomes on the surface.
- **Functions:**
  1. **Synthesis of proteins** by ribosomes on its outer surface.
  2. **Transfer vesicles** transfer the formed protein to Golgi.



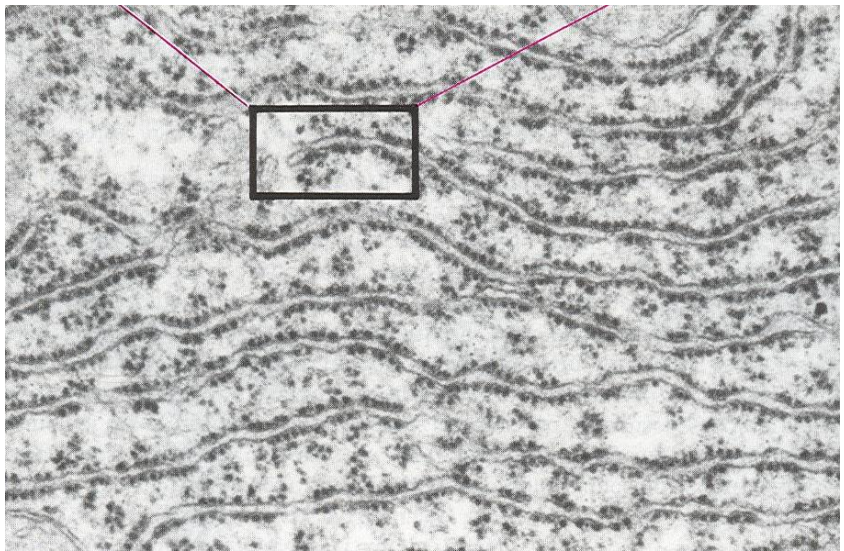
Rough Endoplasmic Reticulum

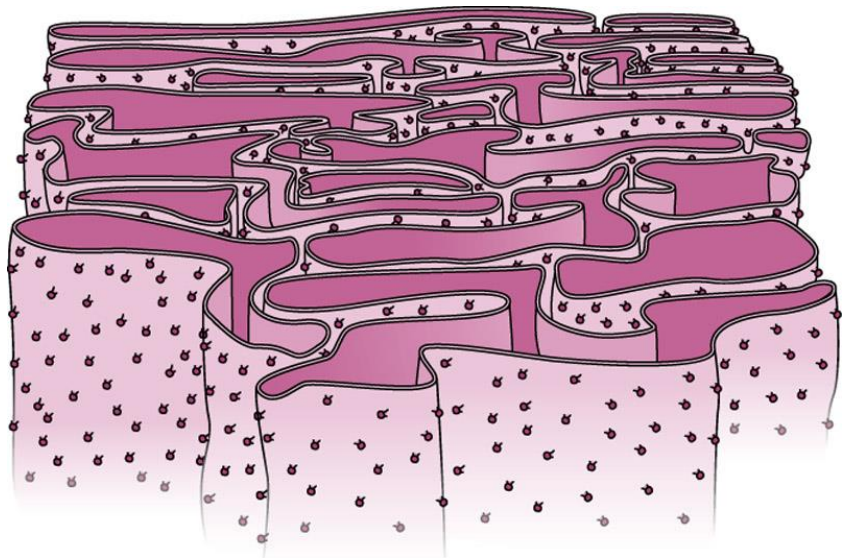
- LM

Intense basophilia

- EM

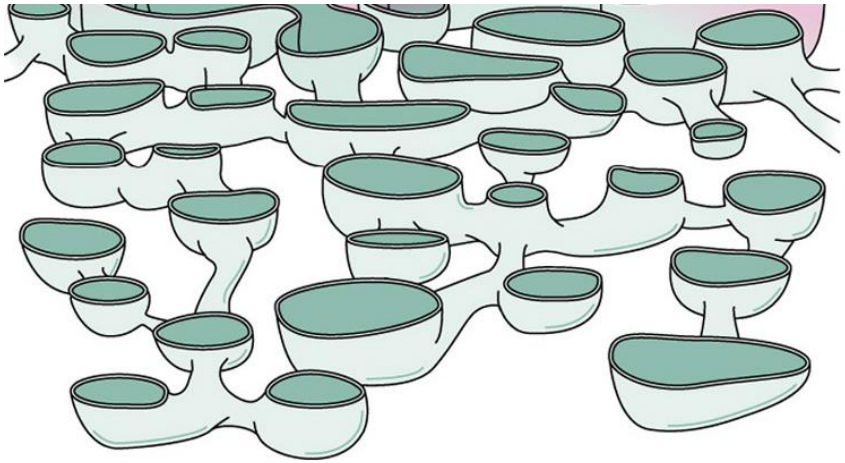
Appears as interconnected flat cisternae and tubules associated with ribosomes

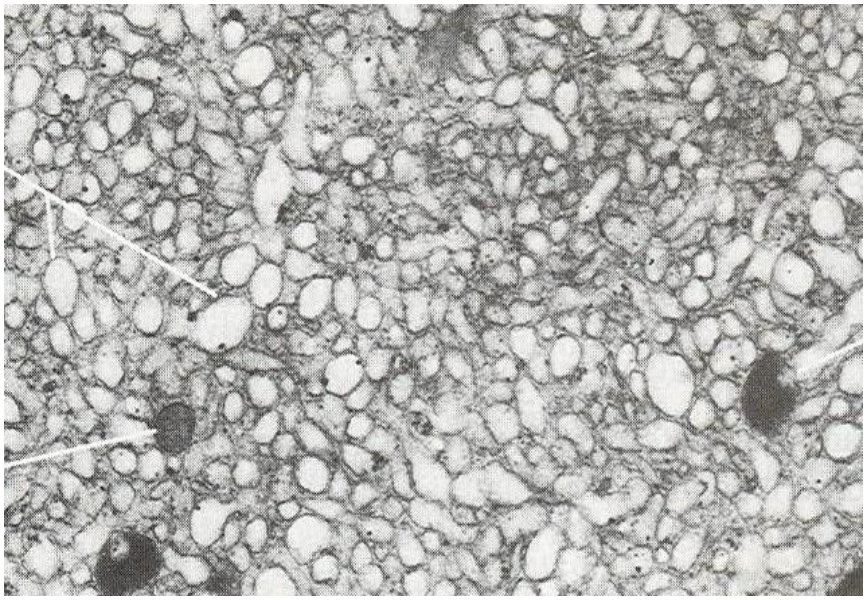




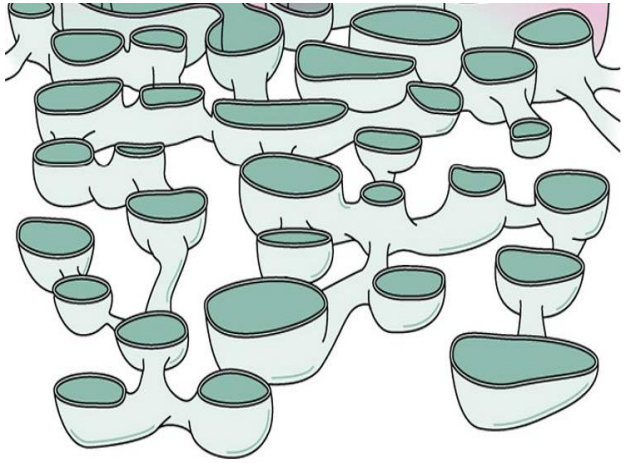
Smooth Endoplasmic Reticulum

- Membranous tubules and vesicles, with no ribosomes on the surface.
- **Functions:**
  1. Synthesis of **lipids** & **cholesterol**.
  2. Metablism of lipids and glycogyn
  3. Synthesis of **steroid** hormones, e.g. cortisone.
  4. Helps **muscle contraction**, by acting as a calcium pump.
  5. **Detoxification** of drugs & toxins.





Smooth Endoplasmic Reticulum



- LM

can not be seen under LM

- EM

✓ Appears as interconnected tubules with various shapes and sizes and not stack of flattened cisternae

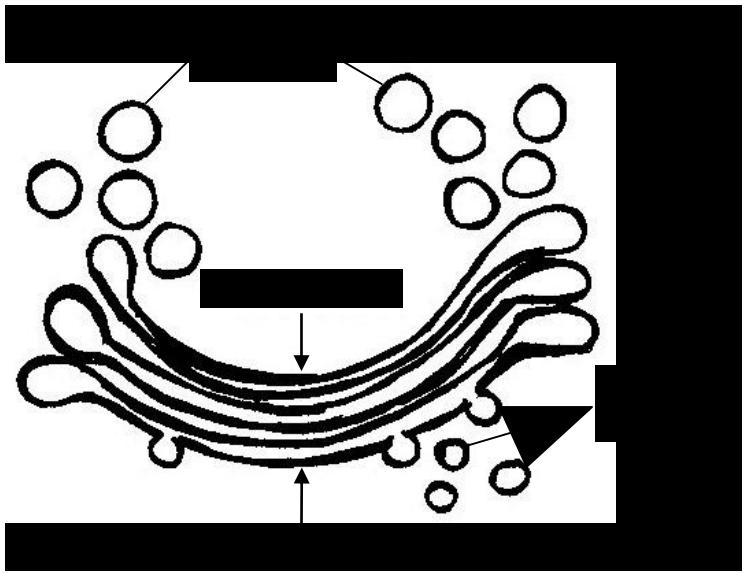
✓ not associated with ribosomes

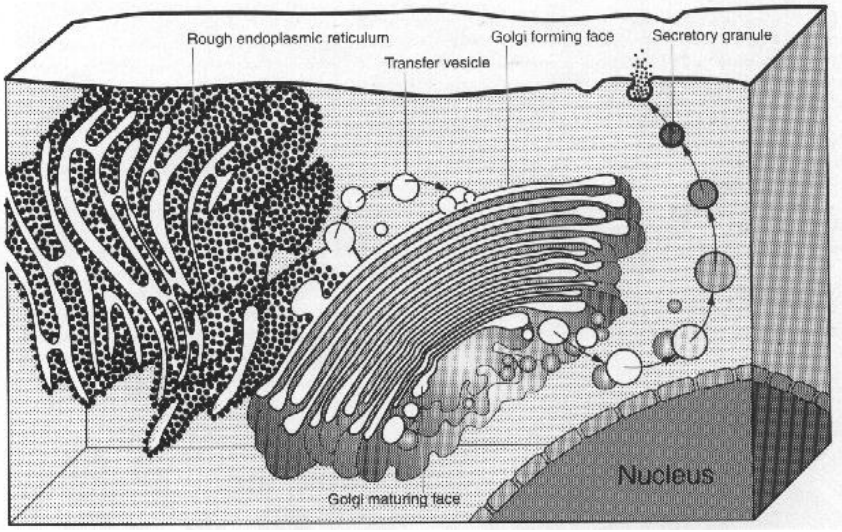
Golgi Apparatus

- **The secretory apparatus** of the cell.
- Consists of stacked saucer-shaped flattened vesicles.
- Each vesicle has two faces:
  Convex (forming) face, receives **transfer vesicles**.
  Concave (mature) face, forms **secretory vesicles**.

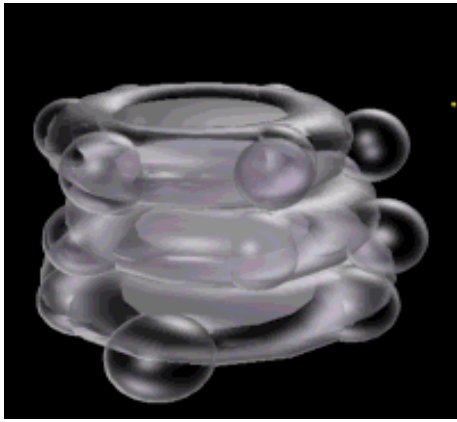
Functions:

1. **Sorting, modification & packaging** of proteins.
2. **Secretory vesicles** formation.
3. **Formation of lysosomes**.





Golgi Apparatus

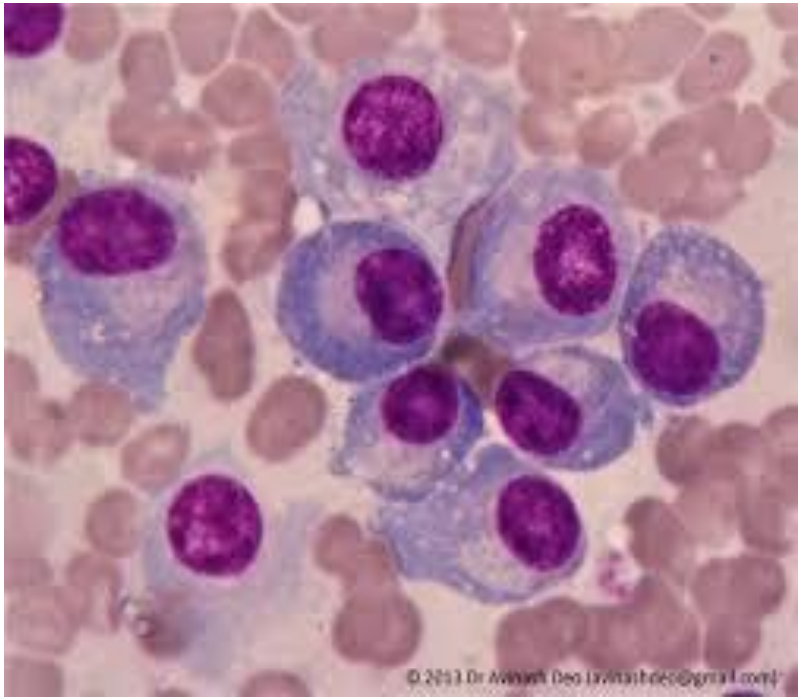


- LM

➢ It is not seen in HE stained sections

In high active cells, it appears as empty space called negative Golgi image

➢ can be demonstrated by silver impregnation



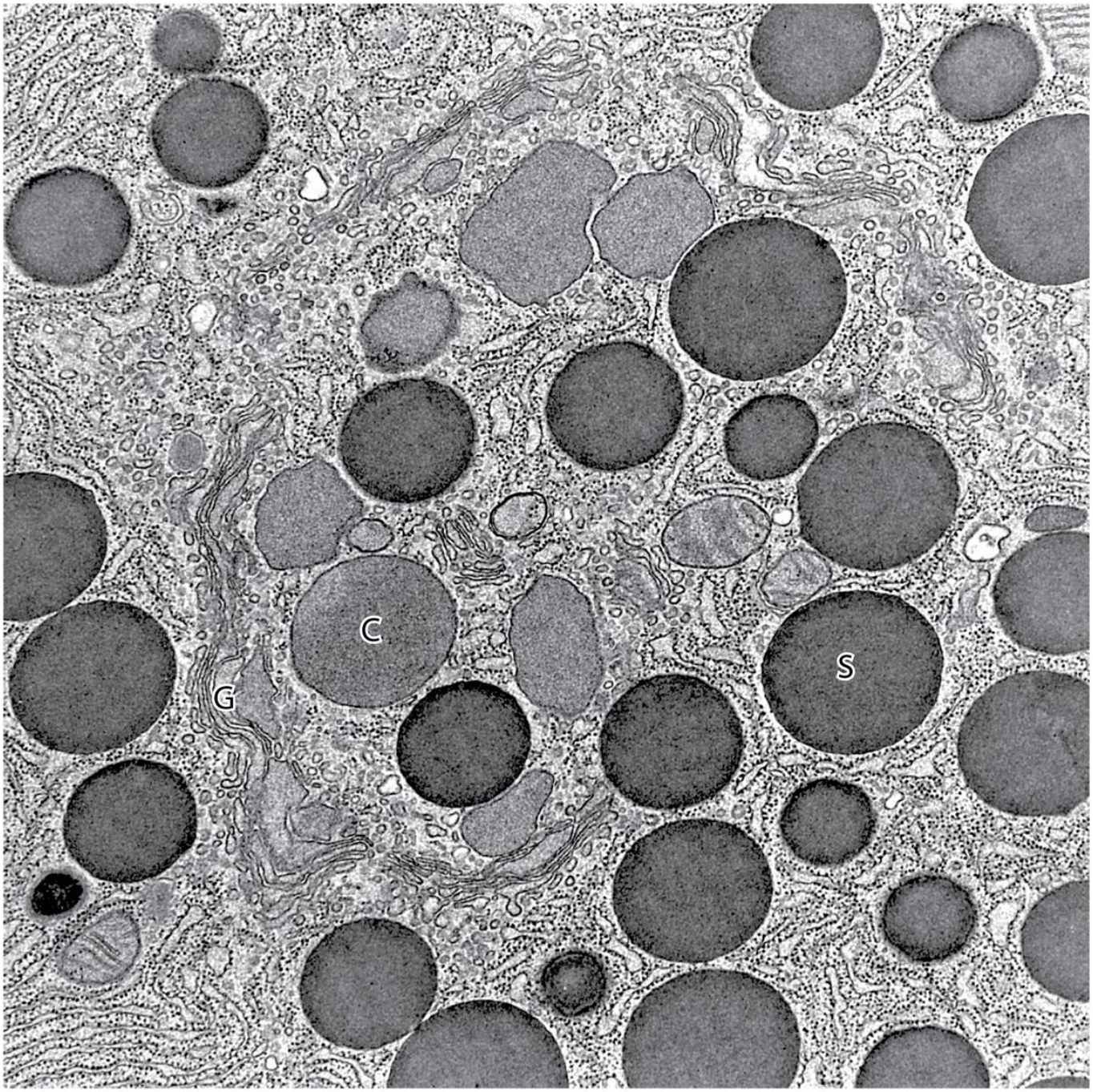
Secretory granules

- Originate as condensing vesicles in the Golgi apparatus
- Found in cells that store a product until its release by exocytosis
- They contain a concentrated form of the secretory product

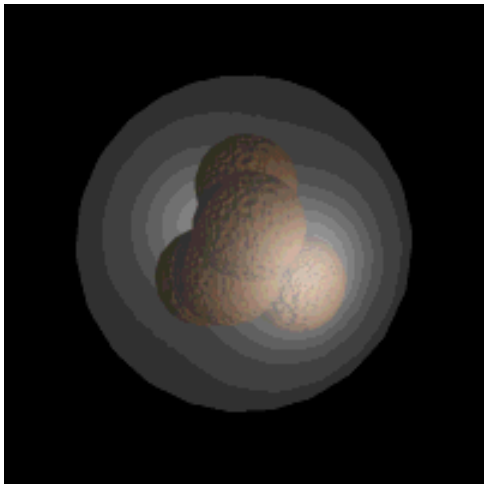
Secretory granules

- LM: intense eosinophilia concentrated in apical region prior to exocytosis

- EM: several electron dense secretory granules in association with condensing vacuoles


C
S
G

Lysosomes



- **The digestive apparatus** of the cell.
- Contain hydrolytic enzymes.
- Originate from mature surface of the Golgi apparatus, while their hydrolytic enzymes are formed in the rough endoplasmic reticulum.
- **Function:** intracellular digestion of ingested material or old organelles.

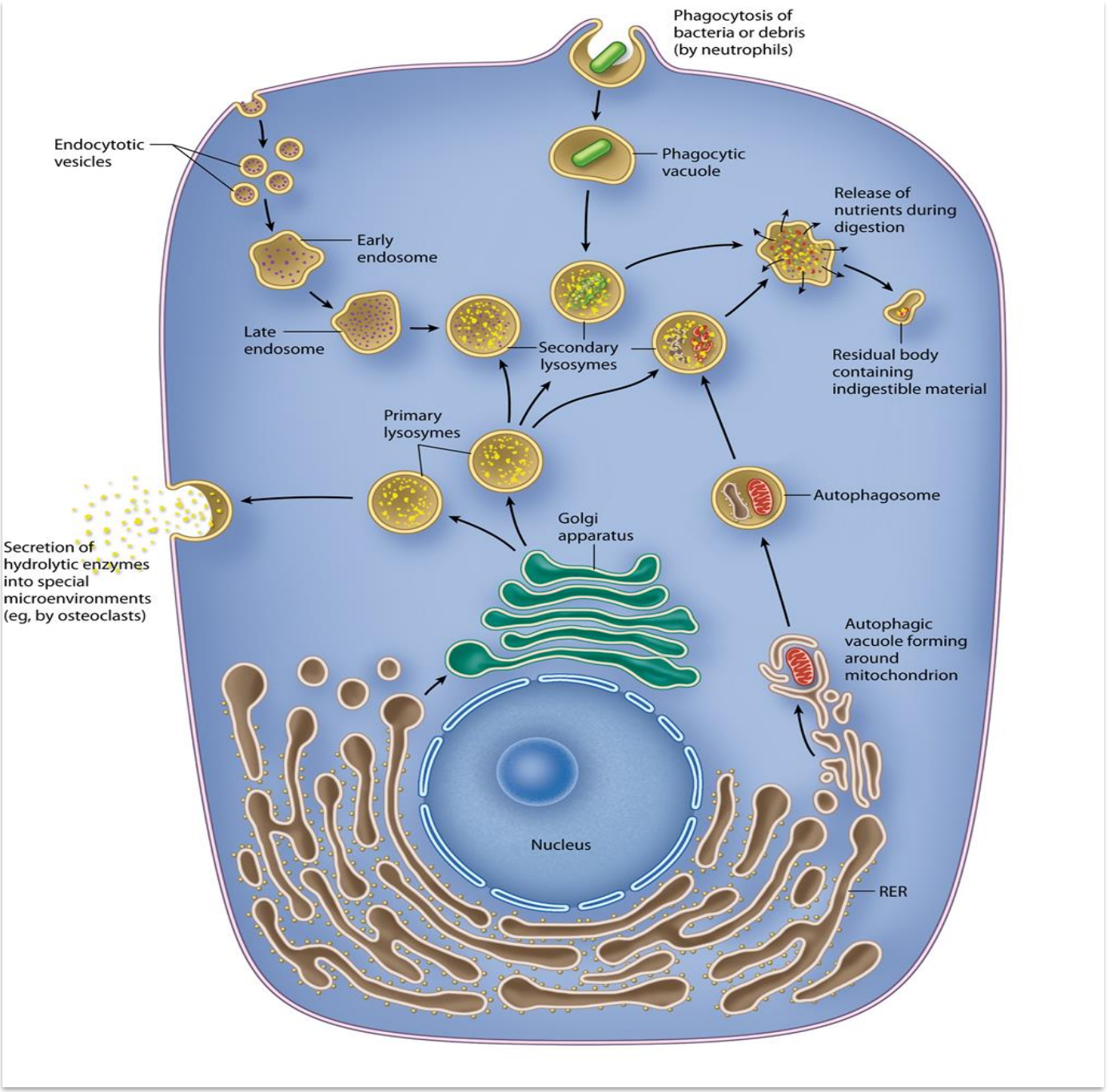


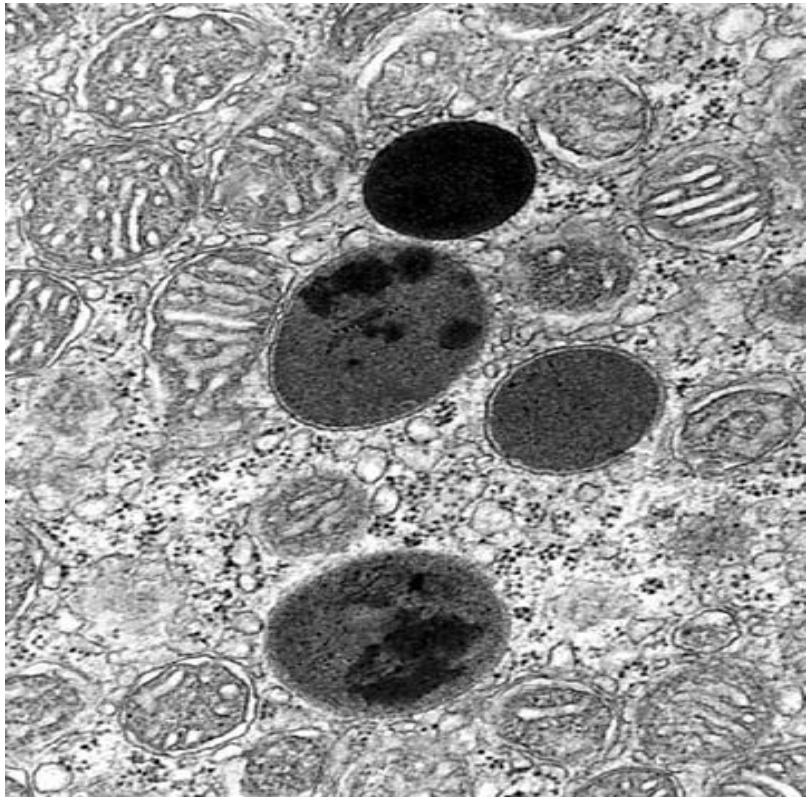
Figure 2-17

Lysosomes

- LM : not seen
- EM :

➢ *Primary*: Uniformly granular electron dense appearance

➢ *Secondary*: Larger with heterogenous appearance (particulate content)



Ribosomes

- 20-30 nm
- Consists of

1- large subunit

2- small subunit

- Composed of:

✓ rRNA (4 types)

✓Proteins (80 associated different types)

Ribosomes

- 2 forms :

1- free ribosomes scattered in cytoplasm

(synthesize proteins designed for use within the cell like hemoglobin in erythrocytes)

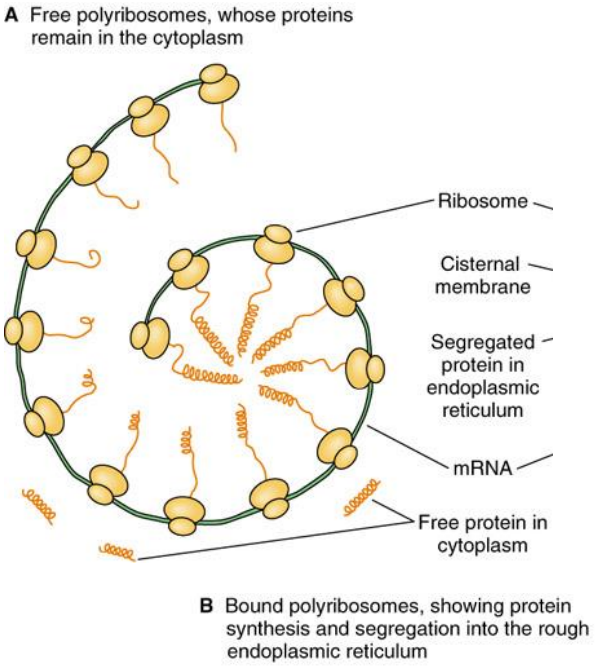
2- attached ribosomes to ER

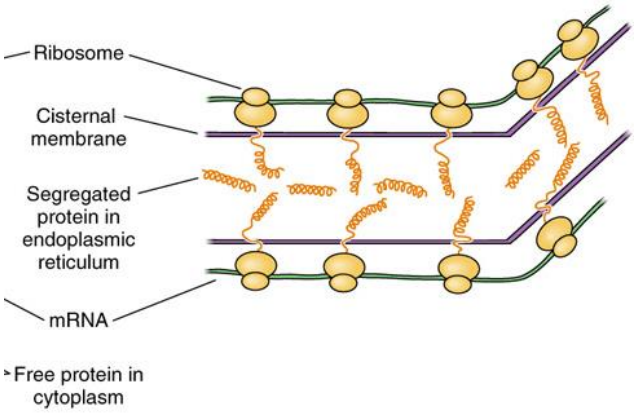
(synthesize proteins secreted by the cells as pancreatic and salivary enzymes or stored in the cells as lysosomal enzymes like macrophages and neutrophils)

Ribosomes

- **LM:** Basophilic cytoplasm is due to numerous ribosomes.

- **EM:** Formed of 2 subunits.
- Free in the cytoplasm (may form polyribosomes) or attached to rER.
- Formed in the nucleolus.
- **Function:**
  Protein synthesis





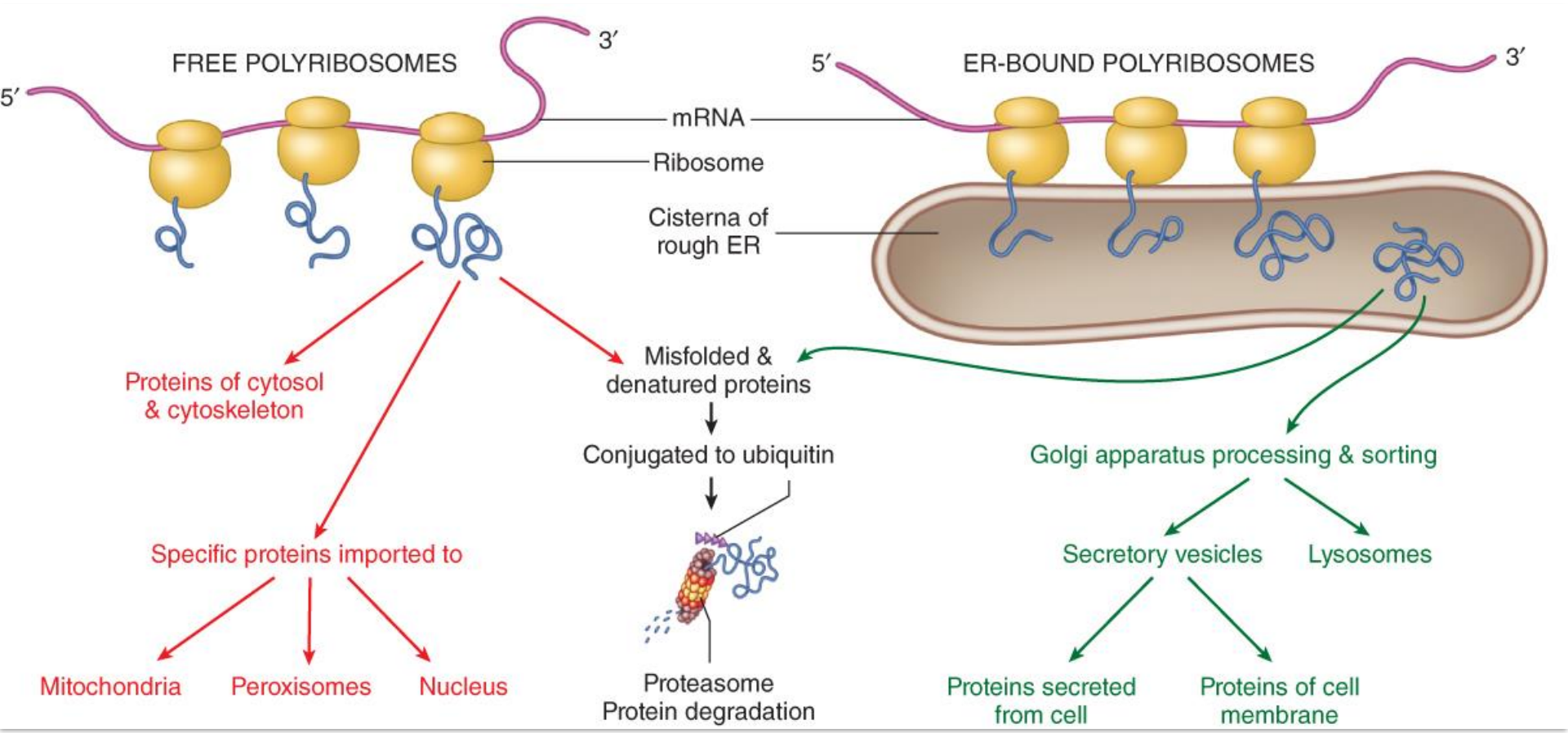
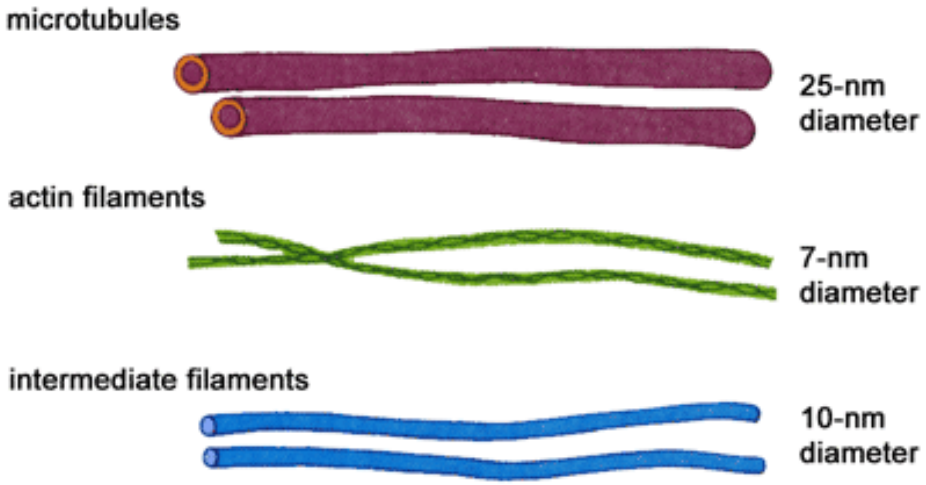
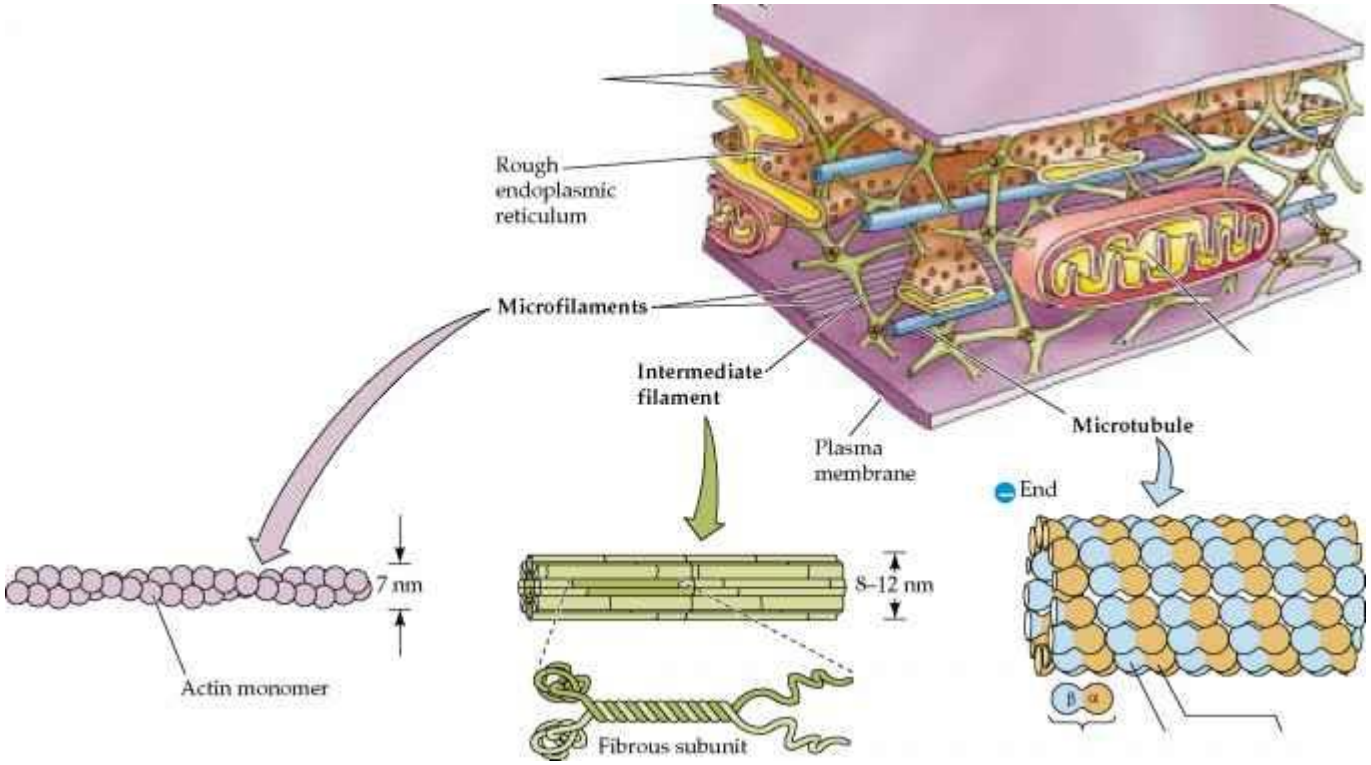


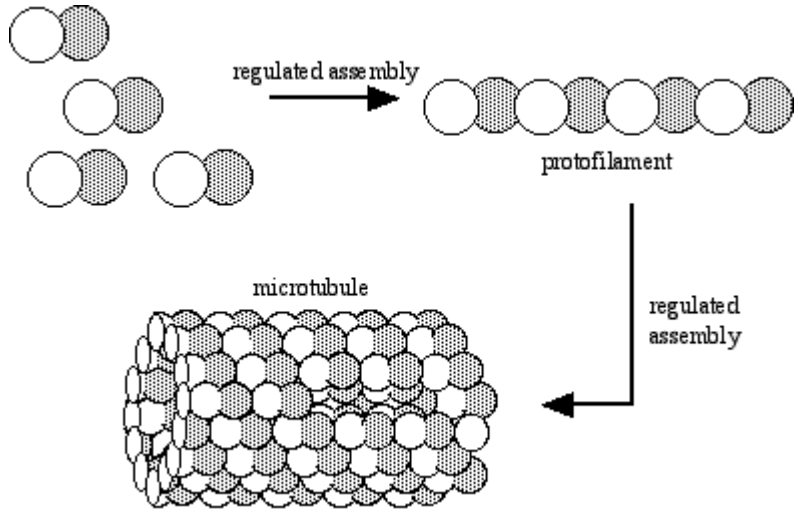
Figure 2-9

Cytoskeleton

- Acts as **skeleton**
- Provides shape and structure
- Movement
- Helps move organelles within the cell/ transport
- Made of three types of filaments




Rough endoplasmic reticulum
Microfilaments
Intermediate filament
Microtubule
Plasma membrane
End
7 nm
Actin monomer
8–12 nm
Fibrous subunit



A **microtubule** is a hollow cylinder, about 24 nm in diameter.

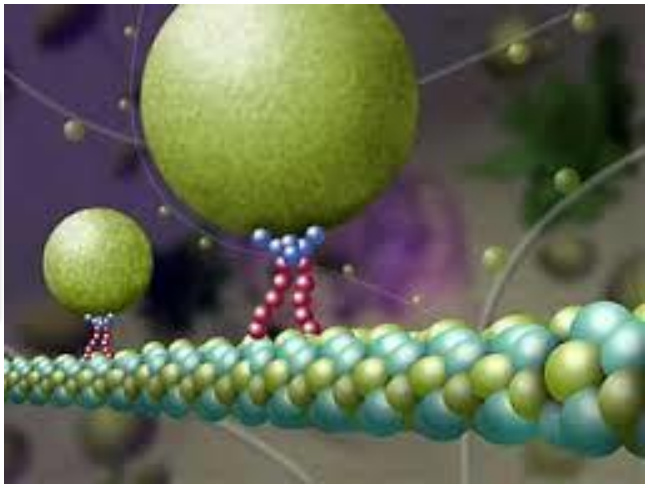
Along the microtubule axis, tubulin heterodimers join end-to-end to form **protofilaments**, with alternating α & β subunits.

Staggered assembly of **13** protofilaments yields a **helical** arrangement of tubulin heterodimers in the cylinder wall.

An **α, β-tubulin heterodimer** is the basic structural unit of microtubules

Cells use microtubules to provide structural support

move vesicles and other complexes along the microtubule surface



Centrioles:

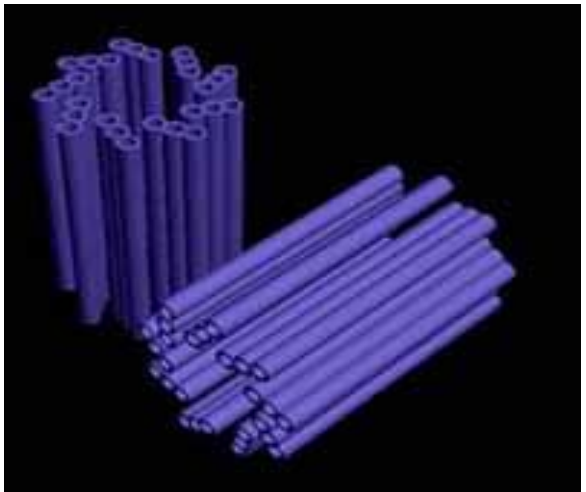
•generally appear in animal cells

•they look like two cylinders at right angles to one another

•when viewed with an electron microscope, the cylinders show up as nine bundles of tiny microtubules arranged in a circle

•they help to form the fibers that move chromosomes around when the cell is dividing

•as animal cells prepare for cell division these two centrioles separate and go to opposite ends of the cell.



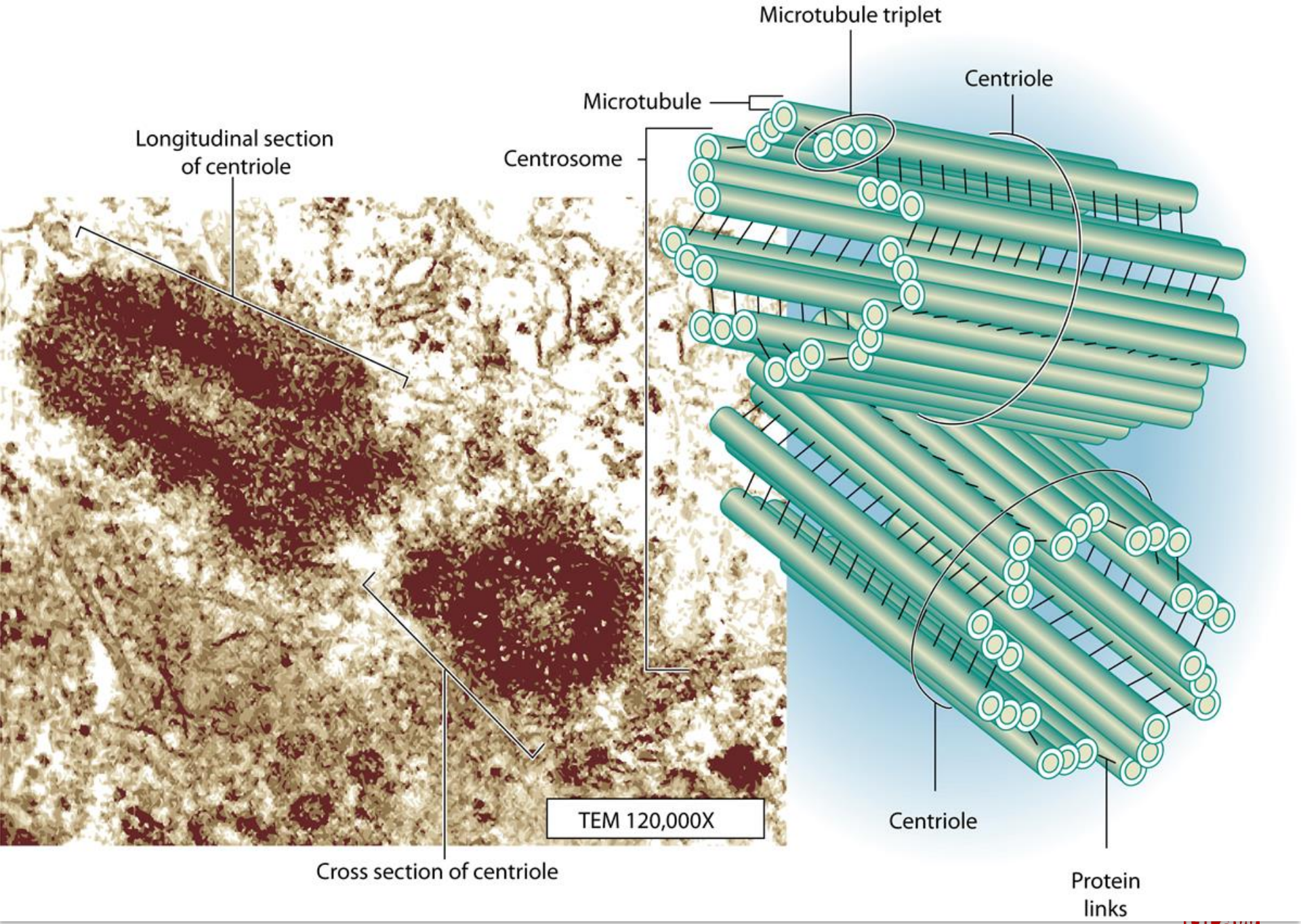


Figure 2-24

Cell inclusions

- Temporary non living components of the cytoplasm

- Types:

1- stored metabolic products

- Carbohydrates (glycogen particles)
- Lipids (lipid droplets)

2- pigments (melanin, lipofuscin and hemosiderin)

LIPID DROPLETS GLYCOGEN GRANULES **hemosiderin granules**

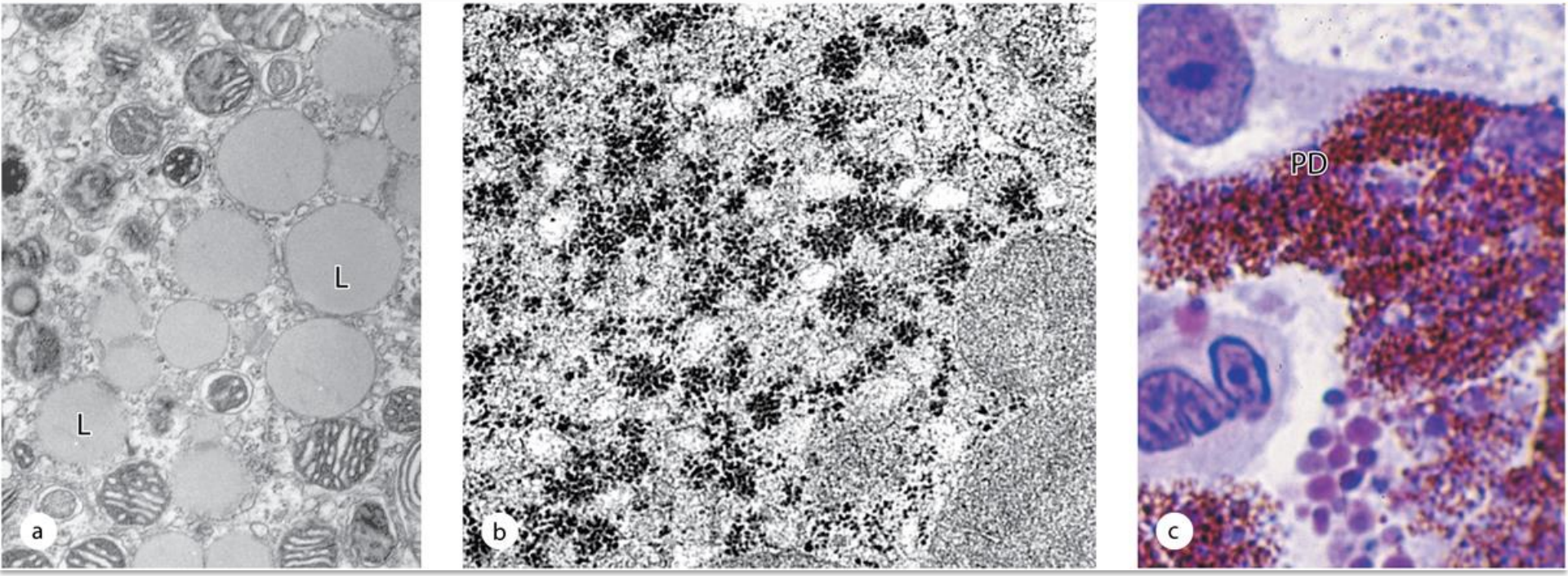


Figure 2-28