Cell Overview

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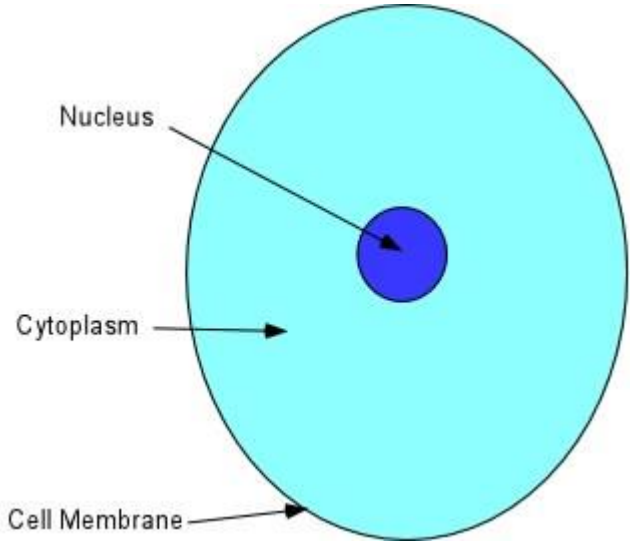
THE CELL

THE CELL is made of:

1- Nucleus

2- Cell Membrane

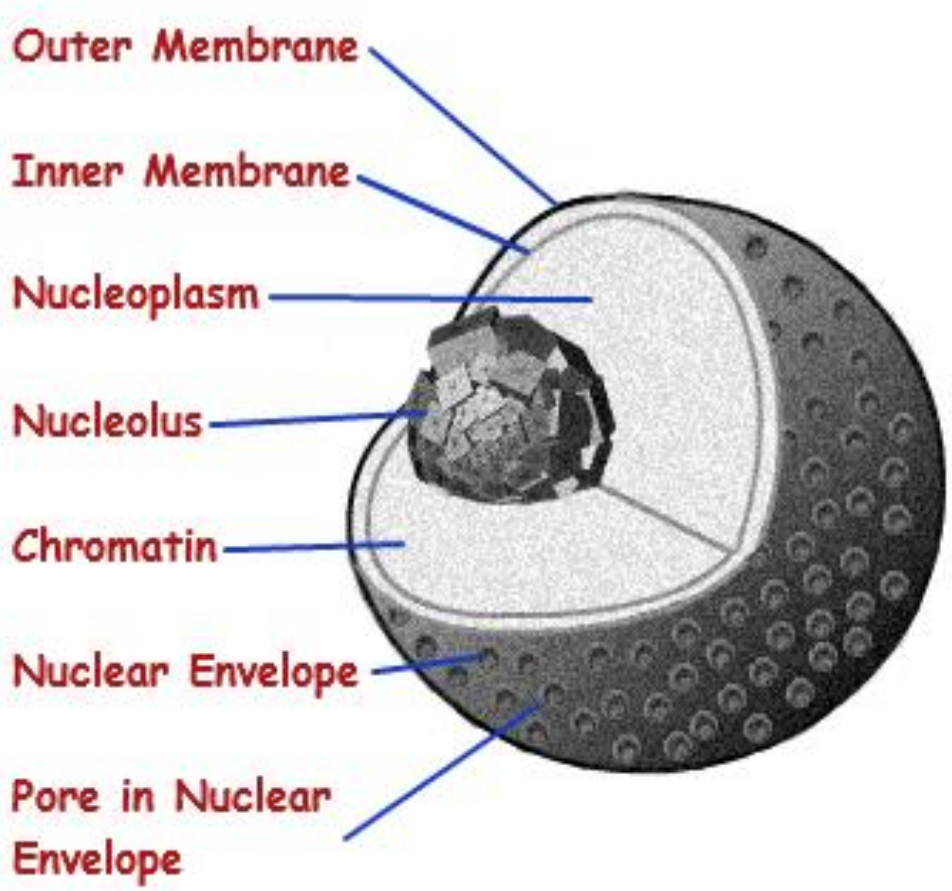
3- Cytoplasm



NUCLEUS

Formed of:

1. **Nuclear envelope**
2. **Chromatin**
3. **Nucleolus**
4. **Nucleoplasm (nuclear matrix)**

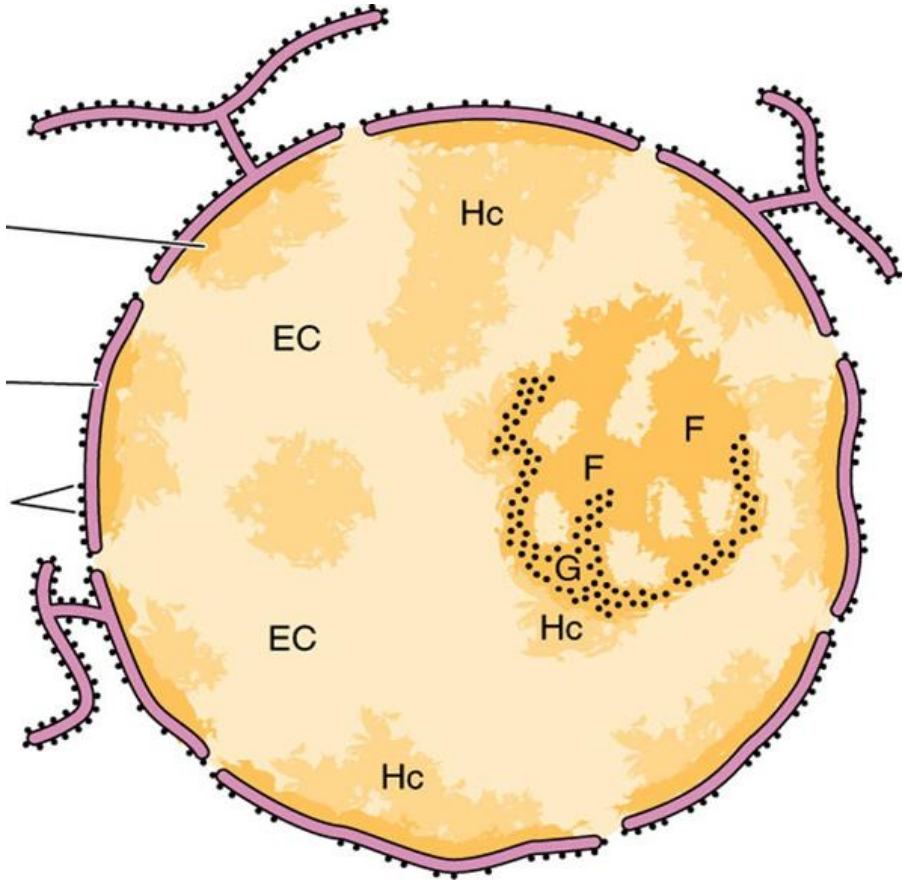


Functions of the Nucleus

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.

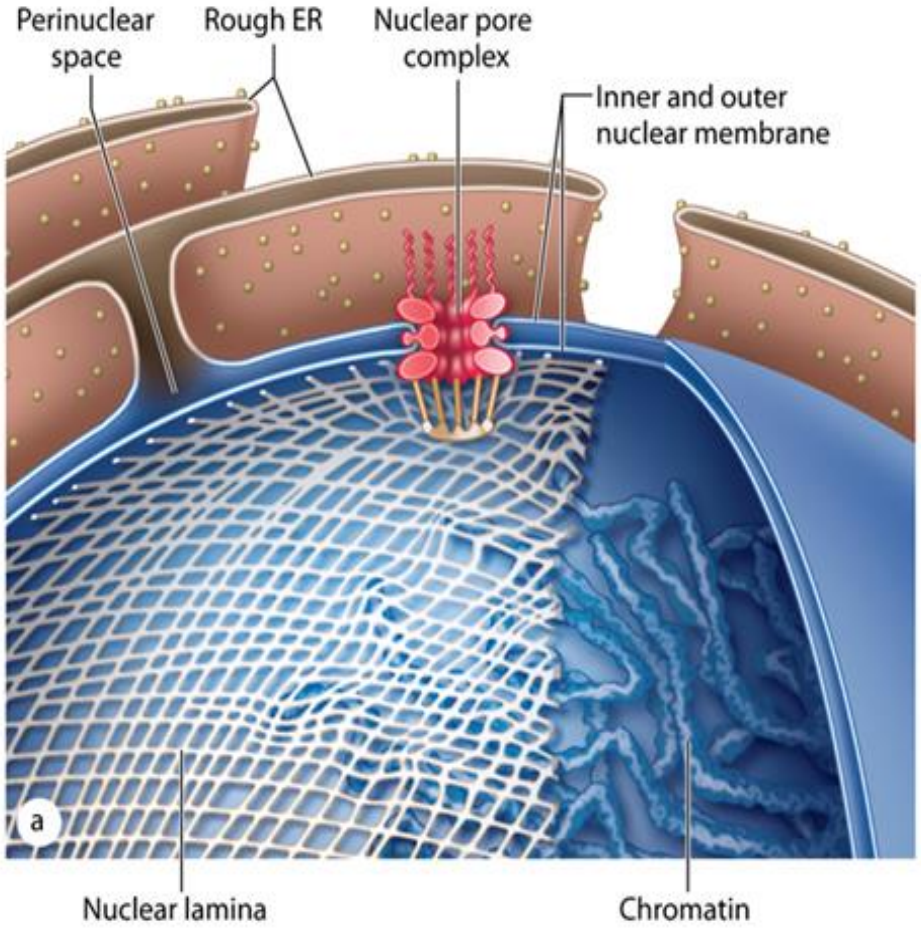
Nuclear Envelope

a) Outer membrane.
b) Inner membrane.
c) Perinuclear space
d) Nuclear pores: provide controlled communication between nucleus and cytoplasm.



Nuclear (fibrous) lamina is a meshwork of intermediate filaments proteins, called lamins, providing mechanical support to stabilize the nuclear envelope

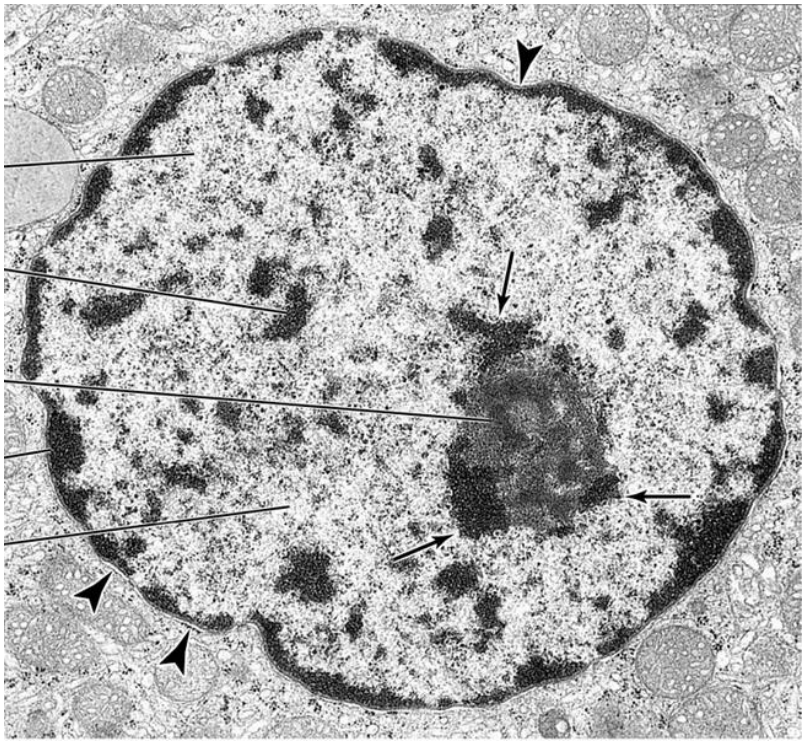
Nucleoporins are protein complexes associated with the nuclear envelope. They make up the nuclear pore complex where inner and outer nuclear membranes fuse.



Chromatin

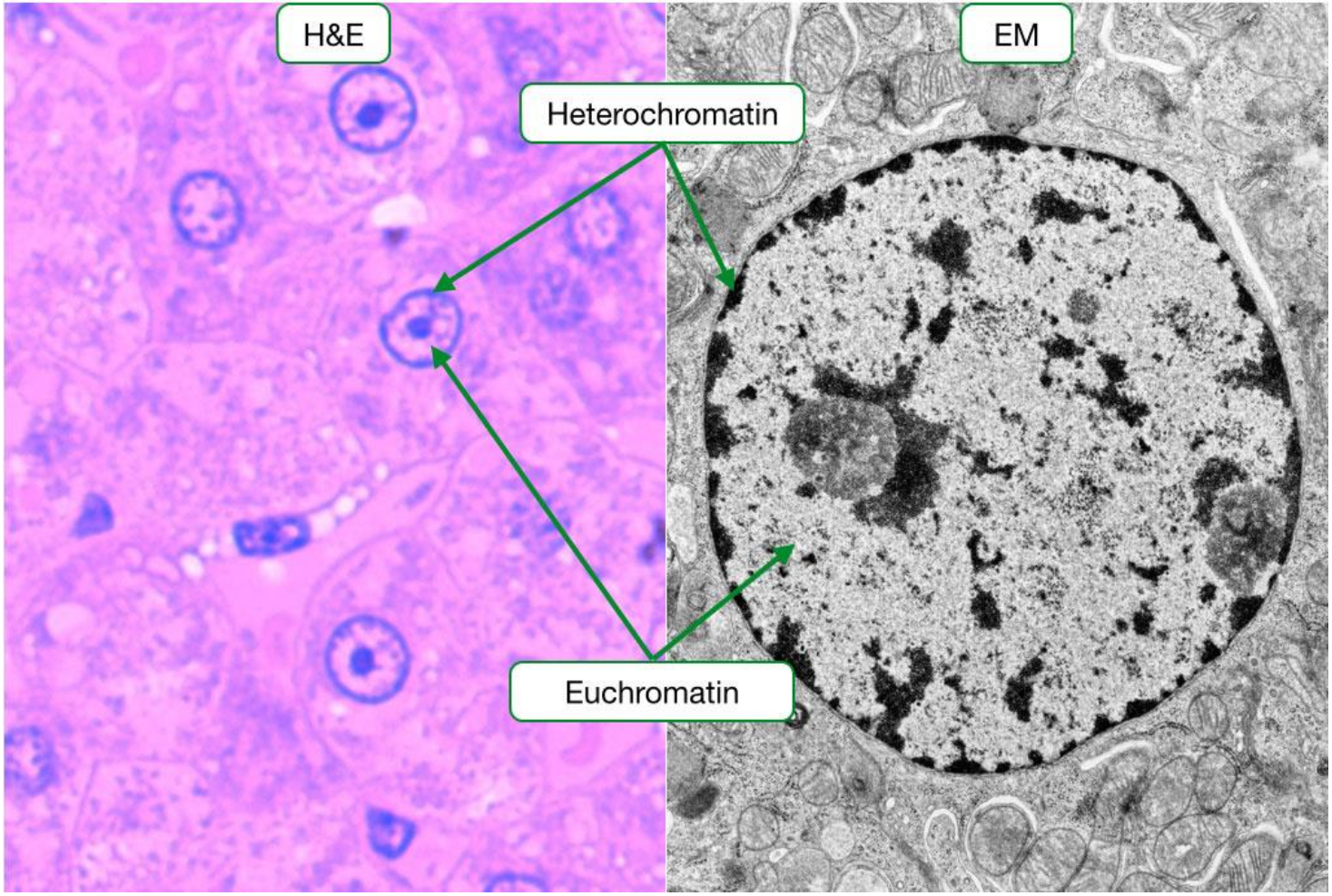
Formed of **DNA**.

- **2 Forms:**
  - **Euchromatin**: extended active chromatin (pale).
  - **Heterochromatin:** condensed inactive chromatin (dark)

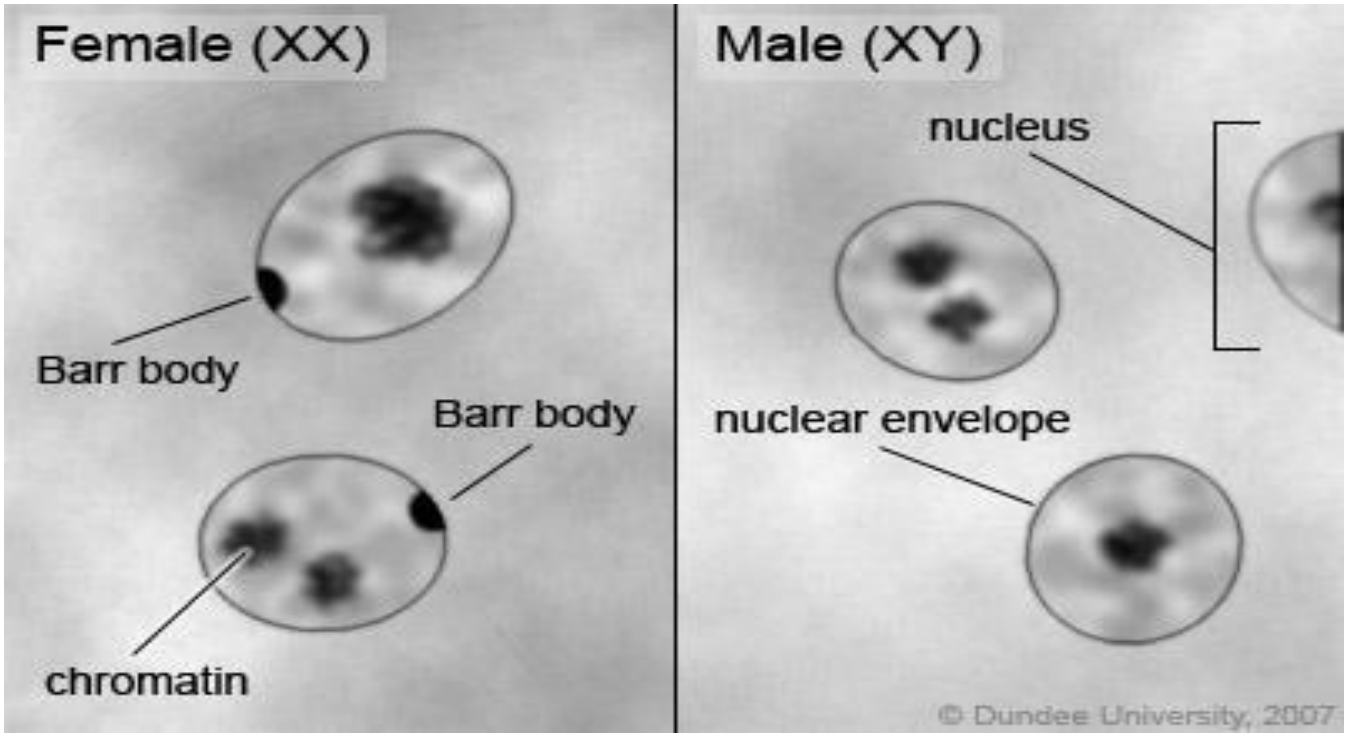


Functions:

- Carries genetic information.
- Directs protein synthesis

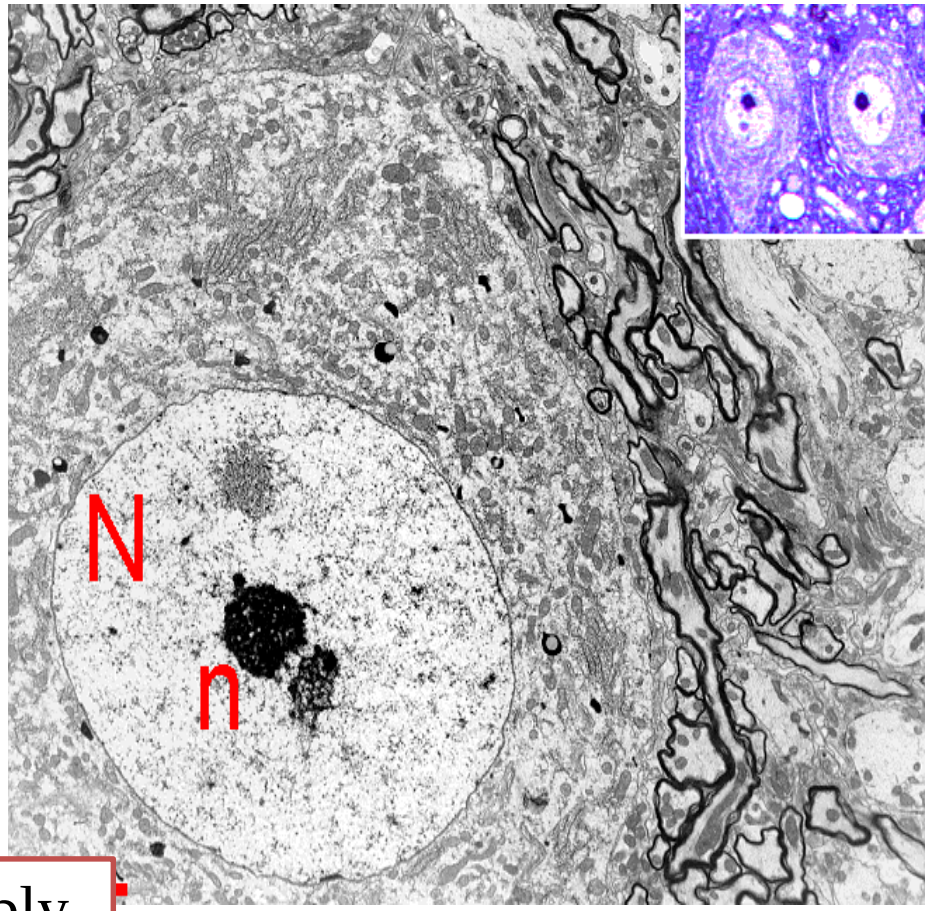

H&E
EM
Heterochromatin
Euchromatin

Barr body or sex chromatin: inactive X chromosome in a female somatic cell appears as small dense mass of heterochromatin (often seen clearly in epithelial cells)



Nucleolus

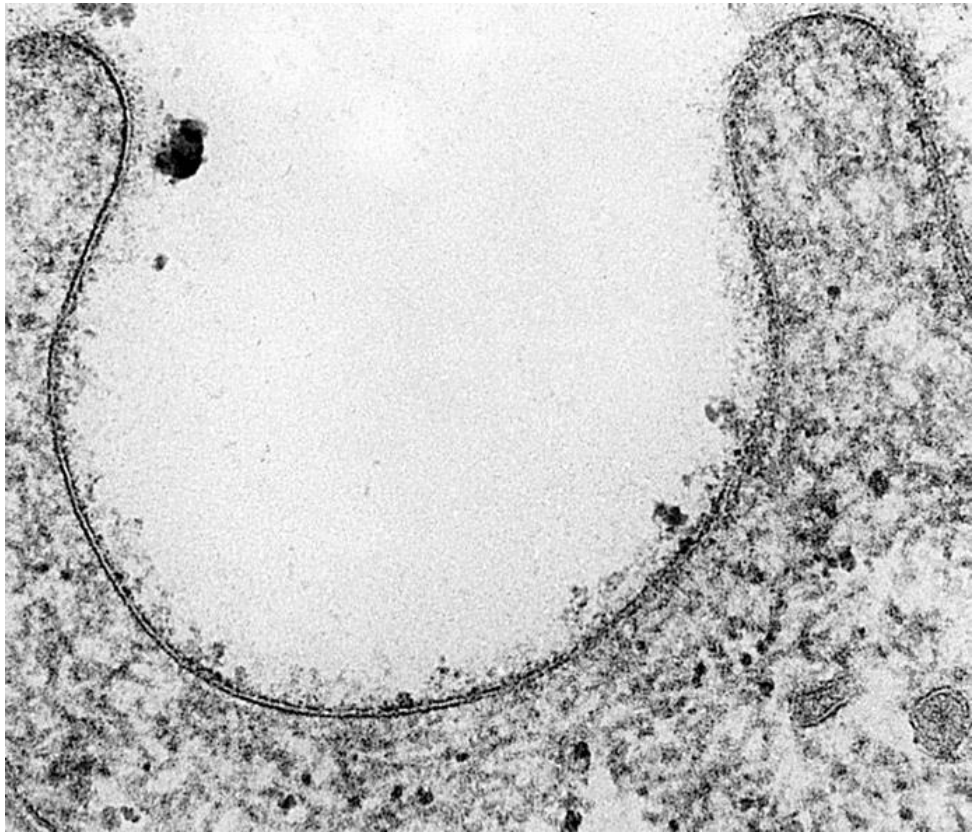
- It is a spherical dark basophilic mass not surrounded by a membrane, rich in rRNA and protein
- Usually one.



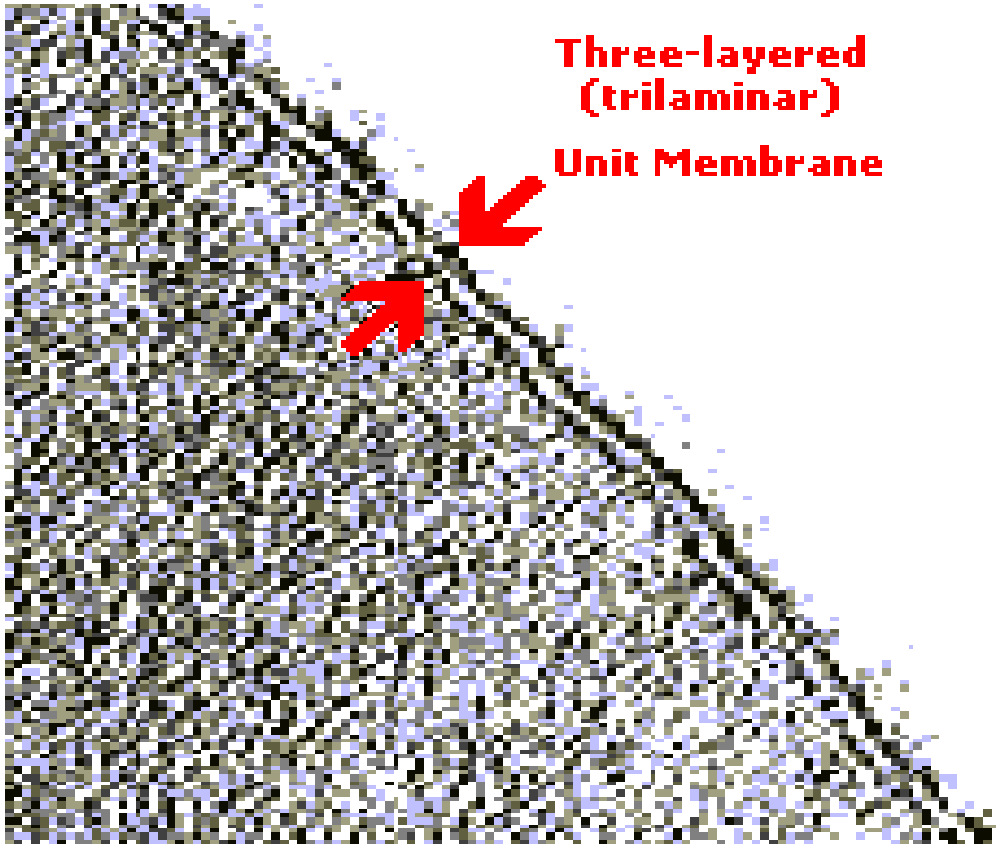
<u>Function</u>: formation and assembly of ribosomal subunits

Cell Membrane

- A very thin membrane that surrounds the cell.
- Also called plasmalemma
- **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

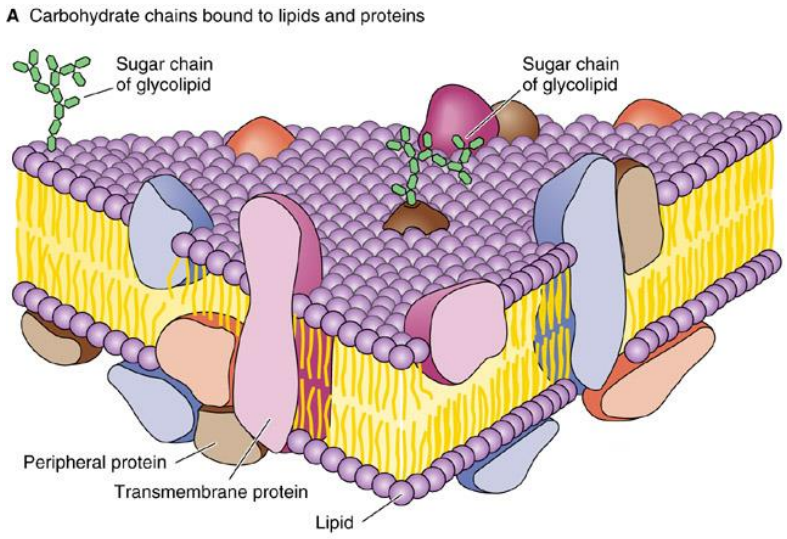

Three-layered
(trilaminar)
Unit Membrane

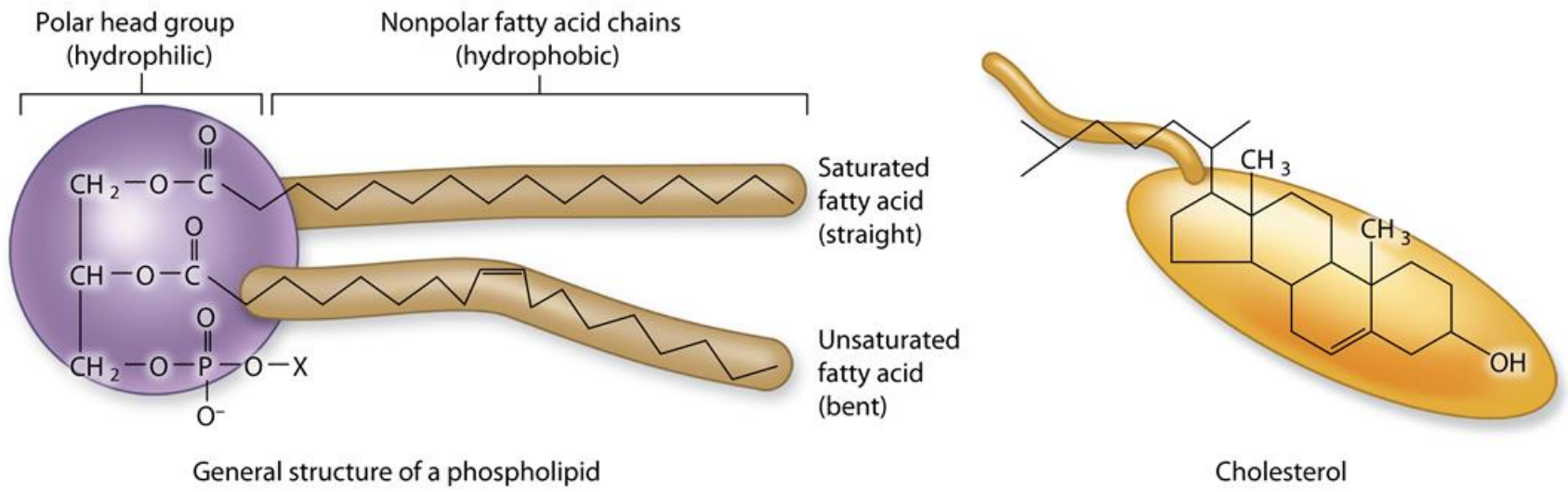
Cell Membrane

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.





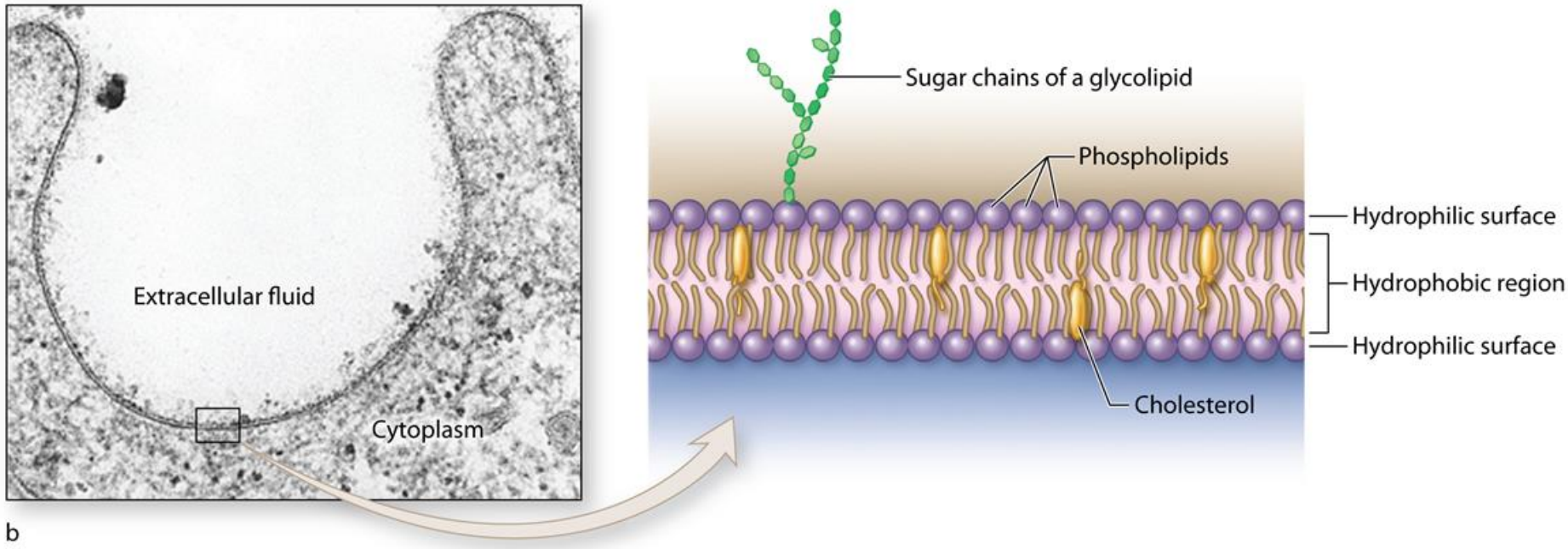
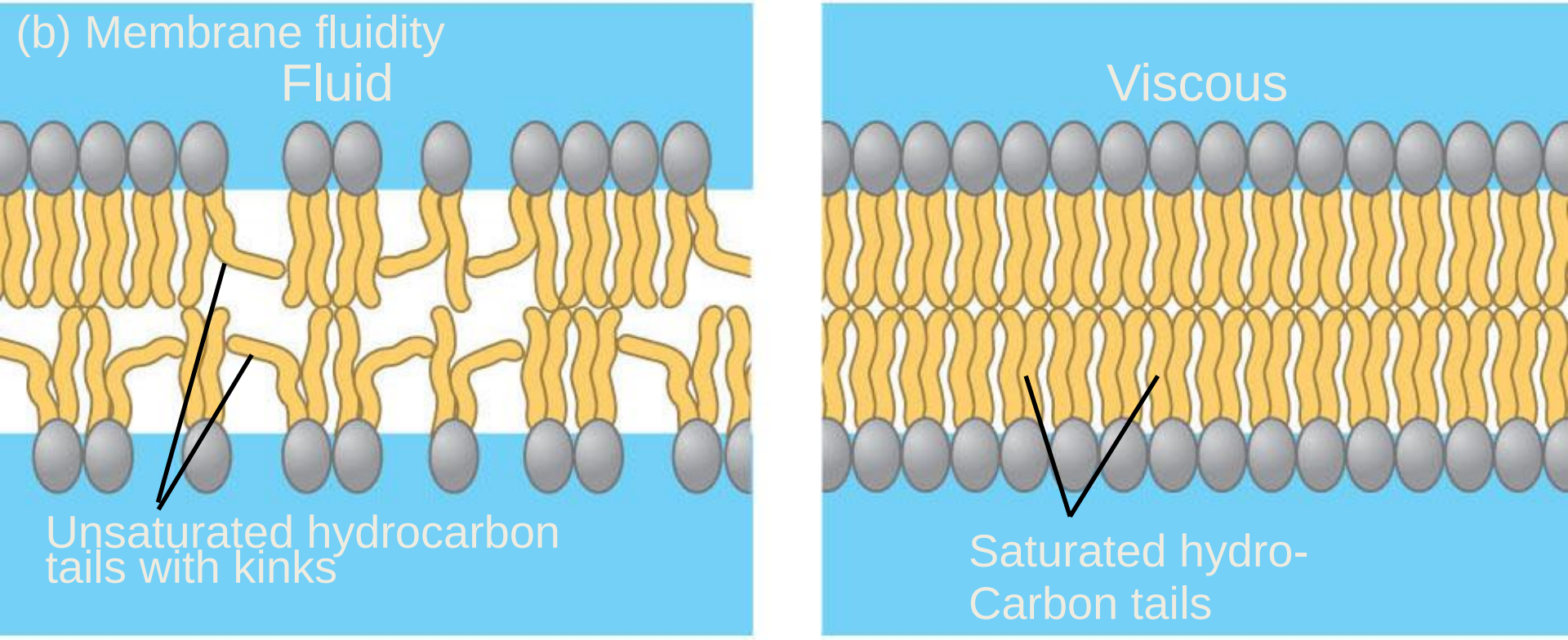


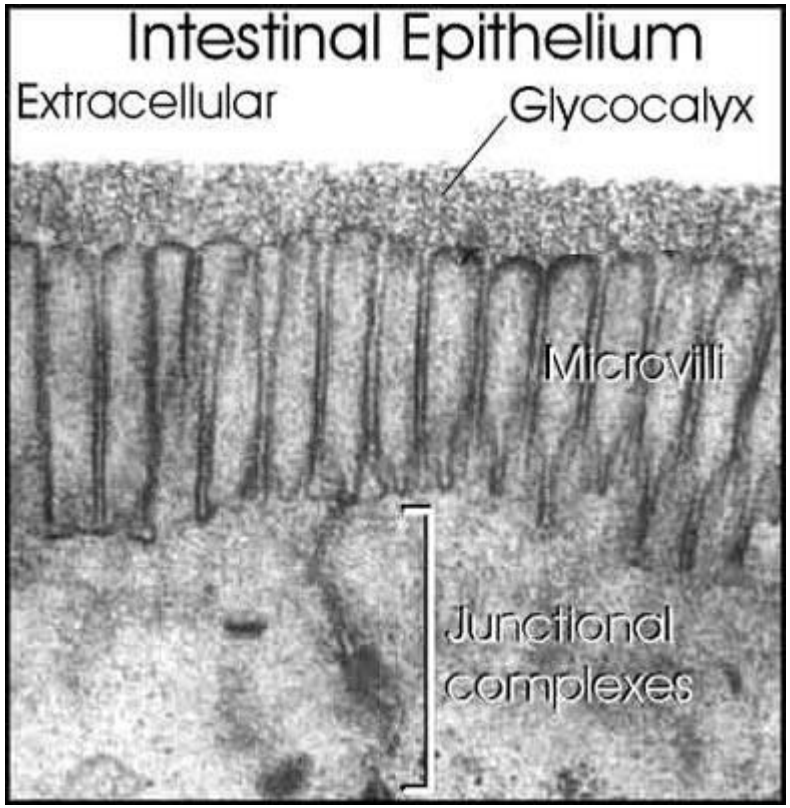
Figure 2-1

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



Glycocalyx

EM



LM (PAS stain)

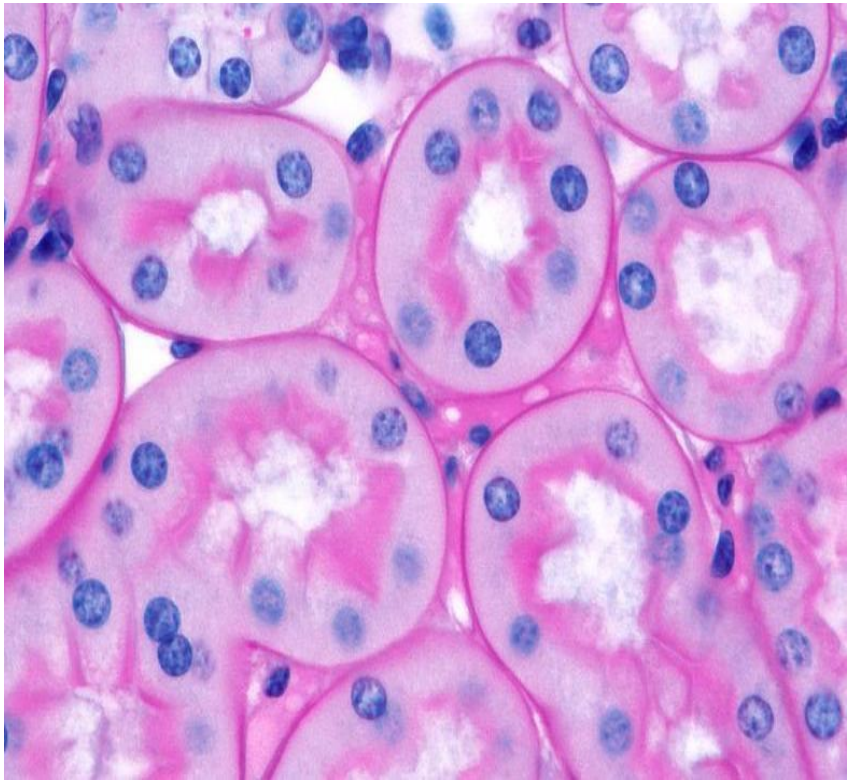
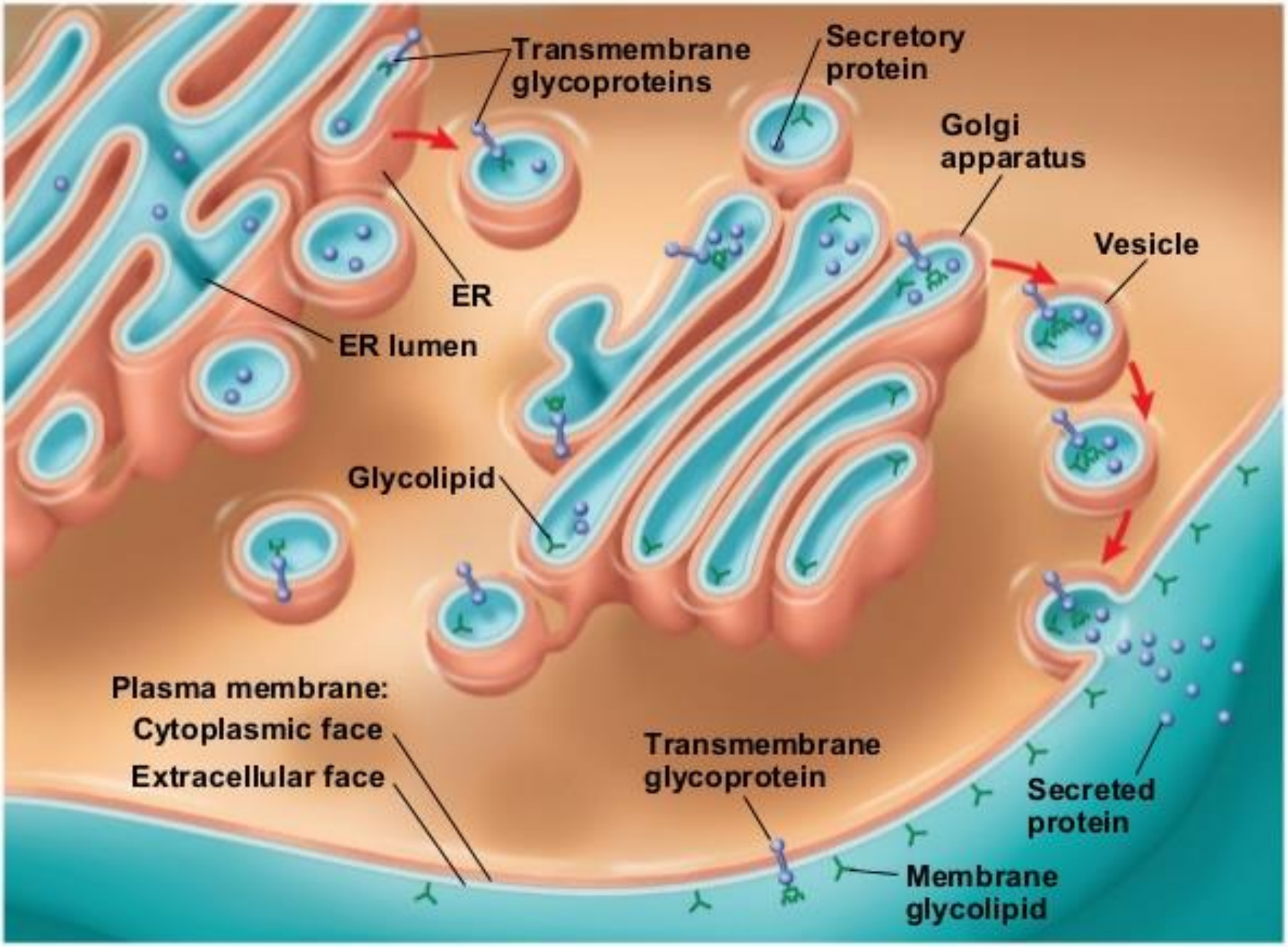
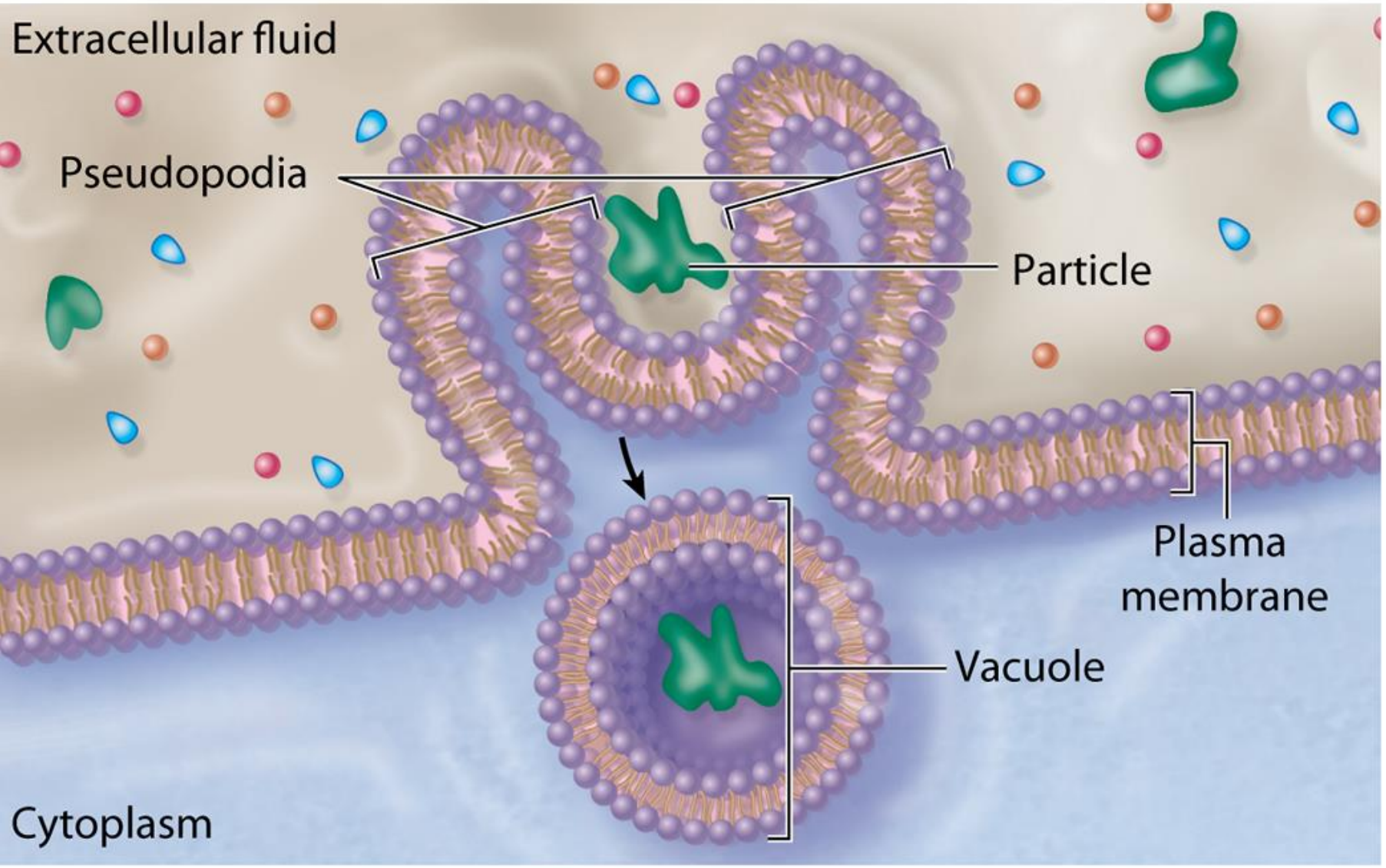


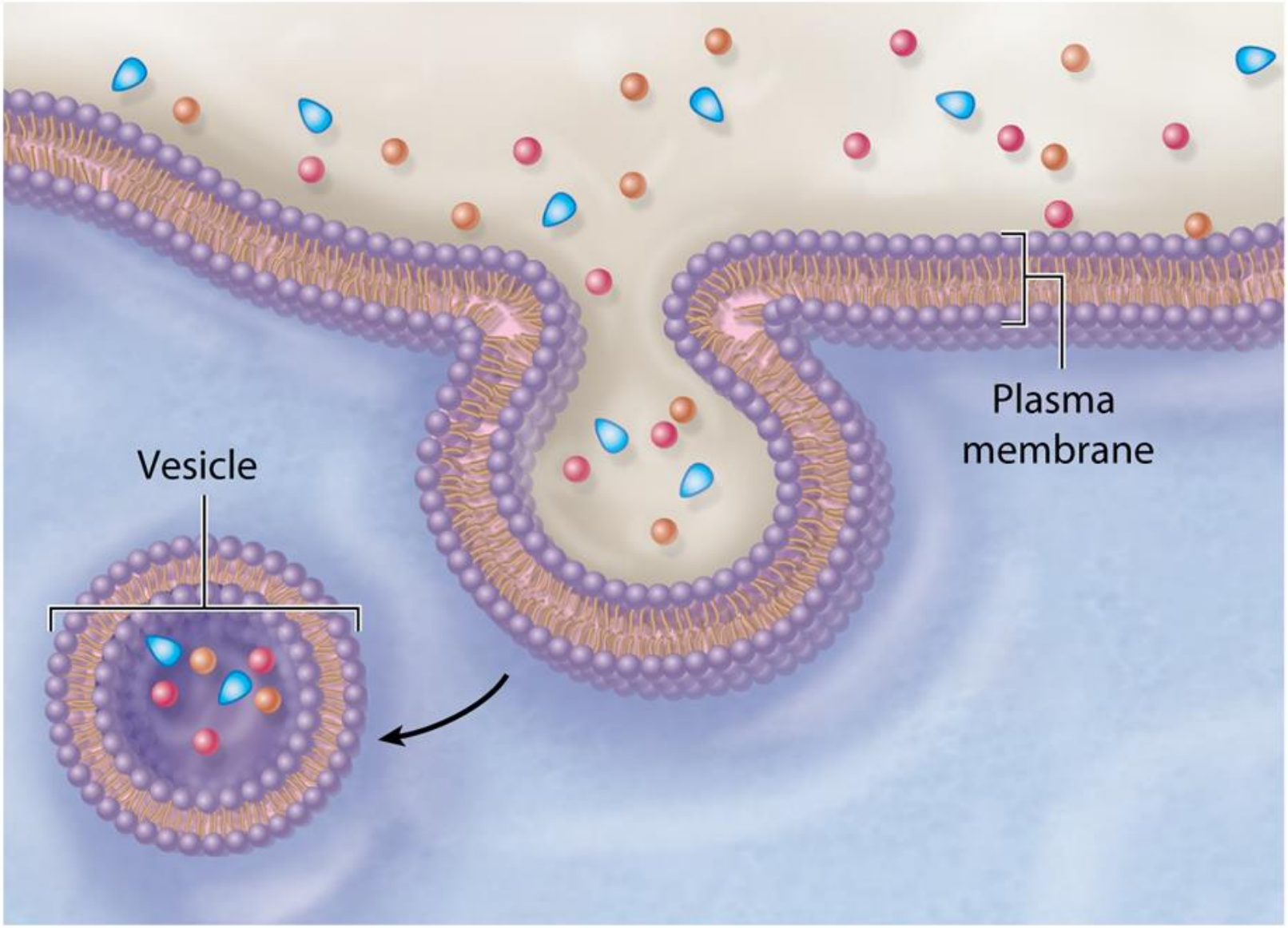
Figure 7.12





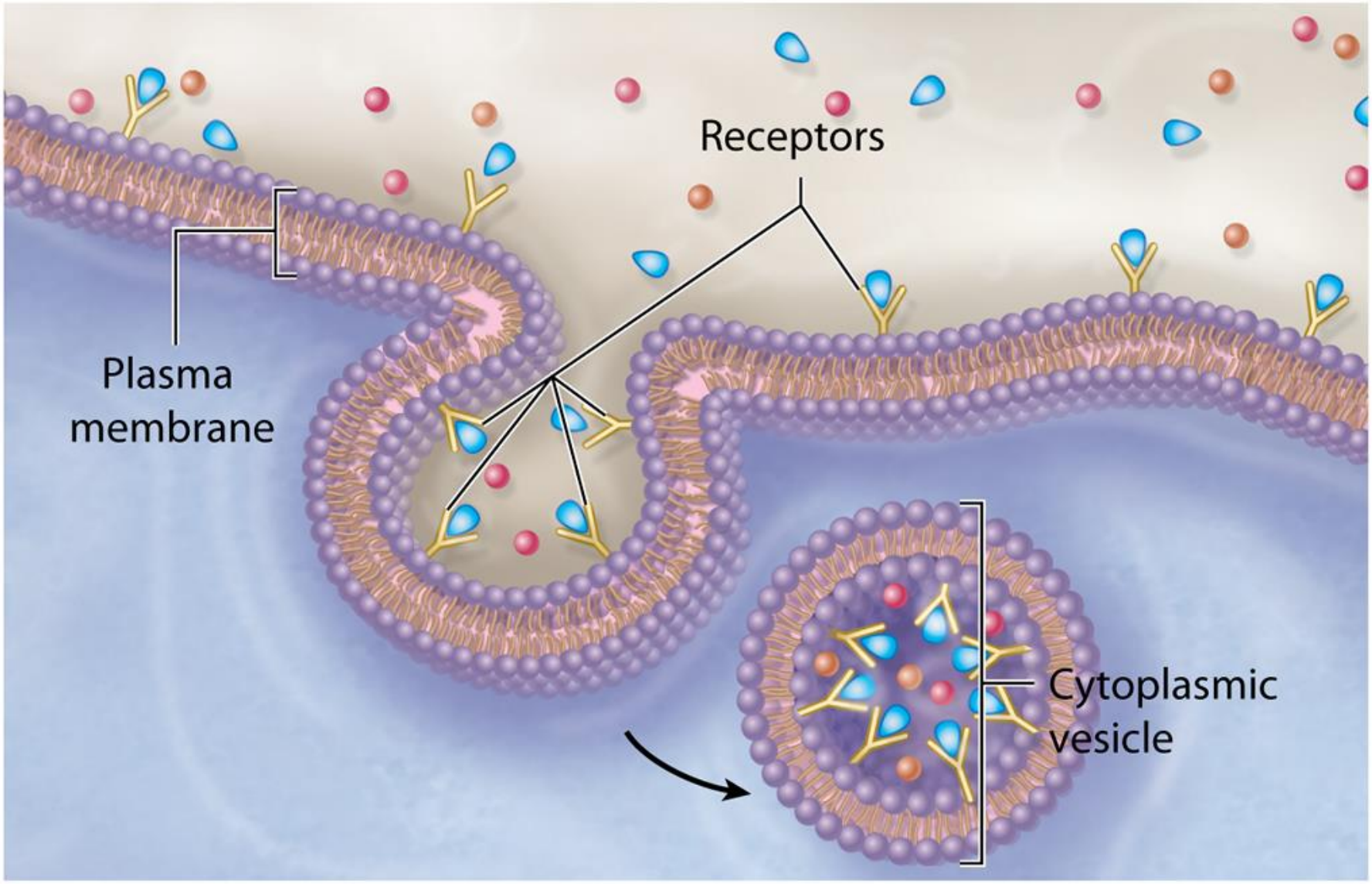
a Phagocytosis

Figure 2-6



b Pinocytosis

Figure 2-6



c Receptor-mediated endocytosis

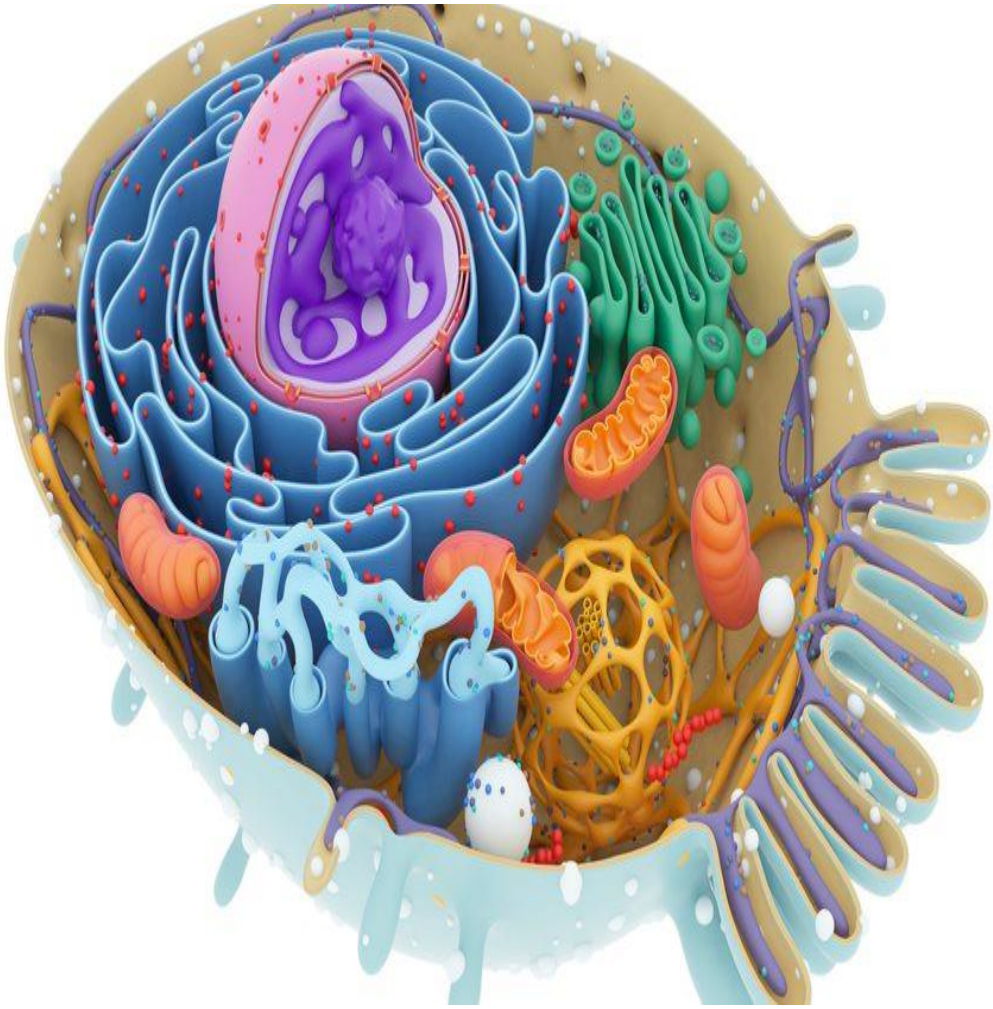
Figure 2-6

CYTOPLASM

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



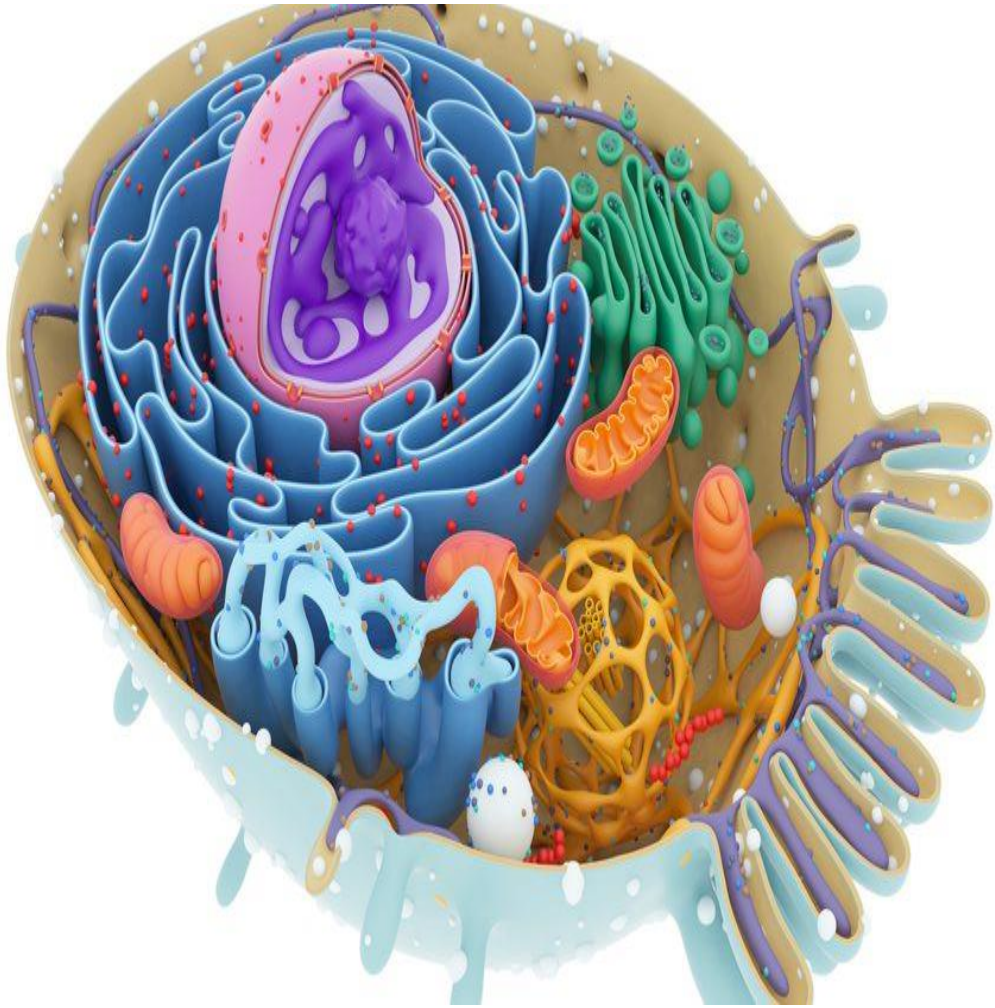
CYTOPLASMIC ORGANELLES

A. Membranous:

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

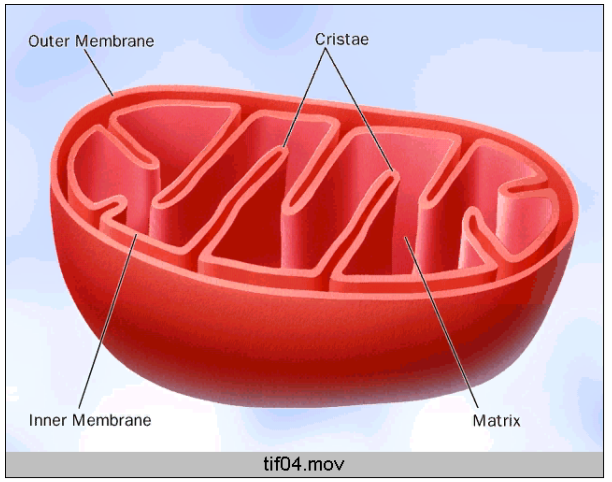
B. Non-membranous:

1. Ribosomes.
2. Centrioles.



Mitochondria

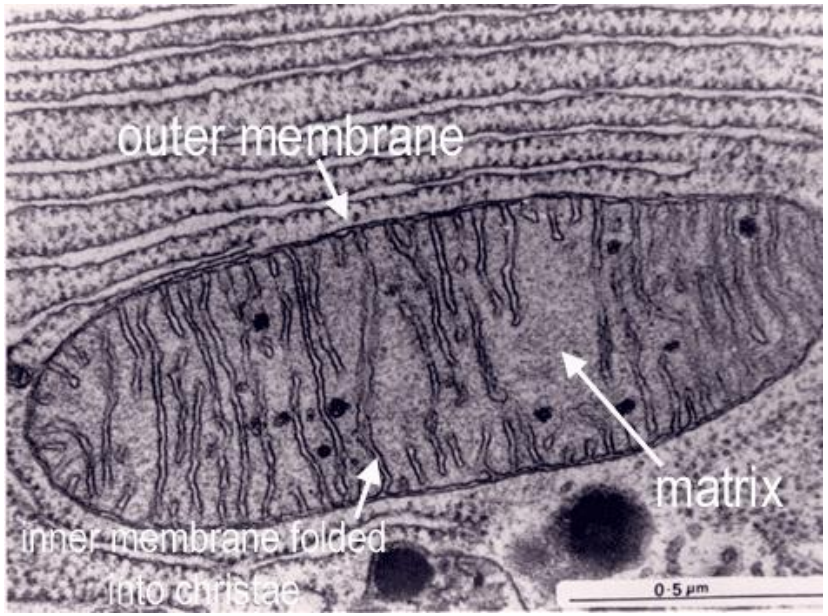
- Each mitochondrion is rod-shaped .
- The wall is composed of 2 membranes.
- The outer is smooth, the inner is folded to form cristae.
- The cavity is filled with mitochondrial matrix, which contains enzymes. Also contains its own DNA.



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.



Mitochondria

- LM

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

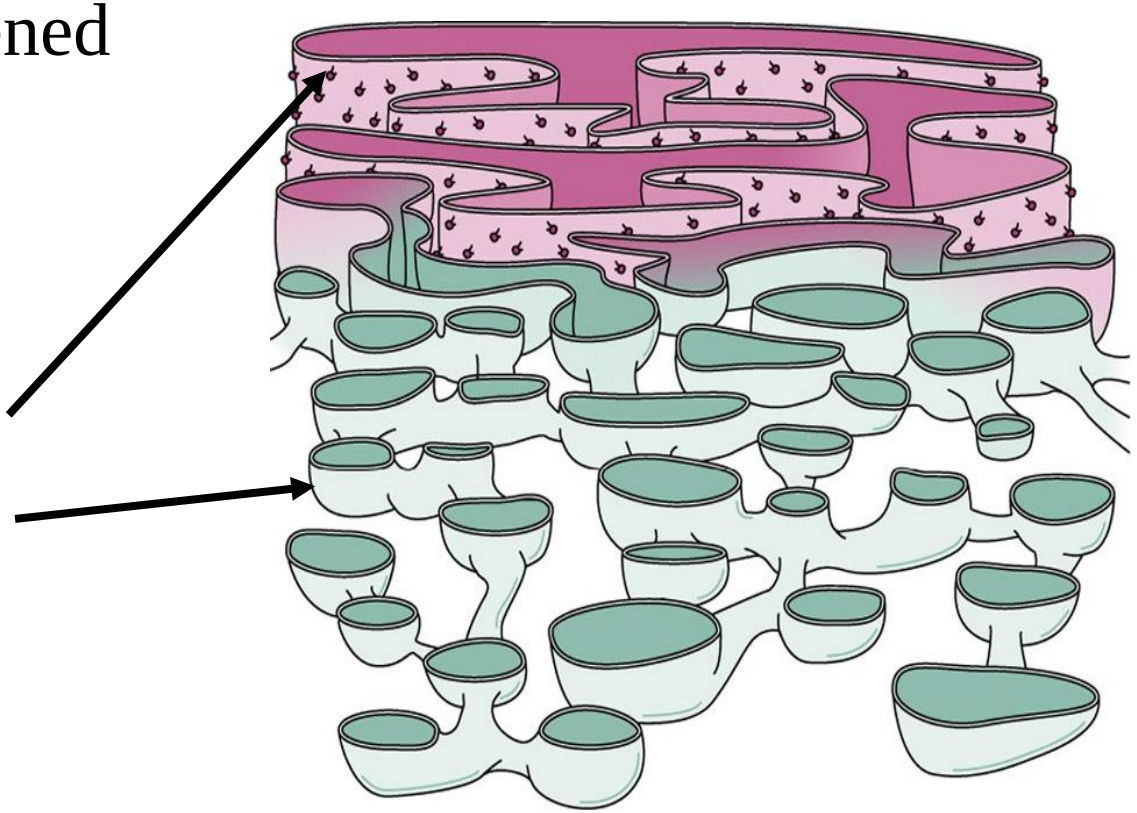
If the cells have a high number of mitochondria, it appears as acidiophilia of the cytoplasm

- EM

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

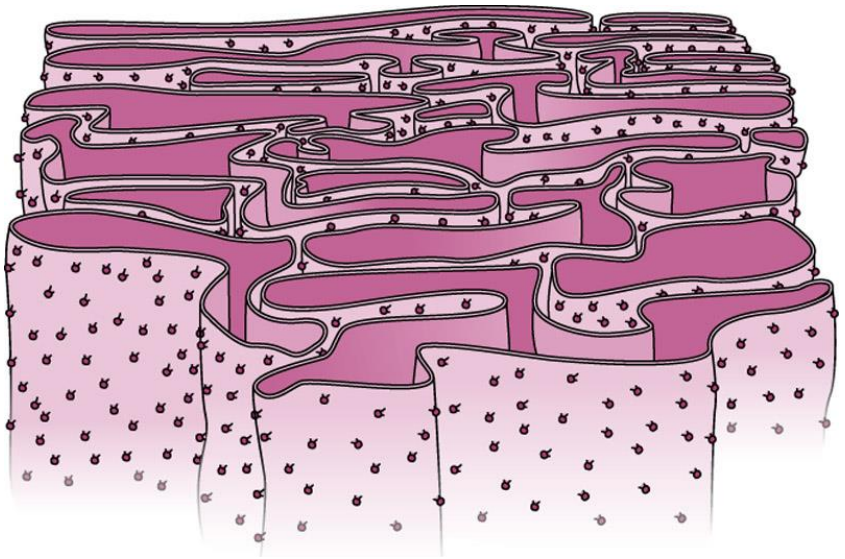
Endoplasmic Reticulum (ER)

- It is a system of communicating membranous tubules, vesicles, and flattened 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.

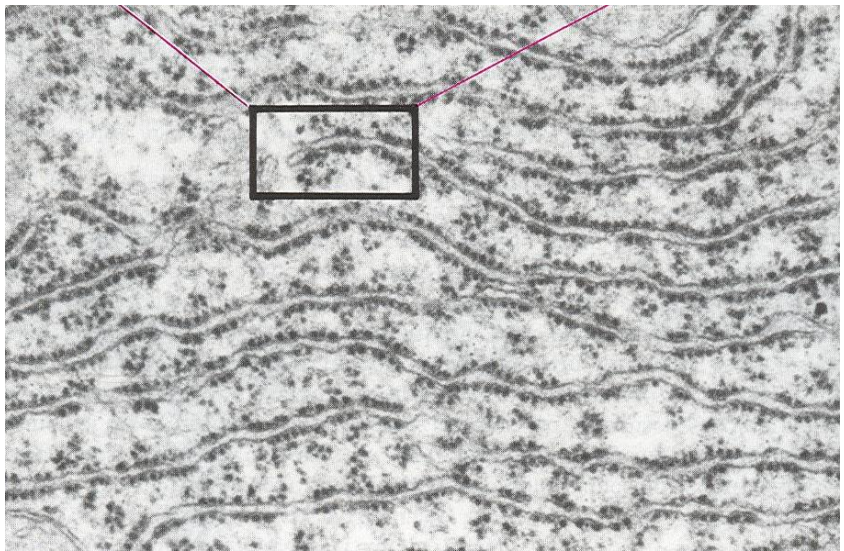
Rough Endoplasmic Reticulum

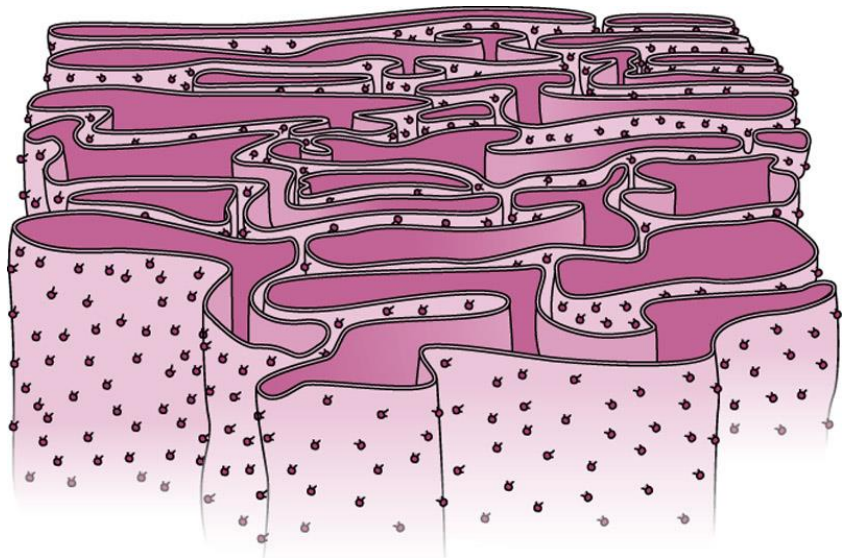
- LM

Intense basophilia

- EM

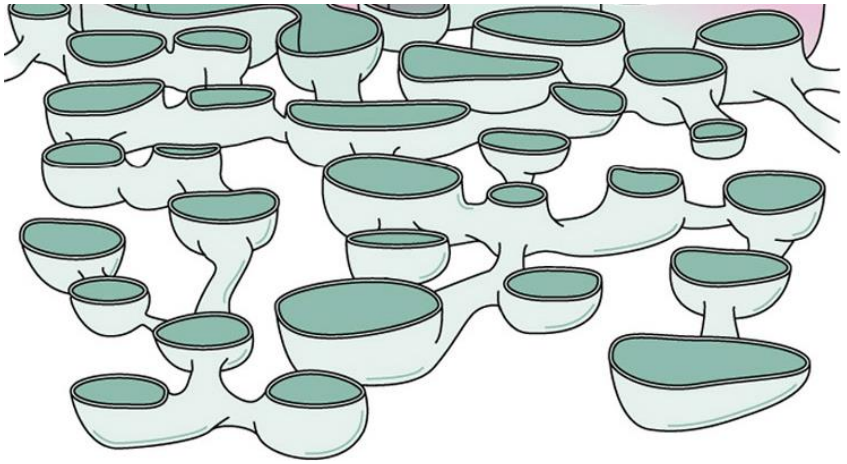
Appears as interconnected flat cisternae and tubules associated with ribosomes





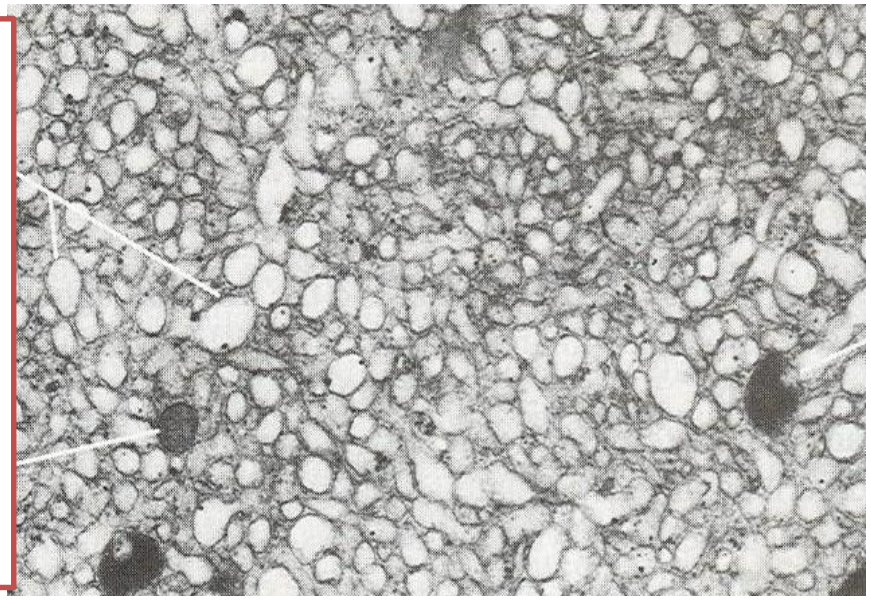
Smooth Endoplasmic Reticulum

- Membranous tubules and vesicles, with no ribosomes on the surface.

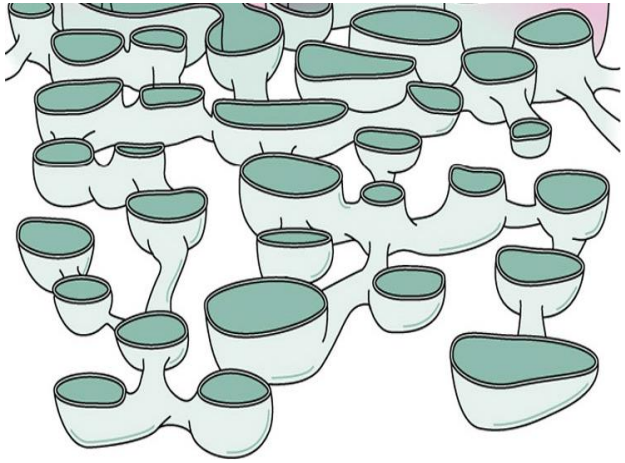


Functions:

1. Synthesis of lipids & cholesterol.
2. Metabolism of lipids and glycogen
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

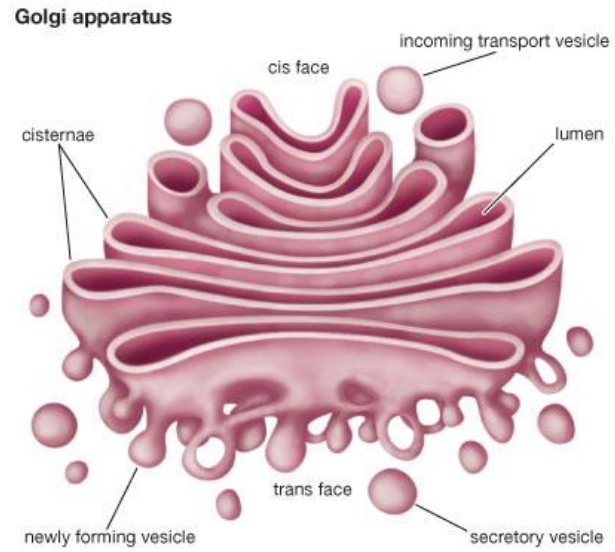
✓ not associated with ribosomes

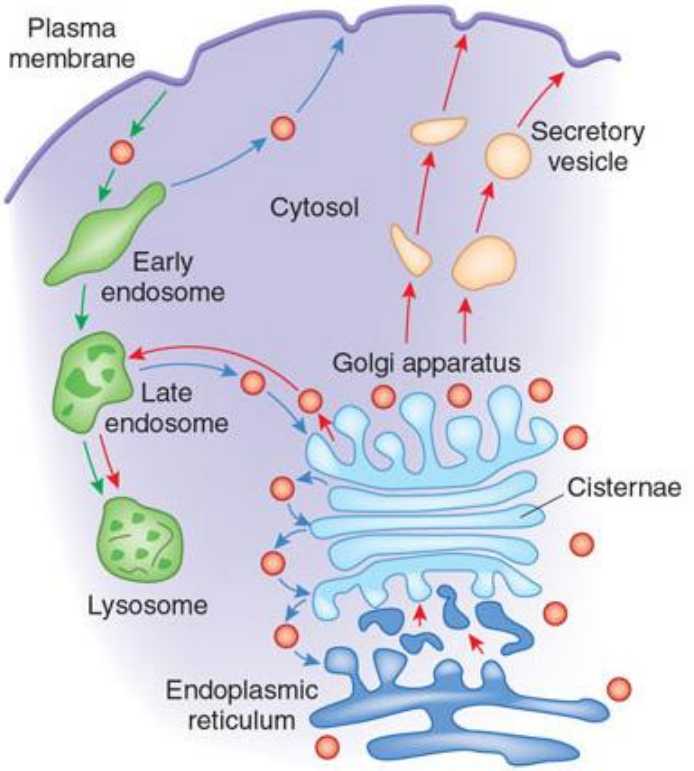
Golgi Apparatus

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

Functions:

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





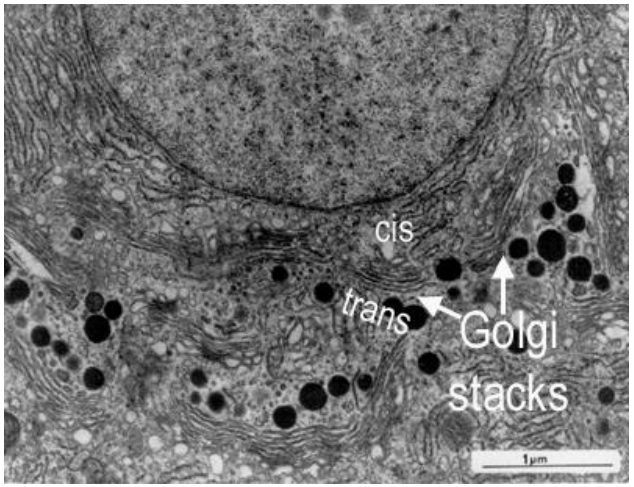
Golgi Apparatus

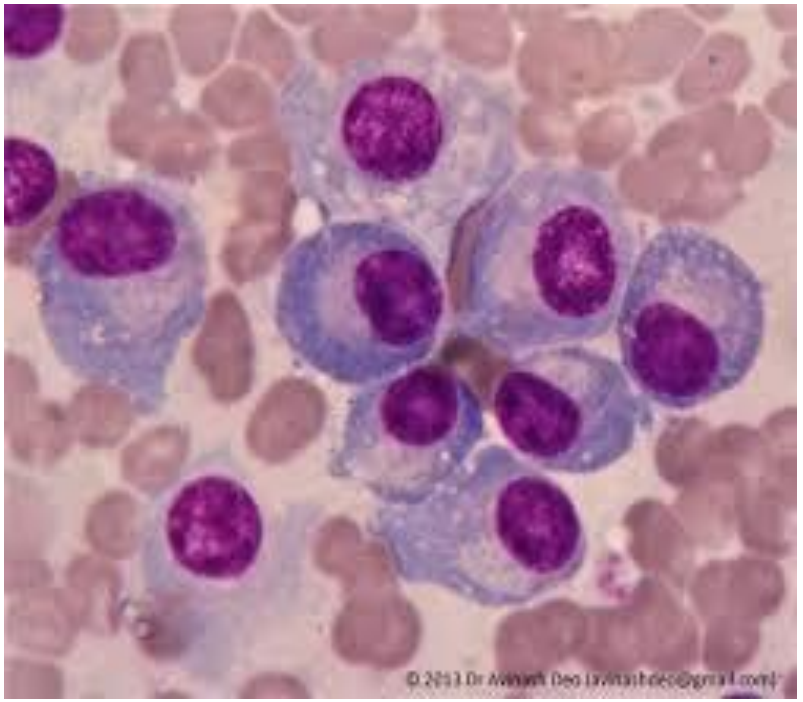
- LM

➢ 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





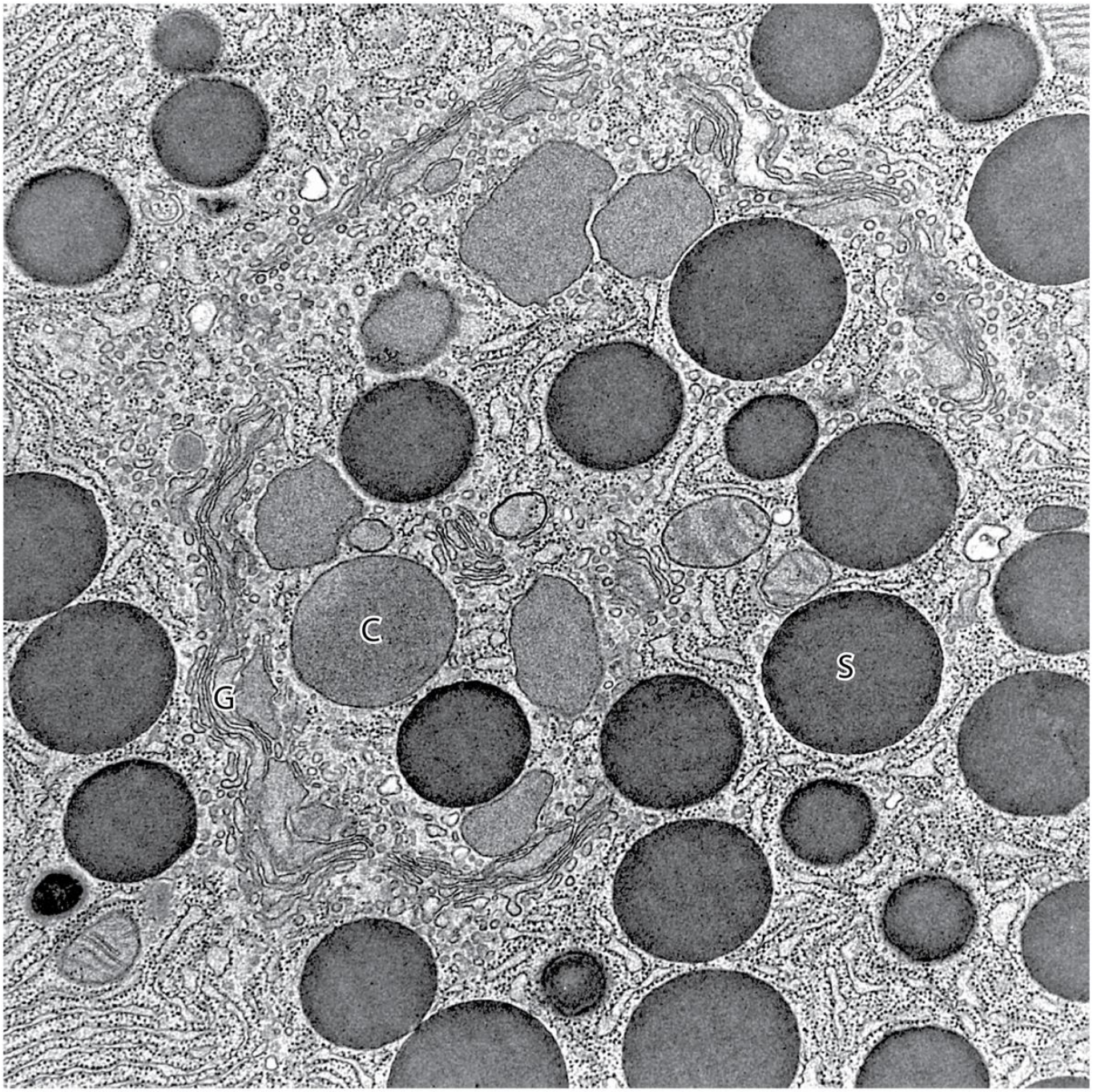
Secretory granules

- 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.

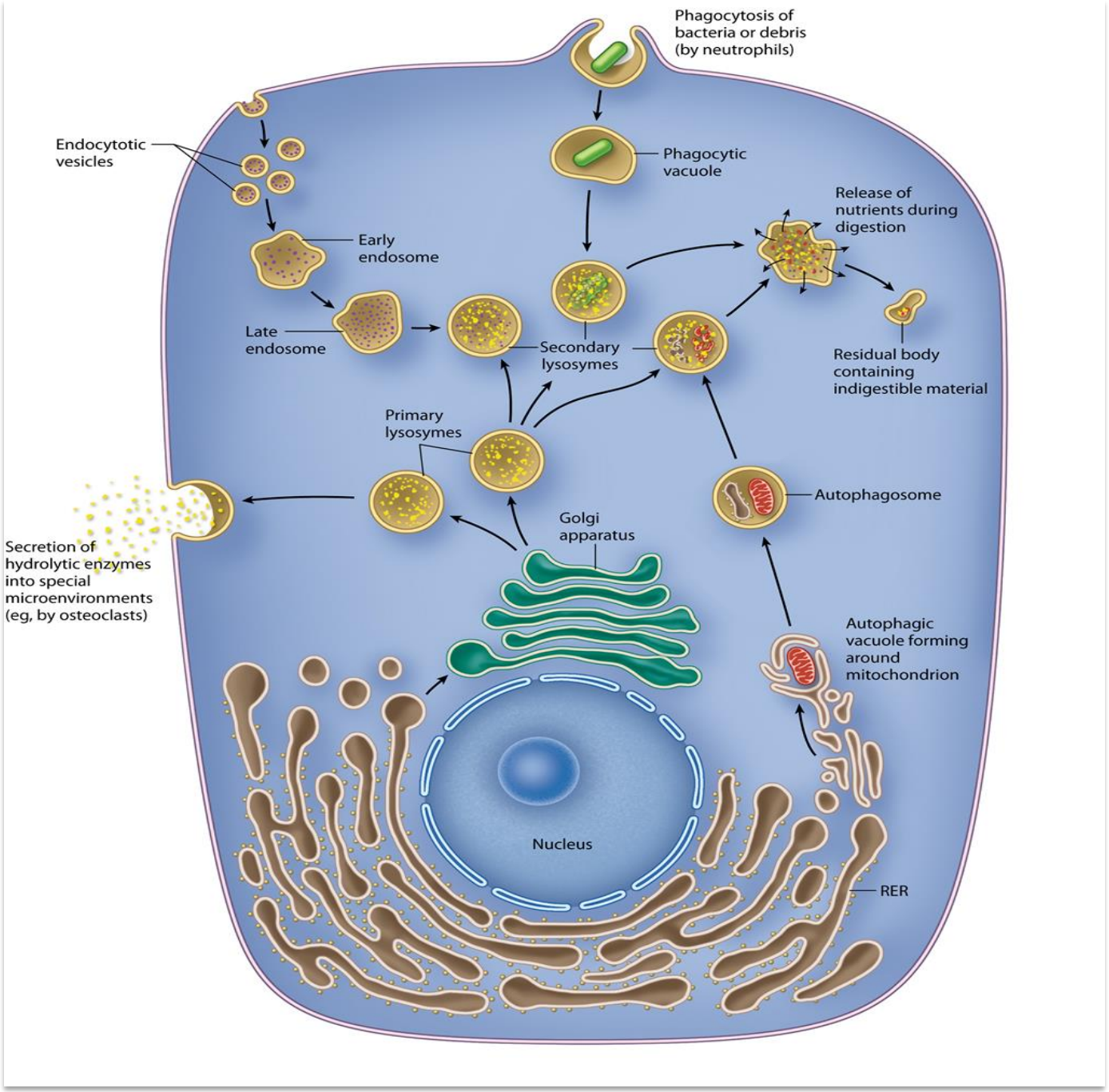


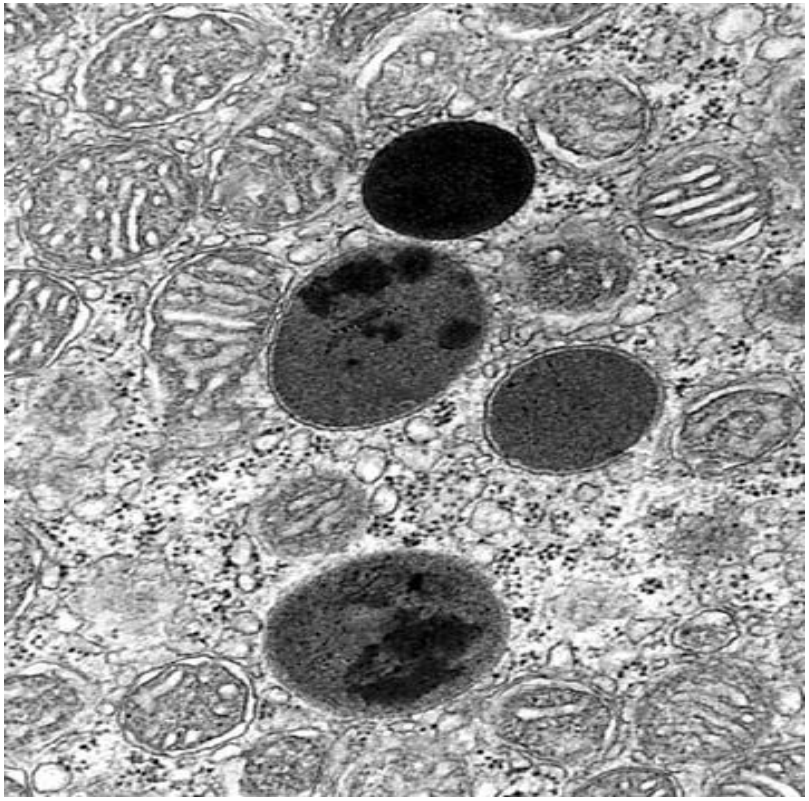
Figure 2-17

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)

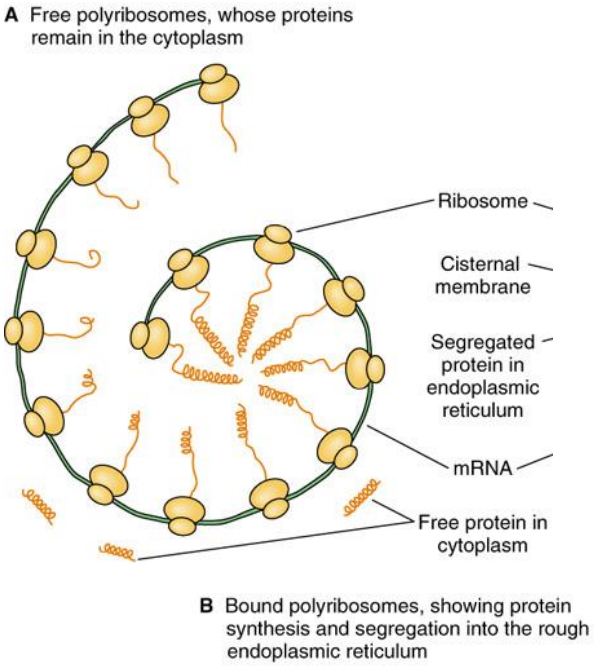
2- attached ribosomes to ER

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

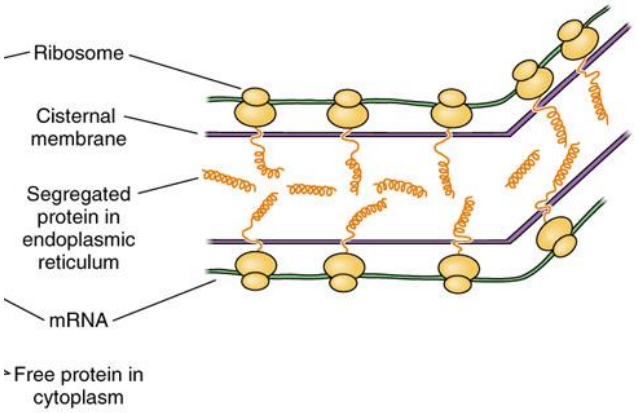
Ribosomes

- 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



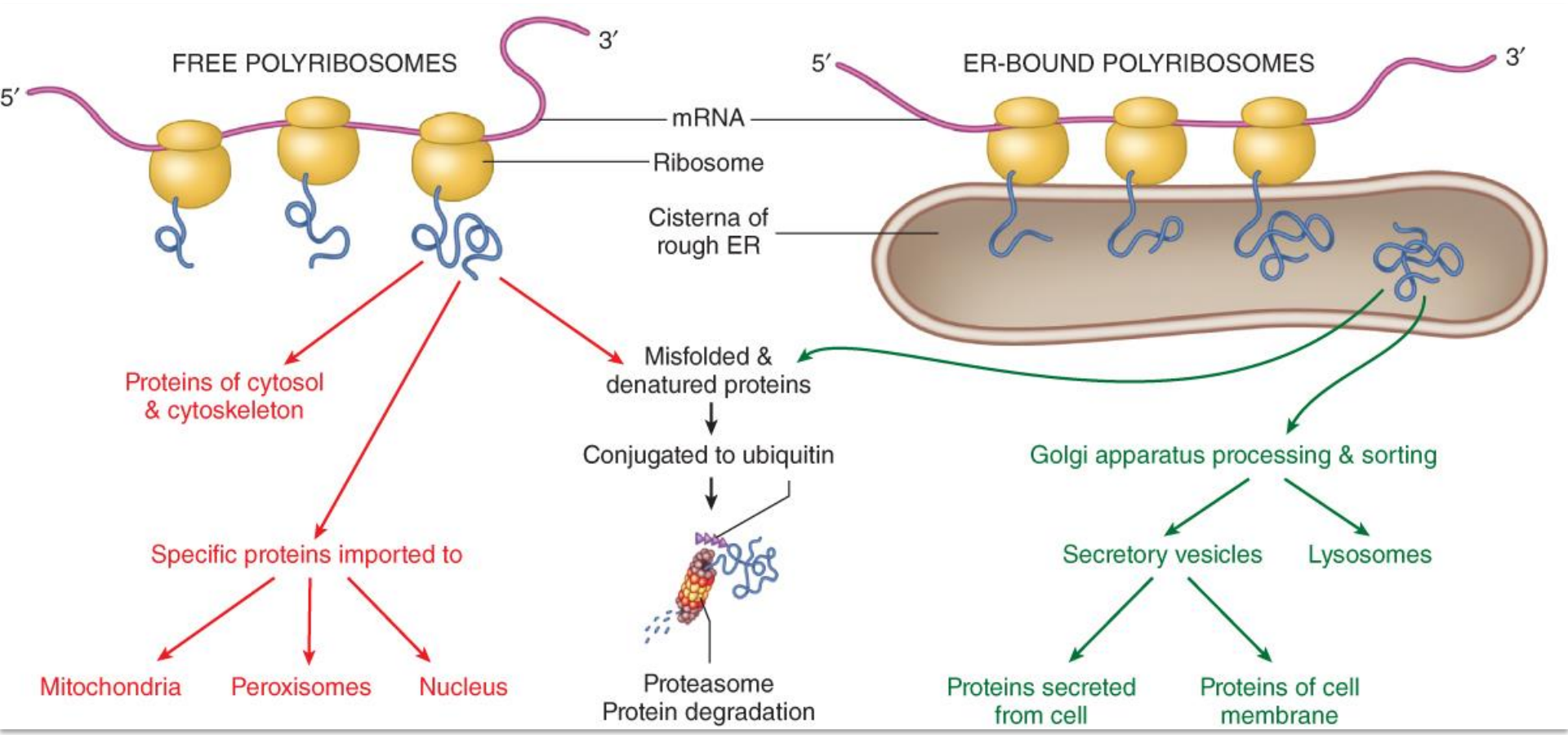
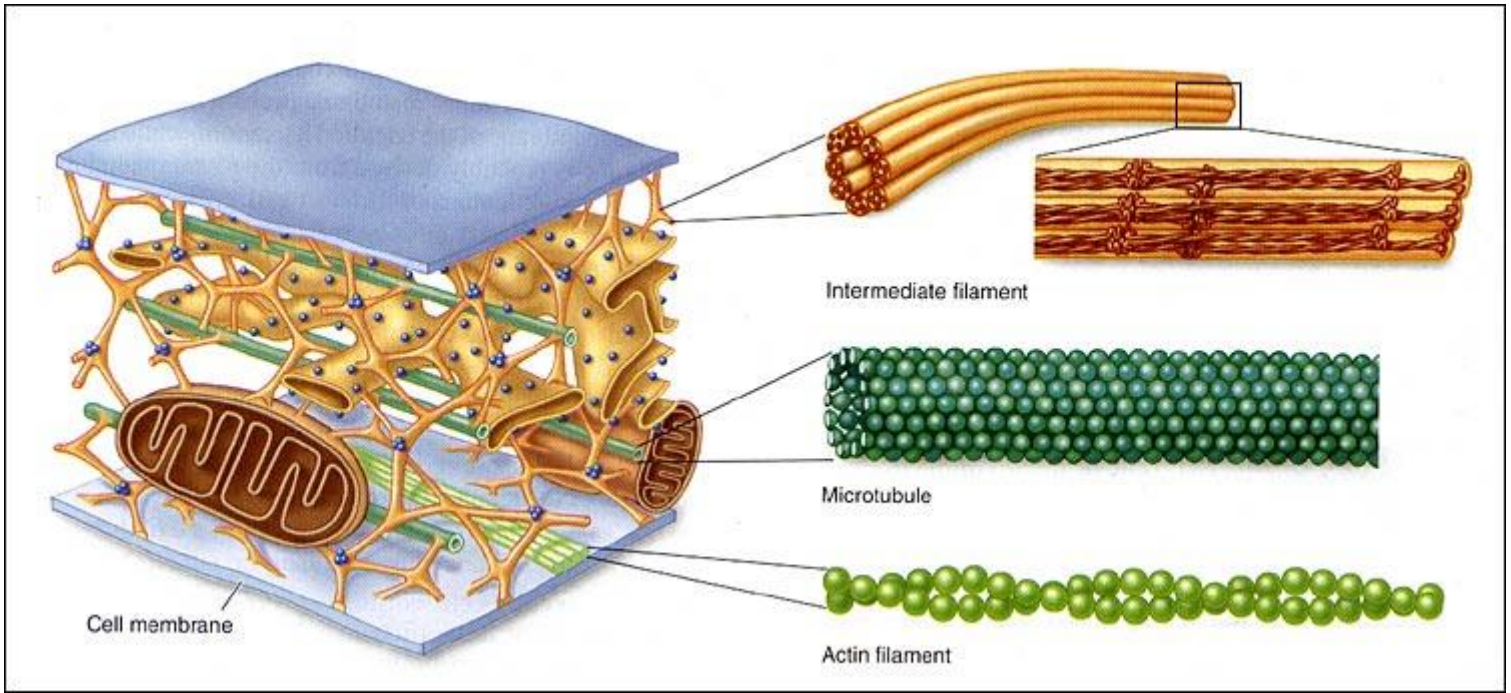
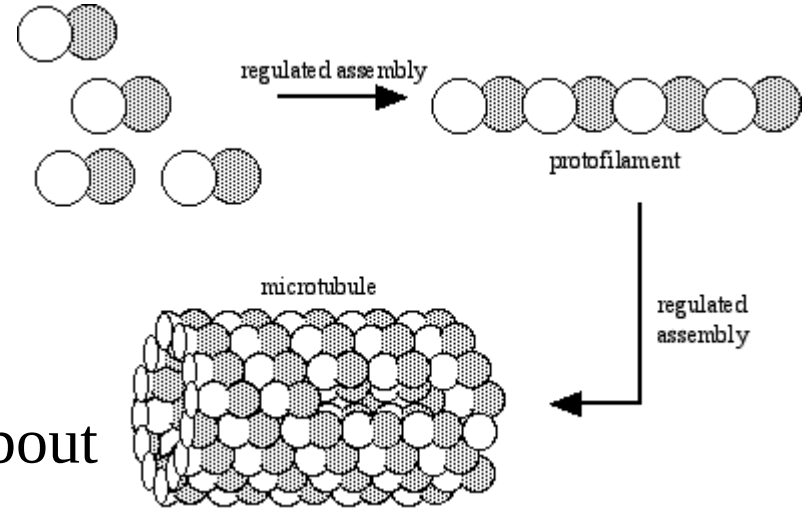


Figure 2-9

Cytoskeleton

- Acts as skeleton
- Provides shape and structure
- Movement
- Helps move organelles within the cell/ transport
- Made of three types of filaments (microtubules, intermediate filaments, microfilaments)





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 a & b subunits.

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

An **a, b-tubulin heterodimer** is the basic structural unit of microtubules

Centrioles

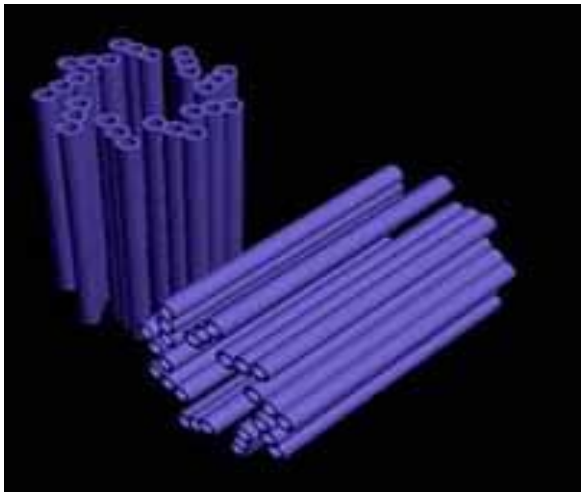
✓Generally appear in animal cells

✓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.



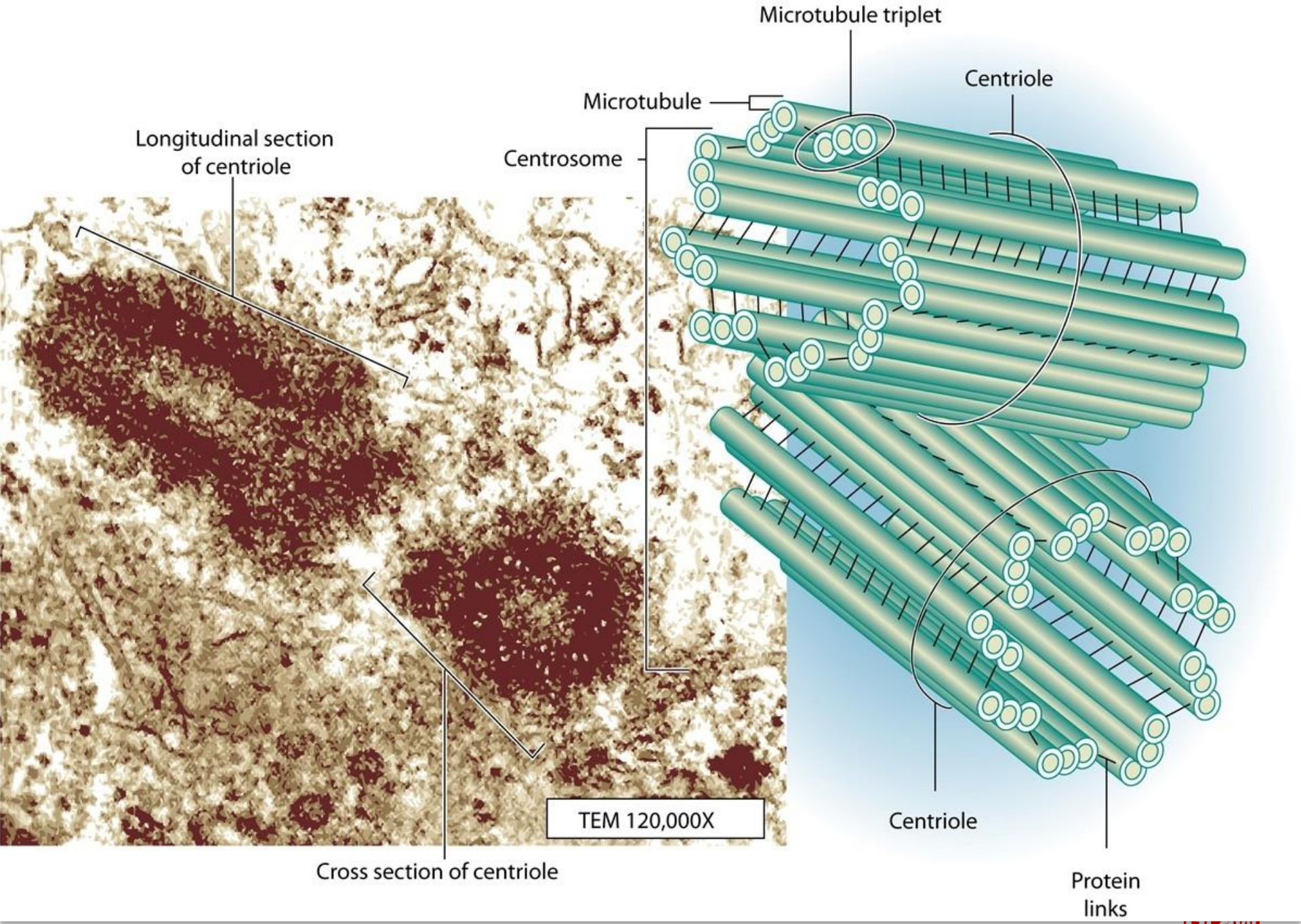


Figure 2-24

Cell inclusions

- non living components of the cytoplasm

- Types:

1- store metabolic products

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

2- pigments (melanin, lipofuscin and hemosiderin)

Lipid droplets

Glycogen granules

Hemosiderin granules

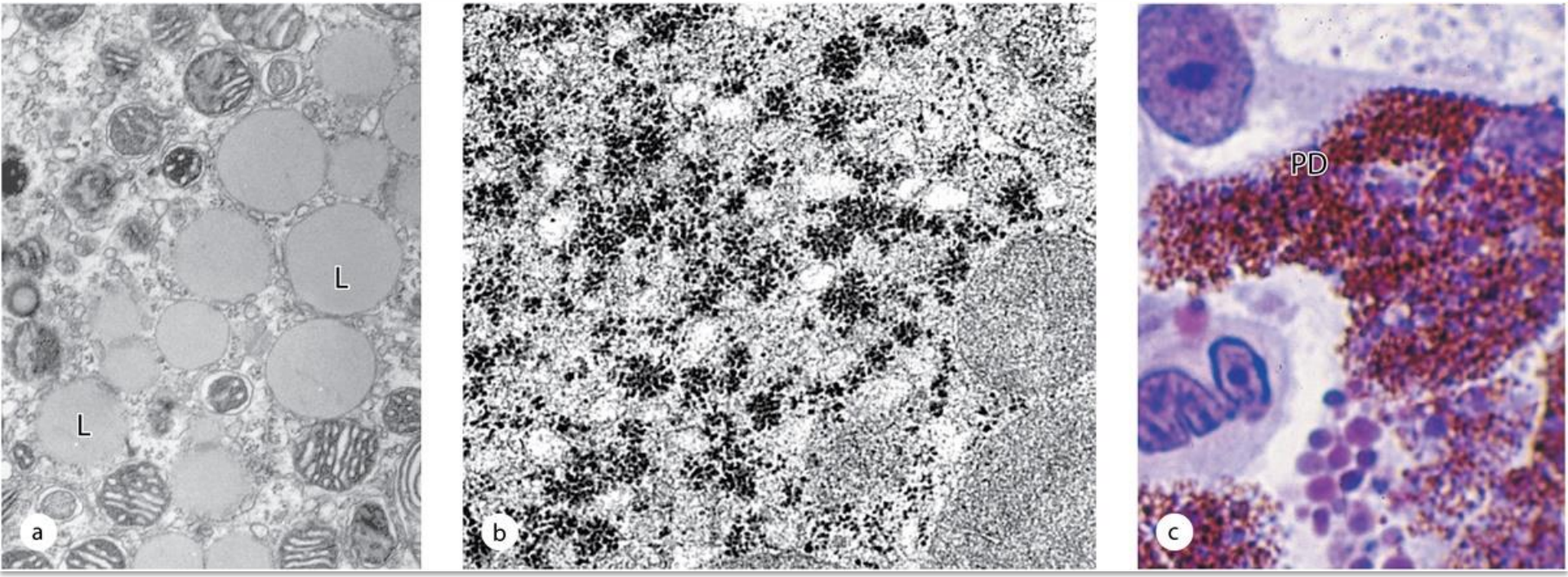


Figure 2-28

Lipofuscin
(age pigment)