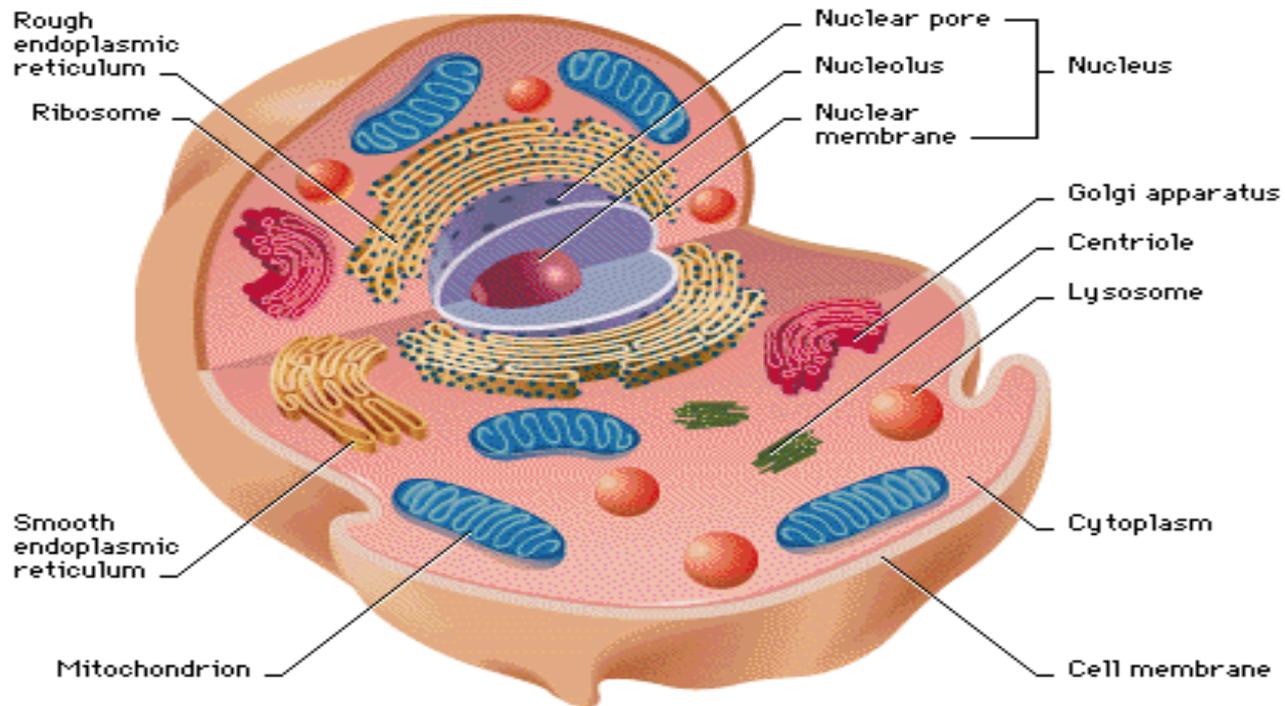


CELL ORGANELLES I



By

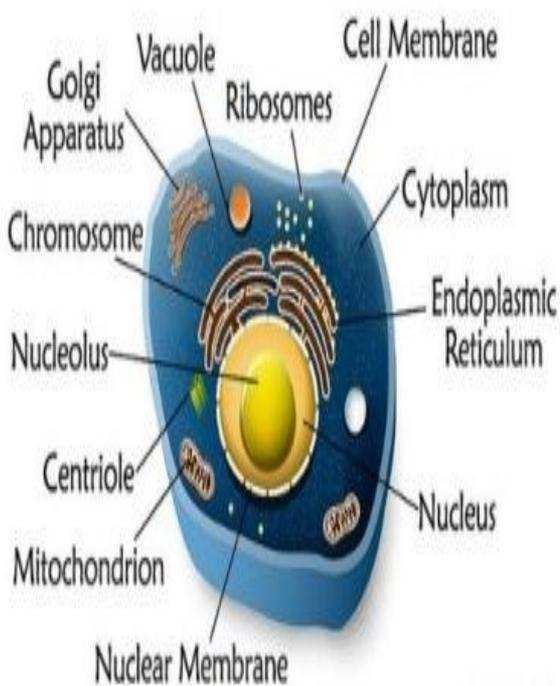
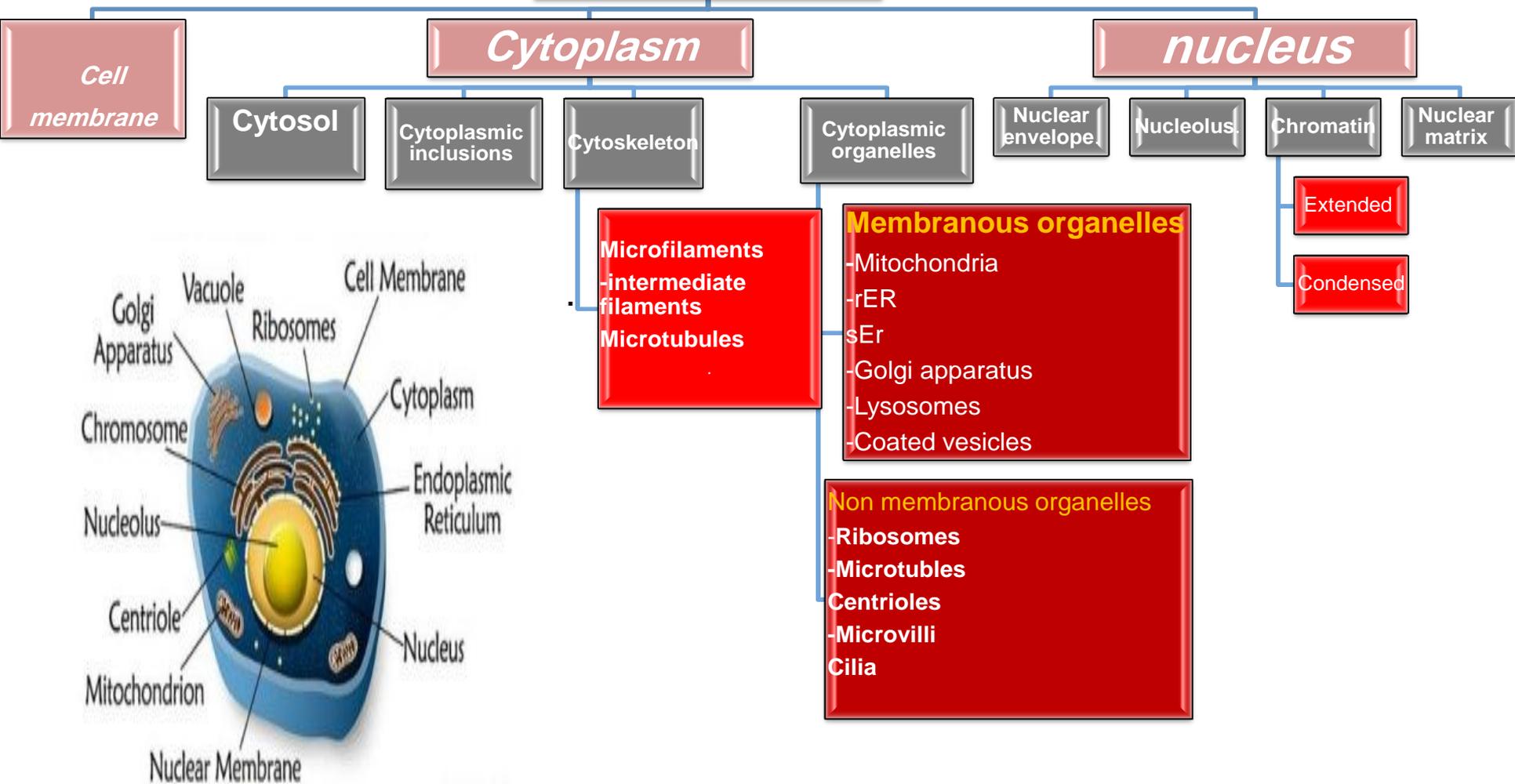
Dr. Heba Sharaf Eldin

Assistant Professor of Histology & Cell Biology

OBJECTIVES OF THE LECTURE

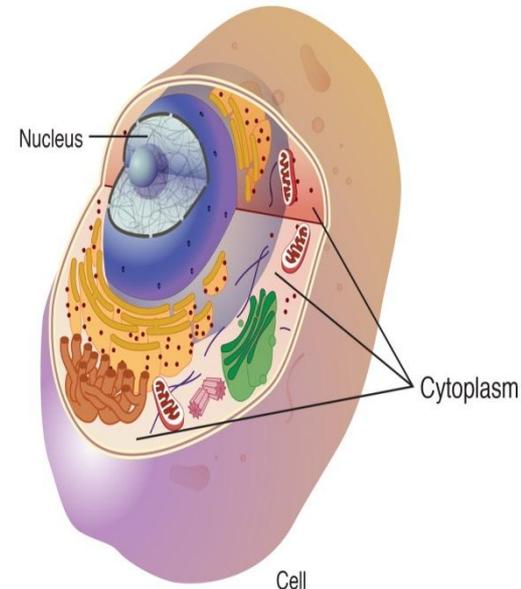
1. Classify the cell organelles.
2. Define and describe the structure and functions of the cytoplasmic organelles.
3. correlate the structures of the organelles with their functions.
4. Predict structures present in a cell from their functions.
5. Recognize different cellular components in electron photomicrographs.

The cell



The cytoplasm is formed of:

1. **Cytosol**: It is **semifluid** matrix. In which organelles, cytoskeleton and inclusions are embedded
2. **Cytoplasmic organelles**: active **permanent** structures that are **essential for the life** and the function of the cell.
3. **Cytoskeleton**: It is formed of tubules and filaments that maintain the shape of the cells, help in the cell movement.
4. **Cytoplasmic inclusions**: They are **non living temporary** structure, consist of metabolic products, stored nutrients.
They are not essential for the life of the cell.



CELL ORGANELLES I

They are classified according to the presence or absence of surrounding membranes into-

A-Membranous cell organelles:

- 1- Mitochondria
- 2- Endoplasmic reticulum (rough & smooth)
- 3- Golgi apparatus
- 4- Membrane bounded vesicles.
 - Lysosomes
 - Peroxisomes
 - Endosomes

B-Non membranous cell organelles

- 1- Ribosomes
- 2- Proteasomes
- 3- Cytoskeleton:
 - Filaments
 - Microtubules

Intracytoplasmic membranes surround organelles are similar in structure to the cell membrane (**unit membrane**) with some differences:

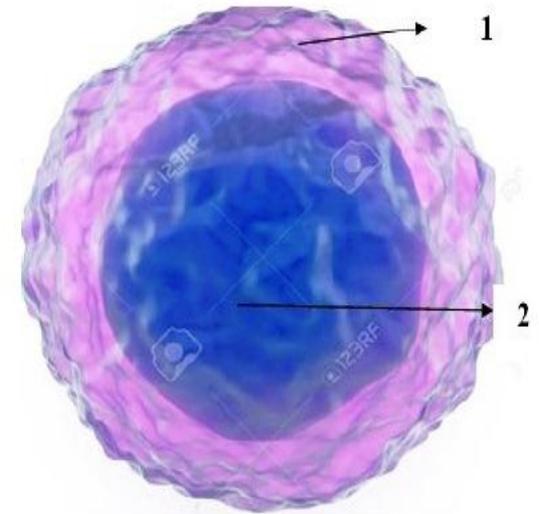
- Less thick than the cell membrane
- Devoid of cell coat.

H&E (Routine histological stains)

1-Eosin (E):

red acidic dye (- ve charged)

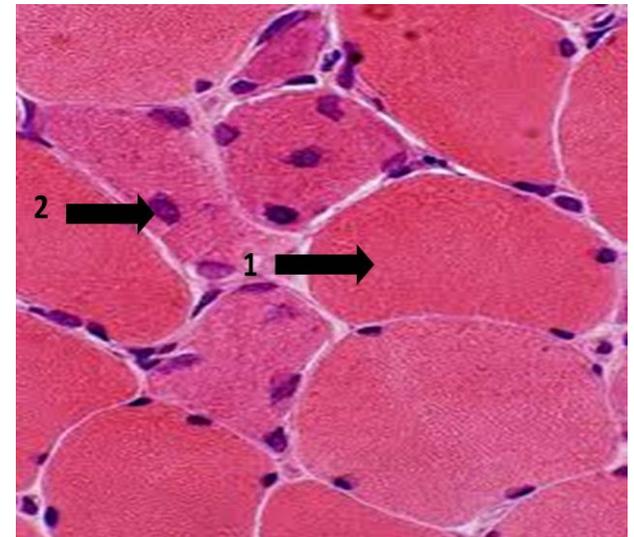
- Stains basic (cationic +ve) components of the cell with a red color e.g. cytoplasm (proteins).
Acidophilic structure=red



2-Hematoxylin (H) :

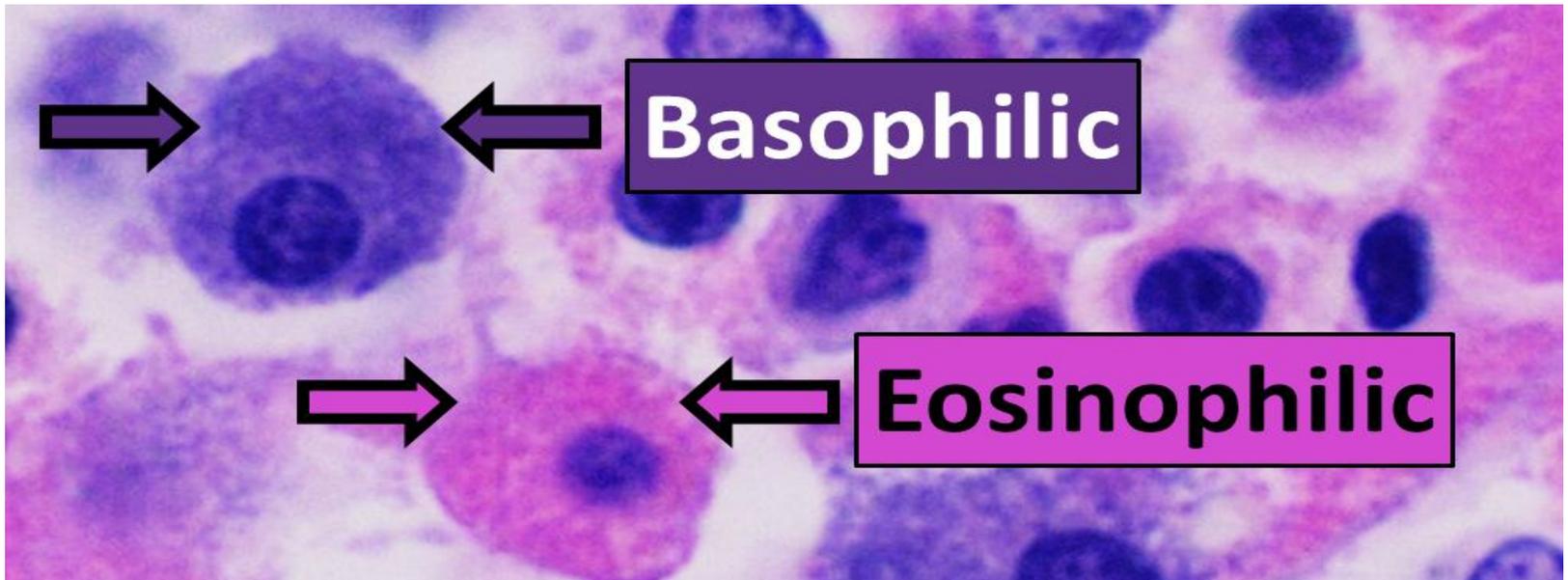
blue basic dye (+ve charged)

- Stains acidic (anionic -ve) components of the cell with a blue color e.g. nucleus, ribosomes (r-RNA).
Basophilic structure=blue



Routine Stain : Hematoxylin & Eosin
Colour: blue & red

- Acidic substance (Nucleus DNA+RNA) + Basic dye (Hematoxylin) → blue colour → **Basophilia**
- Basic substance (cytosol) + Acidic dye (Eosin) → red colour → acidophilia (eosinophilia)



What we will discuss about cell organelles?

Definition:

Site:

Structure:

-L/M:

-E/M:

Functions:

MITOCHONDRIA

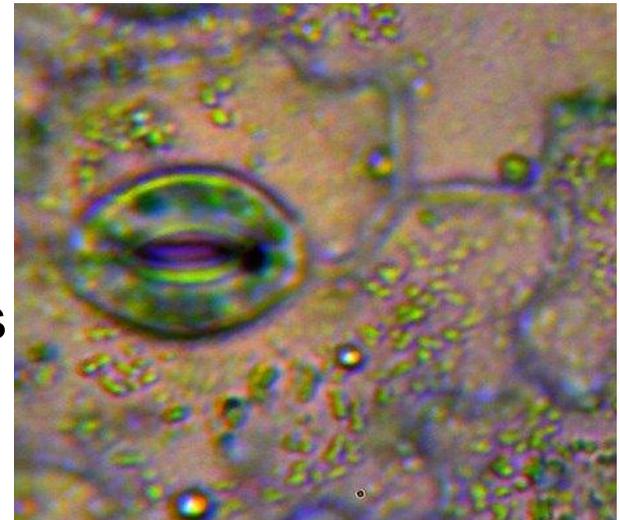
- **Definition:** membranous organelles. (Mitos = thread; chondrion = granule)
- **Site:** present in all cells *except* mature red blood cells.
- **Size & Number & shape:** characteristic for each specific cell.

-increased in number in cells with high metabolic activity
e.g: may reach 2000 in each liver cell.

- **Structure:**

- L/M:**

- **By ordinary H&E stain:** could not be seen
 - **By special stain: (Janus green B)** appears green
 - shape: thread-like, rod-shaped or granules.



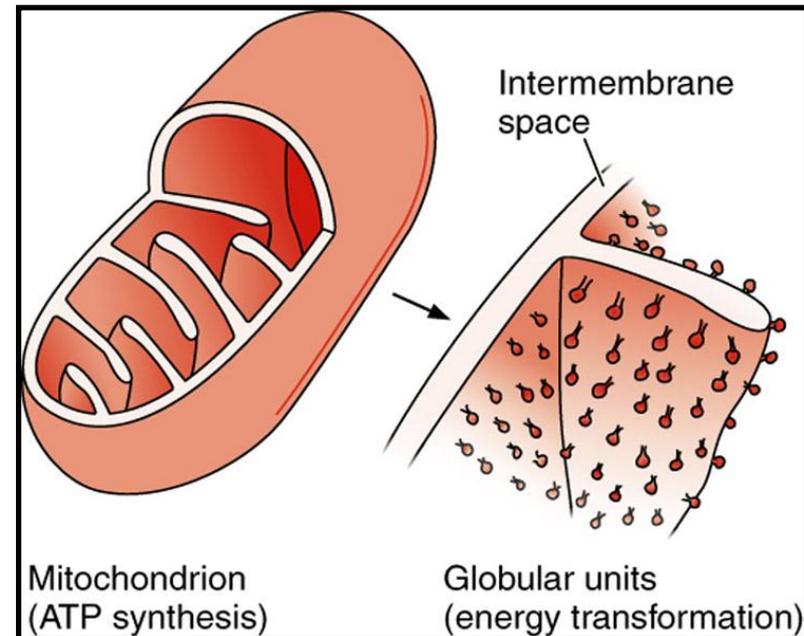
2 membranes: Each is trilaminar (unit membrane)

- *outer membrane:* Smooth.
- *inner membranes:* Folded forming *cristae* to increase surface area. (increased with high energy requirements as in cardiac muscle cells).

Elementary particles are club-shaped structure attached to the inner surface of the inner membrane. In which $\text{ADP} + \text{inorganic phosphate} + \text{energy} \rightarrow \text{ATP}$.

2 spaces:

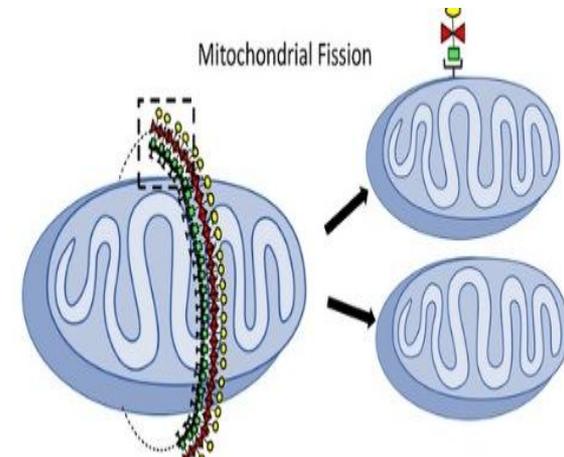
- *Intermembrane space:* narrow space between inner and outer membranes.
- *Matrix space:* large space enclosed by the inner membrane.



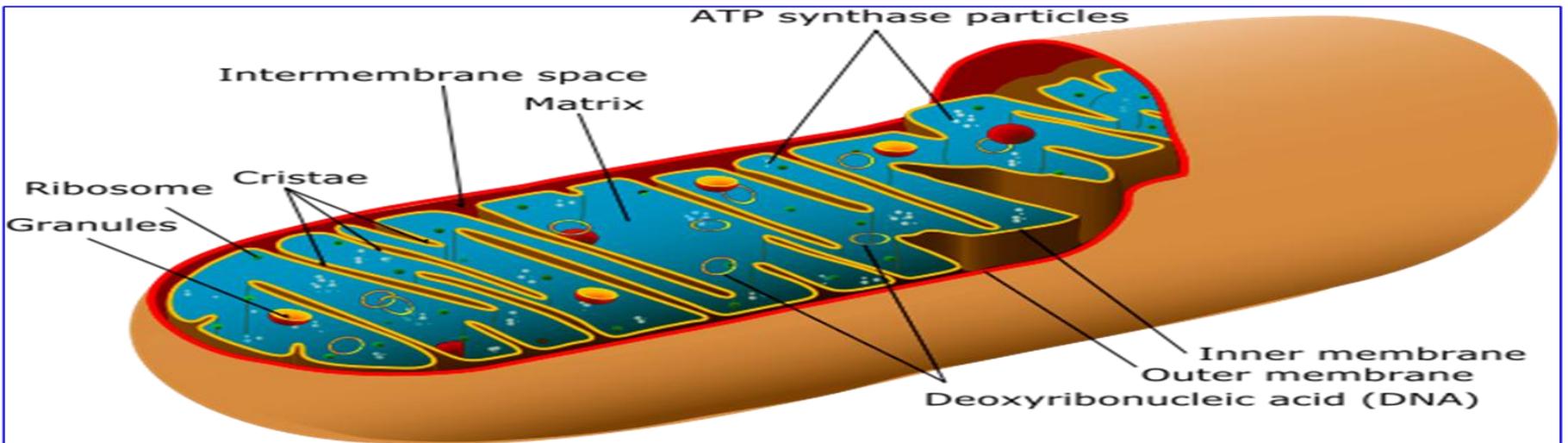
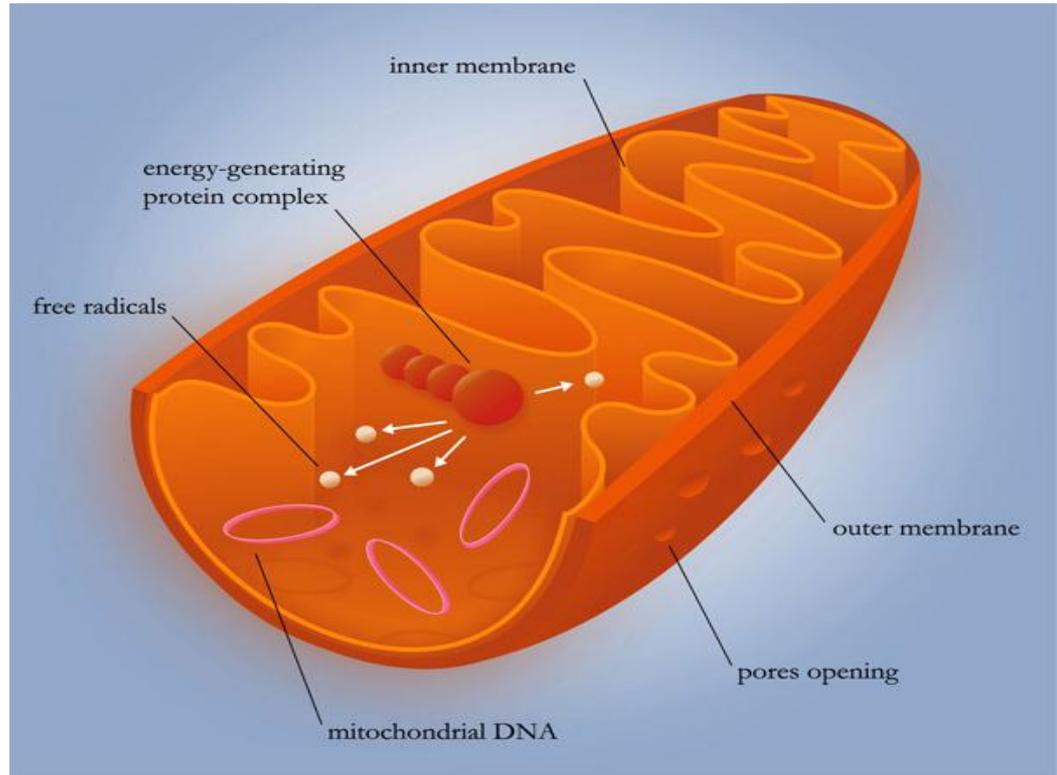
- **Matrix:** filled with dense fluid composed of:
 - Enzymes of kreb's cycle (citric acid cycle).
 - Mitochondrial ribosomes, transfer RNA and messenger RNA.
 - Double-stranded mitochondrial circular DNA.
 - Few electron dense granules consisting of divalent cations (Ca^{+2}).

Functions of Mitochondria:

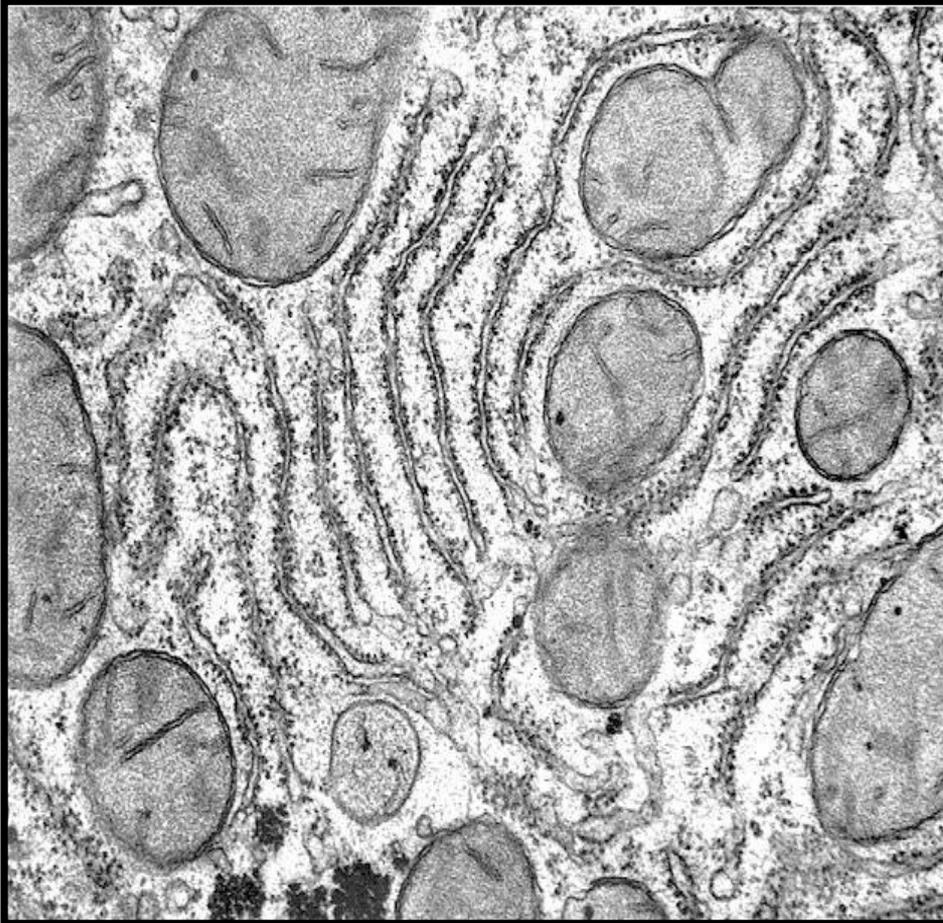
- Production of energy as mitochondria are the power houses of the cell as they produce adenosine triphosphate (ATP).
- Concentration of calcium.
- Mitochondria possess their own DNA & RNA, so they can synthesize small proportion of their proteins (e.g. enzymes).
- Mitochondria are self replicating organelles. They increase in size, replicate their DNA and undergo fission.



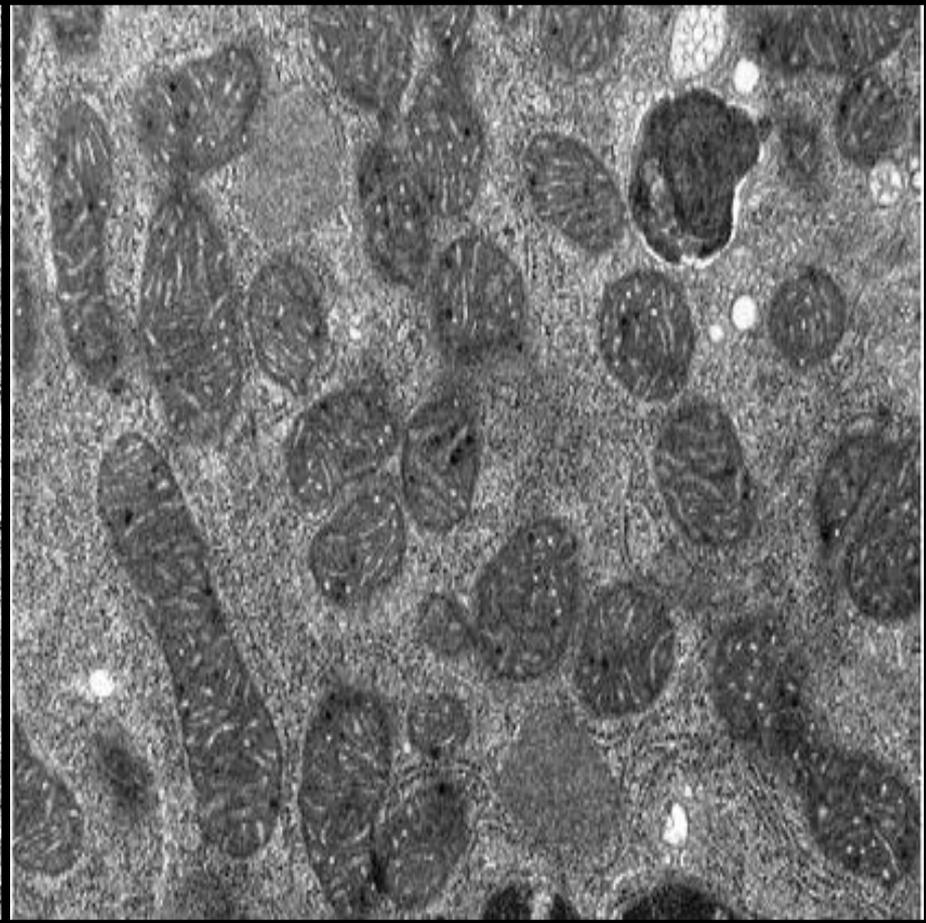
Mitochondria



E/M of mitochondria



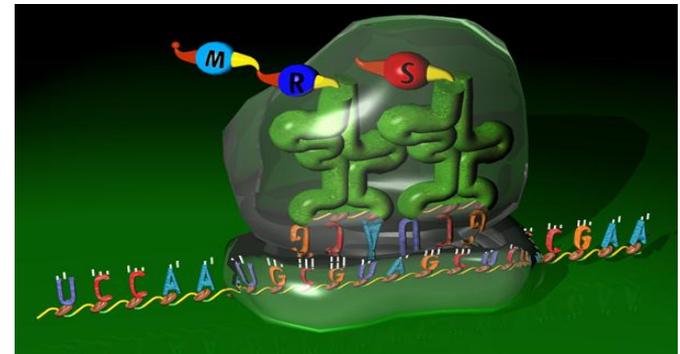
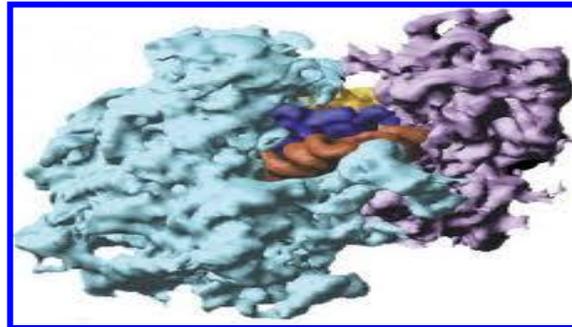
Inactive cell



Active cell

RIBOSOMES

- **Definition:** non-membranous cell organelles.
- **Sites:**
- They are present in all cells Except mature red blood cells.
- Increases in number in **protein synthesizing cells.**
- **Site of their formation:**
the nucleolus and then pass to the cytoplasm to perform their functions.

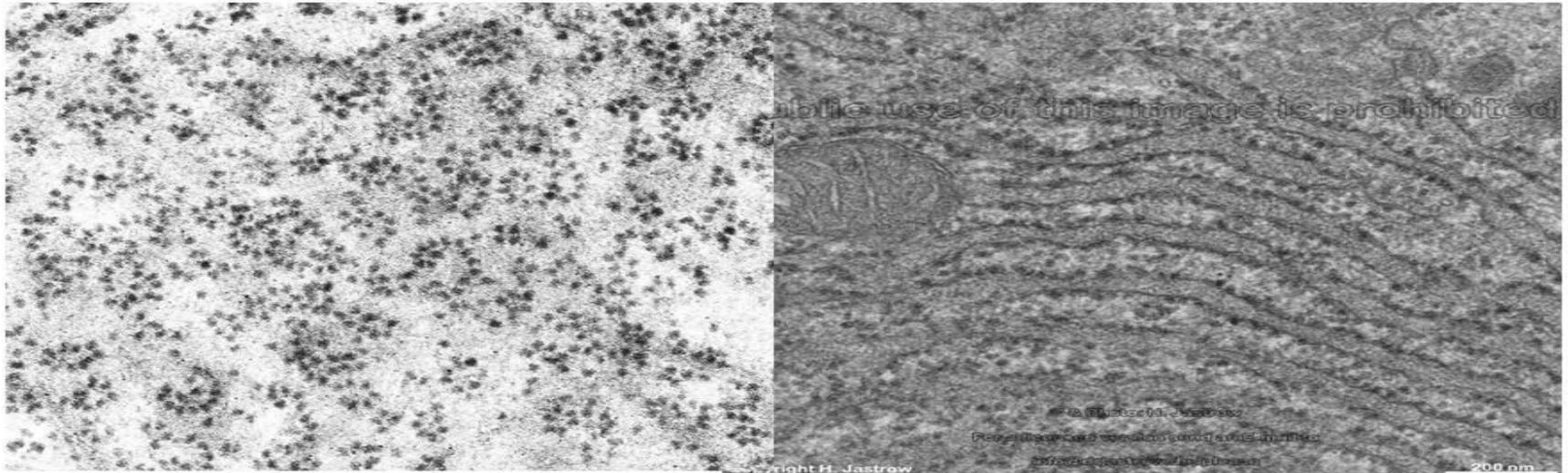


Types:

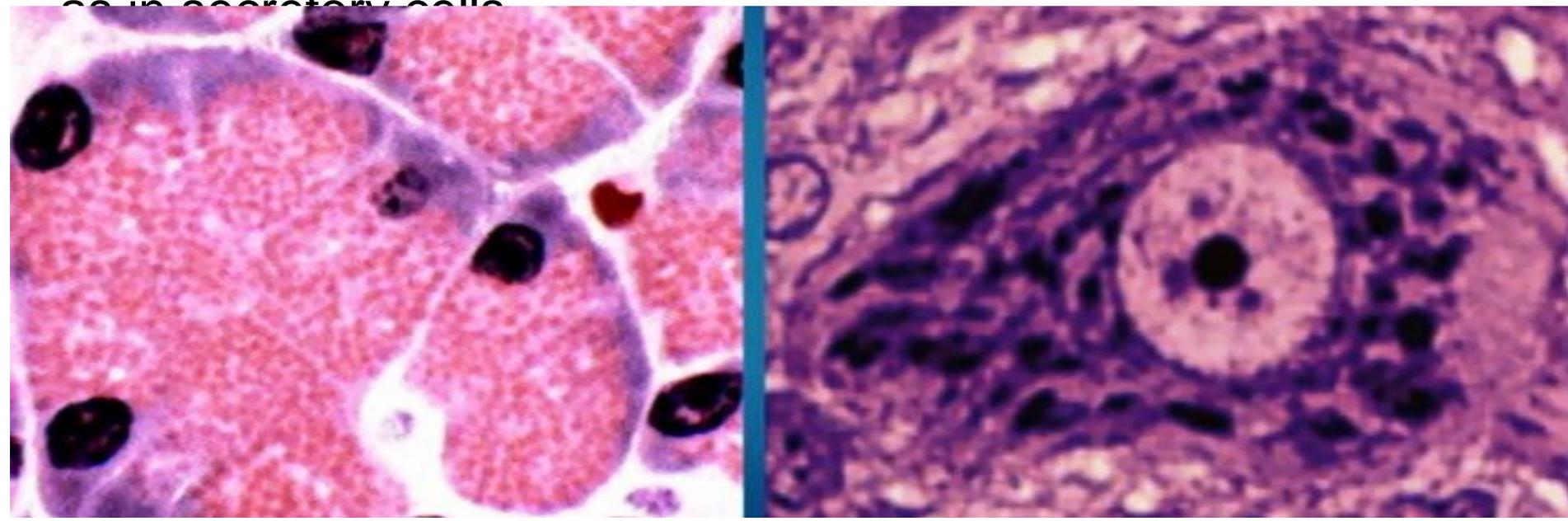
- ❑ **Free ribosomes** are scattered in the cytoplasm
- ❑ **Attached ribosomes** are attached to the rough endoplasmic reticulum (rER)

Free

Attached

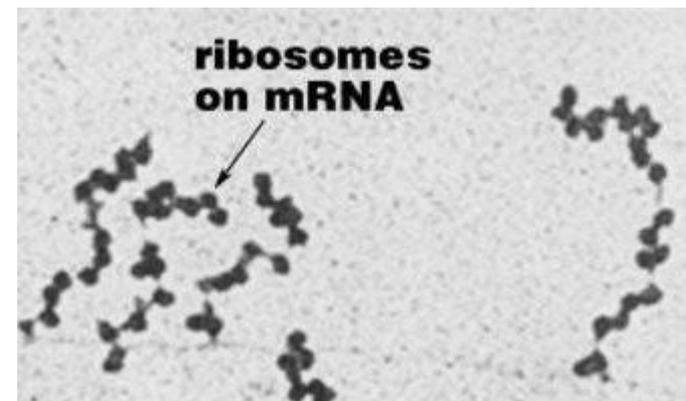
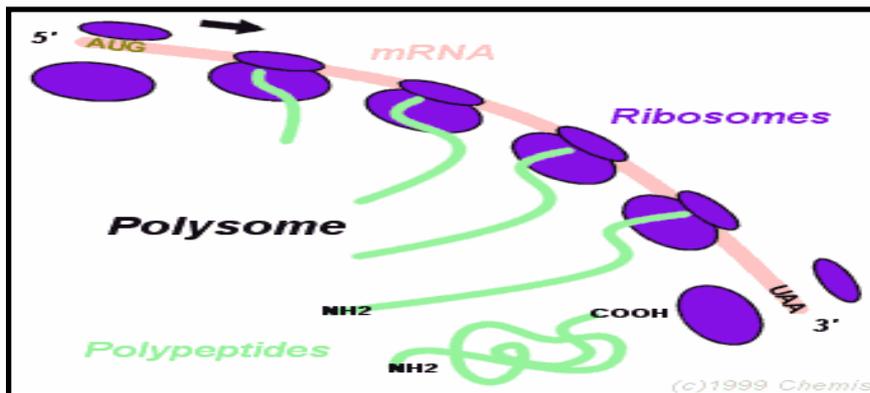
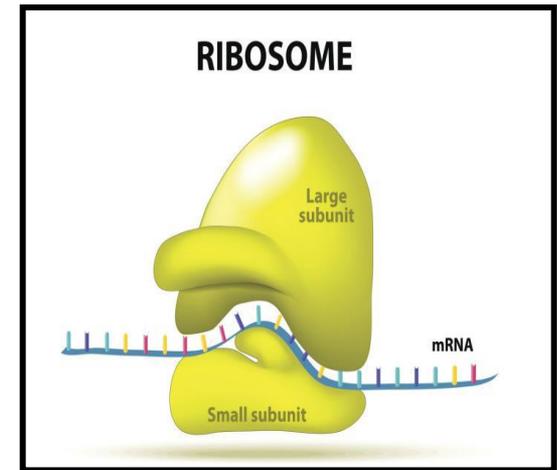


- **Structure:** consist of: granules of nucleoproteins
 - ❑ Two thirds ribosomal ribonucleic acid (rRNA). Formed into the nucleolus.
 - ❑ One third proteins. Formed into the cytoplasm.
- L/M:*** by H&E: basophilic (blue) due to their content of rRNA.
 - This basophilic reaction might be:
 - 1-Diffuse basophilia:** due to presence of free ribosomes as in growing cells.
 - 2-Localized basophilia:** due to presence of attached ribosomes as in secretory cells.



- E/M:

- Low magnification:
- ribosomes appear as small electron dense particles.
- High magnification:
- each ribosome consists of two subunits:
 - Small subunit
 - Large subunit
- Ribosomes also appear in small groups held together by a fine thread of mRNA forming **polysomes**, which may be free or attached to rER.



Functions:

□ Protein synthesis.

- Free ribosomes

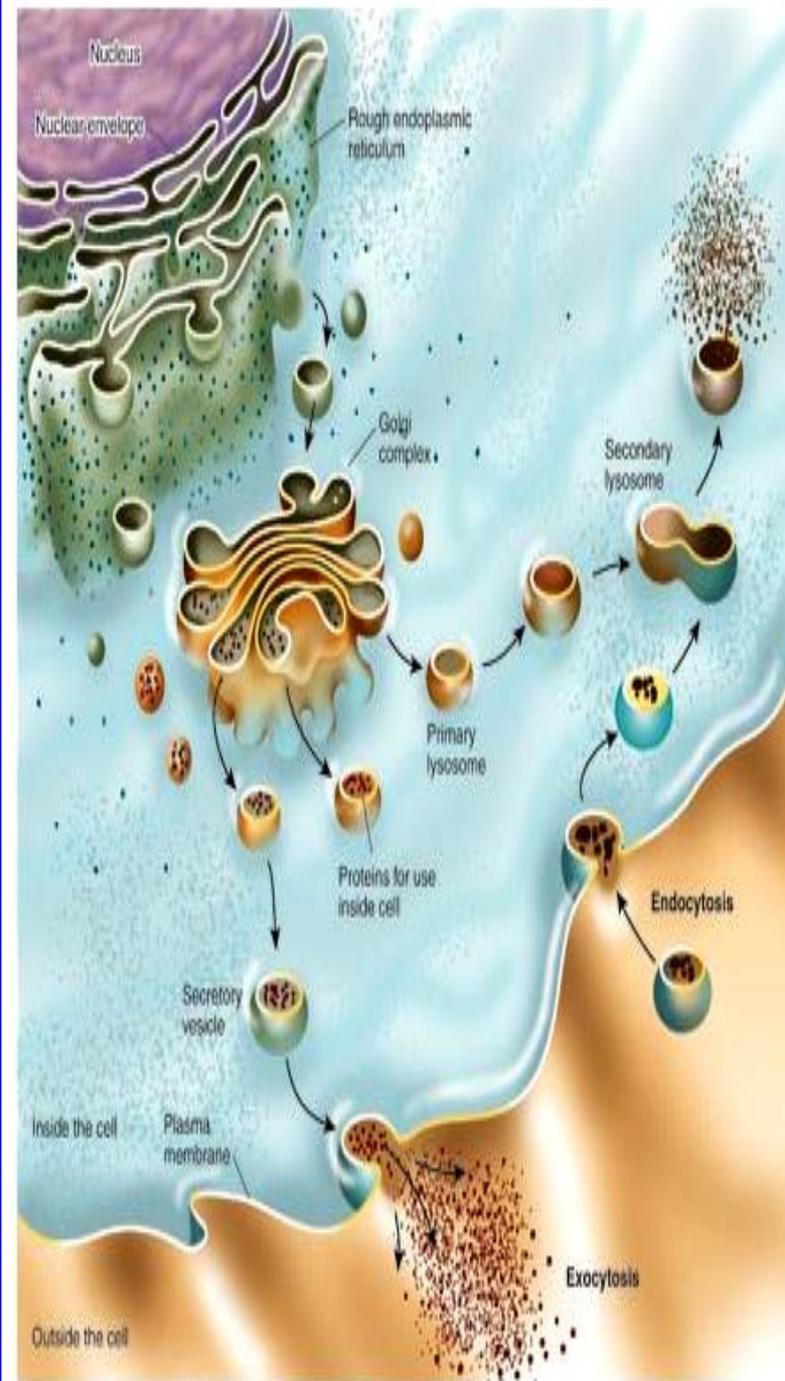
responsible for synthesis of **structural proteins** such as:

- a) Cell's cytoskeleton.
- b) Various enzymes.
- c) Protein for internal use of the cell.

- Attached ribosomes

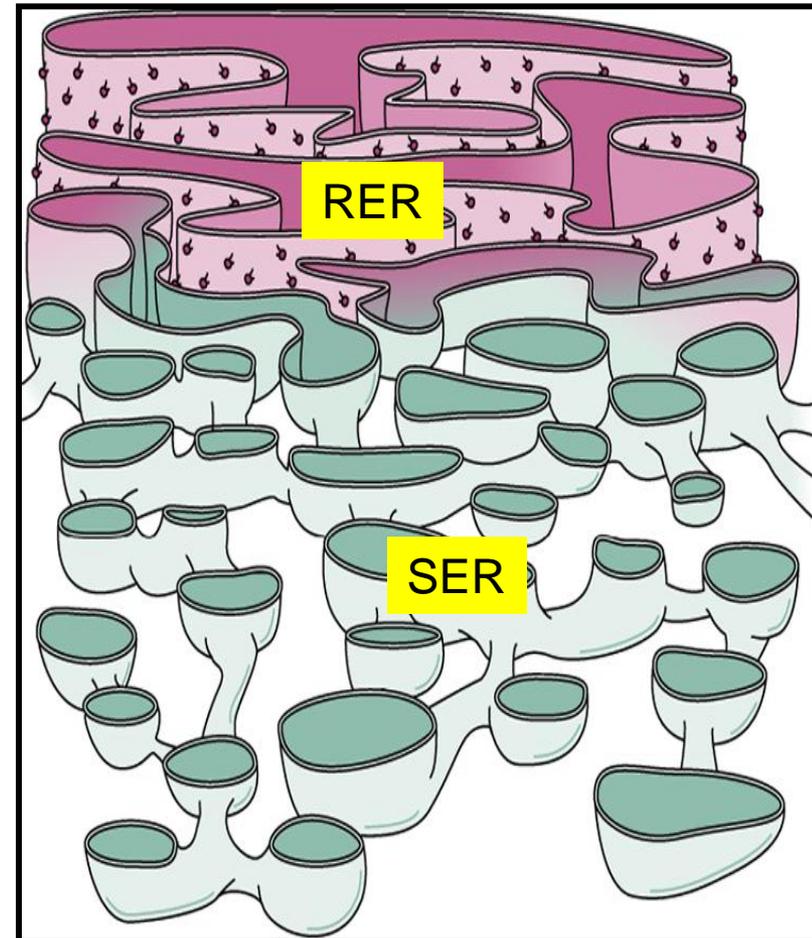
responsible for synthesis and segregation of protein which may be:

- a) Secretory proteins.
- b) Lysosomal enzymes.
- c) Plasmalemmal proteins.



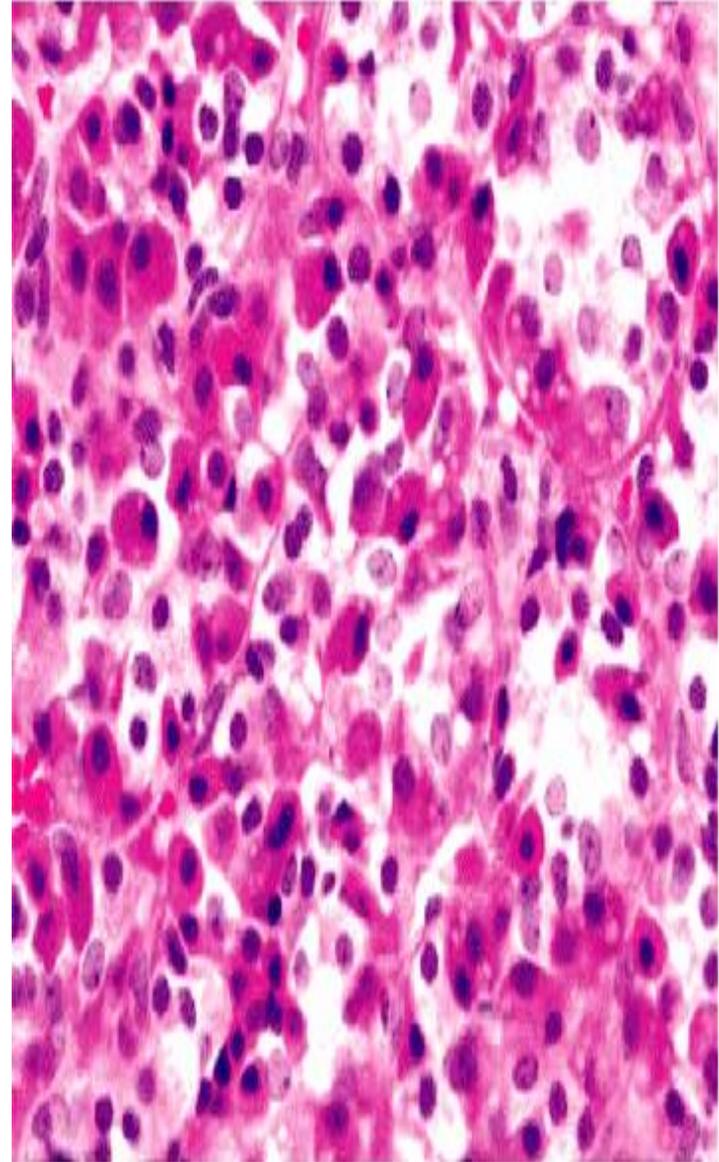
ENDOPLASMIC RETICULUM (ER)

- **Definition:** membranous organelle formed of flattened communicating **vesicles** and **tubules** that form a reticulum (network) in the cytoplasm.
- **Types:** *two* forms of ER and both are continuous with each other:
 - Smooth endoplasmic reticulum (SER) without attached ribosomes.
 - Rough endoplasmic reticulum (RER) with attached ribosomes.



Smooth Endoplasmic Reticulum (SER)

- **Site:** present in large amount in cells that synthesize lipid, cholesterol (e.g liver cells) and steroid hormones (e.g. endocrine cells).
- **Structure:**
- ***LM:*** By H&E stain: Give **acidophilic** when present in enough amount.
- ***EM:*** It is made of smooth-surfaced network of anastomosing tubules **without ribosomes** on its membranes.



▪ Function of SER:

SER performs different functions according to the type of the cell:

- ❑ In adrenal cortex e.g steroid secreting cells, it synthesizes steroid hormones.
- ❑ In liver cells:
 1. **detoxification** of certain drugs.
 2. **glycogen breakdown** to glucose (glycogenolysis)
 3. conversion of **glucose into glycogen** (glycogenesis).
- ❑ Synthesis of phospholipids for all cell membranes.
- ❑ In skeletal and cardiac muscle it regulates the calcium level essential for muscular contraction.

Rough Endoplasmic Reticulum (RER)

- **Site:** It is prominent in cells **specialized for protein secretion**
e.g:

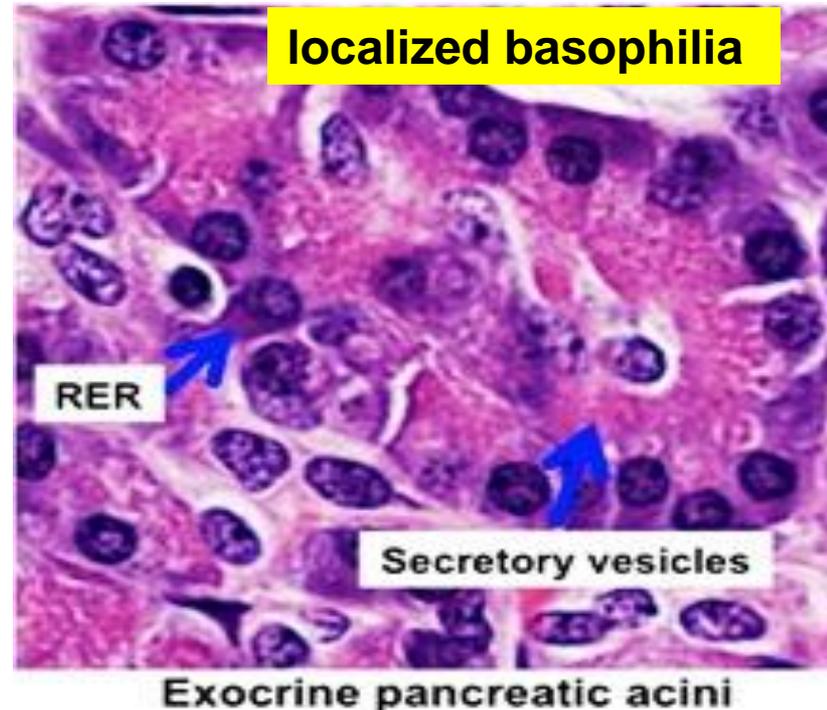
1- Pancreatic cells (digestive enzymes).

2- Plasma cells (immunoglobulins).

- **Structure:**

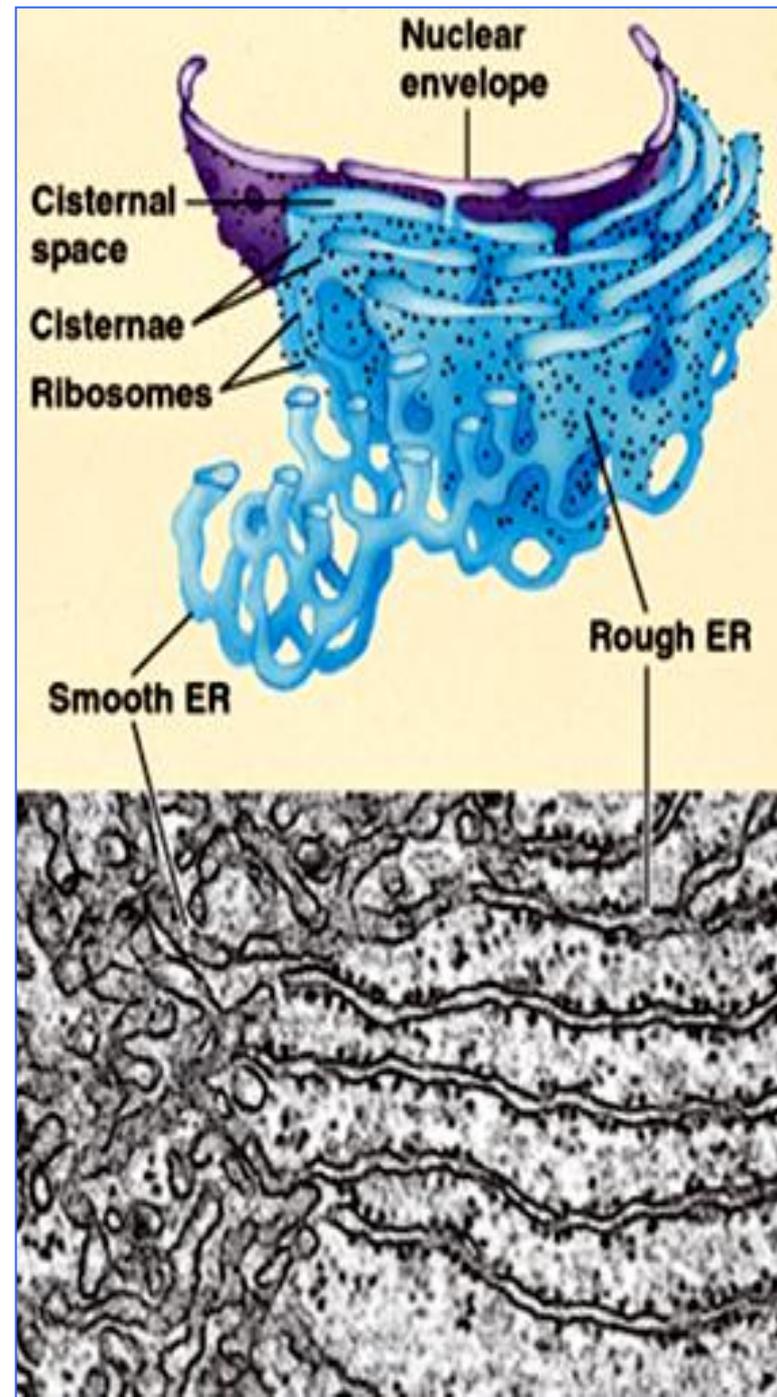
L/M: By **H&E stain:**

RER causes **localized cytoplasmic basophilia** due to the presence of ribosomes and polyribosomes attached to it.



E/M:

- It consists of **network of parallel tubules and parallel flattened cisternae (sacs)**.
 - Its outer surface is studded with ribosomes.
- **Functions of RER:**
- 1- Synthesizes cellular proteins that are segregated from the cytosol. As:
 - Secretory proteins (exported proteins).
 - Lysosomal enzymes.
 - Plasma membrane integral proteins.
 - 2-Renewal of immature face of Golgi.

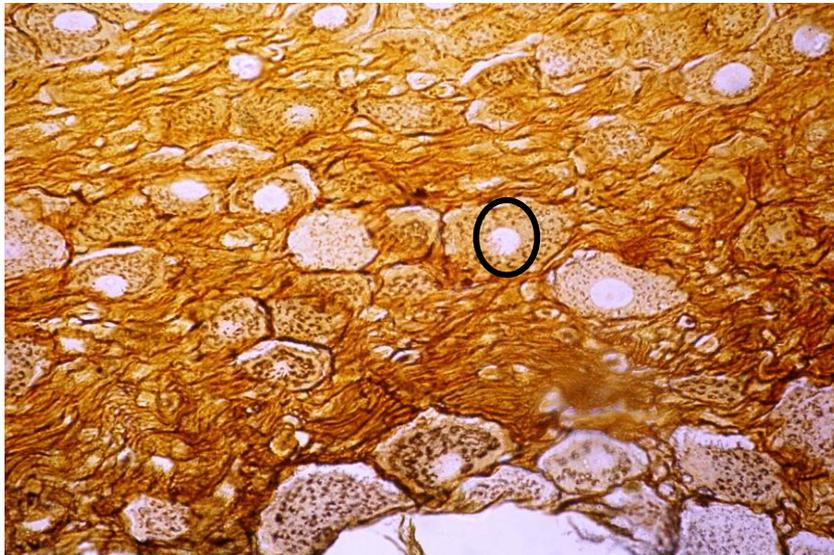


GOLGI APPARATUS (Golgi complex)

Structure - L/M:

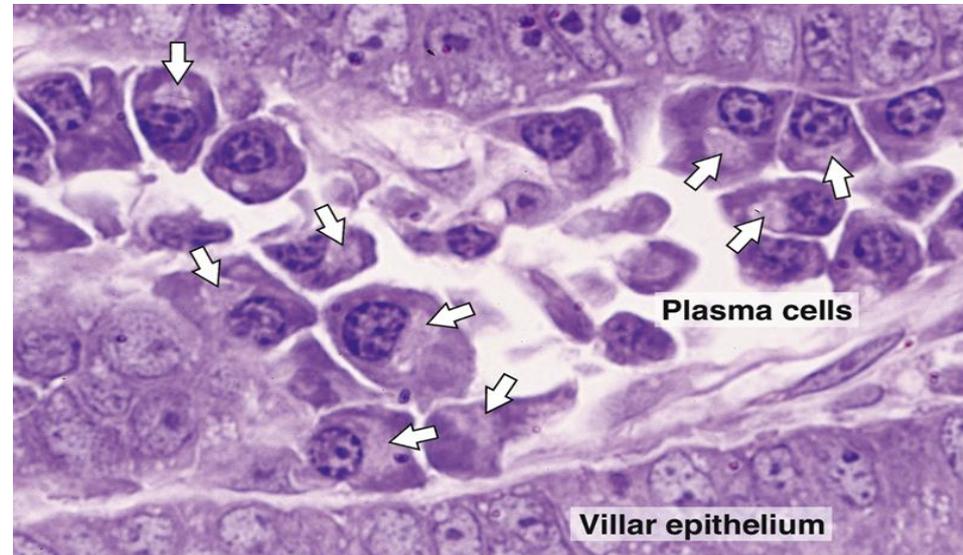
By silver or osmium tetroxide,

appears as darkly stained network located **near the nucleus.**



By H&E stain: appears as **clear unstained area** near the nucleus

.This pale area is called **negative Golgi image** seen in intensely basophilic cytoplasm of *plasma cells.*

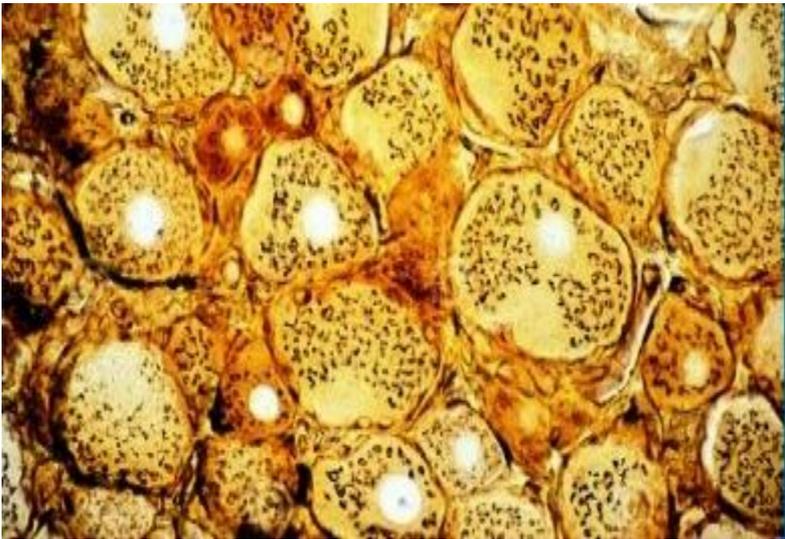


Site:

- Well developed in secretory cells.
- Sometimes there are **multiple** Golgi in one cell.

-its site varies according to the cell type

- Supranuclear in secretory cells
- Perinuclear (around the nucleus) in nerve cells



Perinuclear in nerve cells



Supranuclear in secretory cells

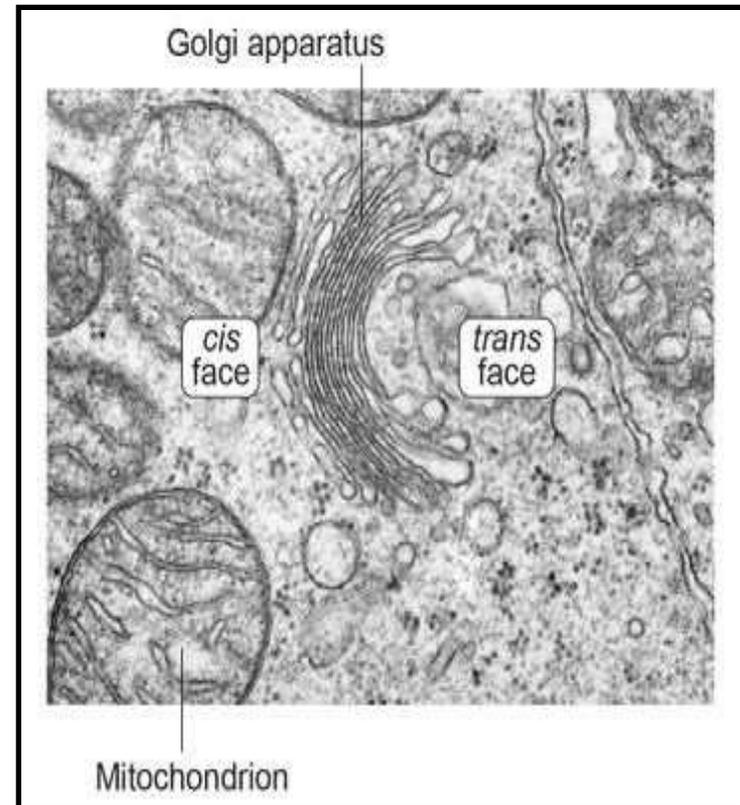
- **EM:** composed of
 1. **Golgi stacks**
 2. **Transport (transfer) vesicles**
 3. **Condensing vacuoles and secretory vesicles**



1-Golgi stacks

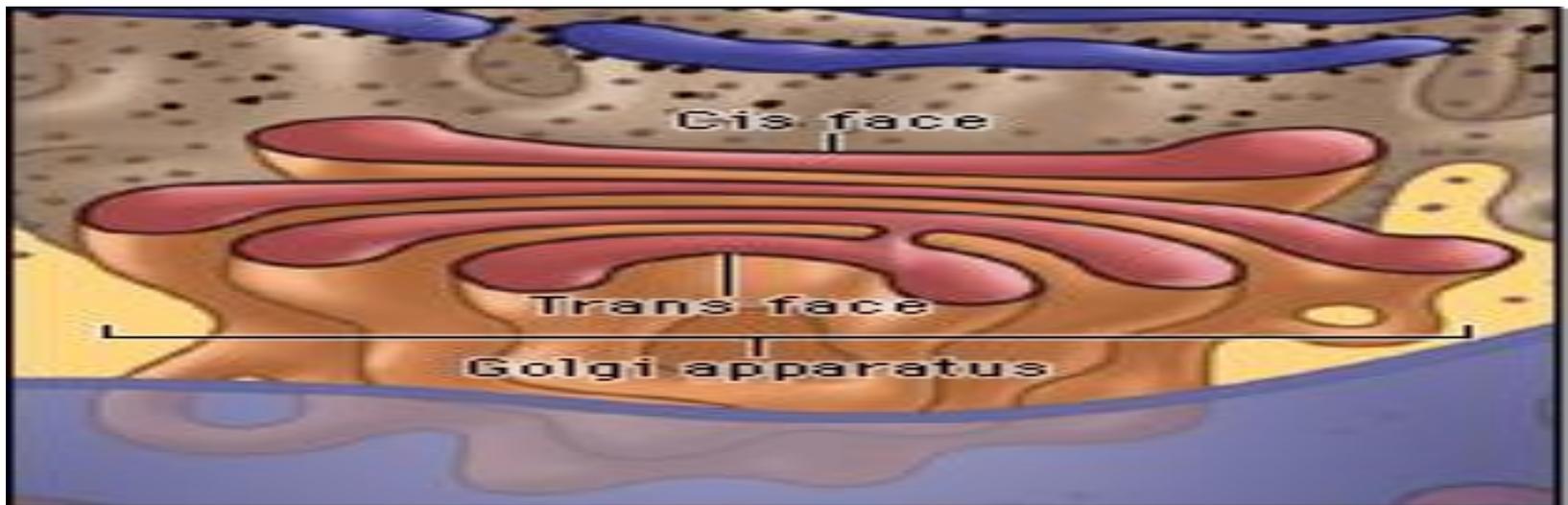
Each stack consists of slightly curved flat saccules (small sacs) or cisternae (3-12 in number).

The periphery of each cisterna is dilated and surrounded by vesicles.



Each stack has two faces:

- ❑ **Cis-face** (immature or forming face) which is usually convex. It is directed towards rough endoplasmic reticulum.
- ❑ **Trans-face** (mature or secretory face) is usually concave and is directed towards the plasmalemma. Its lumen is wider than that of Cis face.
- ❑ The secretory products are moved through the stack (from cis-face to the trans-face) by vesicles budding off from one cisternae and fusing with the next in the stack.



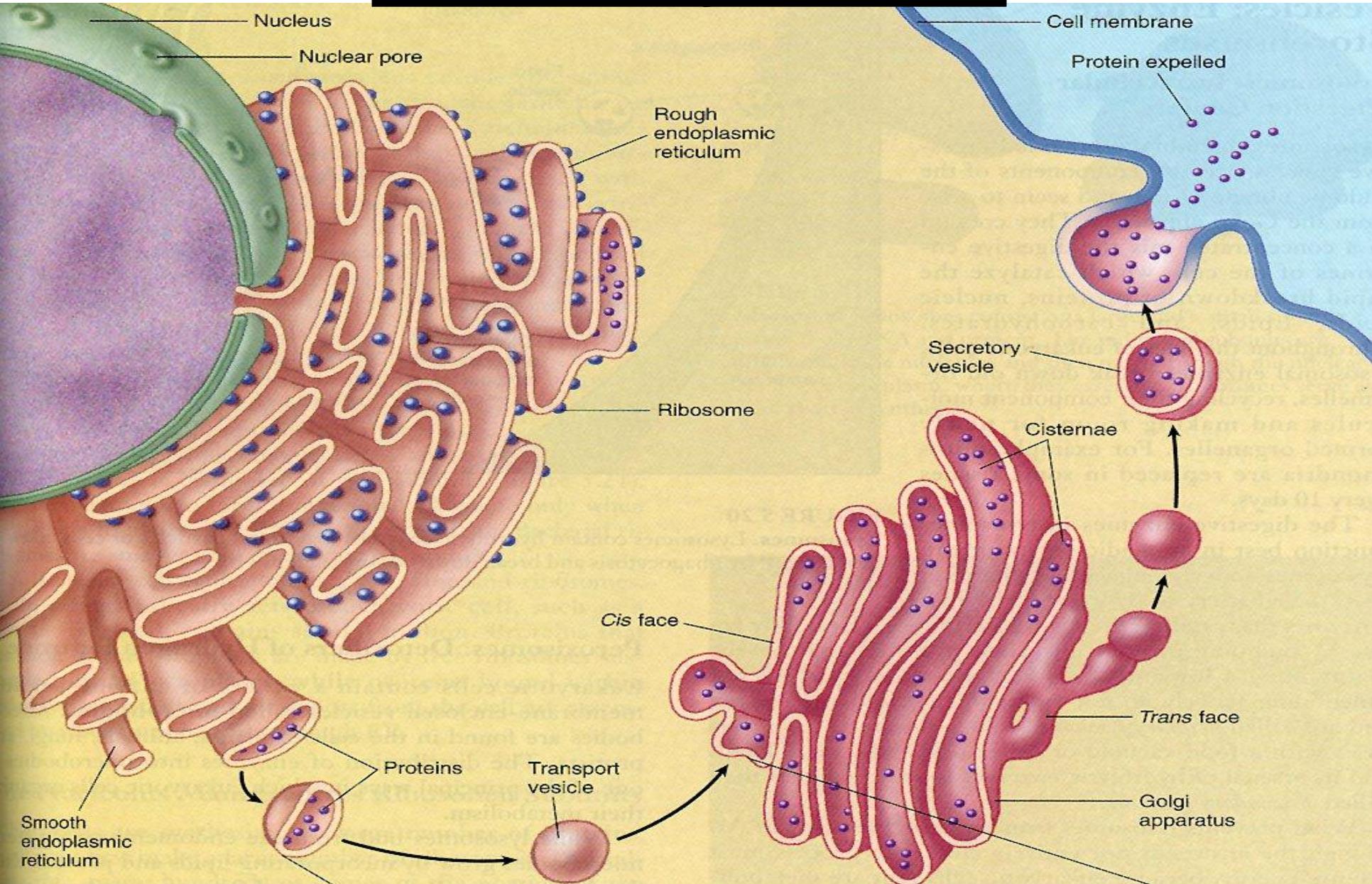
2-Transport vesicles:

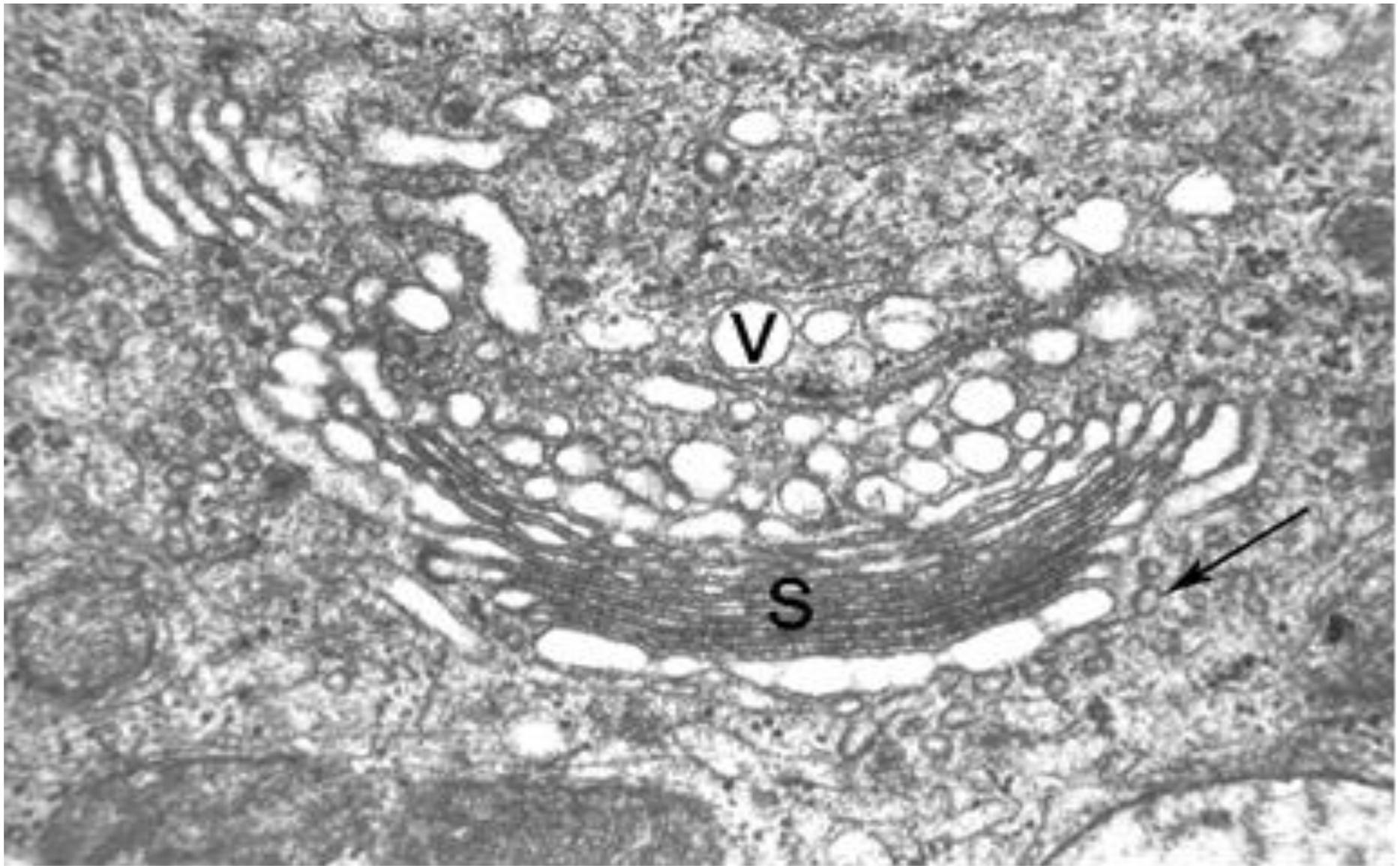
- pinch off from rER, migrate to the cis-face of Golgi and fuse with its dilated rim.
- carry newly synthesized polypeptides formed in rER.

3-Condensing vacuoles and secretory vesicles:

- Arise from the periphery of the trans-face of Golgi stacks.
- will be either:
 - Fusing with the cell membrane and release their contents to the exterior of the cell (**exocytosis**).
 - Remaining inside the cell and carry inside them hydrolytic enzymes forming primary **lysosomes**.

Protein synthesis





Golgi complex (E.M)

- **Function of Golgi apparatus:**

1- **Modification and secretion** of proteins generated in RER .

2- **Concentration, condensation and packaging** of secretory proteins into secretory vesicles.

3- Formation of membrane proteins.

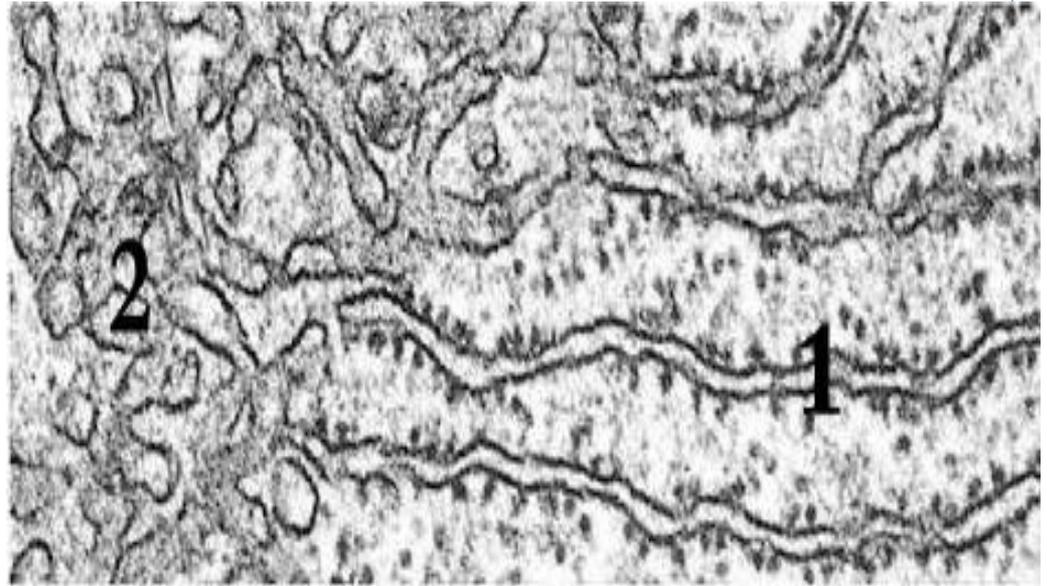
4- **Modification**, segregation and packaging of lysosomal enzymes to protect the cells from their hydrolytic action.

Examine your self

A) Label the following picture:

1.....

2.....



B)

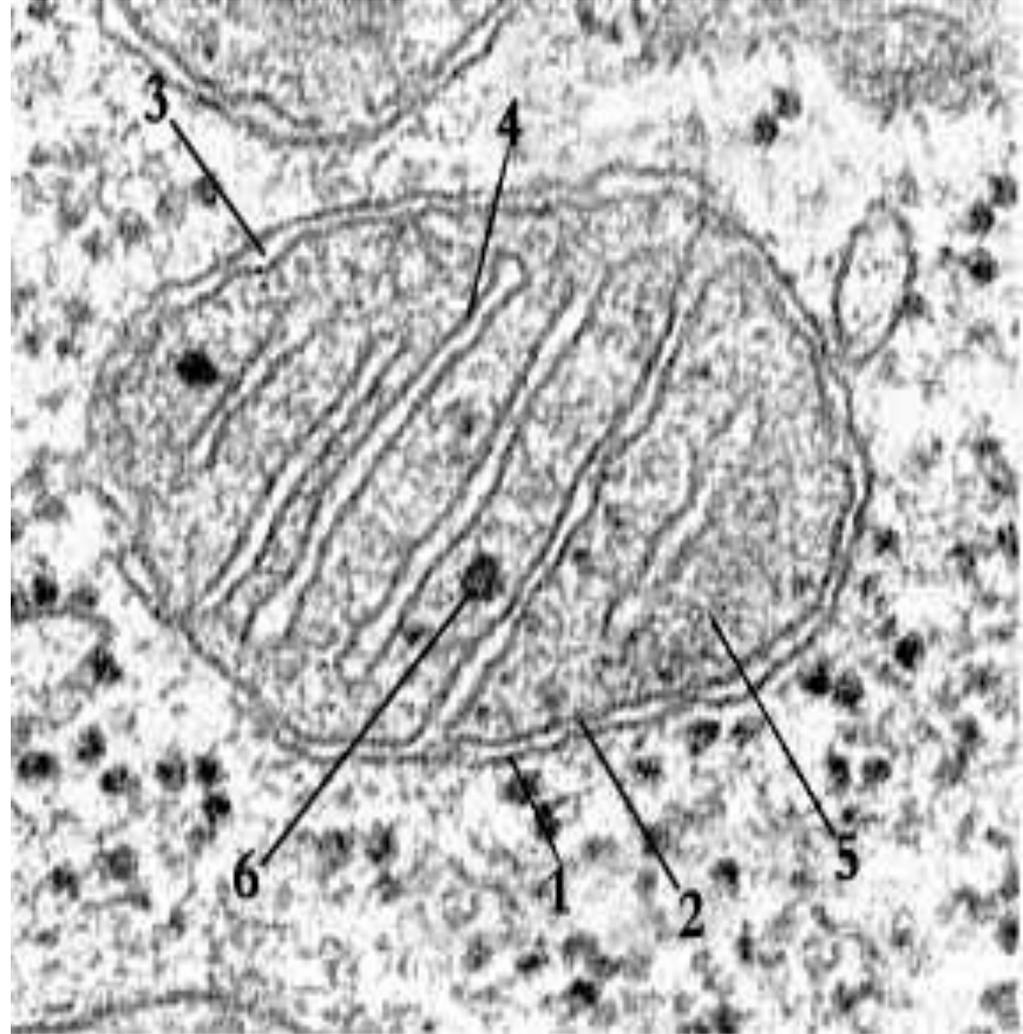
The labeled organelle in the previous EM picture is

- The arrow refers to
- "S" letter refers to.....
- "V" letter refers to
- This organelle has two faces called:
- &
-



C) Label the following E.M picture:

- 1-.....
- 2-.....
- 3-.....
- 4-.....
- 5-.....
- 6-.....





THANK
YOU