

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



# Membranous Organelles



Cell Biology

Semester 1, Year 1

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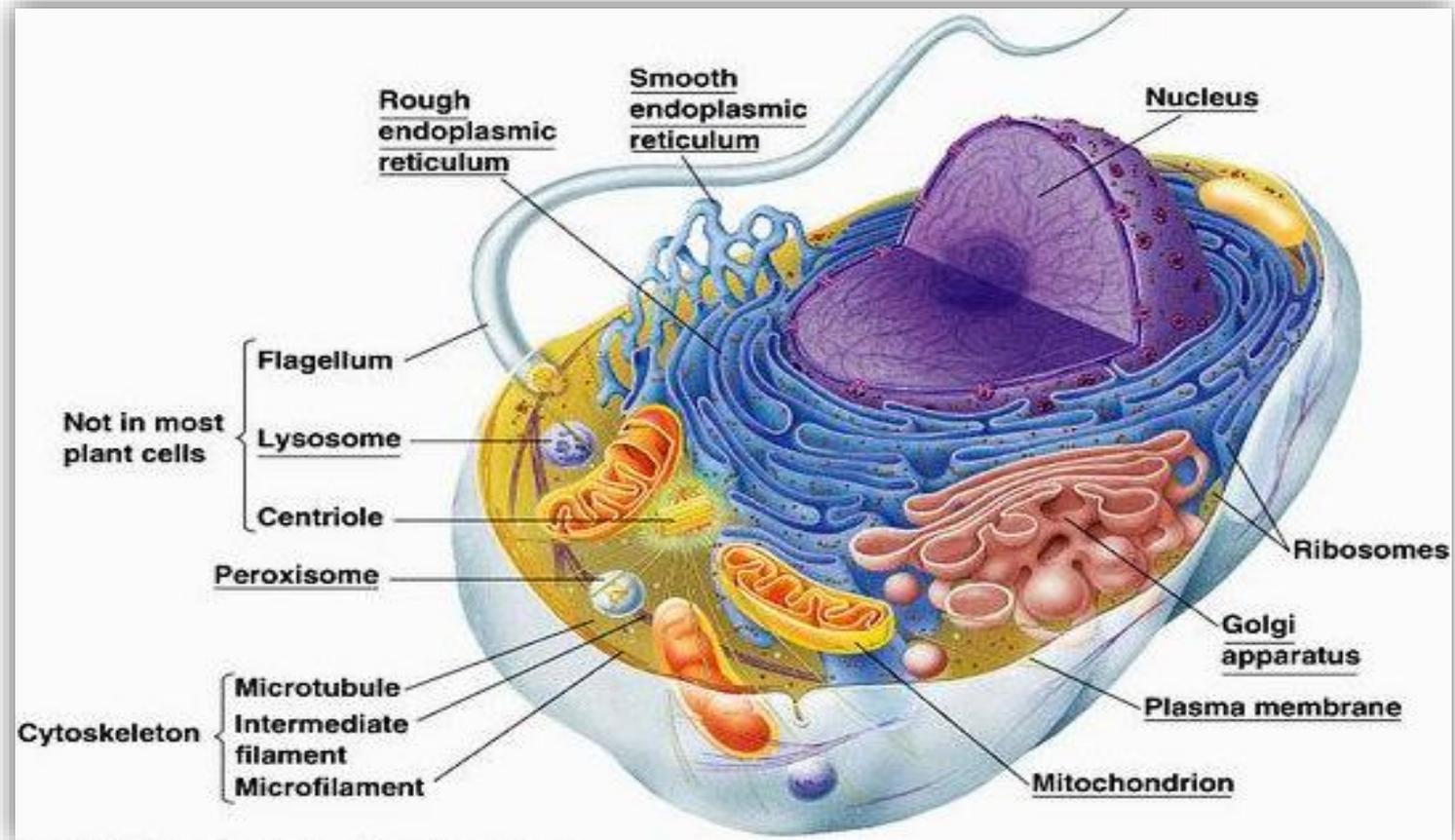
# Cytoplasm

## Learning objectives:

1. Describe the structure of Mitochondria.
2. Predict functions of Mitochondria.
3. Describe the structure of SER, RER.
4. Predict functions of SER, RER.
5. Define Golgi Apparatus and Lysosomes.
6. Describe the structure of Golgi Apparatus and Lysosomes.
7. Predict functions of Golgi Apparatus and Lysosomes .

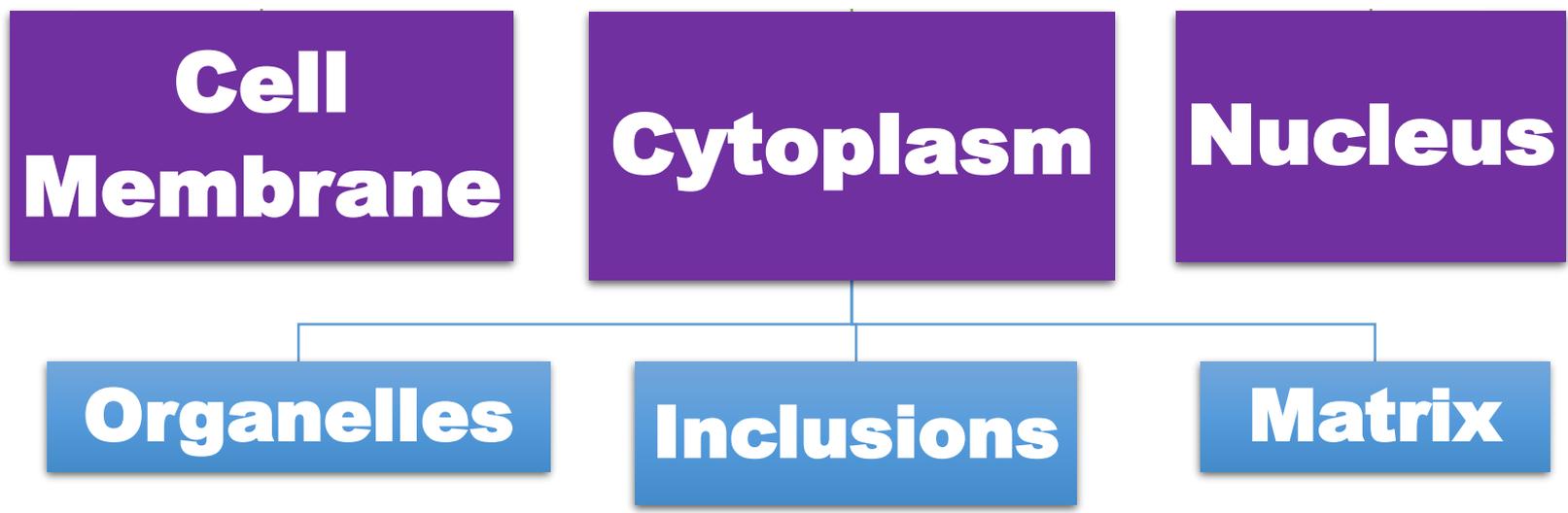


# THE CELL



# THE CELL

Structural & functional unit of the body



# Organelles

## Membranous

**Mitochondria**

**rER**

**sER**

**Golgi**

**apparatus**

**Lysosomes**

**Peroxisomes**

## Non- membranous

**Ribosomes**

**Centrioles**

**Microfilament**

**Microtubules**

**Cilia**

**Flagella**

# MITOCHONDRIA

- **Definition:** Mitochondria are **membranous** organelles, it is power house of the cell.
- **Site:** They are present in all cells except mature erythrocytes ( red blood cells).
- **Size:** Their size, number and shape are characteristic for specific cell types.
- **Number:** Their number is increased in cells of high metabolic activity e.g. liver cells (may reach 2000 in each liver cell).

Mitochondria Come from cytoplasm in the EGG cell during fertilization

Therefore ...

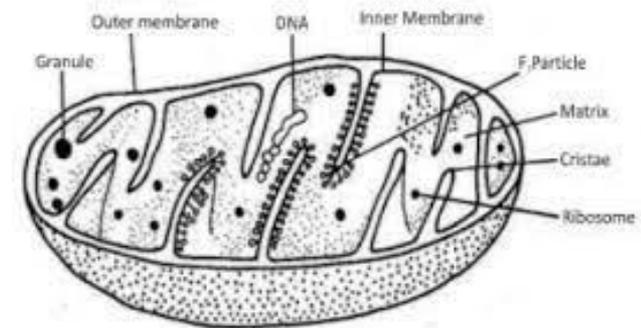
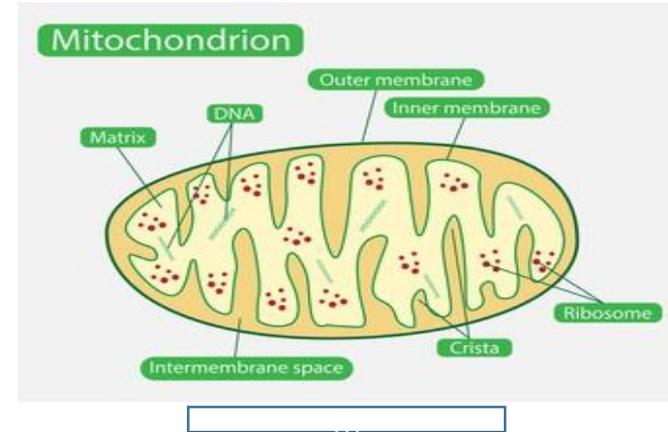
**You inherit your mitochondria from your mother!**



# Structure of mitochondria:

L/M:

- Mitochondria need special stains to be seen. They can be stained **green** after supravital staining with dyes such as Janus green.
- They appear as thread-like, rod-shaped, ovoid or granules.

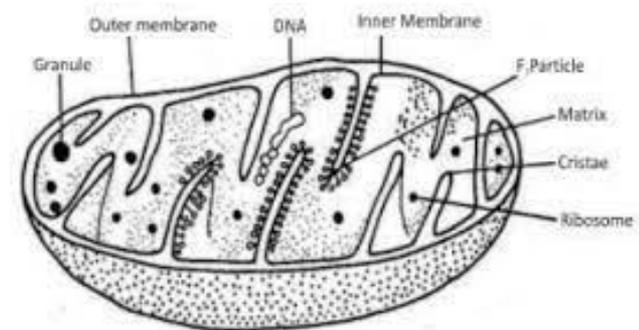
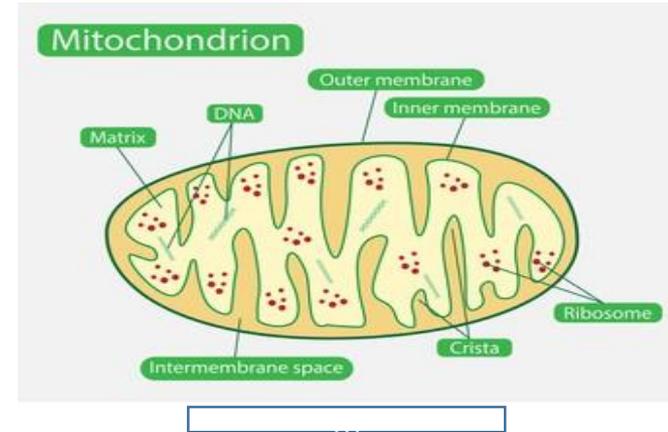


# Structure of mitochondria:

E/M:

a rounded or oval vesicle, surrounded by two membranes and **intermembranous space** in-between. The **outer** membrane is **smooth**, while the **inner** is **folded** and projects as shelf-like structures called **cristae**.

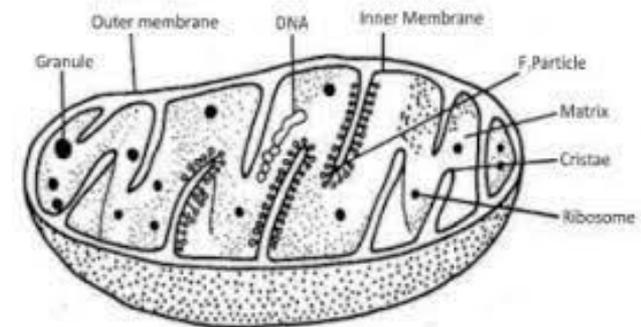
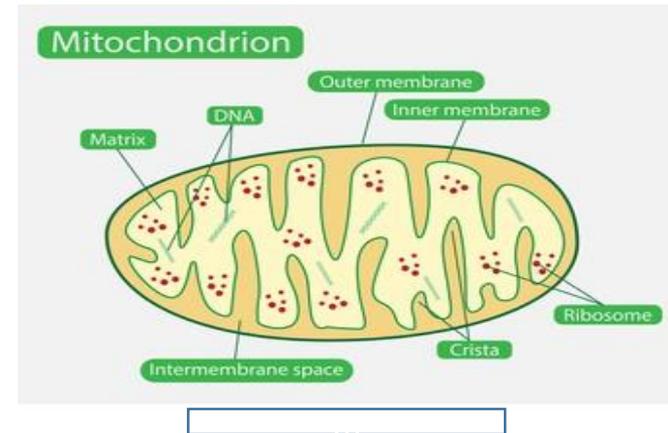
The mitochondria are filled with fluid called **matrix**, which appears finely **granular**.



# Structure of mitochondria:

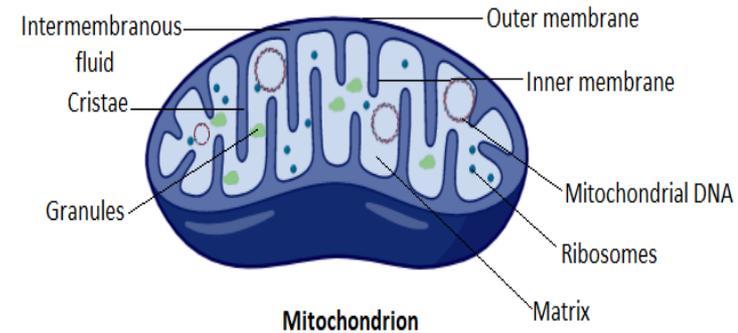
## Matrix contains:

- 1-Proteins: mainly enzymes of kreb's cycle.
- 2-Ribosomes, RNA and DNA.
- 3-Dense granules contain calcium ions.



## Functions of Mitochondria:

- Mitochondria are the **energy house** (power house) of the cell needed for cellular metabolism (production of **ATP**).
- They **concentrate calcium** in their matrix leading to calcium regulation within the **cytoplasm**.
- Mitochondria possess their own ribosomes, DNA & RNA; so they can **synthesize proteins** (e.g. enzymes).



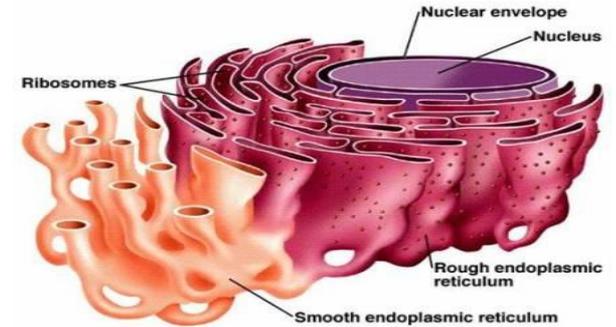
**N.B.** Mitochondria are self-replicating (i.e. they are generated from preexisting mitochondria) by **simple fission** as they turn over in 10 days.



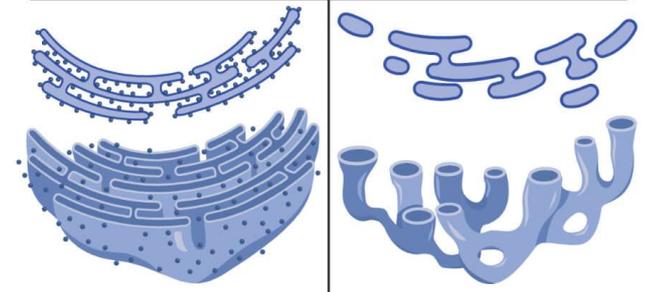
# ENDOPLASMIC RETICULUM (ER)

• Nearly all cells contain an extensive system of membrane-bounded **tubules** and **sacs** known as endoplasmic reticulum. There are **two** general categories of ER:

- **A-Smooth endoplasmic reticulum (sER)** without attached ribosomes.
  - **B-Rough endoplasmic reticulum (rER)** with attached ribosomes.
- Both are **continuous** with each other.



Differences Between Rough and Smooth Endoplasmic Reticulum



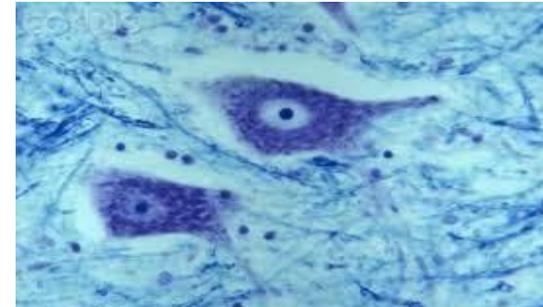
## A- Rough Endoplasmic Reticulum (rER)

- **Def** : a membranous organelle prominent in cells specialized for protein secretion

### Structure of rER: LM & EM

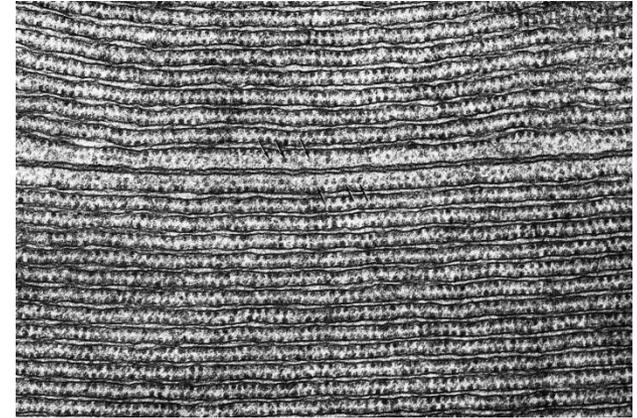
#### LM of rER: :

- It shows **localized cytoplasmic basophilia** which is due to the presence of **ribosomes and polyribosomes** attached to RER.

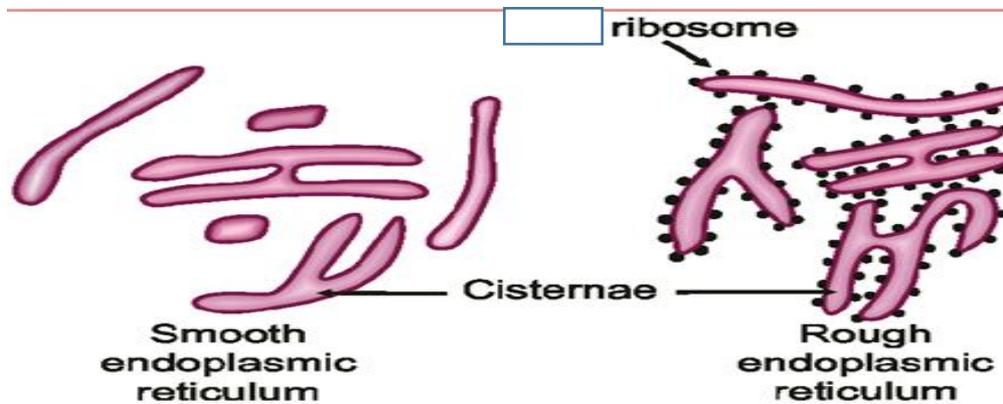


## EM of rER:

- It consists of parallel interconnecting membranous tubules, flattened sacs (cisternae).
- Its outer surface is studded with *ribosomes* and *polyribosomes* giving rough or granular appearance.
- It is continuous with the nuclear envelop.



Cisterna



3: Diagram showing RER and SER

## Functions of rER:

1- Formation of **secretory** proteins by the attached ribosomes

(i.e. Synthesis of proteins that will be secreted **outside** the cell).

2- Formation of lysosomal **enzymes**.

3- Formation of plasma membrane **integral proteins**.

4- SER may be derived from rER after losing ribosomes.



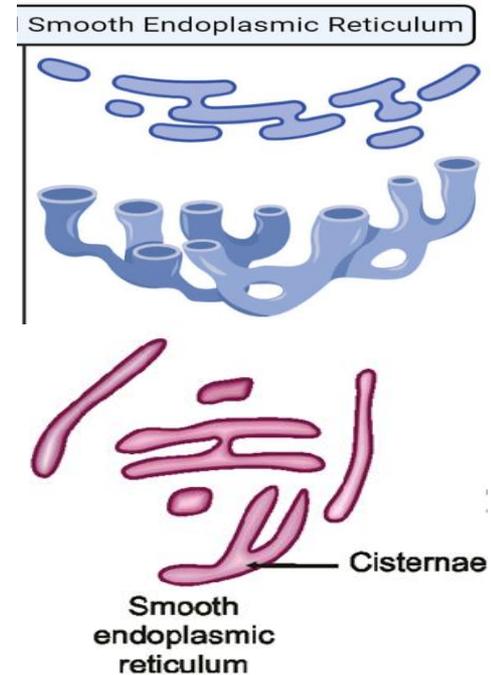
## **B- Smooth Endoplasmic Reticulum (sER)**

• Def : a membranous organelle present mainly in cells that synthesize **lipid, cholesterol** (e.g. liver cells) and **steroid hormones** (e.g. steroid secreting cells).

### **Structure of sER:LM &EM**

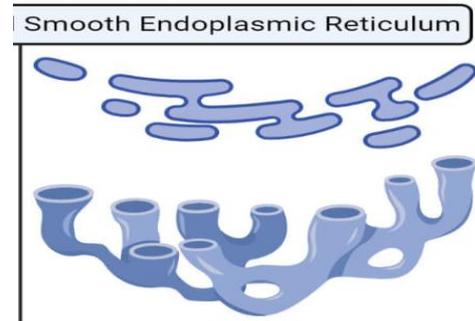
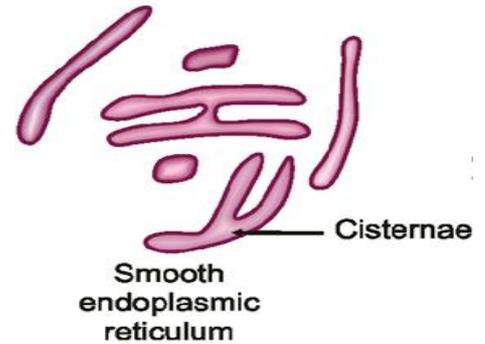
#### **LM of sER:**

sER colors the cytoplasm **acidophilic** when present in large amount.



• *EM of sER:*

- It is composed of smooth-surfaced **branching and anastomosing tubules** present in the cytoplasm (i.e. its membranes not studded with ribosomes).



## Function of SER:

- In different cell types, SER performs different functions:
  1. In **steroid secreting cells** /adrenal cortex,
  2. **detoxification** of certain drugs/ liver
  3. **glycogen , cholesterol &lipid** synthesis. /liver
  4. Calcium storage/ muscle



# GOLGI APPARATUS

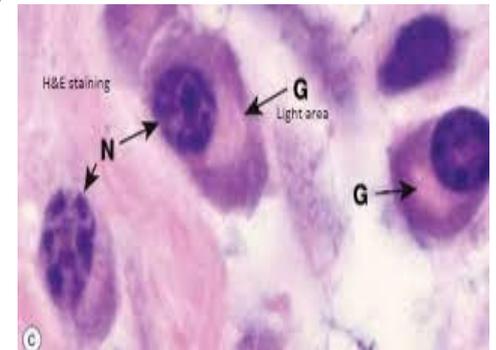
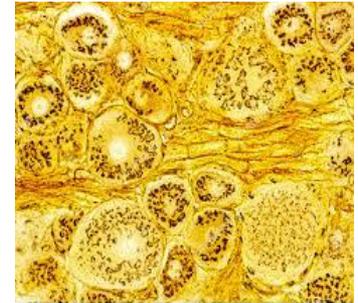
- Def: a membranous organelle found in nearly all cells.
- It is well developed in secretory cells.
- Sometimes there is multiple Golgi in one cell.



# LM of Golgi Apparatus

1- When stained with silver ;Golgi apparatus appears as **darkly brown stained network** located near the nucleus.

2- When the cells stained with Hematoxylin and Eosin, Golgi apparatus appears as clear **unstained** area near the nucleus. This pale unstained area is called **negative Golgi image** e.g. plasma cells ( which have intensely basophilic cytoplasm).

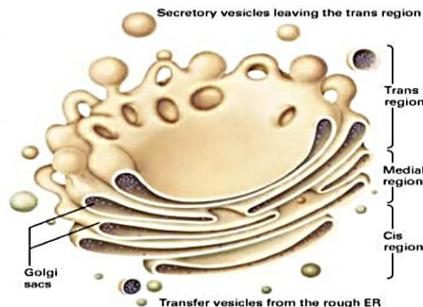


# EM of Golgi Apparatus

Golgi apparatus is composed of:

## 1- Stacks:

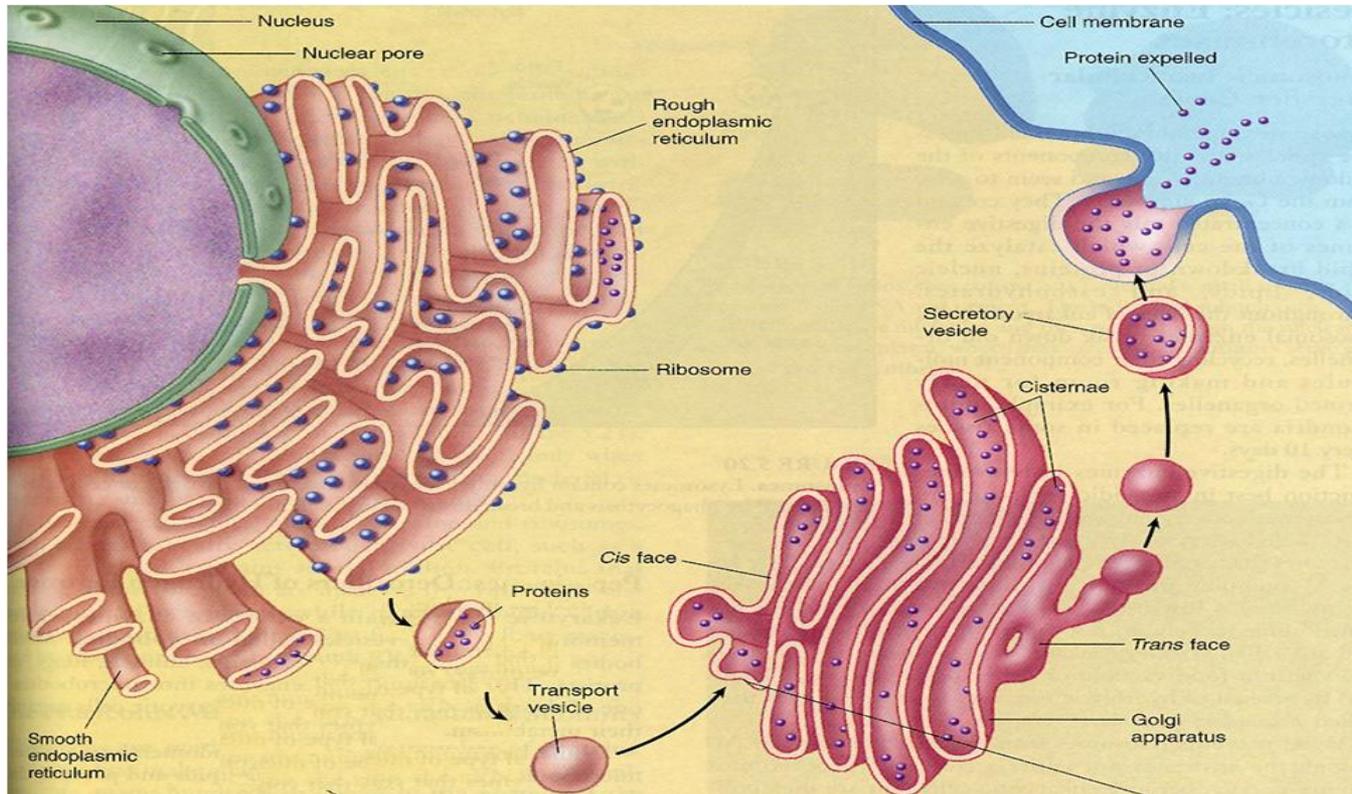
- Each stack consists of 3- 12 flattened **membranes (sacculles)**.
- The lumen of each sacculle is narrow but the periphery is dilated.
- Each stack has two faces:
  - **Immature (cis)** face which is **convex** and directed to RER.
  - **Mature (trans)** face which is **concave** and directed towards the cell membrane.



golgi apparatus looks like a stack of pancakes



# GOLGI APPARATUS



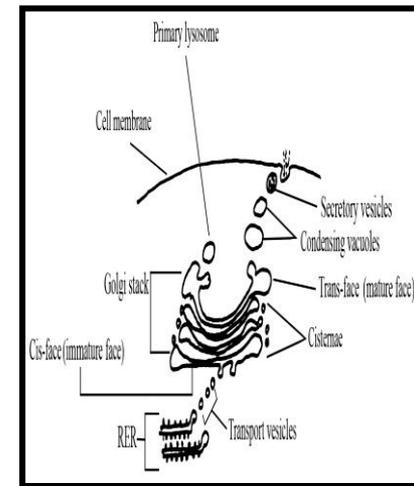
## 2-Transfer vesicles:

- They are **small** in diameter.
- They pinch off from small portions of RER **devoid** of ribosomes.
- They migrate to immature of Golgi and **fuse** with its **dilated rim**.

## 3- Secretory vesicles:-

The **secretory vesicles** migrate to cell membrane where they fuse with it and release their content to the exterior of the cell by **exocytosis**.

**Primary lysosomes** arise also from mature of Golgi but remain inside the cell.



## Function of Golgi apparatus:

**1-Modification** of secretory proteins.

**2-Concentration** and **packaging** of secretory products into membrane-bound secretory vesicles.

**3- Modification, segregation** and **packaging** of lysosomal enzymes.



# *LYSOSOMES*

- **Definition:** Lysosomes are membranous cell organelles, they constitute an **intracellular digestive system**.
- **Origin of lysosomal enzymes:** They are synthesized in RER and transported in vesicles to Golgi complex, where they are modified and sequestered into separate membrane-bounded vacuoles.
- **Contents:** Lysosomes contain **hydrolytic digestive enzymes** called hydrolases (lipase-protease-nuclease).



- **Sites of Lysosomes:** They are found in all cells **except mature erythrocytes**. They are numerous in **phagocytic cells**

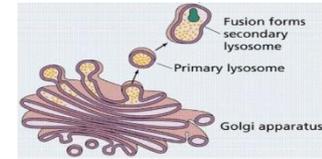
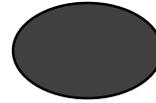
- **Structure of Lysosomes LM&EM:**

- **By LM** They can be seen by **specific histochemical reactions that show their enzymatic activity.**

- **By EM:** They are spherical (rounded) small membranous vesicles which are classified into: primary lysosomes and secondary lysosomes.



# Types of lysosomes:

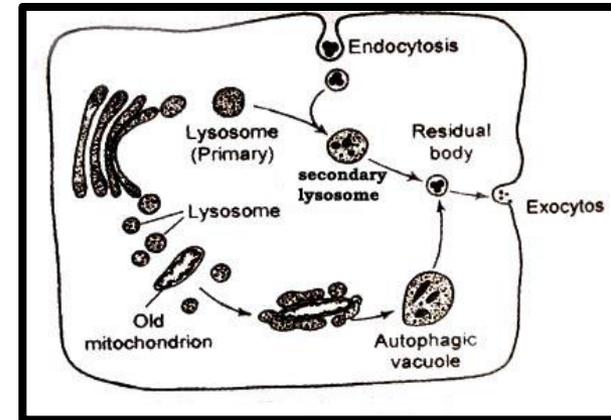


## • A- Primary lysosomes:

- They are **homogenous** when seen by electron microscope .
- They are **newly** formed lysosomes and are not involved in any digestive events.

## • B- Secondary Lysosomes:

- The contents of secondary lysosomes are **heterogeneous**.
- They are formed **after fusion** of primary lysosomes with other substances from within or outside the cells (i.e. when it interact with other substances).



## Substances of extracellular origin enter the cells by endocytosis as

- Fluid material (with pinocytosis) will give pinocytotic vesicles
- Solid materials (with phagocytosis) will give phagocytic vesicles.

Substances of **intracellular origin** (e.g. mitochondria, RER, cell membrane) are enclosed in a membrane → autophagic vacuole.



# Types of secondary lysosomes:

- When primary lysosome interacts with pinocytotic vesicles it gives multivesicular body.
- When primary lysosome interacts with phagocytic vesicles it gives phagosome.
- When primary lysosome interacts with autophagic vacuole it gives autophagosome.
- Multivesicular body, phagosome and autophagosome; all are varieties of secondary lysosomes.



## Summary : Types of secondary lysosomes

Solid material  Phagocytic vacuole  
 **Phagosome**

Fluid material  Pinocytotic vesicle  
 **Multivesicular body**

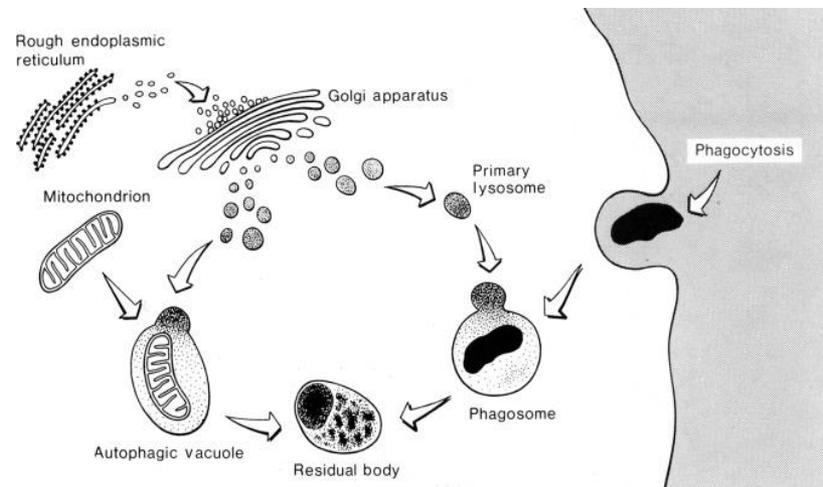
Dead organelle  Autophagic vacuole  
 **Autophagosome**



## • Fate of secondary lysosomes:

- In secondary lysosomes, enzymatic digestion breaks down the contents into small molecules that pass back across the lysosomal membranes into the cytoplasm.
- The indigestible material as pigments or lipids remains inside the secondary lysosomes, and are known as **residual bodies** which are released by **exocytosis**.

- In long lived cells e.g. nerve cells and cardiac muscle, residual bodies accumulate with age and are called **lipofuscin pigments**.



# Functions of Lysosomes:

**1- Digestion:** In Healthy cells, they constitute an **intracellular digestive system** capable of **breaking down** materials originated from outside and inside the cell.

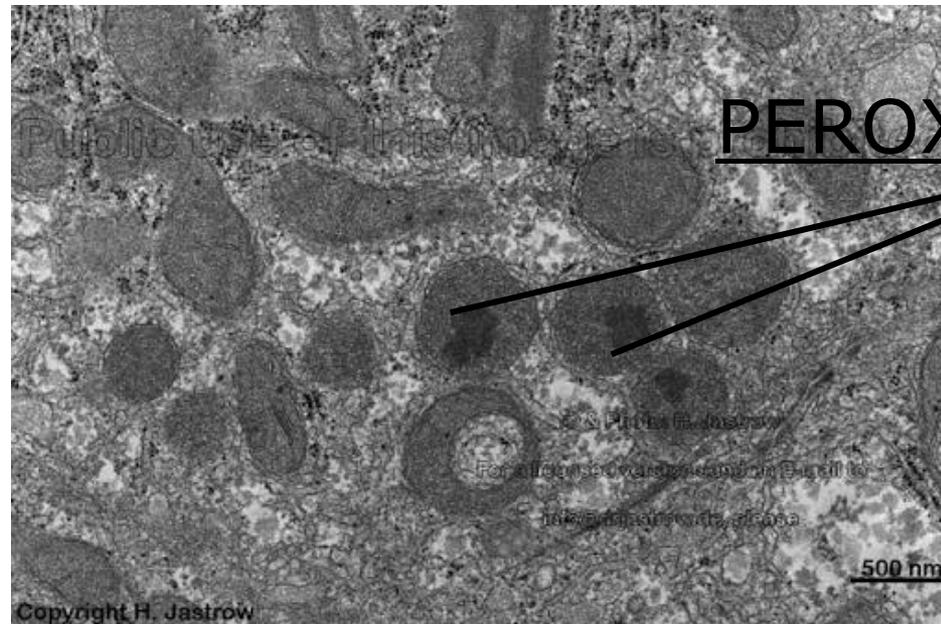
- **Heterophagy:** Break-down of materials from **outside** the cell such as bacteria for cellular **defense** mechanisms.
- **Autophagy:** digestion of materials from **inside** the cell for normal **replacement** of cellular components and organelles.

**2- Autolysis:** Lysis and breakdown of the **dead cells**.



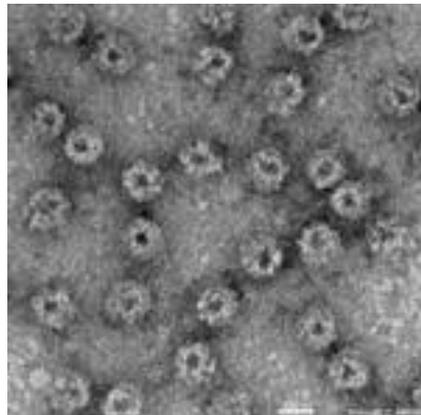
## PEROXISOMES (Microbodies):

- They are **membranous organelles** like lysosomes but differ from them in the type and function of their enzymes (**oxidative enzymes**).
- In some animal species, peroxisomes have a denser central region (core) called the nucleoid, which contains a crystal of urate oxidase. Their enzymes react with other substances to form hydrogen peroxide (**H<sub>2</sub>O<sub>2</sub>**), which is used to detoxify various substances



# PROTEASOMES

- **Definition:** Proteasomes are **non-membranous organelles** that are very small in size.
- **Function:** break down and recycle unwanted proteins ,removes damaged, or misfolded, which is essential for maintaining protein homeostasis





Thank You

