

# Structure of the cell

## Cell nucleus

- was the first organelle to be discovered by Franz Bauer in 1804.
- is the largest cellular organelle in animals.
- is the control center of the cell and repository of genetic information.

**Position:** mostly the center of the cell/ depend on the function of the cell

**Shape:**

round

flat

rod

string

**Size:** 5-10  $\mu\text{m}$  ( in mammalian 6 $\mu\text{m}$ , about 10% of total cell volume)

**Number:** 1, 2 or more

**Function:** place of almost all DNA replication, RNA synthesis and RNA processing

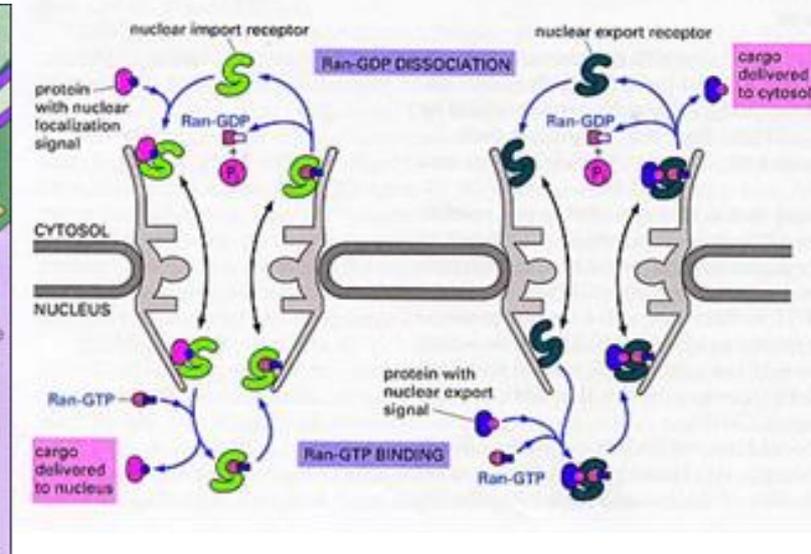
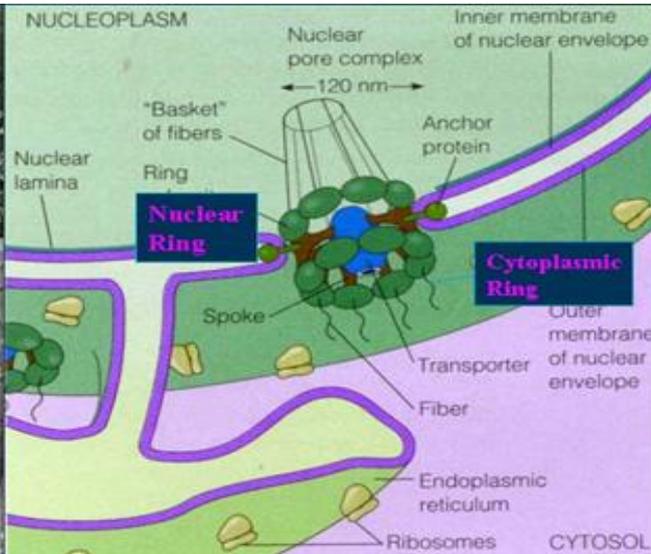
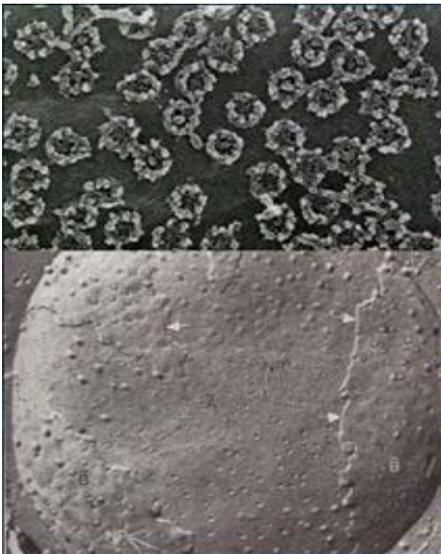
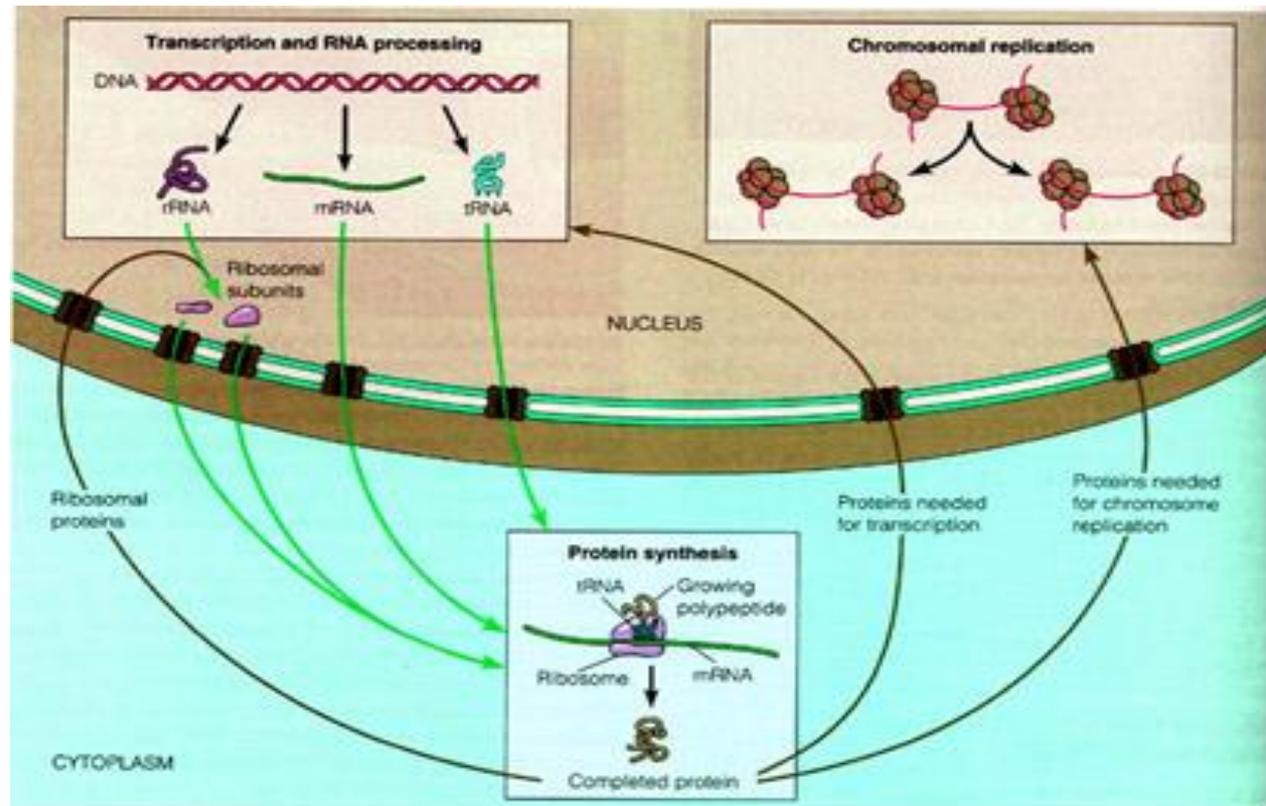
# Cell nucleus

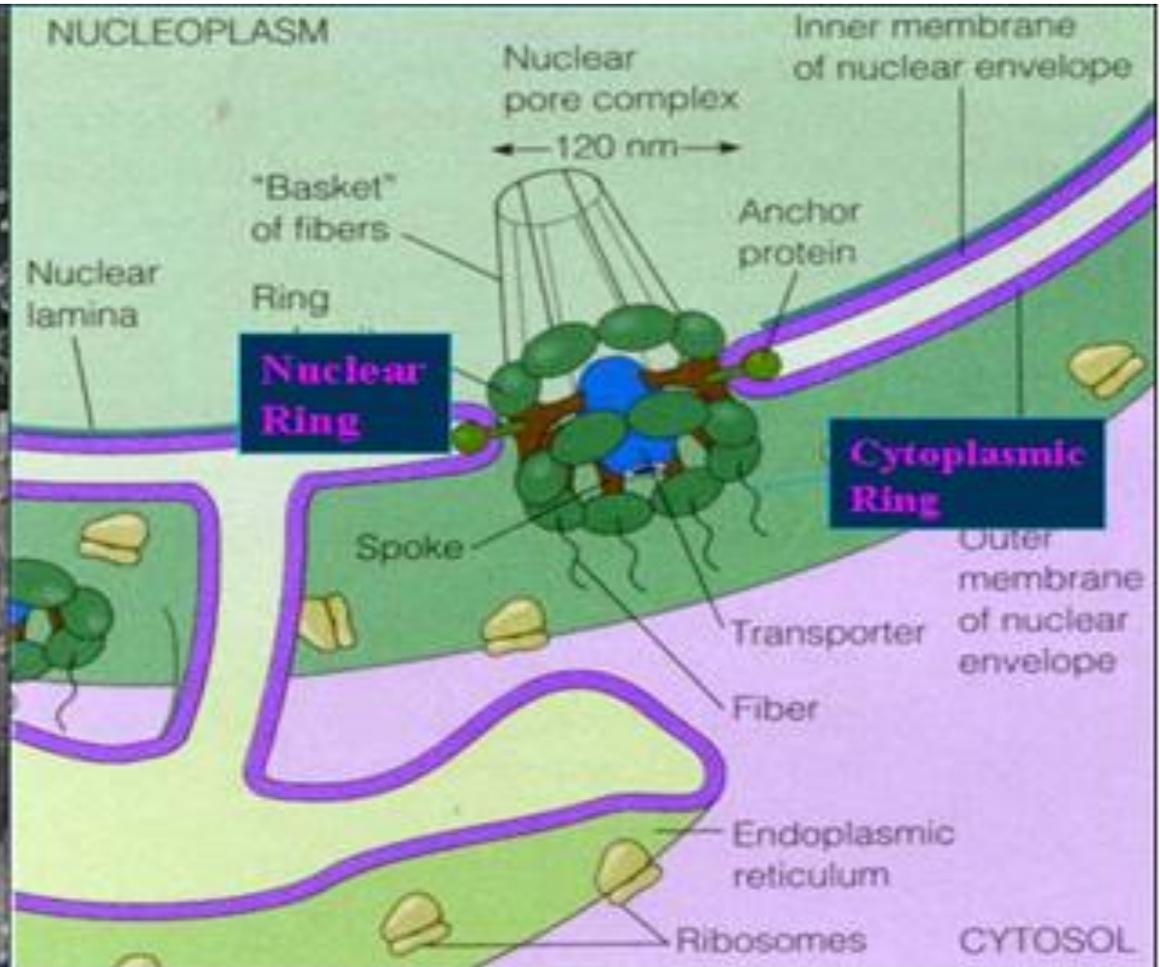
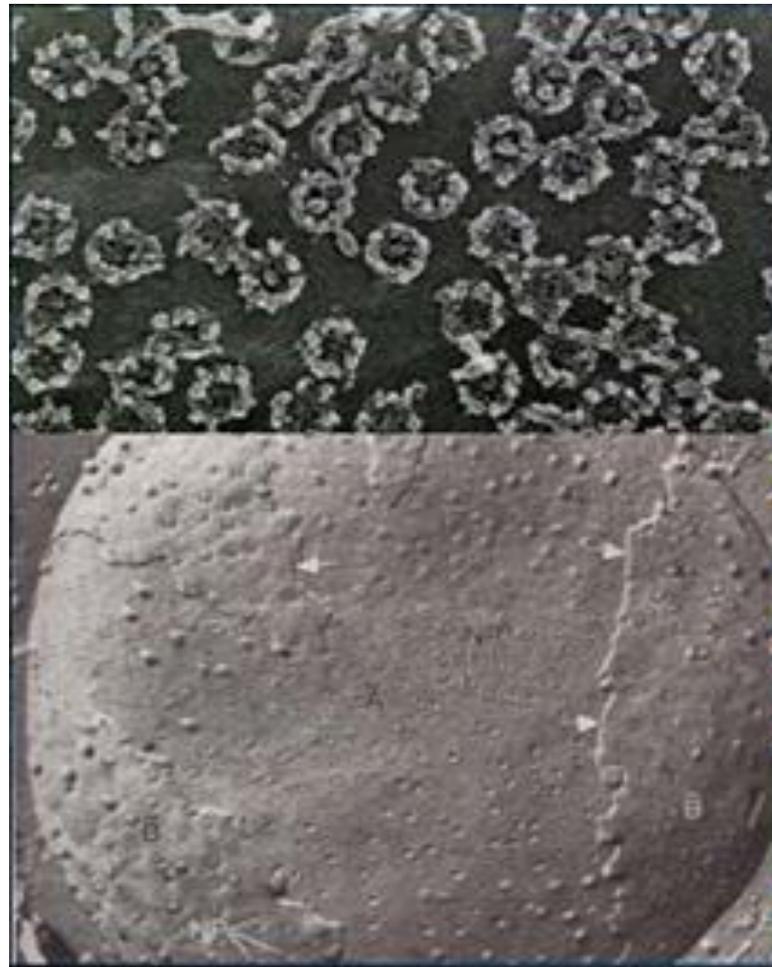
## Structure: nuclear envelope

- outer membrane
- perinuclear space
- inner membrane

## nuclear pores:

nuclear transport (RNA export, protein import)





# Cell nucleus

**nuclear lamina**: meshwork composed of lamin protein→mechanical support

mutation of lamin→laminopathies

## *Hutchinson-Gilford progeria syndrome*

- Lamin A mutation
- Early aging, usually have small, fragile bodies, wrinkled skin, atherosclerosis and cardiovascular problems.
- Incidence is 1:8 million
- Scientists→to research the normal process of aging

(In HGPS patients, the cell nucleus has dramatically aberrant morphology )



# Cell nucleus

**nucleolus**: place of rRNA synthesis and maturation

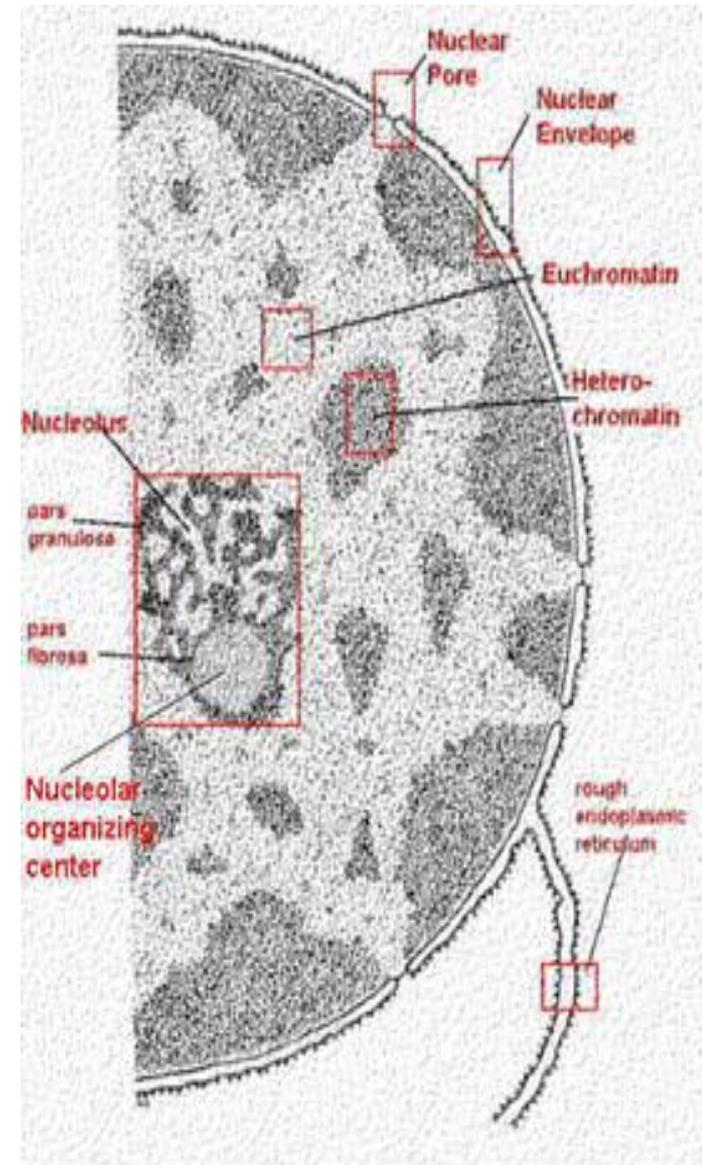
- fibrillar centers
- fibrillar component
- granular component

**nucleoplasm**: the material within the nuclear membrane *or* the fluid content of the nucleus

contains the majority of the genetic material in form of chromosomes

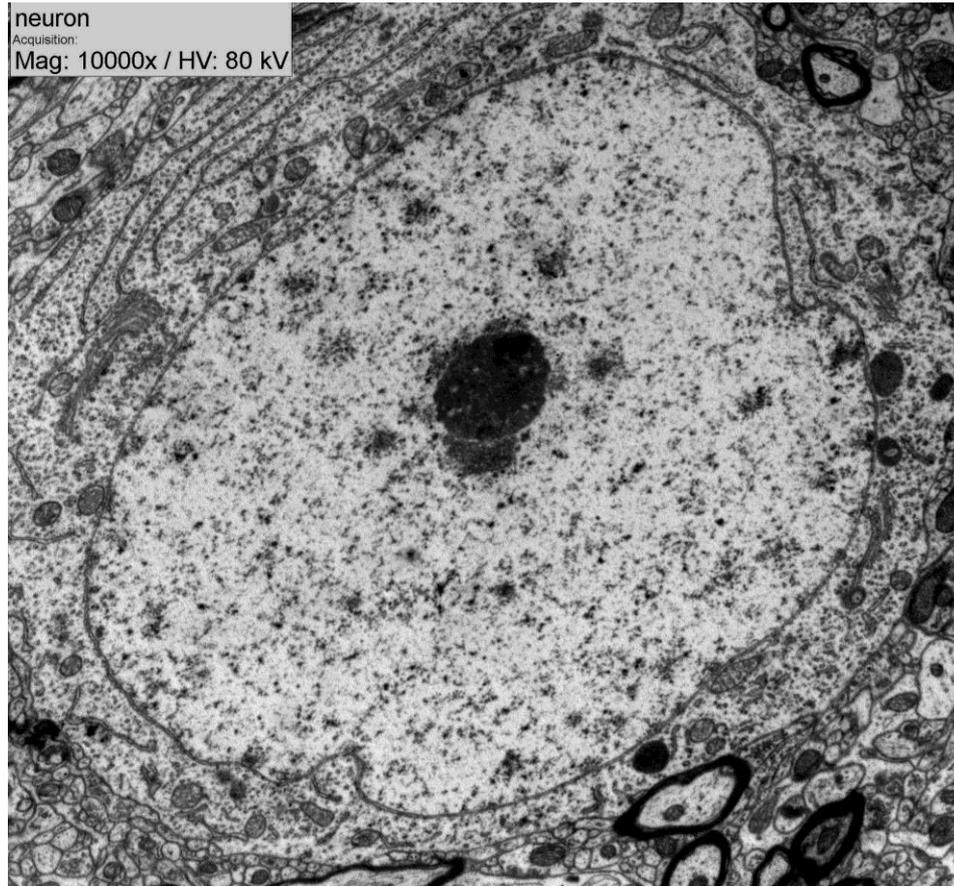
- euchromatin → transcriptionally active
- heterochromatin → transcriptionally inactive /constitutive, facultative/

types: perinucleolar, peripheral, diffuse



# The structure of cells:

## The ER, Golgi-apparatus, vesicles and lysosomes

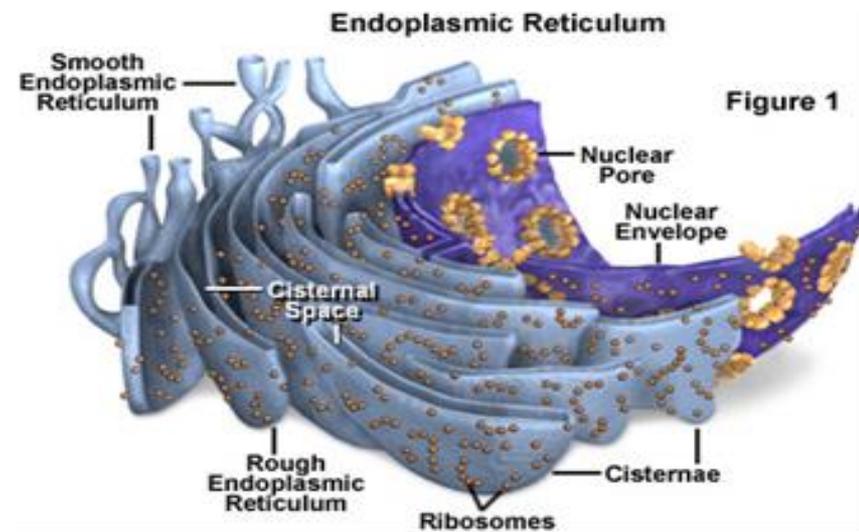


# Endoplasmic reticulum

- is an interconnected network of tubules, vesicles, and cisternae within cells.
- is part of the endomembrane system.
- Is connected to the outer nuclear membrane

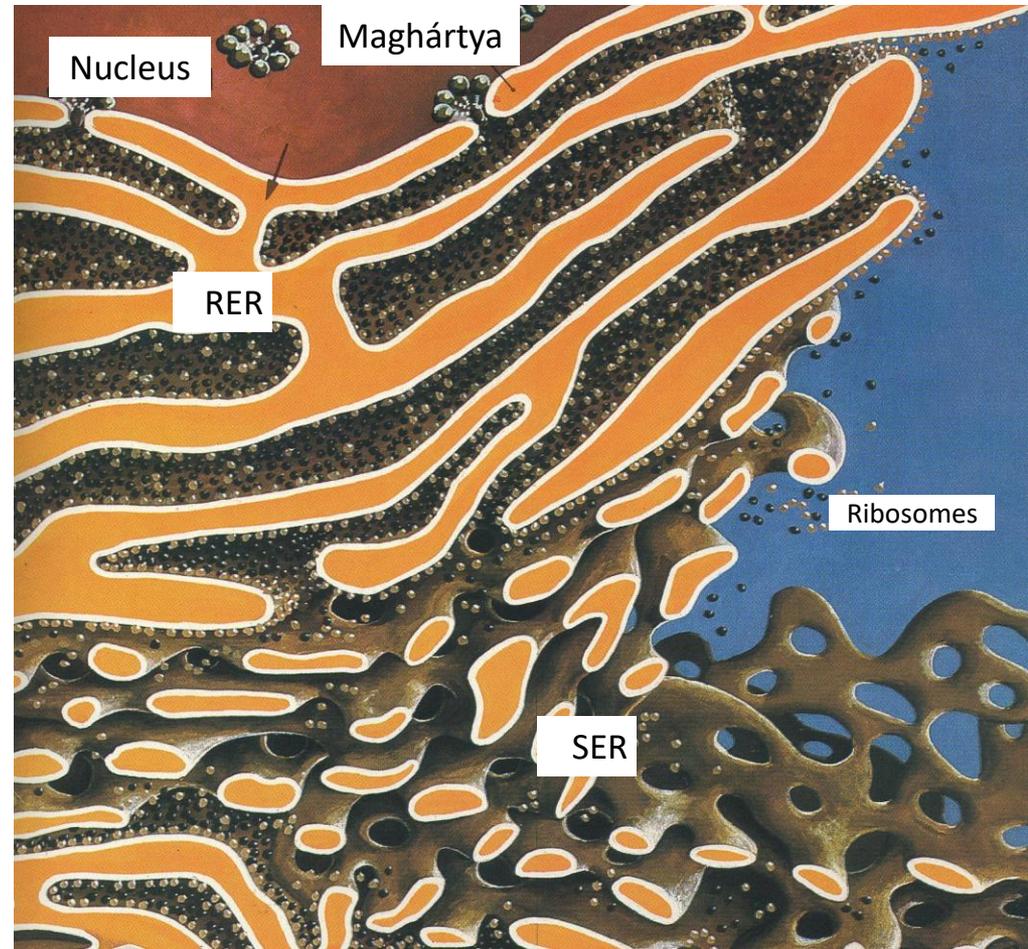
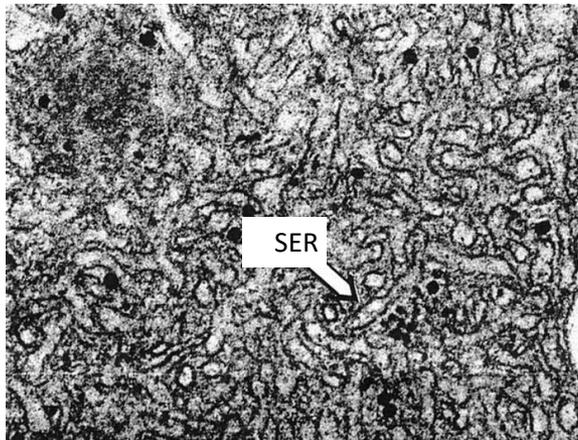
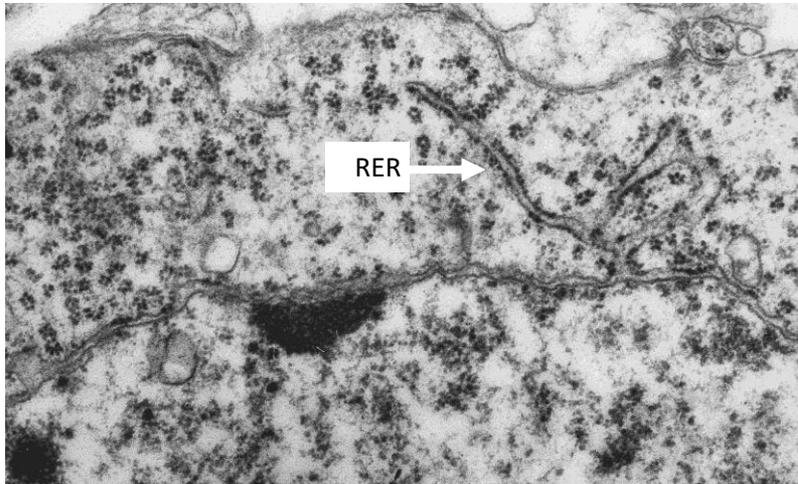
## Structure

- is an extensive membrane network of cisternae held together by the cytoskeleton.
- cisternal space (or lumen) enclosed by a phospholipid membrane from the cytosol.



- Types

- rough endoplasmic reticulum
- smooth endoplasmic reticulum /sarcoplasmic reticulum/

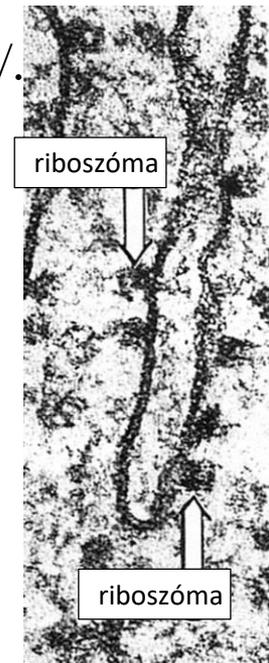
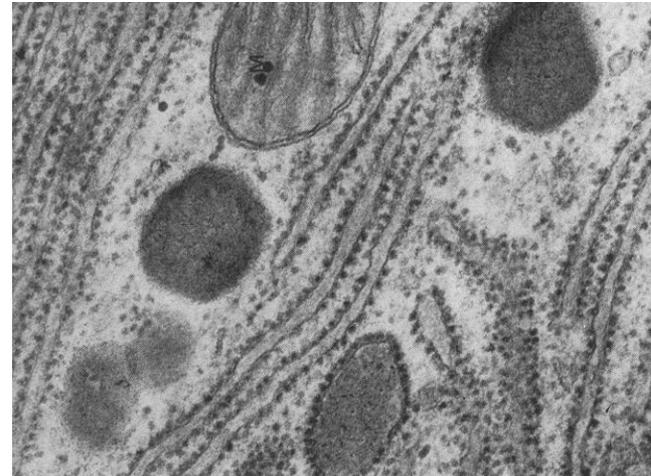


# Rough endoplasmic reticulum

The surface is studded with ribosomes giving it a "rough" appearance

## **Key functions of the RER:**

- Protein synthesis: proteins of the cell membrane, secretory, lysosomes, Golgi, ER
- Protein maturation (processing)
  - Stabilization of conformation/folding/: chaperone proteins
  - Glycosylation: attachment of oligosaccharides / N-linked glycosylation/.
  - Disulfide bond formation and rearrangement
- Quality control of proteins



# Smooth endoplasmic reticulum

There are no ribosomes on the surface

## **Key functions of SER:**

- synthesis of lipids eg. phospholipids and steroids
- regulation of calcium concentration ( $\text{Ca}^{2+}$  storage)
- drug detoxification – biotransformation (cytochrome P450 enzyme system)

## **Sarcoplasmic reticulum**

- is a special type of smooth ER
- found in smooth and striated muscle
- contains large stores of calcium/ sequesters and releases it when the muscle cell is stimulated/
- role in the contraction of muscle, by electrical stimulation

# Golgi apparatus

The Golgi apparatus also called the Golgi body, Golgi complex

It was identified in 1898 by the Italian physician Camillo Golgi

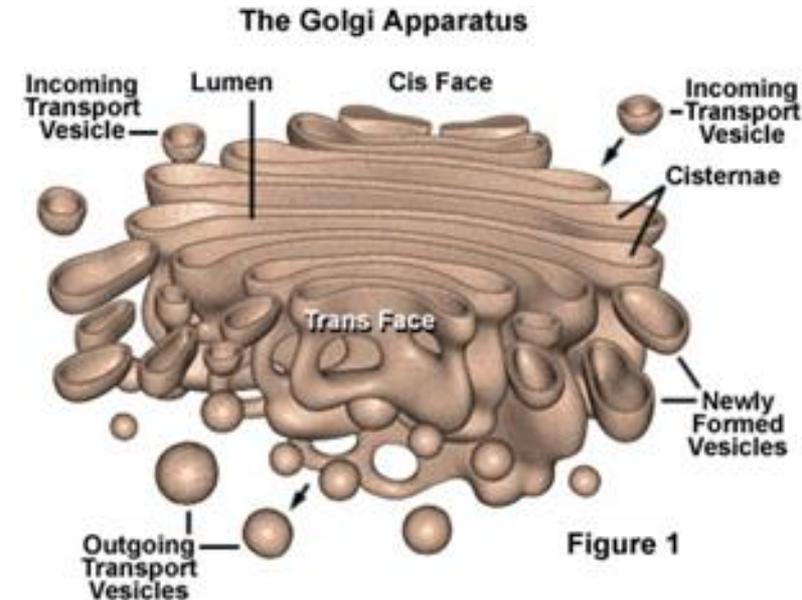
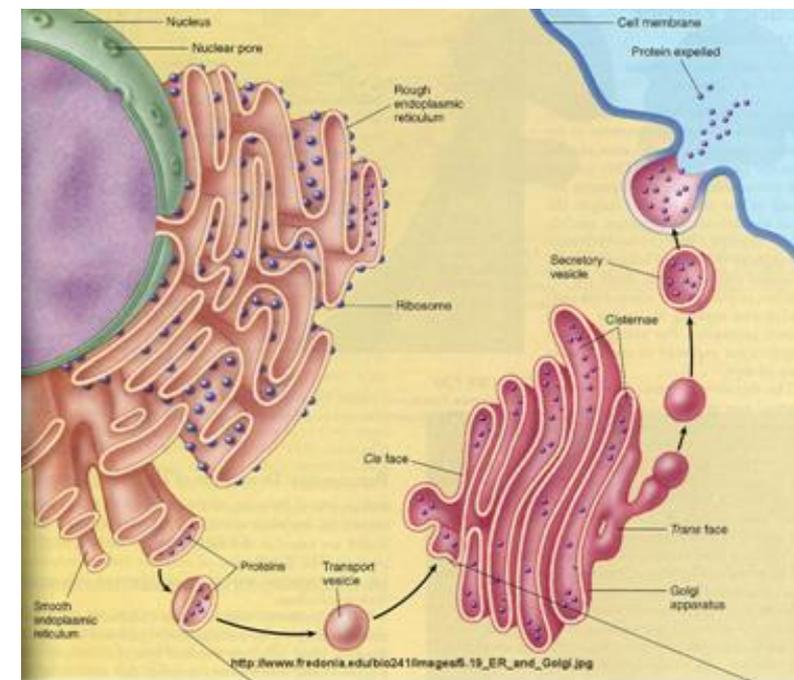
Is part of the endomembrane system

## Structure

- The Golgi is composed of membrane-bound stacks known as cisternae
- The cisternae stack has five functional regions: the cis-Golgi network, cis-Golgi, median-Golgi, trans-Golgi, and trans-Golgi network.

## Function

- Maturation, packaging and sorting of proteins /lysosomal, membrane, secretory/
- Glycosylation: attachment of oligosaccharides/ O-linked glycosylation → form a signal sequence which determines their final destination, for example: mannose-6-phosphate- lysosomal proteins/



# Vesicle

## **Structure**

- Is a small, intracellular, membrane-enclosed sac
- Is separated from the cytosol by a phospholipid bilayer/ one phospholipid bilayer, →*unilamellar* vesicles, more→*multilamellar*/
- Vesicles can fuse with the plasma membrane to release their contents outside of the cell or also fuse with other organelles within the cell.

**Functions:** store, transport, or digest cellular products and waste

## **Types of vesicles:**

- **Transport vesicles**

Transport vesicles can move molecules between locations inside the cell, e.g., proteins from the

rough endoplasmic reticulum to the Golgi apparatus.

- **Secretory vesicles**

contain materials to be transported out of the the cell

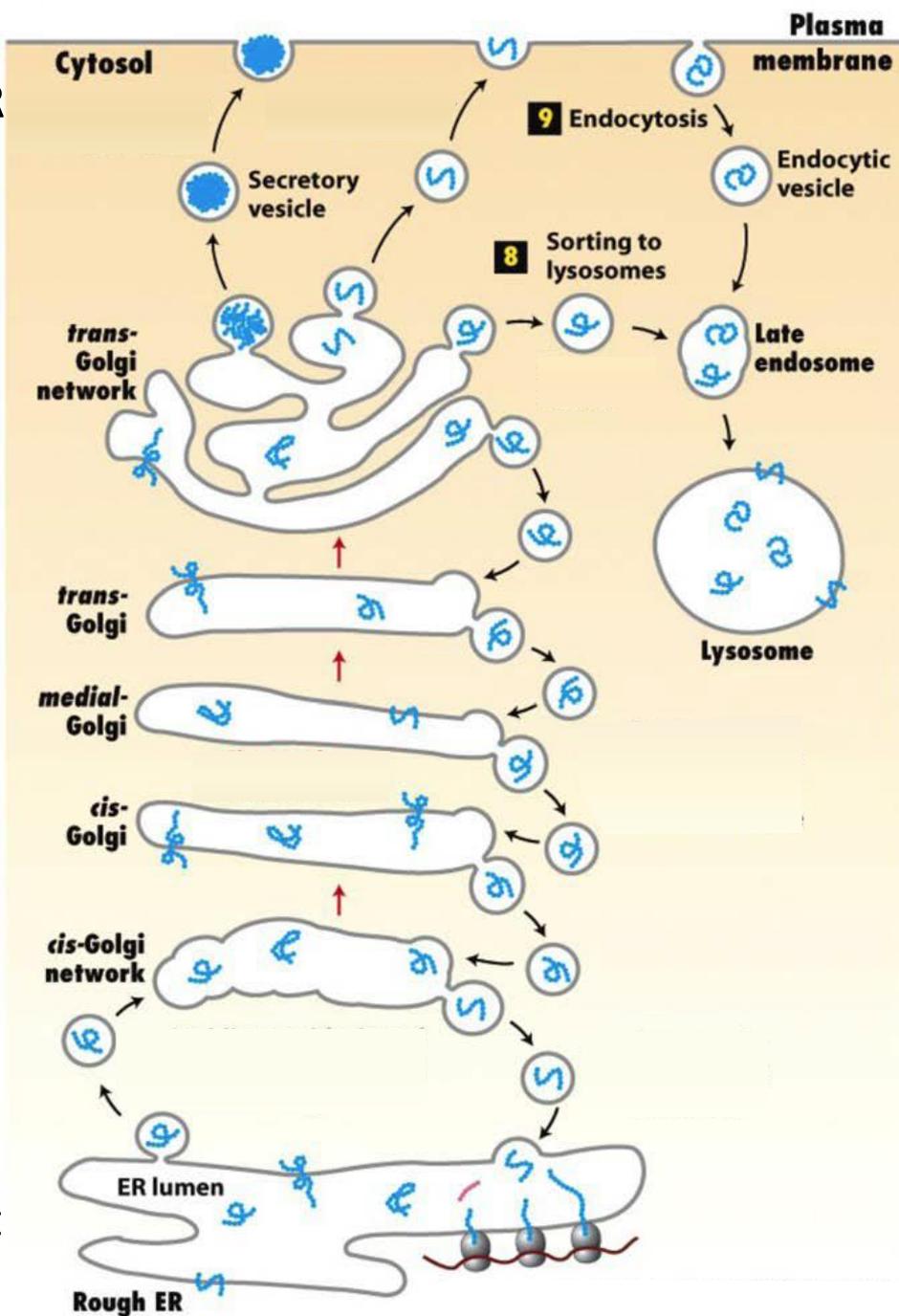
**Vesicle coat: clathrin, COPI, COPII**

# Vesicular transport

- Between RER, Golgi, cell membrane, SER transport (of eg. proteins) is carried out by vesicles
- Along main pathways:
  - endocytosis → endocytic pathway: materials are taken up from outside of the cell:
    - Phagocytosis (eg. engulfing bacteria)
    - Pinocytosis (taking up solutions, „cell drinking“)
    - Receptor-mediated endocytosis (eg. Uptake of LDL particles)

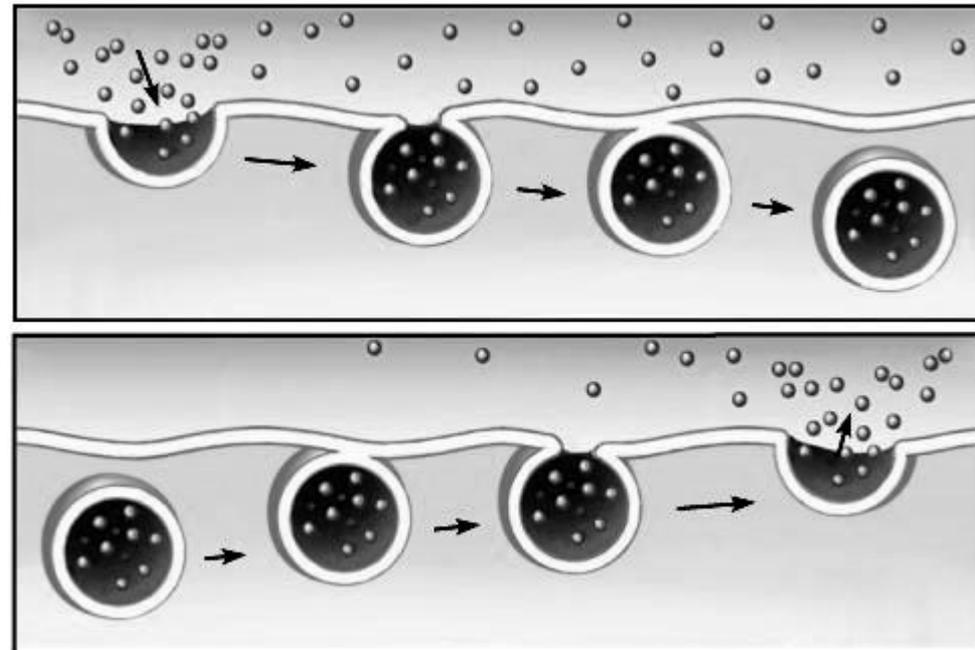
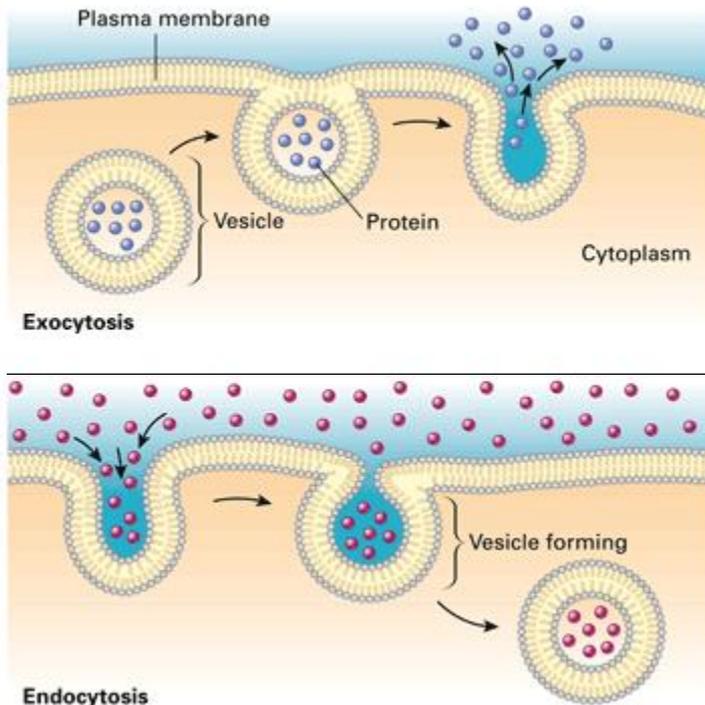
Endocytosis → endosome → merging with primary lysosomes → secondary lysosome (or alternatively storage, exocytosis)

- Secretory pathway → exocytosis (secretion): transport of materials into the extracellular space: RER → transport vesicle → Golgi-apparatus → transport (secretory-) vesicle → exocytosis

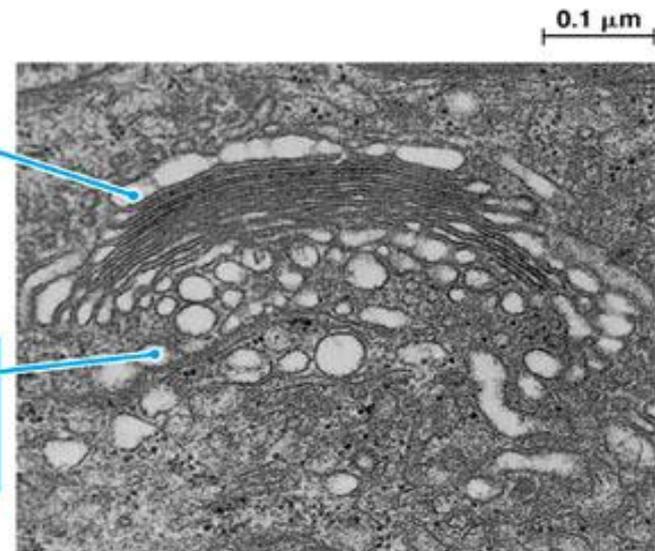
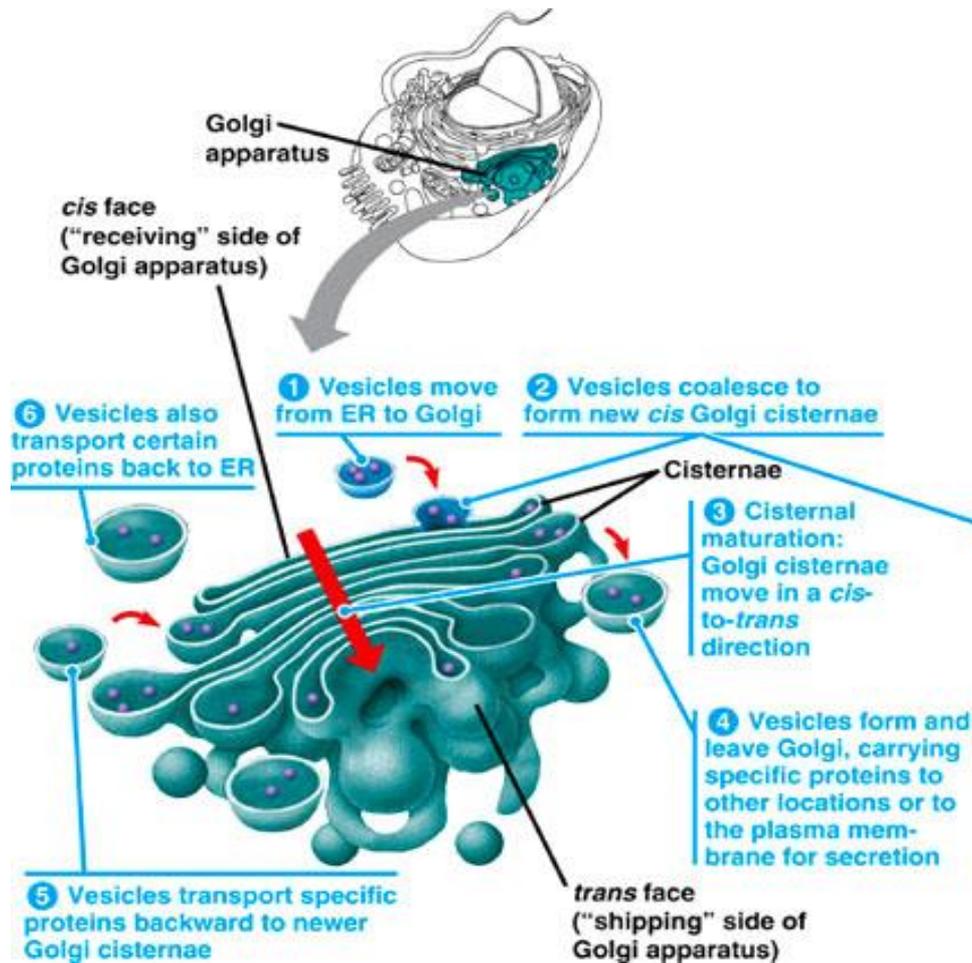


- **Endocytosis:** uptake of extracellular material in vesicles, which are formed from the cell membrane
  - phagocytosis, pinocytosis, receptor mediated endocytosis

- **Exocytosis:** Fusion of the membrane of a secretory vesicle with the cell membrane, excretion of content of the secretory vesicle.

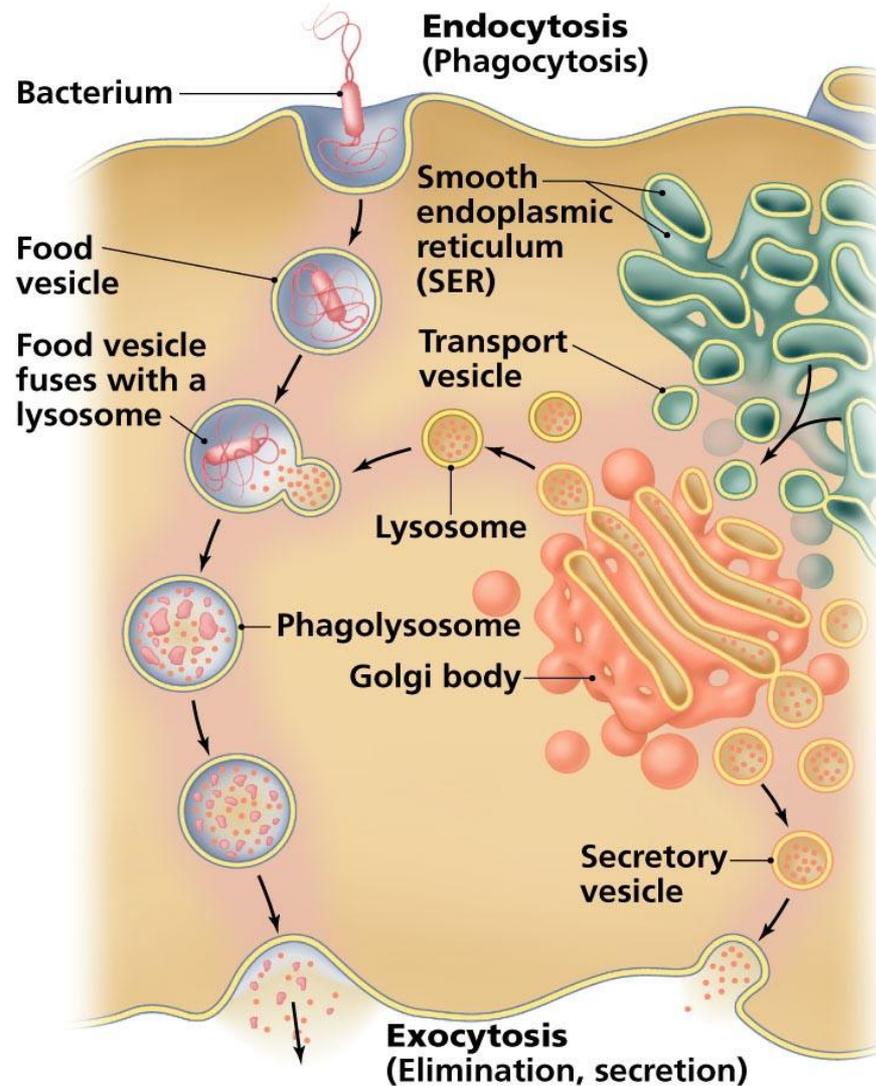


# Vesicular transport: Golgi



TEM of Golgi apparatus

# Endocytosis, exocytosis



# Lysosome

- The name derives from the Greek words *lysis*(destruction) and *soma*(body)
- Lysosomal enzymes are synthesized in the RER, sent to the Golgi, released from here
- They digest worn-out organelles, food particles, and phagocytosed viruses or bacteria.

**Size:** varies from 0.1–1.2  $\mu\text{m}$

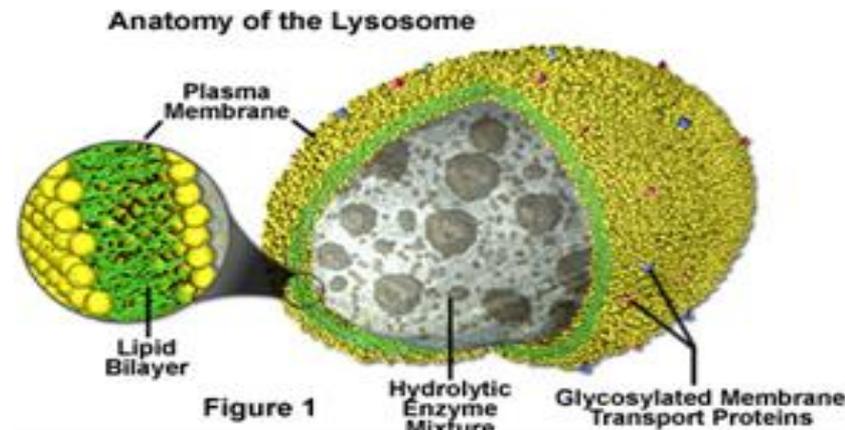
**Structure:** specialized vesicle surrounded by a single membrane

## • **Types:**

- Primary lysosomes: contain digestive enzymes
- Secondary lysosomes: contain digestive enzymes + the digested material

**Enzymes:** acid hydrolases

**Functions:** digestion of macromolecules from phagocytosis, endocytosis, autophagy



## Peroxisomes:

- vesicle, often crystalline structure in the middle
- Contains many enzymes
- involved in production and elimination of hydrogen peroxide
- Breakdown and synthesis of different materials (e.g. lipids)

<http://faculty.une.edu/com/abell/histo/histolab2.htm>

