The cell III

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The cell III

Deffinition of cell

The cell is the smallest structural and functional unit of all known living organisms

The cell was discovered by Robert Hooke in 1665 and also the name was chosen by Hook (the word cell comes from the Latin cellula and it means “small room”).

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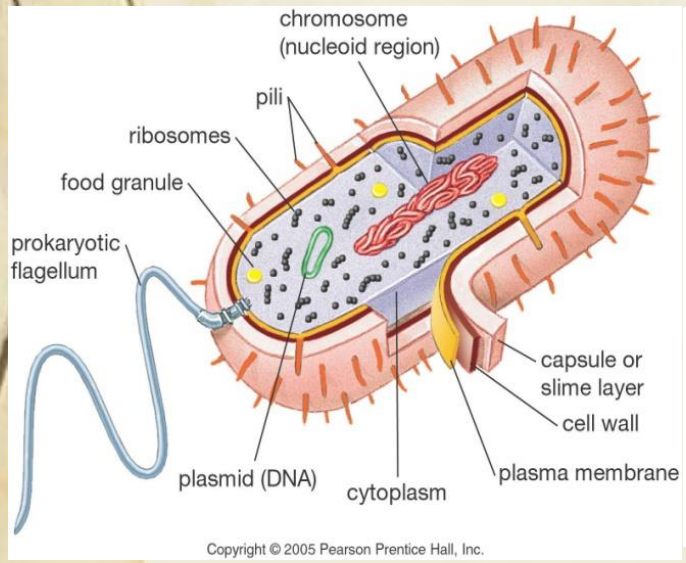
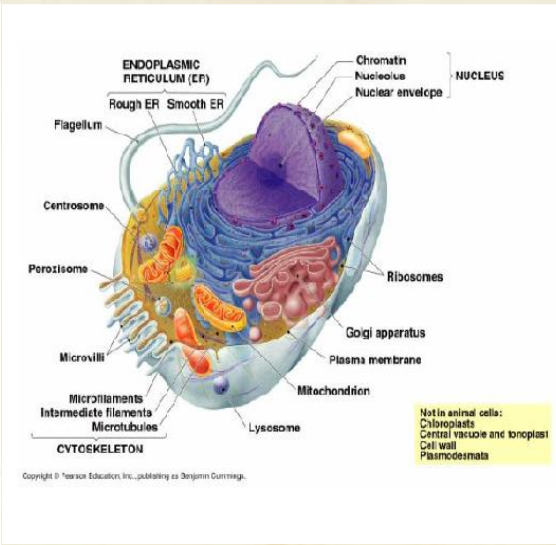
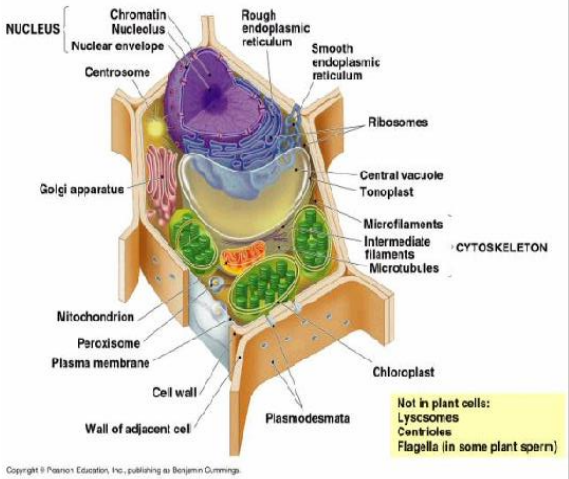
Types of cells

- **Prokaryotes** - cells with no nucleus or membrane bound organelles

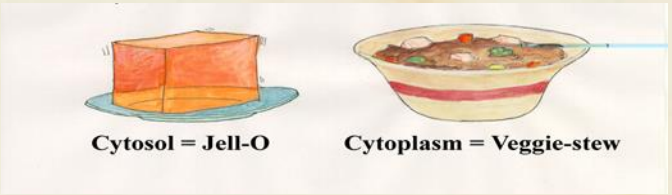
  Bacteria and blue-green bacteria are prokaryotic cells
- **Eukaryotes** - cells that contain a nucleus and organelles surrounded by a membrane.







The Cell II



Cytoplasm

- cytoplasm is a three-dimensional jelly-like material
- it is about 70% to 90% water and usually clear in color
- the dry mass contains macromolecules: proteins , carbohydrates, nucleic acids, and lipids
- the cytoplasm contains everything that is found within the plasma membrane, including the cytosol
- the cytoplasm is the site where most cellular activities occur
- it contains dissolved nutrients, helps dissolve waste products, moves materials, plays a mechanical role, maintain the shape
- has three major elements: **cytosol, organelles and inclusions**

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Cytosol

- cytosol is the jelly like part of the cytoplasm without the organelles

Cytoplasmic inclusions

- inclusions are small nonliving particles in the cytosol
- are not membrane bound
- calcium oxalate or starch in plant cells, glycogen or pigments in animal cells
- lipid droplets

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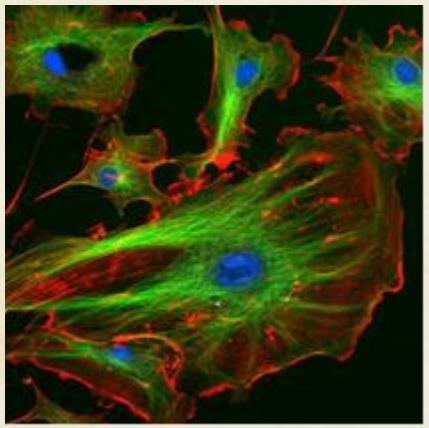
Cytoskeleton

Structure

- it is an internal network of protein filaments
- it is presented in all eukaryotic cell and also in prokaryotic cells
- eukaryotic cells contain three main kinds of cytoskeletal filaments: **microfilaments, intermediate filaments, and microtubules**.

Functions

- determines cell shape
- drives active cell movements
- transport organells
- drives cell division
- signaltransduction



The eukaryotic cytoskeleton/actin, microtubules, nuclei/

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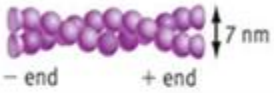
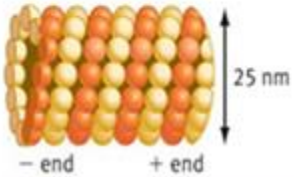
	Structure	Subunits	Functions
Actin filaments (microfilaments)	Strands in double helix 	Actin 	• maintenance of cell shape • cell motility (as in pseudopodia) • cell division (contractile ring formation) • muscle contraction • organelle movements
Intermediate filaments	Fibers wound into thicker cables 	Keratin or vimentin or lamin or others 	• maintenance of cell shape • anchor nucleus and some other organelles
Microtubules	Hollow tube 	α- and β-tubulin dimers 	• maintenance of cell shape • cell motility (as in cilia or flagella) • chromosome movements in cell division • organelle movements

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Cell organelles

- organelles are membrane bound structures
- they perform specialized functions

(The name *organelle* comes from the idea that these structures are to cells what an organ is to the body)

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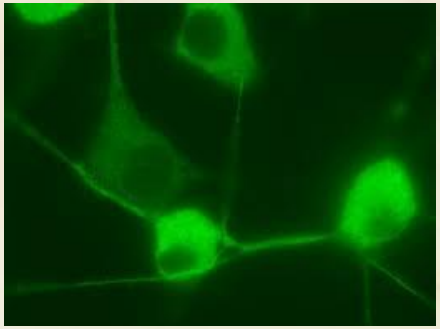

Cell nucleus

- 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 μm (in mammalian 6μm, about 10% of total cell volume)

Number: 1, 2 or more

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

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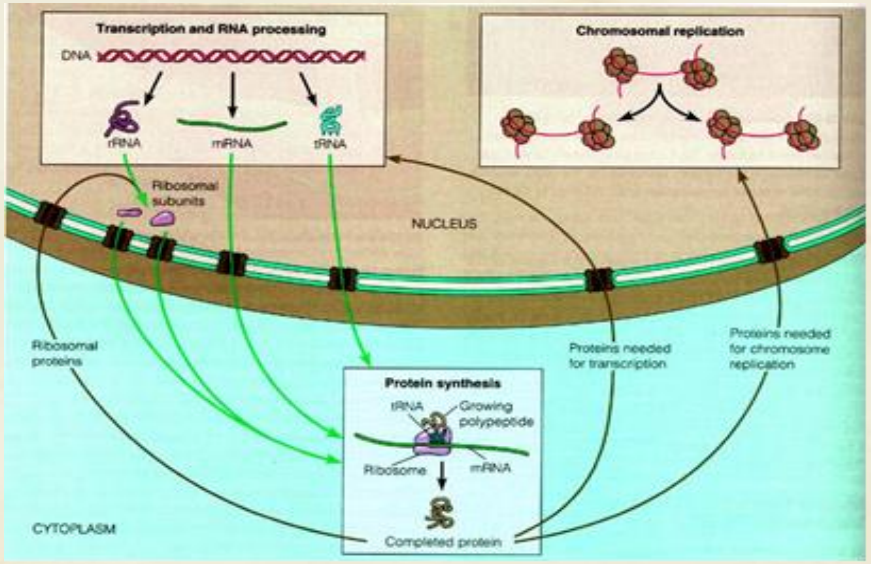


Cell nucleus

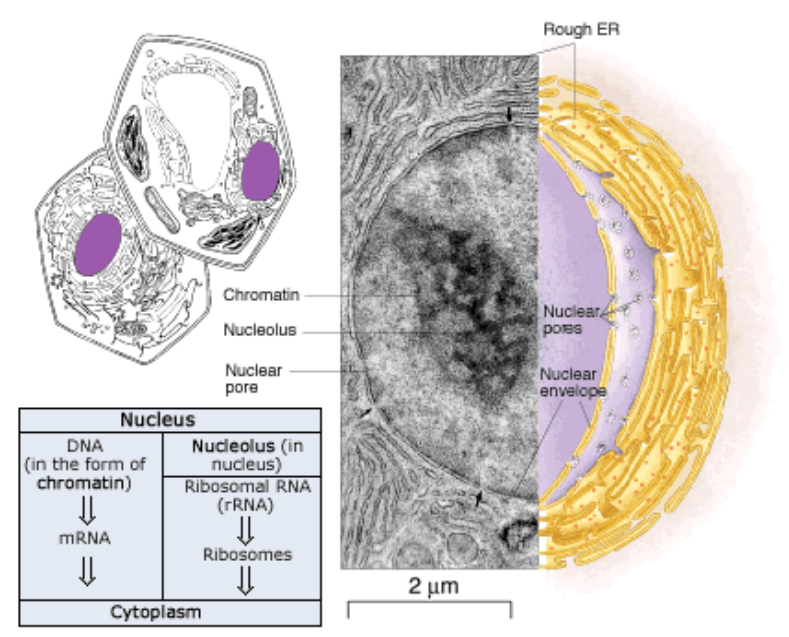
Structure: **nuclear envelope**

-outer membrane

- perinuclear space

- inner membrane

nuclear pores: nuclear transport (RNA export, protein import)



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Cell nucleus

nuclear lamina: meshwork composed of lamin protein→mechanical support,
mutation of lamin→laminopathies
(lamins-intermedier filament expressed in every cell)

Hutchinson-Gilford progeria syndrome

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

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

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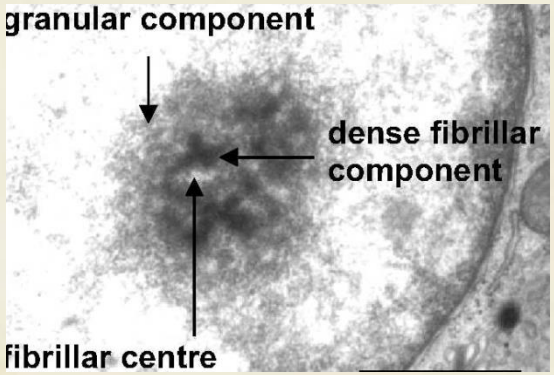
Cell nucleus

nucleolus: place of rRNA synthesis and maturation

- fibrillar centers
- fibrillar component
- granular component

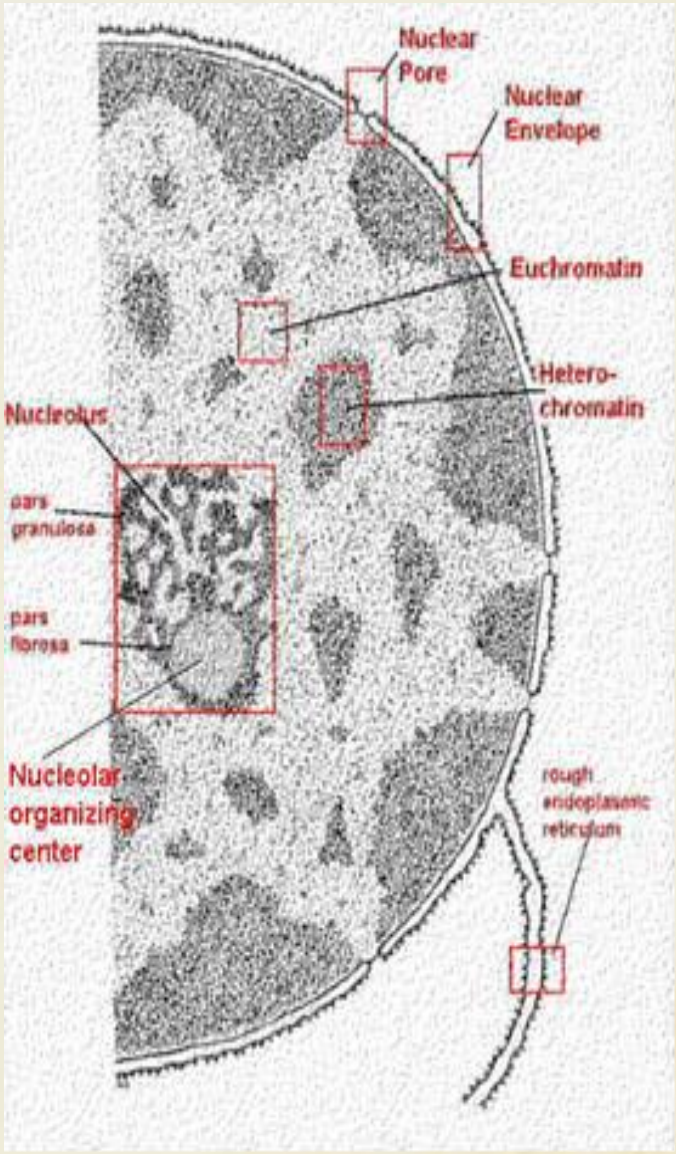


nucleoplasm: the material within the nuclear membrane *or* the fluid content of the nucleus

contains the majority of the genetic material in form of chromatin (chromosomes)

- euchromatin→transcriptionally activ
- heterochromatin→ transcriptionally inactiv /constitutive, facultative/

types: perinucleolar, peripheral, diffuse


Nuclear Pore
Nuclear Envelope
Euchromatin
Hetero-chromatin
Nucleolus
pars granulosa
pars fibrosa
Nucleolar organizing center
rough endoplasmic reticulum

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Endoplasmic reticulum

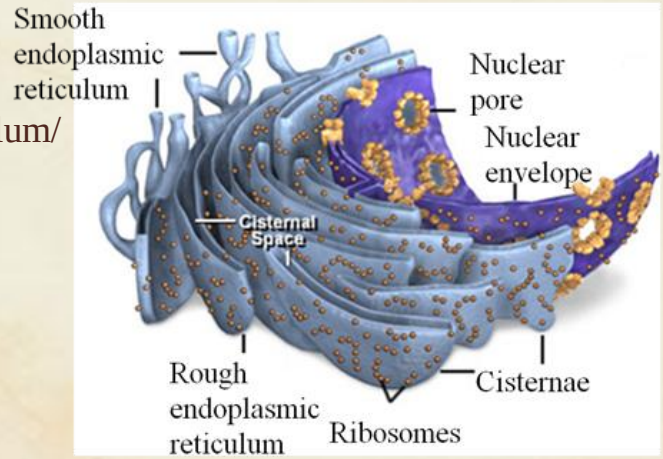
- is an interconnected network of tubules, vesicles, and cisternae within cells
- is part of the endomembrane system.

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
- extends from the nuclear envelope throughout the cytoplasm

Types

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



General functions

- protein synthesis
- folding and transport of proteins
- Calcium storage
- lipid synthesis
- biotransformation

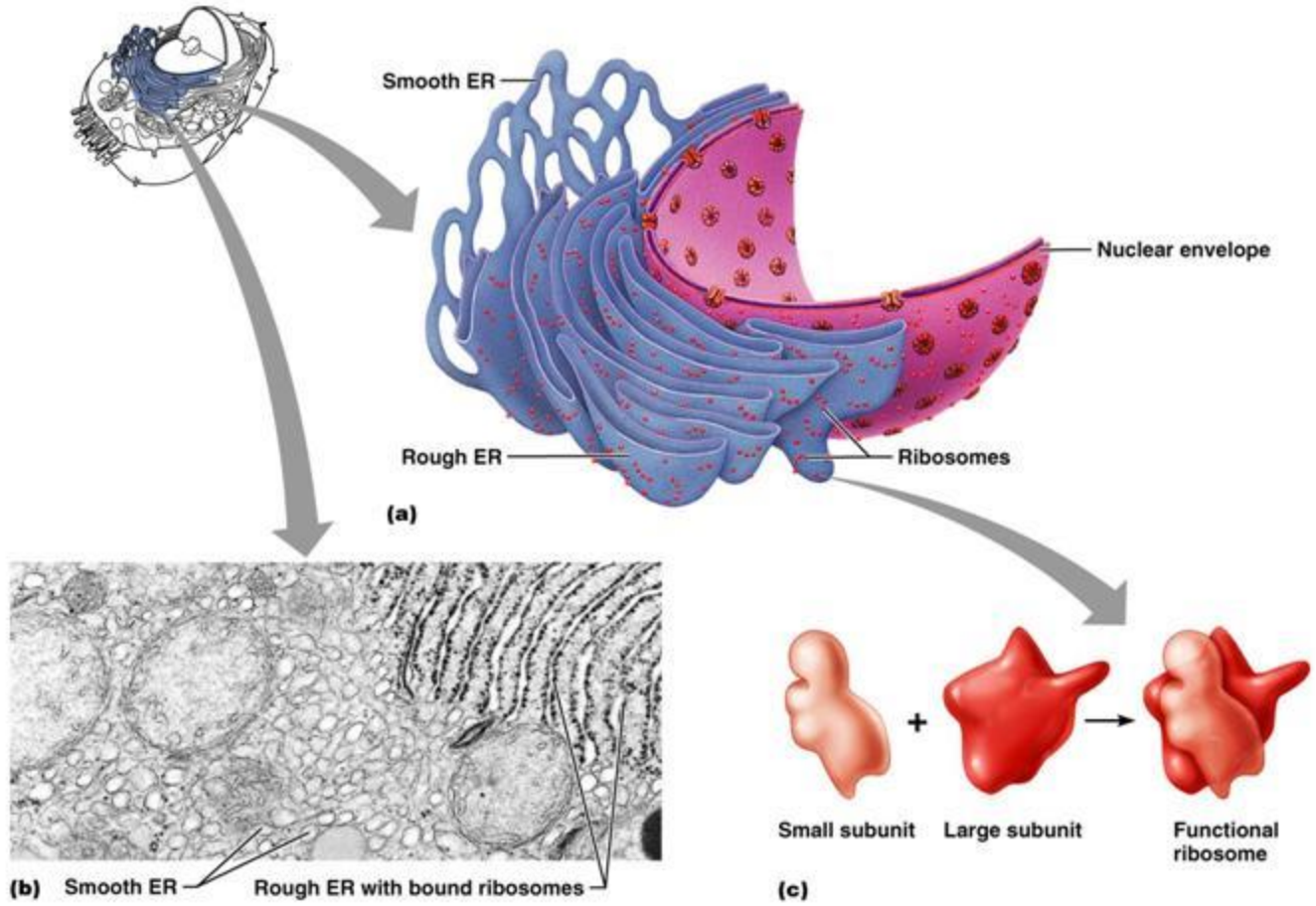


Figure 3.18

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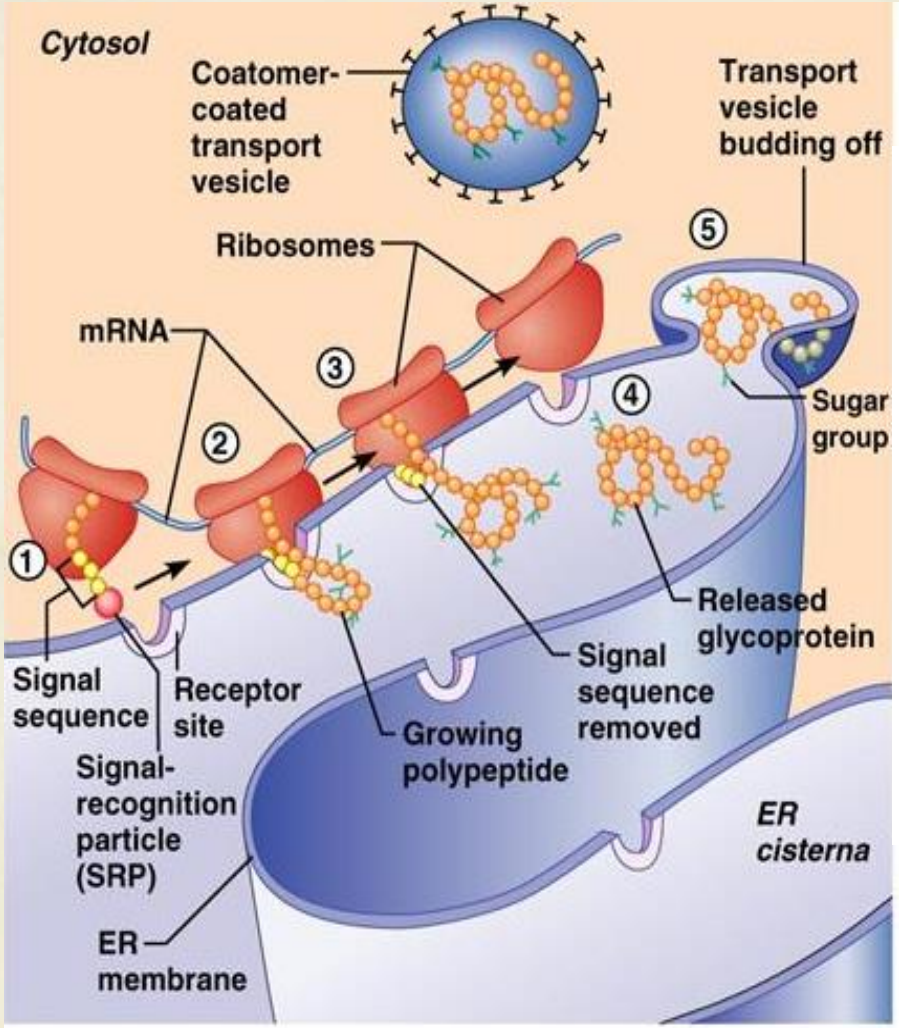
Endoplasmic reticulum

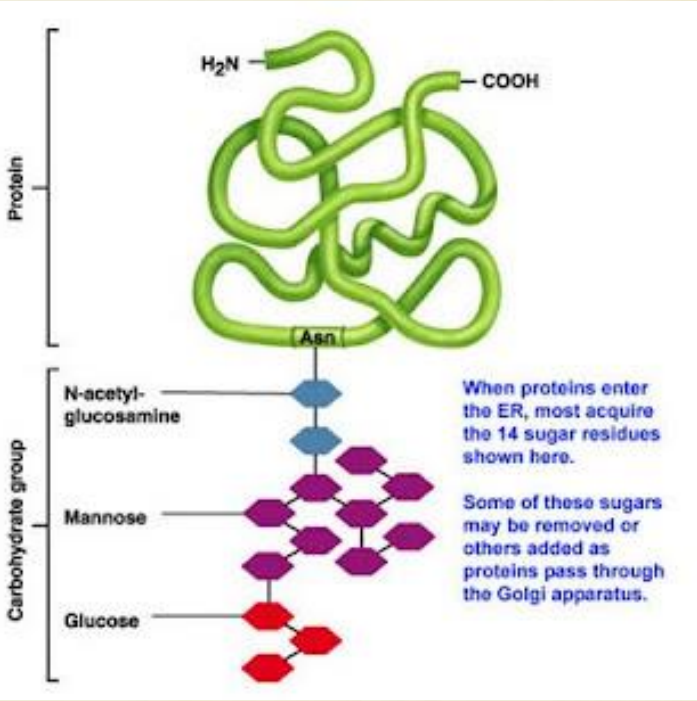
Rough endoplasmic reticulum

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

Key functions of RER:

- protein synthesis: cell membrane, secretory, lysosomes, Golgi, ER
- stabilization of conformation/folding/: chaperon proteins
- quality control
- glycosylation: attachment of oligosaccharides / N-linked glycosylation/.
- disulfide bond formation and rearrangement





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Endoplasmic reticulum

Smooth endoplasmic reticulum

There are no ribosomes on the surface

Key functions of SER:

- synthesis of phospholipids and steroids
- regulation of calcium concentration (Ca^{2+}storage)
- drug detoxification – biotransformation cytochrom 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 contraction of muscle by electrical stimulation

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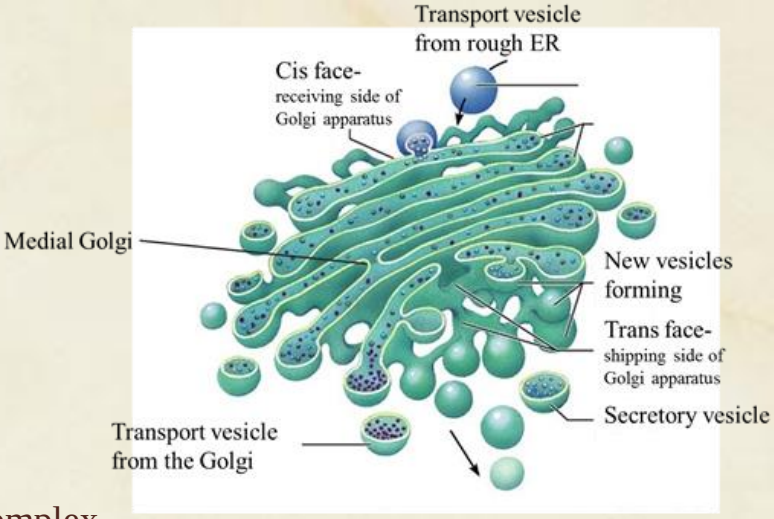

Golgi apparatus

- 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 three functional regions: the cis-Golgi network, medial-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/

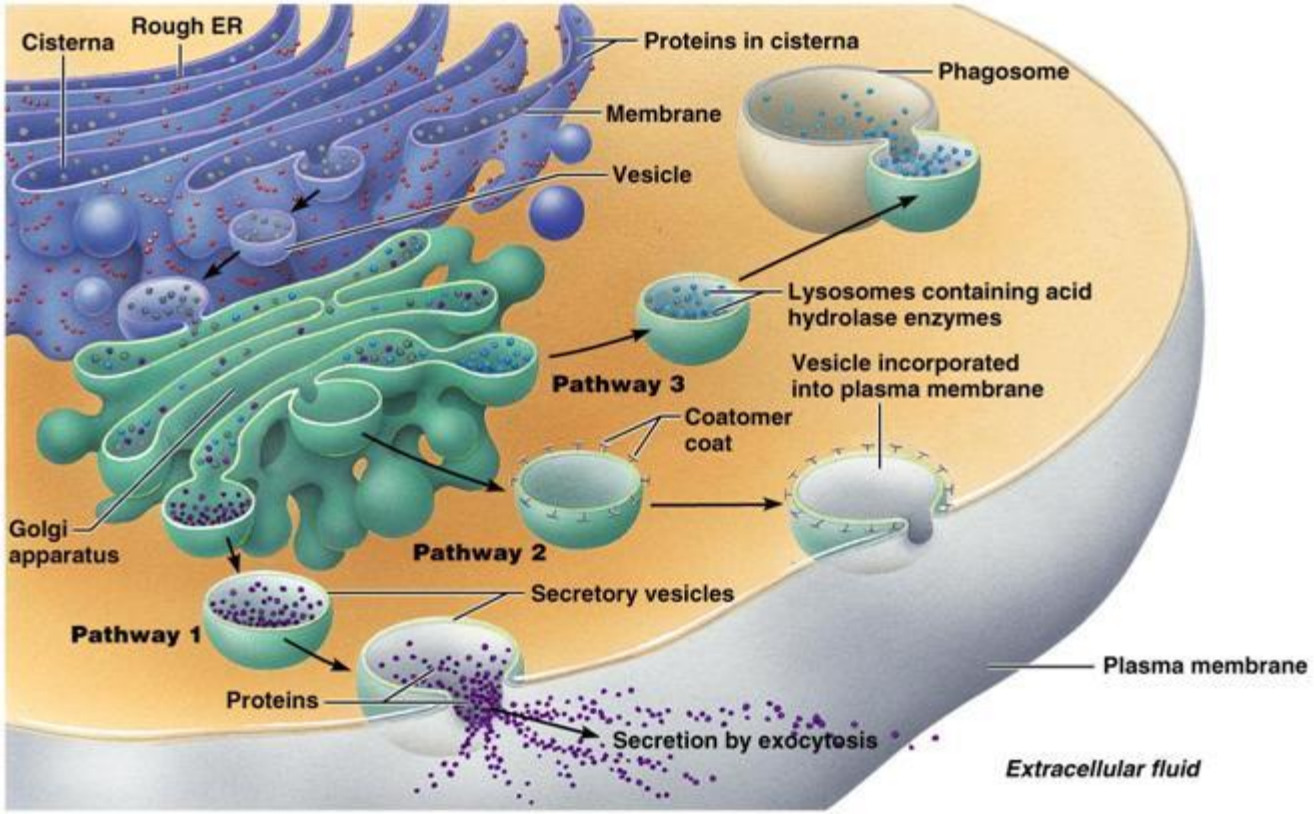

Figure 3.21

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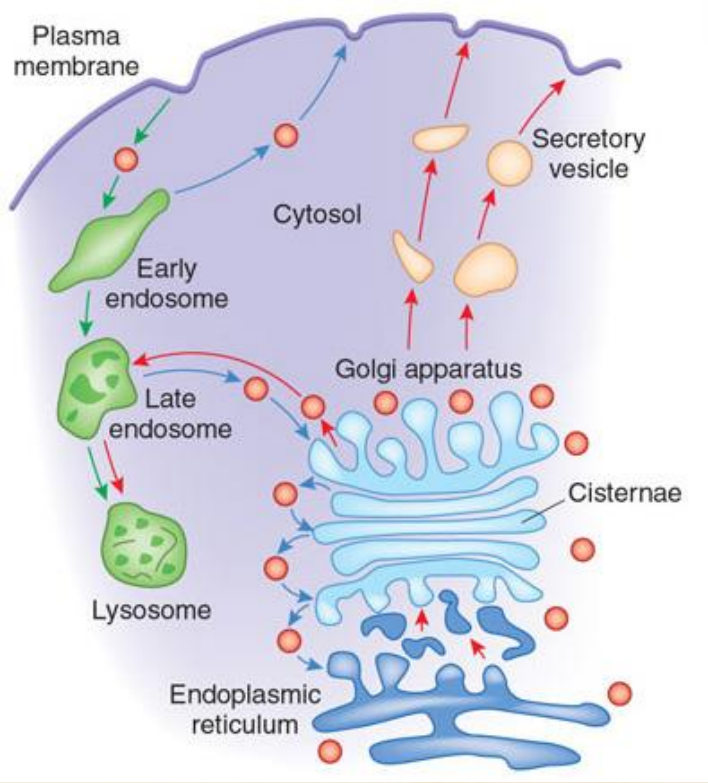
Vesicular transport

- it is an active process, in which materials are transported inside the cell, out of or into the cell
- vesicles are bubble like structures surrounded by a membrane
- it can occur between cell organelles like the ER and the Golgi or many diffrenet molecules can be moved across the membrane using vesicle



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Vesicle

Structure

- Is a small, intracellular, membrane-enclosed structure
- 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 cellullr products and waste

Types of vesicles:

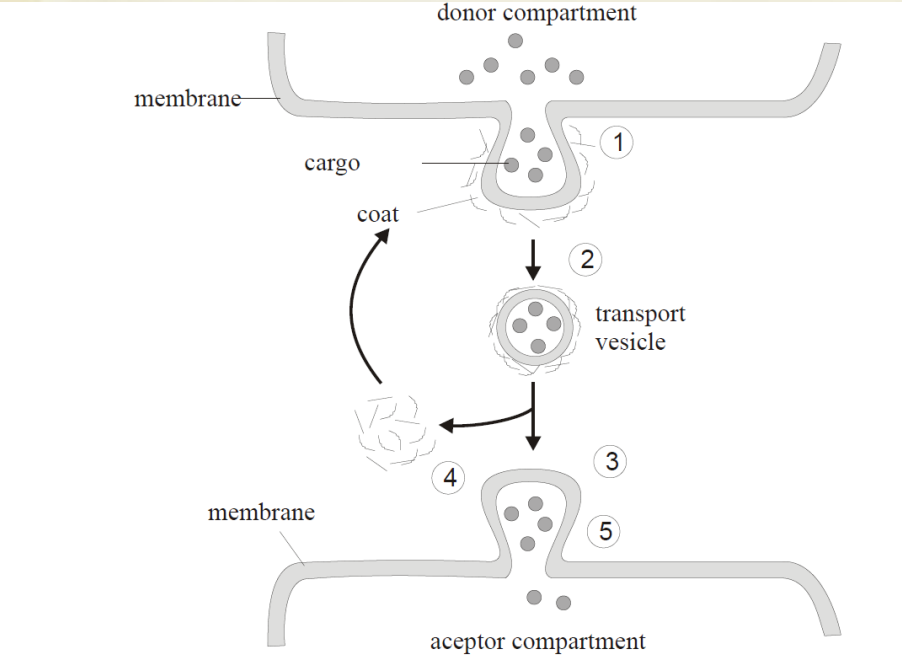
- **Transport vesicles**

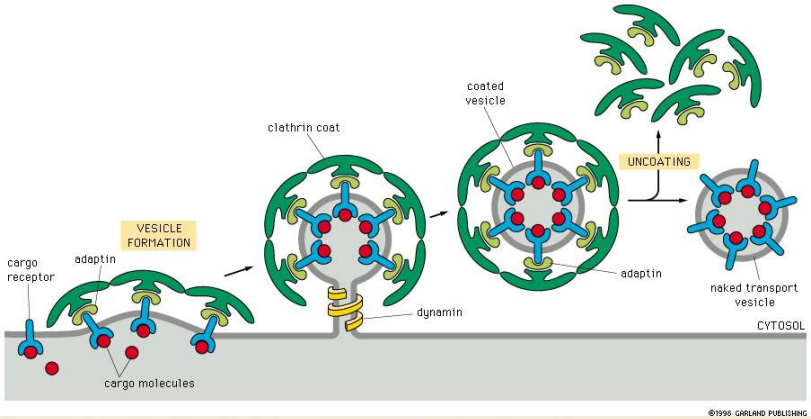
Transport vesicles can move molecules between locations inside the cell, e.g., proteins from the rough endoplasmic reticulum to the Golgi apparatus.

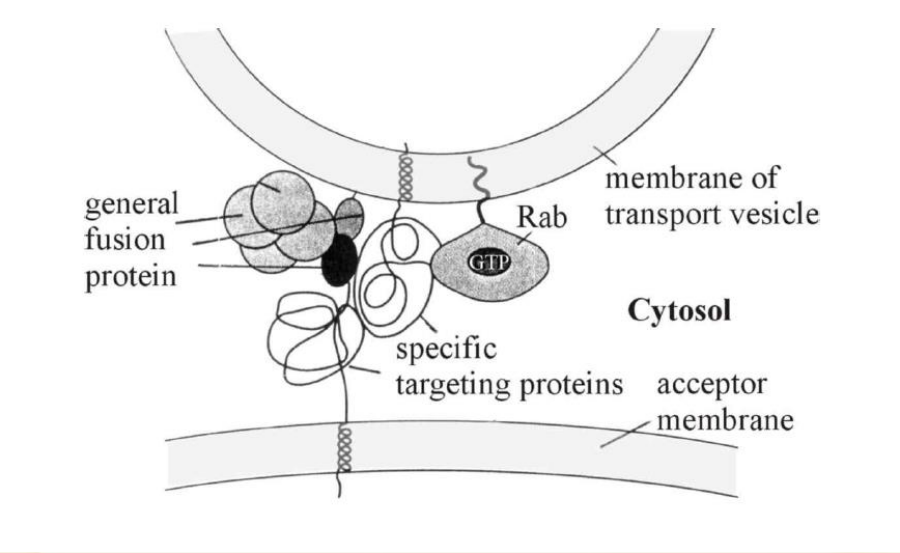
- **Secretory vesicles**

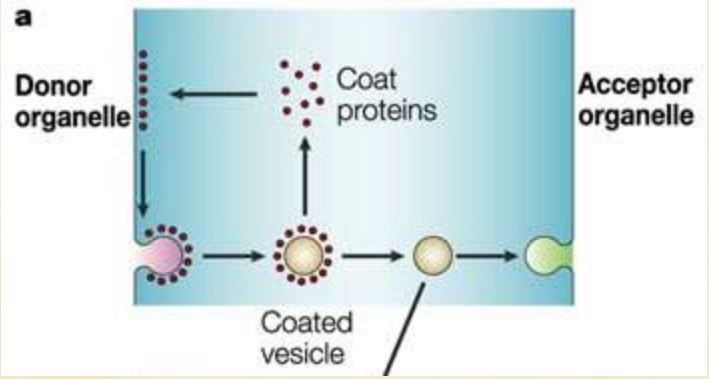
contain materials to be excreted from the cell

Vesicle coat: clathrin, COPI, COPII


donor compartment
membrane
cargo
coat
1
2
transport vesicle
3
4
membrane
5
aceptor compartment


coated vesicle
clathrin coat
UNCOATING
VESICLE FORMATION
cargo receptor
adaptin
adaptin
naked transport vesicle
dynamin
CYTOSOL
cargo molecules
©1998 GARLAND PUBLISHING


general fusion protein
Rab
GTP
membrane of transport vesicle
Cytosol
specific targeting proteins
acceptor membrane


a
Donor organelle
Coat proteins
Acceptor organelle
Coated vesicle

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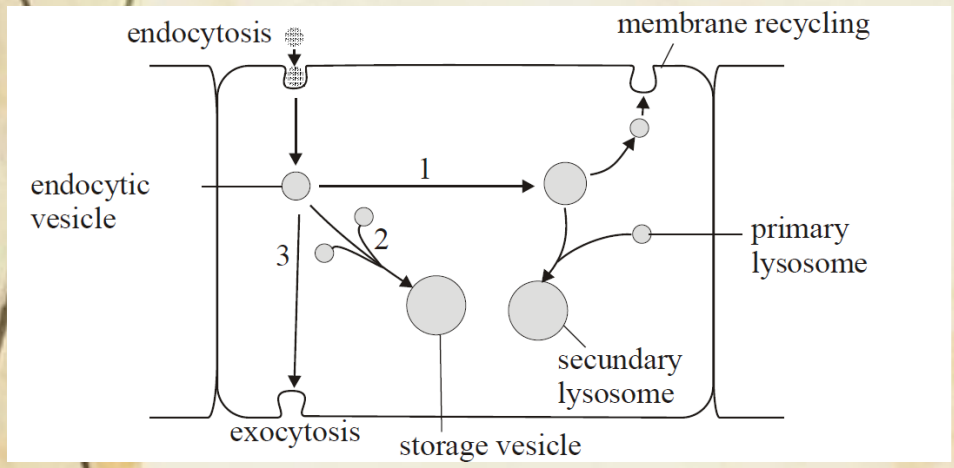
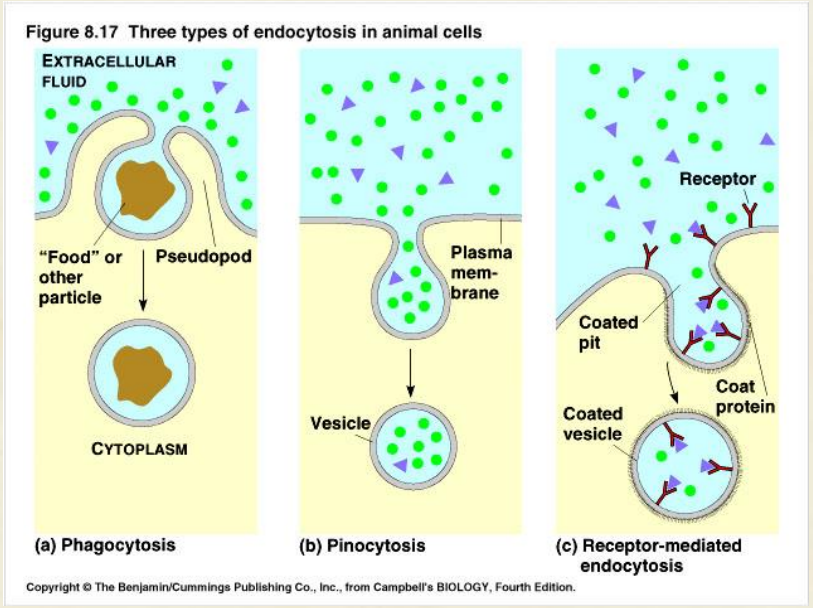
Vesicular transport

- there are two basic transport types of VT: **endocytosis** and **exocytosis**

Endocytosis –transport into the cell

- phagocytosis – engulfing large particles
- pinocytosis – taking in fluid droplets
- receptor mediated endocytosis – taking in specific molecules bound to receptors





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Vesicular transport

Exocytosis –transport out of the cell

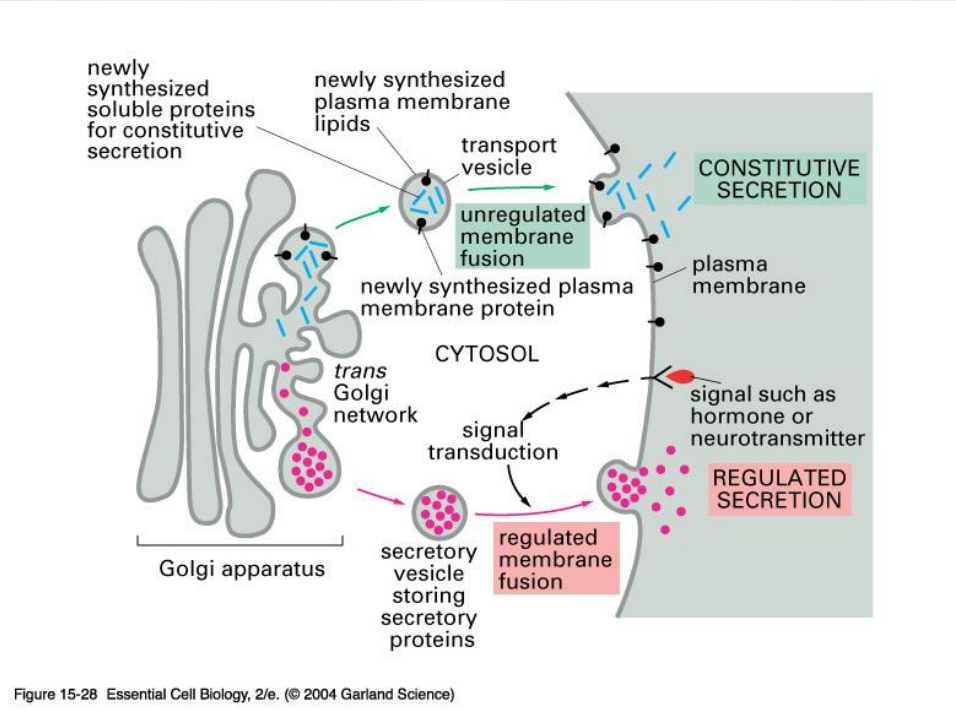


Figure 15-28 Essential Cell Biology, 2/e. (© 2004 Garland Science)

The cell III

Lysosome

- The name derives from the Greek words *lysis*(destruction) and *soma*(body)
- Lysosomal enzymes are synthesized in the RER, sent to the Golgi, creat the vesicels
- They are found in animal cells, while in plant cells the same organell is the vacuole

Size: varies from 0.1–1.2 μm

Structure: specialized vesicle surrounded by a single membrane

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

Enzymes: acid phosphatase

Functions: digest worn-out organelles, food particles and phagocyted particles

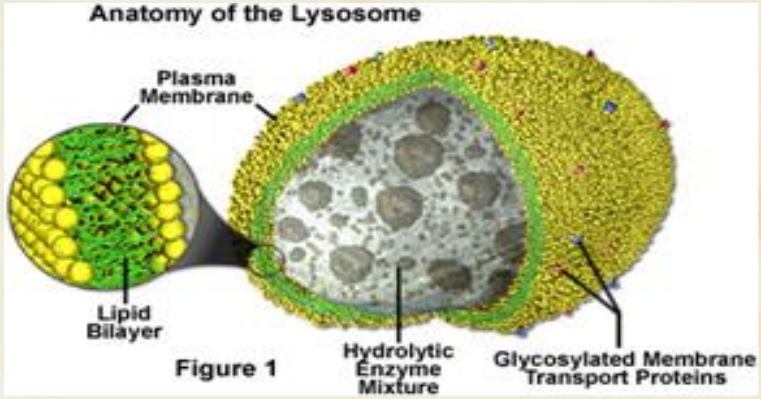
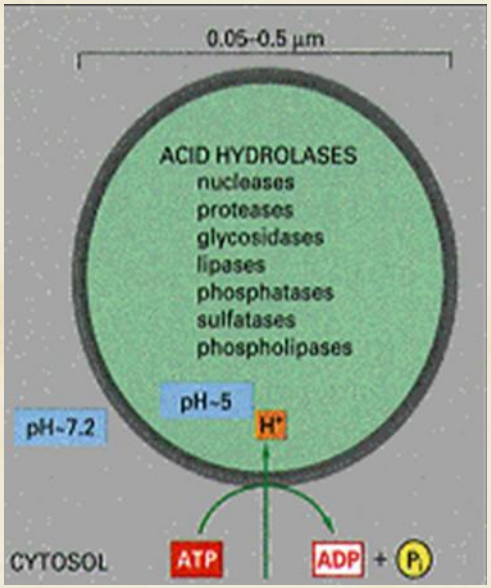


Figure 1



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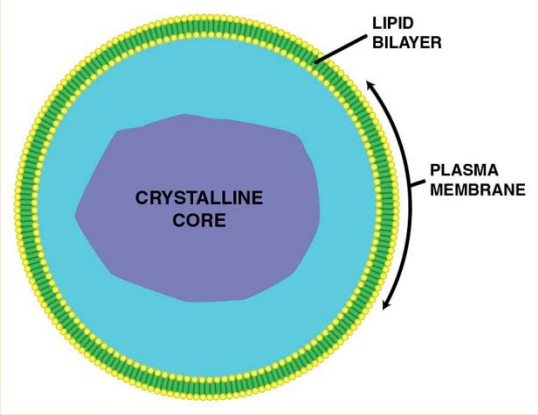
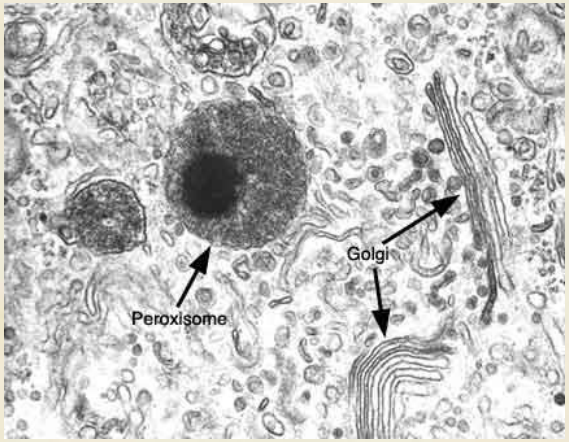
Peroxisome

- their size is about the size of lysosomes (0.5–1.5 μm)
- are enclosed by a single membrane
- often contains a crystalline structure in its center
- containes enzymes

Function

- breakdown (by oxidation) of fatty acids
- breakdown of hydrogen peroxide (H_2O_2)
- participates in the synthesis of bile acids



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