Cell organelles III.: Cytoplasm, cytoskeleton, SER, RER, vesicles, lysosomes, peroxisomes

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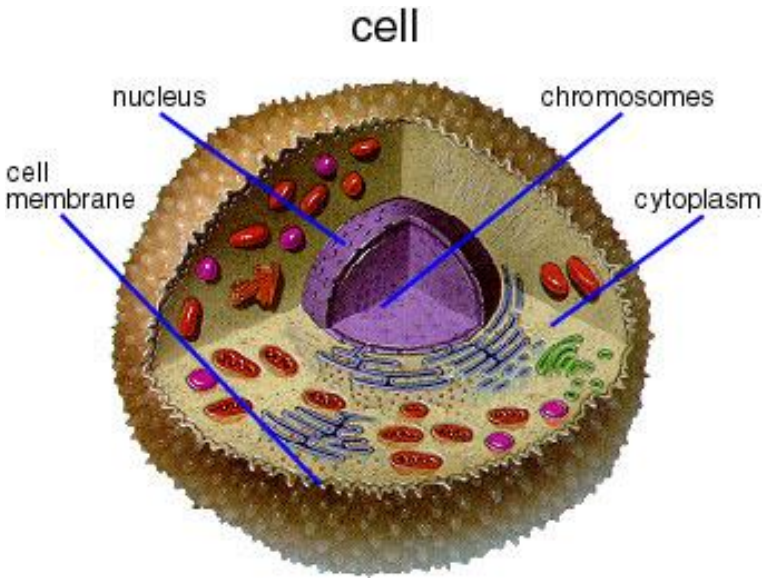
2016

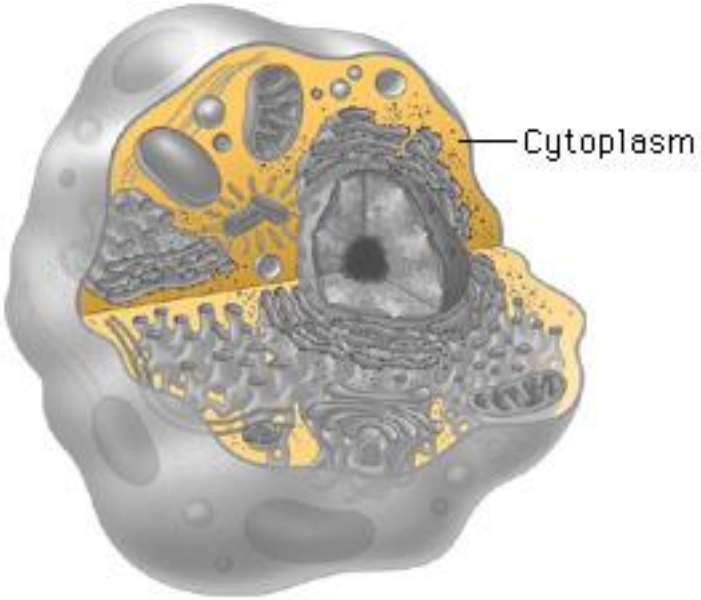
Cytoplasm



- Jelly like material, suspends the cell organelles
- Found inside the cell membrane, surrounding the nucleus of the cell (in eukaryotes)
- **Contains the nutrients, dissolves waste products, conducts electricity and participates in cell movements (cytoskeleton)**
- **Nucleoplasm**: in eukaryotes it is separated from the cytoplasm
- Major parts: **cytosol, cell organelles and inclusions**

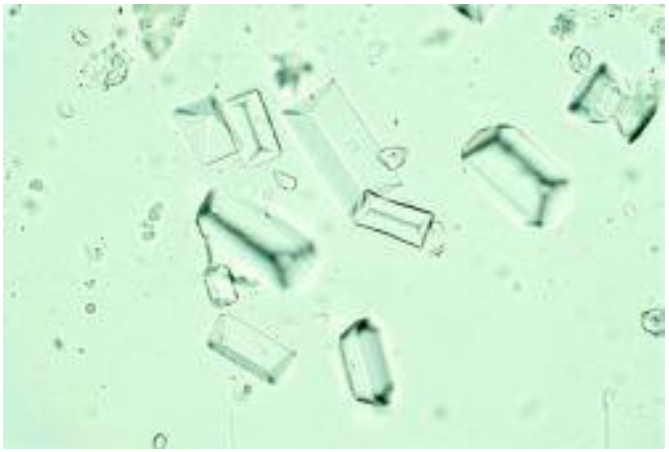
Cytosol

- Part of the cytoplasm
- Mixture of **cytoskeletal proteins, salts, organic molecules**
- Mostly **water**
- Yellow on this picture

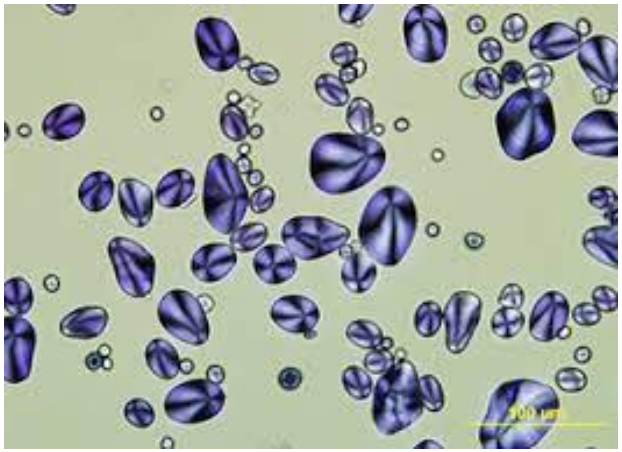


Cytoplasmic inclusions

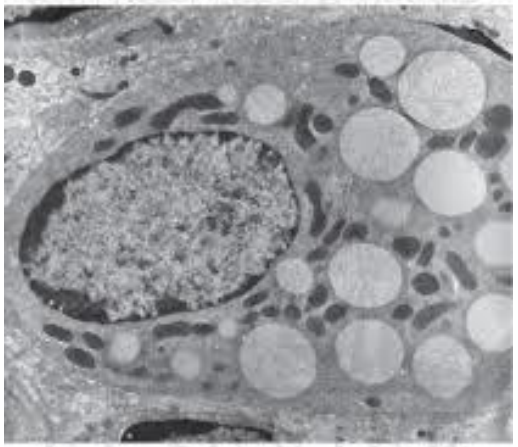
- Insoluble substances in the cytoplasm
- Not surrounded by membranes
- Do not participate in metabolism



Calcium oxalate



Starch



Lipid droplets

Cytoskeleton

Function:

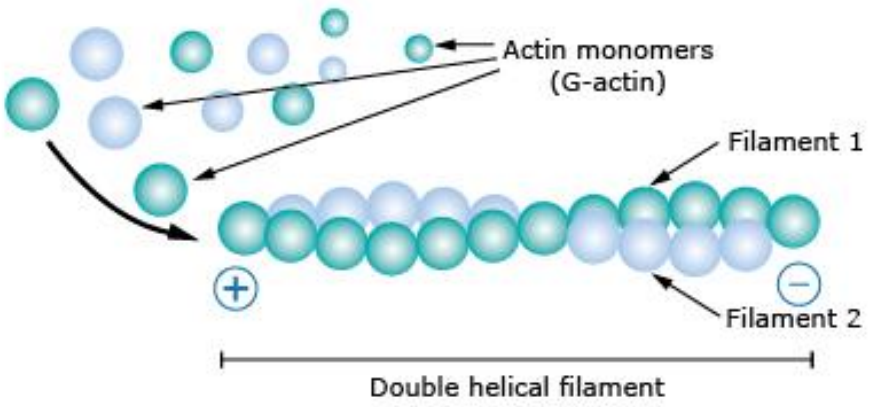
- Defines the shape of the cell
- Intracellular transport of cell organelles
- Cell movements
- Division: chromosome transportation
- Gives mechanical strength

Cytoskeleton

Main types:

- Actin microfilaments
- Intermediate filaments
- Microtubules

Cytoskeleton

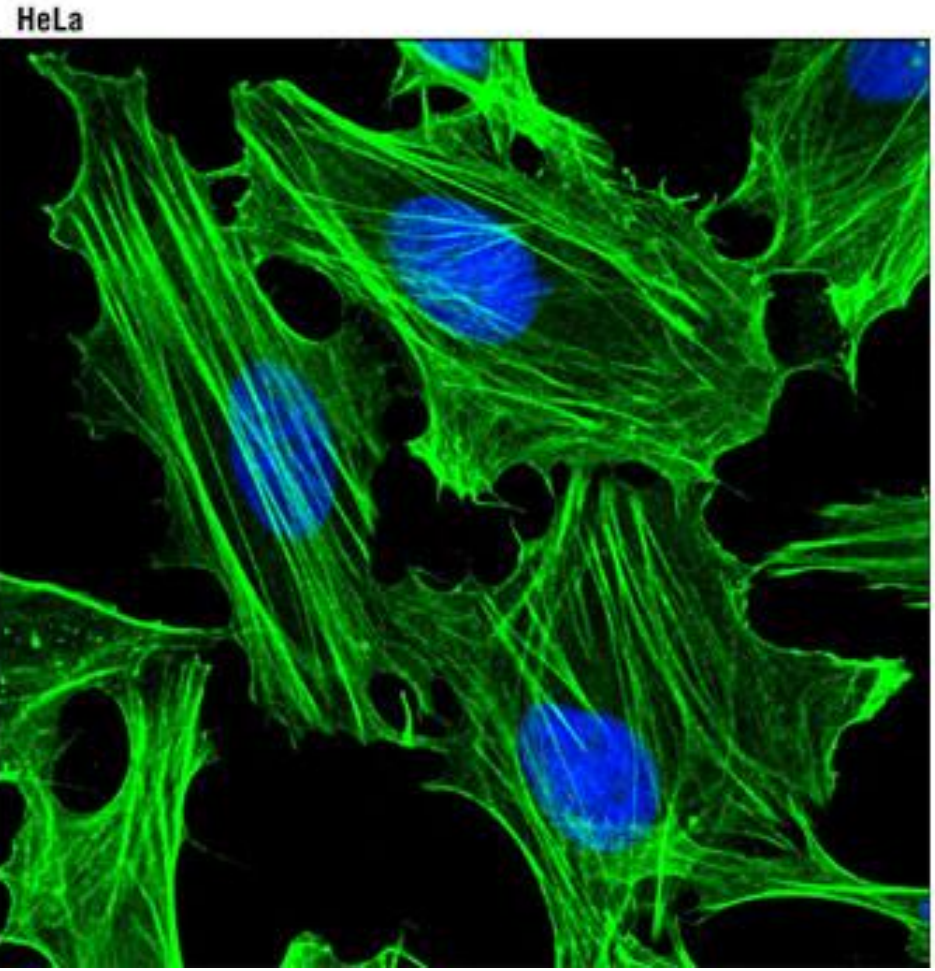


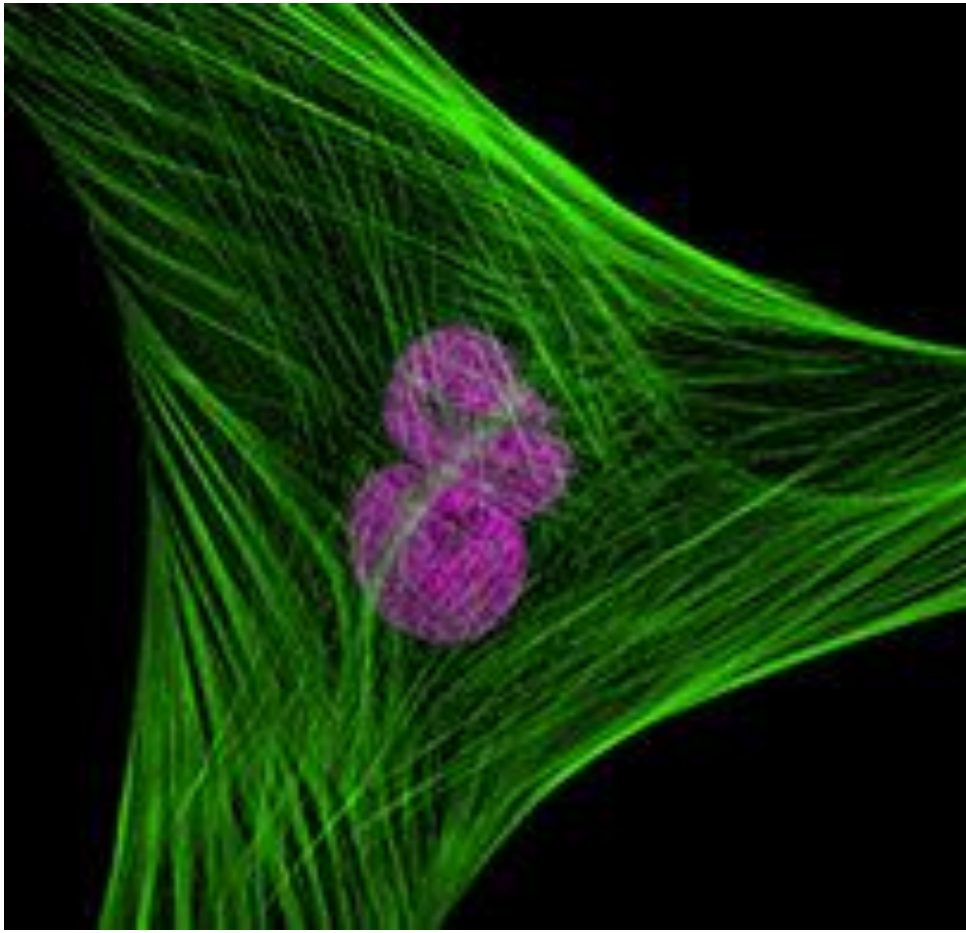
Actin microfilaments

- Diameter: 3-6 nm
- Monomers: globular actin proteins (G actin)
- Polymerisation: formation of long fibrillar actin (F actin)
- Dynamic instability
- Combines with several binding proteins → different functions:
  - With myosin in muscle cells → muscle contraction
  - Contractile ring during cytokinesis
  - Transport vesicles, cell organelles
  - Cell movements

https://lookfordiagnosis.com/mesh_info.php?term=actins&lang=1

Actin microfilaments with immunofluorescent staining

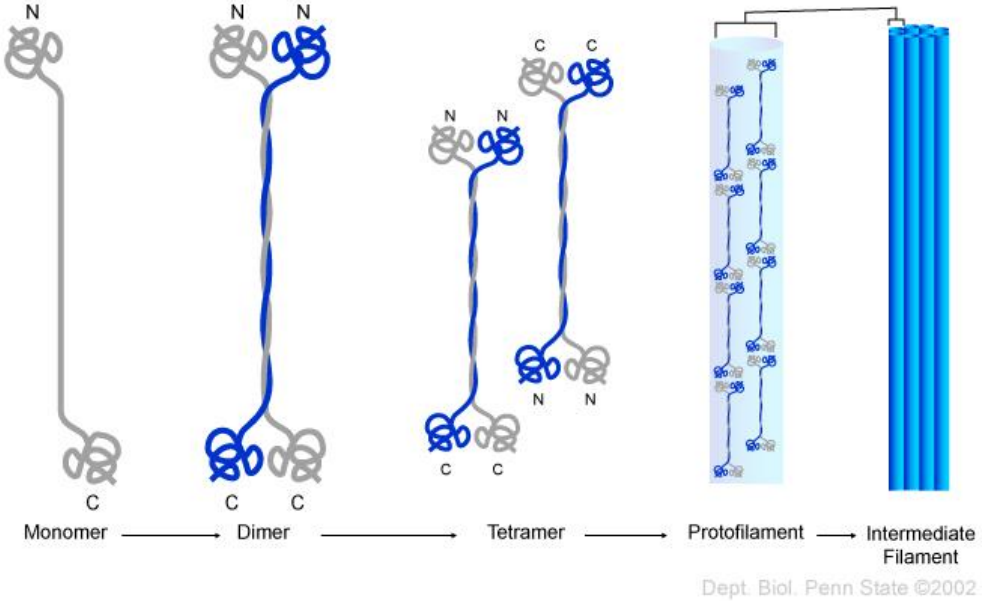




https://www.cellsignal.com/products/primary-antibodies/pan-actin-d18c11-rabbit-mab/8456

https://www.thermofisher.com/hu/en/home/life-science/cell-analysis/cell-structure/cytoskeleton/phalloidin-and-phalloidin-conjugates-for-staining-actin.html

Cytoskeleton

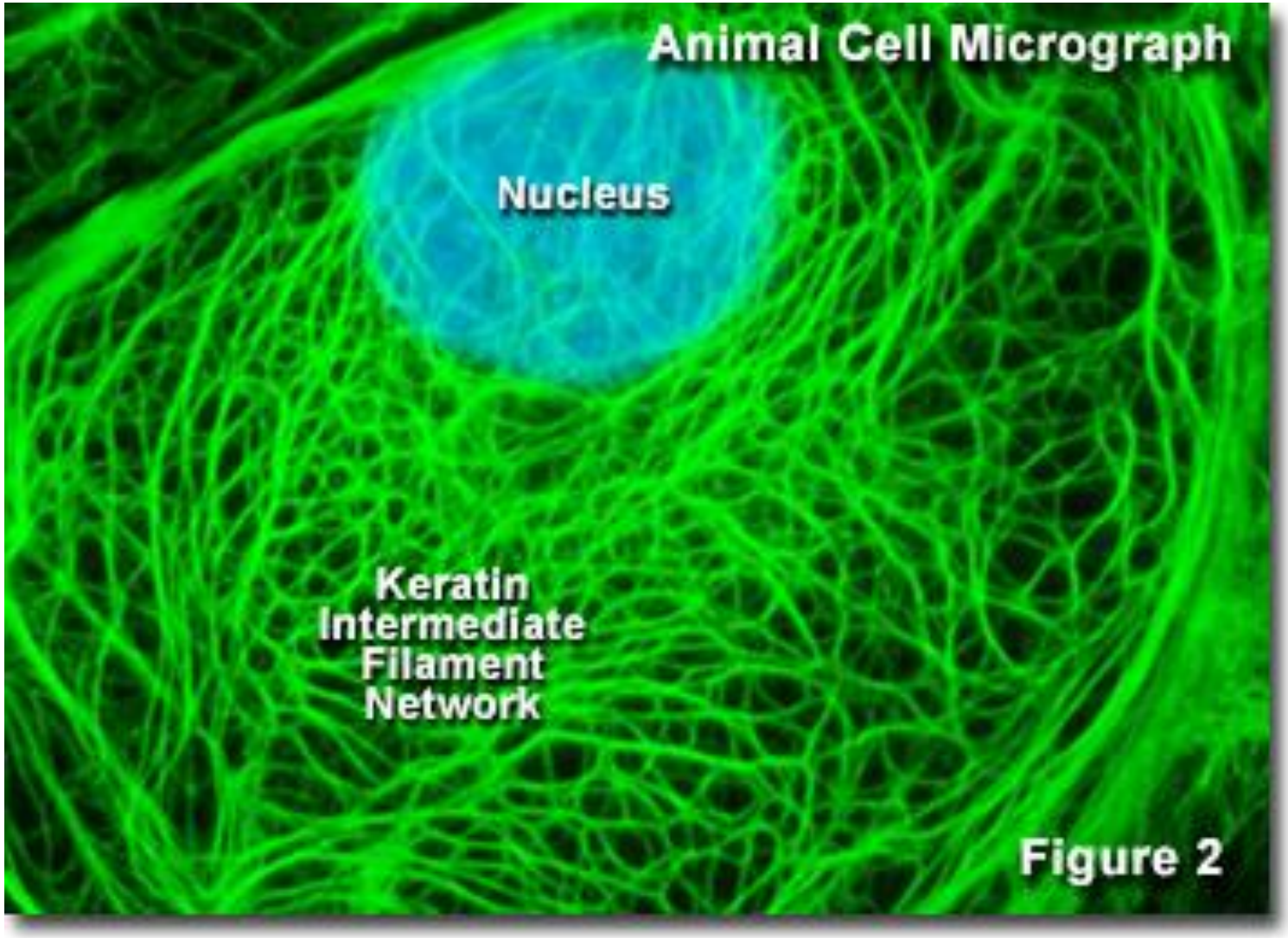


Intermediate filaments

- Diameter: 10 nm
- Rod-like monomers
- Polymerisation: formation of fibers
- Specific for cell types:
  - Desmin in muscle cells
  - Keratin in skin, hair and nail
- Only one of them found in every cell: lamin (in the nucleus)
- Role mostly to define the cell shape and give strength

http://www.glogster.com/bonnienienie/intermediate-filaments/g-6l91ds4fqp1re02ih0olka0

Intermediate filaments IF



https://micro.magnet.fsu.edu/cells/intermediatefilaments/intermediatefilaments.html

Cytoskeleton

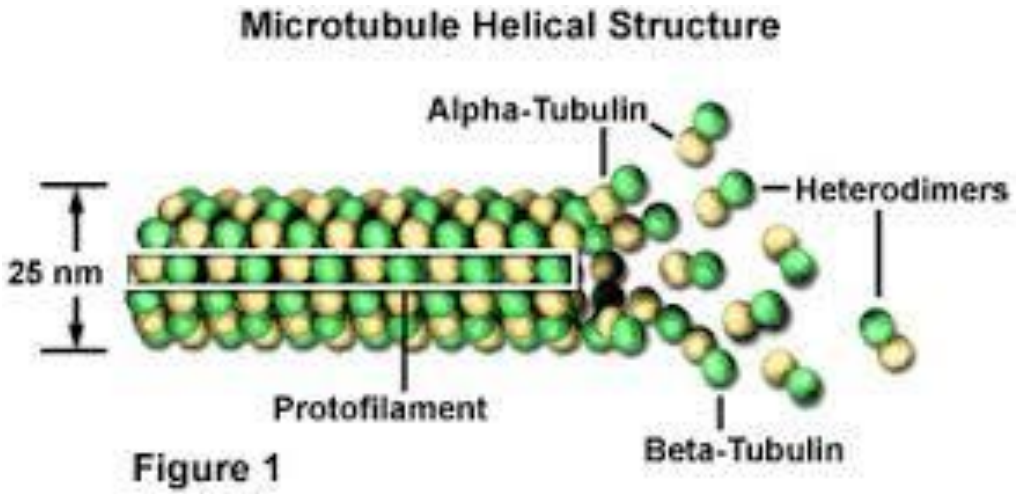


Figure 1

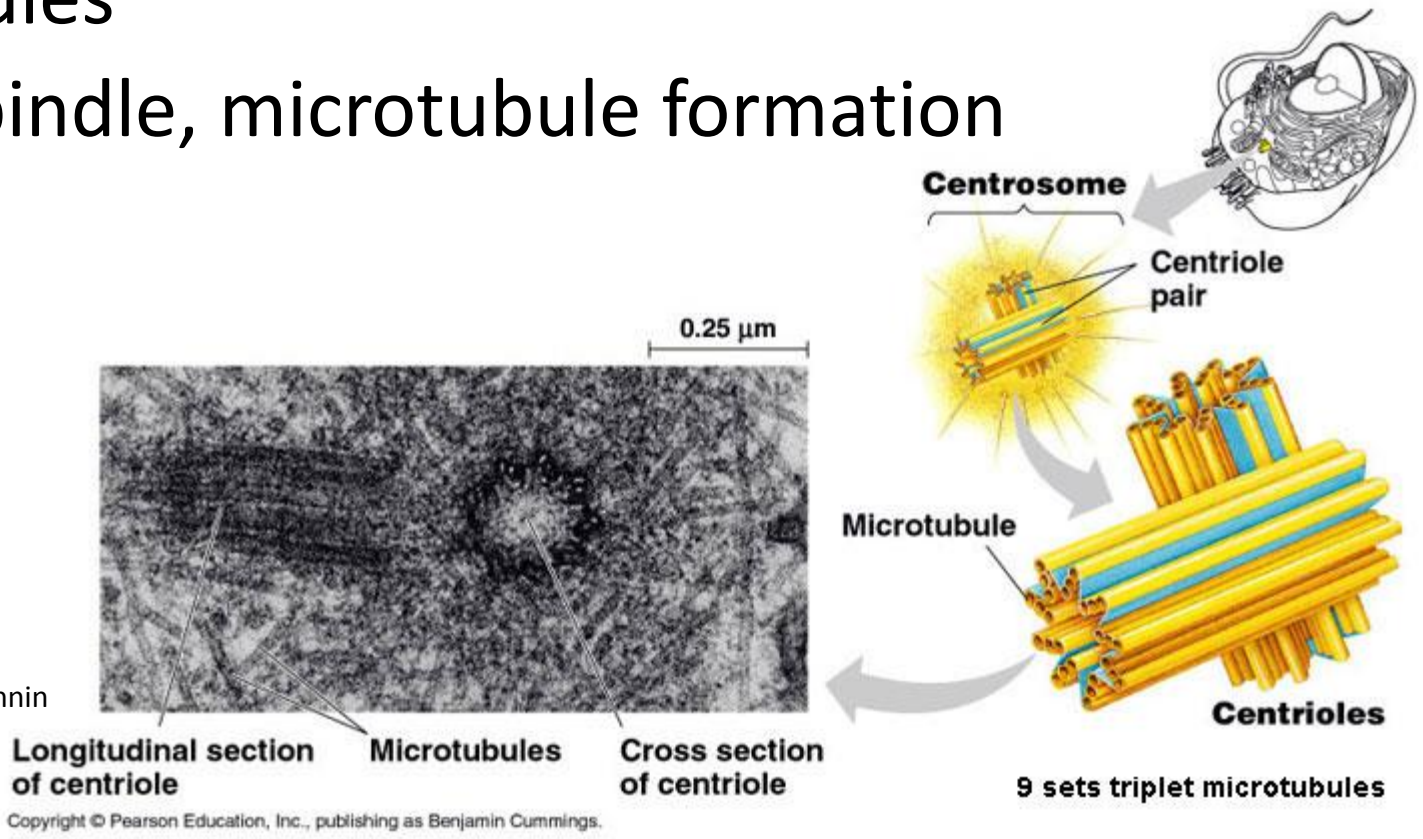
Microtubules

- Diameter: 20-25 nm
- Monomers: α and β tubulin proteins→dimers
- Polymerisation: starts from the centrosome, form tubular structures
- Dynamic instability
- Roles:
  - Shape
  - Cell movements
  - Vesicle and organelle transport
  - Form the mitotic spindles during cell division (chromosome transportation)

https://micro.magnet.fsu.edu/cells/microtubules/microtubules.html

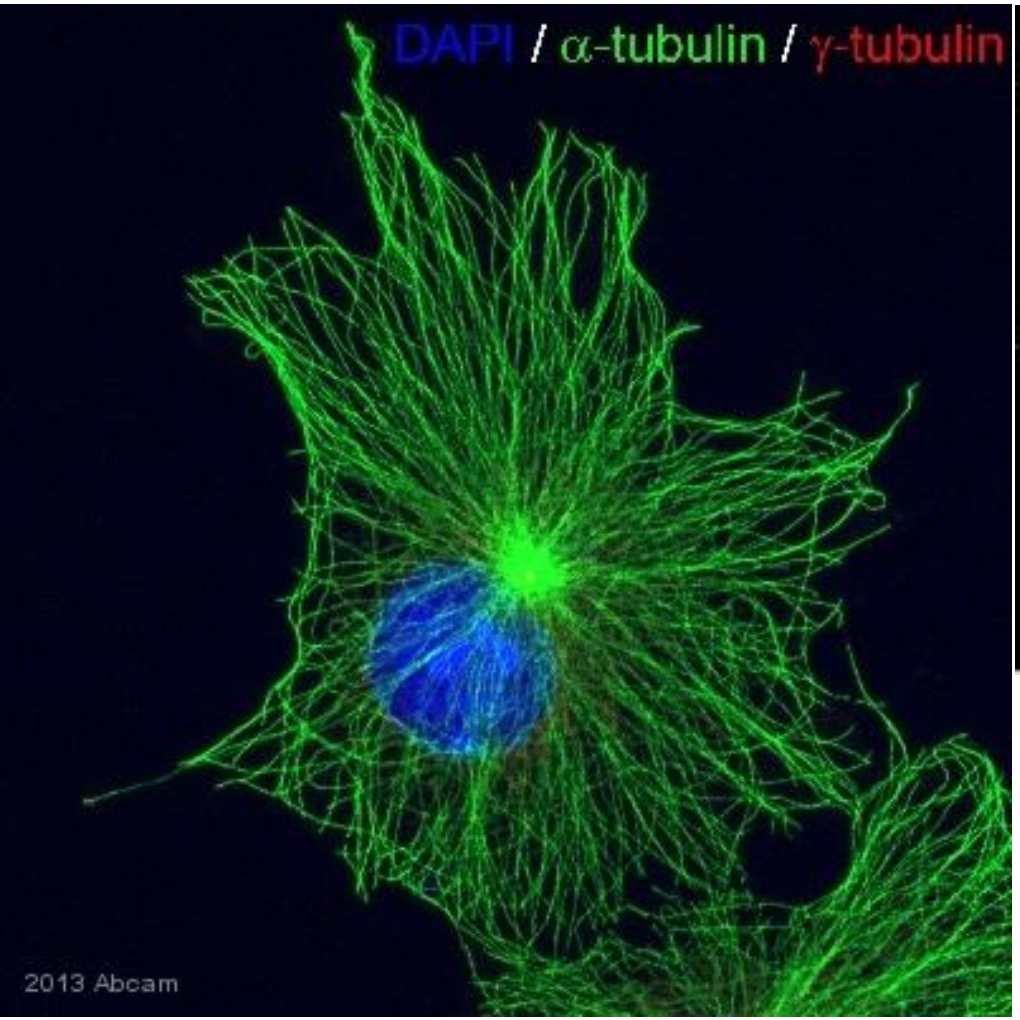
Centrosome/MTOC (Microtubule organising center)

- Consists of 2 perpendicular centrioles
- 1 centriole is made up of 9 groups of microtubules
- Mitotic spindle, microtubule formation

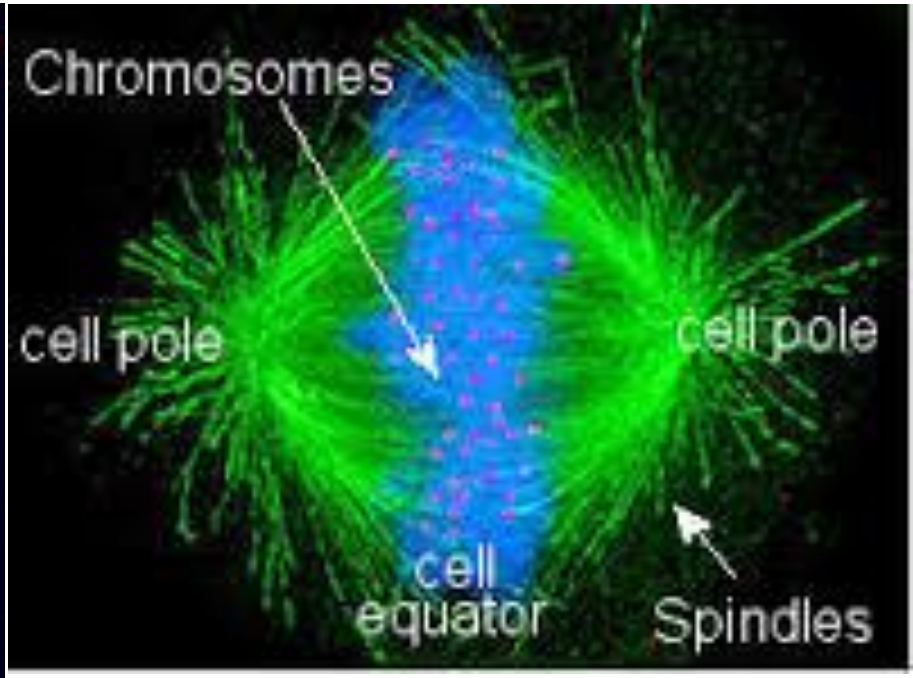


https://www.stolaf.edu/people/giannini/cell/cent.htm

Microtubules IF



http://www.abcam.com/alpha-tubulin-antibody-ab18251.html



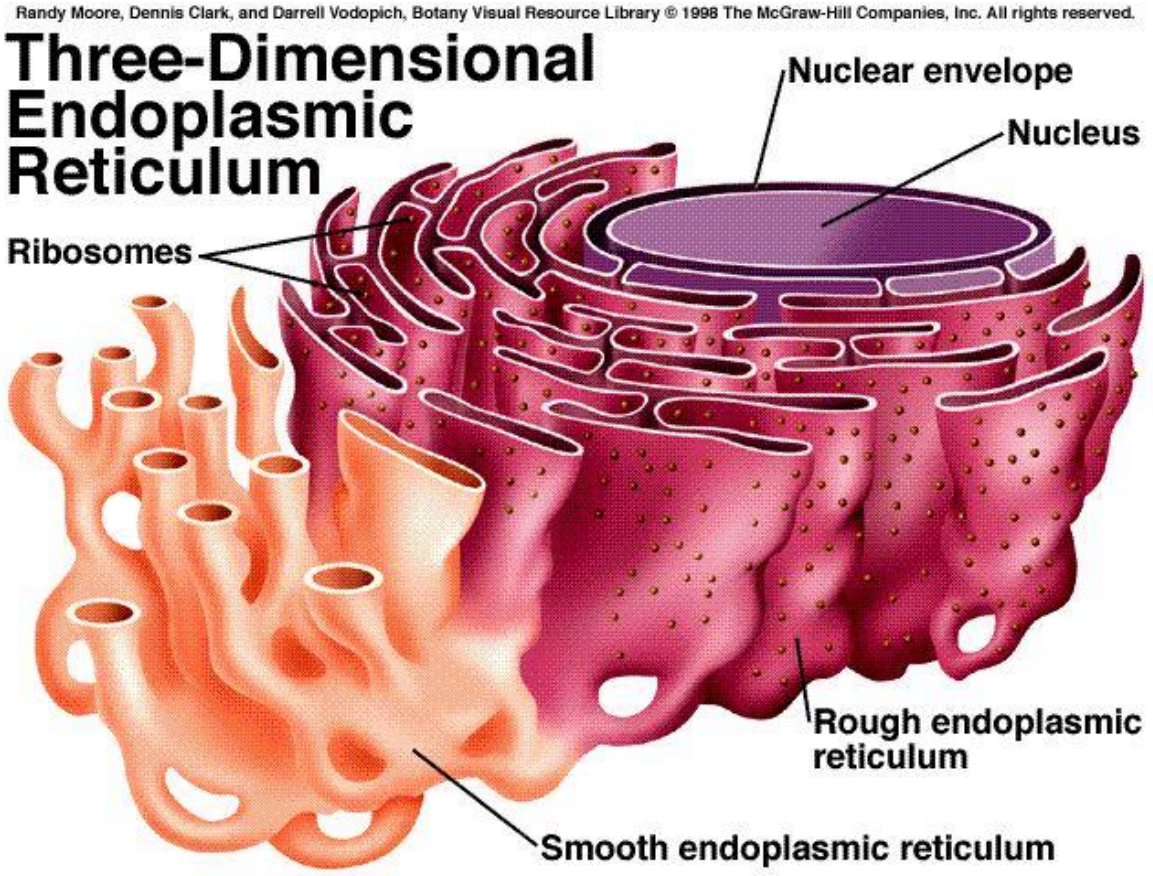
https://universe-review.ca/R10-13-innercell03.htm

Endoplasmic reticulum I.

- Network of membrane-enclosed tubules and flattened sacs
- The inside of them is called **lumen**
- Two types:
  Smooth Endoplasmic Reticulum (SER)
  Rough Endoplasmic Reticulum (RER)

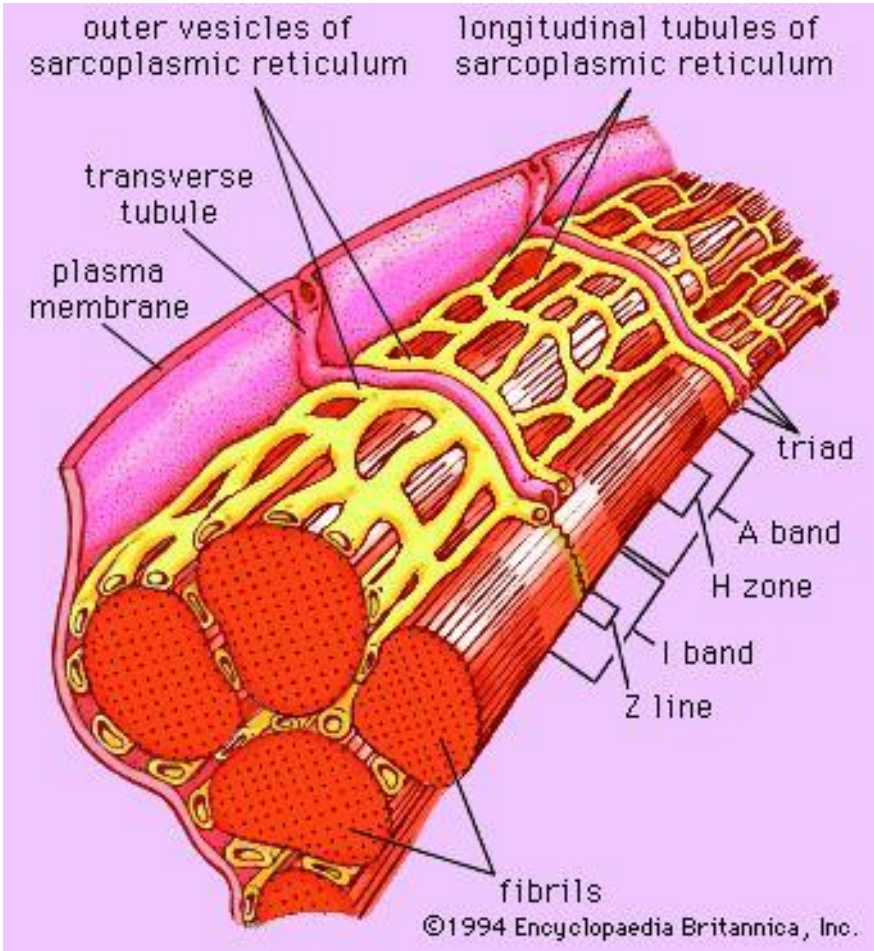
Endoplasmic reticulum II.
SER

- No ribosomes on the surface
- Functions:
  $Ca2^{+}$ storage
  Detoxification
  Lipid synthesis



Endoplasmic reticulum III. SER-Sarcoplasmic reticulum

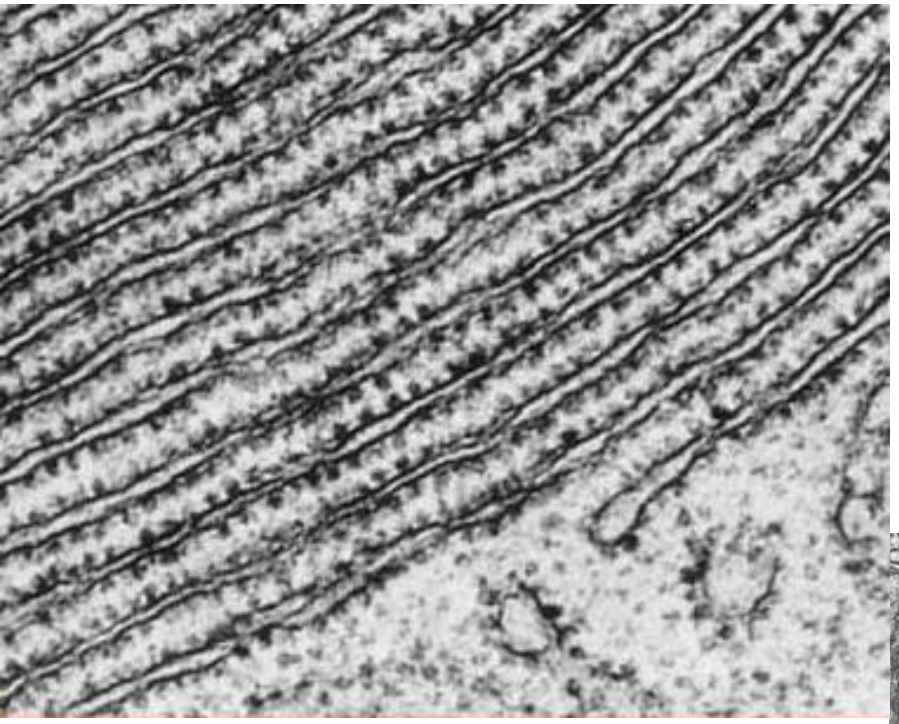
- Special type of SER
- Found in smooth and striated muscles
- $Ca2^{+}$ storage and release upon stimulation of muscle cells → muscle contraction



Endoplasmic reticulum IV.
RER

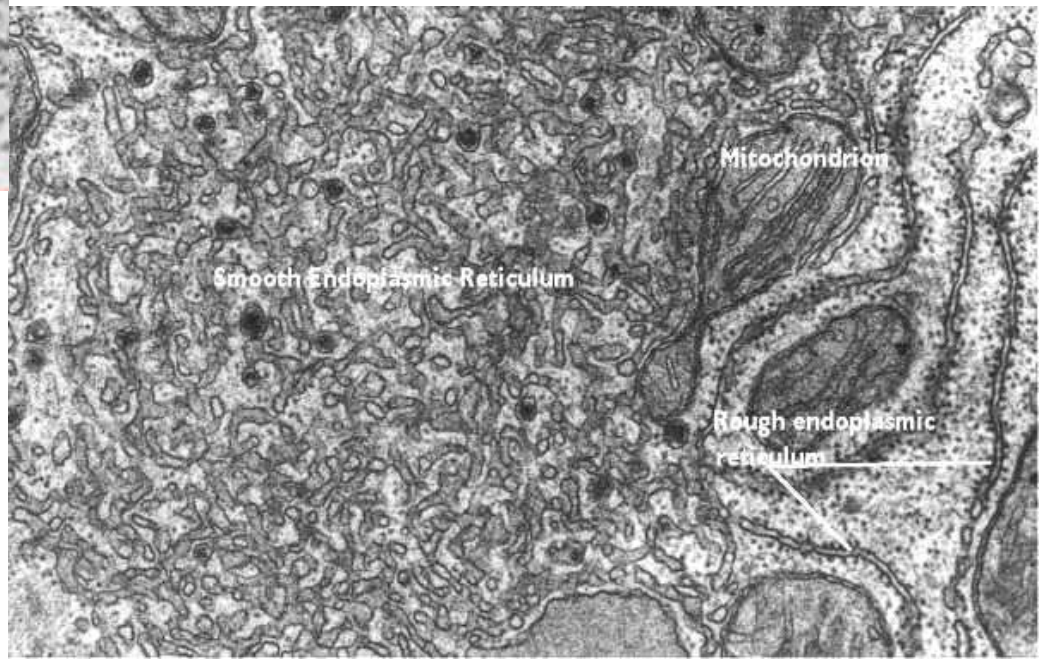
- Continuous with the outer membrane of the nuclear envelope
- Ribosomes are attached to it
- Function:
  Synthesis of proteins (cell membrane, secretory, lysosomal, RER, SER, Golgi)
  Folding of proteins
  Glycosylation of proteins (oligosaccharide attachment)
  Disulfide bond formation and rearrangement
  Quality control

Endoplasmic reticulum V.



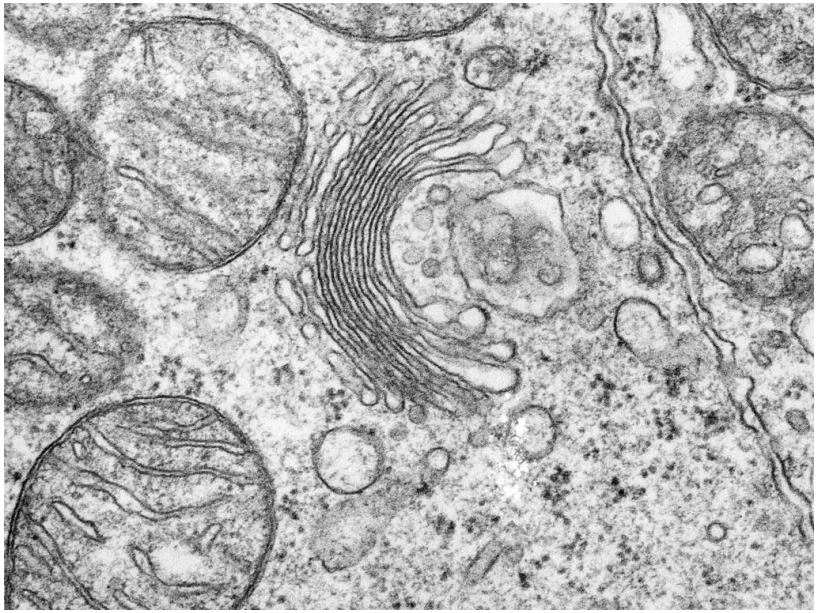
RER

RER and SER

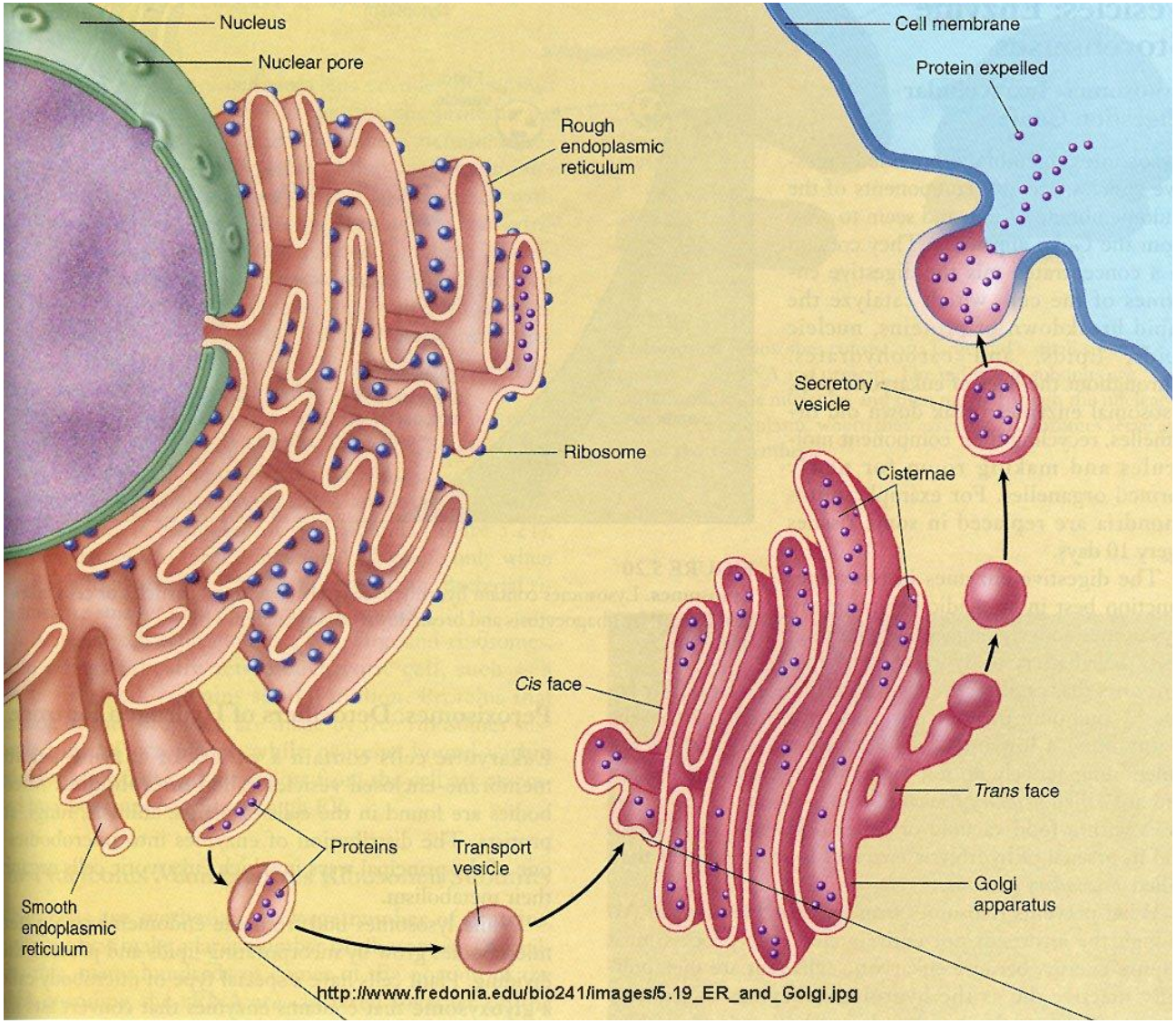


Golgi apparatus I.

- Consists of flat, membrane enclosed sacs, the so called **cisternae**
- Parts:
  cis-Golgi network
  medial-Golgi network
  trans-Golgi network
- These parts contain different enzymes
- Proteins from RER are transported by vesicular transport to the cis-Golgi
- Function:
  continue/finish glycosylation
  sorting



Golgi apparatus II.

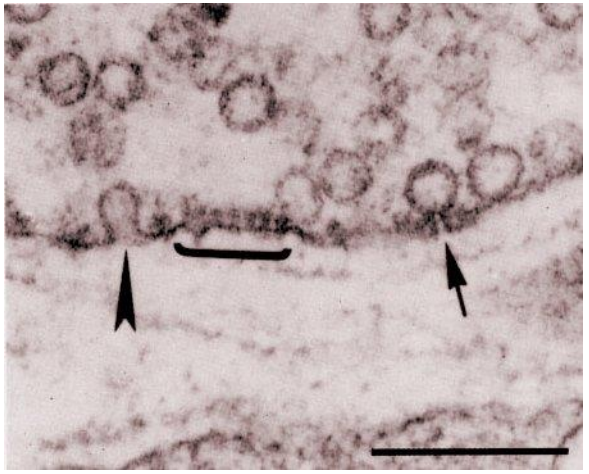


Vesicles

- Small, intracellular, bubble-like structures surrounded by a phospholipid bilayer
- Function:
  Transport of molecules
  Storage of molecules
- May fuse with membranes
  (Golgi-, lysosome-, cell-)
- Types:
  Transport vesicles: move molecules inside the cell
  Secretory vesicles: move molecules toward the extracellular space, finally fuse with cell membrane

Vesicular transport I.

- Moving molecules through membranes with the help of vesicles
- Active process (needs ATP)
- Main types:
  Exocytosis (from the cell to the extracellular space)
  Endocytosis

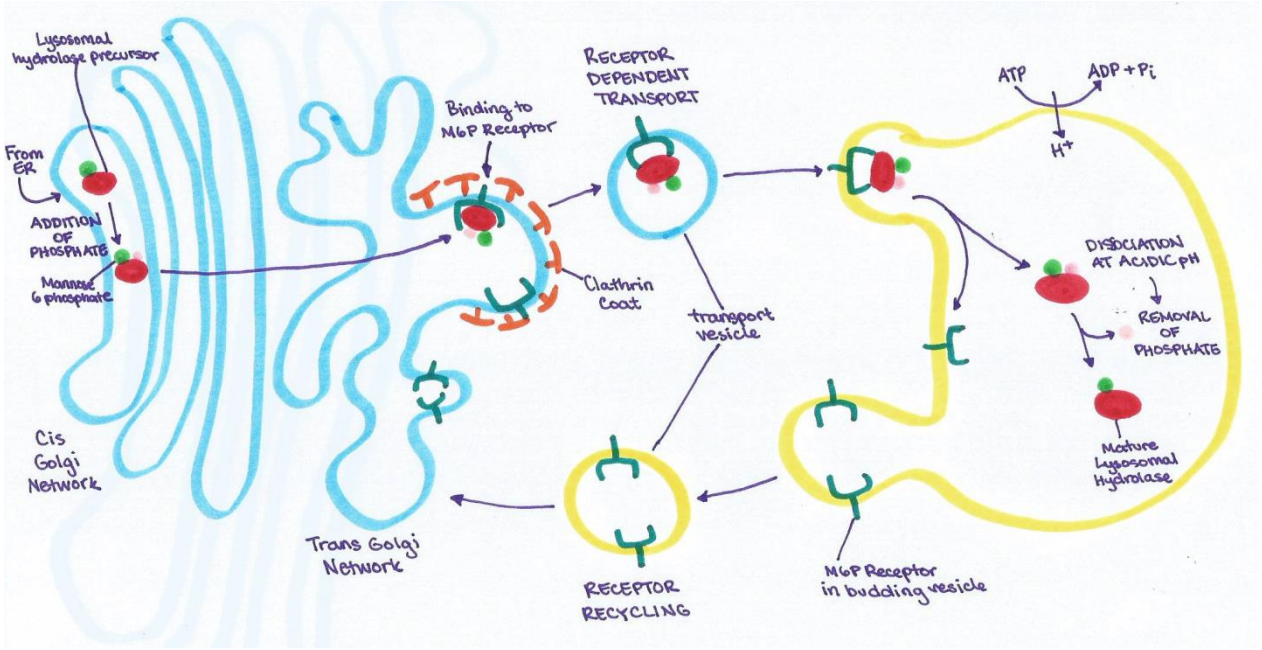


Vesicular transport II. Endocytosis

- From the extracellular space to the cell
- The formed vesicle is called endosome
- Endosomes may fuse with lysosomes (becomes phagolysosome/secondary lysosome) and the contents will be digested
- Types of endocytosis
  Phagocytosis: uptake of solid molecules
  Pinocytosis: uptake of fluids
  Receptor mediated endocytosis: uptake of specific molecules

Lysosomes I.

- Single membrane enclosed organelles
- **Cellular digestion** (hydrolysis of cellular, bacterial or viral macromolecules)
- Its enzymes are synthesized on the RER, transported to the Golgi, become modified and sorted to vesicles



Lysosomes II.

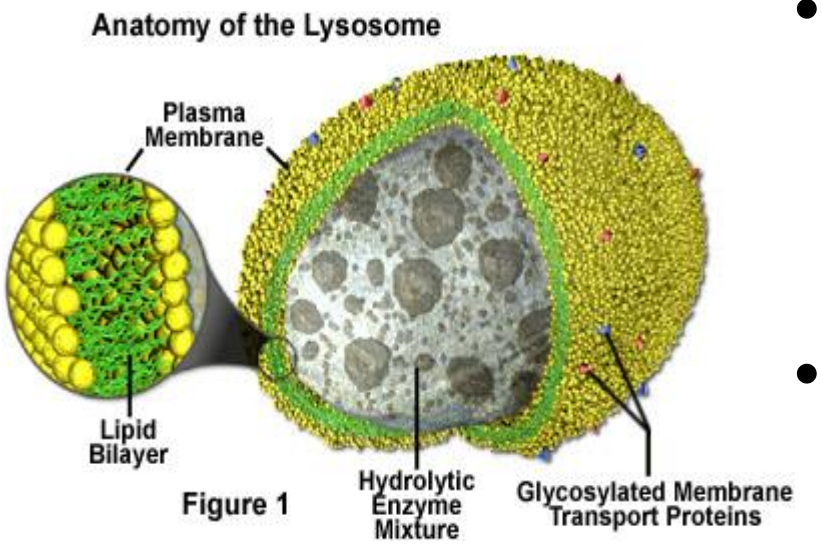


Figure 1

- The **pH** inside lysosomes is **acidic**
- Lysosomal enzymes are **acidic hydrolases** (hydrolytic enzymes working on acidic pH)
- Types:
  Primary: contains enzymes
  Secondary: fused with endosome, contains enzymes + macromolecules to be digested

Peroxisomes

- Small, single membrane enclosed organelles
- Participate in different metabolic processes
  Oxidization reactions
  $H_2O_2 \rightarrow H_2O$ (enzyme: catalase)
  Lipid and bile acid synthesis

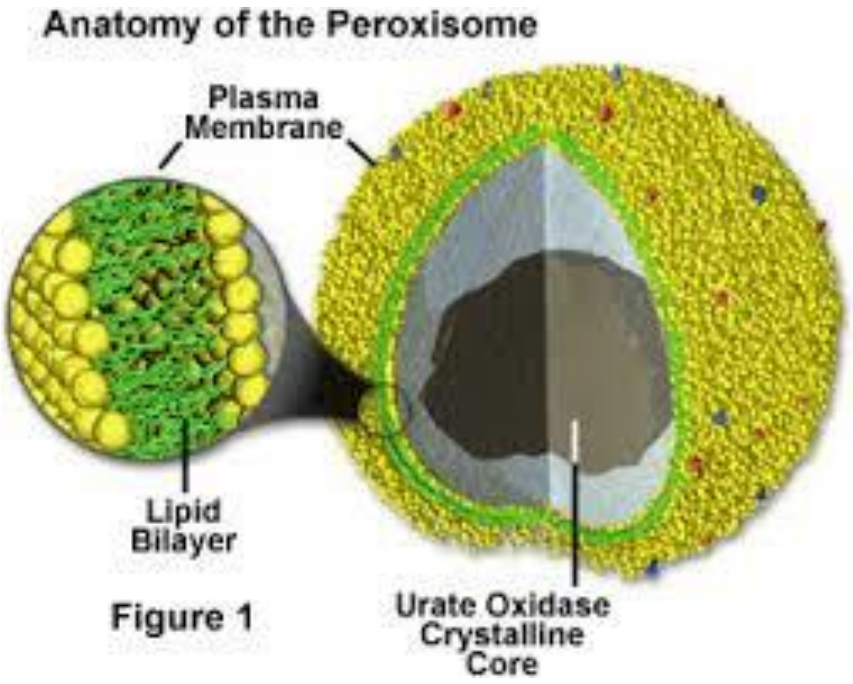


Figure 1

Thank you for your attention!