

Cell Organelles

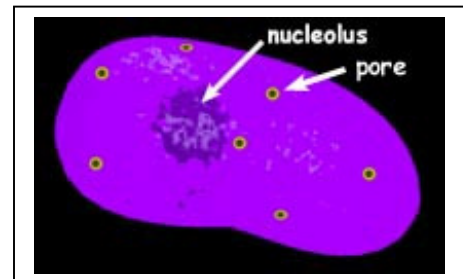
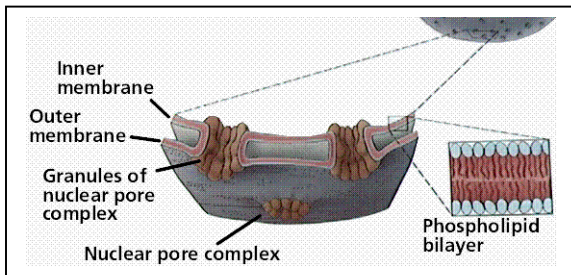
Organelles- membrane bound, sub-cellular structures that perform specialized tasks.

- 1) Physically separate different chemical reactions
- 2) Separate different chemical reactions that take place at different times

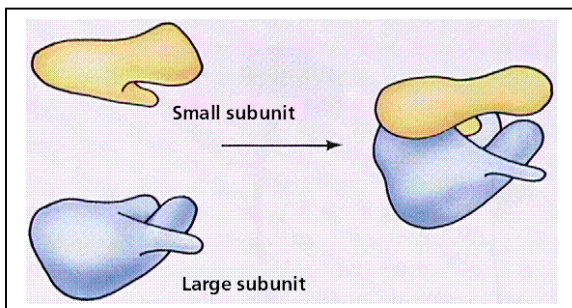
1) Nucleus and Ribosomes – these two organelles are involved in the genetic control of the cell. The nucleus houses the cell's DNA while the ribosomes use the information from the DNA to make proteins.

a) Nucleus – largest organelle, usually near the center of the cell.

- Nuclear envelope – 2 phospholipid bilayers
- Nuclear pores – lipid layers fuse/lined with channel proteins to create the pore complex that regulates the passage of certain large macromolecules and particles (selectively permeable).
- Nuclear lamina – netlike array of proteins that maintains the shape of the nucleus.
- Chromatin – loosely coiled DNA
- Chromosomes – tightly coiled DNA, forms as cell prepares for division
- Nucleoplasm – DNA, RNA, proteins
- Nucleoli – produce ribosomal RNA (rRNA) which is assembled into ribosomal subunits. These subunits are passed through the nuclear pores to the cytoplasm where they form ribosomes.



b) Ribosomes – particles made of rRNA and protein that carry out protein synthesis. Each ribosome is composed of two subunits. Ribosomes (like nucleoli) are not enclosed in a membrane.



Free Ribosomes – suspended in the cytosol, most proteins Produced by free ribosomes function within the cytosol.

Bound Ribosomes – attached to the outside of the ER or Nuclear envelope.

- generally make proteins for inclusion into membrane
- for packaging within certain organelles such as lysosomes
- or for export from the cell (secretion)

Ribosome can alternate between free and bound depending on the cell's need.

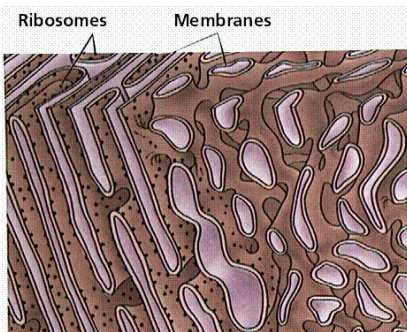
2) Endomembrane System – Includes the nuclear envelope, endoplasmic reticulum, golgi apparatus, lysosomes, various kinds of vacuoles, and the plasma membrane.

- a) Endoplasmic Reticulum (ER) – Phospholipid bilayer with enzymes on surface. Accounts for half the total membrane in many eukaryotic cells. Fluid filled membrane that forms tubules and cisternae (spaces) within the membrane.

Transport – flattened sacs connect the nuclear envelope, cell membrane, and some organelles.

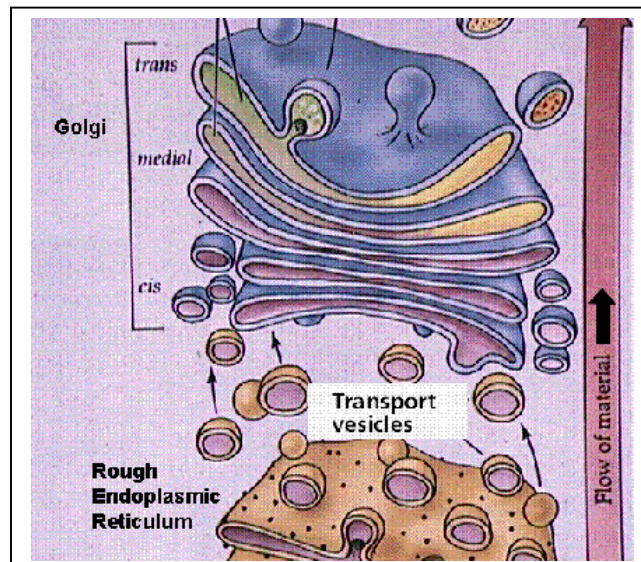
Rough ER – ribosomes attached to surface, makes secretory proteins and membrane proteins (glycoproteins) that leave wrapped in transport vesicles. This is where the cell makes proteins for export.

Smooth ER – No ribosomes attached.

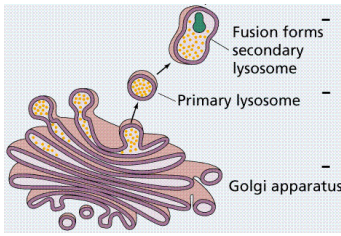


- i) Synthesis, storage, and transport of lipid-containing substances including steroids.
- ii) Toxin and Drug detoxification – addition of hydroxyl group makes the drugs more soluble and easier to flush from the body. Liver cells have a lot of smooth ER.
- iii) Enzyme for hydrolysis of glycogen to glucose. First step of carbohydrate metabolism. Glycogen to glucose phosphate, smooth ER enzyme removes that phosphate group so glucose can leave the cell.
- iv) Ca^{+2} pump – Smooth ER membrane pumps ions from the cytosol into the cisternal space.

- b) Golgi Complex (Apparatus) – Flattened, slightly curved membrane bound sacs (cisternae). Thin in the middle, enlarged at the ends. They collect, package, and distribute molecules made elsewhere in the cell (ribosomes, ER).
- ER protein and sugar – glycoprotein packaged in piece of ER membrane vesicle passes to golgi where it fuses and is modified.
 - Transport vesicles from ER are received at the cis end modified and released at the trans end.
 - Hormone glands have a large number of golgi complexes.



- c) Lysosomes – Vesicles (small vessel) bud from golgi complex. Filled with hydrolytic enzymes that can break down proteins, nucleic acids, macromolecules, lipids, and carbohydrates.



- Digest worn out parts and recycle materials (autophagy)– liver cells recycle half macromolecules per week.
- Works best at pH of 5 – maintains low pH by pumping protons (H^+) into the lumen of the lysosome. Can autodigest cell if many break at once.
- Programmed destruction of cells by their own lysosomes (apoptosis) is important in the development of many organisms.
- Lysosomal storage diseases (Pompe's disease and Tay-Sachs) are caused by the absence of a lysosomal enzyme needed to break down macromolecules.

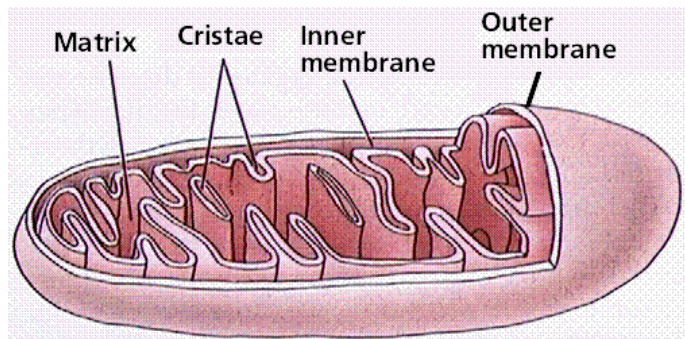
- d) Vacuoles - Large vesicles.

- Food vacuoles – formed by phagocytosis
- Contractile vacuoles – pump out excess H_2O
- Central vacuole – large vacuole in plant cells, enclosed by tonoplast (membrane)
 - o Stores organic molecules (proteins in seeds)
 - o Stores ions: K^+ and Cl^-
 - o Pigments
 - o Toxic compounds for protections against predators
 - o Plants cells grow (elongate) by adding H_2O not cytoplasm

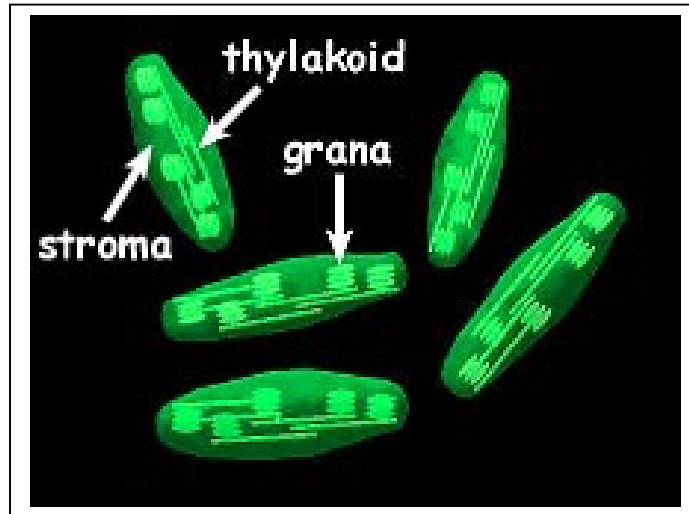
3) Mitochondria and Chloroplast – Energy transformations.

a) Mitochondria – Sausage shaped power house of the cell. Some cells may have thousands of mitochondria, related to cell's metabolic activity. They have their own DNA.

- Mitochondria are enclosed by two membranes, each a phospholipid bilayer with their own unique embedded proteins.
- Cristae – infolding of the inner membrane creating more surface area
- Matrix – fluid inside the inner membrane
- Site of Respiration.



- b) Chloroplast – Site of photosynthesis. As with mitochondria they have their own DNA.
- Chlorophyll and enzymes for photosynthesis
 - Inside the chloroplast in another membrane system – thylakoids (flattened sacs)
 - Grana are stacks of thylakoids
 - Stroma – fluid surrounding the thylakoids, contains chloroplast DNA, ribosomes and enzymes.

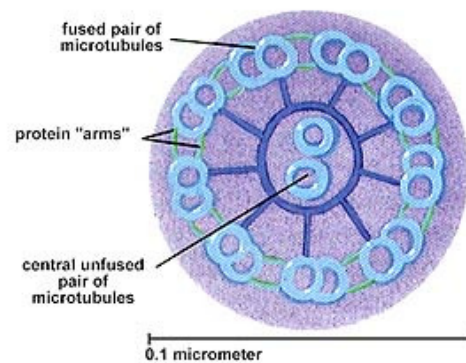
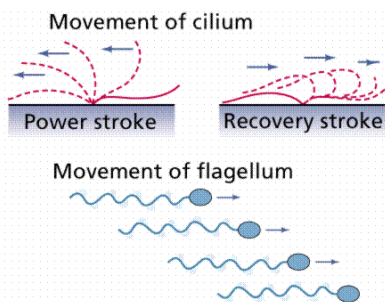


4) Cytoskeleton – network of protein fibers that crisscross the cytoplasm and anchors many of the organelles. The cytoskeleton is very dynamic allowing it to be quickly dismantled and reassembled in new locations.

a) Microtubules – Largest of the cytoskeleton structures. Hollow rods constructed from a globular protein called tubulin. Microtubules resist compression. Serve as tracks for organelles equipped with motor molecules (secretory vesicles from golgi to plasma membrane).

Centrosomes and Centrioles – microtubules grow out of the centrosome and function as compression resisting girders of the cytoskeleton. Within the centrosome of an animal cell are a pair of centrioles (nine sets of triplet microtubules in a ring) that help anchor spindle fibers which move chromosomes during cell division.

Cilia and flagella – Nine doublets of microtubules surrounding two single microtubules form the core of these structures. Attached to the cell by a basal body these structures are responsible for movement.

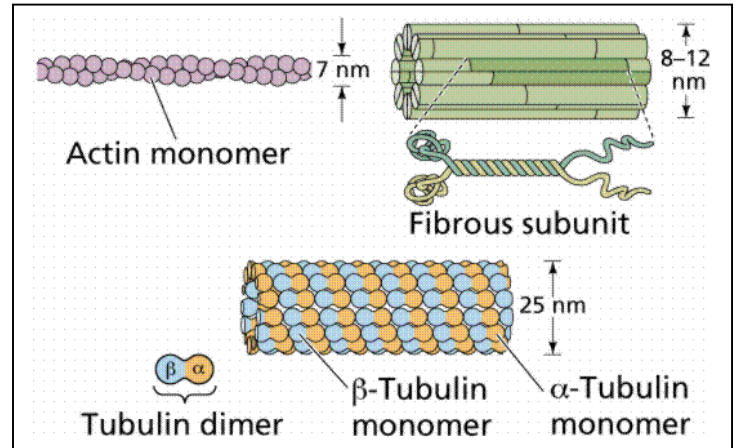
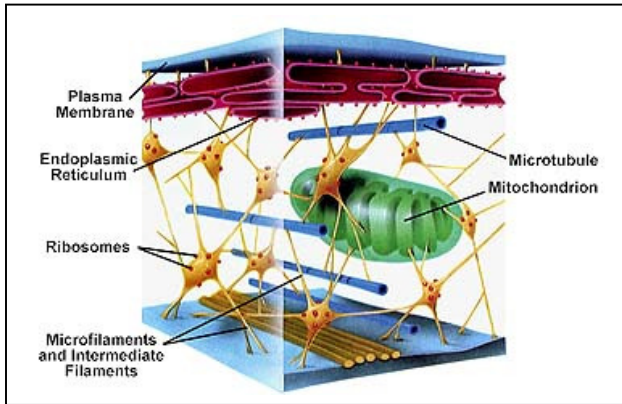


b) Microfilaments – Smallest unit of the cytoskeleton. Tiny solid rods of globular protein actin. They bear tensional (pulling) forces.

- along with myosin make muscle contraction possible.
- Also responsible for cytoplasmic streaming.
- Amoeboid movement.

c) Intermediate (size) filaments – Fibrous proteins (keratin) supercoiled into thicker cables.

- Maintenance of shell shape (tension-bearing elements)
- Reinforce cytoskeleton and hold organelles in place.



5) Cell Surface and Junctions – Most cells synthesize and secrete coats external to plasma membrane.

a) Cell Wall (plants)– protects, shapes, and prevents excess H₂O intake.

- Cellulose (polysaccharide) embedded in other polysaccharides and protein
- Middle Lamina – with pectin sticks to adjacent cells

b) Extracellular Matrix (animal cells) – Glycoproteins, collagen, proteoglycan, fibronectin, integrins. Span membrane and communicate changes.

c) Intercellular junctions – In tissues neighboring cells adhere at patches through direct contact. Interact and communicate.

- Plant Cells – Plasmodesmata – channel through cell walls that connects cytoplasm of neighboring cells.
- Animal Cells
 - Tight Junctions – Fuses neighboring cells , forms continuous belt around cell seal in epithelial cells. Glands, Intestinal lining.
 - Desmosomes – keratin proteins fasten cells together like rivets. Small circular area of protein adheres cells. Lets skin cells move in all directions without tearing.
 - Gap Junctions – Cytoplasmic connections created by membrane proteins making pores between cells. Embryos and heart muscle where communication is vital.