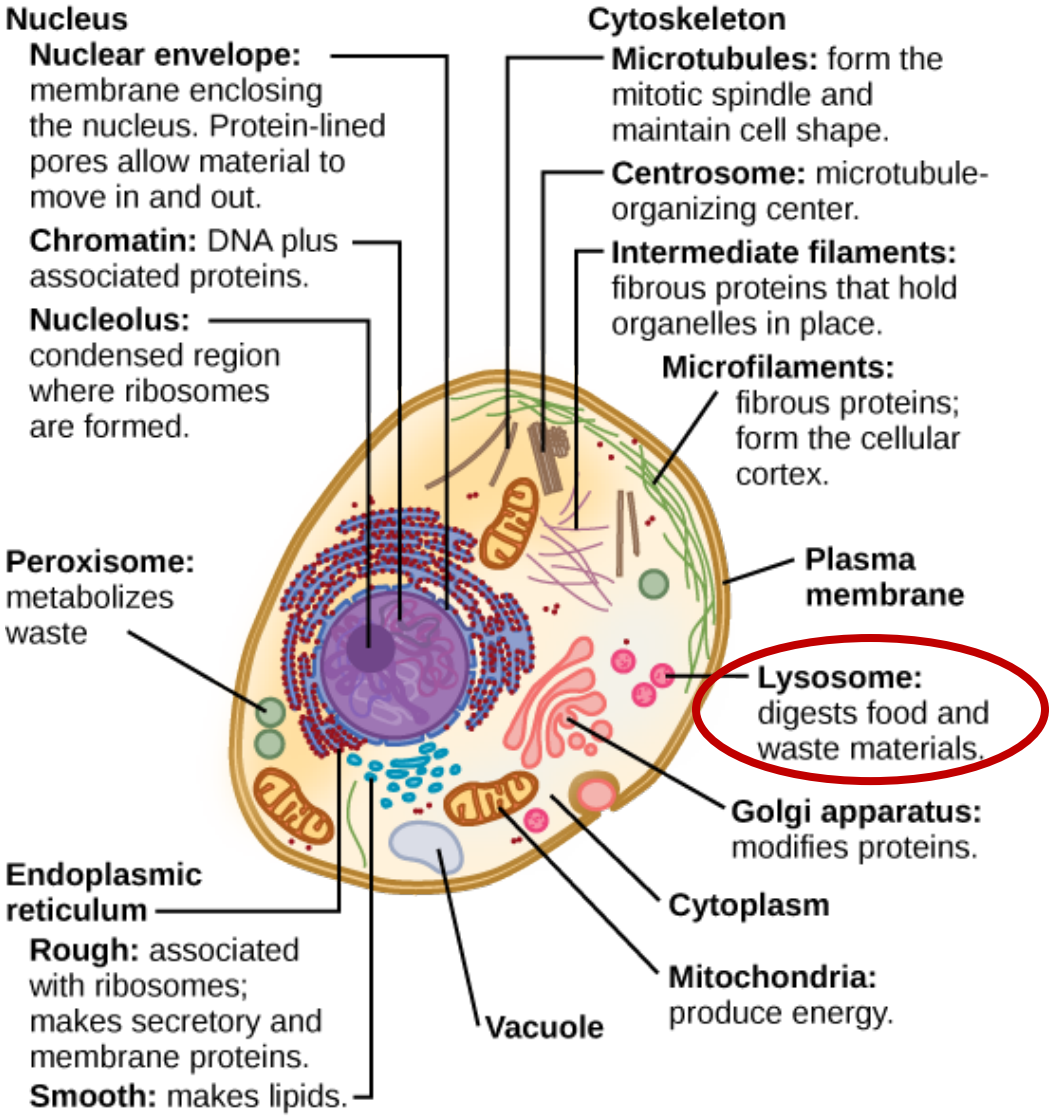
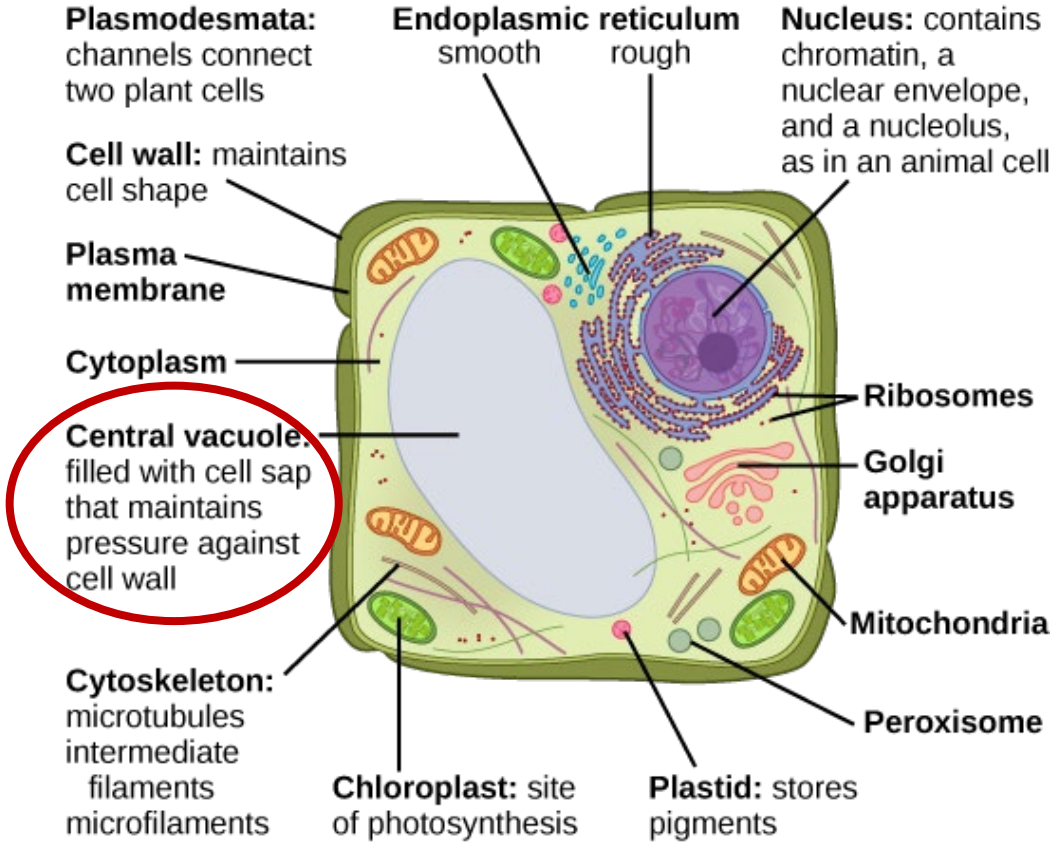
Lysosome and vacuole

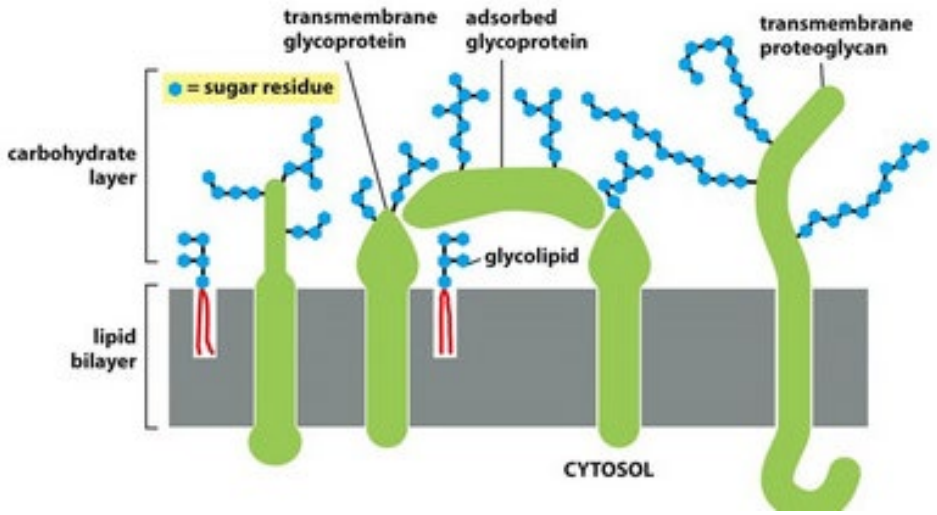


a typical animal cell



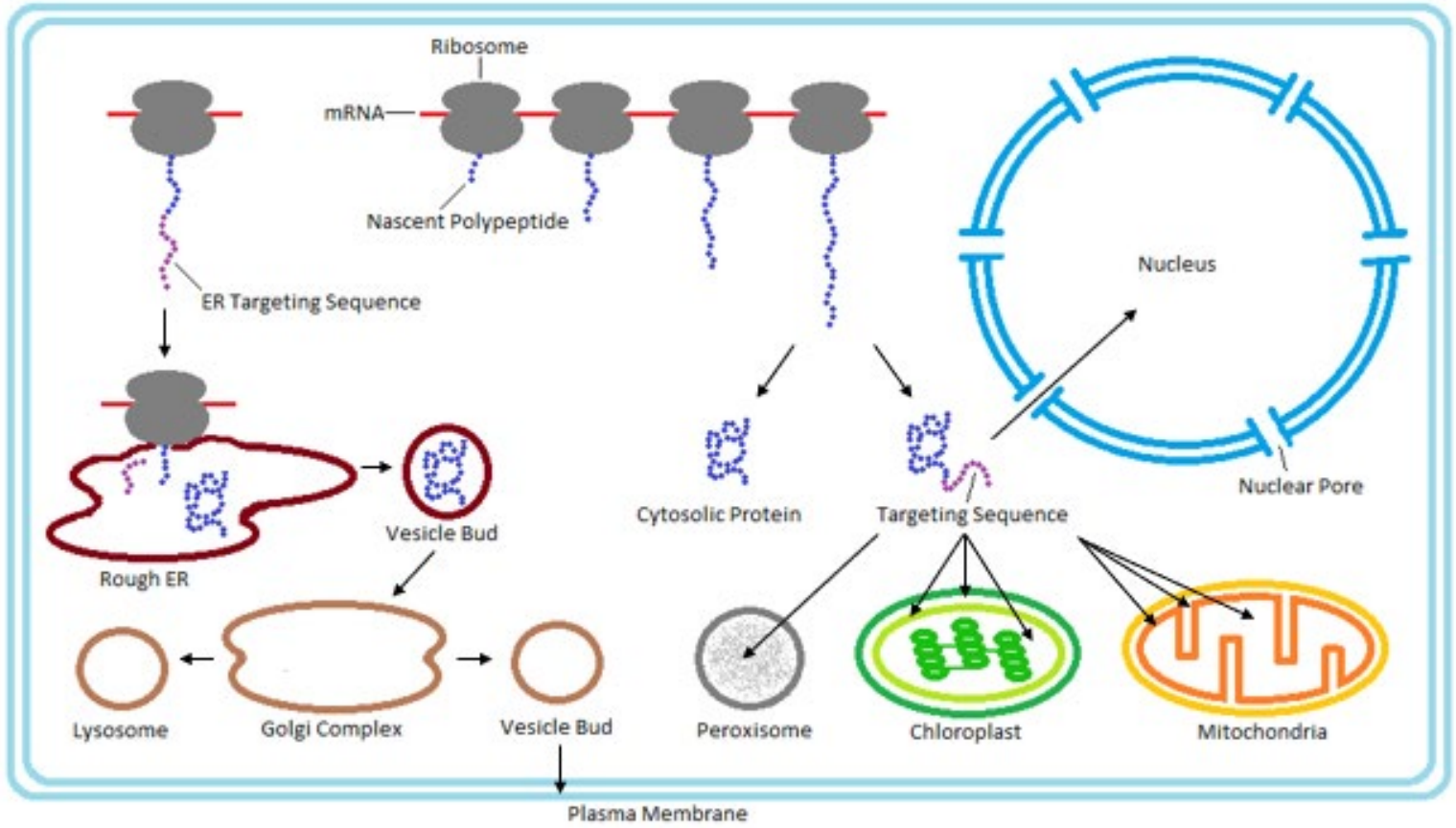
a typical plant cell

Glycocalyx coat



The cell coat is made up of the oligosaccharide side chains of glycolipids and integral membrane glycoproteins and the polysaccharide chains on integral membrane proteoglycans.
The carbohydrate is on the noncytoplasmic surface of the membrane.

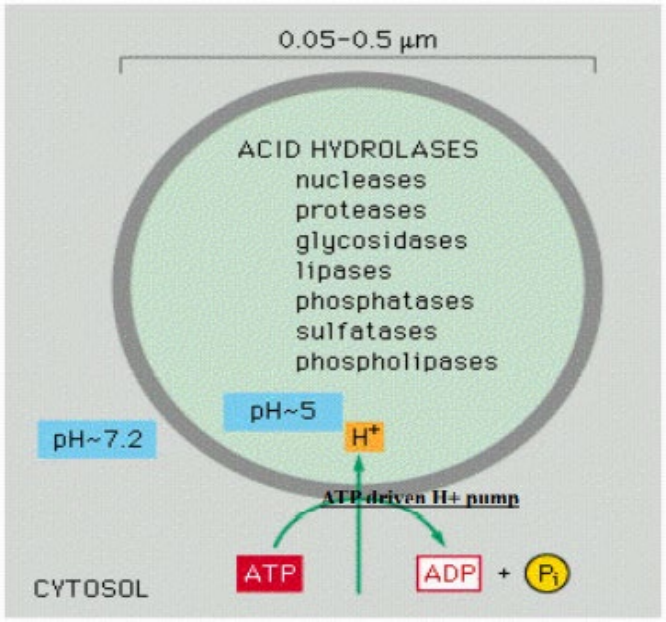
Flow of proteins from translation to destination



Lysosomes digest materials through three major pathways: endocytosis, phagocytosis, and autophagy

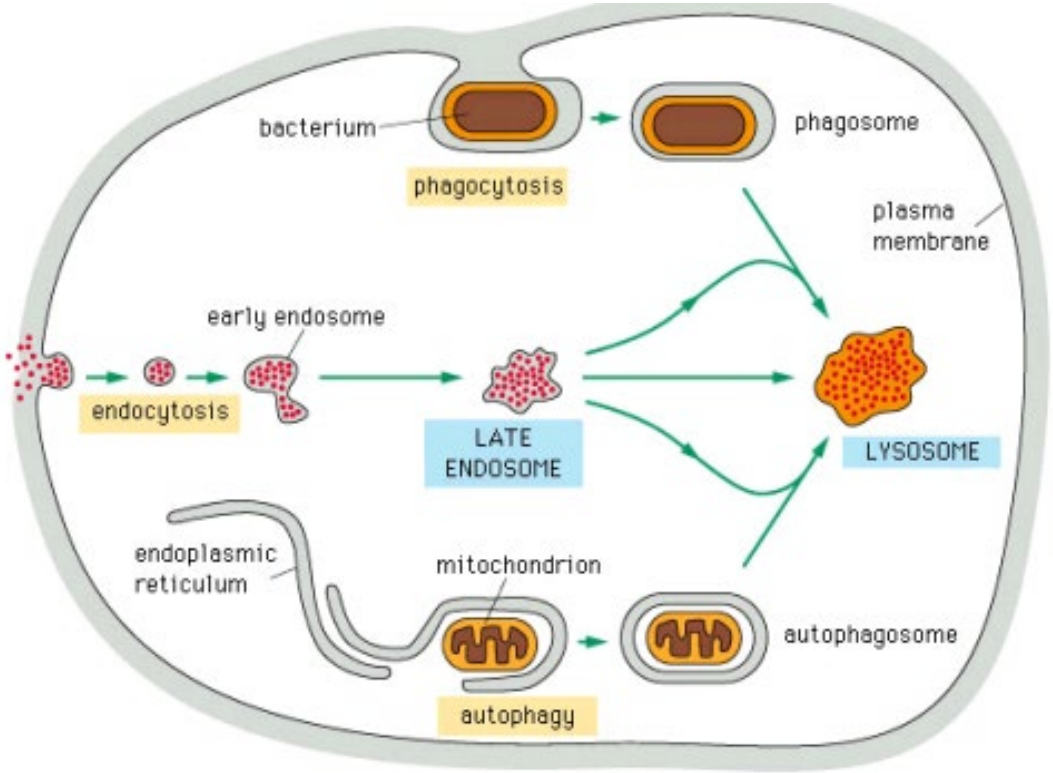
Lysosomes are the sites of intracellular digestion

- Membrane-enclosed organelles that contain 50 different degradative enzymes capable of breaking down all types of biological polymers.
- Lysosomes degrade material taken up from outside the cell and to digest obsolete components of the cell itself.



Most of the lysosomal membrane proteins are unusually highly glycosylated, which helps to protect them from the lysosomal proteases in the lumen.

- Mutations in the genes that encode these enzymes causes more than 30 different human genetic diseases, which are called **lysosomal storage diseases**. Examples;
  - Gaucher's disease, caused by a mutation in the gene that encodes a lysosomal enzyme required for the breakdown of glycolipids.
  - I-cell disease, caused by a deficiency in the enzyme that catalyzes the first step in the tagging of lysosomal enzymes with mannose-6-phosphate in the Golgi apparatus.



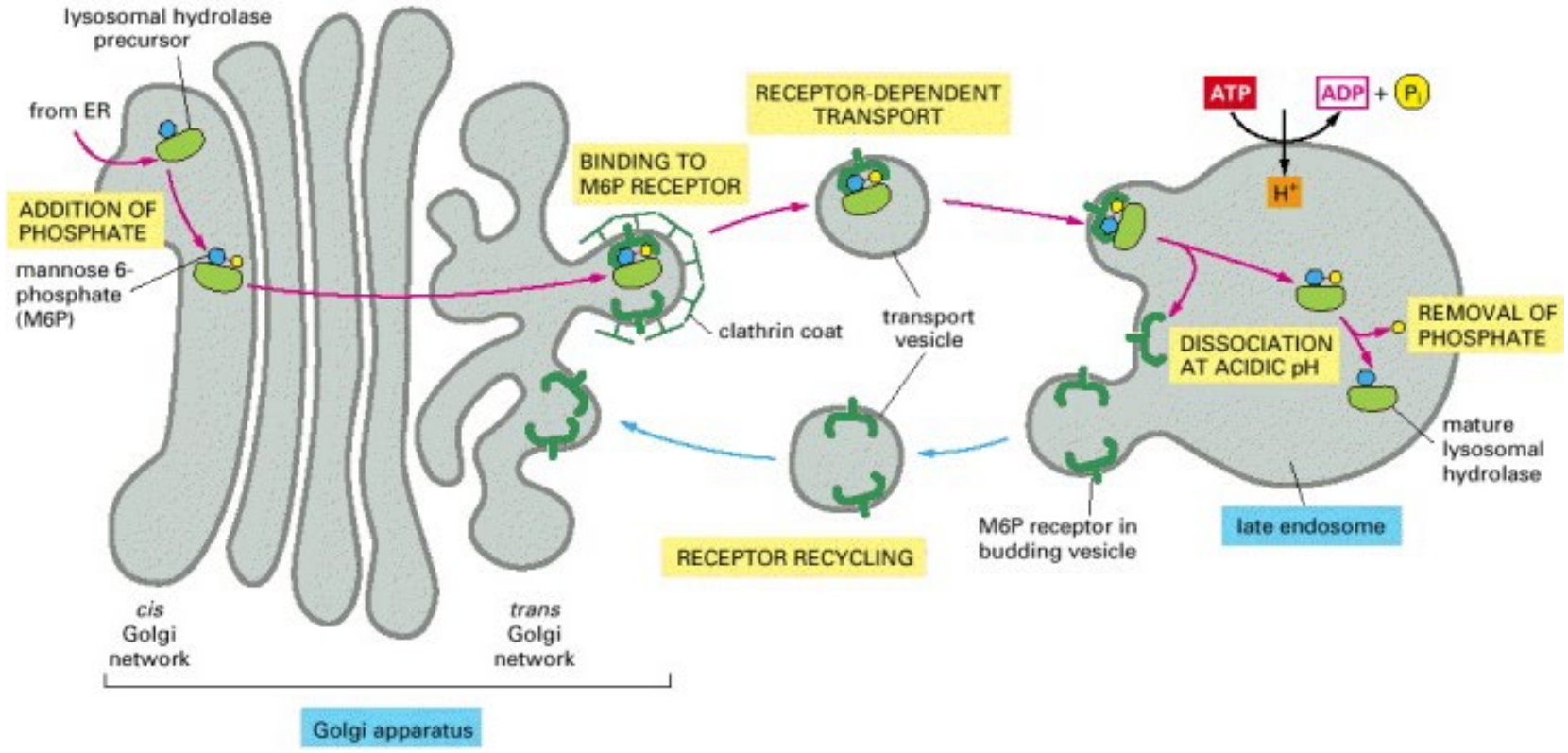
The glycocalyx of a lysosome is a layer of oligosaccharides that protects the lysosome's phospholipid bilayer from hydrolytic destruction. The glycocalyx is made up of oligosaccharides from lysosomal membrane glycoproteins

Three pathways of degradation in lysosomes

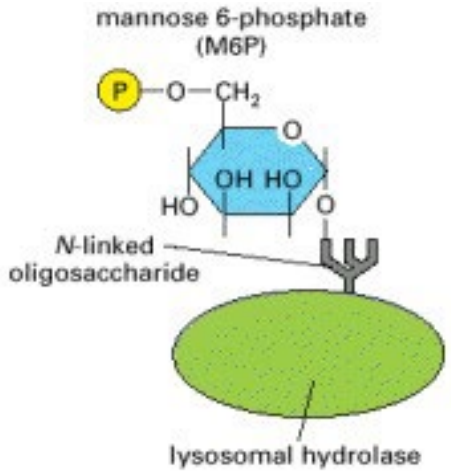
Role of lysosomes in exocytosis?

Transport of newly synthesized lysosomal hydrolases to lysosomes

The M6P Receptor Shuttles Between Specific Membranes

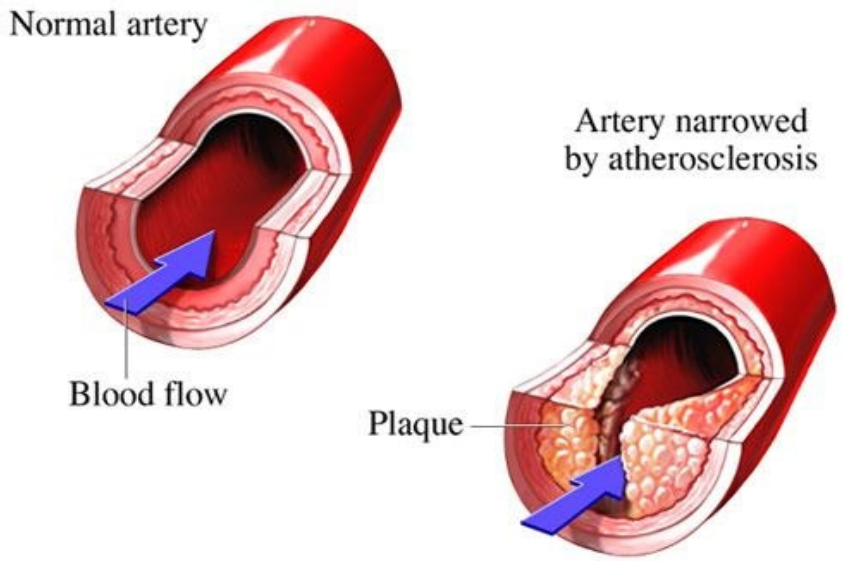


The structure of mannose 6-phosphate on a lysosomal enzyme

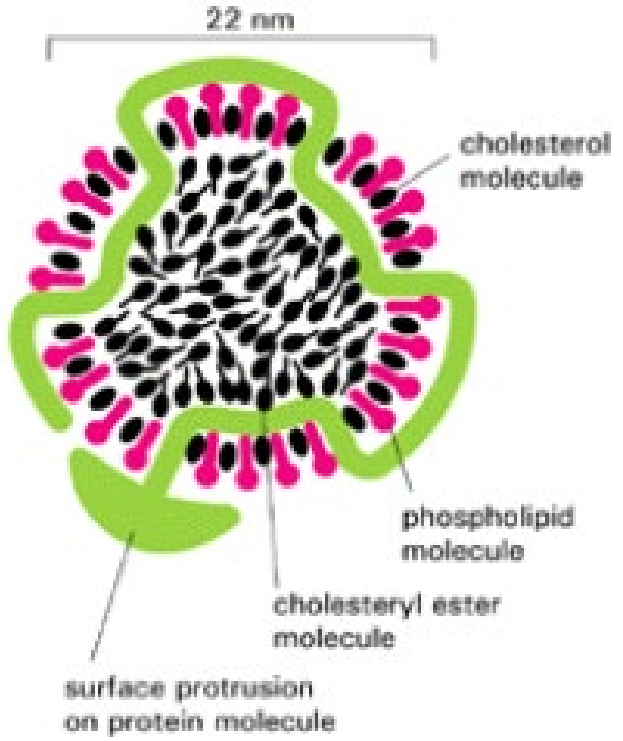


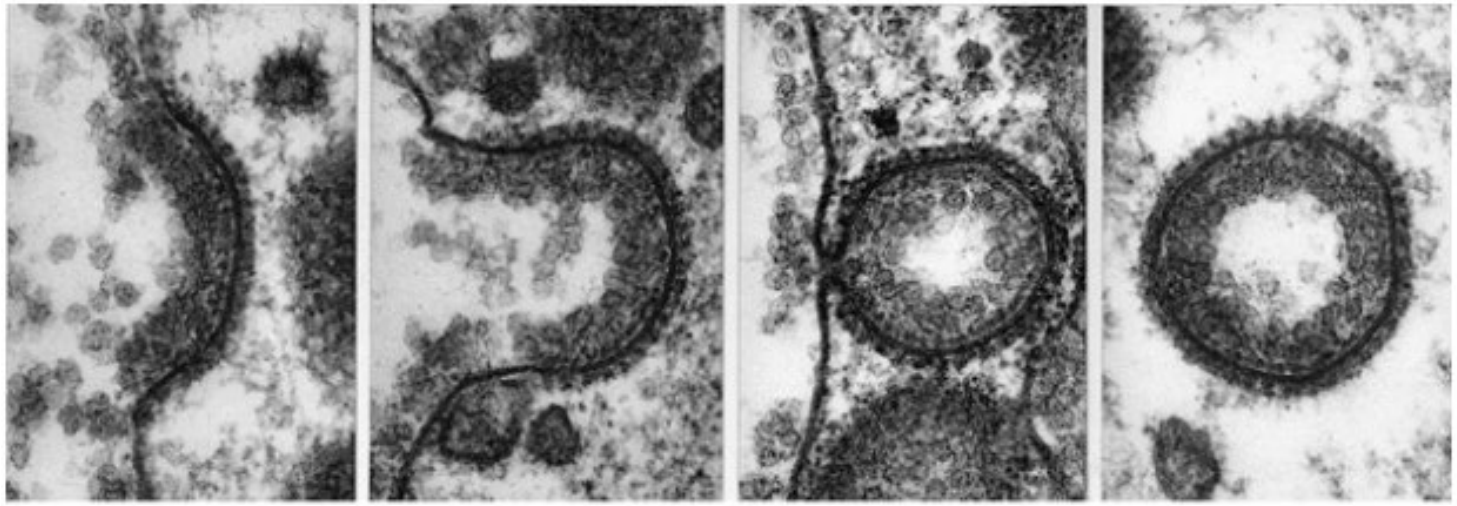
- If the uptake of LDL is blocked, cholesterol accumulates in the blood and can contribute to the formation in blood vessel walls of atherosclerotic plaques - the deposits of lipid and fibrous tissue can cause heart attacks by blocking blood flow.
- If too much free cholesterol accumulates in a cell, it shuts off both the cell's own cholesterol synthesis and the synthesis of LDL receptor proteins, so that the cell ceases either to make or to take up cholesterol.
- This regulated pathway for the uptake of cholesterol is disrupted in individuals who inherit defective genes encoding LDL receptor proteins and whose cells, consequently, are deficient in the capacity to take up LDL from the blood.

Cells import Cholesterol by receptor-mediated endocytosis



A low-density lipoprotein (LDL) particle



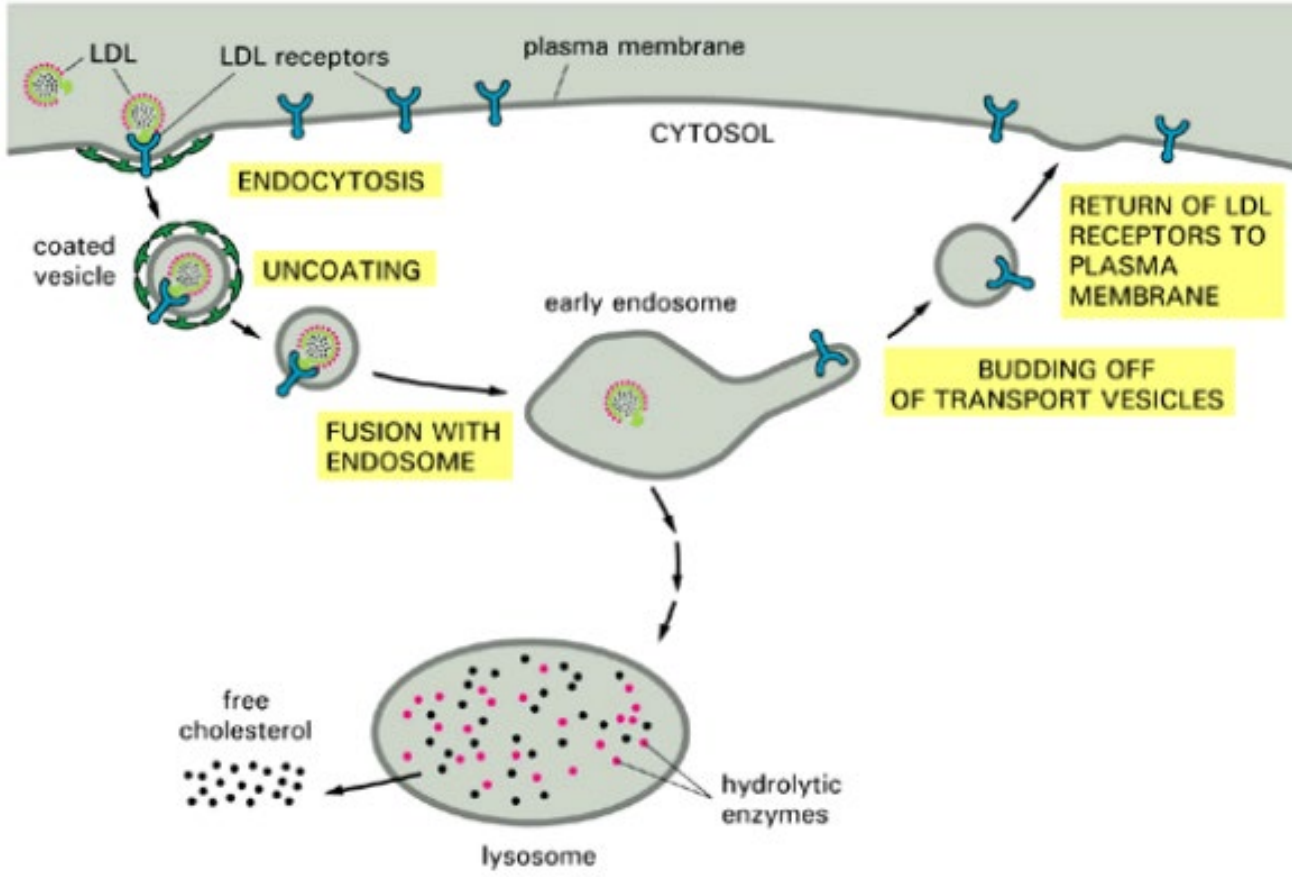


The formation of clathrin-coated vesicles from the plasma membrane. They are involved in taking up lipoprotein particles. The lipoprotein particles bound to their membrane-bound receptors on the extracellular surface of the plasma membrane.

Receptor-mediated endocytosis:

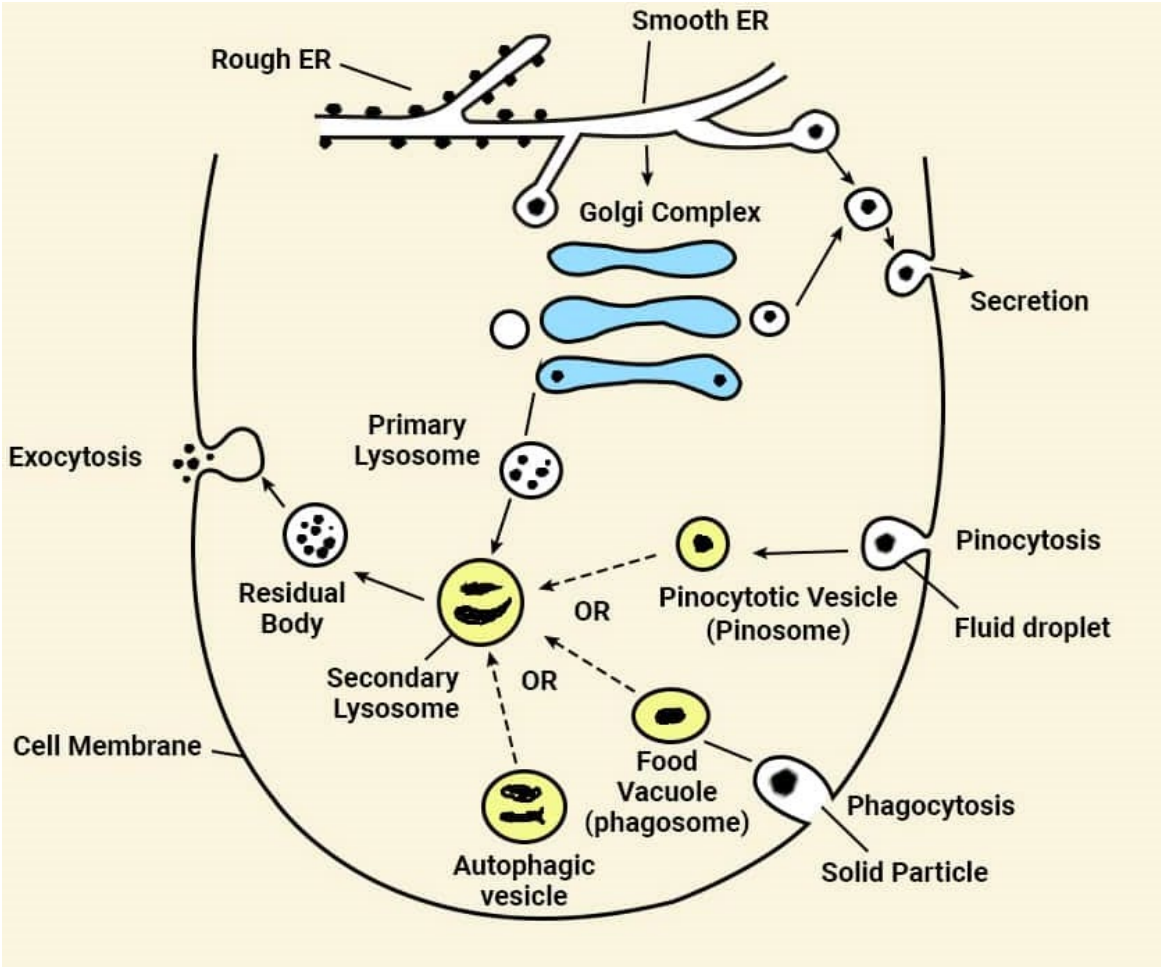
Clathrin-coated Pits Serve as a Concentrating Device for Internalizing Specific Extracellular Macromolecules,

Example, mammalian cells take up cholesterol



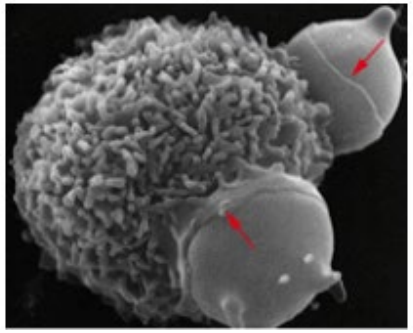
Cells Import Cholesterol by Receptor-mediated Endocytosis

Phagocytosis, endocytosis and pinocytosis

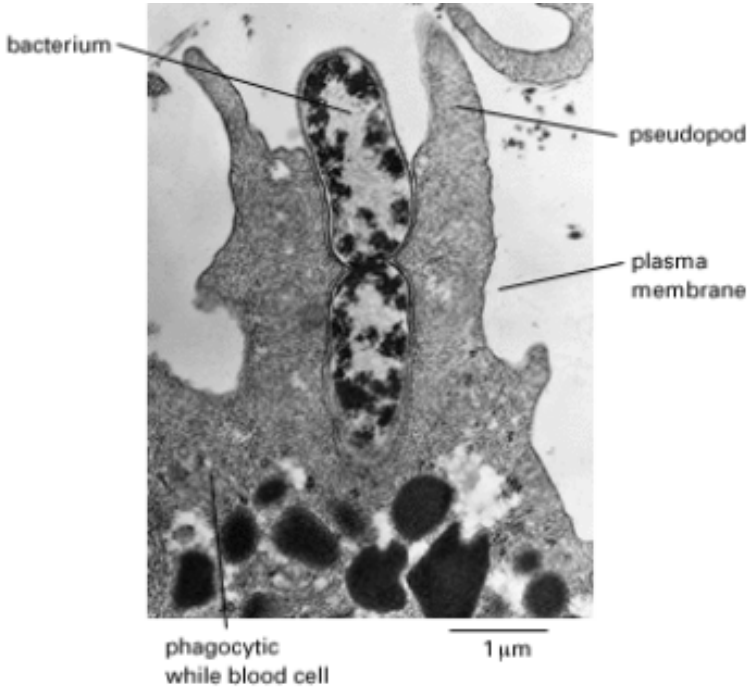


Specialized Phagocytic Cells Can Ingest Large Particles

- Phagocytosis is a special form of endocytosis, large particles are ingested by endocytic vesicles called phagosomes.
- In protozoa phagocytosis is a form of feeding: large particles are taken up by phagosomes fuse with lysosomes, utilized as food.
- **Other than nutrition,** in most animals, **professional phagocytes perform other functions**
  - In mammals there are two classes of white blood cells that act as professional phagocytes - **macrophages and neutrophils**. These two types of cells defend us against infection by ingesting invading microorganisms and also scavenge senescent and damaged cells and cellular debris.
- The phagosomes fuse with lysosomes, and the ingested material is degraded.

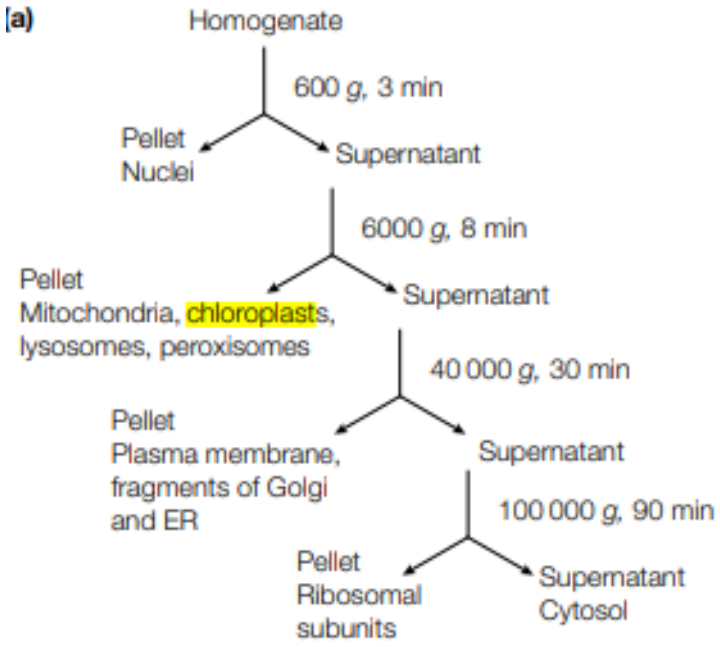


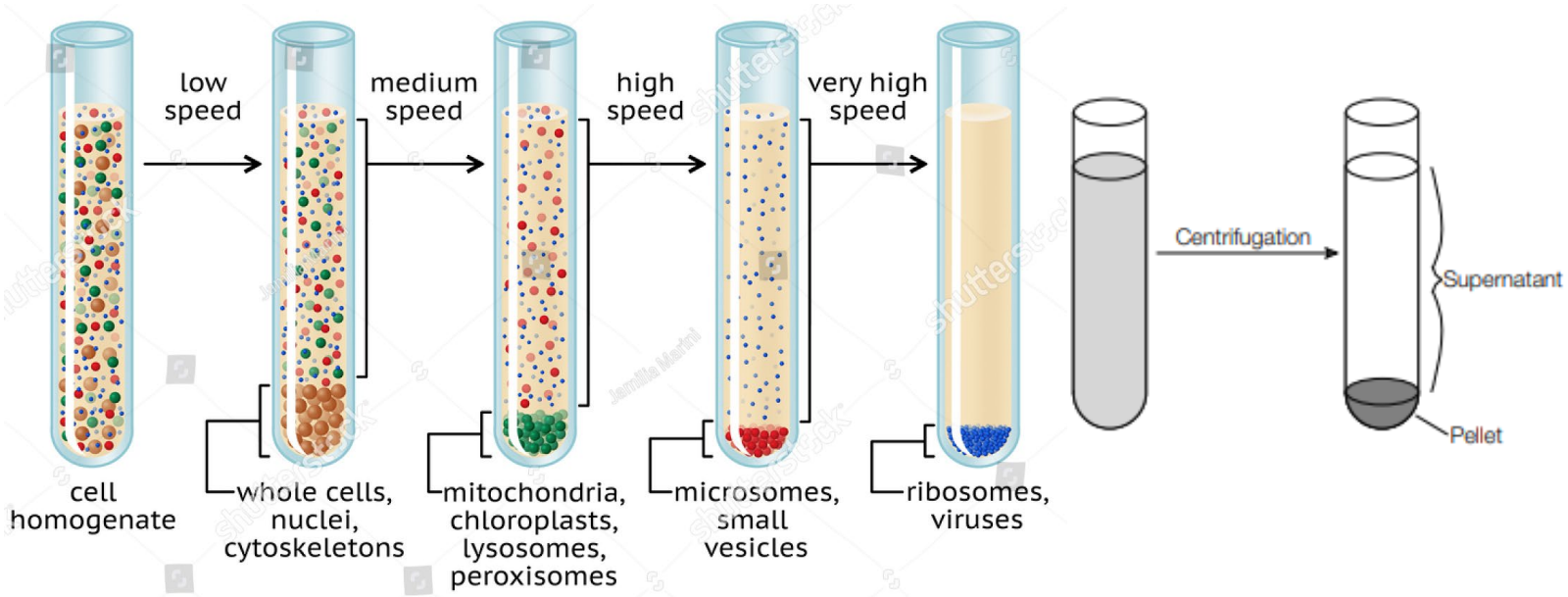
SEM of a mouse macrophage phagocytosing red blood cells

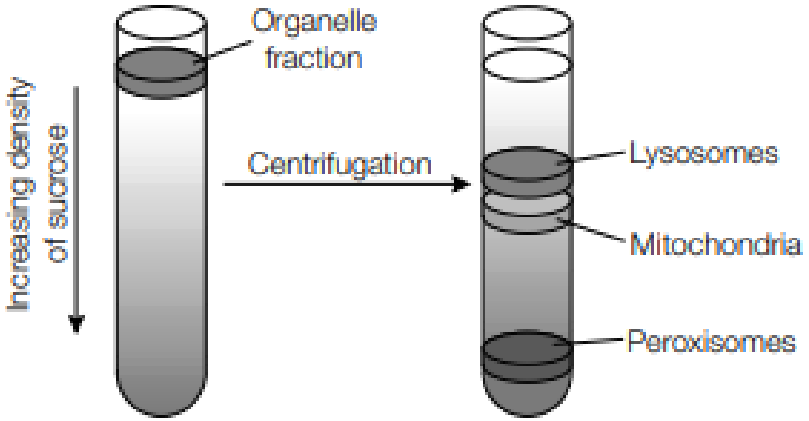


Electron micrograph of a neutrophil phagocytosing a bacterium

Isolation of lysosome: Cell fractionation by differential velocity centrifugation



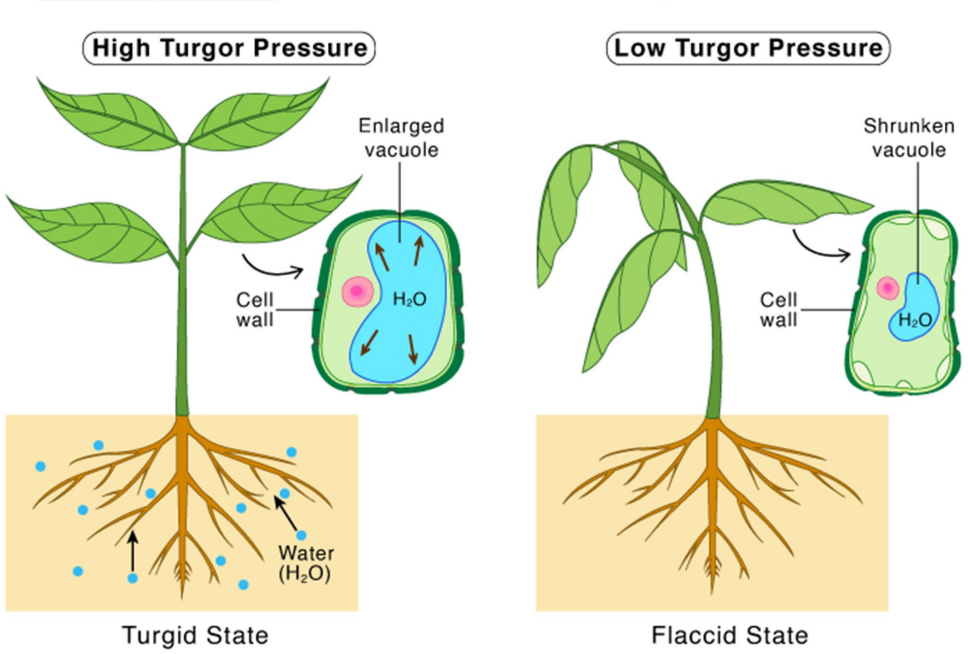


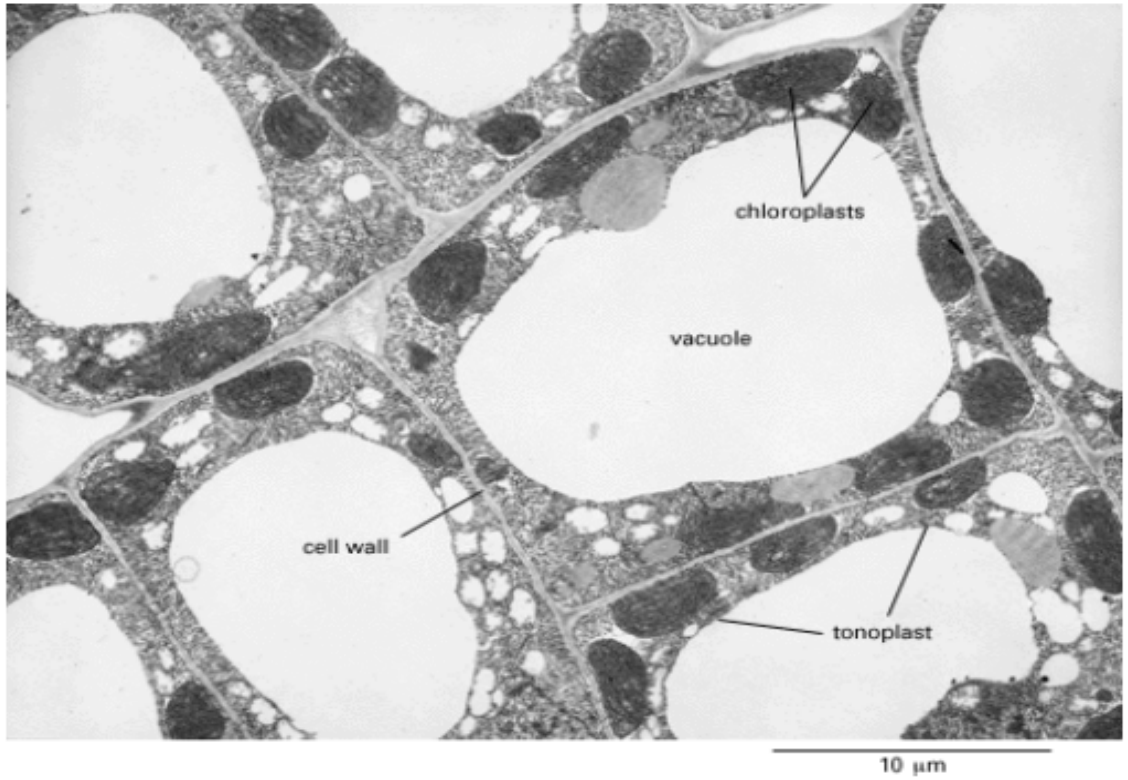


Separation of organelles by equilibrium density-gradient centrifugation

Vacuoles

- Plant cells maintain constant turgor pressure by changing the osmotic pressure of the cytosol. The osmotic pressure is maintained through the controlled breakdown and re-synthesis of biopolymers and by altering rates of transport of sugars, amino acids, and other metabolites across the plasma membrane and the vacuolar membrane.
- Substances stored in plant vacuoles such as rubber, opium and flavoring of garlic which are needed for different purposes. For example, proteins can be preserved for years in the vacuoles of the storage cells of many seeds. When the seeds germinate, the proteins are hydrolyzed and the mobilized amino acids provide a food supply for the developing embryo.



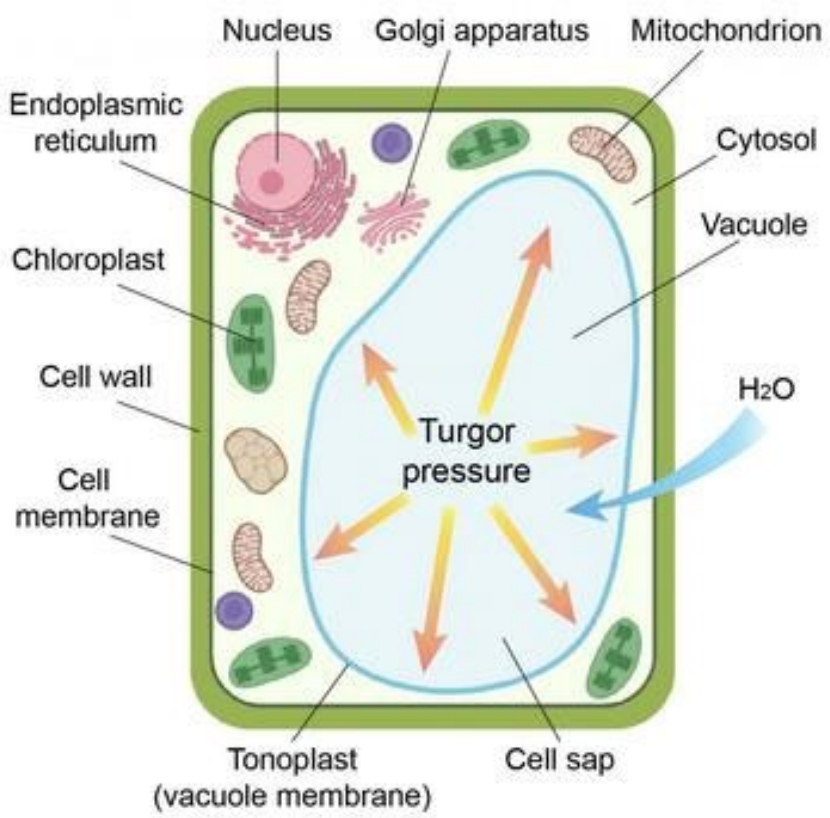


This electron micrograph of cells in tobacco leaf shows a large vacuole in cytosol surrounded by a thin layer known as tonoplast.

Osmosis depends on the number of solute particles in a solution

Vacuoles perform following functions in plant and fugus cells:

- Most plant and fungal cells contain one or several very large, vesicles called vacuoles, surrounded by a membrane called the tonoplast. They typically occupy cell volume in the range of 30 - 90%.
- Vacuoles contains a variety of hydrolytic enzymes like lysosomes in animal cells. Plants do not contain lysosomes.
- Vacuoles help plant cells to withstand variations in their environment. When pH in the environment drops, flux of H+ into the cytosol from the vacuole to keep the pH in the cytosol constant.
- **Maintains turgor pressure in plants.**
- **Stores pigments in plants: For example, a**nthocyanin pigments are stored in vacuoles to color the petals of many flowers to attract pollinating insects, while noxious molecules are released from vacuoles provide a defense against predators.
- **Protein degradation**: The vacuole contains enzymes that break down damaged, excess, and old proteins and organelles. This process is especially important when yeast cells are under nutrient stress.
- **Storage**: The vacuole stores ions, amino acids, carbohydrates, phosphate and waste material.
- **Buffering**: The vacuole recycles ions, amino acids, and metals back into the cytosol. The vacuole's storage and recycling functions help maintain ion and amino acid homeostasis.



Large vacuoles are formed when multivesicular bodies that originate from the Golgi body fuse together