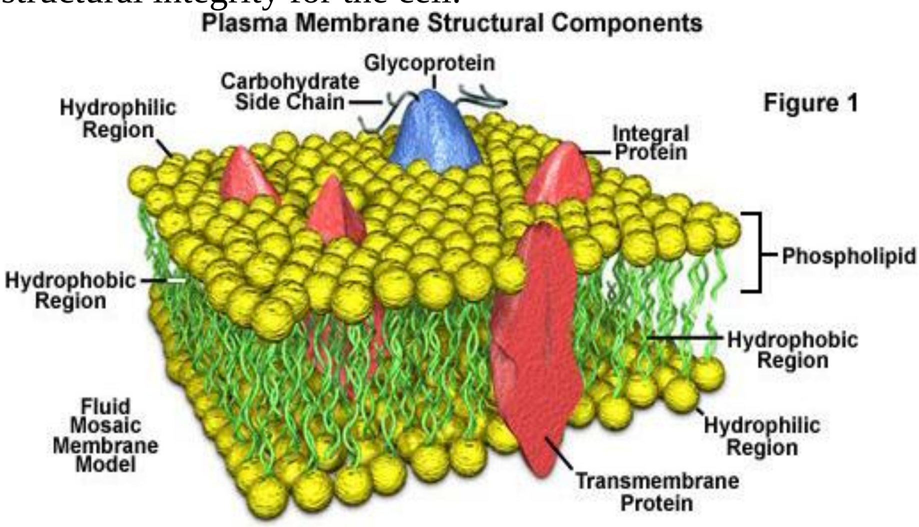
II. Protoplast
A. Plasma membrane

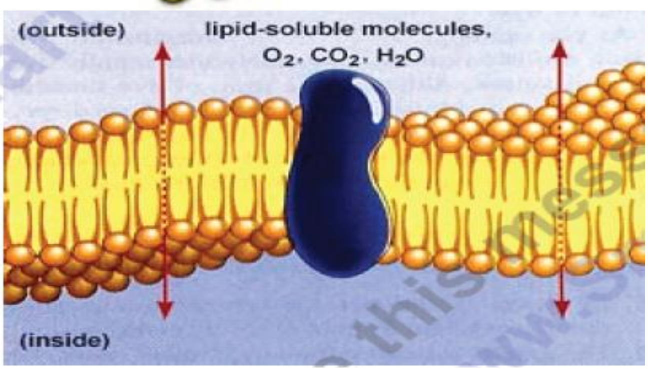
Cell boundary; selectively permeable; bilayer of phospholipids with inserted protein. Phospholipids are unique molecules - they are amphipathic, meaning that they have both hydrophilic and hydrophobic regions. They have a glycerol backbone; one of the hydroxyls is bonded to a phosphate and another charged group, the other two hydroxyls are esterified to fatty acids. Hydrophobic interactions between the tail regions of the phospholipids hold the membrane together. Some proteins are found:

(1) just on the outside or inside surfaces of the membrane (peripheral proteins – noncovalent interactions and anchored proteins - covalently bound to lipids, etc); or

(2) Embedded in the membrane (integral protein), many of which span the membrane (trans-membrane proteins). Hydrophilic regions of the integral proteins are oriented to the outside of the membrane whereas hydrophobic regions are embedded within the phospholipids bilayer. Lipid soluble materials can readily pass through but charged or ionized substances (hydrophilic) pass through very slowly, if at all. The function of the membrane is to:

(1) Regulate traffic.
(2) Separate the internal from external environment.
(3) Serve as a platform on which some reactions can occur.
(4) Participate in some reactions (i.e., the membrane components are important intermediates or enzymes).
(5) Provide some structural integrity for the cell.





Phospholipids bilayer biological membrane

B. Nucleus

Surrounded by a double membrane (two phospholipids bilayers) - the nuclear membrane. Have pores. The structure of the pores is complex comprised of more than 100 proteins. The pore opening is surrounding by a series of proteins and these are attached to a series radial spokes. Nucleoplasm - matrix within nucleus. DNA, which is found in the nucleus, may be condensed into chromosomes or not (chromatin). There may be one or more nucleolus (site of ribosome production). The nucleus is 5- 20 μm in diameter. There is a layer of intermediate filaments just inside the nuclear envelope; called the nuclear lamina. Nucleus is the control center of all activities in the cell.

C. Cytoplasm/cytosol

The cytosol is the gel-like matrix within the cell in which the other structures are embedded. The cytoplasm refers to the cell contents inside the membrane provides a medium for chemical reactions to take place.

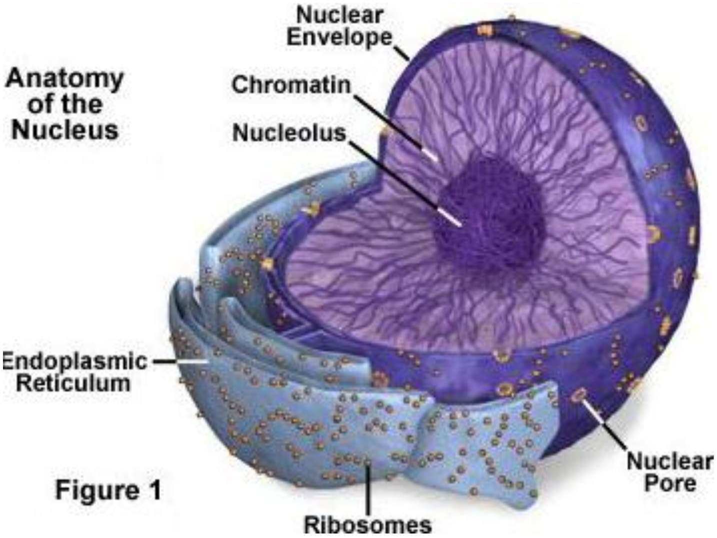
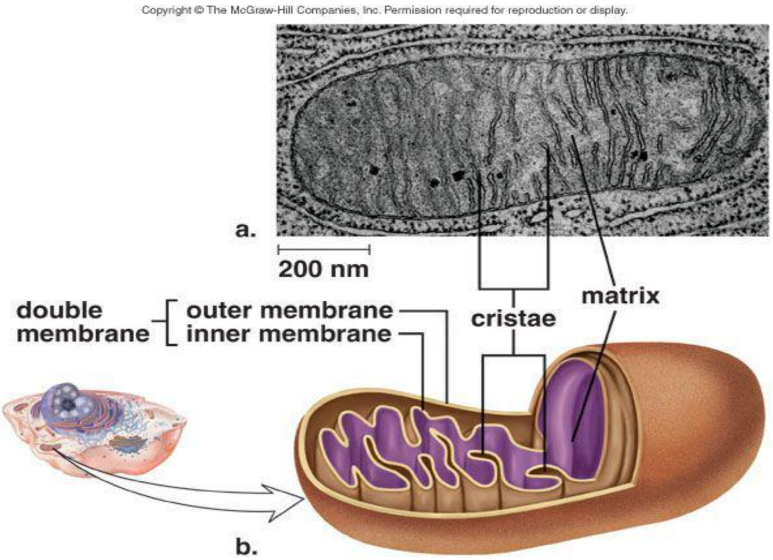


Figure 1

D. Mitochondria

These organelles, like the nucleus and plastids, are double-membrane bound. They vary in shape from tubular to spherical. They reproduce by fission; have their own ribosomes and DNA. The inner membrane has a larger surface area so it must be folded into finger-like projections (called cristae) to fit inside the outer membrane.

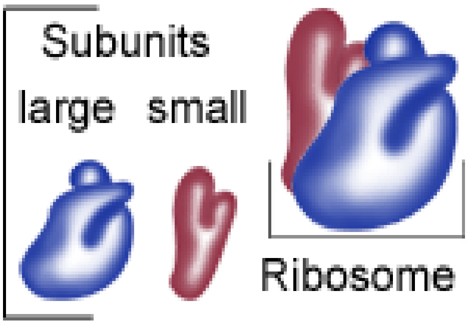
Mitochondria are found in all eukaryotic cells. They are the sites of cellular respiration process by which energy is released from fuels such as sugar. The mitochondria are the power plant of the cell. They are small (1-5 μm) and generally numerous (500-2000 per cell). Mitochondrial DNA which comprises about 200 kbases, codes for some of the genes required for cellular respiration including the 70S ribosomes and components of the electron transport system.



Mitochondrium

E. Ribosome

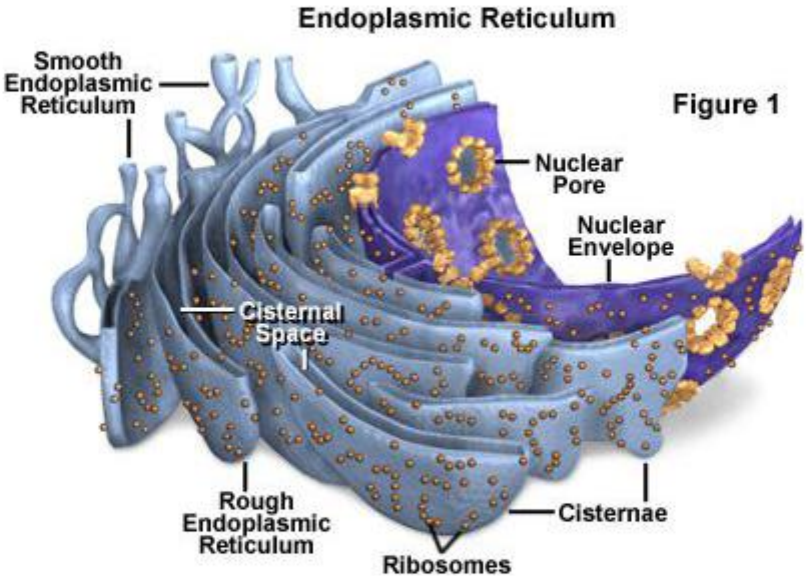
Sites of protein synthesis (translation). Two subunits; one large and the other small. Made in the nucleus from rRNA and protein. Ribosomes are tiny (0.25 µm) and numerous (5 -50 × 10^{10} per cell). Since ribosomes are not surrounded by a membrane, they are not considered to be "true" organelles. Some ribosomes are 'free' (produce proteins that remain in the cell) while others are attached to the ER (produce proteins for export). To export a protein, the mRNA and subunits of the ribosome bind together. A signal recognition particle (SRP) binds to specific amino acids in the newly forming protein. The SRP, which is bound to the protein/mRNA/ribosome, then binds to a receptor in the ER membrane. As the protein is made it is released into the lumen of the ER and the SRP sequence of the protein is snipped off.



F. Endoplasmic reticulum

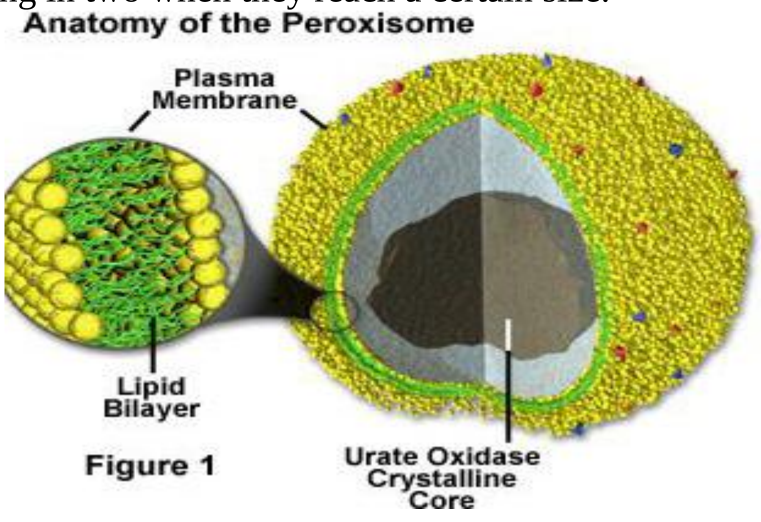
A series of membranous tubes and sacs (cisternae) that run throughout the cell. Rough ER has ribosomes associated with it and is laminar while smooth ER lacks ribosomes and is tubular. The ER has several functions including:

(1) Synthesis of lipids and membranes (smooth ER).
(2) Serving as a site for the synthesis of proteins by the ribosomes (rough ER).
(3) Transport (a type of cell 'highway' system).
(4) Support.



G.Peroxisomes

Membrane sac containing enzymes for metabolizing waste products from photosynthesis, fats and amino acids. Hydrogen peroxide is a product of metabolism in peroxisomes. Catalase, which breaks down the peroxide is also present and serves as a marker enzyme for these organelles. Peroxisomes do not bud from the endomembrane system. They grow by incorporating proteins and lipids made in the cytosol. They increase in number by splitting in two when they reach a certain size.

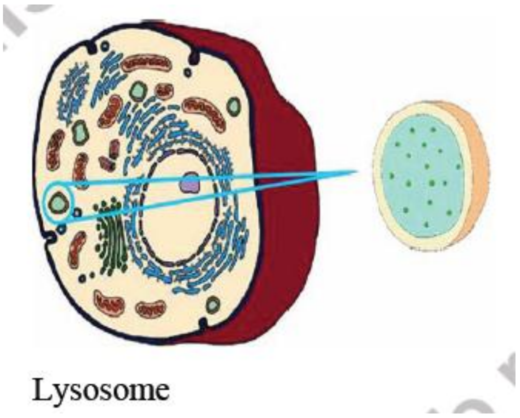


H.Glyoxisomes

Glyoxysome bound by single membrane, Provides energy to germinating seeds and specialized peroxisome involved in breaking down fatty acids (glyoxylate cycle). Abundant in fat-rich seeds such as soybean, tomato, sunflowers, etc…

I. Lysosomes

Are vesicles produced by the Golgi apparatus. Lysosomes contain hydrolytic enzymes and are involved in intracellular digestion.

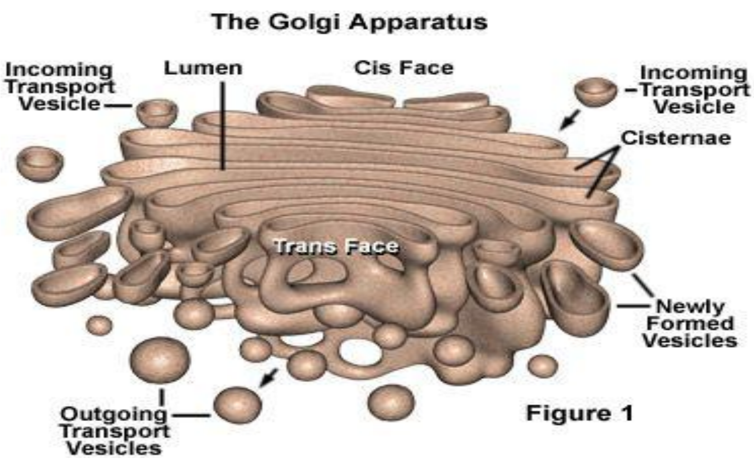


Lysosome

J. Golgi apparatus

Golgi apparatus – organelle made of stacked, flattened membranous sacs (cisternae) that modify stores and routes products of the ER Has a distinct polarity. Membranes of cisternae at opposite ends differ in thickness and composition. Two poles are called the cis face (forming face) and the trans face (maturing face) Cis face, which is closely associated with transitional ER, receives products by accepting transport vesicles from the ER. Trans face pinches off vesicles from the Golgi and transports molecules to other sites Golgi products in transit from one cisternae to the next, are carried in transport vesicles.

The Golgi:
1- Alters some membrane phospholipids.
2- Modifies the oligosaccharide portion to glycoprotein.
3- Target products for various parts of the cell.
4- Sorts products for secretion.



k. The Cytoskeleton

• The eukaryotic cytoskeleton is a network of filaments and tubules that extends from the nucleus to the plasma membrane.

• The cytoskeleton contains three types of elements responsible for cell shape, movement within the cell, and movement of the cell, there is 3 types:

• Microtubules

• Intermediate filaments

• Actin filaments

1-Microtubules

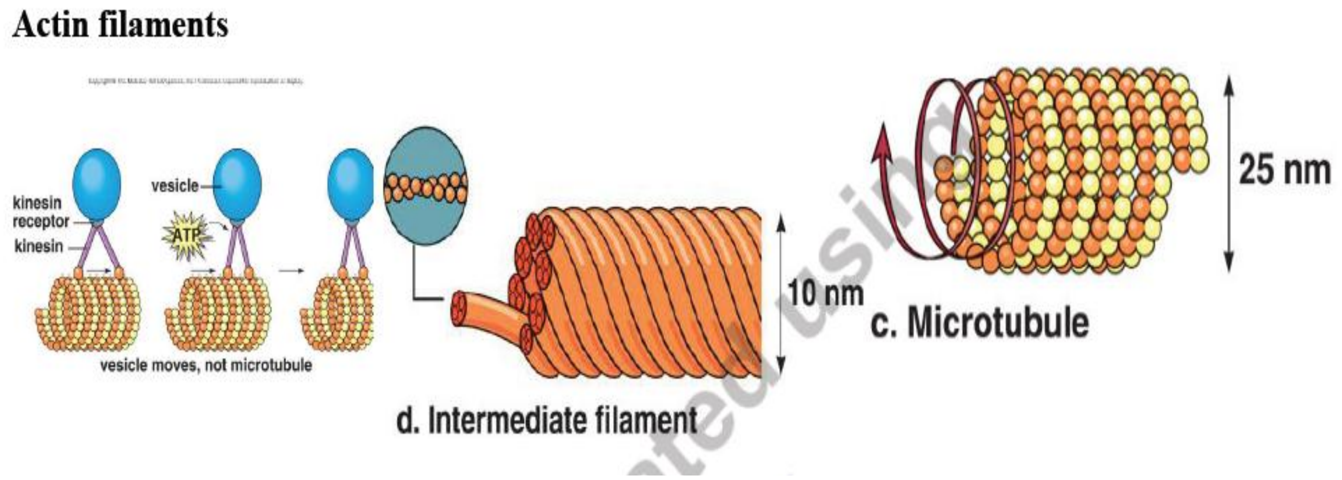
Hollow tubes made of a mix of alpha and beta tubulin, which are globular proteins. There are essentially 13 columns of proteins. The tubes are about 25 µm in diameter. Microtubules are involved in the cell cytoskeleton (for support), cell movements (cilia, flagella) and cell division (spindle).

2-Microfilaments

Protein strands, solid. Made from G-actin. Involved with the cell cytoskeleton. Main function is support. They are about 7 nm in diameter.

3-Actin filaments

Occur in bundles or mesh-like networks. Actin filaments play a structural role and interact with motor molecules, such as myosin.



L.The Cytomembrane system

The membranous organelles (ER, vesicles, Golgi, cell membrane) comprise a group of organelles that cooperate and function together. For example, imagine the synthesis of cellulose in the cell wall of a plant. Cellulose synthesis requires the enzyme cellulose synthase. Ribosomes (rough ER) → makes enzyme → passes through RER to smooth ER → packaged into a vesicle → pinches off → to Golgi (cis face) → processed → repackaged into vesicle → pinches off (trans face) → cell membrane → fuses → releases contents → cellulose synthase makes cellulose.