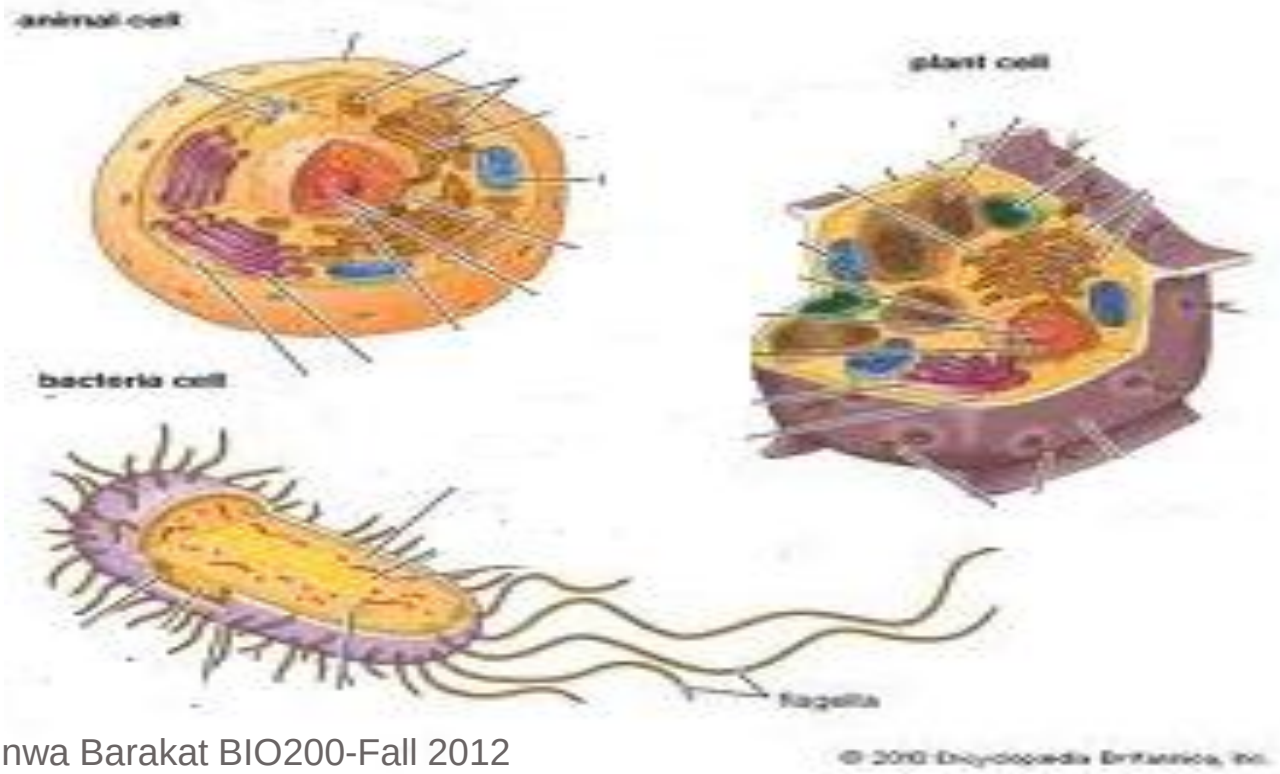
Cell structure and function

Ghinwa Barakat BIO200-Fall 2012

- Cell theory: all living things are made of cells
- Cell is the basic structural and functional unit of living things
- Cell is the smallest unit that displays the characteristics of life
- Despite the fact that all cells come from single fertilized egg, bone and brain cells show structural and metabolic differences
- All living things are composed of cells which have outer membrane, cytoplasm, and genetic material

- Prokaryotic cells: structurally simple cells that lack a nucleus and most other cellular organelles (Bacteria and Archaea). Small in size

- Eukaryotic cells: structurally complex with nucleus and organelles. They are larger than prokaryotic cells. Ex: plant, animal, fungi, protozoa, and algae. 10-100X larger cell size.



- Cell must transport all its nutrients and wastes through its outer membrane to stay alive

- Cells are small in size because as a cell becomes larger, adequate transport of materials through the membrane becomes more difficult

- As the cell increase, its volume and surface area increases with volume increasing more quickly. So the metabolic needs will increase but the surface area is limited; so most cells are small

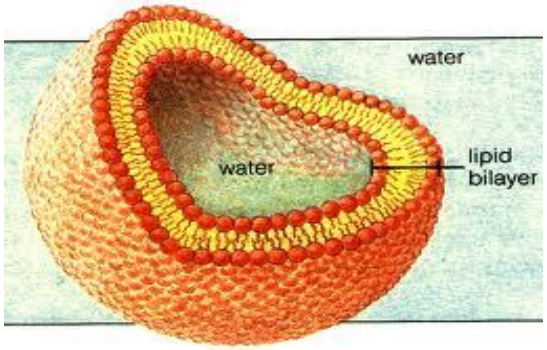
- The metabolically active portion of the cell is at the surface where exchange of material with the surrounding is possible

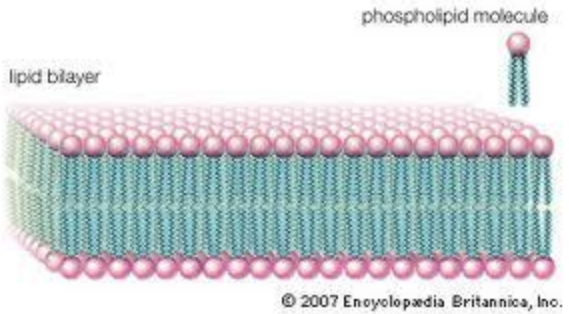
Cellular membranes

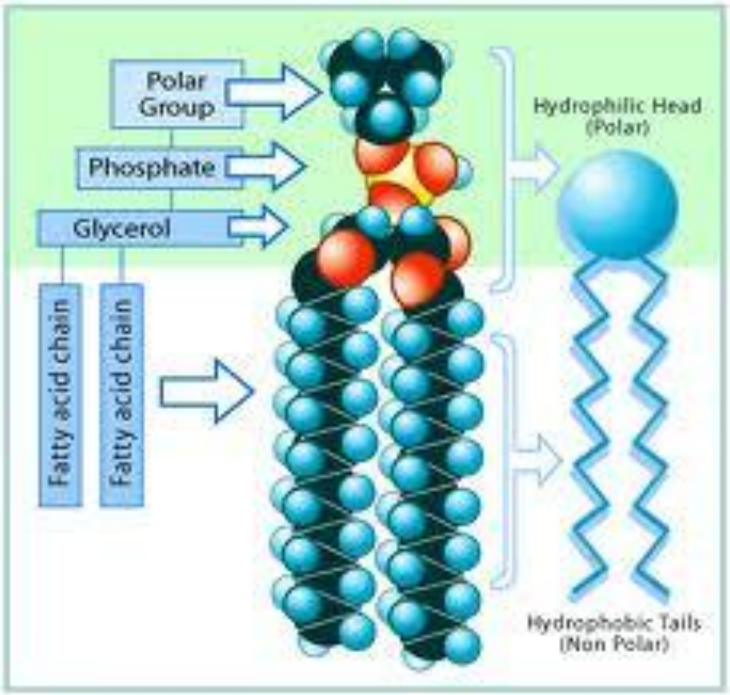
- Cellular membranes: thin sheets composed primarily of phospholipids and proteins
- Fluid mosaic model: Cellular membranes consist of 2 layers of phospholipid molecules and each of these molecules can move within the structure of the membrane
- Many proteins and other molecules are found within the membrane and on the membrane surface

- Phospholipid molecules of the membrane have 2 ends which differ chemically

- One end contains phosphate which is hydrophilic (loves water), and the other is fatty acid which is hydrophobic (fears water)

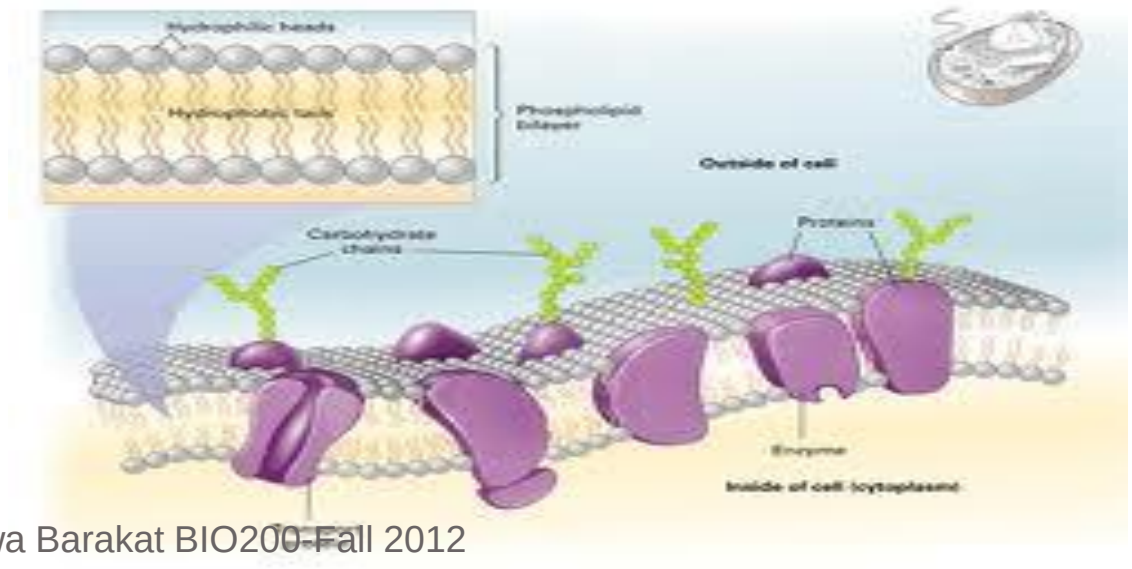






- When phospholipid molecules are placed in water, they form a double layered sheet with the hydrophilic portions of molecules facing away from each other

- Phospholipid molecules are in constant motion as they move with the surrounding water molecules and slide past one another. Other molecules found in cell membrane are **cholesterol, proteins**, and **carbohydrates**



Proteins:

1. help transport molecules across membrane
2. Serve as attachment points for other molecules
3. Serve as identity tags for cells

There are many different proteins associated with the membrane. Some are on the surface, some partially submerged in the membranes, and others traverse the membrane and protrude from both surfaces.

Carbohydrates attached to the membranes on the outside of the cell:

1. play a role in cell –to- cell interactions
2. involved in regulatory molecules

Cholesterol is not water soluble, so it is found in the middle of the membranes in the hydrophobic region:

1. plays a role in stabilizing the membrane and keeping it flexible

Organelles composed of membranes

Eukaryotic cells have many organelles that are composed of membranes

Plasma membrane

It is the outer limiting boundary of the cell.

It is **metabolically active** with many chemical reactions take place within, inside, or outside surface. Many of these chemical reactions involve transport of molecules.

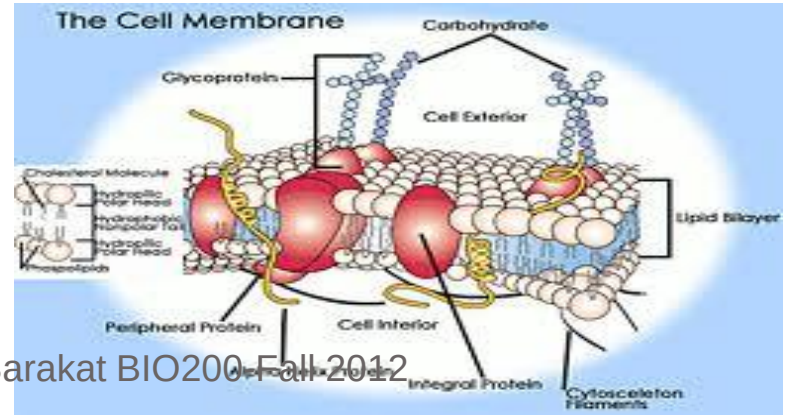
Proteins in the cell membrane are associated with moving molecules across the membrane. Other proteins extend from one side to another to form channels through which substances can travel. Some molecules can move passively while others need push

Plasma membrane

- Outside surface of the plasma membrane has proteins that work as **recognition molecules.** Each organism has unique combination of these molecules.

Ex: immune cells identify protein on the surface of the organism to kill the invader

Ex: in humans there are proteins called histocompatibility antigens with unique combination to each person. The presence of these antigens is responsible for rejection of transplanted tissue



Plasma membrane

Molecules on the surface of plasma membrane serve as **attachment site** for bacteria, viruse, protozoa.. Ex: HIV attaches itself to the specific molecules on the surface of immune system cells, this attachment site can be blocked by drugs called "blockers"

Attachment sites on the plasma membrane are important in **signal transduction.**

Signal transduction: process by which cells detect signal (chemical or physical) and transmit it to the cell interior.

Signal molecule is the primary messenger and the internal signal molecule is the secondary messenger (molecule with cascade of chemical reactions) ending with a response.

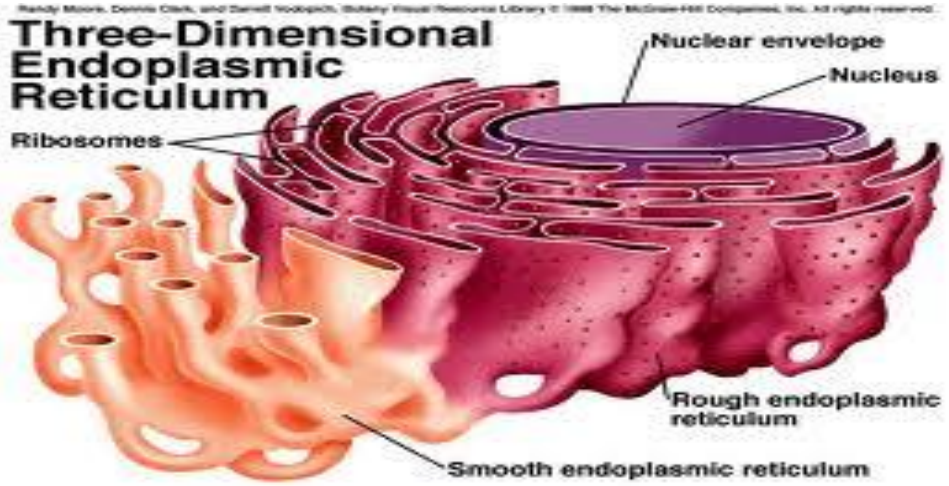
Endoplasmic reticulum (ER)

- Organelle other than the plasma that has membrane or is composed of membranes. ER is one of the most common organelles found in cells. It consists of folded membranes and tubes throughout the cell

- Spaces between folded membranes serve as canals for the movement of molecules within the cell. The system of membranes provide large surface area on which chemical activities take place

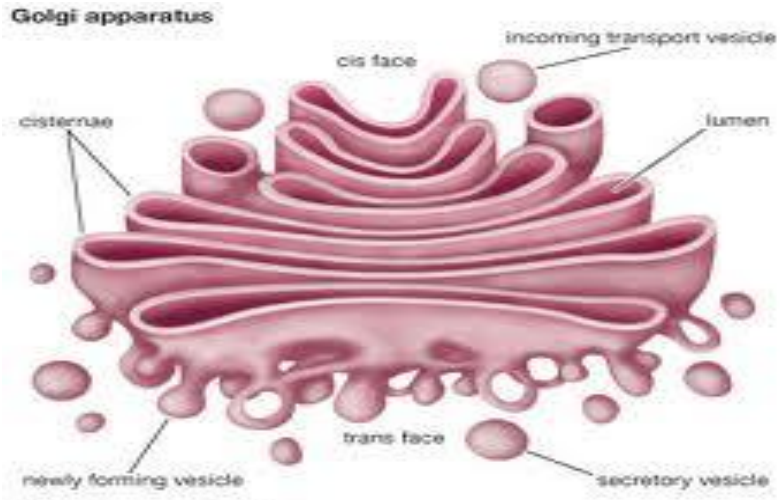
- Proteins on the surface of the ER are actively involved in controlling and encouraging chemical activities, where there are reactions involved in cell growth and development

- Two type of ER: rough ER and smooth ER
- Rough ER has ribosomes attached to its surface (ribosomes involved in protein synthesis). Pancreatic cell for example has extensive amount of rough ER since it synthesizes large amount of proteins.
- Smooth ER: lacks ribosomes, but is involved in fat metabolism and detoxification reaction involved in destruction of toxic substances such as alcohol and drugs. Ex in liver cells



Golgi Apparatus

- Composed of membranes and the cell contains hundreds of them
- Golgi modifies molecules shipped to it from elsewhere. It manufactures some polysaccharides and lipids and packages them within sacs
- There is constant traffic of molecules through the golgi apparatus
- Tiny sacs (vesicles) deliver the molecules from one surface of the golgi to another



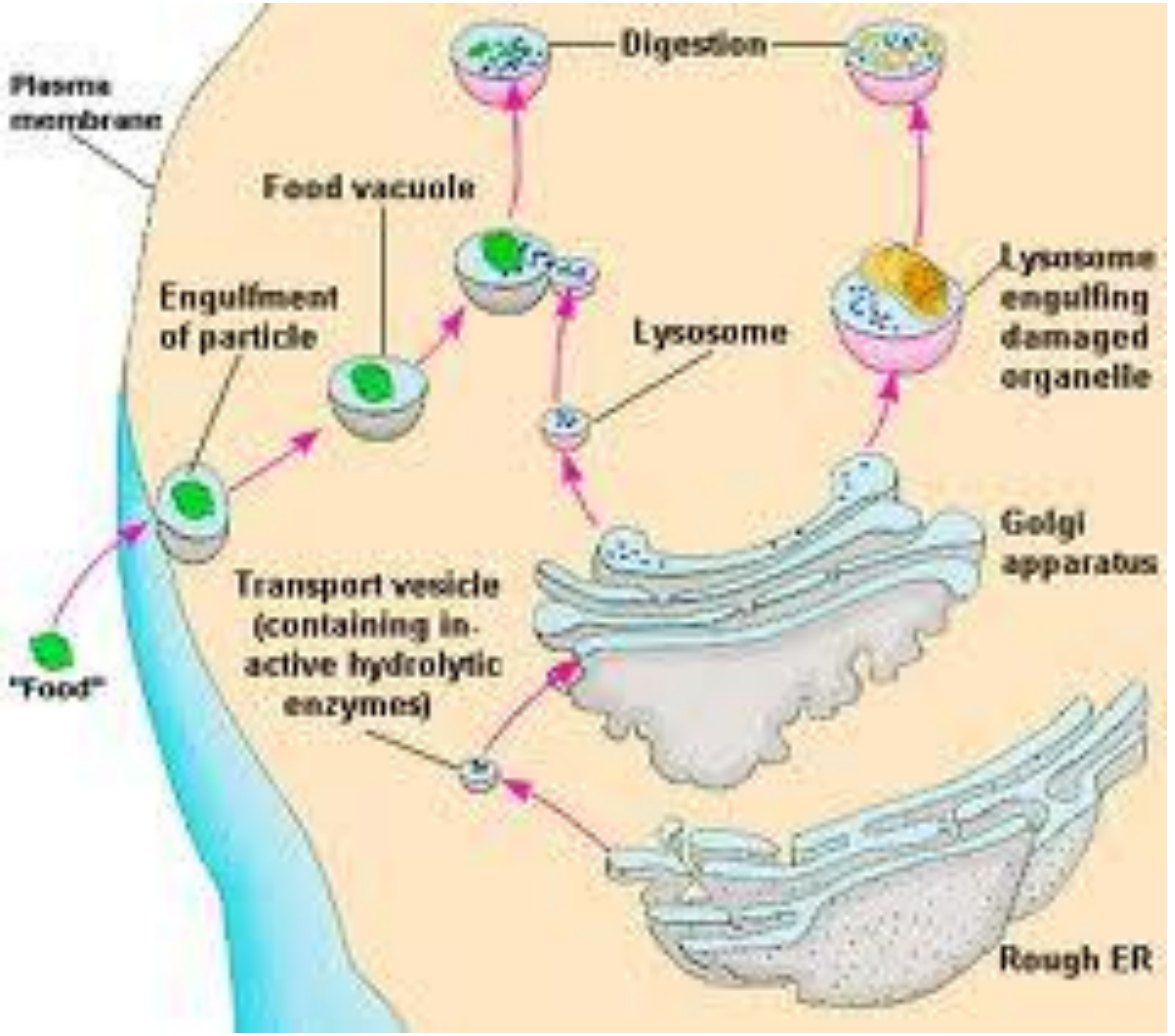
- Many of these molecules are made in the ER and modified in the Golgi.
- After chemical reactions in the golgi, new sacs are produced with the finished product.
- Golgi produces many kinds of sacs each with different function.
- Some are transported in the cell and combine with other membrane structures such as ER
- Others migrate to the plasma membrane and combine to it. These vesicles release molecules such as mucus, insulin, and enzyme to the outside of the cell.
- Some are produced by Golgi with enzymes that can break down molecules . These vesicles are called lysosomes.

Lysosomes

- Tiny vehicles with enzymes to digest carbohydrates, nucleic acids, proteins and lipids.

- The lysosome function in under control since the lysosomes enzymes work best at PH of 5. This acidic PH is formed by hydrogen ions transported into the cell. PH of the cell is 7, so these enzymes will not be functional if released to the cytoplasm.

- Lysosomes function in digestion and destruction. Ex: lysosome destroys disease-causing organisms such as bacteria, viruses, and fungi. These microorganisms will be surrounded by ER membranes. Membranes will combine with lysosomes and destroy invaders, especially found in white blood cells


Digestion
Plasma membrane
Food vacuole
Engulfment of particle
Lysosome
Lysosome engulfing damaged organelle
Golgi apparatus
Transport vesicle (containing inactive hydrolytic enzymes)
"Food"
Rough ER

Peroxisomes

- Membranous organelle that consists of many kinds of enzymes surrounded by membrane
- First identified by the presence of catalase enzyme that breakes hydrogen peroxide (H_2O_2)
- They are not formed from golgi and contain different enzymes than that of lysosomes
- It is formed for the ER and enzymes are imported into sac-like container. Ex: breaking down of fatty acids, cholesterol synthesis, synthesis of specific lipids in plasma membrane of nerve cells