Medical Biology

Lec 1
Dr. Khalida Ibrahim

Biology: is a science that studies living things & provides an understanding of life.
Cell biology: is a specialized branch of biology which deals with the study of structure and function of cell organelles.
Cytology: is the science that deals with studies of the cell.

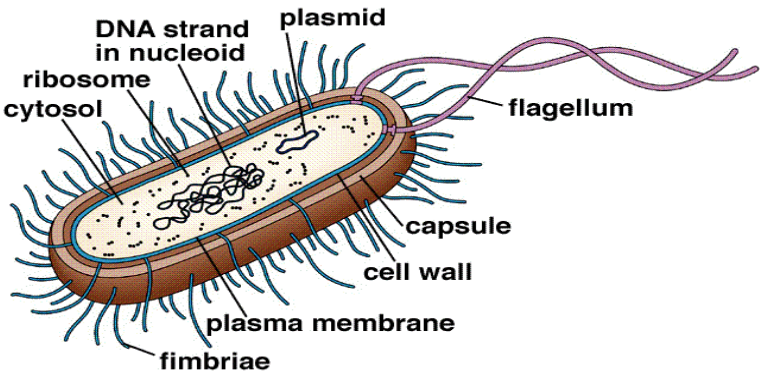
Cells: are the structural units of all living organisms.

Cells are divided to **2** types:

1. **the prokaryotic cell**: e.g., bacteria.

Characterized by:

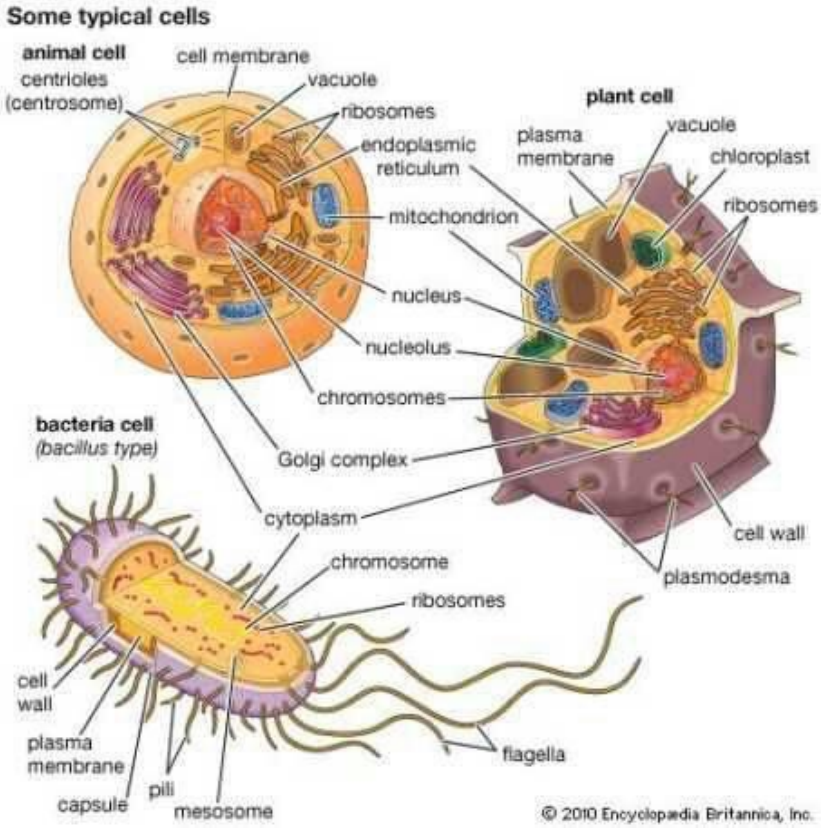
- small (1-5 µm) long.
- Have cell wall outside the cell membrane.
- Lack a nuclear envelope separating the genetic material (DNA) from other cellular constituents.
- Have no histones (specific basic proteins) bound to their DNA.
- Have no membranous organelles.
- Prokaryotic cells divide by **binary fission.**



2. **the eukaryotic cells**: e.g., amoeba.

Characterized by:

- larger than prokaryotic cells.
- Have distinct nucleus surrounded by nuclear envelope.
- Histones are associated with the genetic material.
- Numerous membrane-limited organelles are found in the cytoplasm.
- Eukaryotic cells are divided by **mitosis & meiosis**.



Eukaryotic cell components:

The eukaryotic cell is composed of **2** basic parts:

1. **cytoplasm.**
2. **nucleus.**

Cytoplasm

Is composed of **matrix (cytosol)** in which are embedded the **organelles, cytoskeleton** & deposits of carbohydrates, lipids & pigments.
The cytoplasm of eukaryotic cells is divided into several distinct compartments by membranes that regulate the intracellular traffic of ions and molecules.

The outermost component of the cell, separating the cytoplasm from its extracellular environment, is the **plasma membrane (plasmalemma)**. However, even if the plasma membrane is the external limit of the cell, there is communication between the interior of the cell & extracellular macromolecules.

Plasma membrane
Structure & function

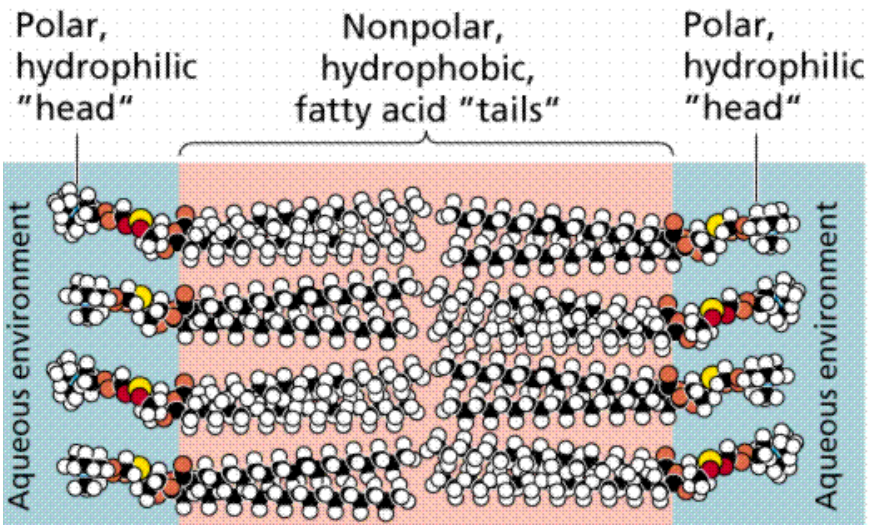
The structure & function of cell plasma membrane are critically dependent on:

a) universally, a plasma membrane protects a cell by acting as a barrier between its living contents and surrounding environment.
b) It regulates what goes into & out of the cell & marks the cell as being unique to the organism.
c) In multicellular organisms, cell junctions requiring specialized features of the plasma membranes connect cells together in specific ways and pass on information to neighboring cells so that the activities of tissues and organs are coordinated.
d) Investigators noted that lipid- soluble molecules entered cells more rapidly than water- soluble molecules.
e) This promoted them to suggest that lipids are a component of the plasma membrane.
f) The formation of biological membranes is based on the properties of lipids, and all cell membranes share a common structural organization, **bilayers of phospholipids with associated proteins.**
g) The **fluid- mosaic model** of membrane structure is widely accepted at this time which proposed that the membrane is a fluid phospholipid bilayer in which protein molecules are either partially or wholly embedded and so the mosaic pattern of membrane is dependent on proteins which vary in structure and function.

Membrane lipids:
Lipid constitutes 50% of the mass of most cell membranes, although this proportion varies depending on the type of membrane.

1. **phospholipids**:

- the fundamental building blocks of all cell membranes, which are amphipathic molecules, consisting of two hydrophobic fatty acid chains linked to a phosphate- containing hydrophilic head group.
- The hydrophilic (polar) heads of the phospholipids molecules face the intercellular and extracellular fluids.
- The hydrophobic (nonpolar) tails face each other in the membrane interior.
- At body temperature, the phospholipid bilayer of the plasma membrane has the consistency of olive oil. The entire phospholipid molecule can move side away, all



this means that the cell is flexible.

- One of the hydrophobic tails of the phospholipid molecule contain a double bound which create a bend in the tail that is important for the general structure of the membrane, because this bend prevent the phospholipid from being too close to each other in the membrane interior and prevent the phospholipid from packed together and this property is very important to maintain the membrane fluidity and the membrane will behave as a viscous fluid.

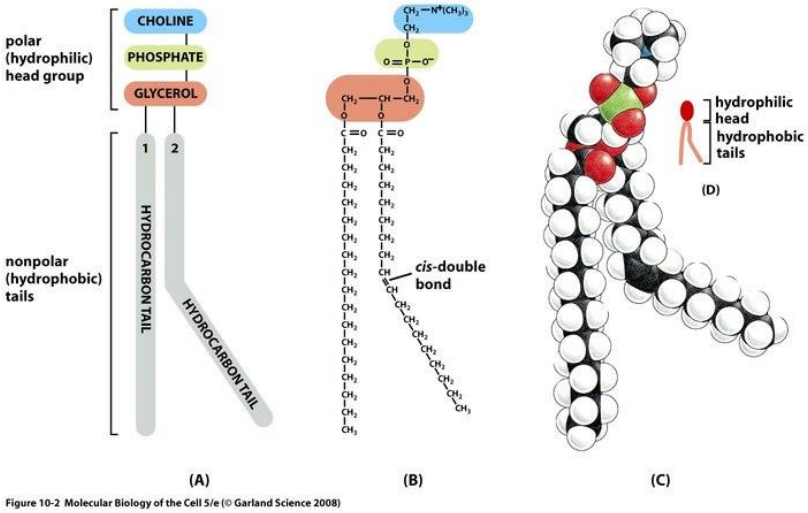
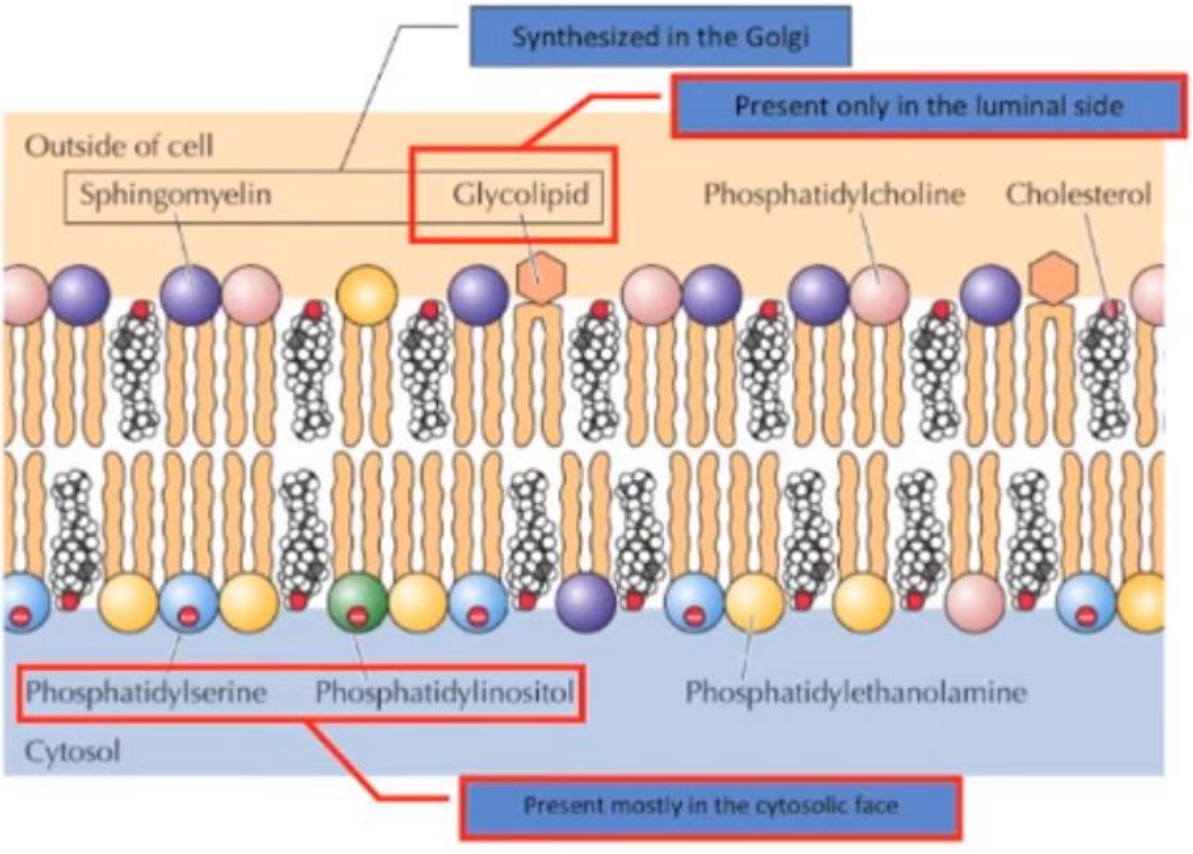


Figure 10-2 Molecular Biology of the Cell 5/e (© Garland Science 2008)

2. **glycolipids**:
    - have a structure like phospholipids except that the hydrophilic head is a variety of sugars joined to form a straight or branching carbohydrate chain.
    - Glycolipids have a protective function as they are present in the outer part of membrane only.
3. **cholesterol**:
    - is a lipid that is found in animal plasma membranes. It is distributed equally in both the outer and inner side of the membrane.
    - Cholesterol reduces the permeability of the membrane to the most biological molecules.

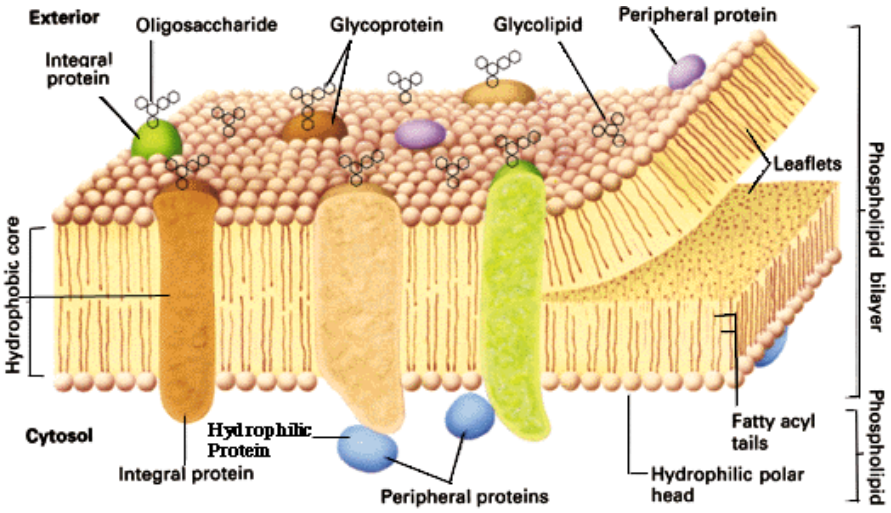


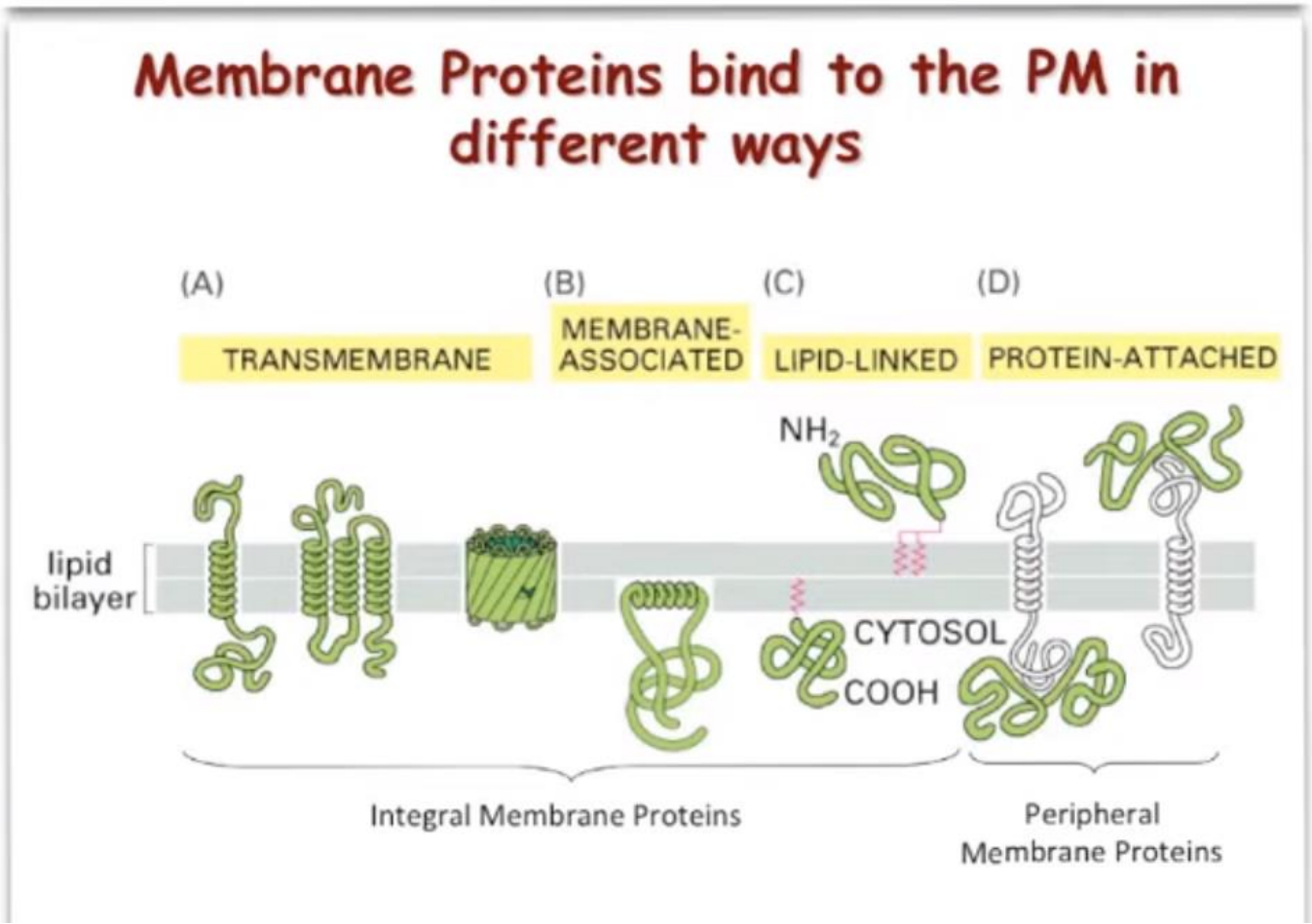
The Lipid Bilayer is a Two-dimensional Fluid: The aqueous environment inside and outside a cell prevents membrane lipids from escaping from the bilayer, but nothing stops these molecules from moving about and changing places with one another within the plane of the bilayer. The membrane therefore behaves as a two-dimensional fluid, which is crucial for membrane function.

Membrane proteins:

- proteins constituting 25- 75% of the mass of various membranes of the cells.
- Membrane proteins carry out the specific functions of the different membranes of the cell.
- These proteins are divided into **2** general classes, based on the nature of their association with the membrane:
    1. **Integral membrane proteins** are embedded directly within the lipid bilayer, many integral membrane proteins called ***transmembrane proteins*** span the lipid bilayer with proteins exposed on both sides of the membrane. Others referred to as ***membrane associated*** or ***lipid linked*** proteins.

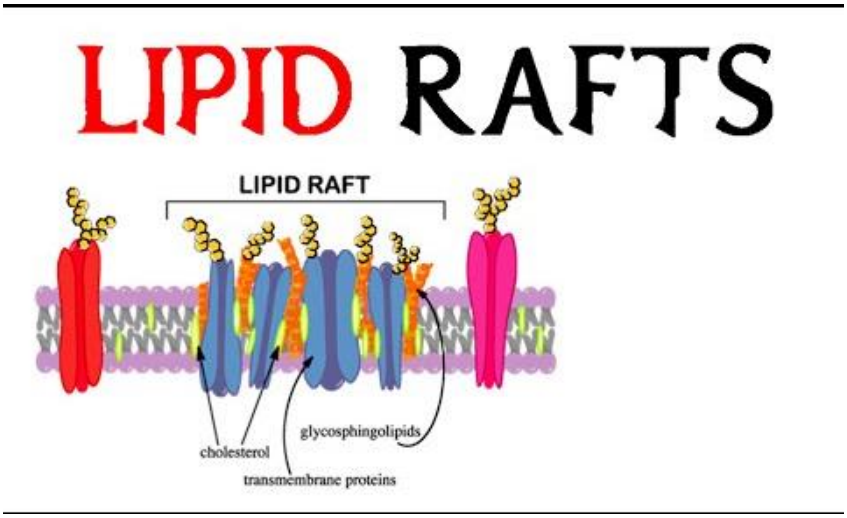
    2. **peripheral membrane proteins** are not inserted into the lipid bilayer but are associated with the membrane indirectly, generally called ***protein attached*** by interactions with integral membrane proteins.





Notes:

- The carbohydrate chains of glycolipids and glycoproteins serve as the **fingerprints** of the cell.
- The carbohydrate chains of the glycolipids & glycoproteins form a carbohydrate coat that envelops the outer surface of the plasma membrane.
- On the inside, proteins serve as links to the cytoskeletal filaments and on the outside, some serve as links to extracellular matrix.
- Many integral and peripheral proteins that function as components of large enzyme complexes are in specialized patches of membrane having higher concentrations of cholesterol. Within these regions called **lipid rafts** membrane fluidity is reduced, allowing the associated proteins to remain in closer proximity and interact more efficiently.



Membrane protein variety:

These are some of functions performed by proteins found in the plasma membrane:

1. **channel protein** allows a particular molecule or ion to cross the plasma membrane freely.

2. **carrier protein** selectively interacts with a specific molecule or ion so that it can cross the plasma membrane.

3. **cell recognition protein**: a type of glycoproteins, which are involved in marking of the cell and are different for each person. e.g., major histo compatibility complex.

4. **receptor protein** is shaped in such a way that a specific molecule can bind to it.

5. **enzymatic protein**: catalyzes a specific reaction.