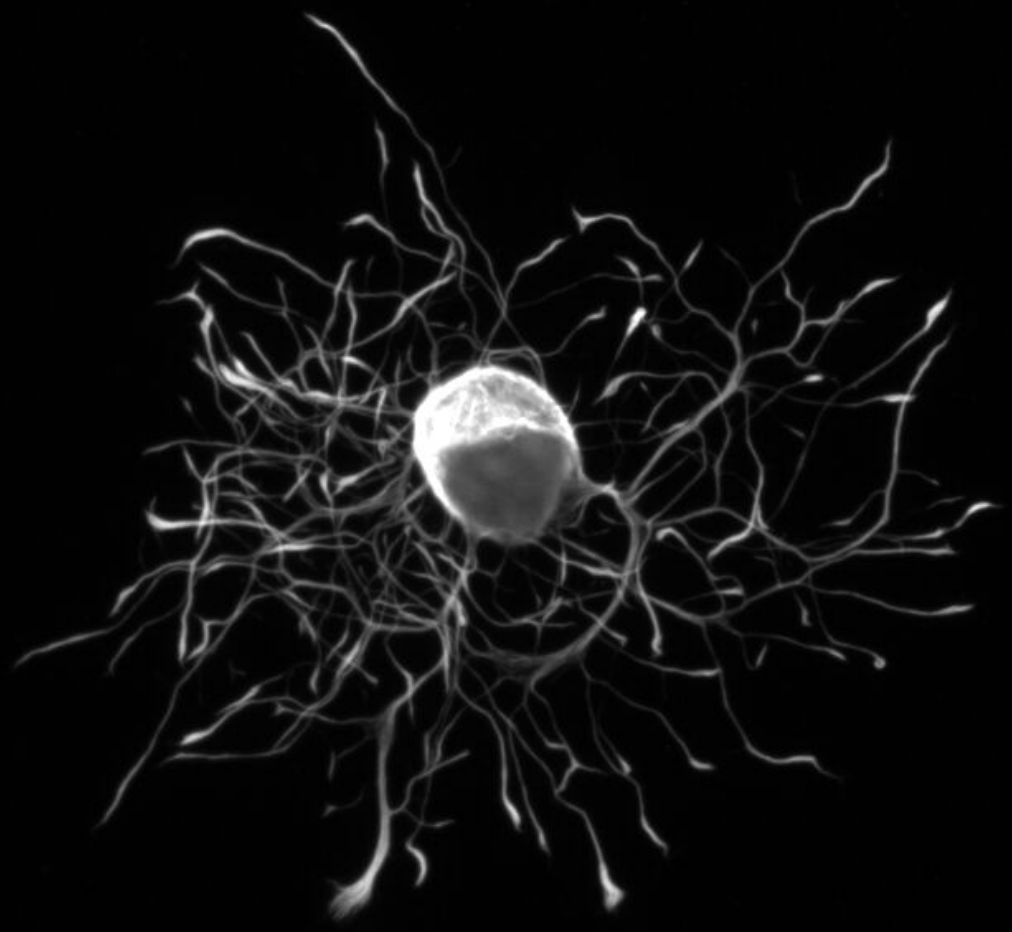
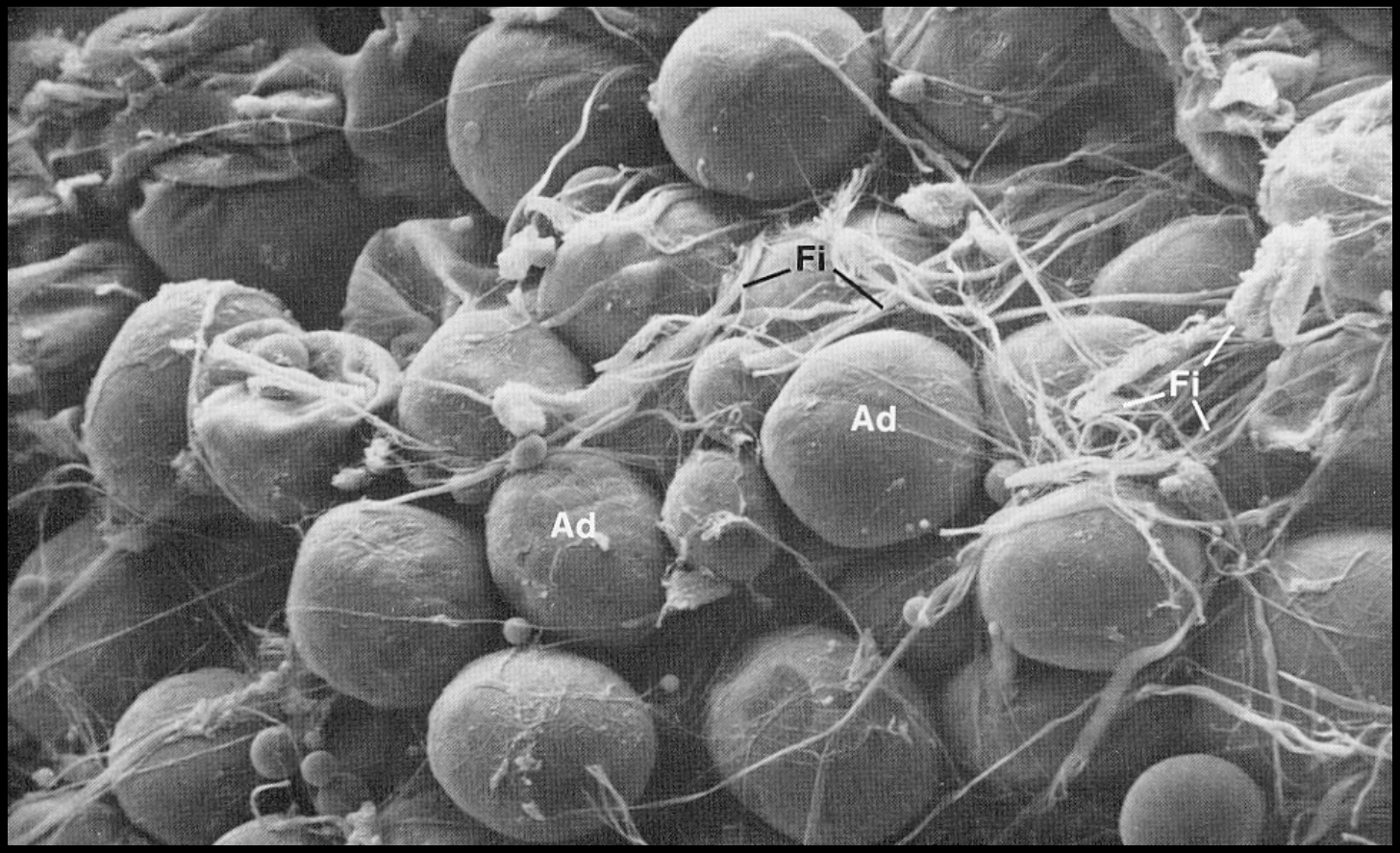
Membrane Structure and Function



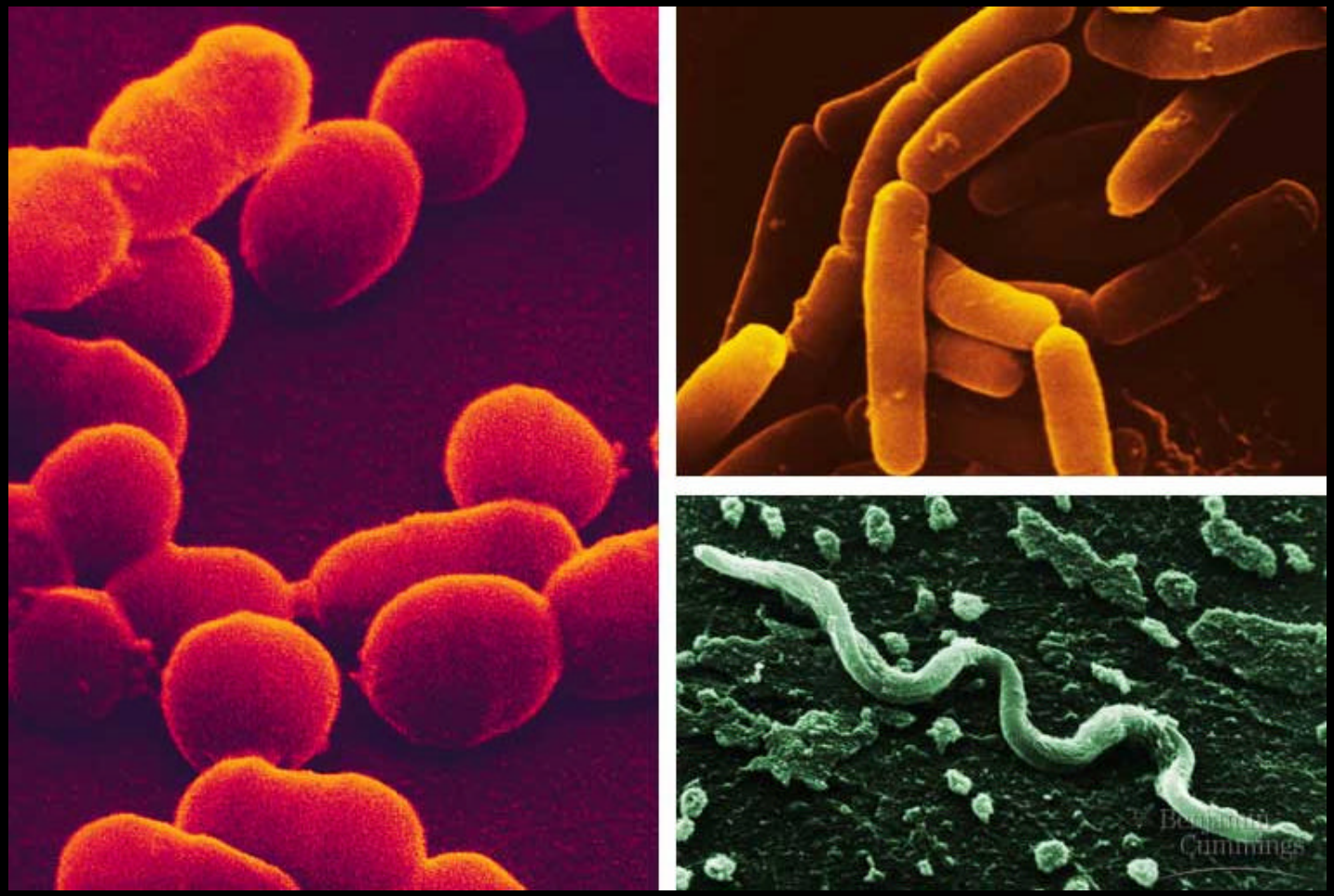
Eukaryotic Cell: Neuron

Membrane Structure and Function



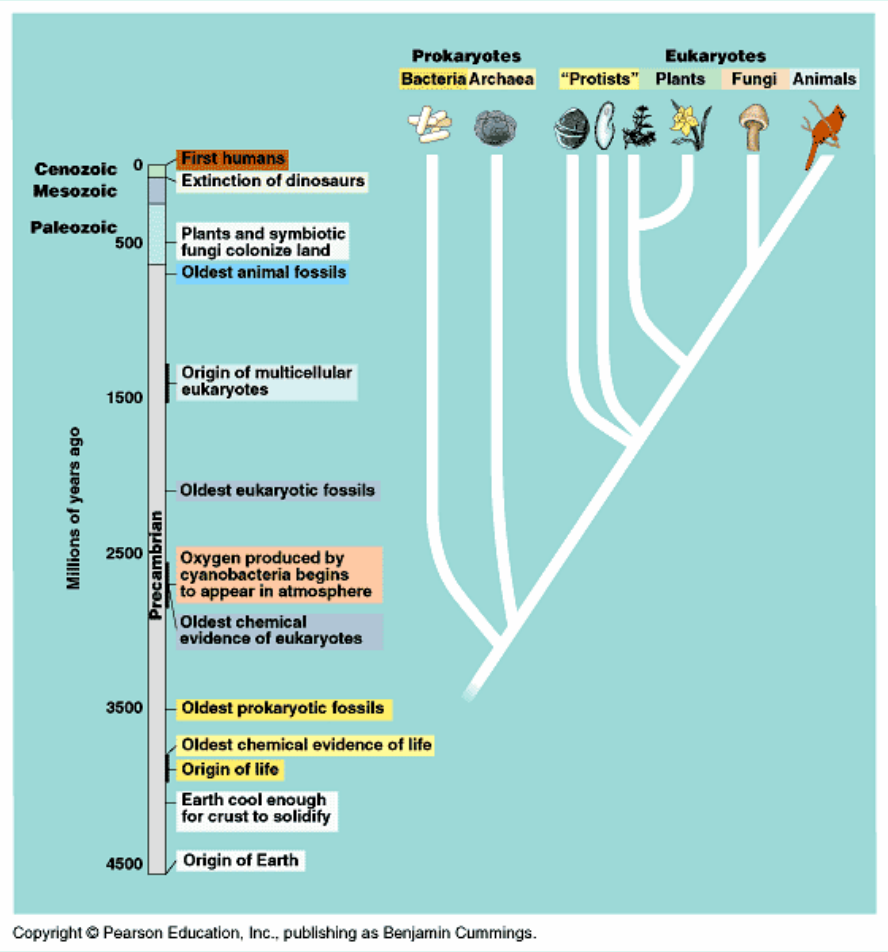
All cells have a plasma or cell membrane, which contains the cell. Scanning electron micrograph (SEM) of adipocytes (Ad)

Membrane Structure and Function



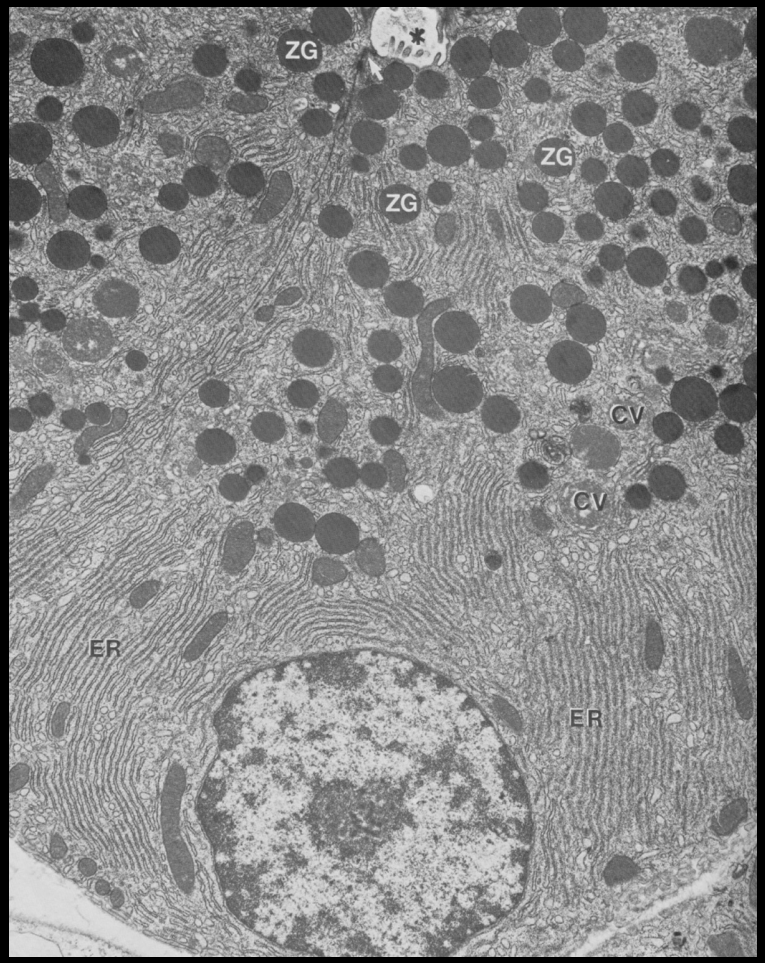
Prokaryotic Cells: Bacteria

The Formation of Cell Membranes is Crucial to Life

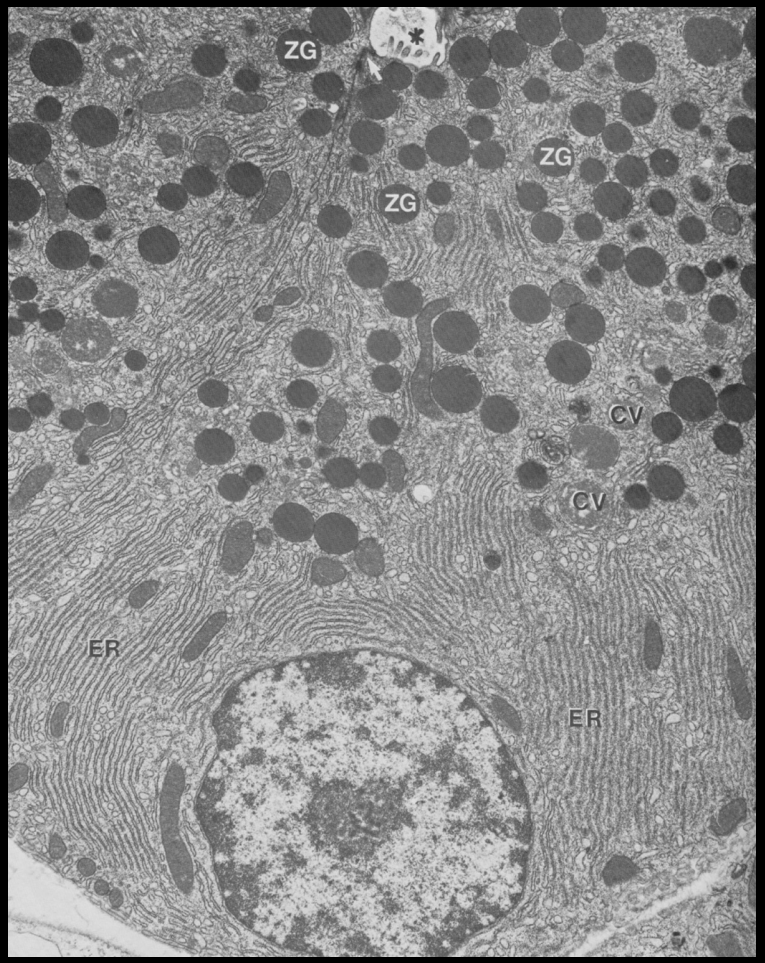


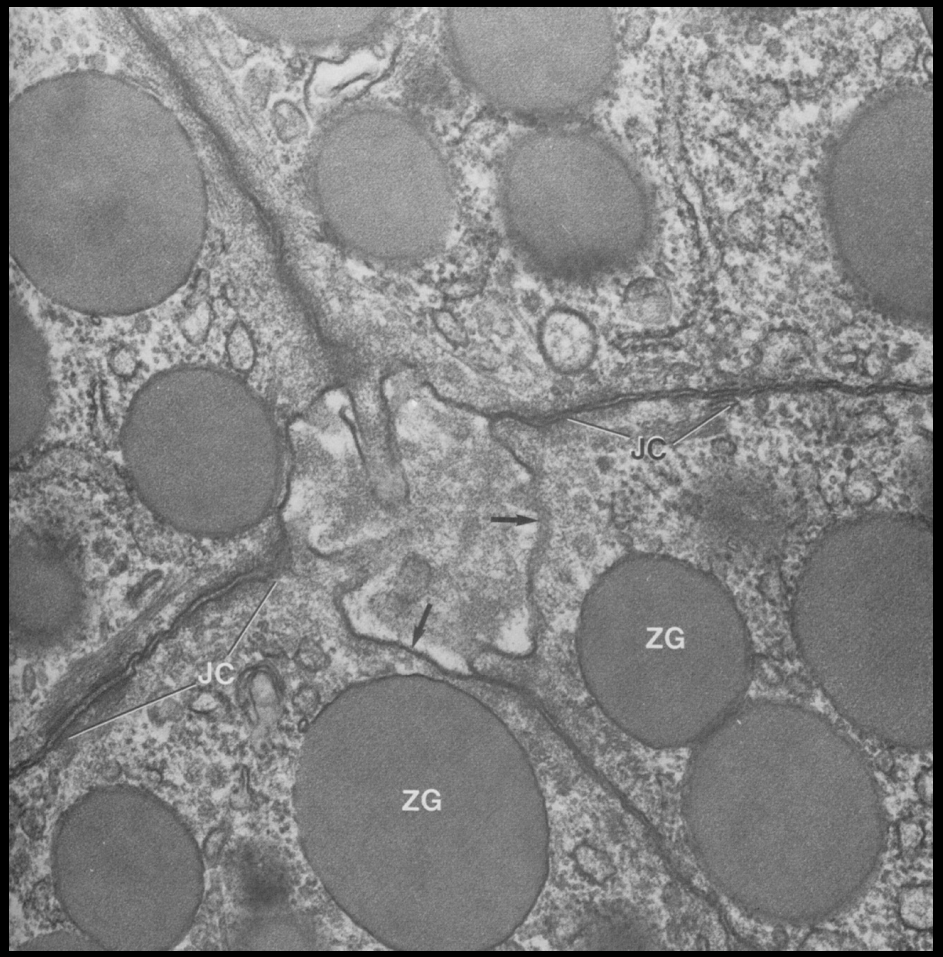
Functions of the Cell Membrane

- Contains the cell
- Regulates the traffic of molecules and substances in and out of the cell (*semi-permeable membrane*)



Cell Membrane Structure

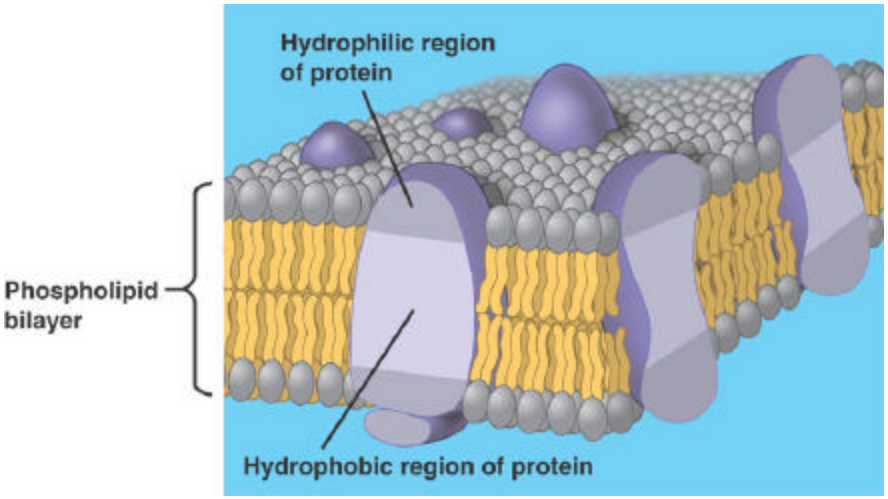




Pancreatic Secretory Cell: TEM of Basal and Apical Parts

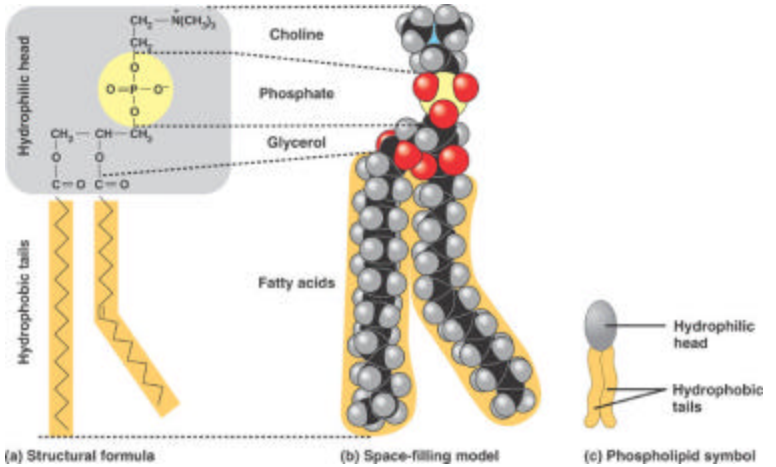
Major Components of the Cell Membrane

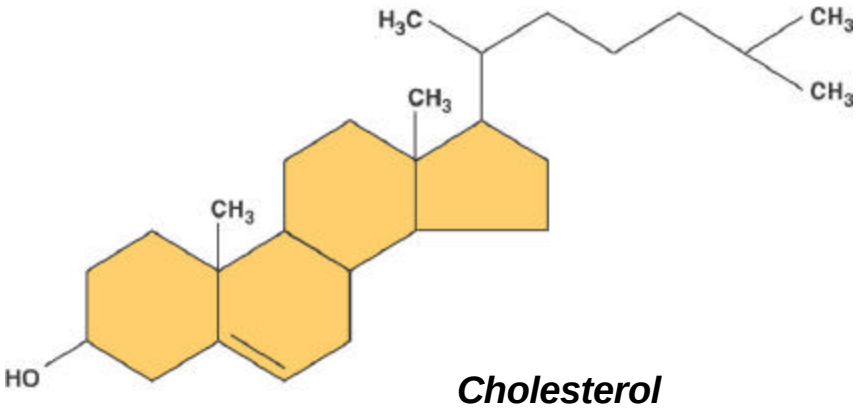
- The major constituents of the cell membrane are proteins and lipids
- *Membrane proteins* and lipids are arranged in a particular fashion, both contributing to containing the cell and to selectively allowing or blocking the traffic of certain substances through the cell
- Such arrangement of molecules provides *fluidity* to the cell membrane



Major Components of the Cell Membrane: Lipids

- Phospholipids are *amphipathic* molecules (with *hydrophobic* tails and a *hydrophilic* head)
- One of the phospholipid tails exist mostly in a *trans* configuration, providing *more fluidity* to the membrane
- Cholesterol is a rigid molecule that makes membranes *less fluid*





Cholesterol

Major Components of the Cell Membrane: Lipids

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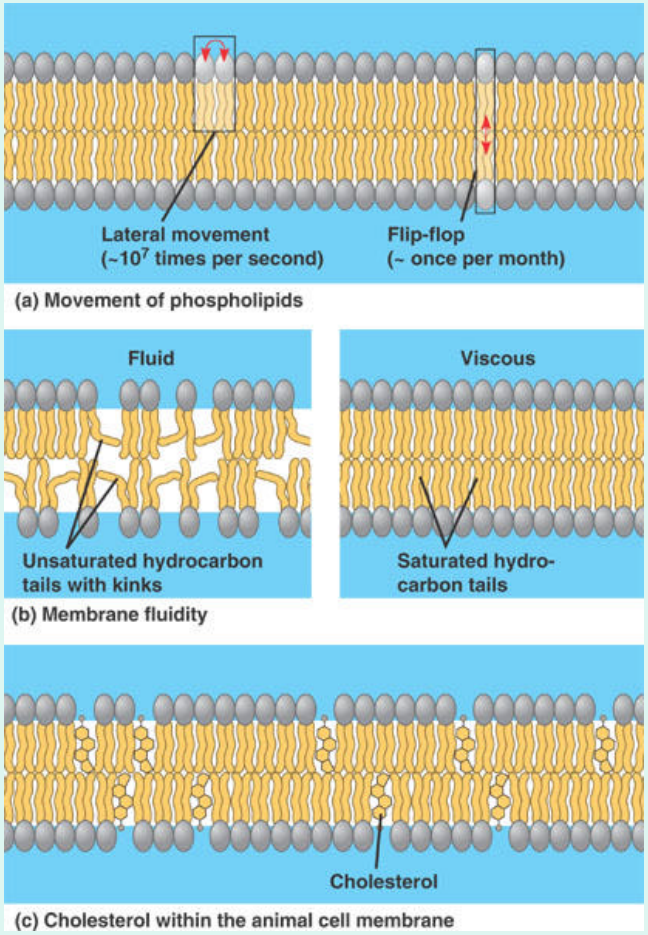
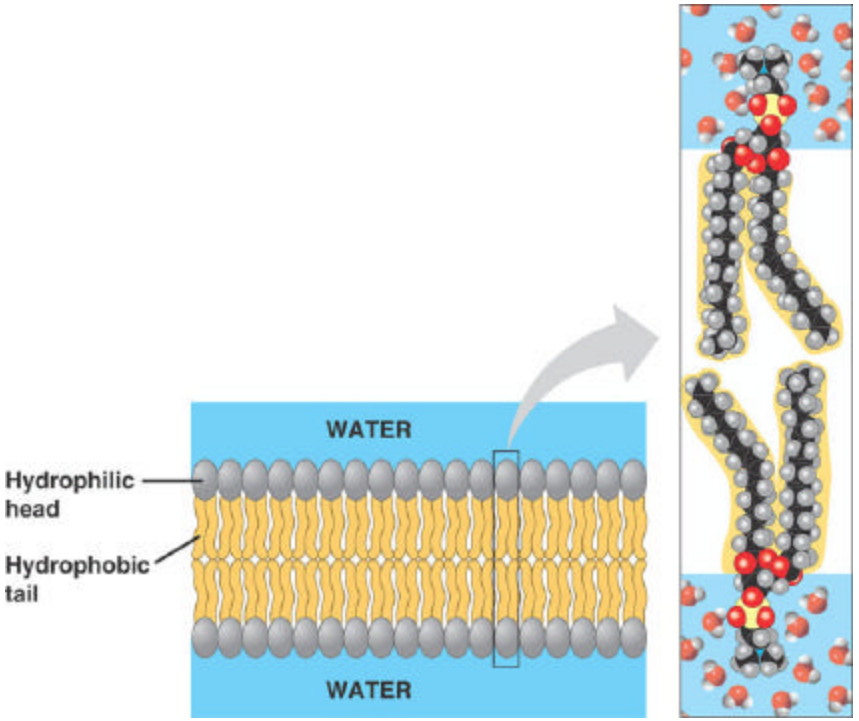


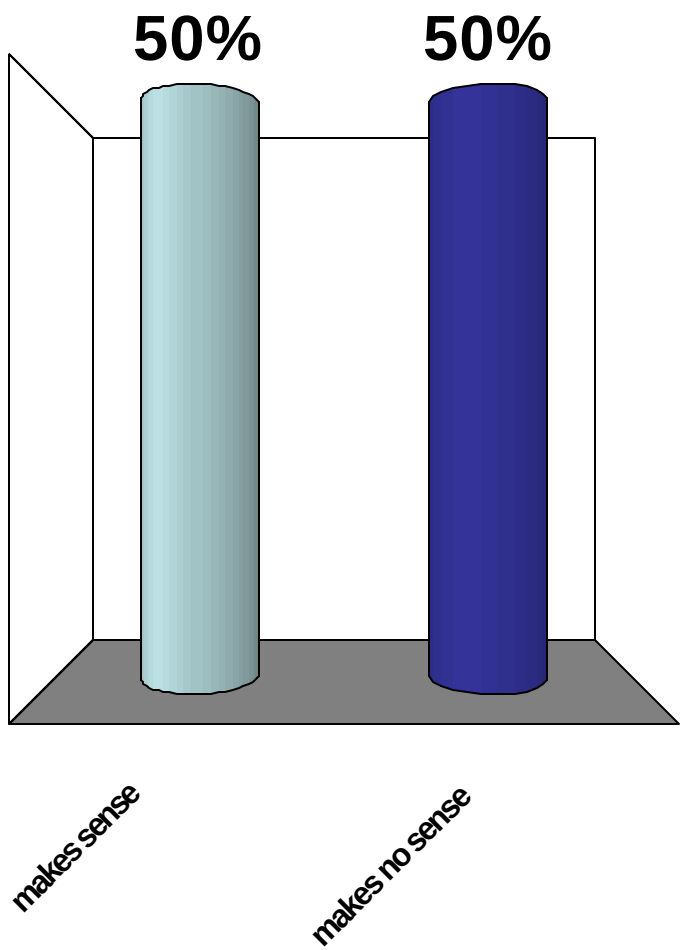
How Are Phospholipids Organized in the Cell Membrane?

- Phospholipids constitute two mirror-image oriented layers — *the lipid bilayer*
- The hydrophilic heads are exposed to the high-content water regions, while the hydrophobic tails constitute a barrier impenetrable to almost all substances



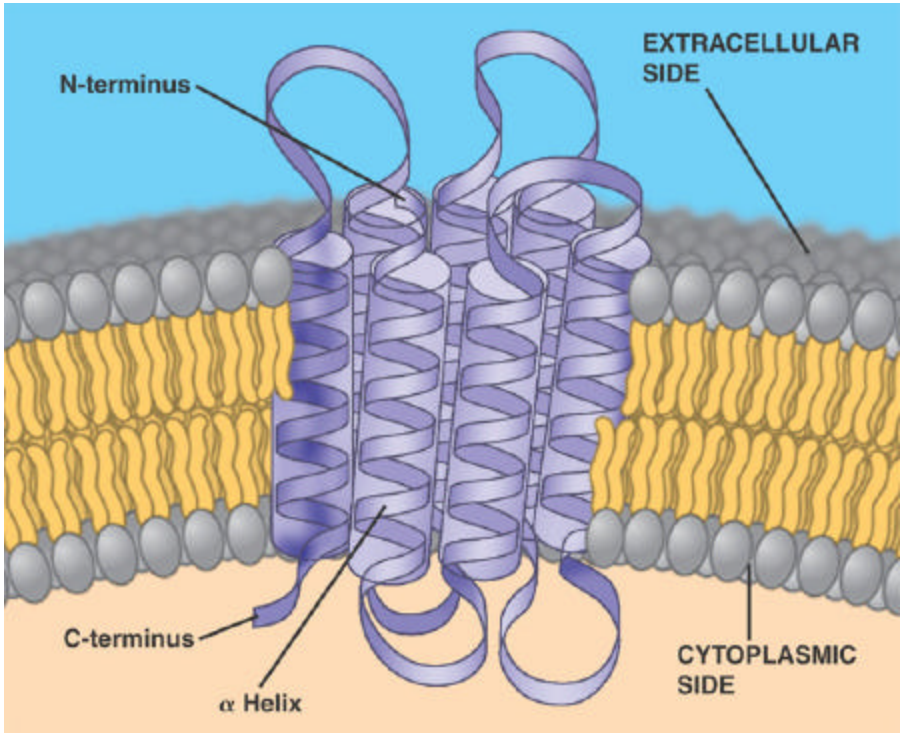
hydrophobic tails: repel water: phospholipids: lipid bilayer

1. makes sense
2. makes no sense

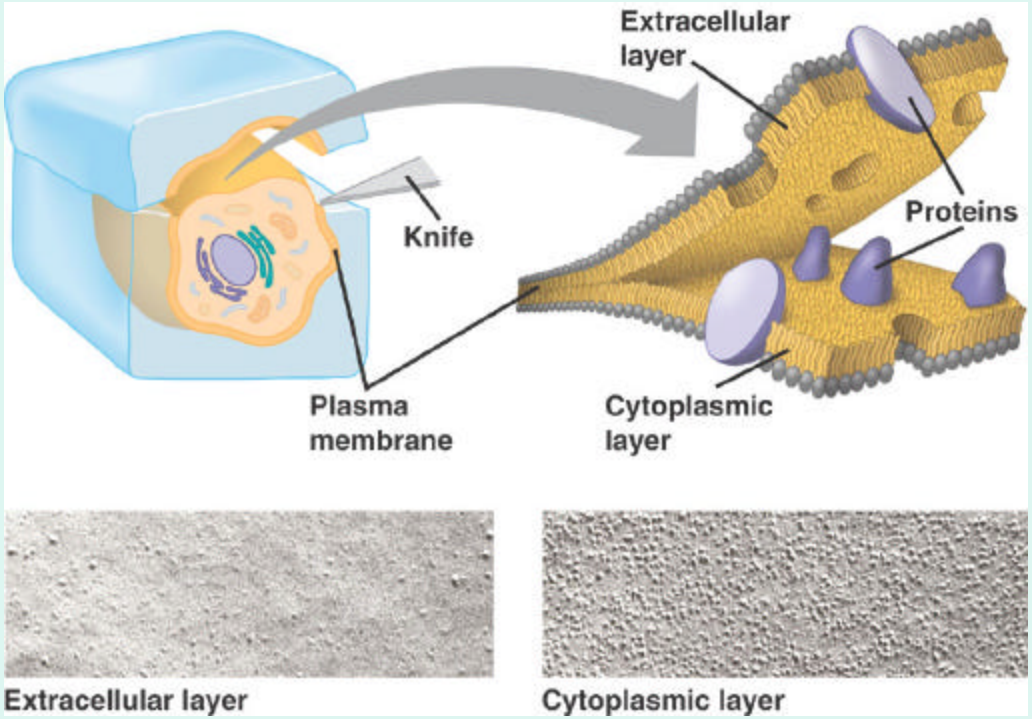


Major Components of the Cell Membrane: Membrane Proteins

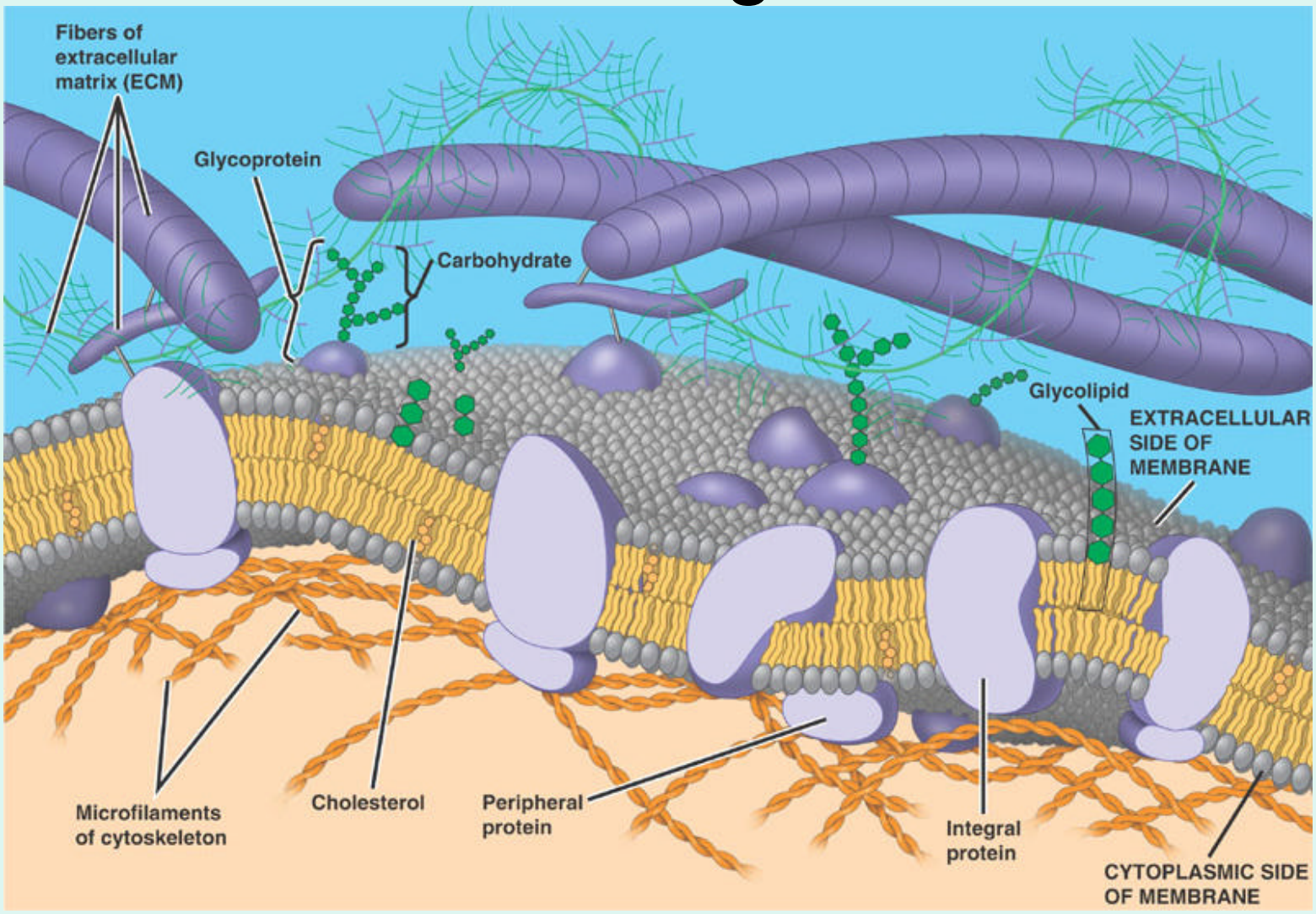
- Membrane proteins are embedded in the fluid matrix of the lipid bilayer
- More than 50 types of proteins have been found in the plasma membrane. Membrane proteins determine most of the membrane specific functions
- Transport proteins, enzymes and receptor proteins (membrane proteins that interact with other cells or molecules) include the vast majority of membrane proteins



Major Components of the Cell Membrane: Organization



Major Components of the Cell Membrane: Organization



Functions of the Cell Membrane

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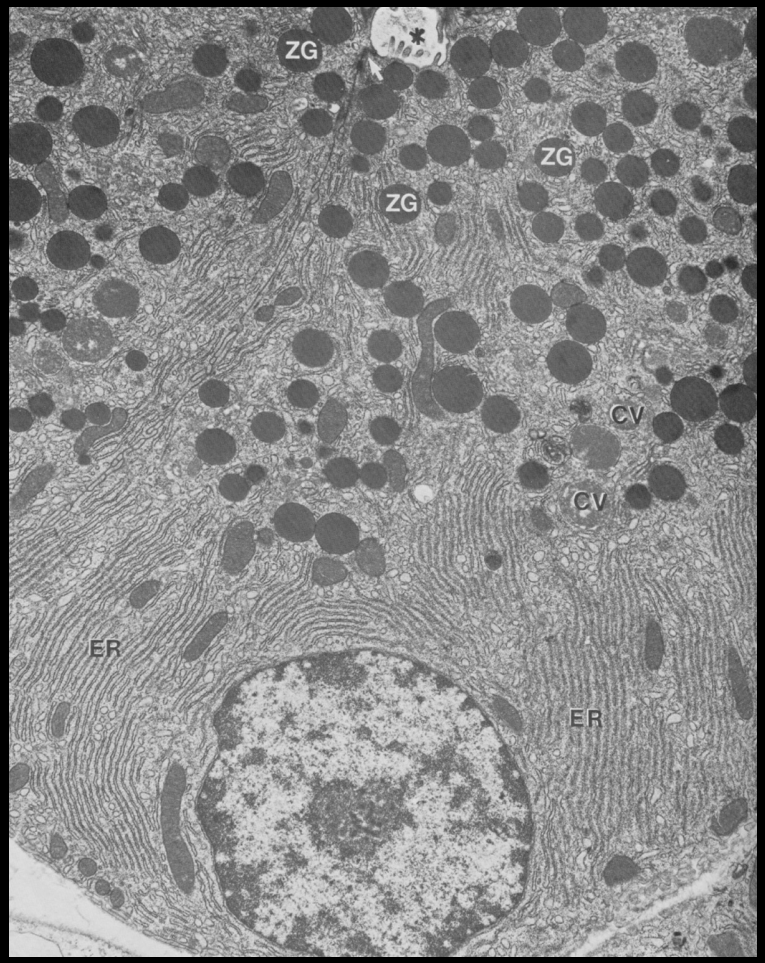
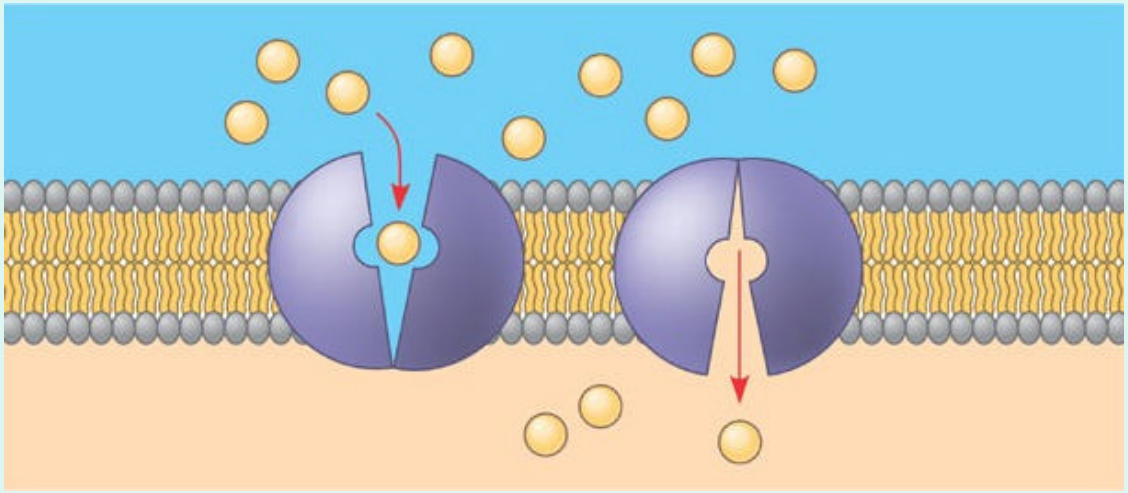


Traffic of Substances Across the Plasma Membrane

- Selective
- Bidirectional
- Depending Upon Differences of Concentration Inside and Outside of the Cell

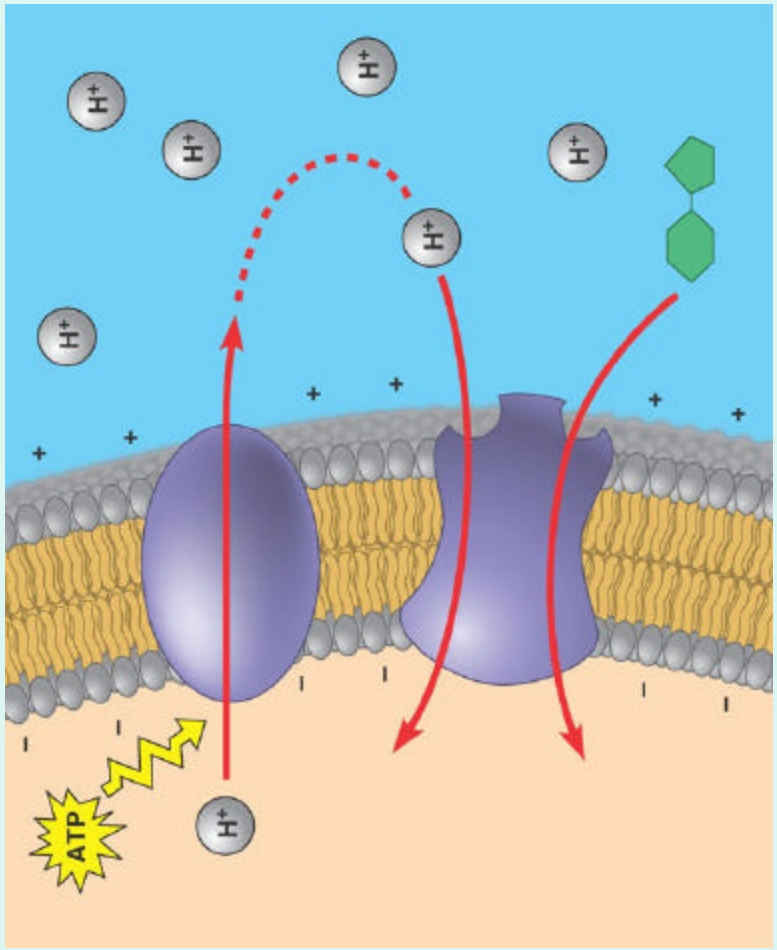
Traffic of Substances Across the Plasma Membrane



- **Selective:** only a few molecules can go through the lipid bilayer. Transport proteins mostly determine what substances cross the cell membrane, as they carry out the majority of membrane transport

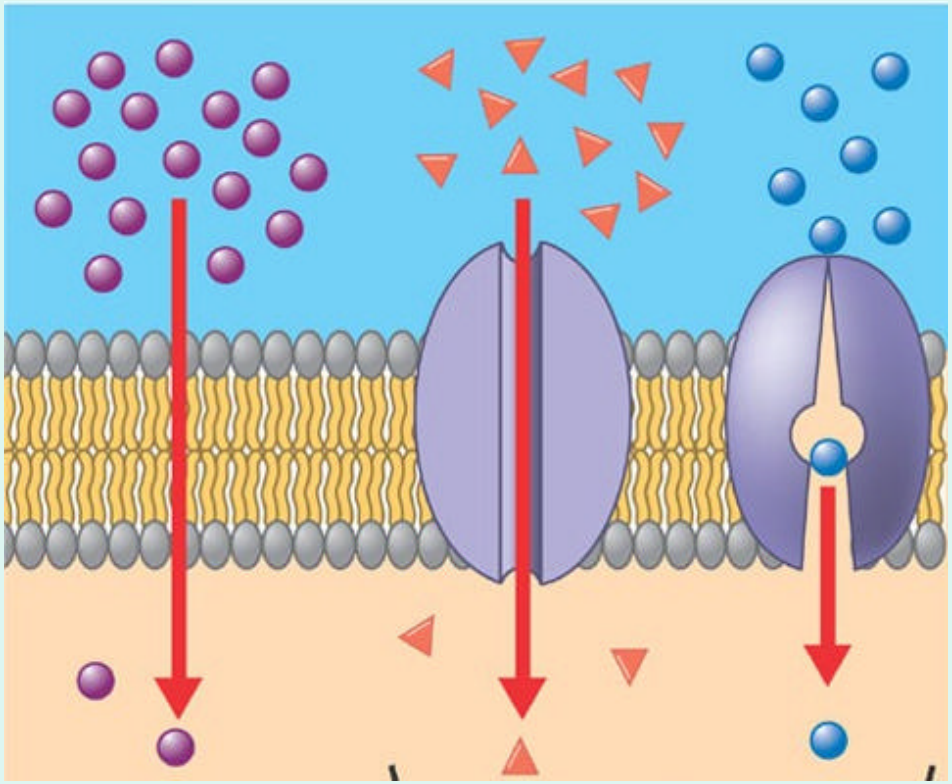
Traffic of Substances Across the Plasma Membrane

- **Bidirectional:** only a few molecules can go through the lipid bilayer. Transport proteins determine what substances cross the cell membrane. Transport can occur in/out or out/in

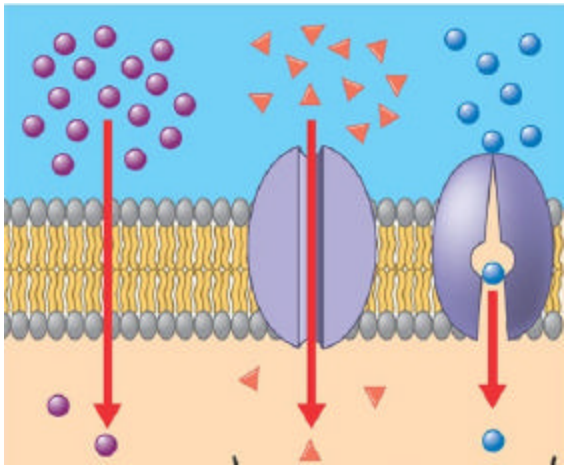


Traffic of Substances Across the Plasma Membrane

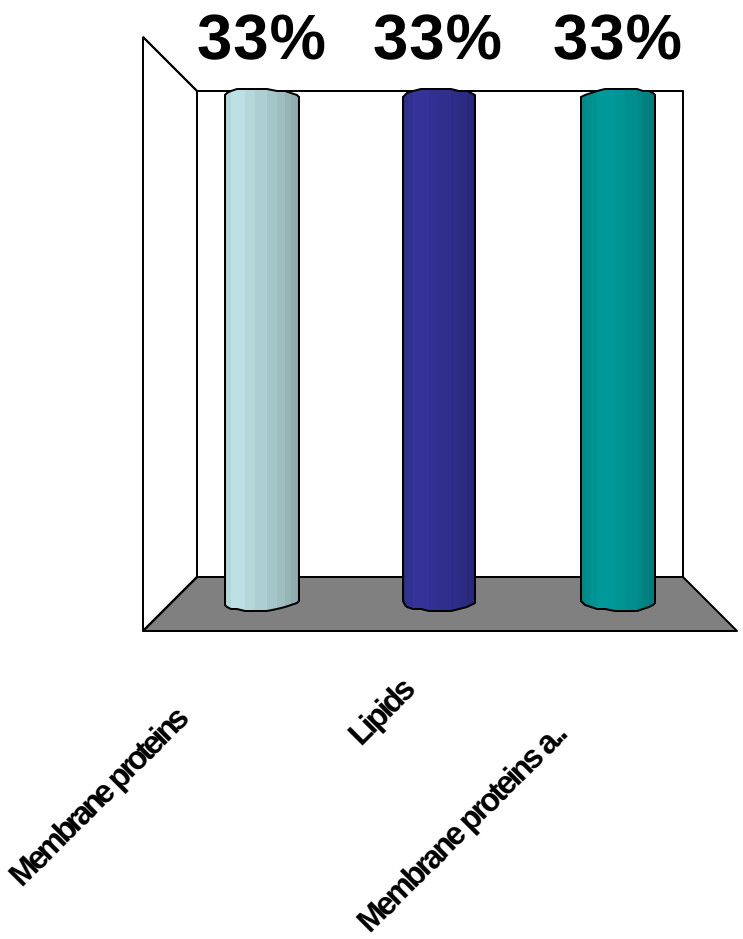
- **Depending Upon Differences of Concentration Inside and Outside of the Cell:** *Osmosis* and *diffusion* are the two main processes by which molecules move across the cell membrane



___ control the traffic of molecules through the cell membrane

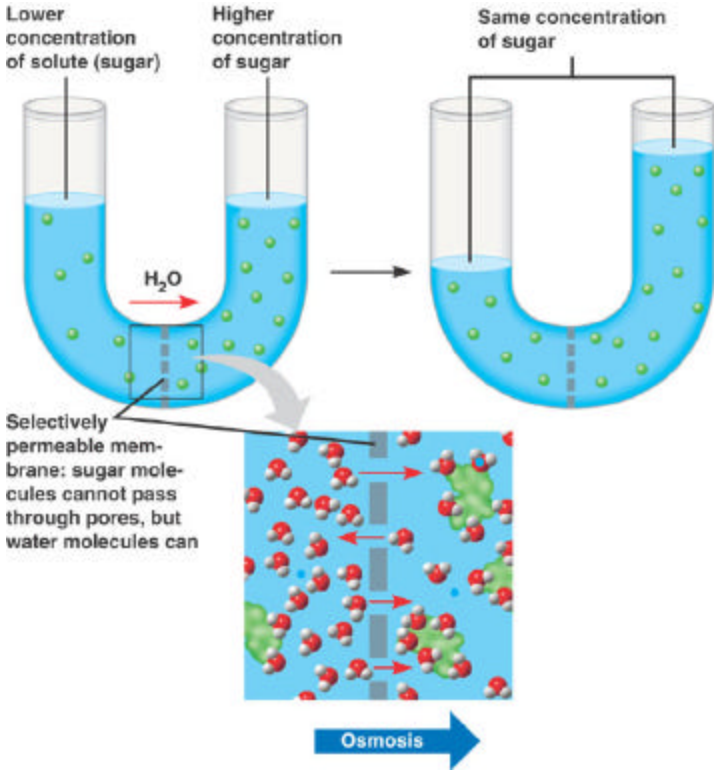


1. Membrane proteins
2. Lipids
3. Membrane proteins and lipids

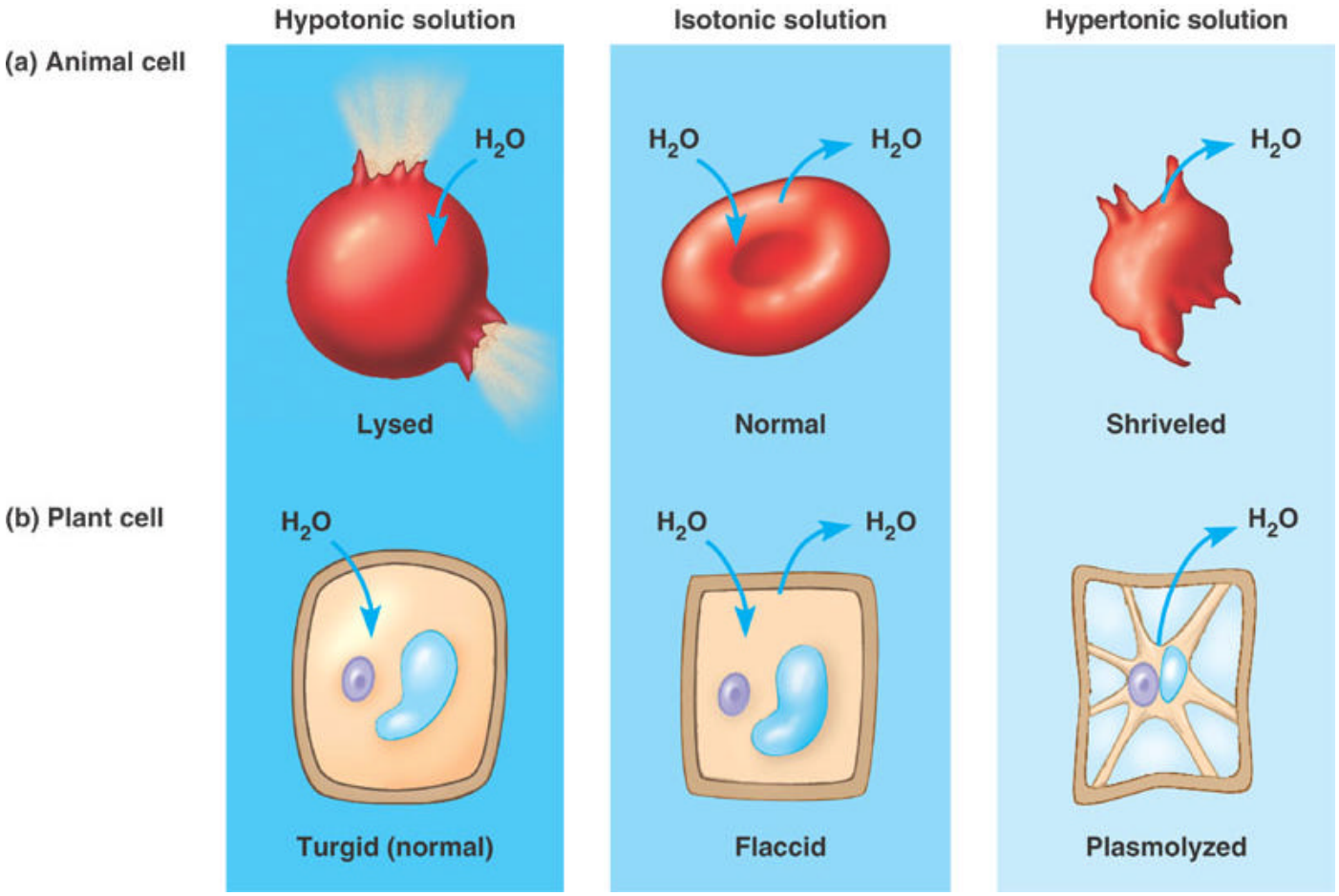


Traffic of Substances Across the Plasma Membrane: Osmosis

- Osmosis is the movement of water and some small molecules *through a semi-permeable membrane* from areas of low concentration of solutes to areas of high concentration of solutes
- Why does water move in that particular direction?



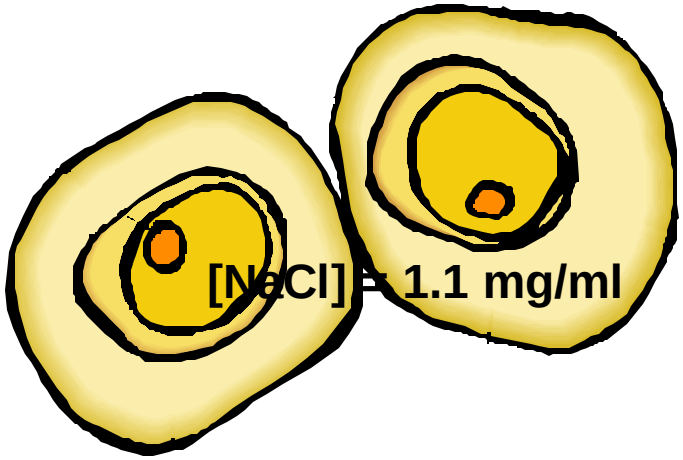
Traffic of Substances Across the Plasma Membrane: Osmotic Shock



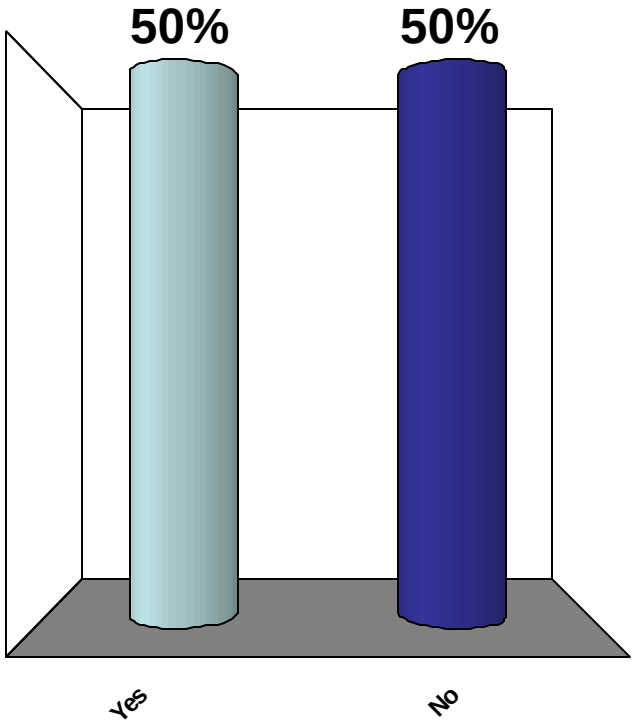
Traffic of Substances Across the Plasma Membrane: Osmosis

- Draw a situation where the extracellular environment is such that water flows out of the cell
- Is the extracellular environment hypo-, hyper-, or isotonic?

In this situation, will water flow out of the cell?



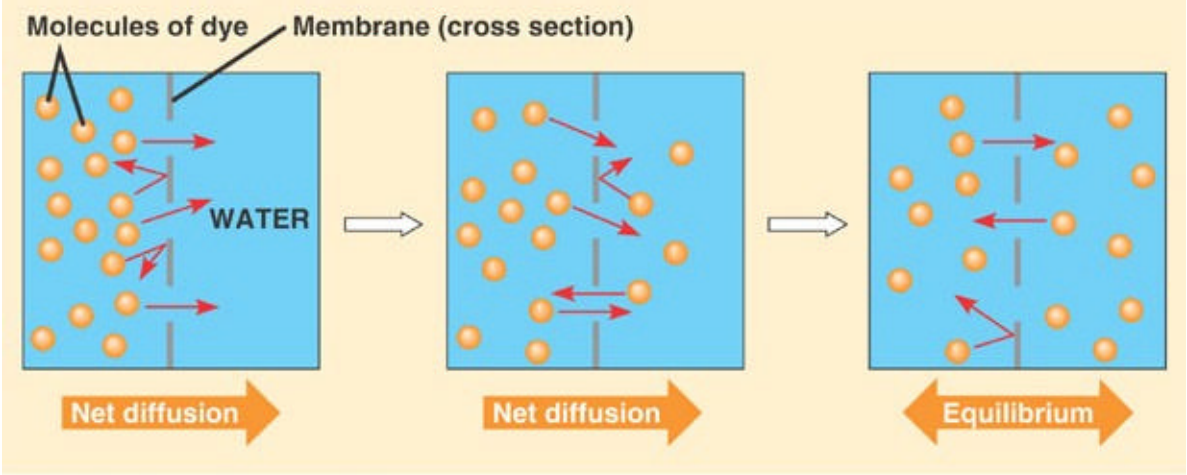
[NaCl] = 0.03 mg/ml



Cartilage cells

1. Yes
2. No

Traffic of Substances Across the Plasma Membrane: Diffusion



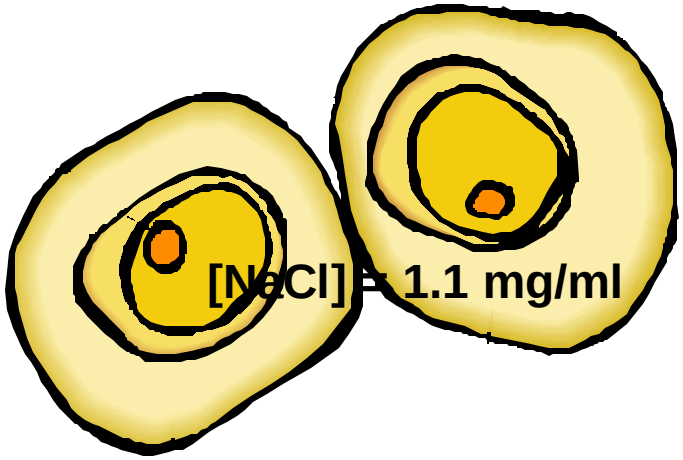
- Diffusion is the movement of substances from an area of high concentration of solutes to an area of low solute concentration (*down to a concentration gradient*)

Traffic of Substances Across the Plasma Membrane: Diffusion

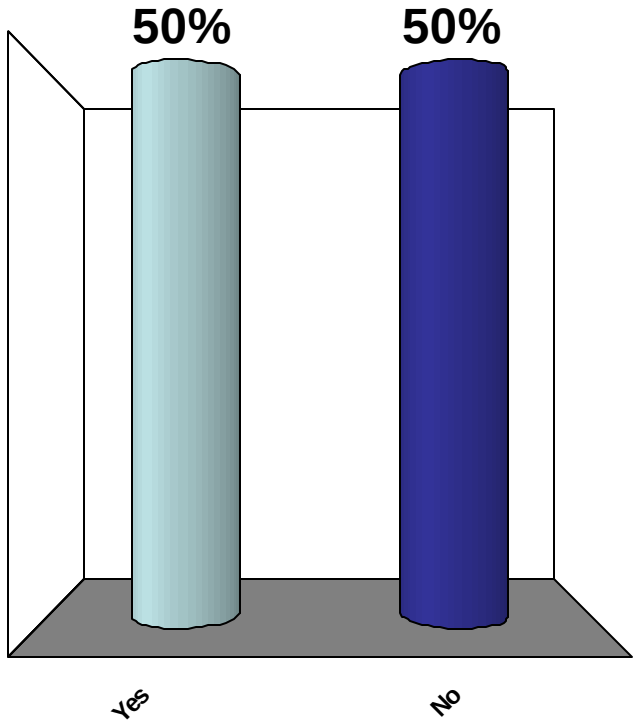
- Draw a situation where a molecule of NaCl will enter the cell. Assume that a transport protein is needed
- Is the extracellular environment hypo-, hyper-, or isotonic?

- Direction of water?

In this situation, will a molecule of NaCl enter the cell?



[NaCl] = 1.9 mg/ml

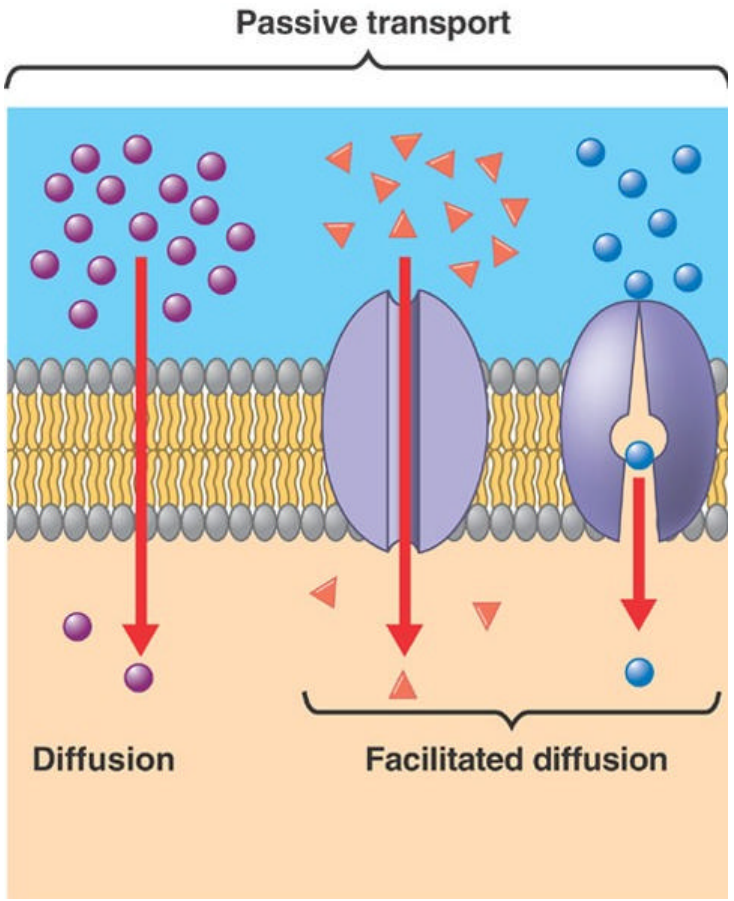


Cartilage cells

1. Yes
2. No

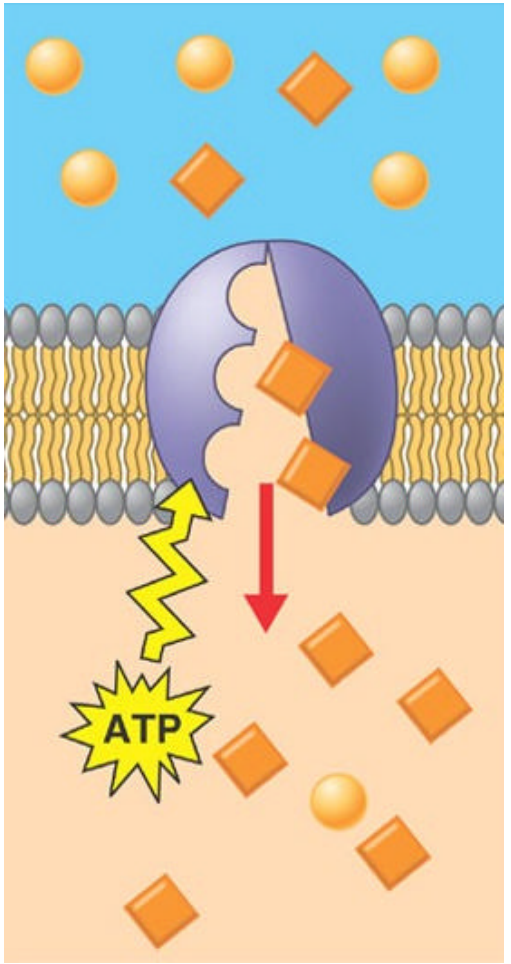
Traffic of Substances Across the Plasma Membrane: Facilitated Diffusion

- Facilitated diffusion is a *protein-mediated passive* (no energy required) diffusion of molecules across the cell membrane
- Transport proteins carry out facilitated diffusion; facilitated diffusion is very selective, as each transport protein transports just one type of molecule

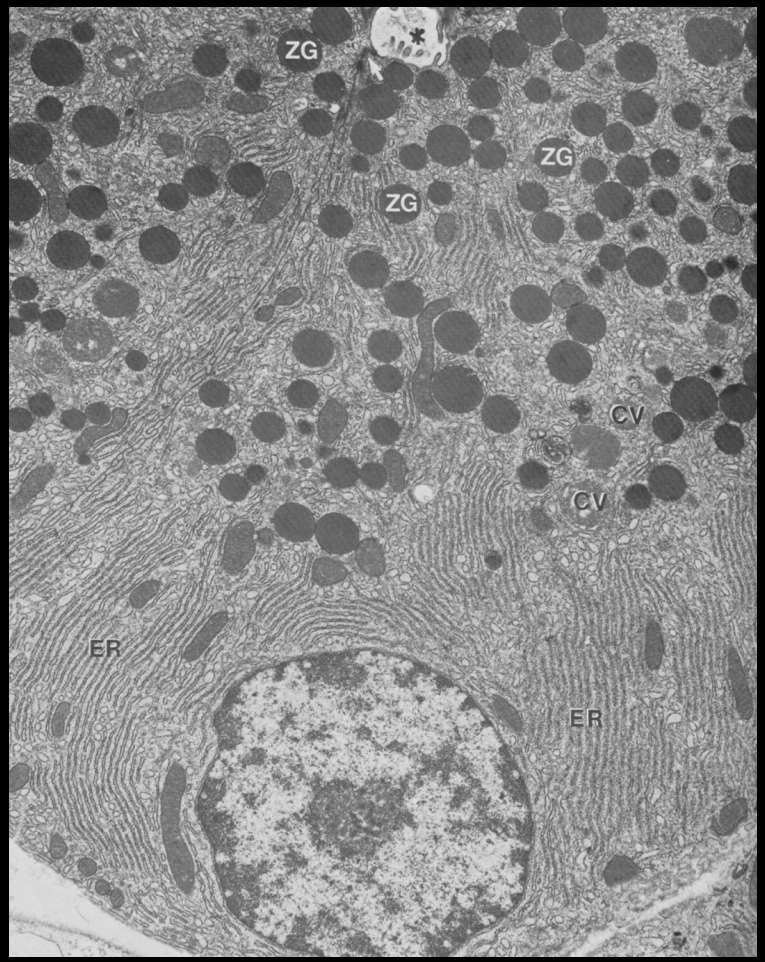


Traffic of Substances Across the Plasma Membrane: Active Transport

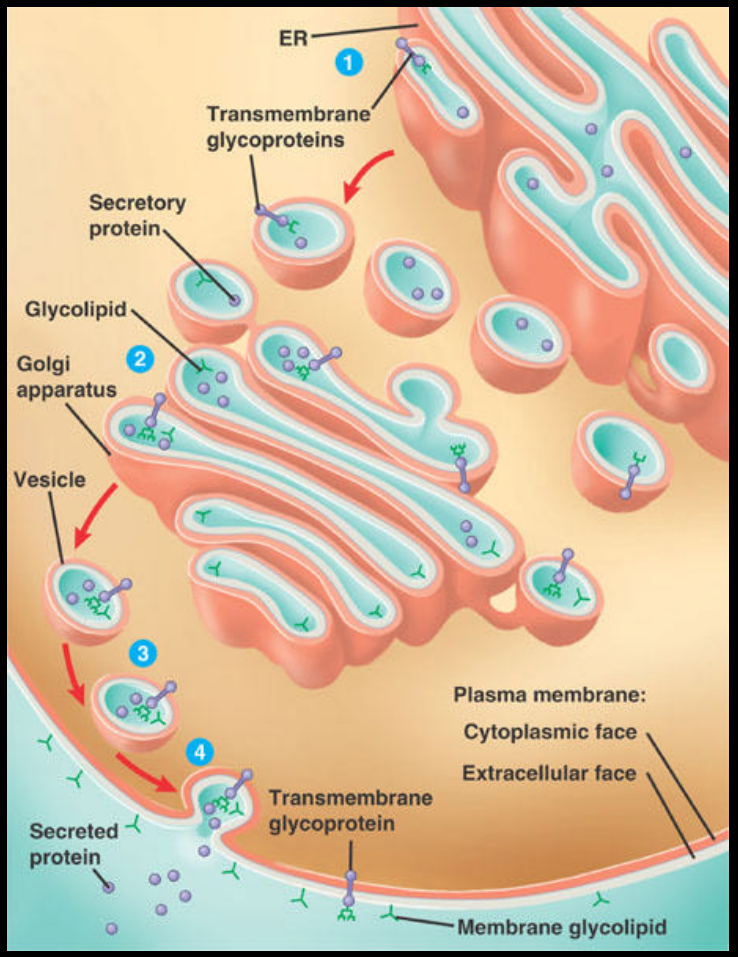
- Active transport is a *protein-mediated* transport of molecules across the cell membrane *against a concentration gradient* (low to high solute concentration areas). It requires a boost of energy (ATP) to occur. As facilitated diffusion, is very selective
- Glucose is actively transported through the plasma membrane of intestinal cells



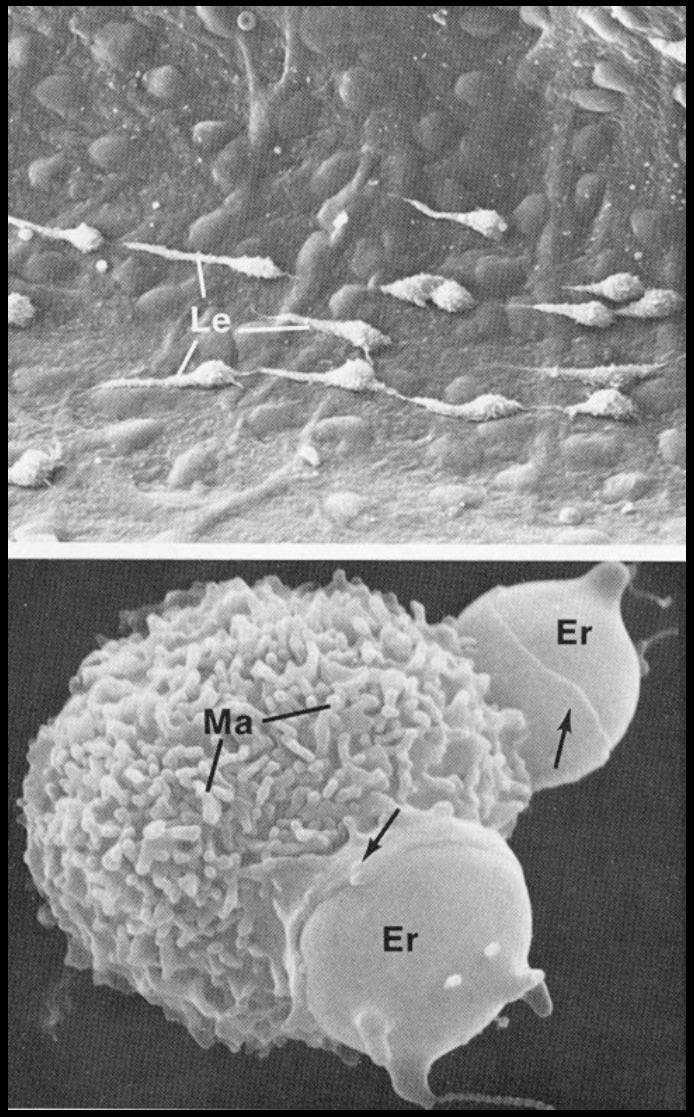
Bulk Transport of Substances Across the Plasma Membrane: Exocytosis and Endocytosis

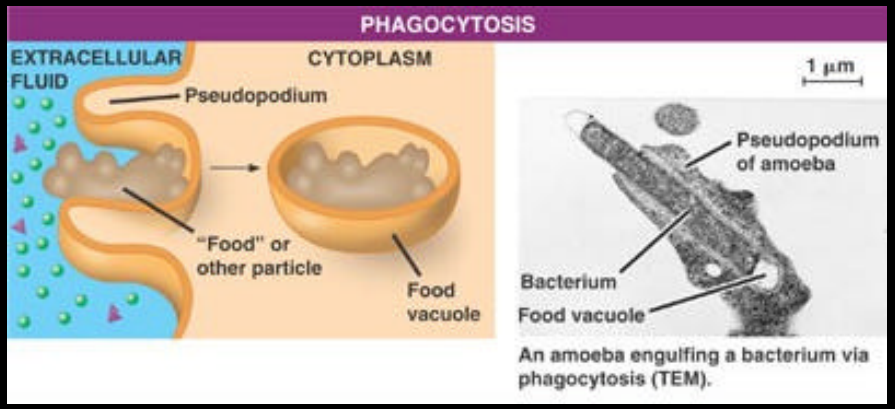


Pancreatic Secretory Cell: TEM



Types of Endocytosis: Phagocytosis

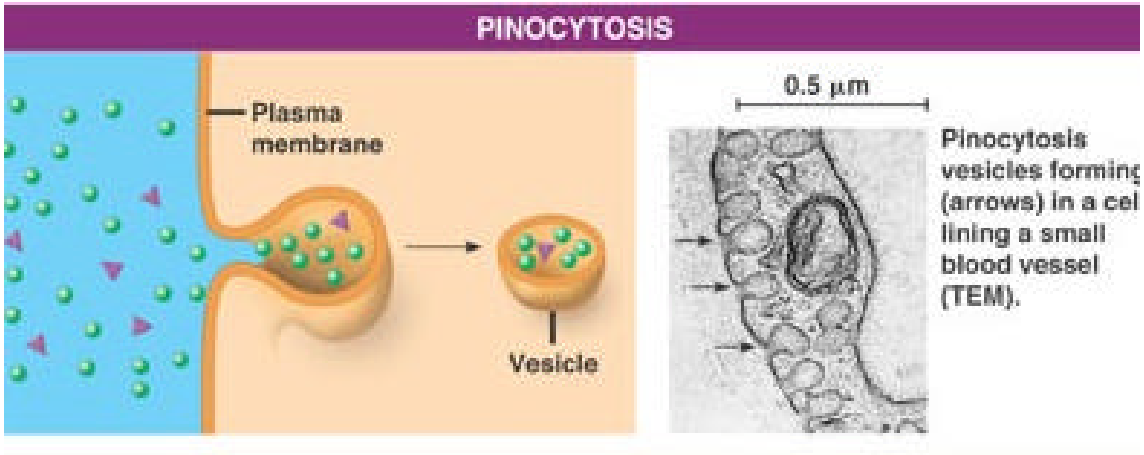




In phagocytosis ("cell eating"), a cell engulfs a particle or another cell through the emission of pseudopodia, and packs it into a vacuole. The contents of the vacuole is digested after the vacuole fuses with a lysosome

Phagocytosis of erythrocytes (Er) by blood macrophages (Ma).

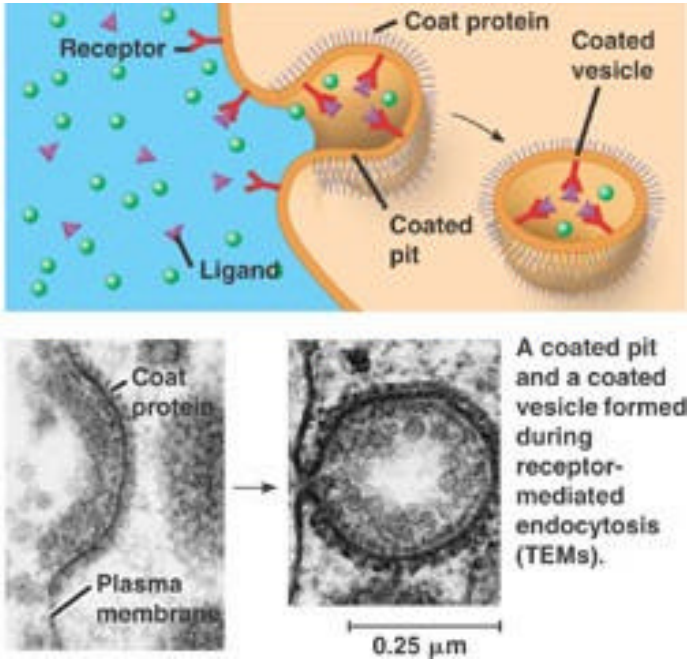
Types of Endocytosis: Pinocytosis



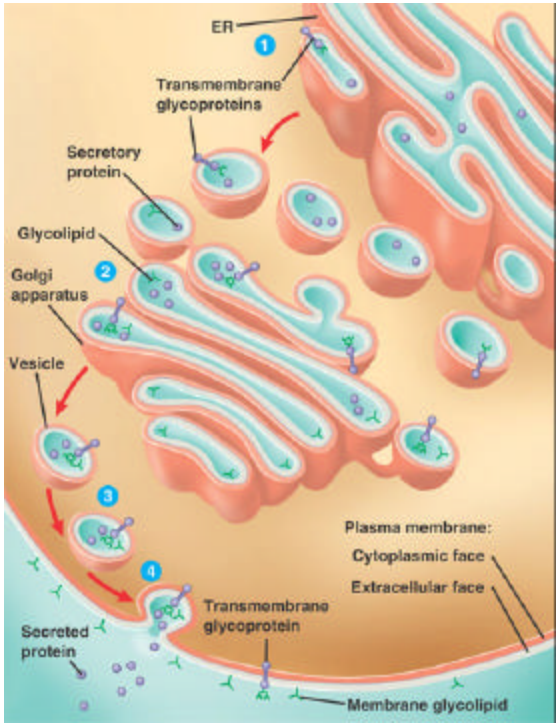
- In pinocytosis (“cell drinking”), the cell takes in droplets of extracellular fluid into small vesicles. Many molecules enter the cell dissolved in the droplets in a non-specific manner

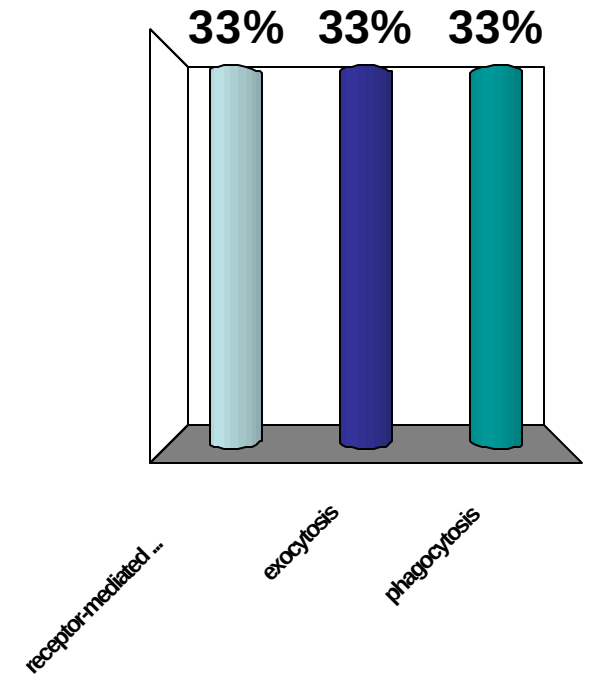
Types of Endocytosis: Receptor-Mediated Endocytosis

- Receptor-mediated endocytosis requires of specific receptor proteins located in the cell membrane. Cell receptors interact with the molecule to be transported into the cell through a *ligand* — a molecule that binds specifically to the receptor
- Receptor-mediated endocytosis is highly specific. Human cells use receptor-mediated endocytosis to take in cholesterol. Some viruses (i.e. HIV virus) enters the cell through receptor-mediated endocytosis
- Mutations in receptor proteins involved in receptor-mediated endocytosis usually block the entrance of substances meant to be transported by this process (i.e. natural HIV immunity, familial hypercholesterolemia)



The arrows point to a process of:





1. receptor-mediated endocytosis
2. exocytosis
3. phagocytosis

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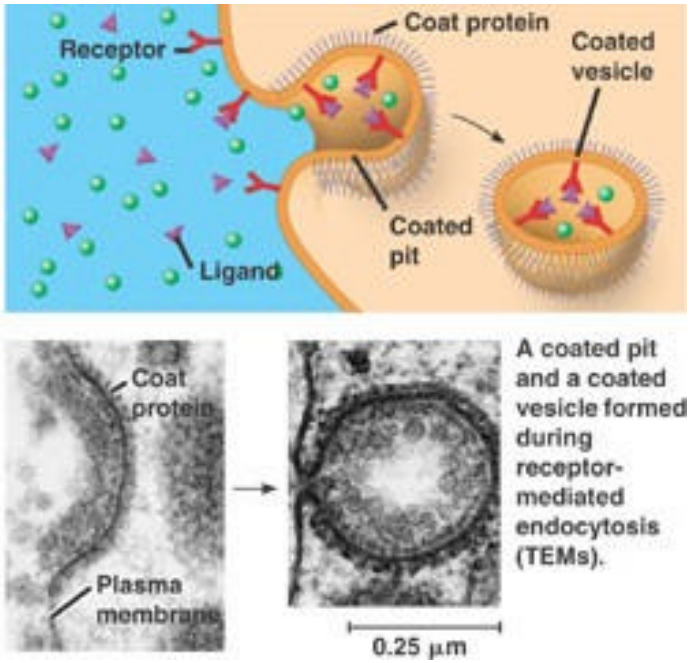

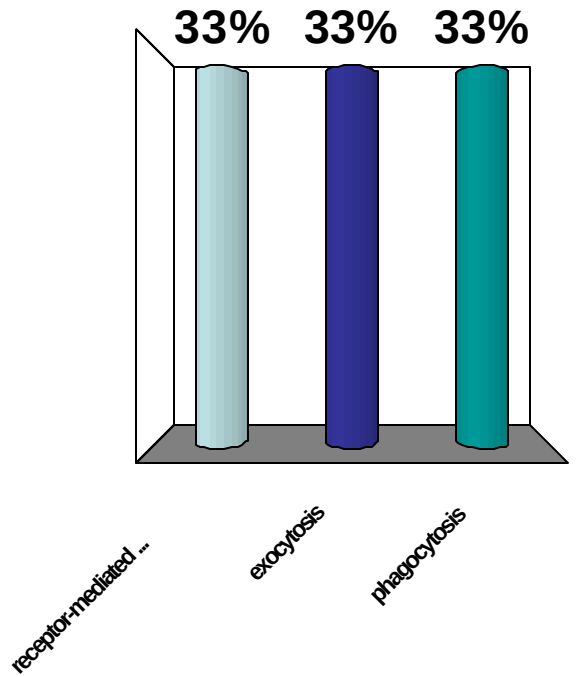

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