CELL MEMBRANE AND TRANSPORT

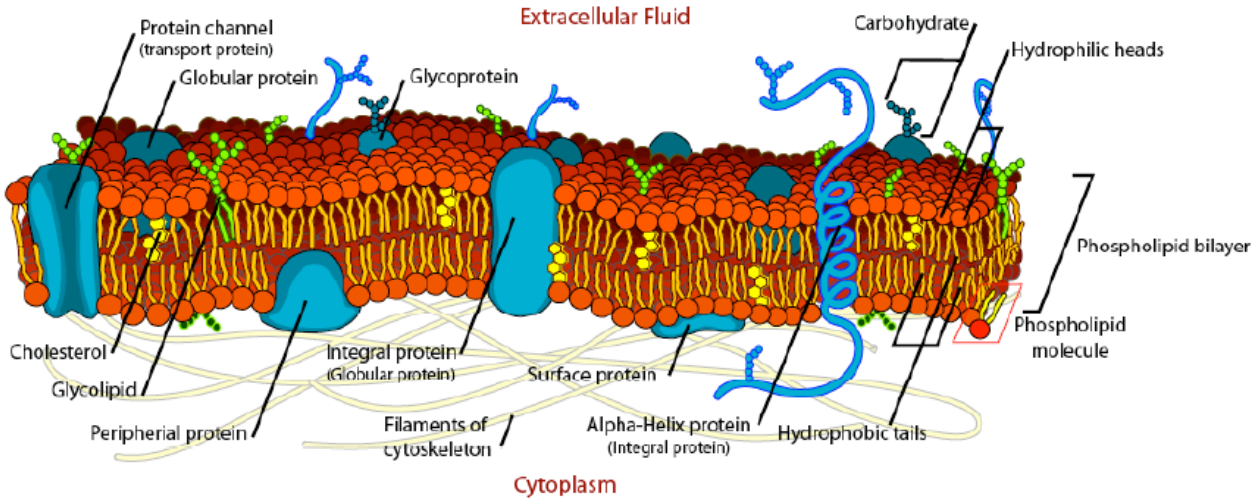
The cell membrane is the gateway into the cell, and must allow needed things such as nutrients into the cell without letting them escape. In the same way, it must allow wastes to leave the cell. A wide variety of molecules and ions must pass through the cell membrane -- large, small, hydrophobic, hydrophilic. Molecules of the same size must sorted out, and the cell must also be able to get large amounts of molecules in and out when necessary.

A. Plasma Membrane

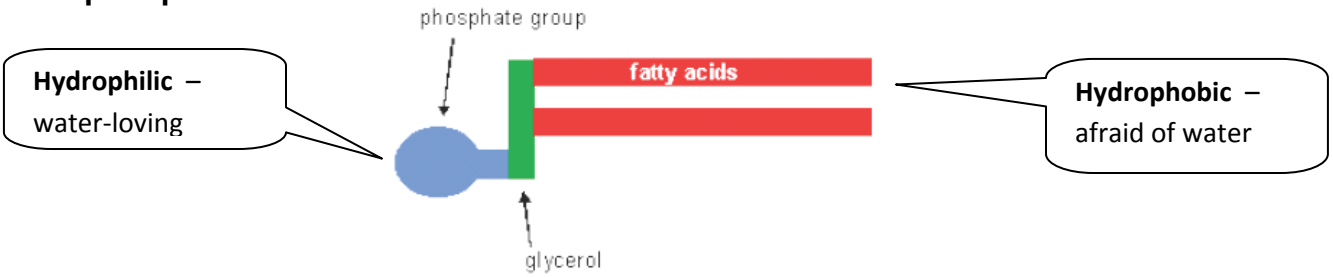
- surrounds the cell
- border between the living interior of the cell and the nonliving exterior.
- regulates movement of molecules in and out of the cell.

Membrane Structure

- The membranes of a cell are **phospholipid bilayers**
- numerous proteins embedded within bilayer
- Some proteins (integral protein) extend through the membrane; others (peripheral protein) do not.



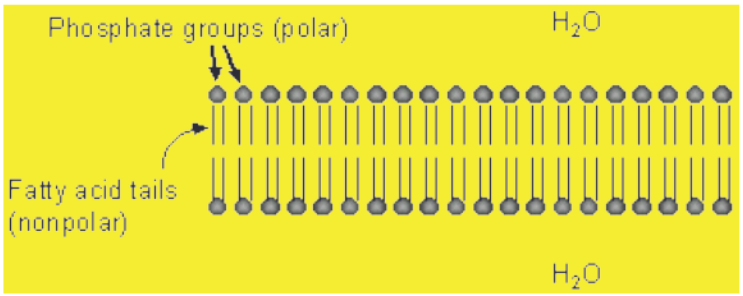
Phospholipids



- Most of the lipids in a membrane are phospholipids.
- Phospholipids contain glycerol, two fatty acids, and a phosphate group
- phosphate group is **polar** (***hydrophilic***)
- fatty acid tails are **non-polar** (***hydrophobic***)

Phospholipid Bilayers (2 layers of phospholipids)

Phospholipids spontaneously form a bilayer in a watery environment.



Bilayer arrangement enables non-polar fatty acid tails to remain together, avoiding water and polar phosphate groups are oriented toward the water.

- polar heads arrange themselves towards the **<u>water</u>**
- fatty acid tails orient themselves towards **<u>each other</u>** (away from water)
- generally, nonpolar molecules do not interact with polar molecules. This can be seen when oil (nonpolar)is mixed with water (polar).
- Polar molecules interact with other polar molecules and ions. For example table
- salt (ionic) dissolves in water (polar).

Flexibility

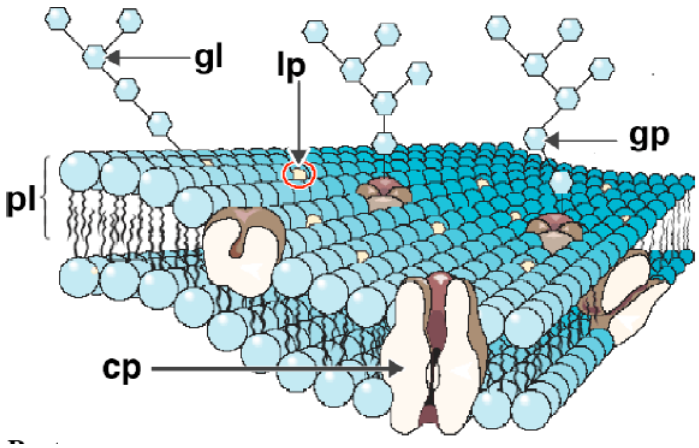
- fatty acid tails are flexible, causing the lipid bilayer to be fluid.
- This makes the cells flexible.
- At 37°C, membranes are a liquid similar to cooking oil in consistency.

Cholesterol

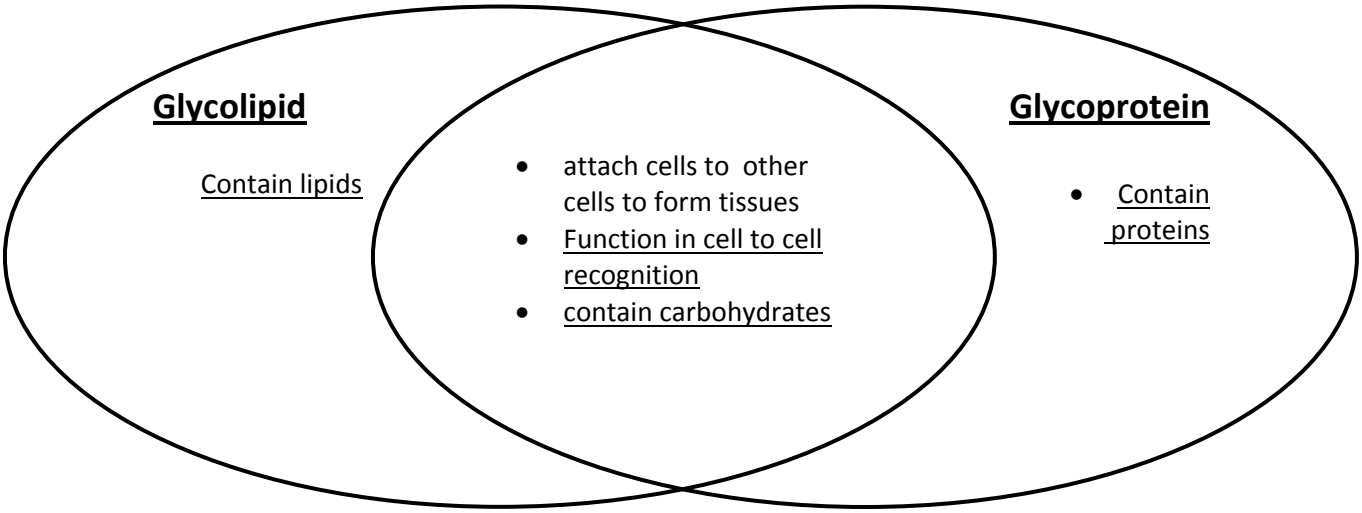
- In animals, cholesterol is a major membrane lipid.
- has a hydrophilic end and a hydrophobic end also.
- Cholesterol makes the membrane less permeable to most biological molecules.

Fluid Mosaic Model

- ***fluid*** **-** based on the changing location and pattern of protein molecules in a phospholipids bilayer
- ***mosaic*** **-** observed pattern lipid, protein and carbohydrate biomolecules.



Fill in the Venn Diagram (p. 68-70) (/4)



What are the 4 other type of integral proteins and what is their function? (p. 70)

1. **Channel protein** - allows a particular ion or molecule to freely cross the plasma membrane. No energy needed.
2. **Carrier protein** –specific molecules or ions pass across the plasma membrane. ATP needed.
3. **Receptor protein** – molecule binds to the protein → protein changes shape → causes a specific cellular response (change)
4. **Enzymatic protein** – catalyze a specific cellular reaction

(/4)

B. Membrane Transport Processes

1 Definitions

Diffusion- the migration of molecules or ions as a result of their own random movements, from a region of higher concentration to a region of lower concentration

Osmosis: the net movement of water molecules from the area of greater concentration to the area of lesser concentration **across a selectively-permeable membrane**. *a special case of diffusion*

Solute: particles which are dissolved in water

Solvent: liquid which dissolves the solute. This is water when we are talking about osmosis.

Solution: combination of solute and solvent.

Osmotic Pressure: the pressure due to the flow of water from the area of greater concentration to the area of lesser concentration. The greater the concentration differences across the membrane, the greater the osmotic pressure.

The rate of diffusion can be increased by...

1. increasing the temperature
2. increasing the concentration gradient
3. decreasing the size of the diffusing molecules

Why does it smell near the WC?

2. Tonicity

- Tonicity refers to the relative concentration of solute on either side of a membrane
- Comparison of [solute] of a cell to [solute] of its **surroundings**

Osmotic Effects (p.75)

i. Hypertonic Medium

- the medium has a **higher** concentration of solutes than the cell
- water flows **out** of the cell
- the cell **shrinks** as it loses water
- **plasmolysis or crenation (p.75)**

ii. Hypotonic Medium

- the medium has a **lower** concentration of solutes than the cell
- water flows **in** to the cell
- the cell **swells** as it gains water
- **cytolysis or turgor pressure**

iii. Isotonic Medium

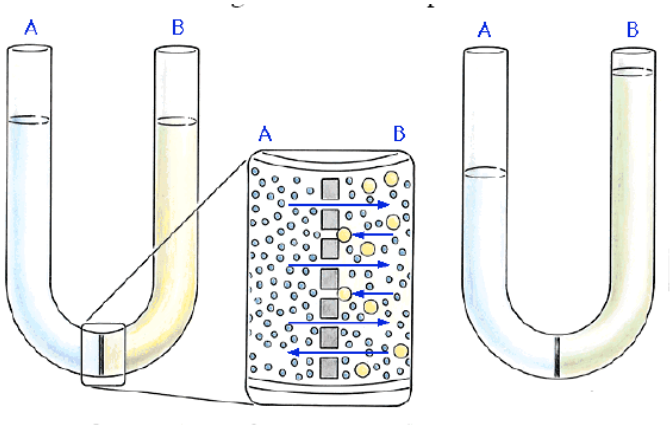
- solute concentration is **equal** to the cell
- movement of H_2O occurs BUT neither gains nor loses water
- the cell is *iso-osmotic* to the medium

Words you may know.
Isotope – **same** type of atom with a different mass
Hyperactive – **more** active than normal
Hypoglycemic – **lower** than normal level of blood glucose

How does the tonicity of the following examples compare to a human cell?

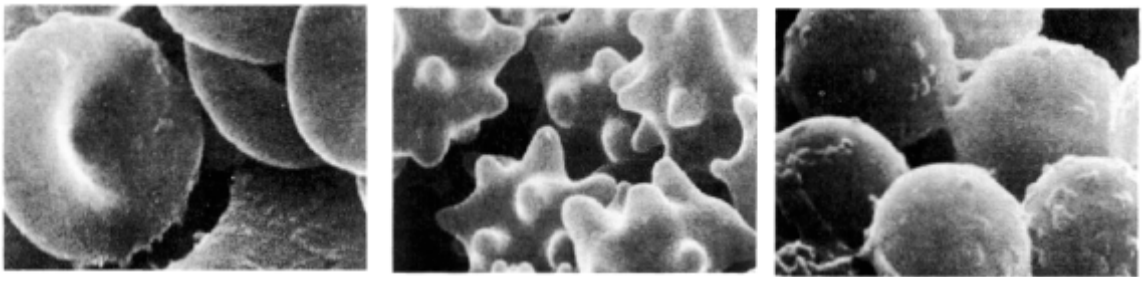
- fresh water → **hypotonic**
- blood → **isotonic**
- sea water → **hypertonic**

Question: Only water exists on the left side of the U tube. Use the words that you have learned and describe what is happening in the diagram? (/4)



- **B is hypertonic compared to A**
- **The solute molecules from B are too large to pass through the semi-permeable membrane**
- **Water moves from A to B by the process of osmosis**
- **From high concentration to low concentration**

The following pictures show red blood cells (p.249) in different solutions. What has caused these changes? (**Explain to your partner**)



3. Membranes are Differentially Permeable

- The plasma membrane is differentially or **selectively permeable**
- some particles can pass through, others cannot.
- It can control the extent to which certain substances pass through.
- Nonpolar molecules pass through cell membranes more readily than polar molecules
    - o center of the lipid bilayer is nonpolar
    - o does not readily interact with polar molecules

The following substances can pass through the cell membrane:

- Nonpolar molecules (example: lipids)
- steroids and alcohol are lipid soluble ∴ diffuse across membrane
- Small polar molecules such as water

The following substances cannot pass through a cell membrane without help:

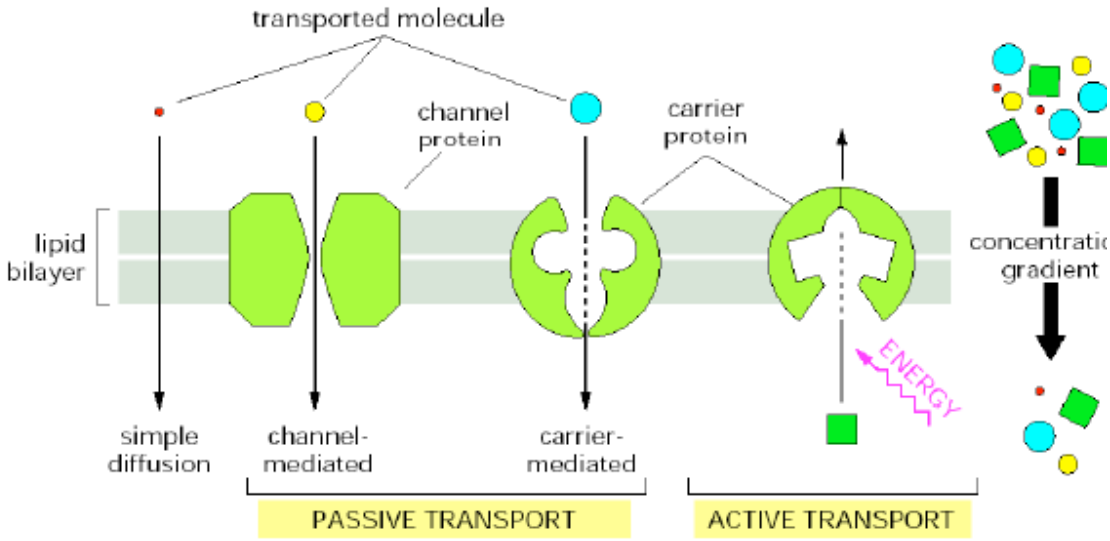
- Ions and charged molecules (example: salts dissolved in water) – *via porins/channels/carrier proteins*
- Large polar molecules (example: glucose)
- Macromolecules – *via endo/exocytosis*

4. Facilitated Transport

- transport of molecules across a cellular membrane via **specific protein channels**
- from a region of high conc. to a region of low conc. - does not require energy
- e.g., the cell membrane, composed of the phospholipids is impermeable to the passage of water…
- **Porins** – type of protein channels
    - o Porins are integral proteins
    - o Inside of porins are polar → allows movement of polar molecules and ions
    - o It is believed water (lipid insoluble) diffuses via porins

5. "Active Transport" - Against the Gradient

- from a region of lower conc. to one of higher conc.
- requires energy →ATP
- the pumping of molecules or ions across a cellular membrane thru a **carrier protein**
- **Na/K pump (p.77) –** necessary for fthe function of nerve and muscle cells

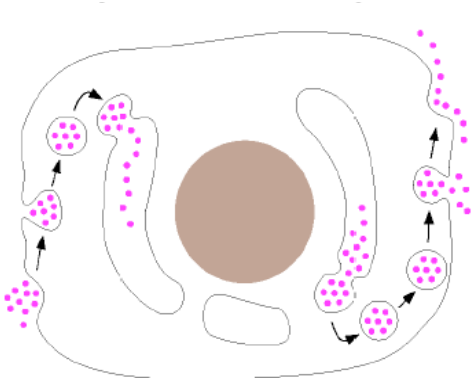


C. Transport by Vesicle Formation

- ATP needed ∴ **active transport**

1. Endocytosis

- material is engulfed by the plasma membrane and deposited in the cytoplasm in pockets that are "pinched off" as vesicles toward the interior of the cell
- the vesicle is then digested by the cell
- two types

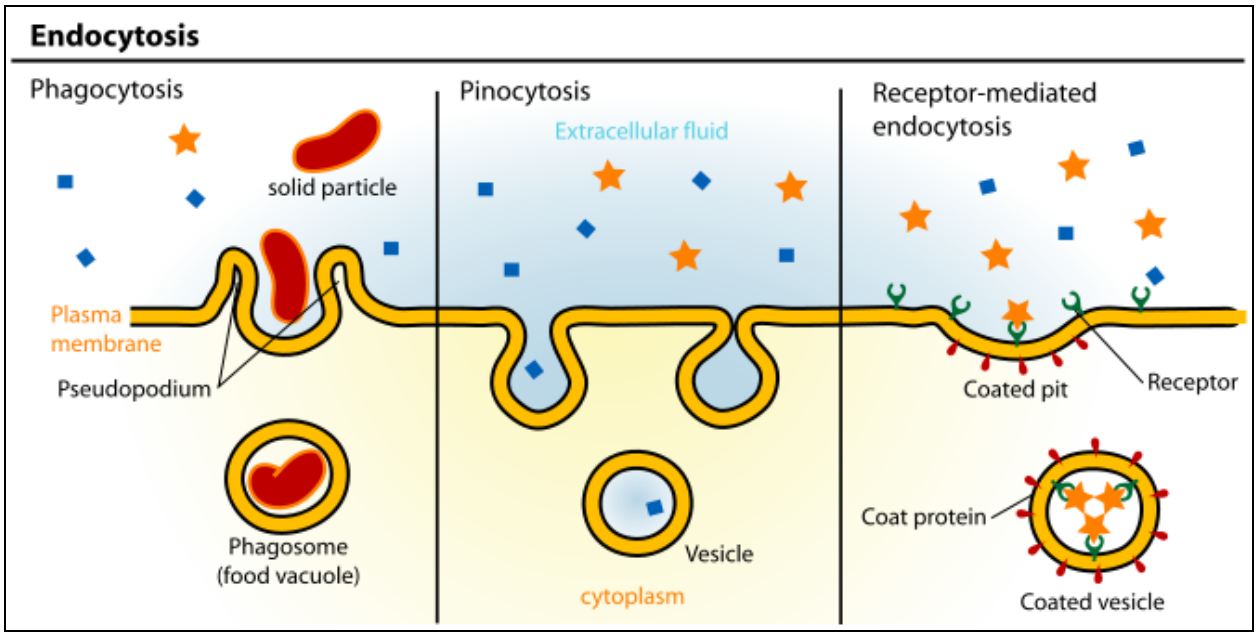


i. Pinocytosis

- Greek "**drink** cell"
- cell takes in **dissolved** material
- includes receptor mediated endocytosis

ii. Phagocytosis

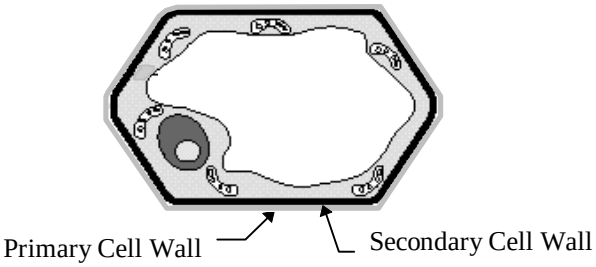
- Greek "**eat** cell"
- cell takes in **solids**
- basically large particulate matter is tightly enclosed by the membrane bound arm of cytoplasm, and most extracellular fluid is excluded, e.g., amoebae eating a paramecium



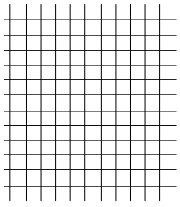
2. Exocytosis

- like endocytosis but direction is **<u>out</u>** of cell
- important in excretion and secretion by cells

D. Plant Cell Wall



- plants have cell walls in addition to cell membranescell
- wall lies outside the cell membrane.
- *Note: bacteria have cell walls too, but bacterial cell walls are NOT the same in composition as plant cell walls.*
- primary cell wall is outermost layer, composed of threadlike cellulose microfibrils.
- sticky substance called middle lamella binds cells together
- woody plants also have a secondary cell wall which forms inside the primary wall.
    - Composed of alternating layers of cellulose microfibrils reinforced with lignin (which adds strength).
    - Function is support of large plants.
    - Wood is made largely of secondary cell wall material.
- Cellulose of plant cell walls used by humans: cotton, rayon, flax, hemp, paper, wood, paper (paper has lignin removed to prevent yellowing). Lignin used in manufacture of rubber, plastics, pigments, adhesives.
- plant cell wall is FREELY PERMEABLE (anything small enough to fit through openings in cellulose microfibrils will get through).
- Plant cell therefore relies instead on its cell membrane to regulate what gets in and out.


Cellulose Microfibrils