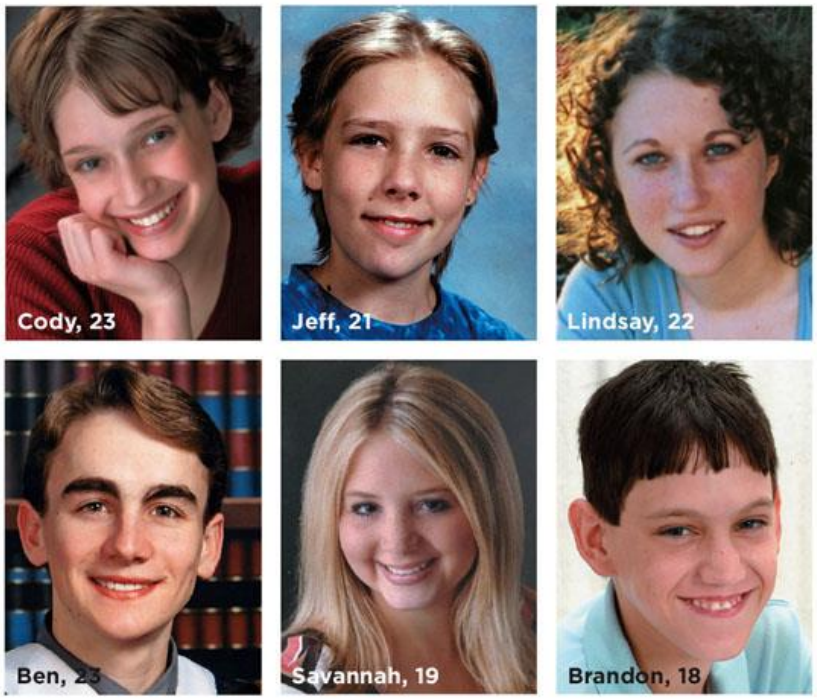
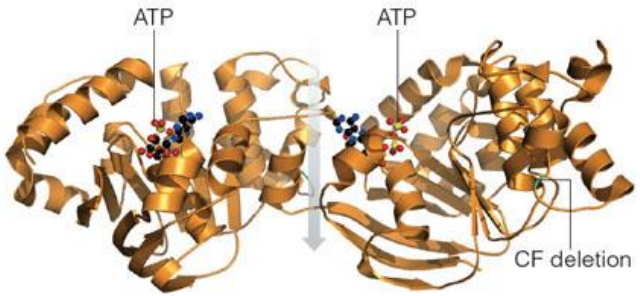
CHAPTER 5 – A CLOSER LOOK AT CELL MEMBRANES

Impacts, Issues:

One Bad Transporter and Cystic Fibrosis

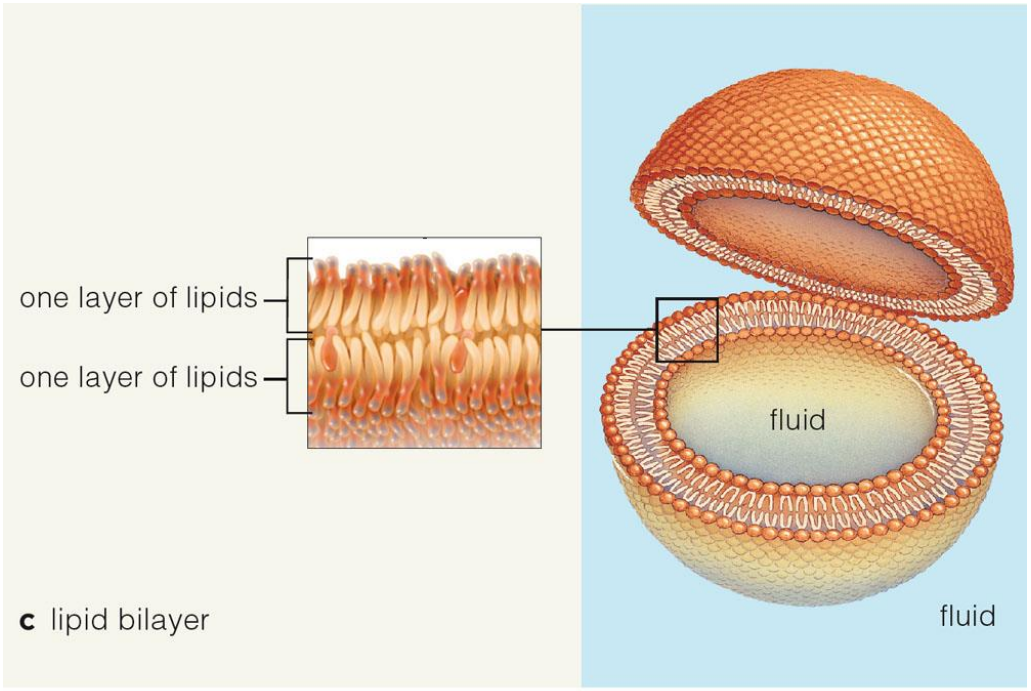
- Transporter proteins regulate the movement of substances in and out of cells; failure of one of these proteins causes cystic fibrosis
- Cause of Cystic Fibrosis Video Living with CF

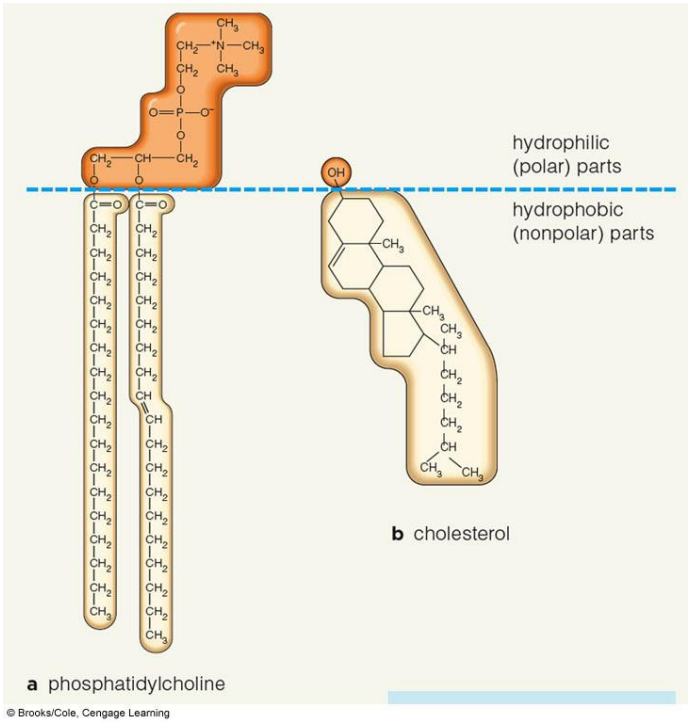




5.1 Organization of Cell Membranes

- Cell membranes
  - Lipid bilayer with many embedded proteins
  - Continuous, selectively permeable barrier





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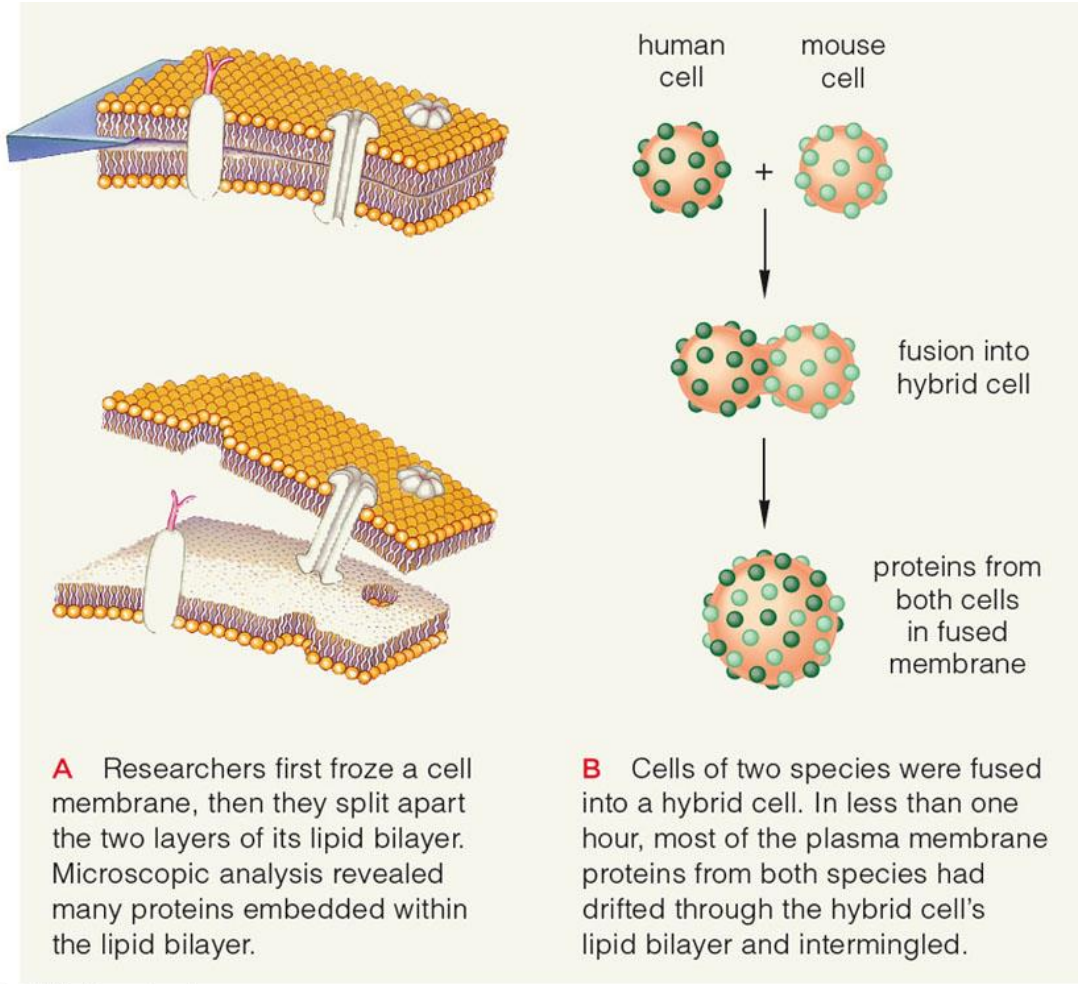
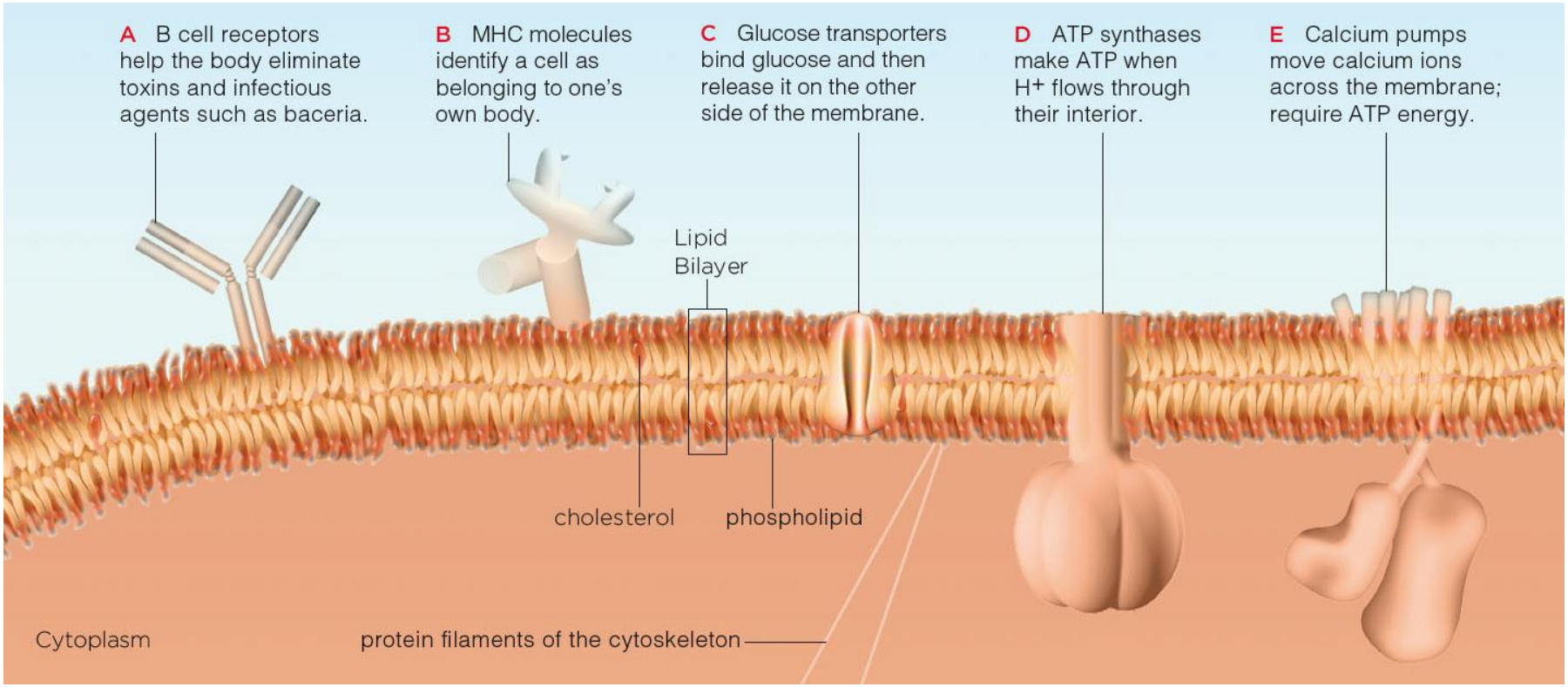
Fluid Mosaic Model

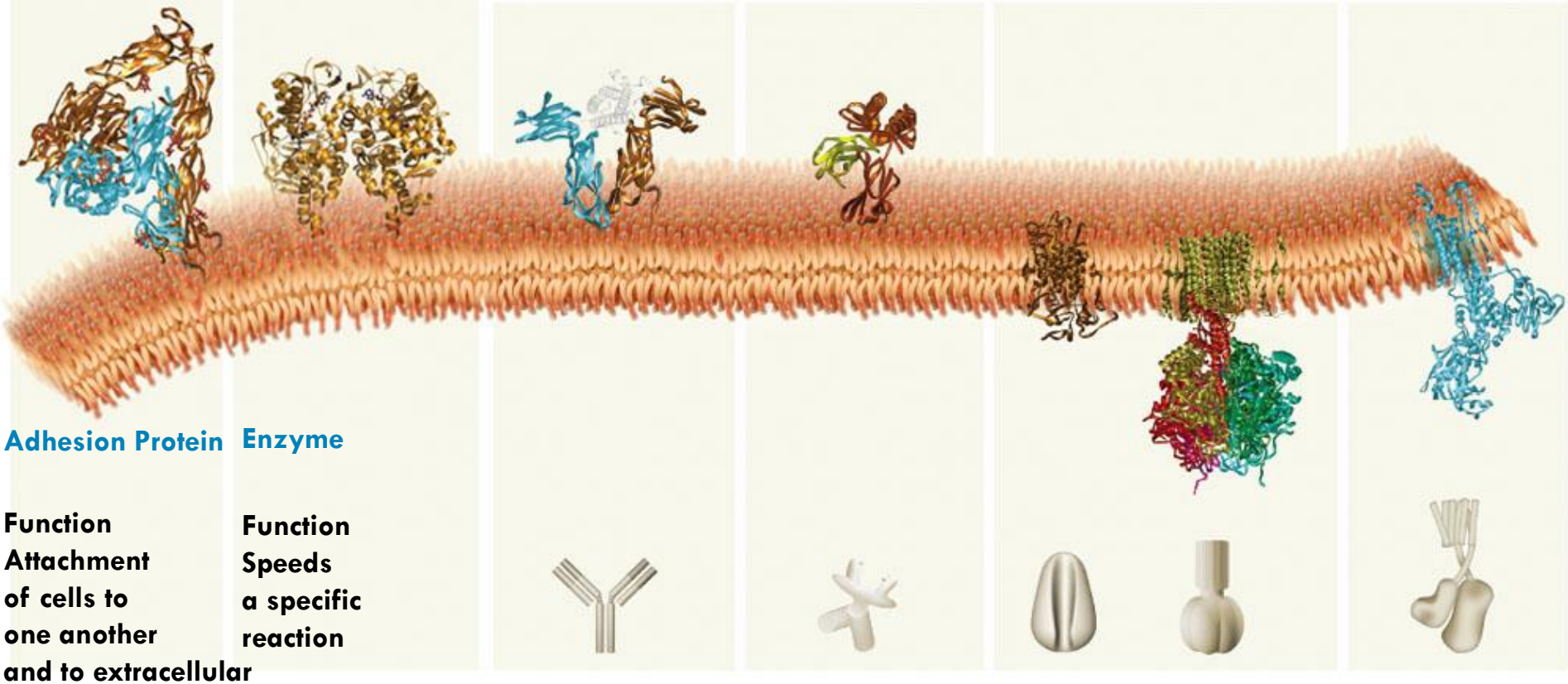
- **Fluid mosaic model**
  - Phospholipids drift and move like a fluid
  - The bilayer is a mosaic mixture of phospholipids, steroids, proteins, and other molecules



Membrane Proteins

- Each type of protein in a membrane has a special function
  - **Adhesion proteins, Recognition proteins, Receptor proteins, Enzymes, Transport proteins (active and passive)**





Adhesion Protein

Function
Attachment of cells to one another and to extracellular matrix

Occurs only on plasma membranes

Membrane Attachment Integral

Enzyme

Function
Speeds a specific reaction

Membranes provide a relatively stable reaction site for enzymes, particularly those that work in series with other molecules.

Receptor Protein

Function Binding signal- ing molecules

Binding causes a change in cell activity, such as gene expression, metabolism, movement, adhesion, division, or cell death.

Recognition Protein

Function Ident-ifier of cell type, individual, or species

Membrane Attachment Integral

Passive Transporter

Function Transport of molecules or ions

Does not require energy

Membrane Attachment Integral

Active Transporter

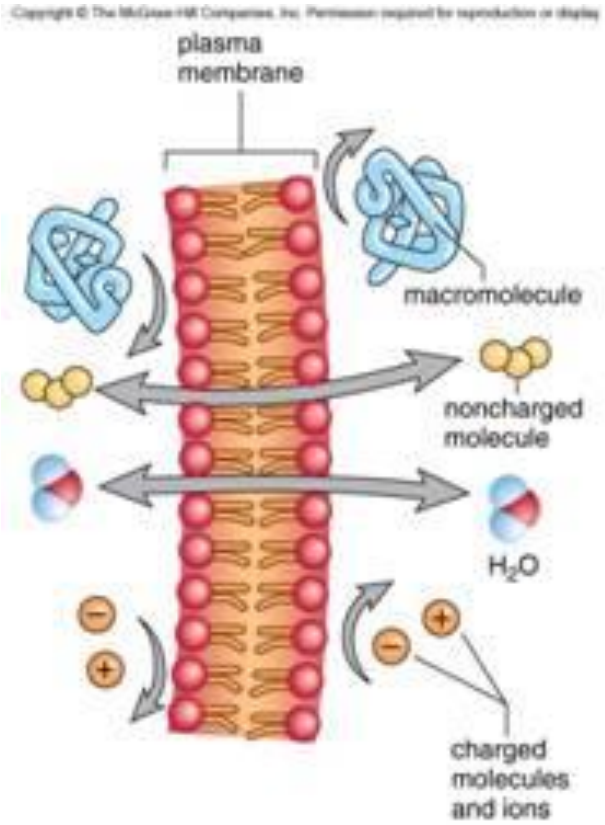
Function Transport of molecules or ions

Membrane Attachment Integral

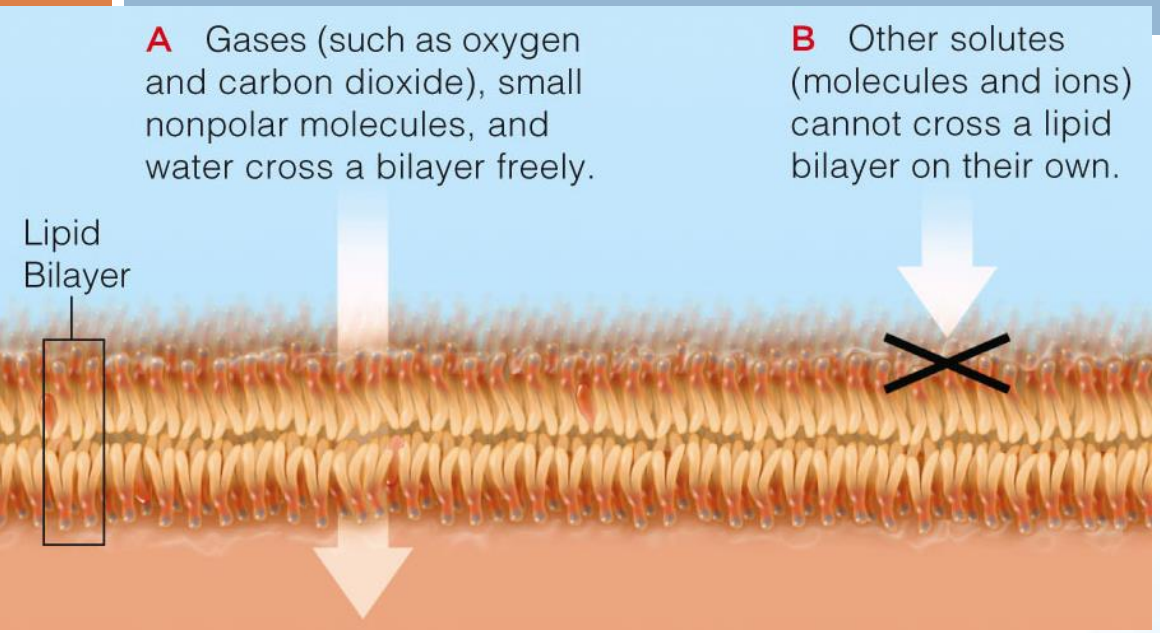
Fig. 5-5, pp. 80-81

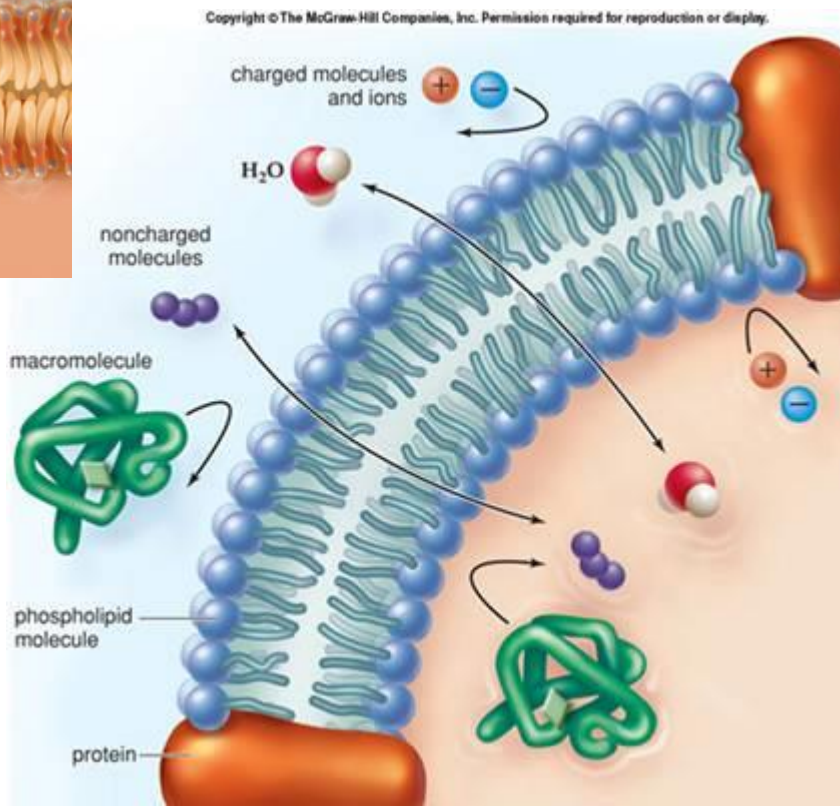
5.3 Diffusion, Membranes, and Metabolism

- **Selective permeability**
  - Cell membranes control which substances and how much of them enter or leave the cell
  - Allows the cell to maintain a difference between its internal environment and extracellular fluid
  - Supplies the cell with nutrients, removes wastes, and maintains volume and pH



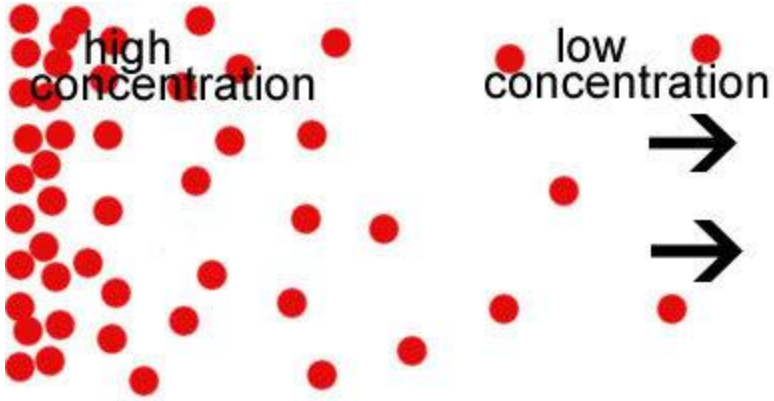
What molecules cross a membrane?





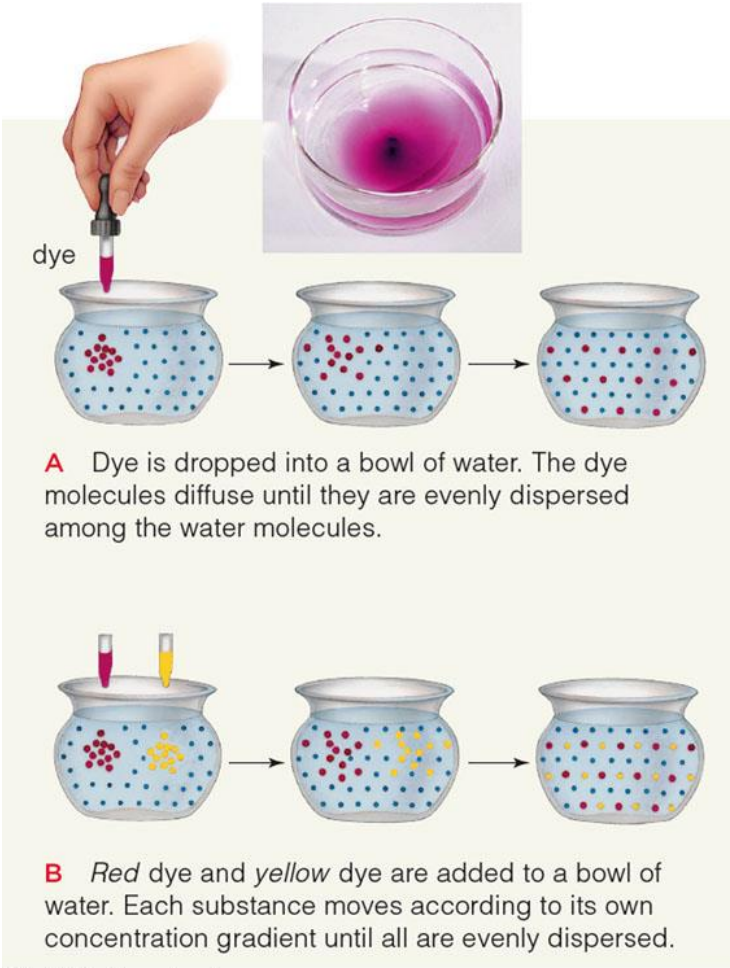
Concentration gradient

- **Concentration =** The number of molecules (or ions) of substance per unit volume of fluid
- **Concentration gradient =** The difference in concentration between two adjacent regions



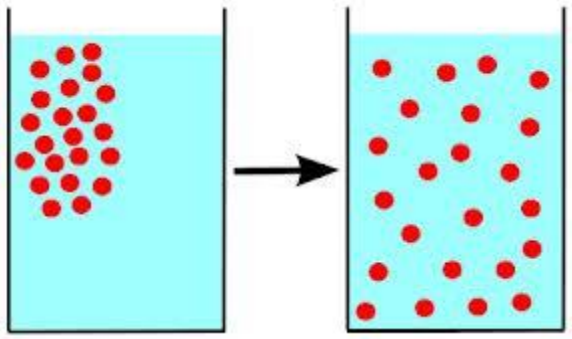
Diffusion – HIGH to LOW

- **Diffusion**
  - The net movement of molecules down a concentration gradient (from high to low concentration)
  - Moves substances into, through, and out of cells
  - A substance diffuses in a direction set by its own concentration gradient, not by the gradients of other solutes around it



The rate of diffusion

- Rate of diffusion depends on five factors
  - Size – smaller = faster
  - Temperature – hotter = faster
  - Steepness of the concentration gradient – steeper gradient = more collisions = faster diffusion
  - Charge – difference in charge = faster
  - Pressure – increase = faster

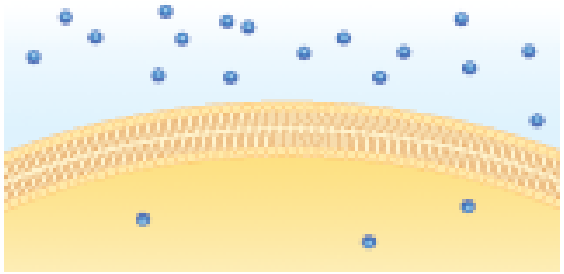


5.4 Passive vs. Active Transport

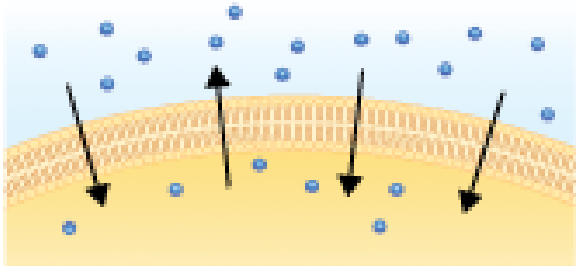
- Yikes…..your book uses terminology that is….almost correct.
- DO NOT READ pg 84 on passive transport in YOUR BOOK – IT WILL CONFUSE YOU!!!

Cell Transport

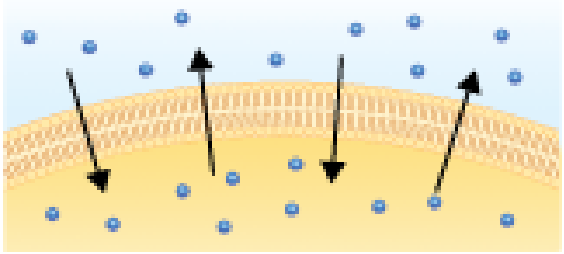
- Passive Transport = The movement of materials across the cell membrane without using cellular energy is called passive transport.
  - Diffusion - The process by which particles move from an area of high concentration to an area of lower concentration
  - Osmosis –the diffusion of water through a selectively permeable membrane



There is a higher concentration of solute on one side of the membrane than on the other.



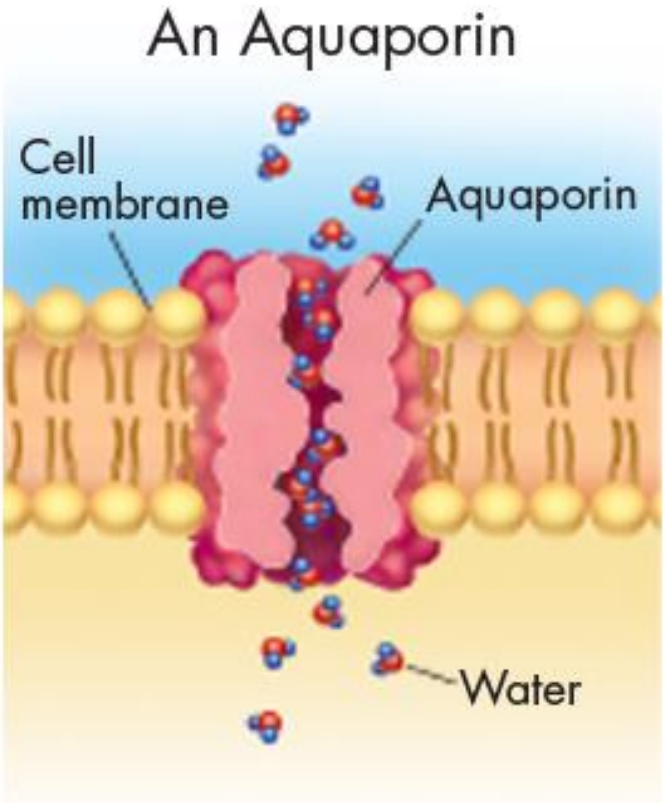
Diffusion causes a net movement of solute particles from the side of the membrane with the higher solute concentration to the side with the lower solute concentration.



Once equilibrium is reached, solute particles continue to diffuse across the membrane in both directions but at approximately equal rates, so there is no net change in solute concentration.

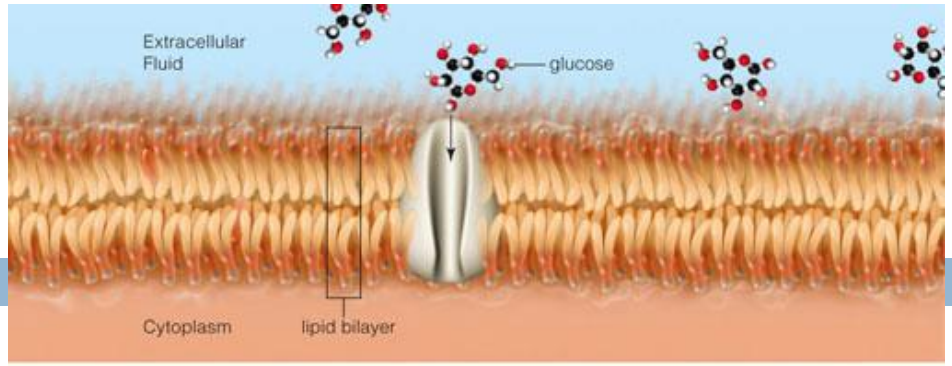
Passive Transport Cont.

- Facilitated Diffusion – the process where molecules that cannot directly diffuse across the membrane pass through special protein channels

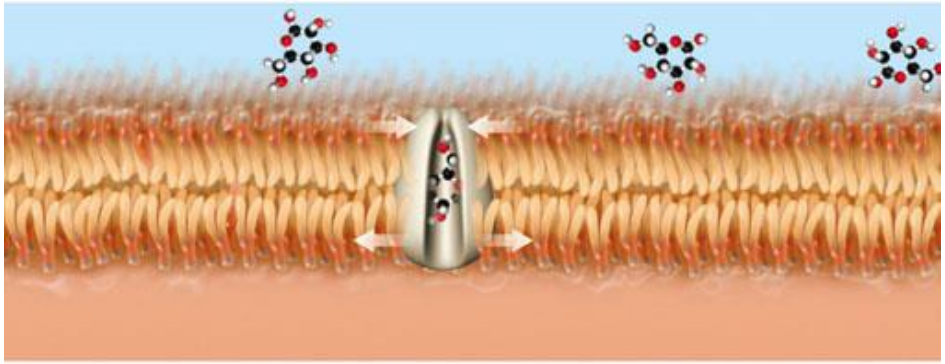


Facilitated Diffusion

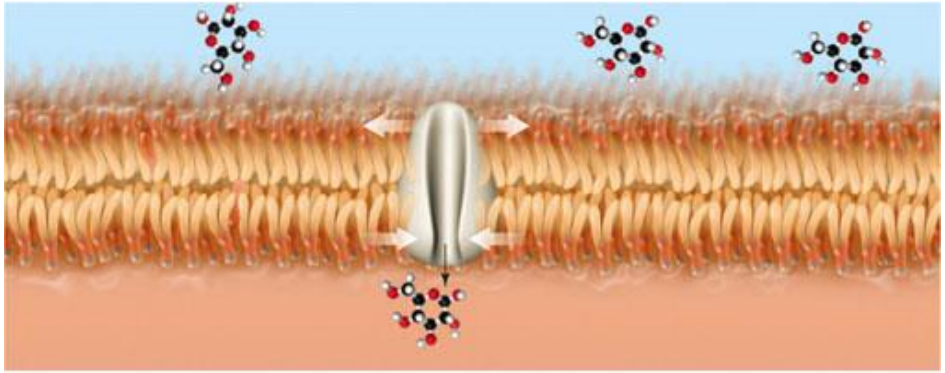
- Glucose



A A glucose molecule (here, in extracellular fluid) binds to a transport protein embedded in the lipid bilayer.



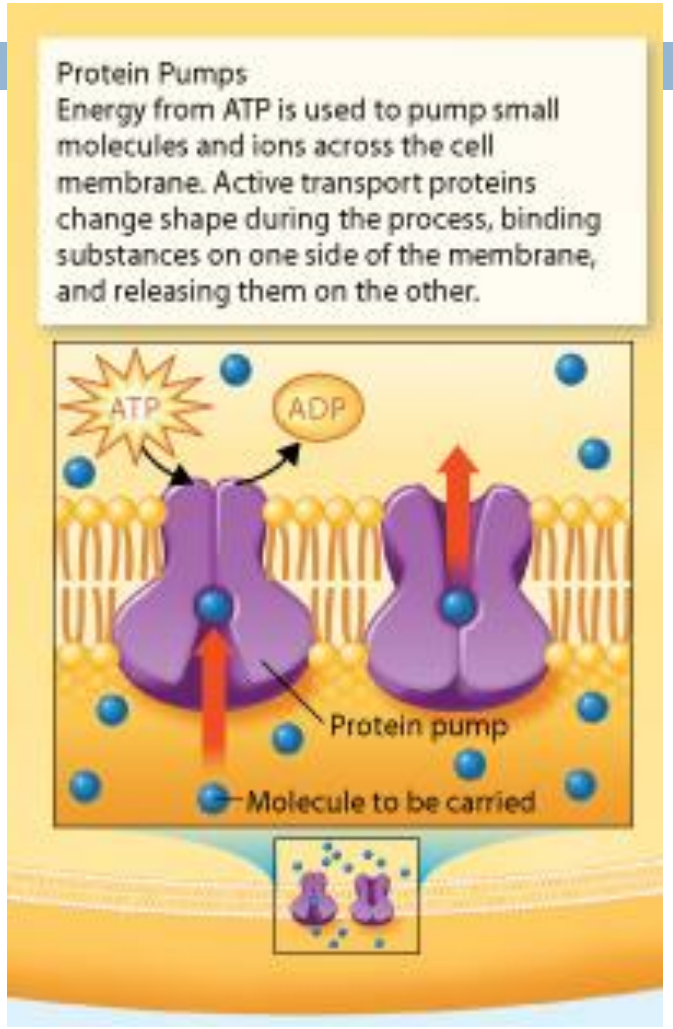
B Binding causes the protein to change shape.



C The glucose molecule detaches from the transport protein on the other side of the membrane (here, in the cytoplasm), and the protein resumes its original shape.

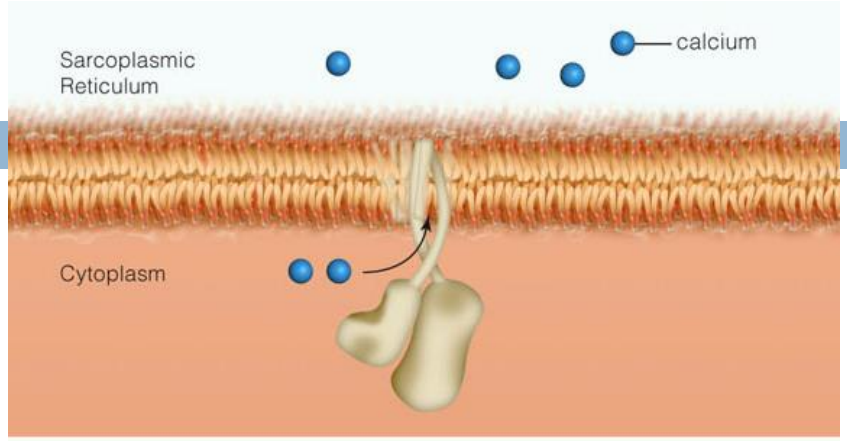
Active Transport

- **Active transport**
  - Requires energy input (usually ATP)
  - Moves a solute against its concentration gradient (low to high)

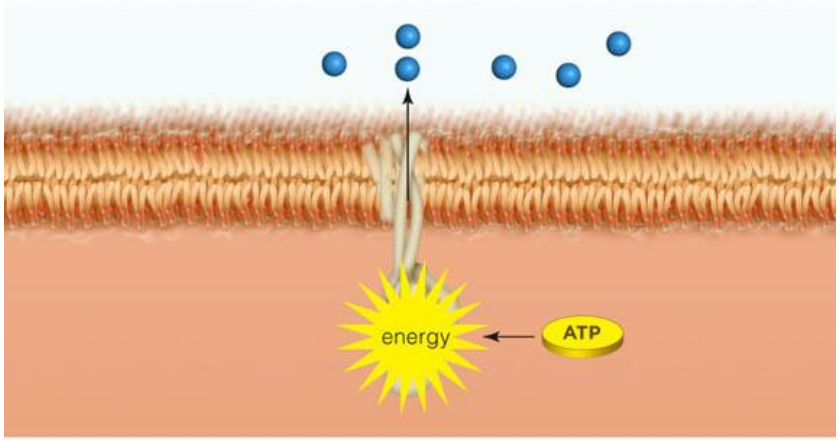


Active Transport

- **Calcium pumps**
  - Move calcium ions across muscle cell membranes into the sarcoplasmic reticulum (surrounds muscle fibers)
  - Ca ions from sarcoplasmic reticulum to cell cause contractions
  - Contraction ends when Ca is actively pumped back out of the cell.
  - Concentration of Ca outside the cell is over 1,000x greater than in cytoplasm



A Calcium ions bind to a calcium transporter (calcium pump).



B A phosphate group is transferred from ATP to the pump. The pump changes shape so that it ejects the calcium ions to the opposite side of the membrane, and then resumes its original shape.

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Cotransporter

- **Cotransporter**
  - An active transport protein that moves two substances across a membrane at the same time
    - *Example:* The sodium-potassium pump moves Na^+ out of the cell and K^+ into the cell

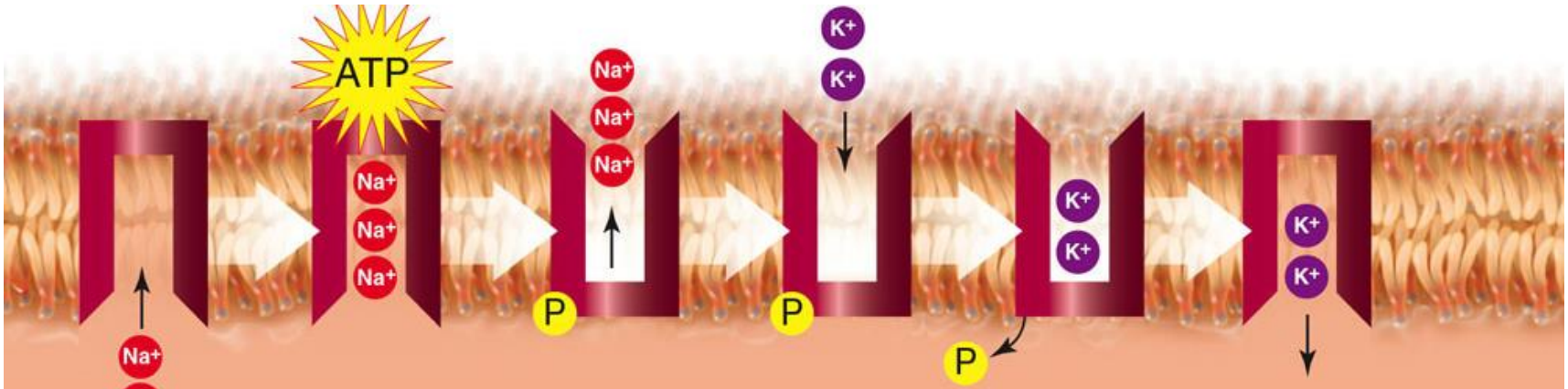


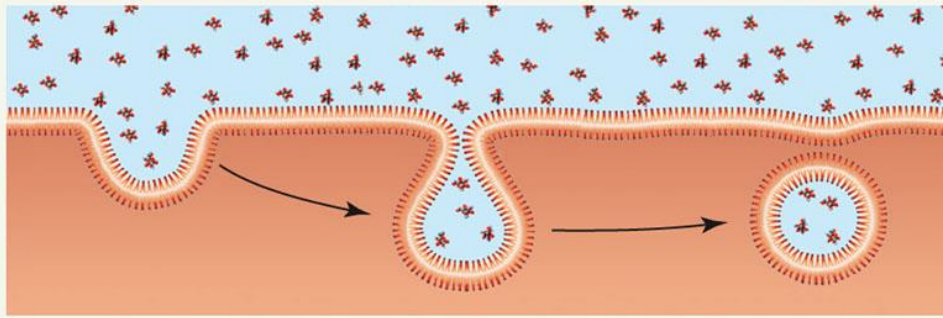
Figure 5.11 Cotransport. This model shows how a sodium–potassium pump transports sodium ions (Na^+, *red*) from the cytoplasm to the extracellular fluid, and potassium ions (K^+, *purple*) in the other direction across the plasma membrane. A phosphate group transfer from ATP provides energy for the transport.

For your info!!!

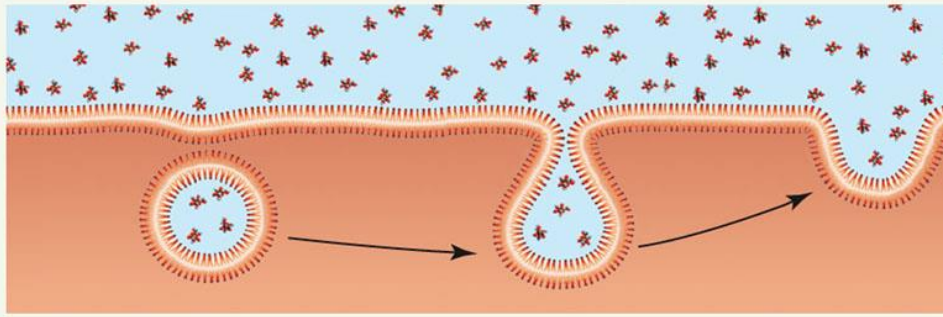
- Oh no! Too much sodium in your cells –
  - Swelling
  - Heart failure, lung problems
  - High blood pressure
- Oh no! Too much potassium –
  - Stops your heart….

5.5 Membrane Trafficking

- **Exocytosis (Exit)**
  - The fusion of a vesicle with the cell membrane, releasing its contents to the surroundings
- **Endocytosis (Enter)**
  - The formation of a vesicle from cell membrane, enclosing materials near the cell surface and bringing them into the cell



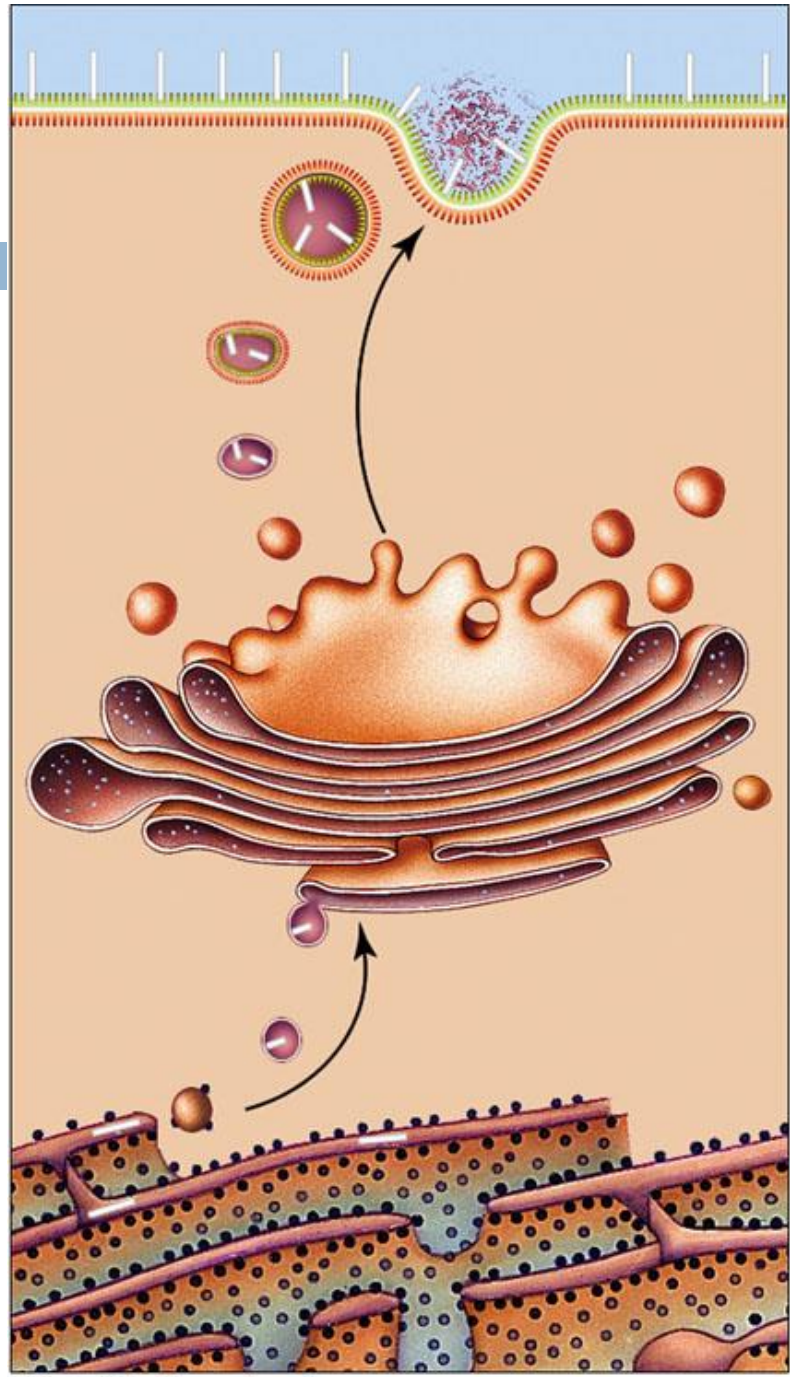
D **Endocytosis** Vesicle movement brings substances in bulk into cell.



E **Exocytosis** Vesicle movement ejects substances in bulk from cell.

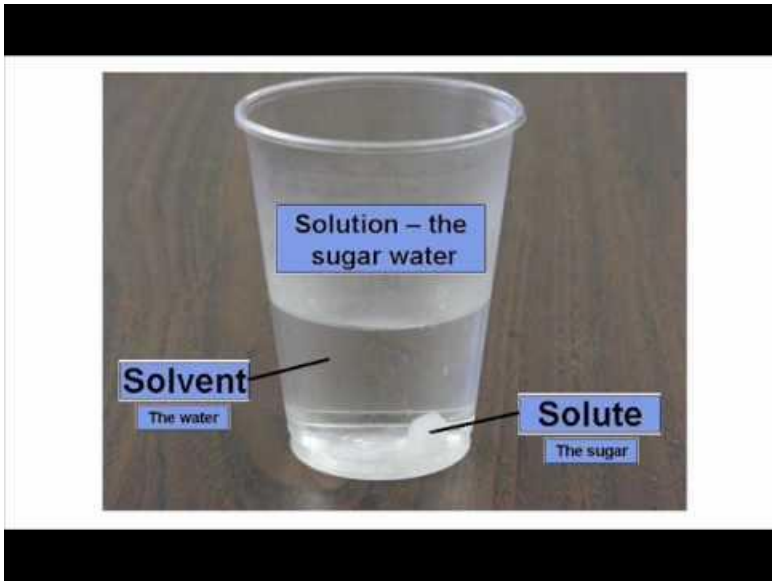
Membrane Cycling

- Exocytosis and endocytosis continually replace and withdraw patches of the plasma membrane
- New membrane proteins and lipids are made in the ER, modified in Golgi bodies, and form vesicles that fuse with plasma membrane



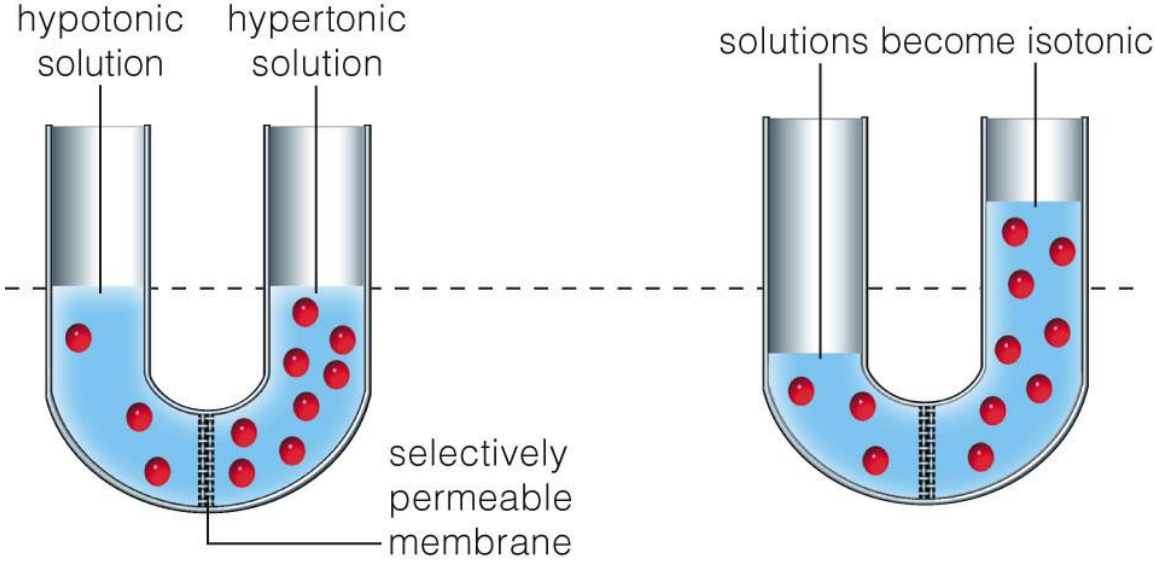
5.6 Which way will water move?

- **Osmosis**
  - The diffusion of water through a selectively permeable membrane
- Solute = the substance being dissolved
- Solvent = the substance doing the dissolving

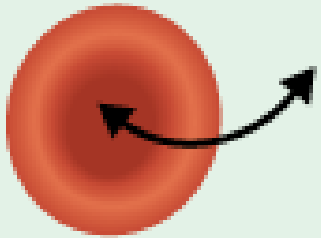
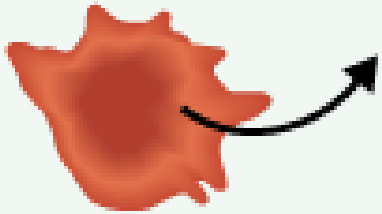
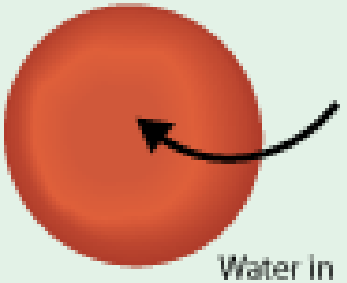
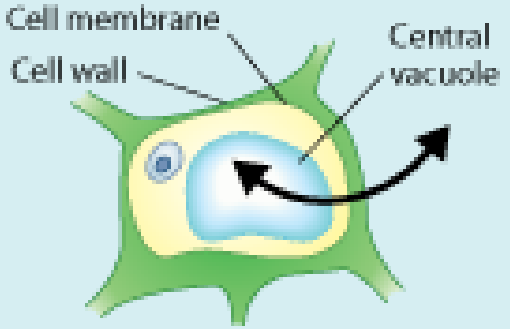
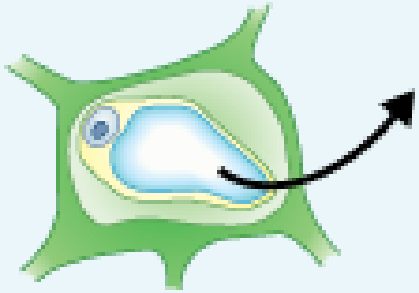
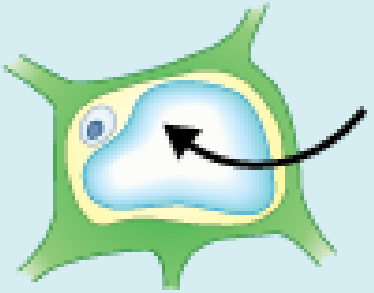


Tonicity

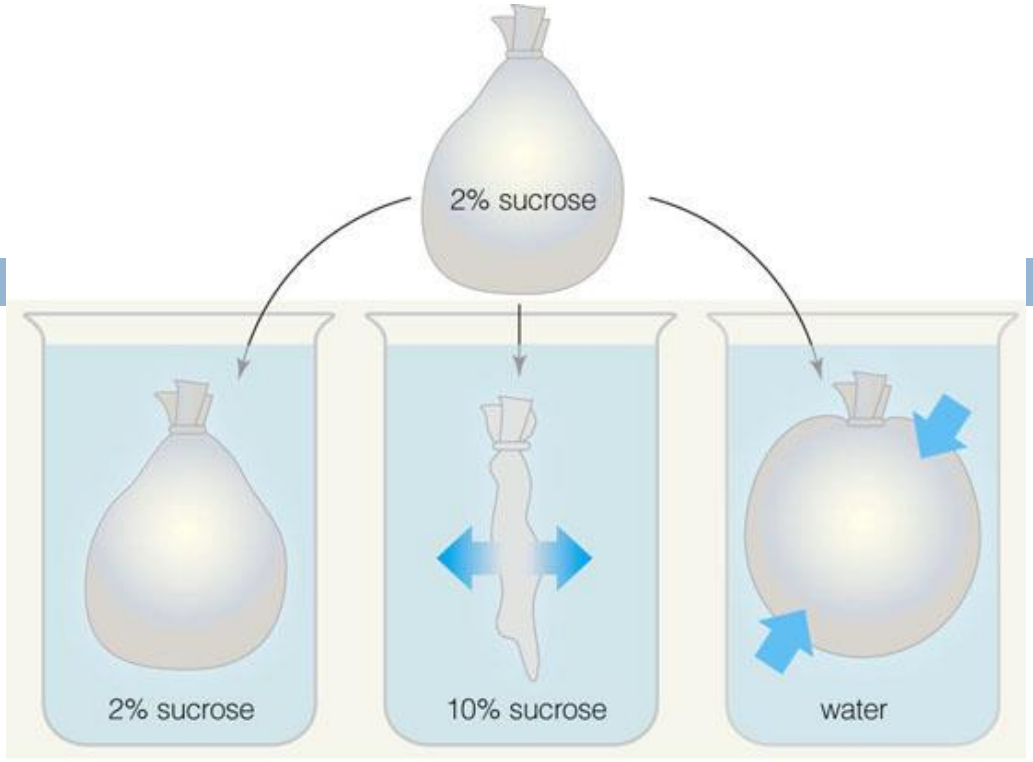
- The relative concentrations of solutes in two fluids separated by a selectively permeable membrane
  - Isotonic = the concentration is the same on both sides of the membrane
  - Hypertonic = The more concentrated solution (higher solute
  - Hypotonic = The dilute solution (lower solute)



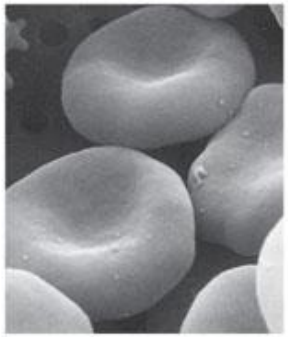
The Effects of Osmosis on Cells

Solution	Isotonic: The concentration of solutes is the same inside and outside the cell. Water molecules move equally in both directions.	Hypertonic: The solution has a higher solute concentration than the cell. A net movement of water molecules out of the cell causes it to shrink.	Hypotonic: The solution has a lower solute concentration than the cell. A net movement of water molecules into the cell causes it to swell.
Animal Cell	 Water in and out	 Water out	 Water in
Plant Cell	 Water in and out	 Water out	 Water in

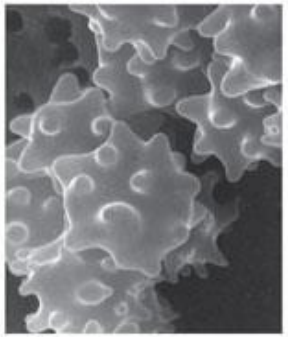
More with tonicity



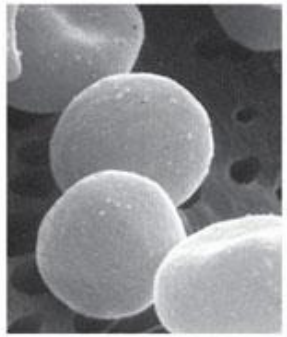
A What happens to a semipermeable membrane bag when it is immersed in an isotonic, a hypertonic, or a hypotonic solution?



B Red blood cells in an isotonic solution do not change in volume.



C Red blood cells in a hypertonic solution shrivel because water diffuses out of them.



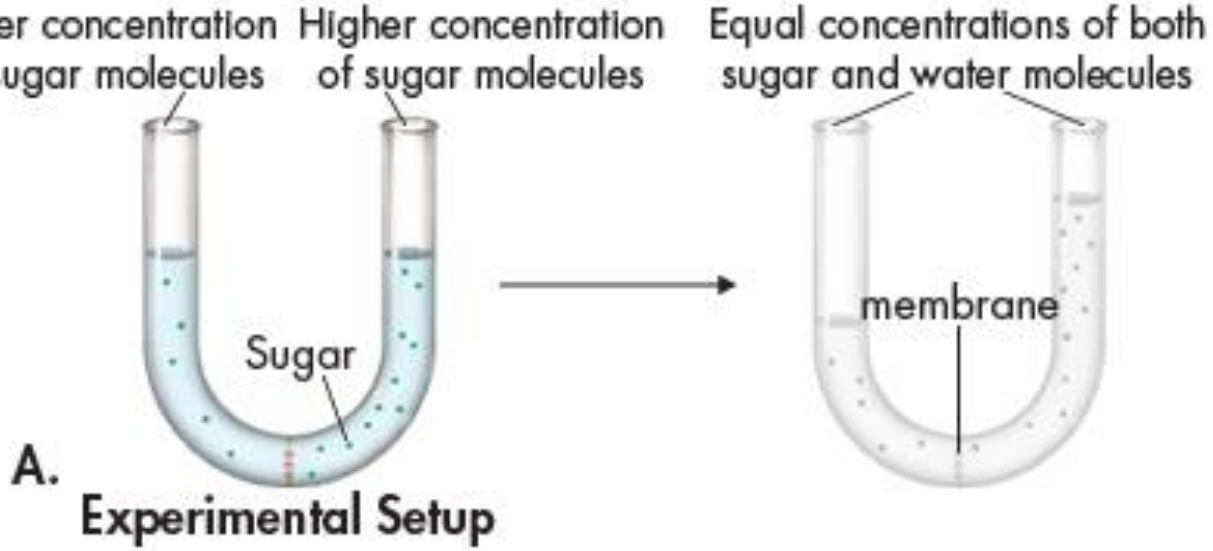
D Red blood cells in a hypotonic solution swell because water diffuses into them.

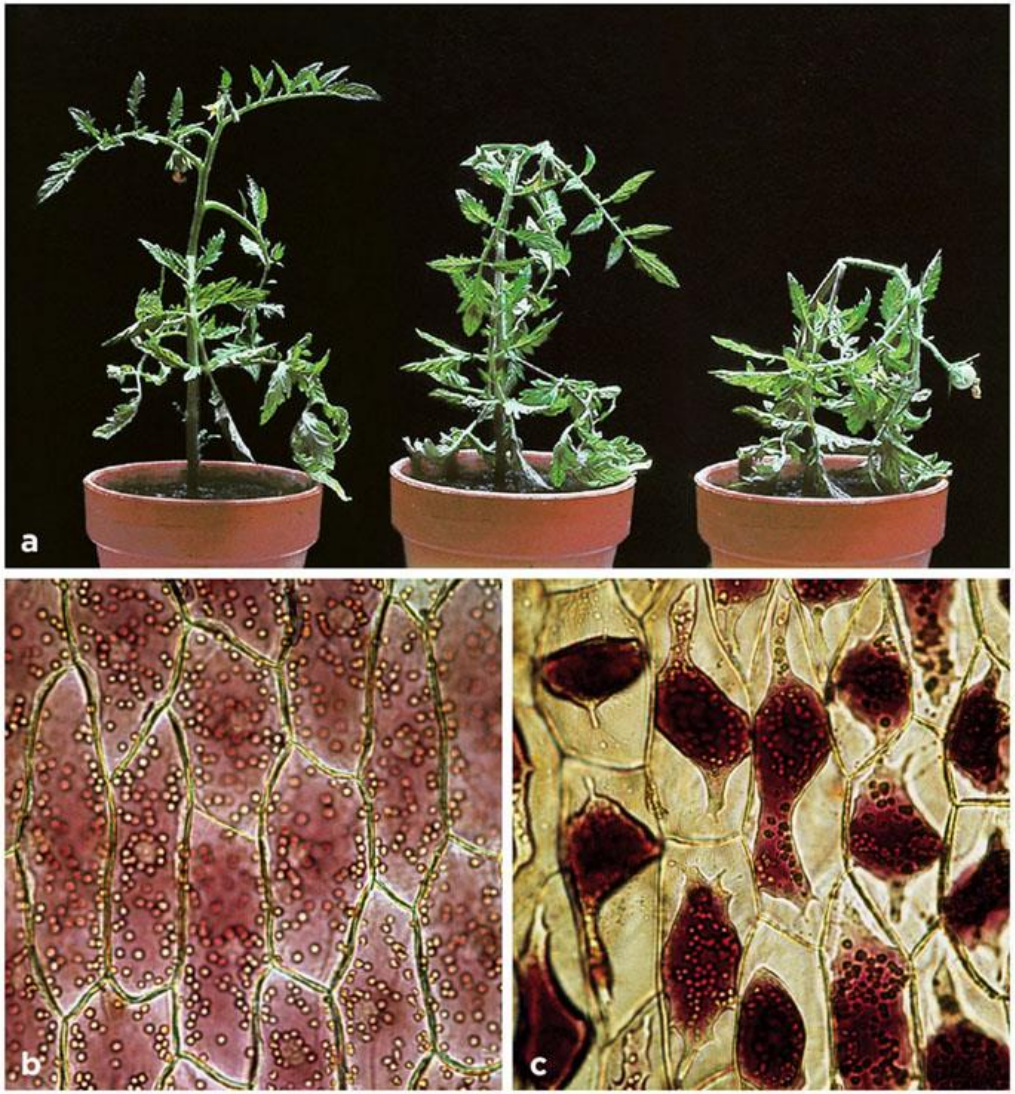
Plasmolysis and Cytolysis

- Plasmolysis = the cell membrane separates from the cell wall in a plant cell
  - (when a cell is placed in a hypertonic solution)
  - Elodea Plasmolysis
- Cytolysis = a cell bursts from being placed in a hypotonic solution
  - Red Blood Cells (:35)

Pressure

- **Hydrostatic pressure (turgor) =** The pressure exerted by a volume of fluid against a structure (membrane, tube, or cell wall) which resists volume change
- **Osmotic pressure =** The amount of hydrostatic pressure that can stop water from diffusing into cytoplasmic fluid or other hypertonic solutions





Why science teachers should not be given playground duty.

White board questions!

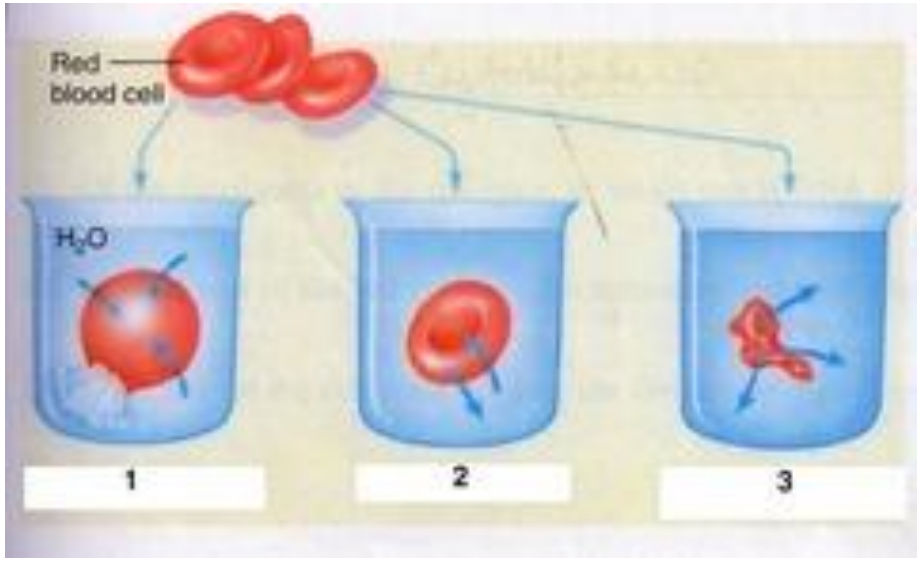
- 1) What is the difference between passive and active transport?

- 2) Which of the following will diffuse through a cell membrane?
  - Oxygen gas
  - Sugar
  - NaCl (salt)
  - Water
  - Carbon Dioxide
  - Protein

- 3) List 3 types of passive transport

- 4) In diffusion, molecules move from _____ to _____ concentration

- 5) Is the red blood cell placed in a hypotonic, hypertonic or isotonic solution?



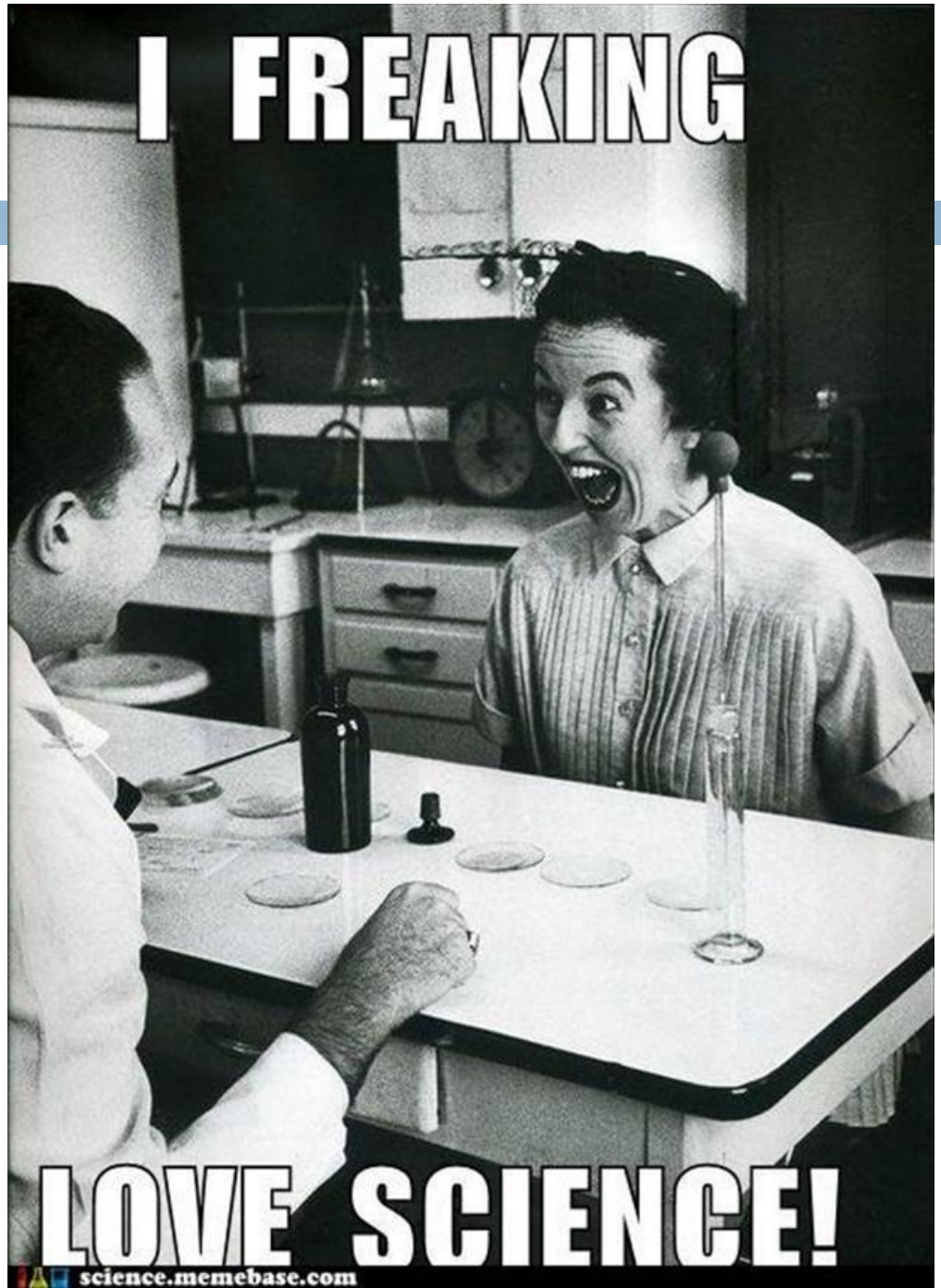
- 6) Is the solution in each beaker hypotonic, isotonic or hypertonic to the cell?

A. B. C.

- 7) For each explain if water moves in or out of the cell and what will happen to the cell

A. B. C.

- 8) Draw the structure of a cell membrane. Label the following
  - Hydrophobic
  - Hydrophilic
  - Protein
  - Phospholipid
  - Tail
  - Phosphate head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