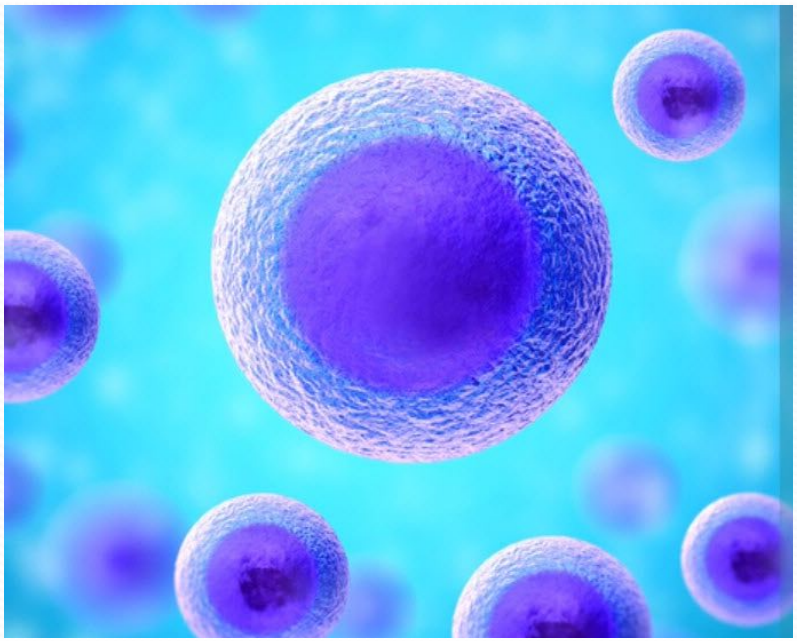
The Cell Membrane

Structure and Function

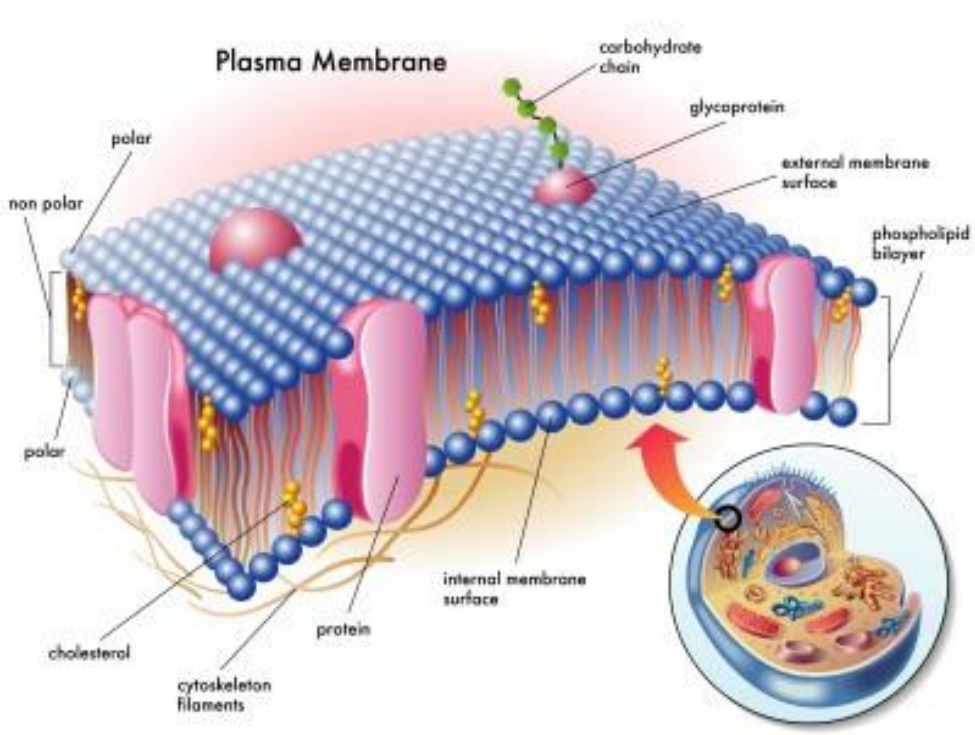
Review: What is a Cell?

- Cell: the basic structural, functional and biological unit of living organisms
  - THE BUILDING BLOCK OF LIFE

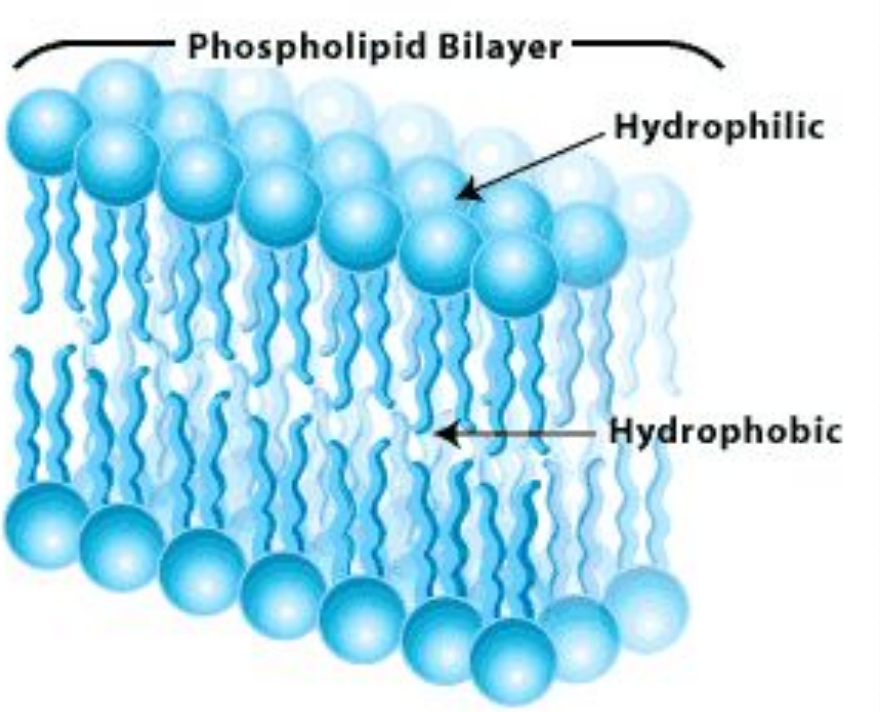


Cell Membrane Functions

- Cell membrane: surrounds the cell, regulating the **transport** of materials into and out of the cell

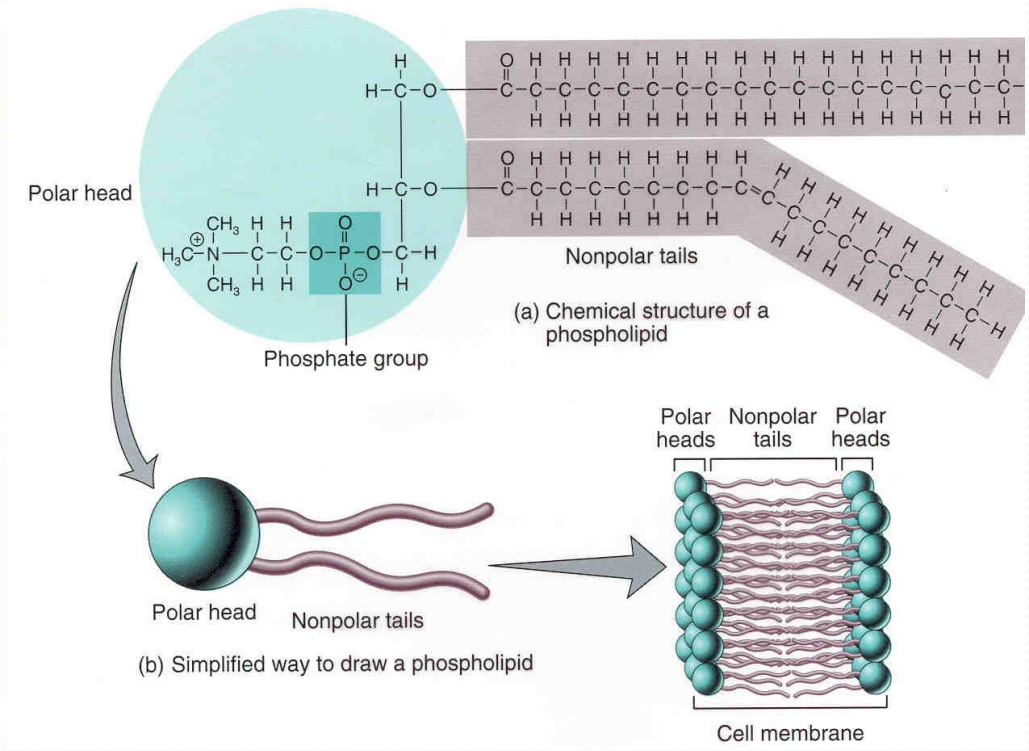


Cell Membrane Structure



- Lipid Bilayer: a double layer of phospholipids that make up the cell membrane

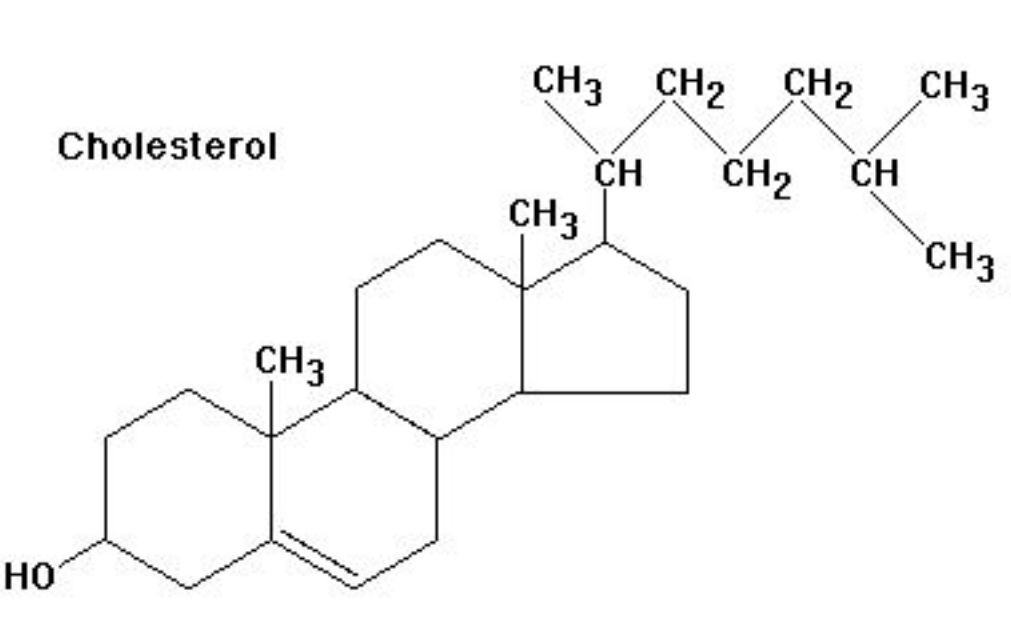
Phospholipid



- Phosphate Head:
  - Polar
  - Hydrophilic (attracted to water)
- Two Fatty Acid Tails:
  - Nonpolar
  - Hydrophobic (avoids water)
- Two Layers
  - Outsides: Polar Heads
  - Inside: Nonpolar Tails

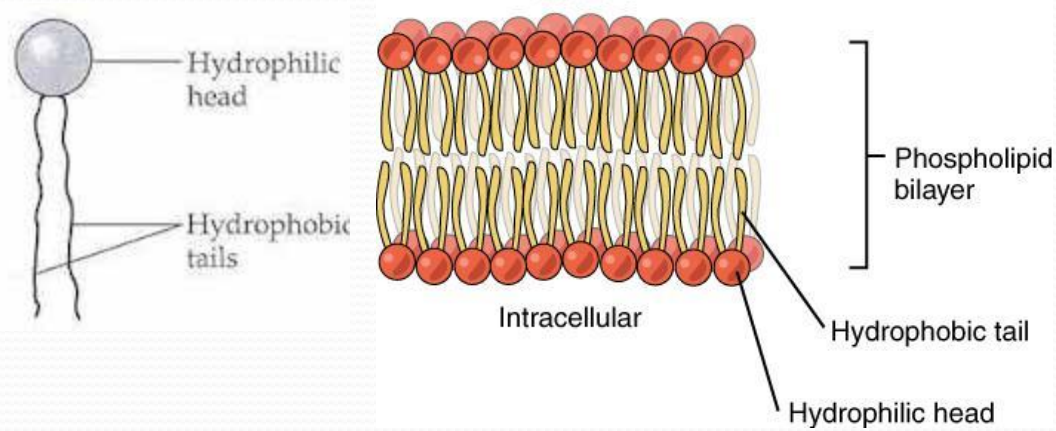
Other lipids ?

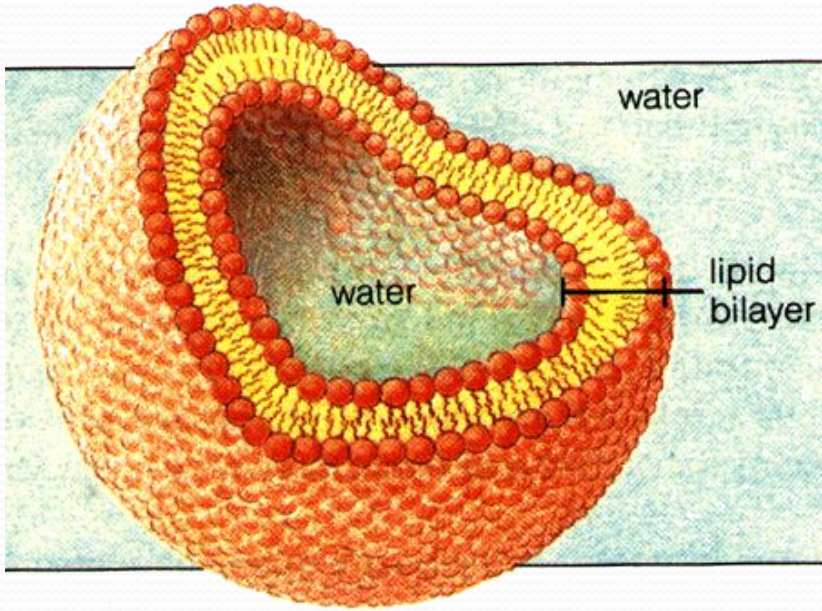
- **Lipids**
  - Fatty acids
  - Fats and waxes
  - Steroids
    - Cholesterol
    - Testosterone
  - Phospholipids



Cell Membrane Structure

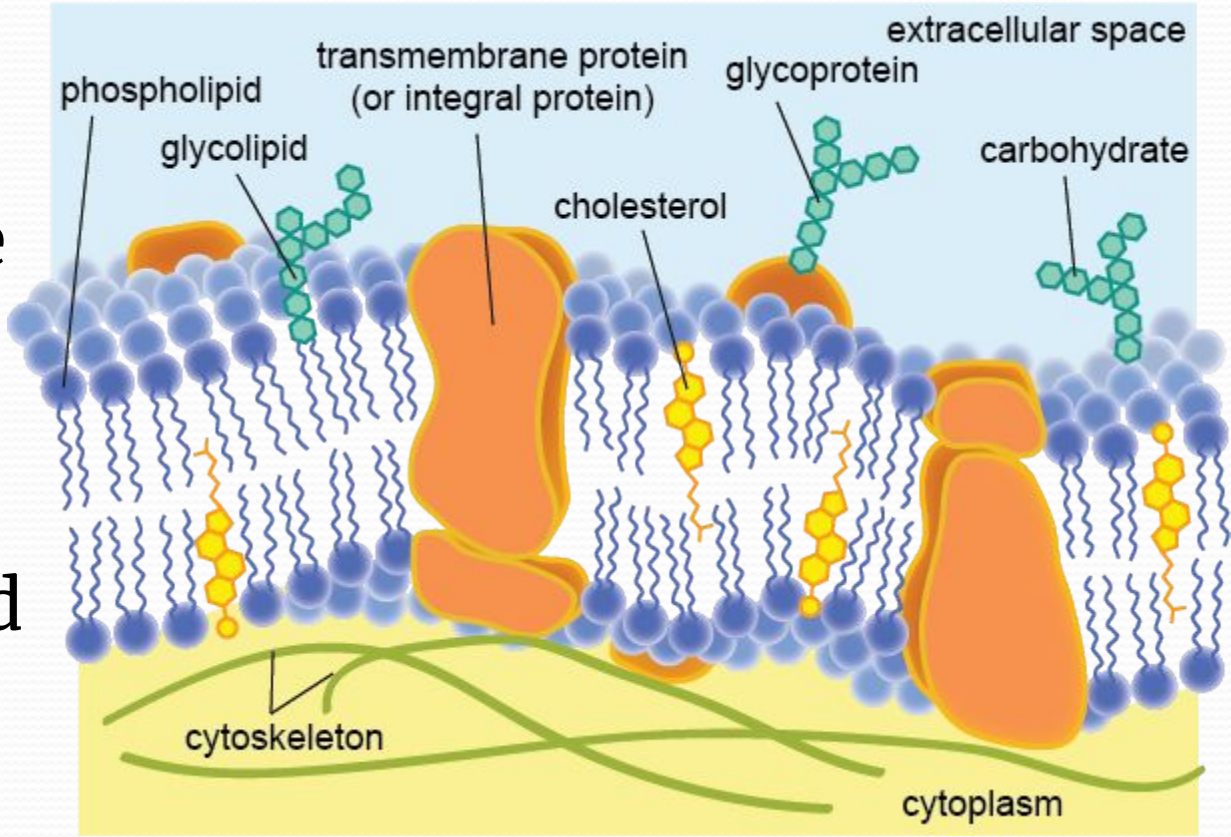
- Phospholipids are arranged so hydrophilic (water loving) ends face outside and hydrophobic (water fearing) tails create the interior





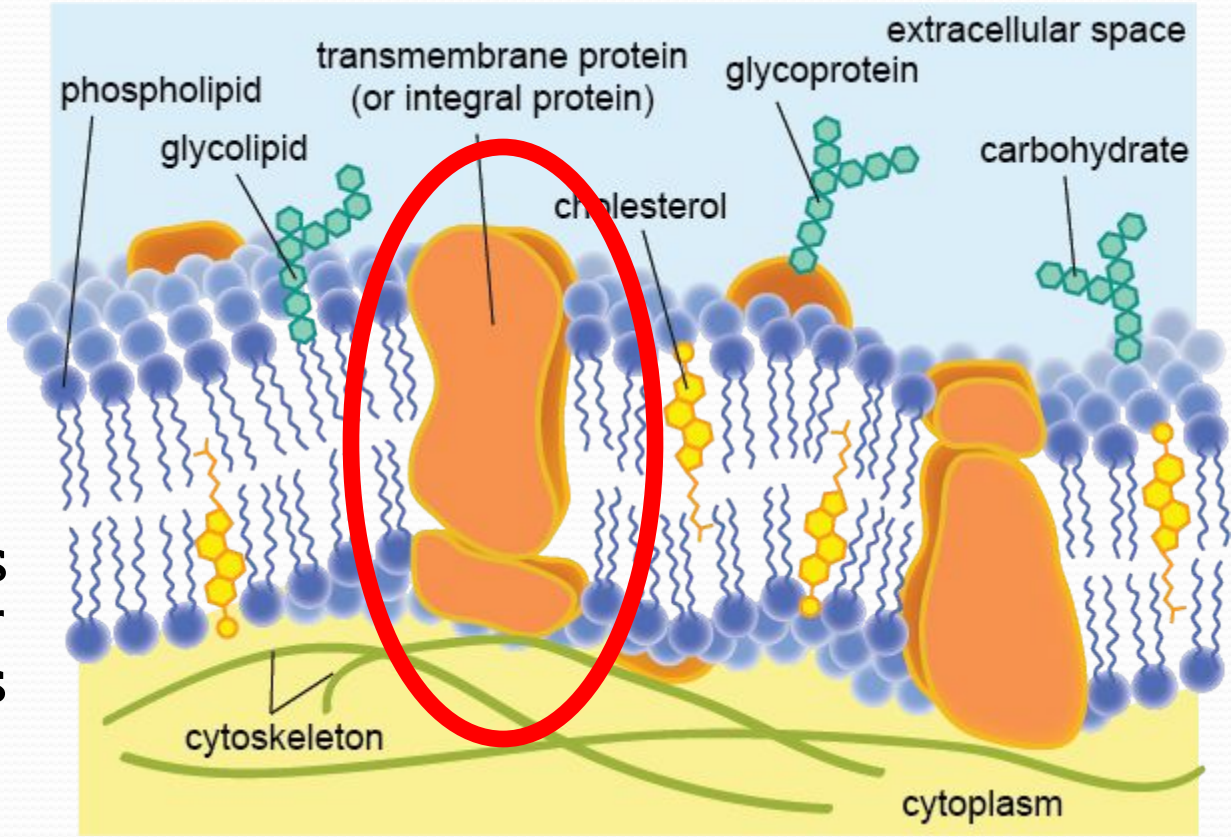
Cell Membrane Structure

- Phospholipid Bilayer
- Transmembrane Proteins
- Cholesterol (a steroid)
- Glycoprotein and Carbohydrate



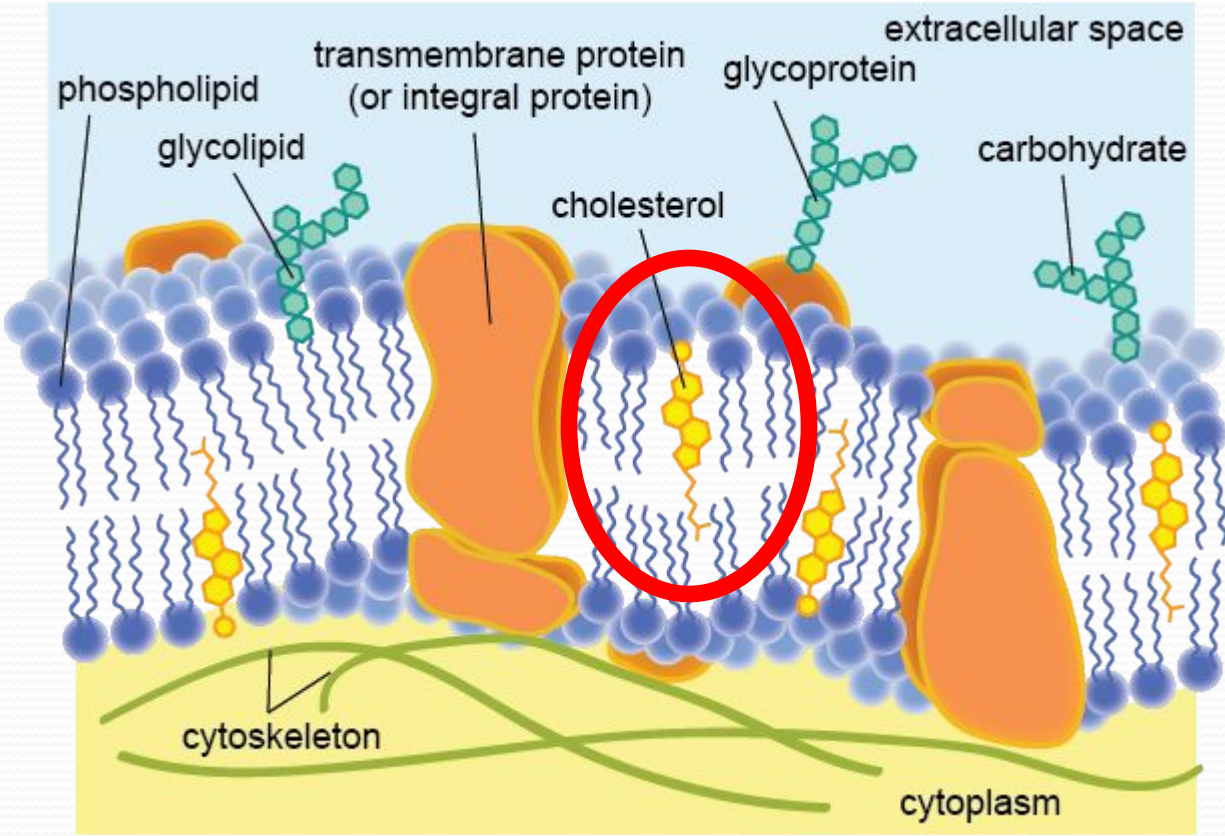
Cell Membrane Structure

- Transmembrane Proteins
  - Job:
    - Attachment point for one cell to attach to a neighbor
    - Anchor cell in place
    - Create channels for large and/or polar molecules to pass



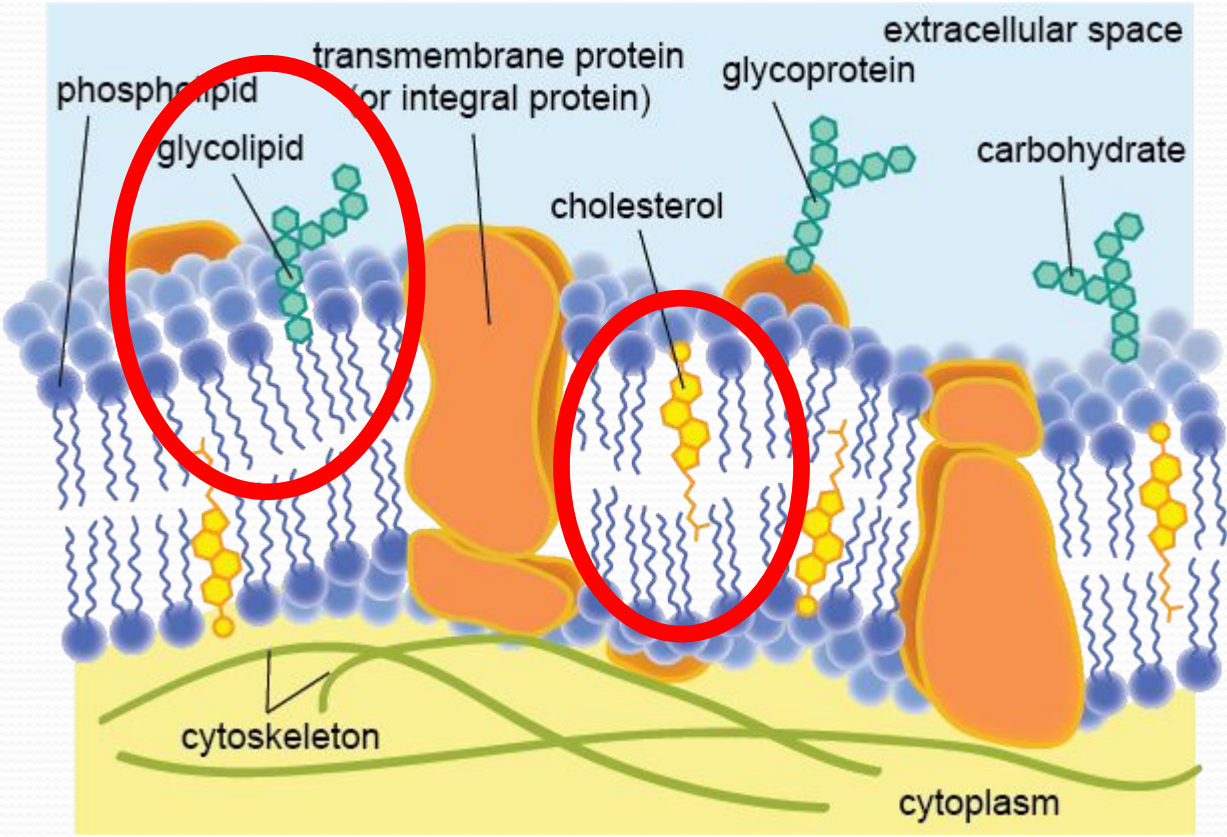
Cell Membrane Structure

- Cholesterol
  - Job:
    - Maintains fluidity of cell membrane



Cell Membrane Structure

- Glycolipids and Carbohydrates
  - Job:
    - Serve as cell markers for identification



Think about it: How do molecules such as glycolipids and surface carbohydrates play a role in organ transplant recipients?

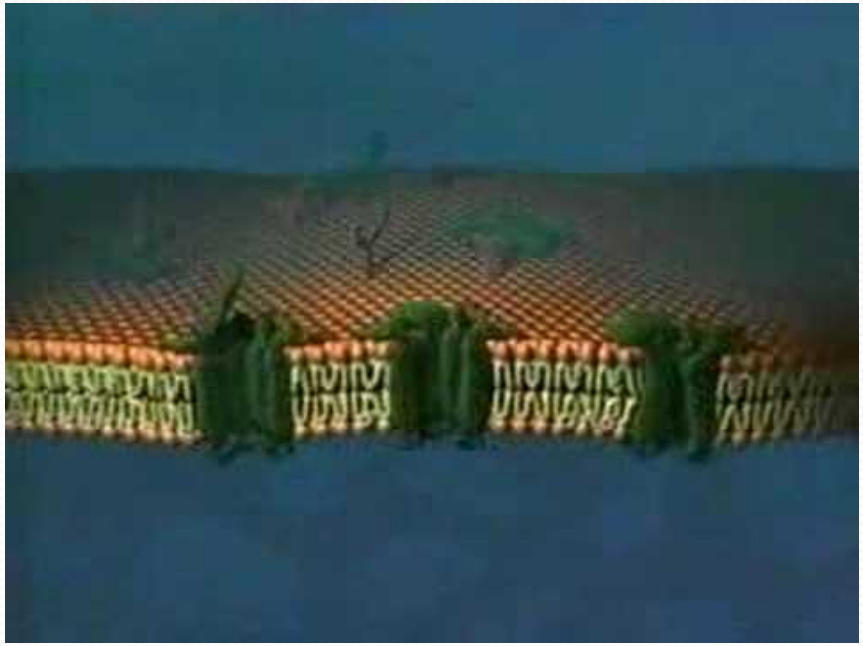
the immune system looks for and attacks foreign cells

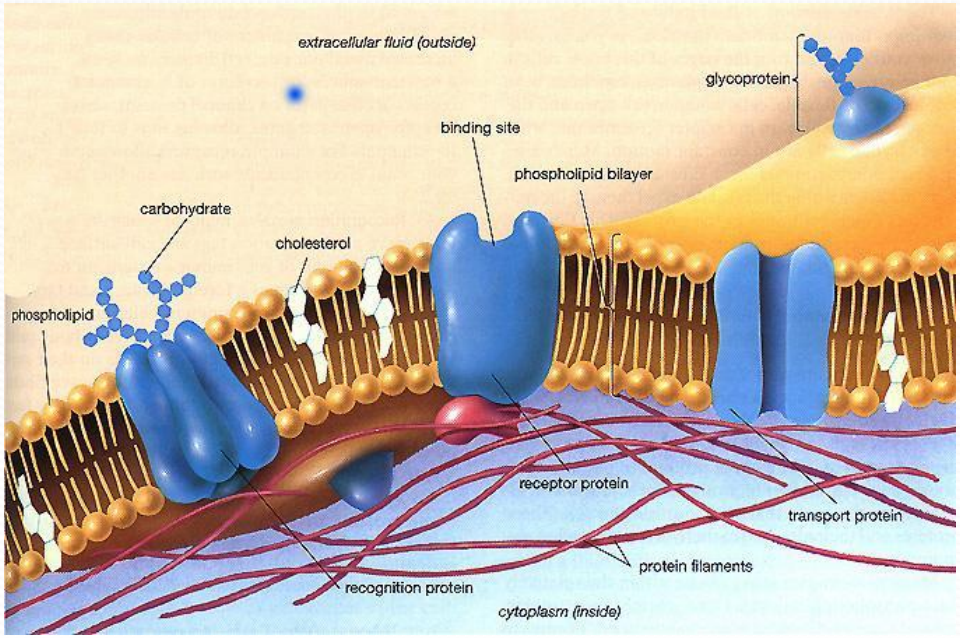
Cell Membrane Structure

The Fluid Mosaic Model

(model that describes the structure of the cell membrane)

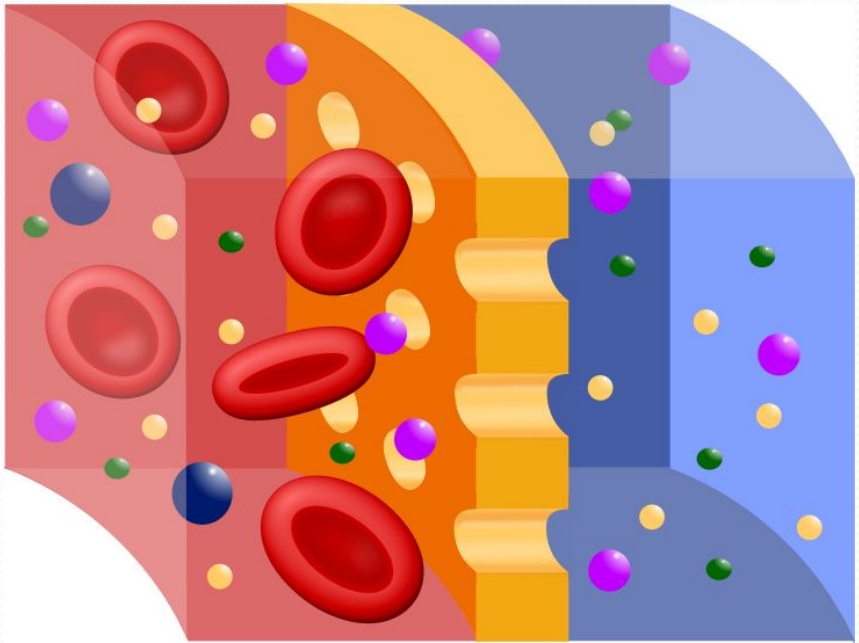
- The membrane is dynamic, molecules are constantly moving





Selectively Permeable

- The cell membrane is selectively permeable, meaning some substances can pass through the cell membrane, but others can't!
- "Permeable" is the ability for something to pass through



Exit Ticket-Did the information "stick?"

- Sketch a simple diagram of the cell membrane, labeling the 5 specific parts listed below:
  - Transmembrane protein
  - Cholesterol
  - Glycolipid
  - hydrophobic tail
  - hydrophilic head?

Review:

Phospholipid Bilayer - a double layer of lipids that make up the cell membrane

phospholipid - polar Hydrophilic head and two non-polar Hydrophobic tails

Channel Protein - facilitate the transport of substances across a cell membrane

Receptor Protein - surface proteins that bind to other molecules

Transporter Protein - involved in the movement of ions, small molecules, or macromolecules, such as another **protein**, across a membrane

Tethered Protein - connects another structure together

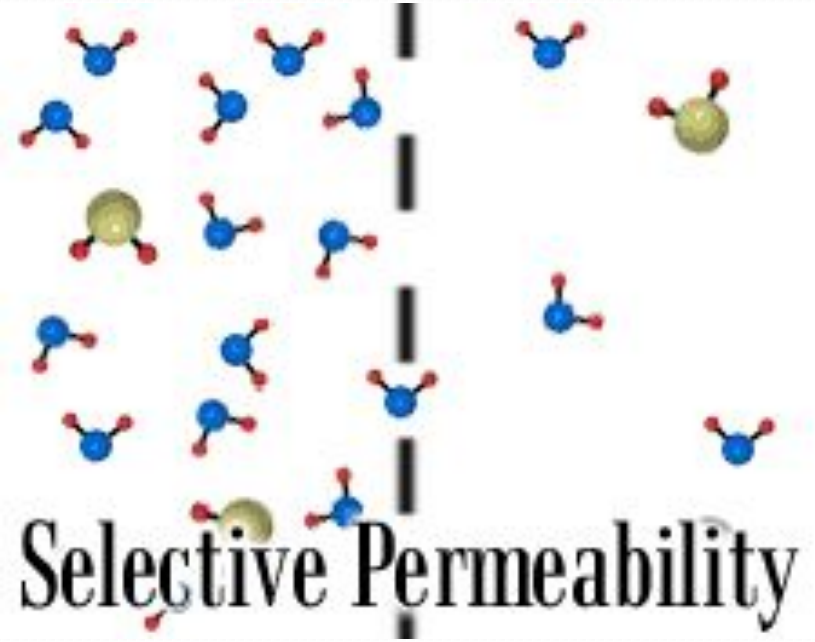
Anchored Protein - attached to lipids embedded

Passive Transport

Osmosis and Diffusion

Selectively Permeable

- The cell may transport substances
  - Passive Transport: No Energy required
  - Active Transport: Uses energy (ATP)



Passive Transport

- Movement of a substance into/out of a cell **<u>without</u>** using **energy**
- HIGH → LOW concentration
- 3 Types
  - Simple Diffusion
  - Facilitated Diffusion
  - Osmosis

About Concentration…

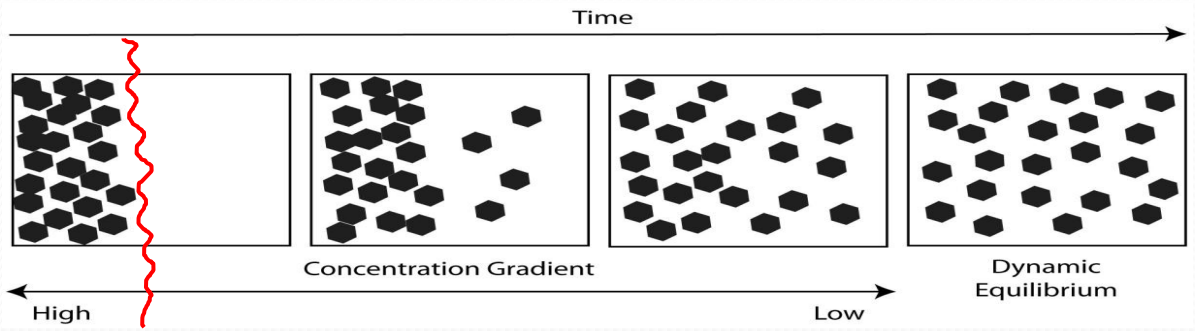
- We just learned that substances move from HIGH→LOW concentration in passive transport…but what do we mean by **concentration**?
  - Means **amount** dissolved in a container
  - How do you like your sweet tea?

    a. Unsweet (low **concentration** of sugar)
    b. Sweet
    c. Super sweet(high **concentration** of sugar)

- Solute = Substance **dissolved** in water

Concentration Gradients

- A **concentration gradient** is the difference in the *concentration*, or amount, of something in a space
  - In the box below, the dots have a higher concentration on the left than the right, so they begin movement to the right

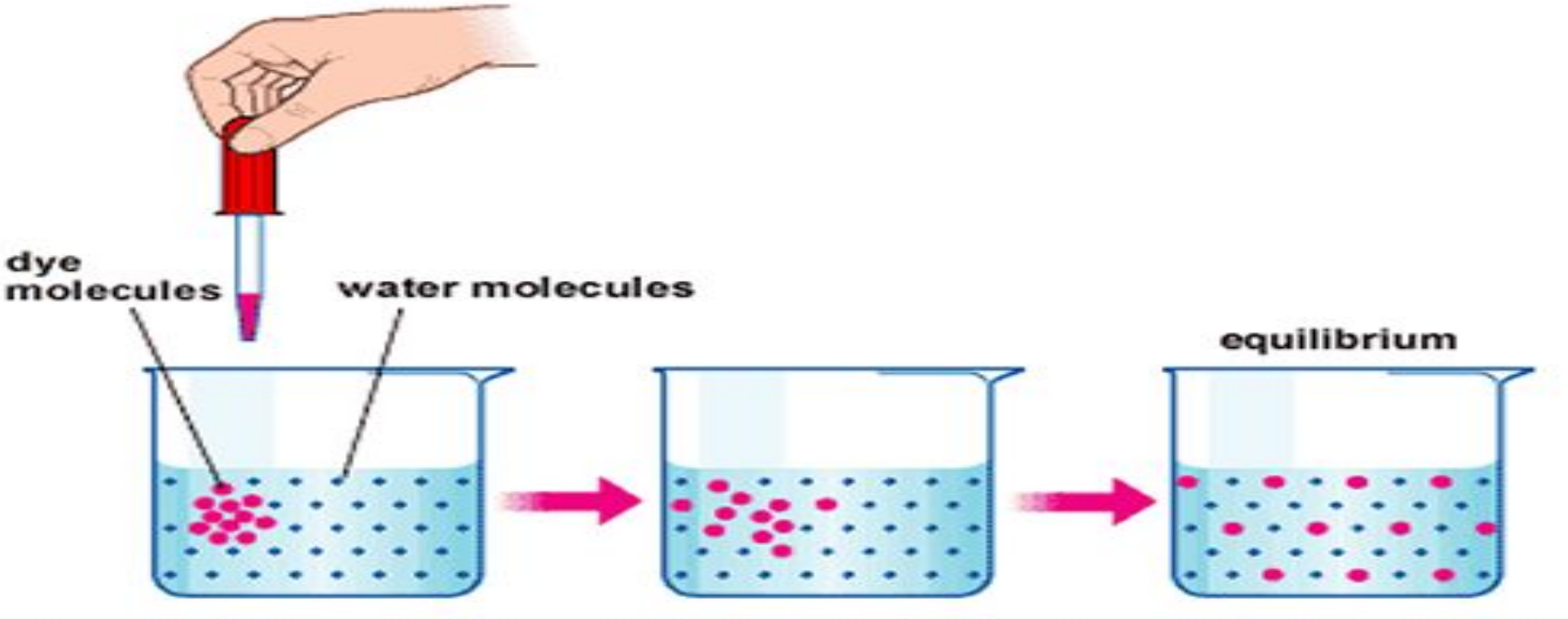


- When the *concentration gradient* is the same throughout the area, it is in a **dynamic equilibrium**
  - Particles are moving from one side to the other, but at the same rate.

Picture: www.hartnell.edu

Passive Transport: Simple Diffusion

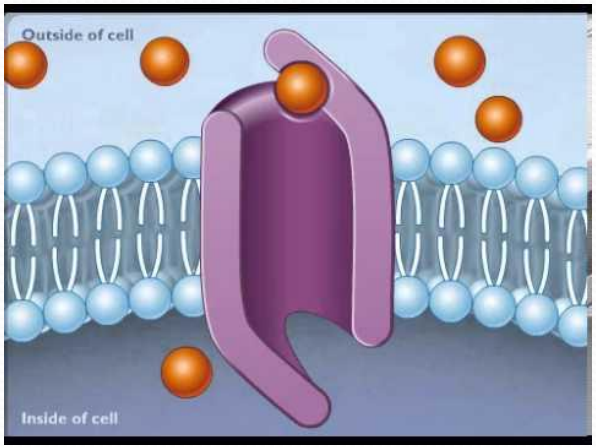
- **Diffusion** is when a substance moves from an **area of high concentration to low concentration** area
- *Diffusion* will continue until balanced/equal "at *equilibrium"*
- In this case, small, nonpolar particles cross through the membrane

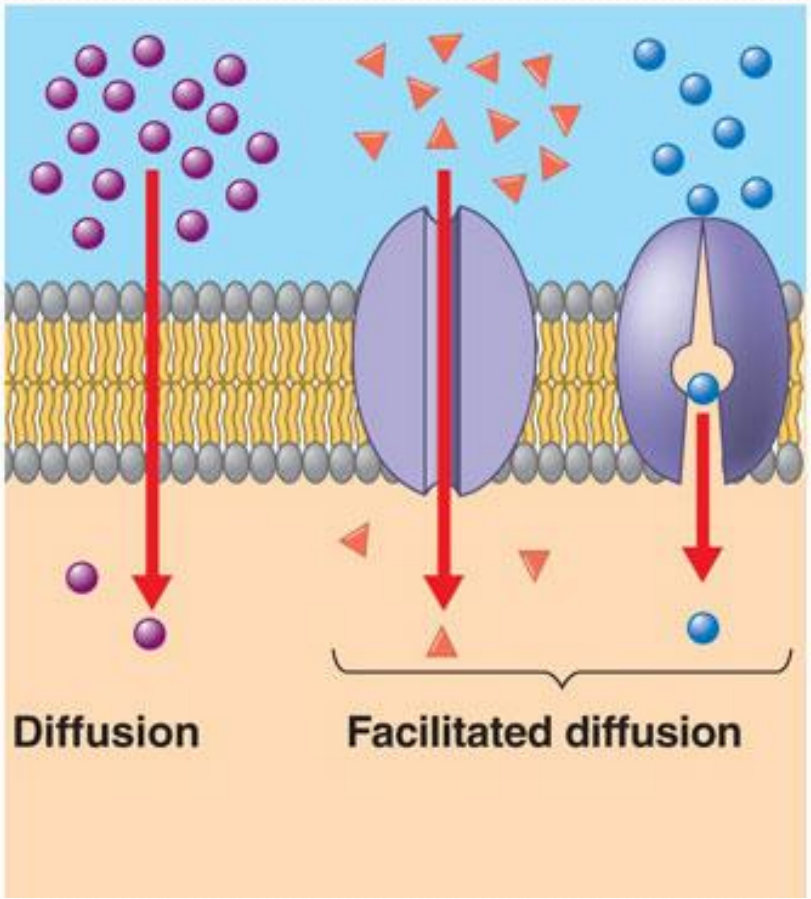

dye
molecules
water molecules
equilibrium


ICE
WATER
(RECENTLY
FILTERED)
TEPID
TAP
WATER
BOILING
WATER

Facilitated Diffusion

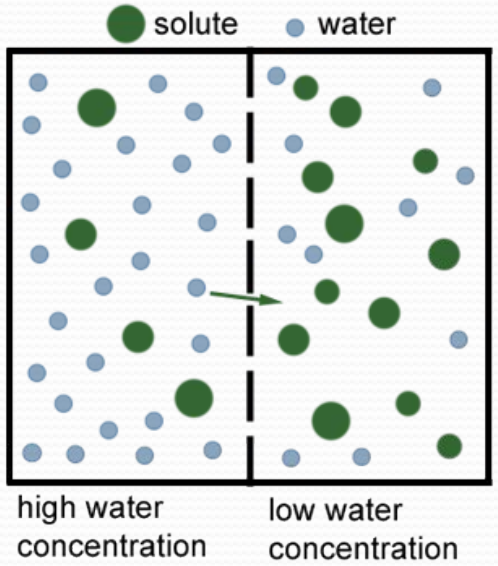
- Large and/or charged molecules require **special protein channels** to move through
  - Ex. Ions, glucose





Passive Transport: Osmosis

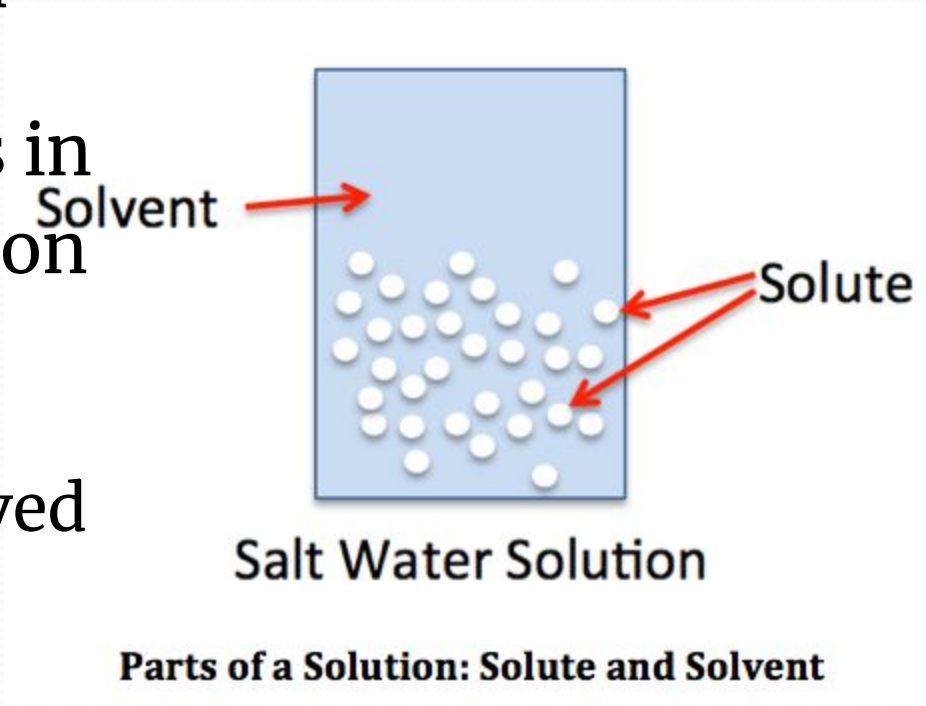
- **Osmosis** is the diffusion of water across a *selectively permeable* membrane
  - Water moves from an area of high concentration (lots of water) to low concentration (little water)
  - Passive Transport:
    - Water moves with its concentration gradient
    - No energy is required



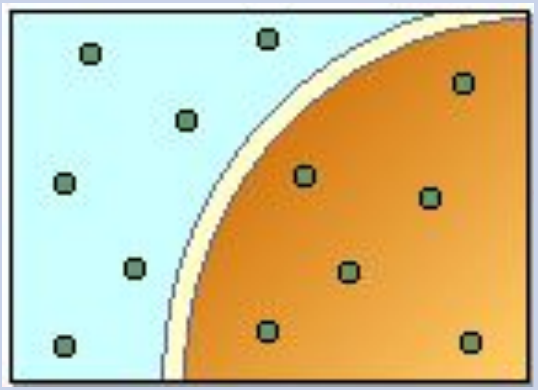
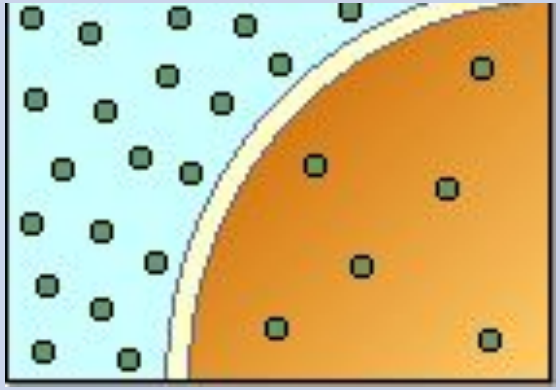
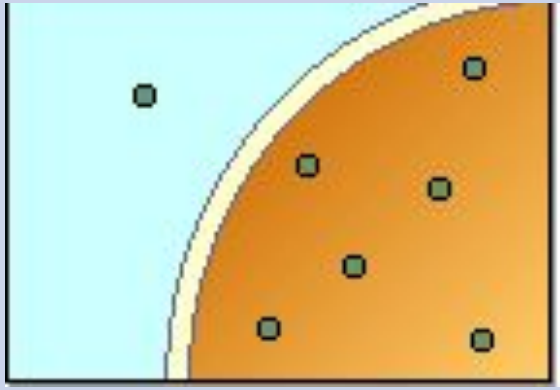
Picture: scienceaid.co.uk

About Osmosis

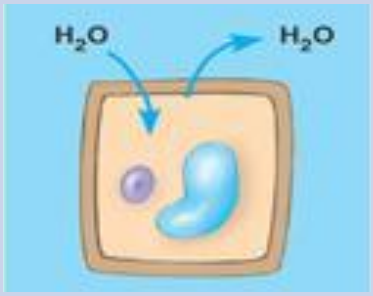
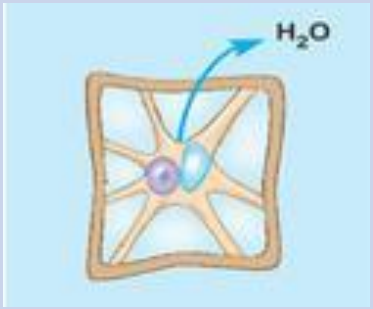
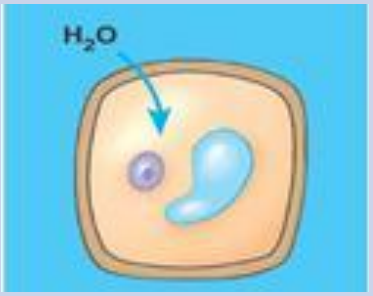
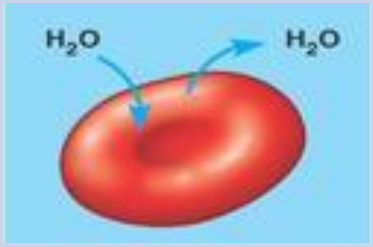
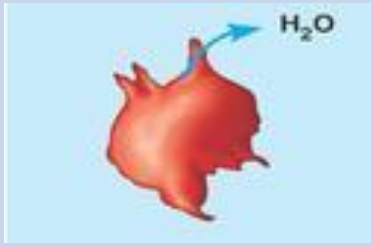
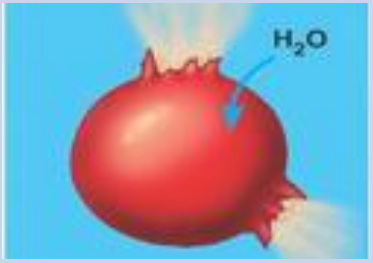
- Water can move into or out of the cell, depending on the environment (solution) that the cell is in
- Solvent + Solute = Solution
  - Solvent does the dissolving (ex. Water)
  - Solute substance dissolved (ex. Salt)



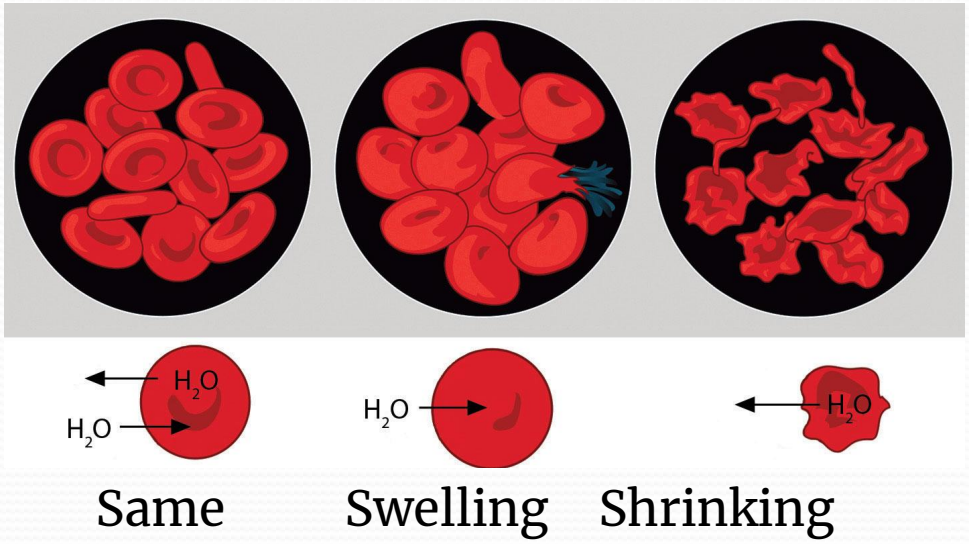
Describing Solutions

Isotonic Solution "same or equal"	Hypertonic Solution "above/over/higher"	Hypotonic Solution "below/under/lower"
		
EQUAL amounts of solute in/out of cell.	HIGHER solute outside.	LOWER solute outside.

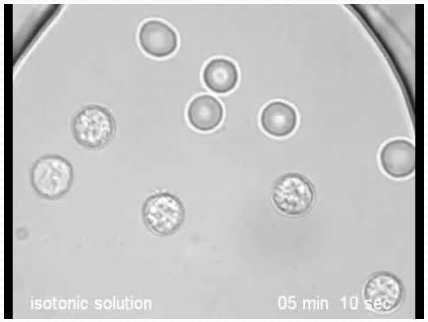
How Osmosis Works

Isotonic "same or equal"	Hypertonic "above/over/higher"	Hypotonic "below/under/lower"
Water in/out.  Plant Cells Flaccid, Central Vac. not full	Water out  Plant Cells Plasmolysis, Cell death	Water in.  Plant Cells** Turgid, Central Vac. Full
 Animal Cell** No Change to cell	 Animal Cell Dehydration, Cell shrivels	 Animal Cell Lysed, Cell bursts

Osmosis

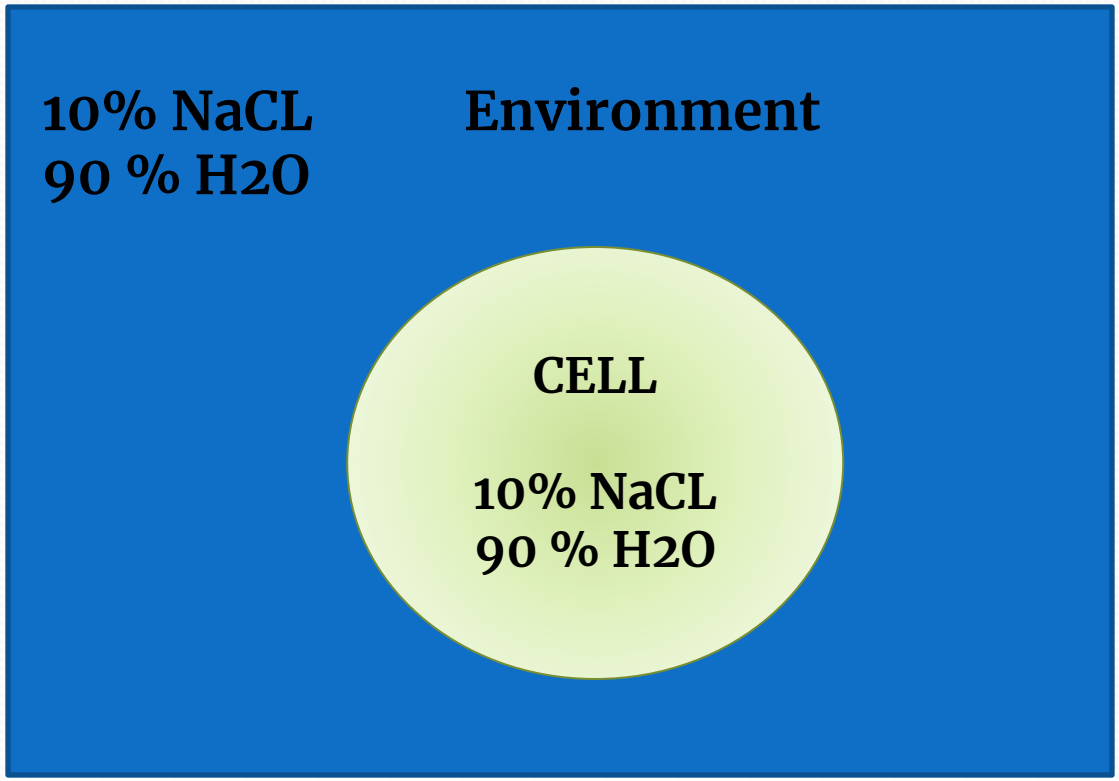


Onion Cells in Salt Water



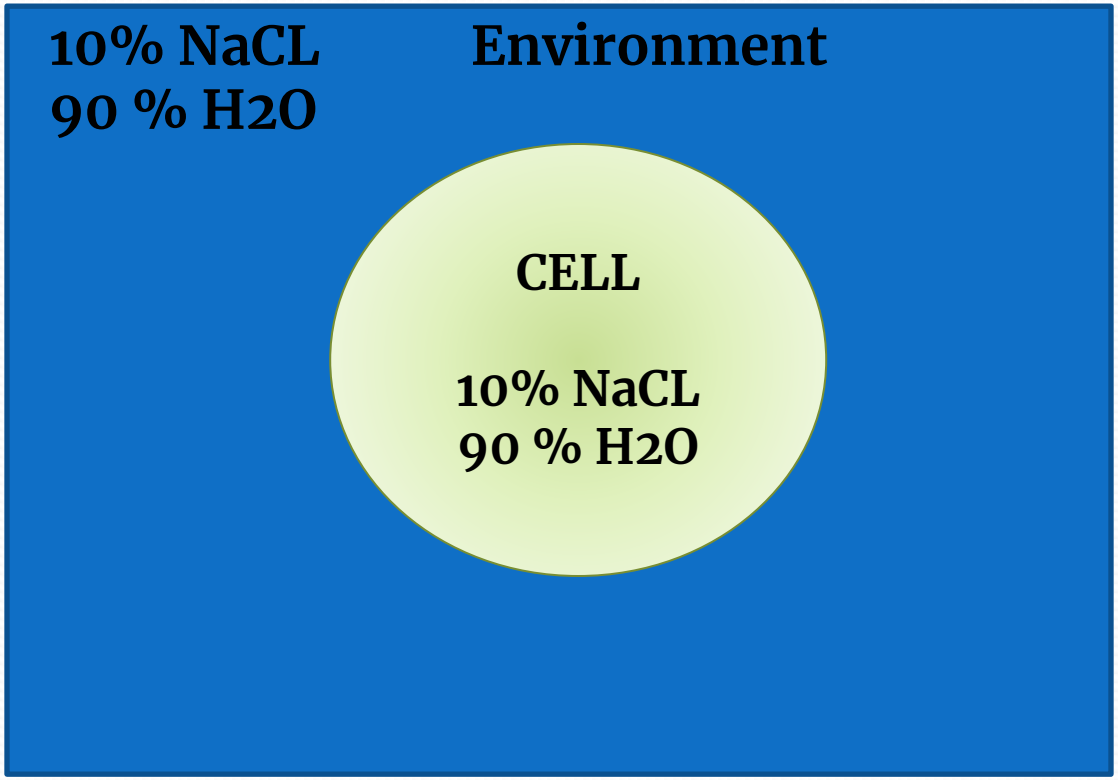
Blood Cells

Is the water….
Isotonic, Hypotonic, or Hypertonic?

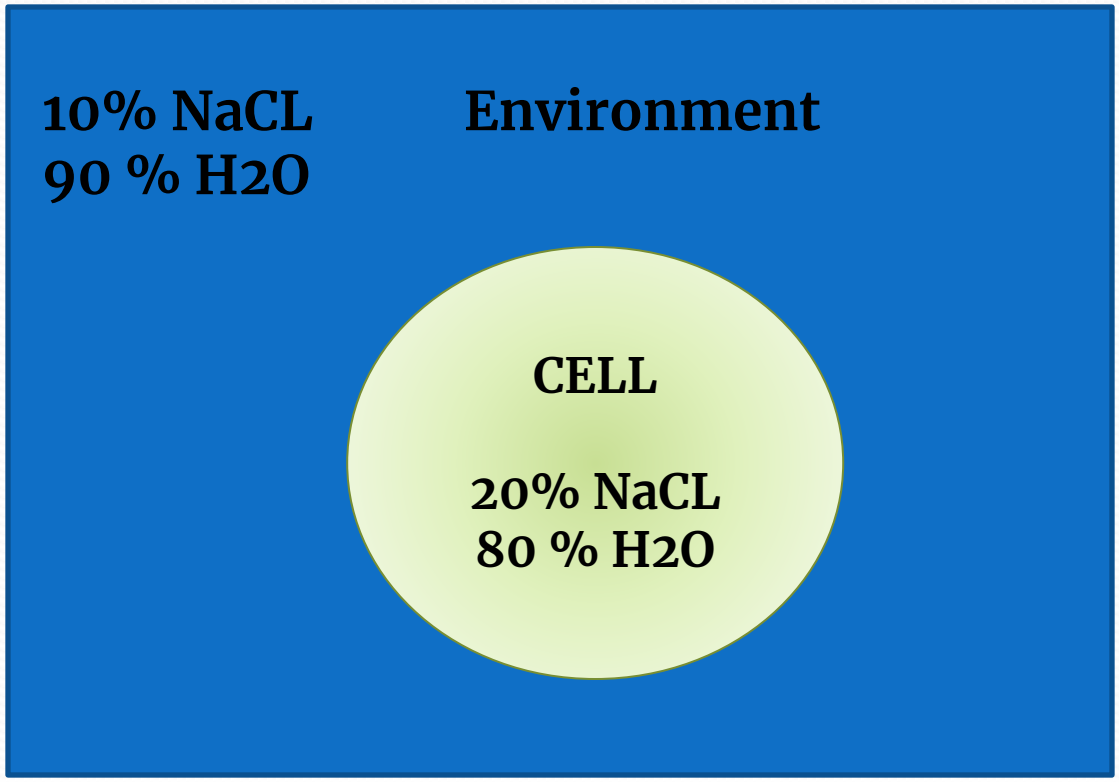


Water Goes?

- Isotonic-Water goes in/out (balanced); cell stays the same!

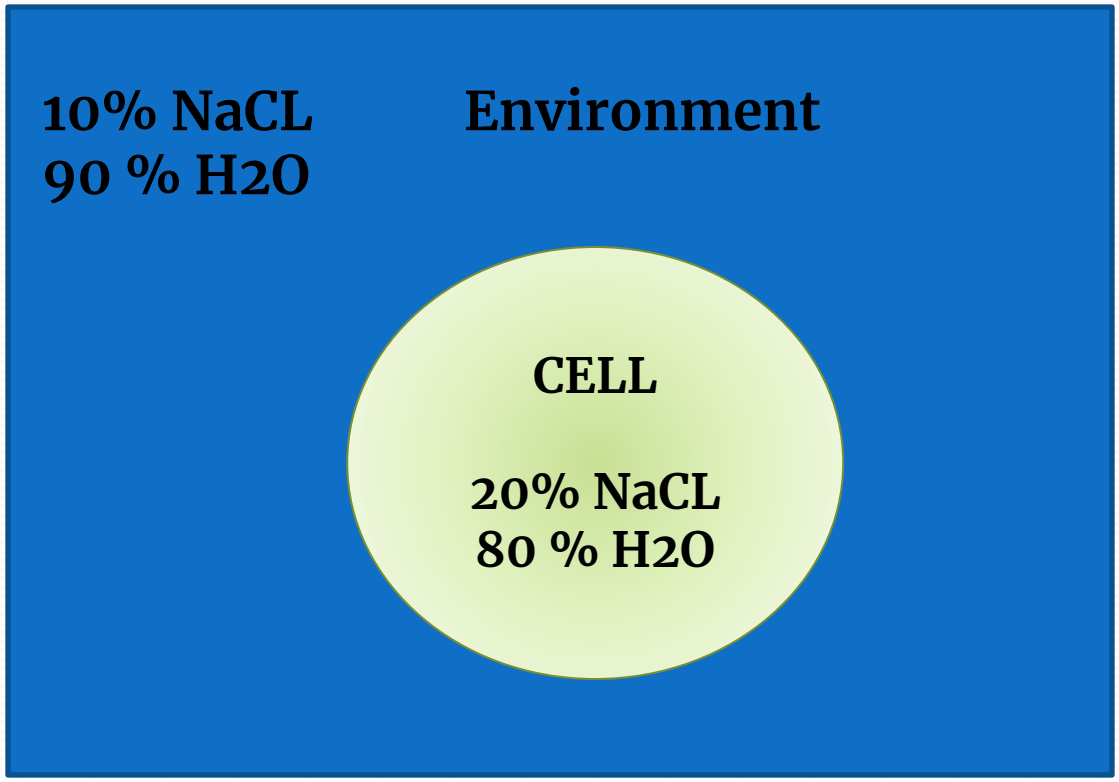


Is the water….
Isotonic, Hypotonic, or Hypertonic?

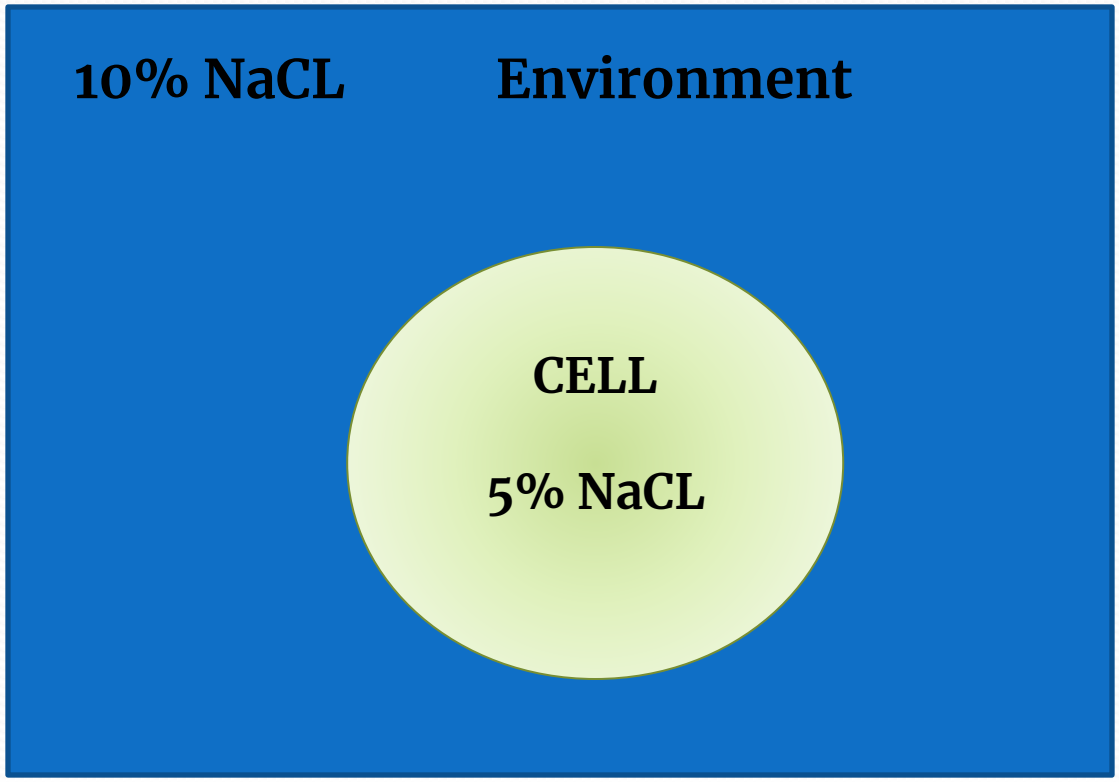


Water Goes?

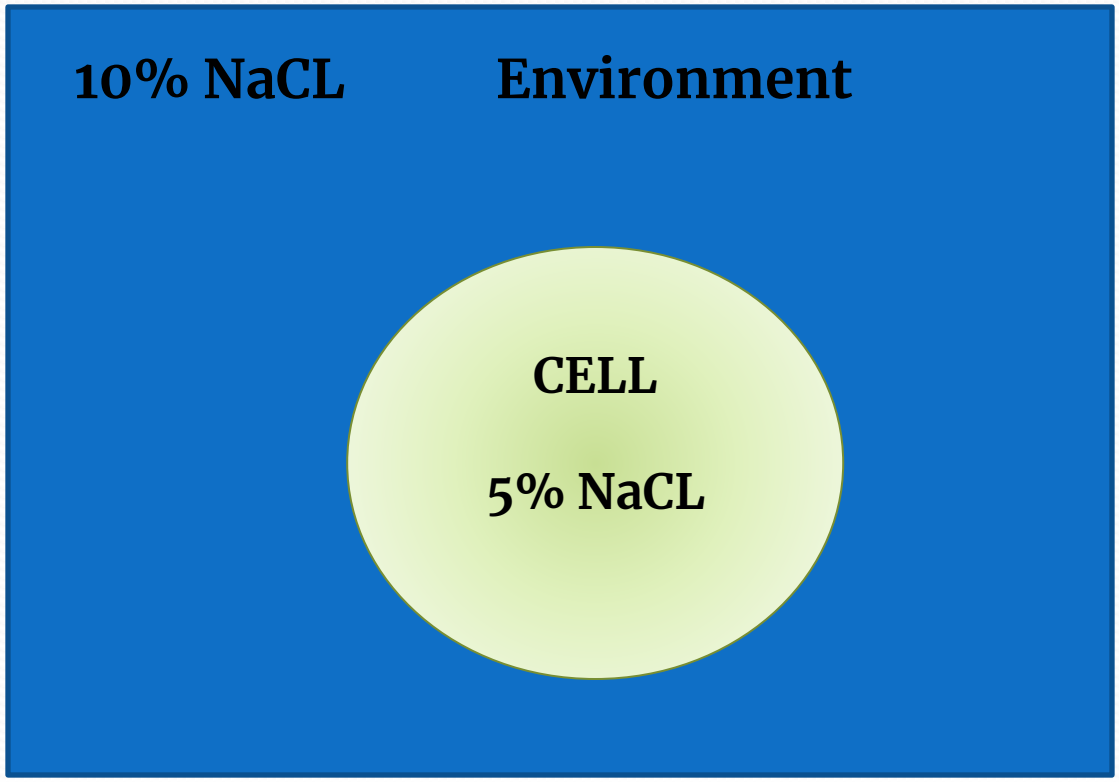
- Hypotonic–water goes IN! Cell swells!



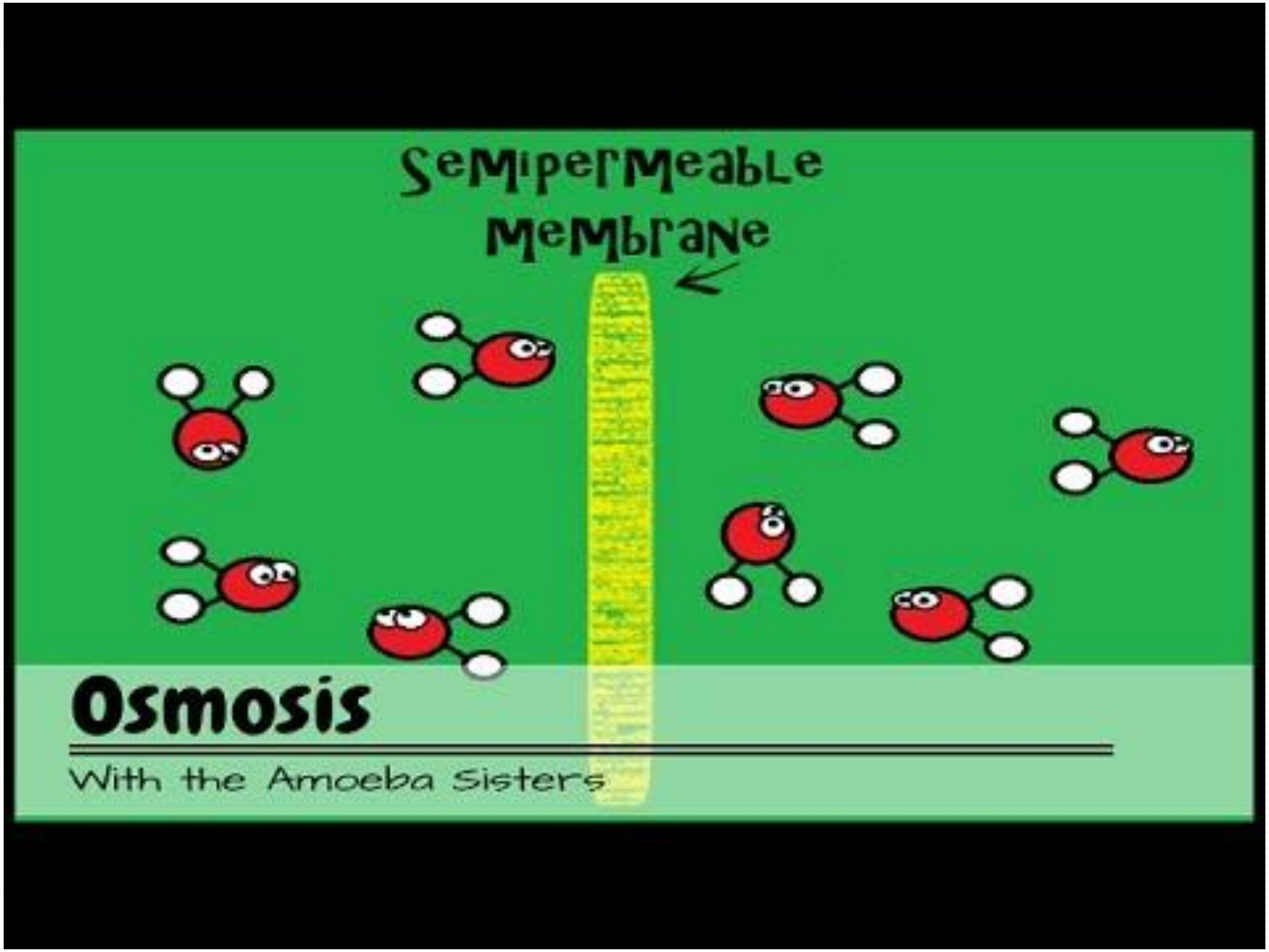
Is the water….
Isotonic, Hypotonic, or Hypertonic?



Is the water….
Hypotonic - water goes into the cell



Osmosis and Diffusion

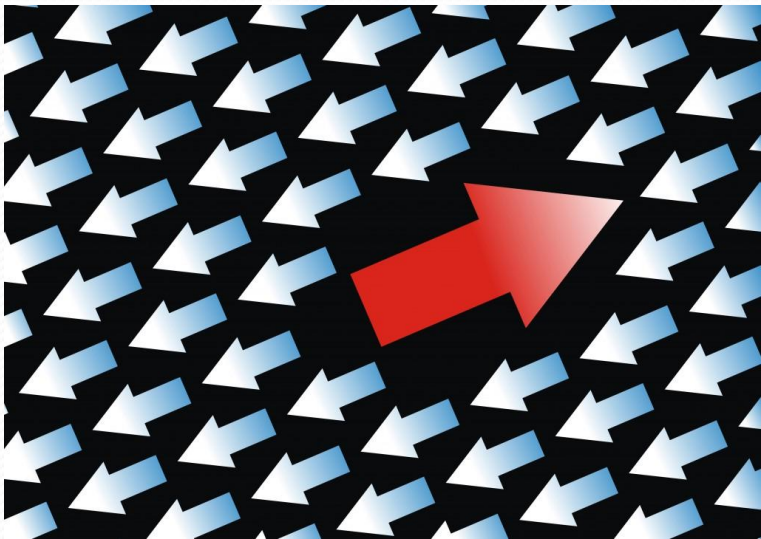


Active Transport

Movement Requiring Energy

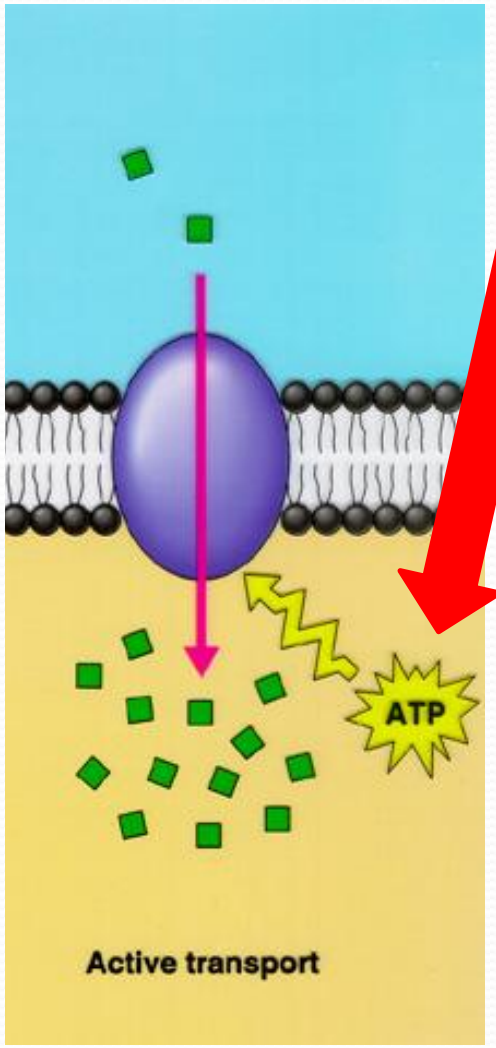
Active Transport

- Molecules move across the membrane AGAINST their concentration gradient
  - Moving LOW to HIGH
  - ENERGY is required! (imagine trying to push your way through a crowd vs. going with the flow…)
- Two Types
  - Protein Pumps
  - Bulk Transport



Protein Pumps

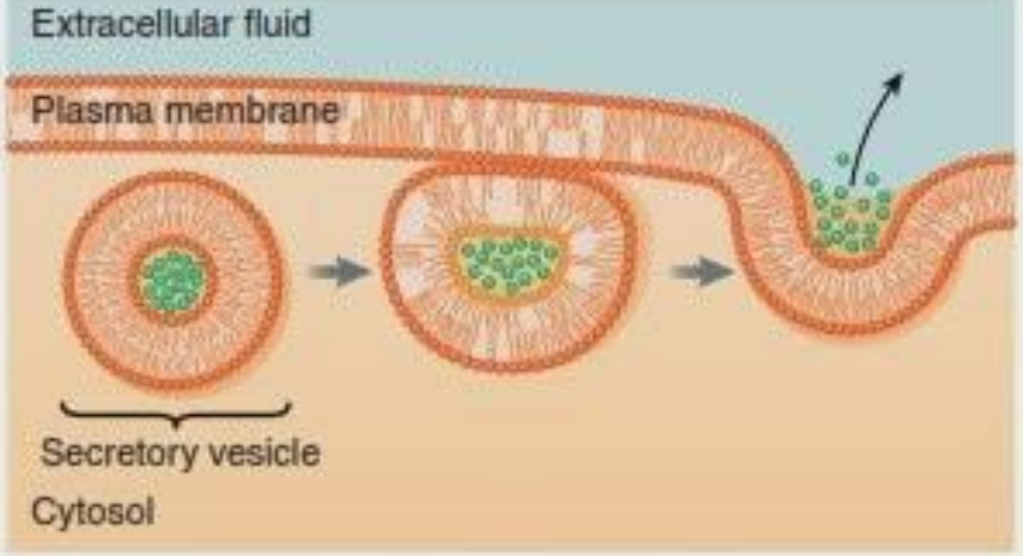
- Transport small molecules/ions AGAINST their concentration gradients
- (LOW →HIGH)
- Uses ATP (cell energy)



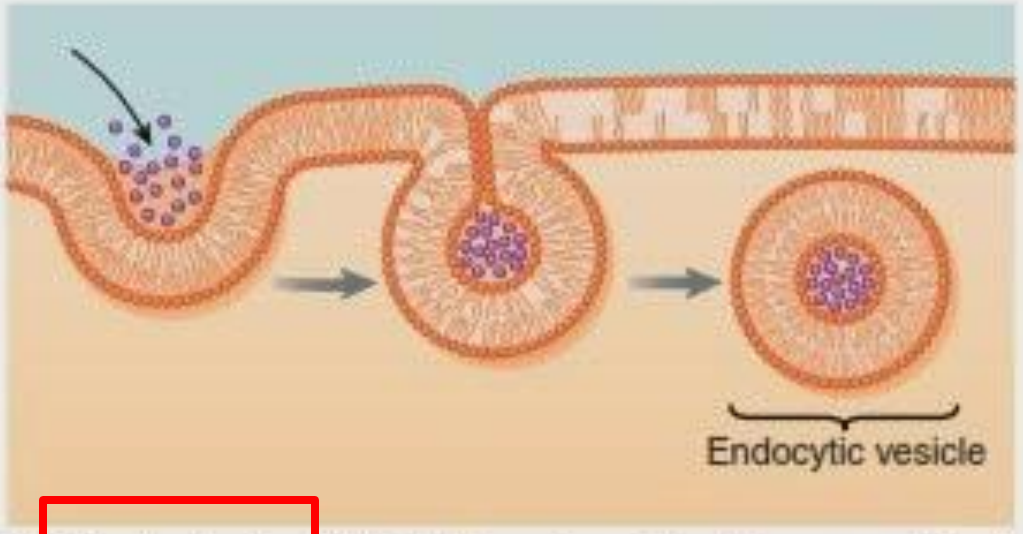
Notice the ATP

Bulk Transport

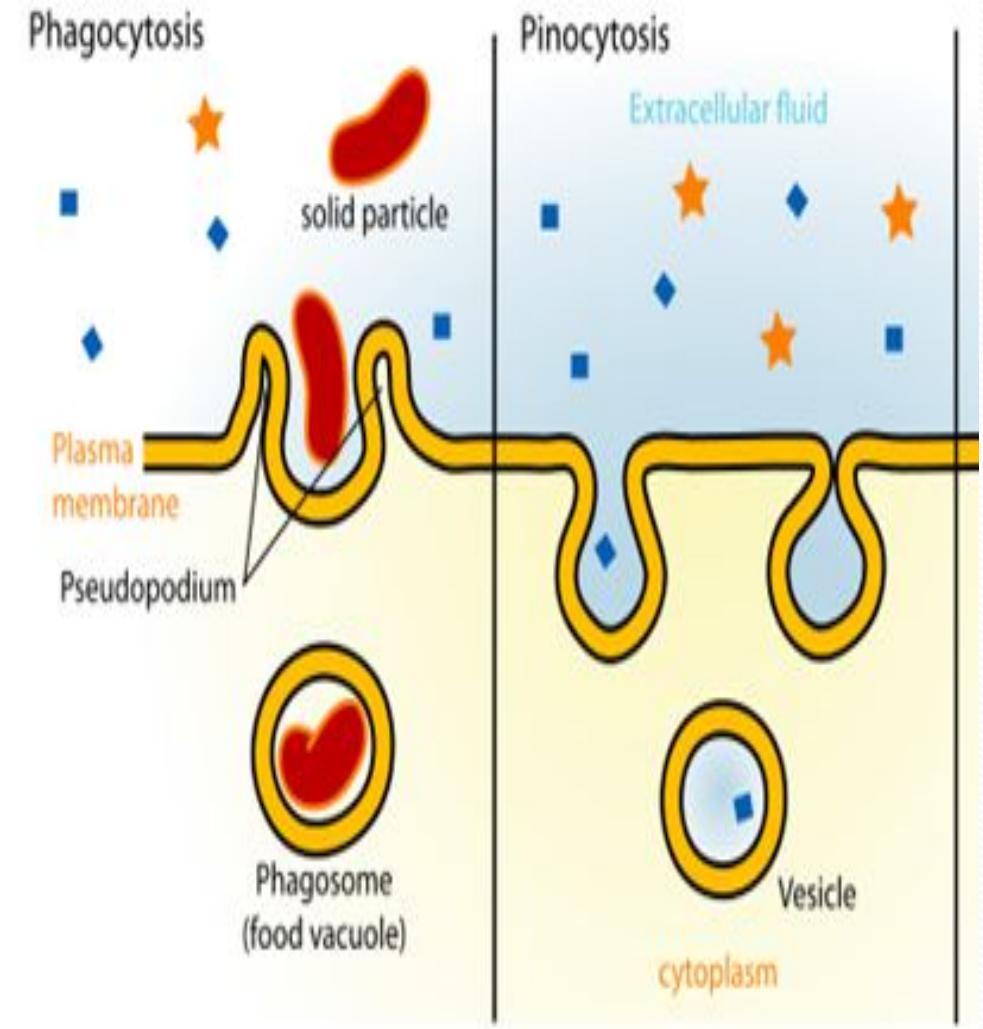
- Larger molecules (proteins, starch) are transported by vesicles that merge with the cell membrane
- Exocytosis-contents ***leaving*** the cell through the membrane
- Endocytosis-contents ***entering*** in vesicles (pinocytosis and phagocytosis)

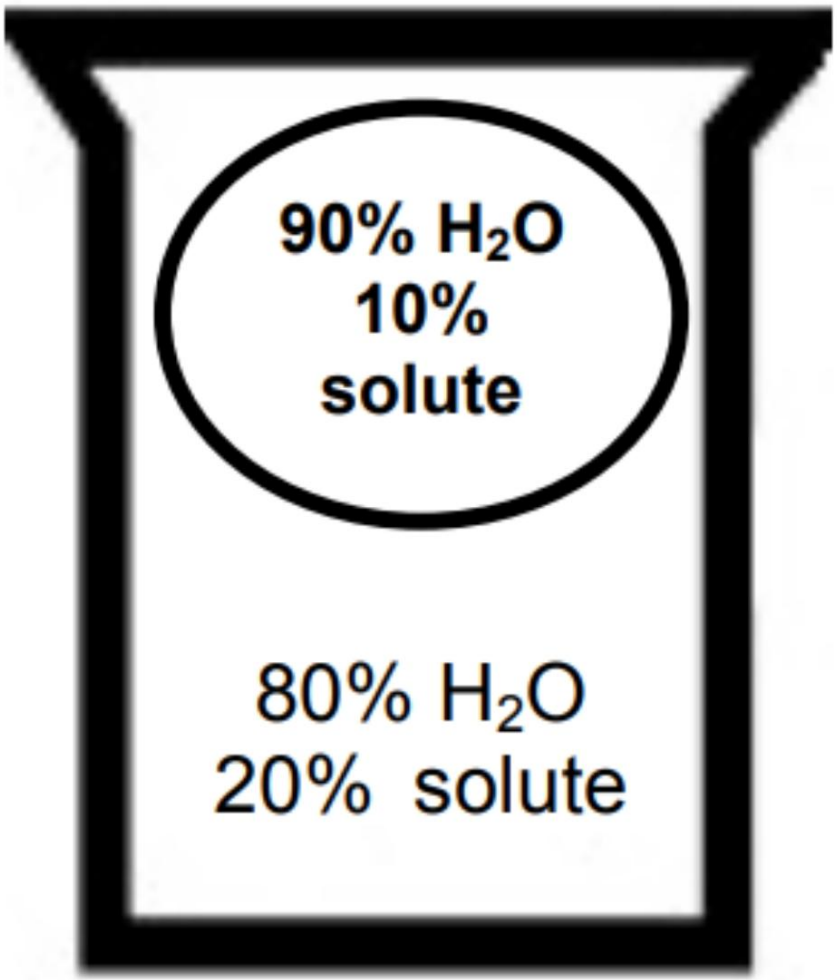


(a) **Exocytosis:** A secretory vesicle fuses with the plasma membrane, releasing the vesicle contents to the cell exterior. The vesicle membrane becomes part of the plasma membrane.

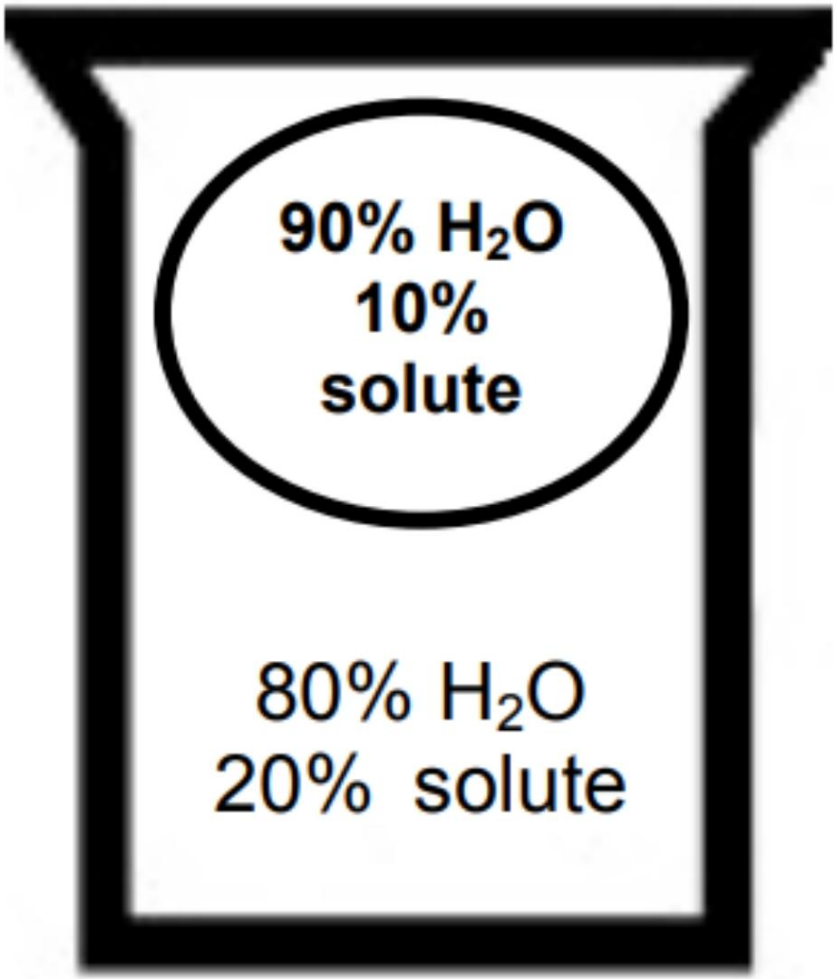


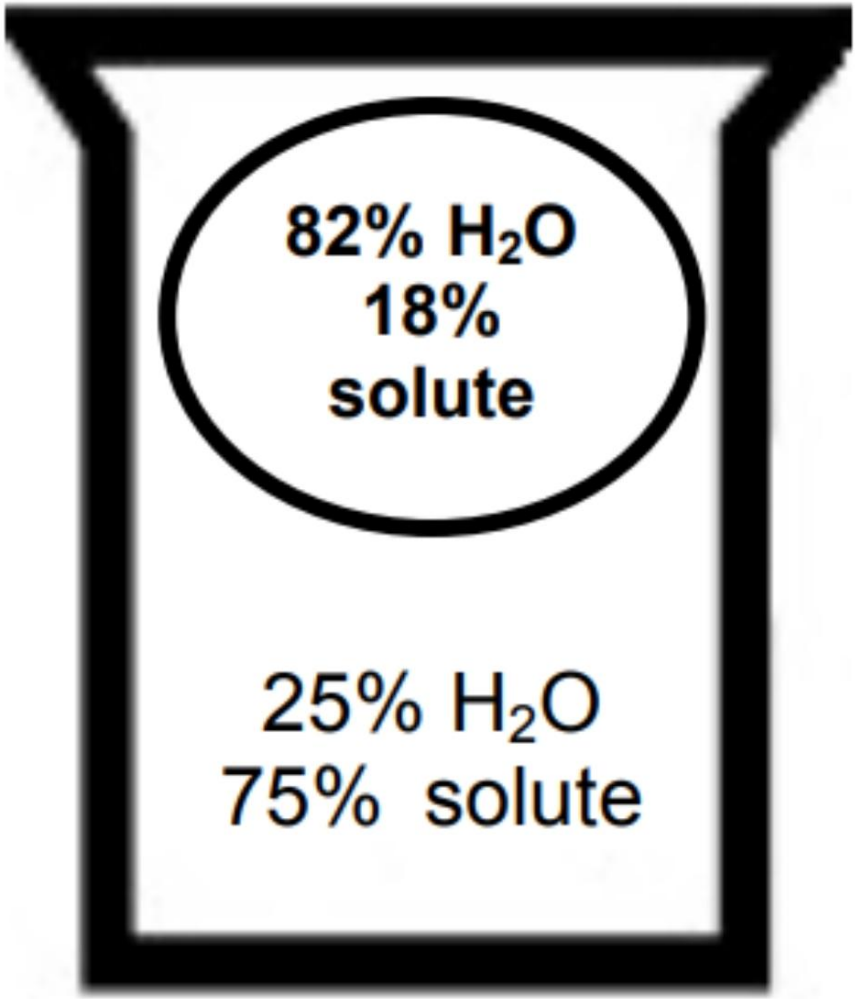
(b) **Endocytosis:** Materials from the cell exterior are enclosed in a segment of the plasma membrane that pockets inward and pinches off as an endocytic vesicle.


Phagocytosis
Pinocytosis
Extracellular fluid
solid particle
Plasma membrane
Pseudopodium
Phagosome (food vacuole)
Vesicle
cytoplasm

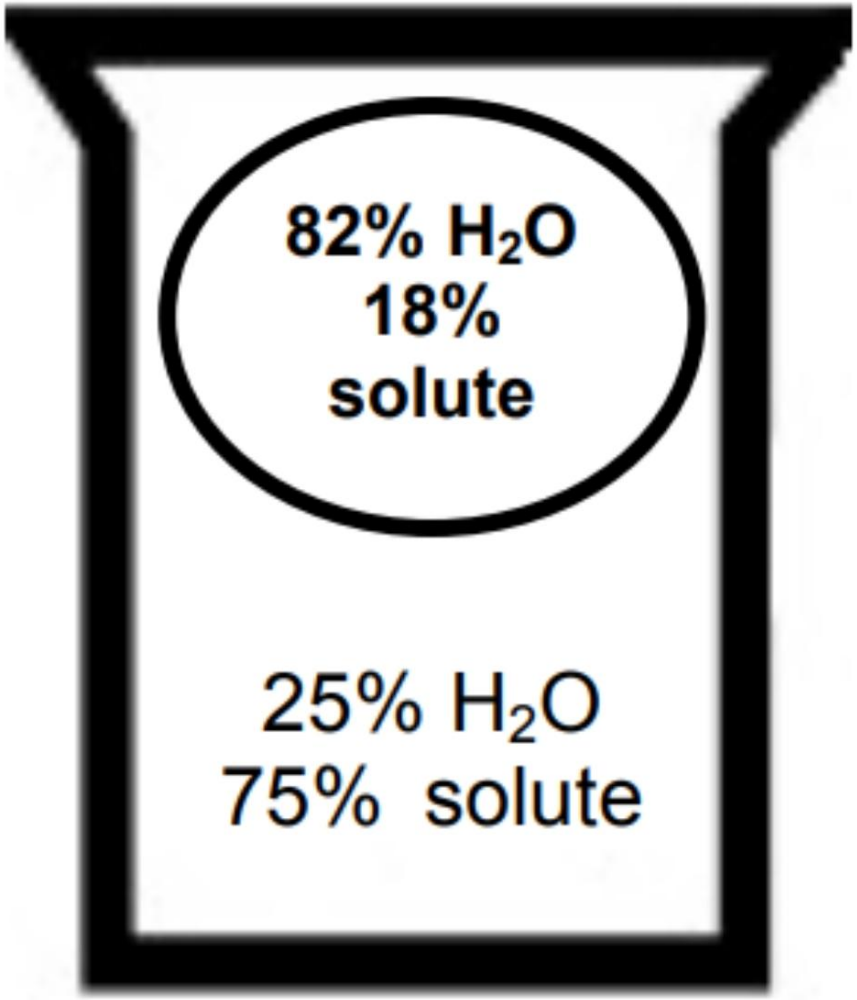

90% H_2O
10%
solute
80% H_2O
20% solute

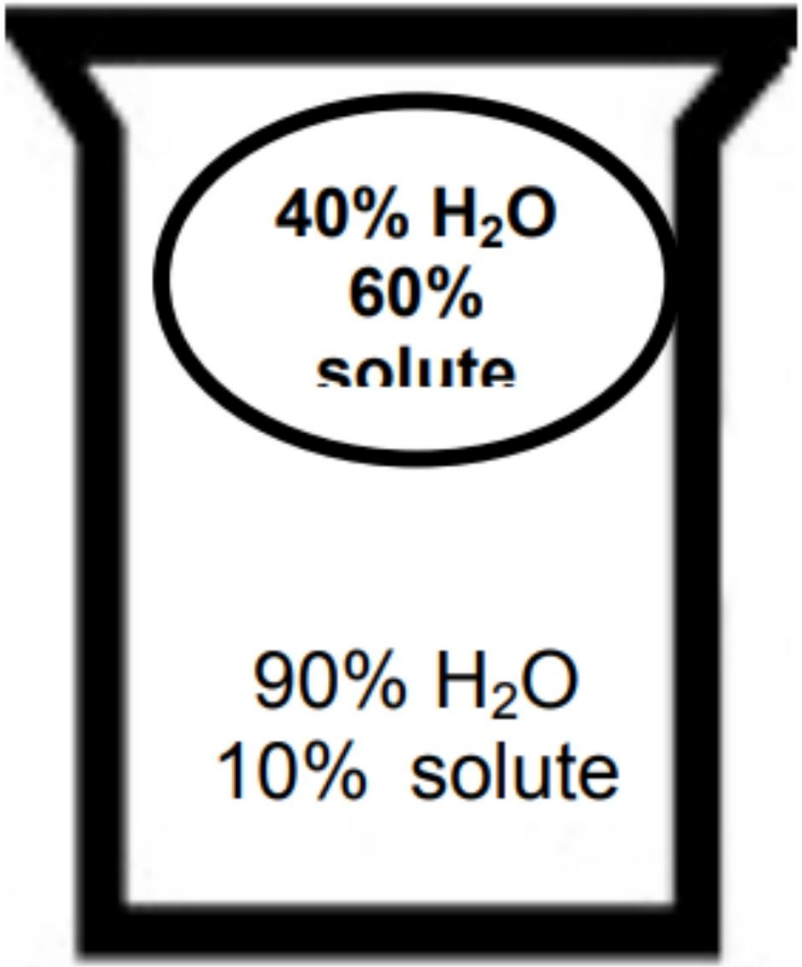
Hypertonic



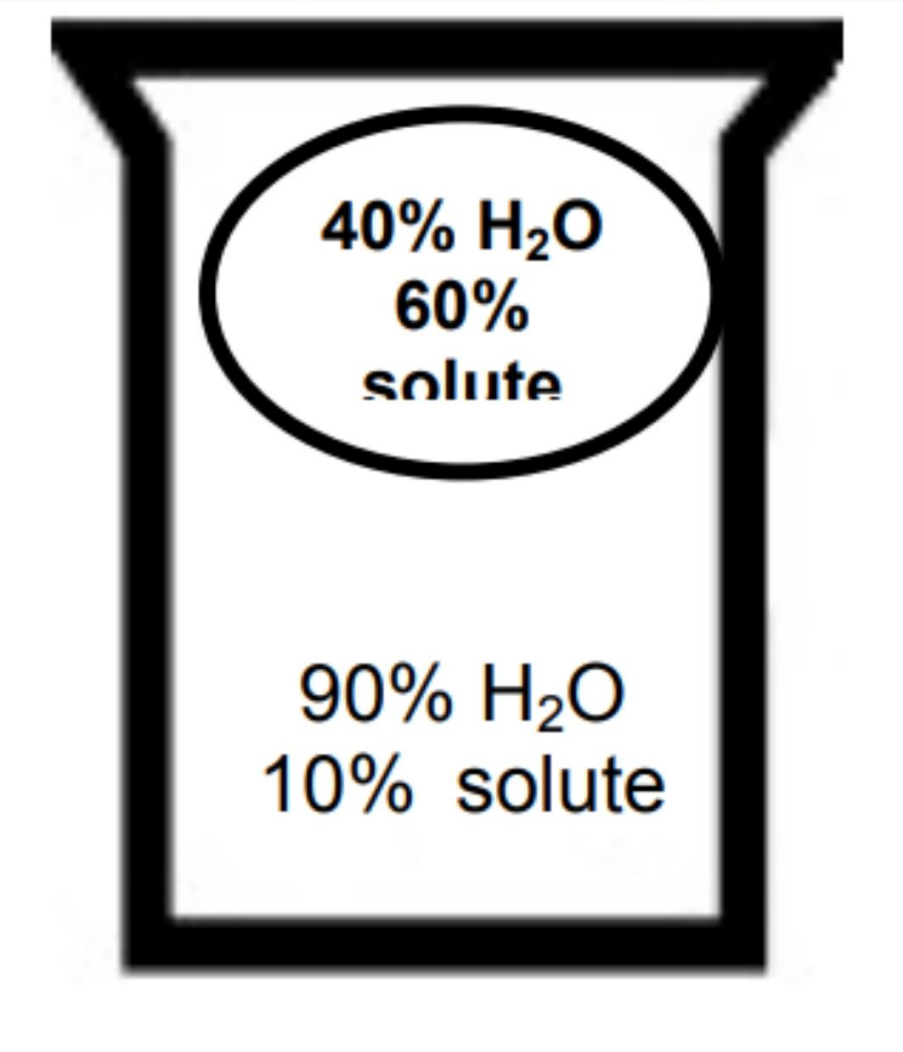

82% H_2O
18%
solute
25% H_2O
75% solute

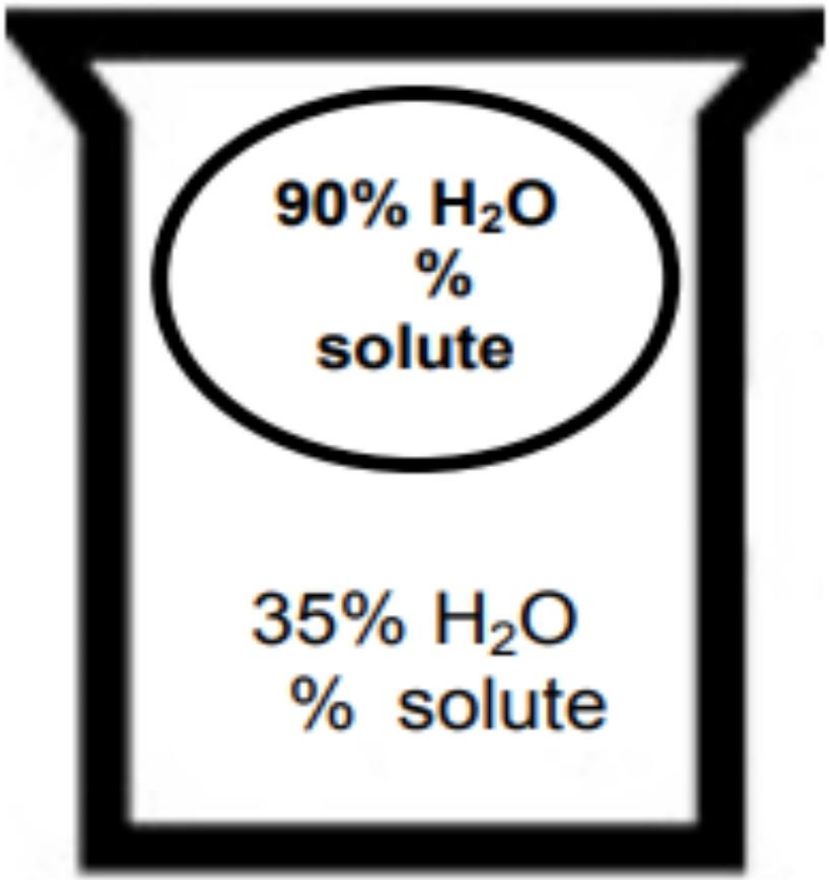
Hypertonic



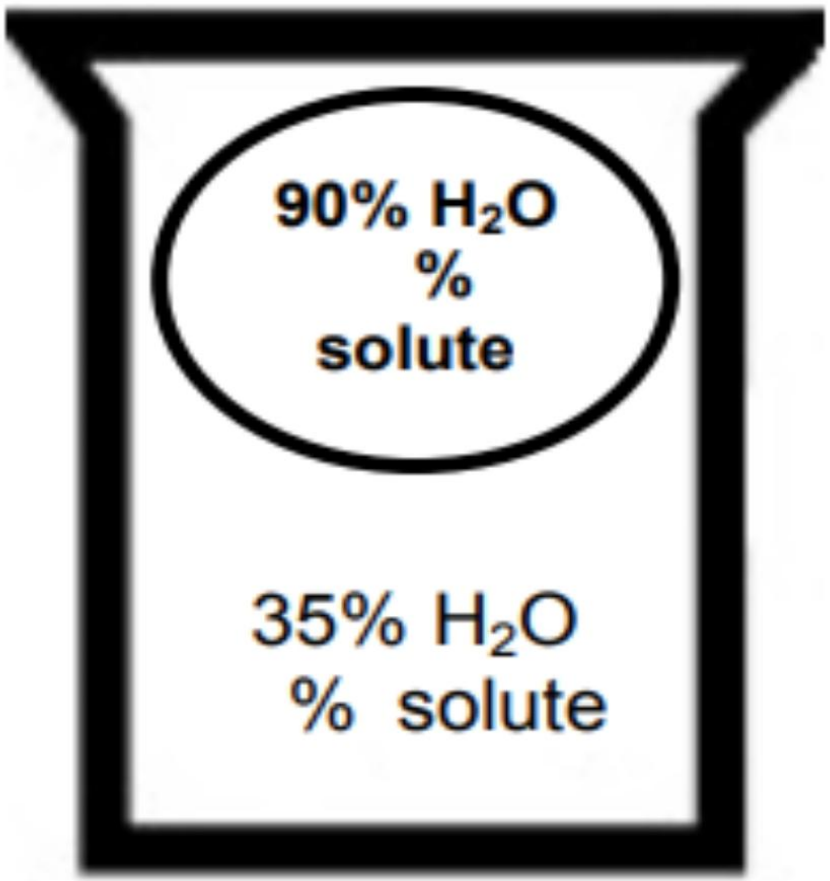

40% H_2O
60%
solute
90% H_2O
10% solute

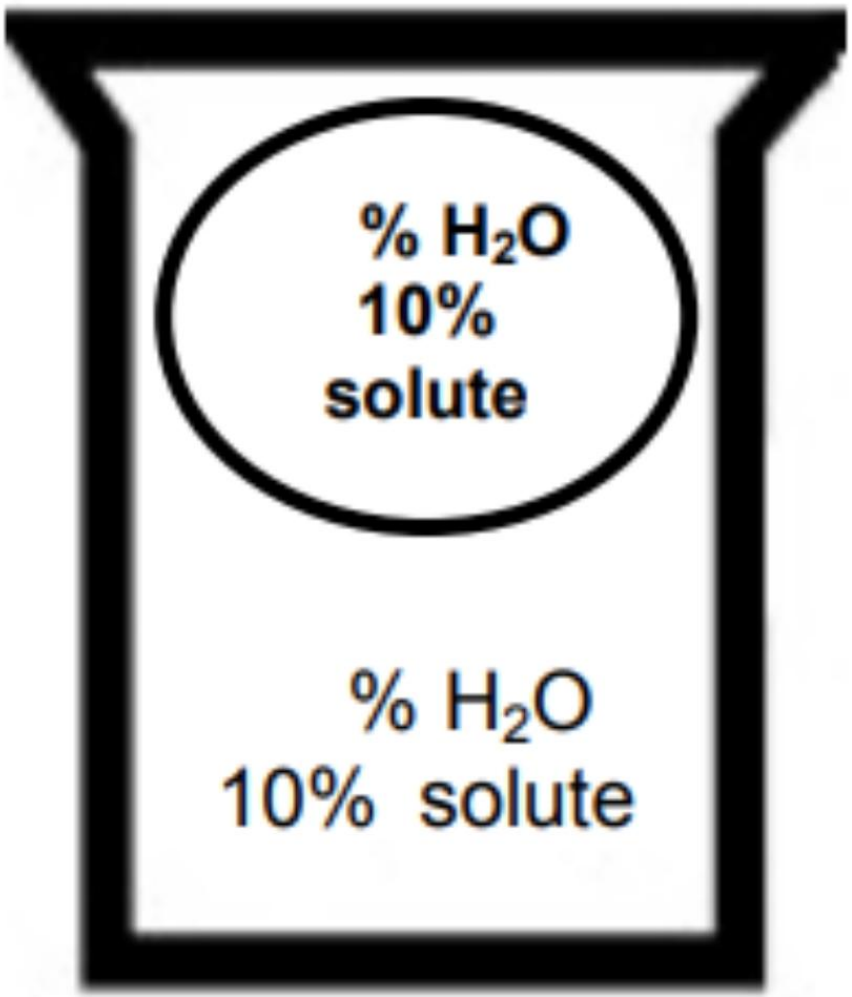
Hypotonic



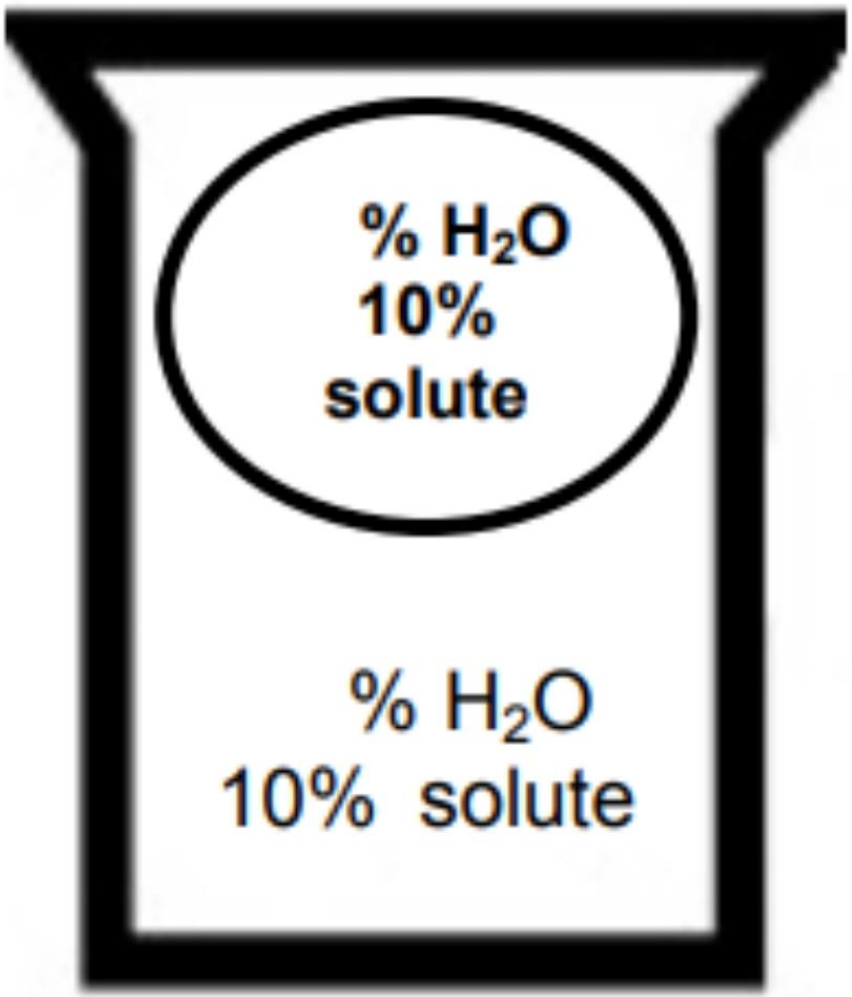

90% H_2O
%
solute
35% H_2O
% solute

Hypertonic



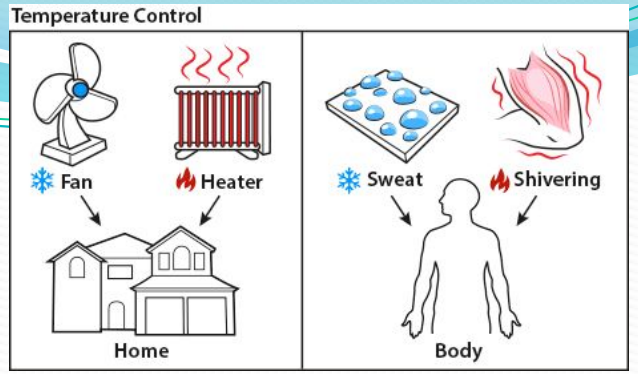

% H_2O
10%
solute
% H_2O
10% solute

Isotonic



Homeostasis

Maintaining Balance



Homeostasis

- The process by which an organism's internal environment is kept in equilibrium (stable) in spite of changes in the external environment
- Examples:
  - Internal Temperature
    - Sweating removes excess body heat
    - Shivering increases heat production
  - Water balance
    - Kidneys adjust water amount in urine
  - A physical response to stress
    - Breathing/heart rate increases
    - Pupils dilate
    - Sweating

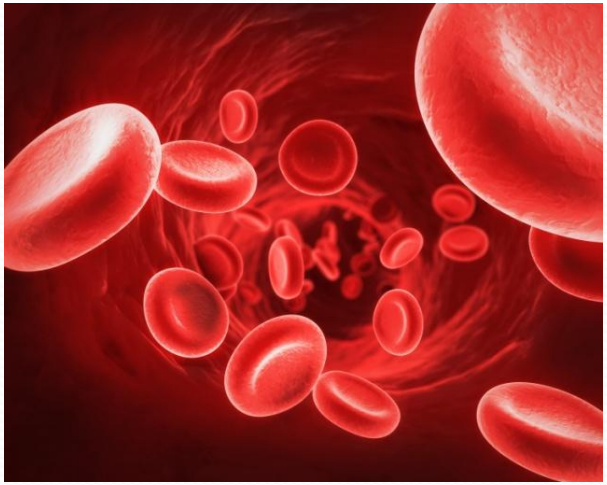
Homeostasis

- Energy production is vital for maintaining homeostasis
- Cells need energy for active transport to maintain homeostasis
- Energy in the form of ATP is used to regulate a cell's
  - delivery of needed molecules
  - rid the cell of toxins
  - to move to avoid danger or find food

Homeostasis in Cells

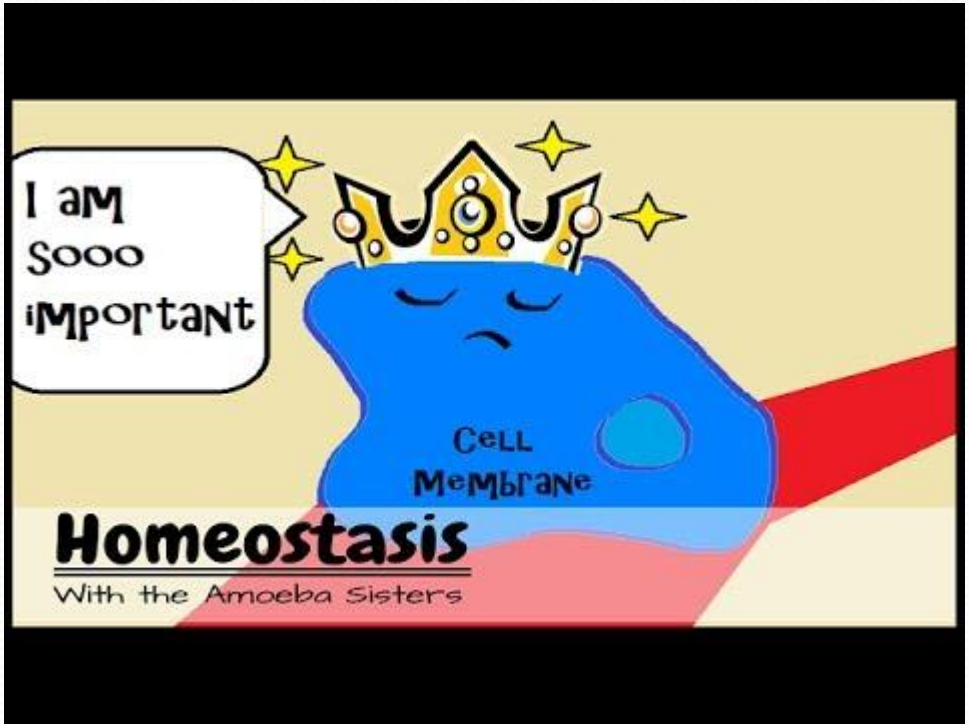
Cells can maintain homeostasis in a number of ways…

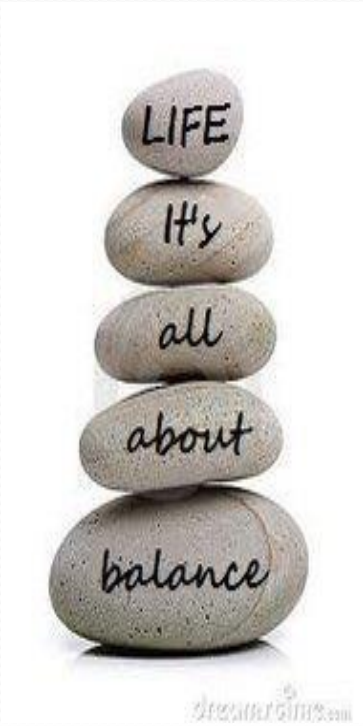
- Controlling substances that cross the membrane
  - Active and Passive transport
  - Buffers



Homeostasis

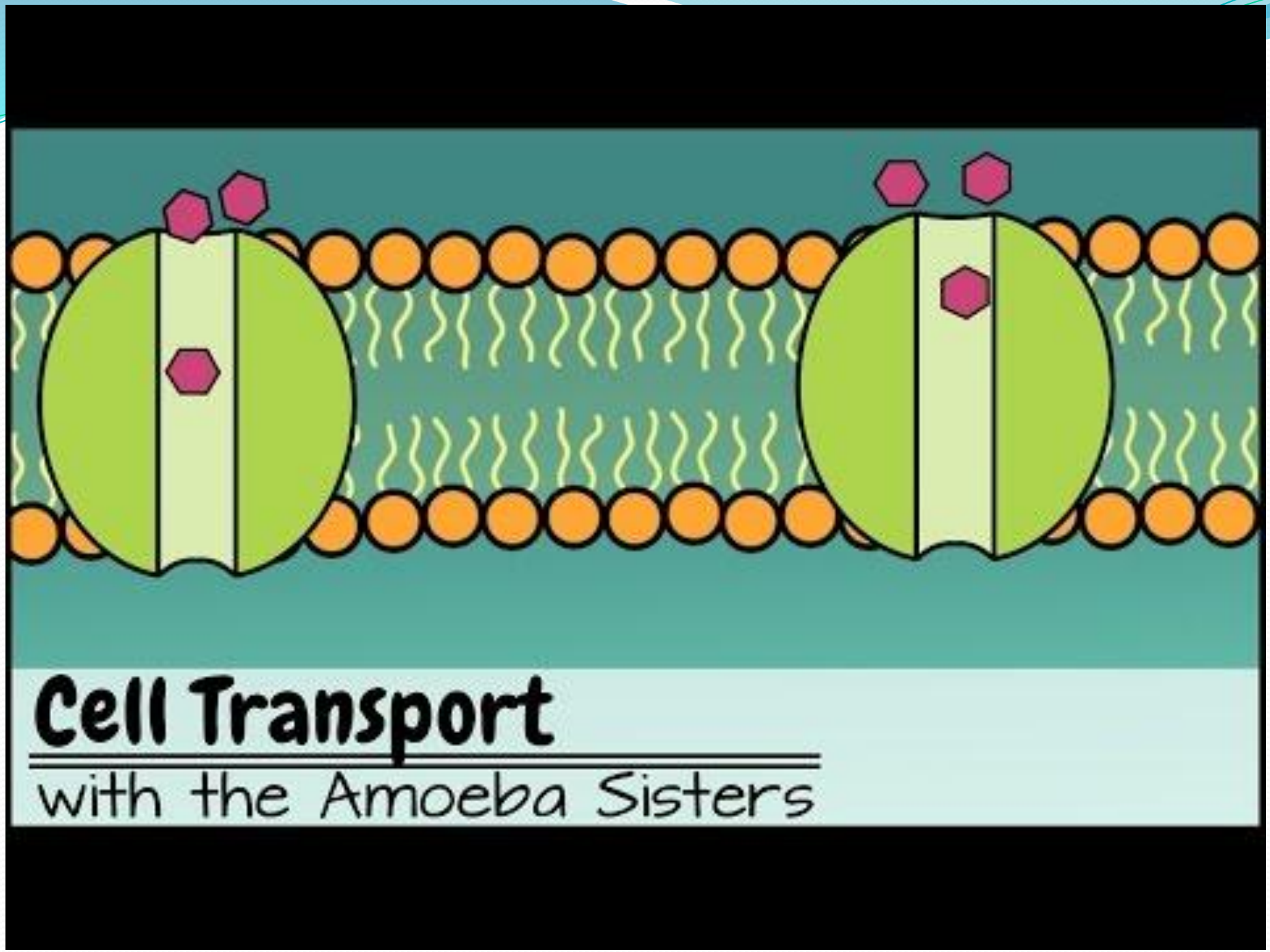
Maintenance of homeostasis is vital for life!





Homeostasis in Cells

- **Buffer-** A chemical that can raise or lower the pH (it can behave like an acid or a base)
  - Cells produce buffers to help maintain a constant pH.
    - Examples:
      - Human blood cells must <u>maintain</u> a pH of 7.35-7.45
      - Cells in stomach maintain a pH of 3
      - Cells in Small Intestine maintain a pH of 6


Cell Transport
with the Amoeba Sisters

Which of the following serves as the cell's boundary from its environment?

a) Mitochondria
b) Cell membrane
c) Chloroplast
d) Channel protein

Which of the following serves as the cell's boundary from its environment?

b.) Cell membrane

Which of the following is a function of the cell membrane?

a) Breaks down lipids, carbohydrates, and proteins in the body
b) Stores water, salt, proteins, and carbohydrates
c) Keeps the cell wall in place
d) Regulates which materials enter and leave the cell

Which of the following is a function of the cell membrane?

d.) Regulates which materials enter and leave the cell

The cell membrane contains channels and pumps that help move materials from one side to the other. What are these channels and pumps made of?

a) Carbohydrates
b) Lipids
c) Bilipids
d) Proteins

The cell membrane contains channels and pumps that help move materials from one side to the other. What are these channels and pumps made of?

d.) Proteins

Diffusion is the movement of molecules from:

a) An area of low concentration to an area of high concentration
b) An area of high concentration to an area of low concentration
c) An area of equilibrium to an area of high concentration
d) All of the above

Diffusion is the movement of molecules from:

B.) An area of high concentration to an area of low concentration

When the concentration of molecules on both sides of the membrane is the same, the molecules will:

a) Move across the membrane to the outside of the cell
b) Stop moving across the membrane
c) Move across the membrane in both directions
d) Move across the membrane to the inside of the cell

When the concentration of molecules on both sides of the membrane is the same, the molecules will:

C.) Move across the membrane in both directions

The diffusion of water across a selectively permeable membrane is called:

a) Osmotic pressure
b) Osmosis
c) Facilitated diffusion
d) Active transport

The diffusion of water across a selectively permeable membrane is called:

b.) Osmosis

An animal cell that is surrounded by fresh water will burst because the osmotic pressure causes:

a) Water to move into the cell
b) Water to move out of the cell
c) Solutes to move into the cell
d) Solutes to move out of the cell

An animal cell that is surrounded by fresh water will burst because the osmotic pressure causes:

a.) Water to move into the cell

Which means of particle transport requires input of energy from the cell?

a) Diffusion
b) Osmosis
c) Facilitated Diffusion
d) Active Transport

Which means of particle transport requires input of energy from the cell?

d.) Active Transport