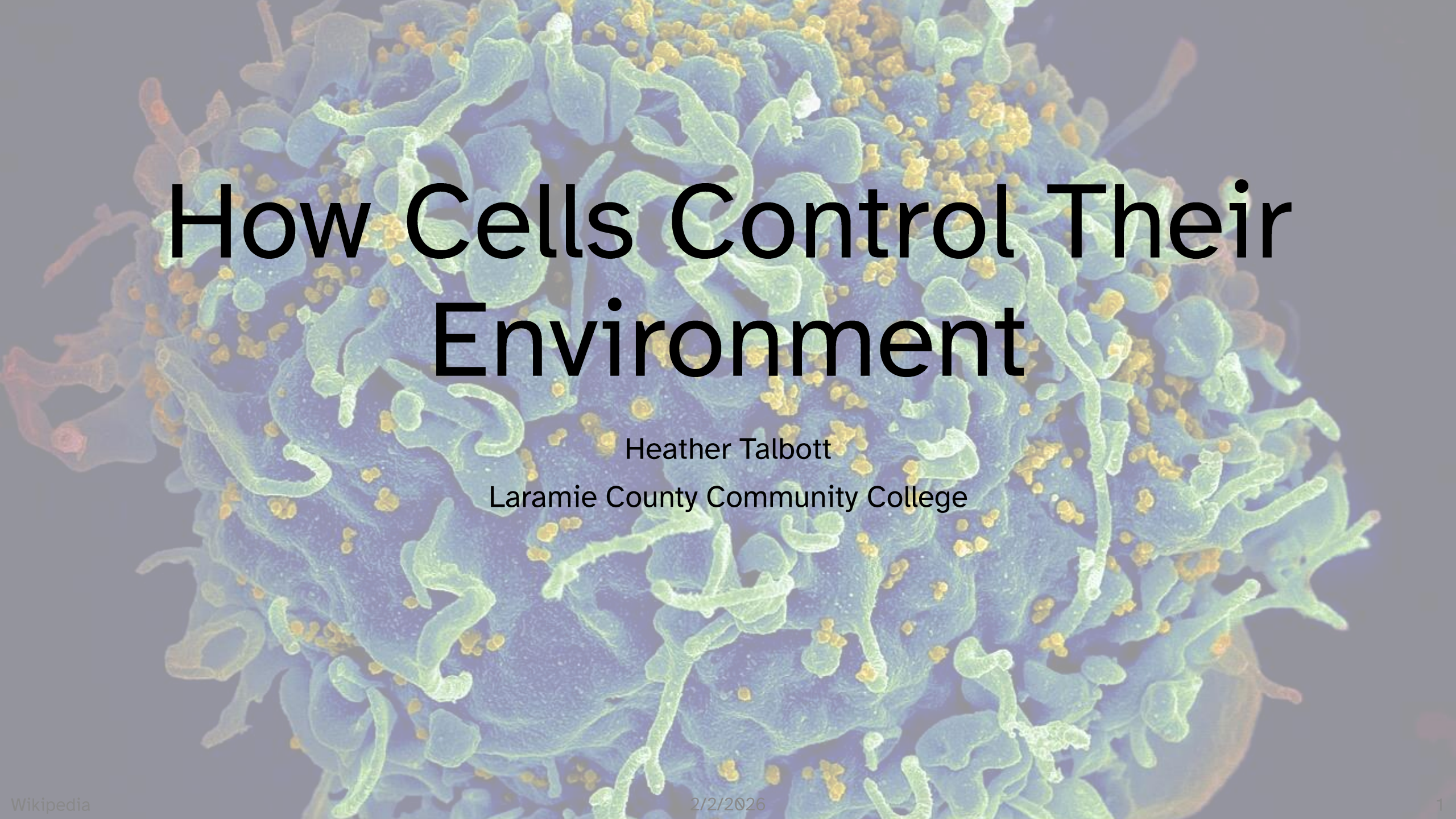


How Cells Control Their Environment

Heather Talbott

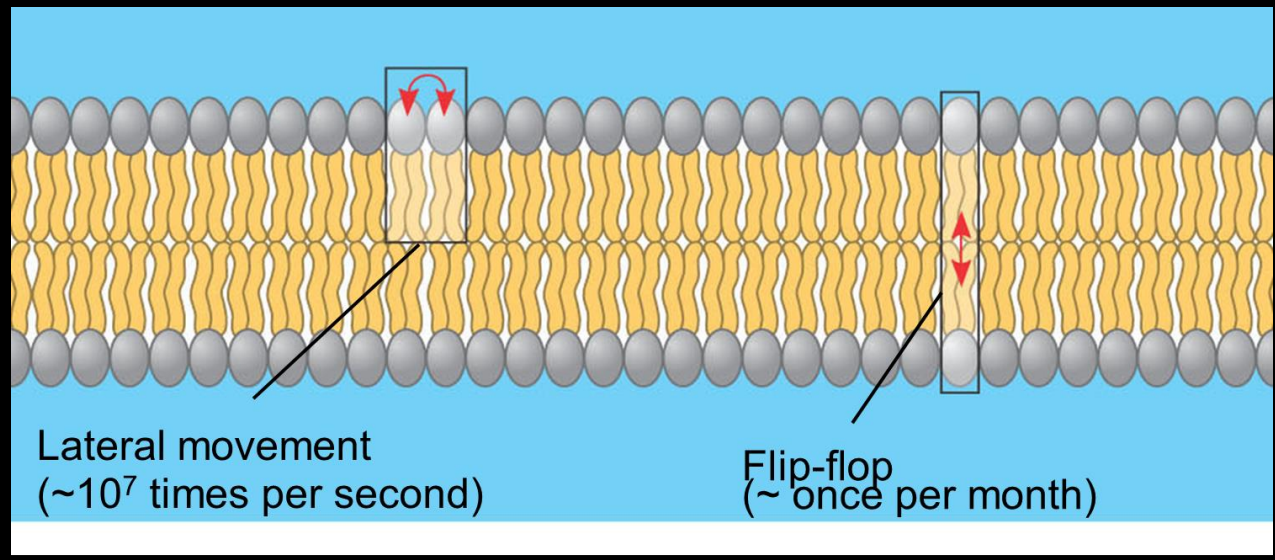
Laramie County Community College

Wikipedia

Everything in physiology is about how cells survive, communicate, and work together.

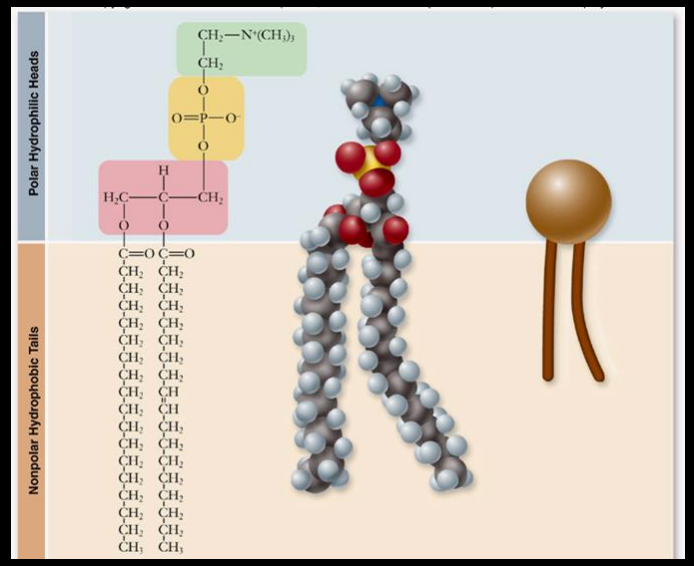
Membranes

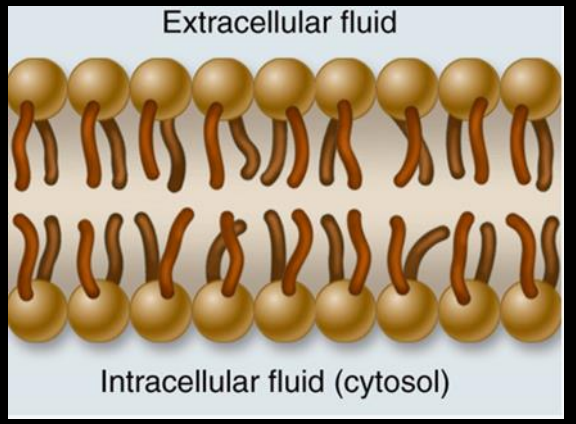
- All cells and organelles are surrounded by membranes
- Membranes function to:
  - Separate compartments
  - Control molecular traffic in and out
- Membranes are selectively permeable
  - Some substances can cross easily and others can not get across



Membrane structure

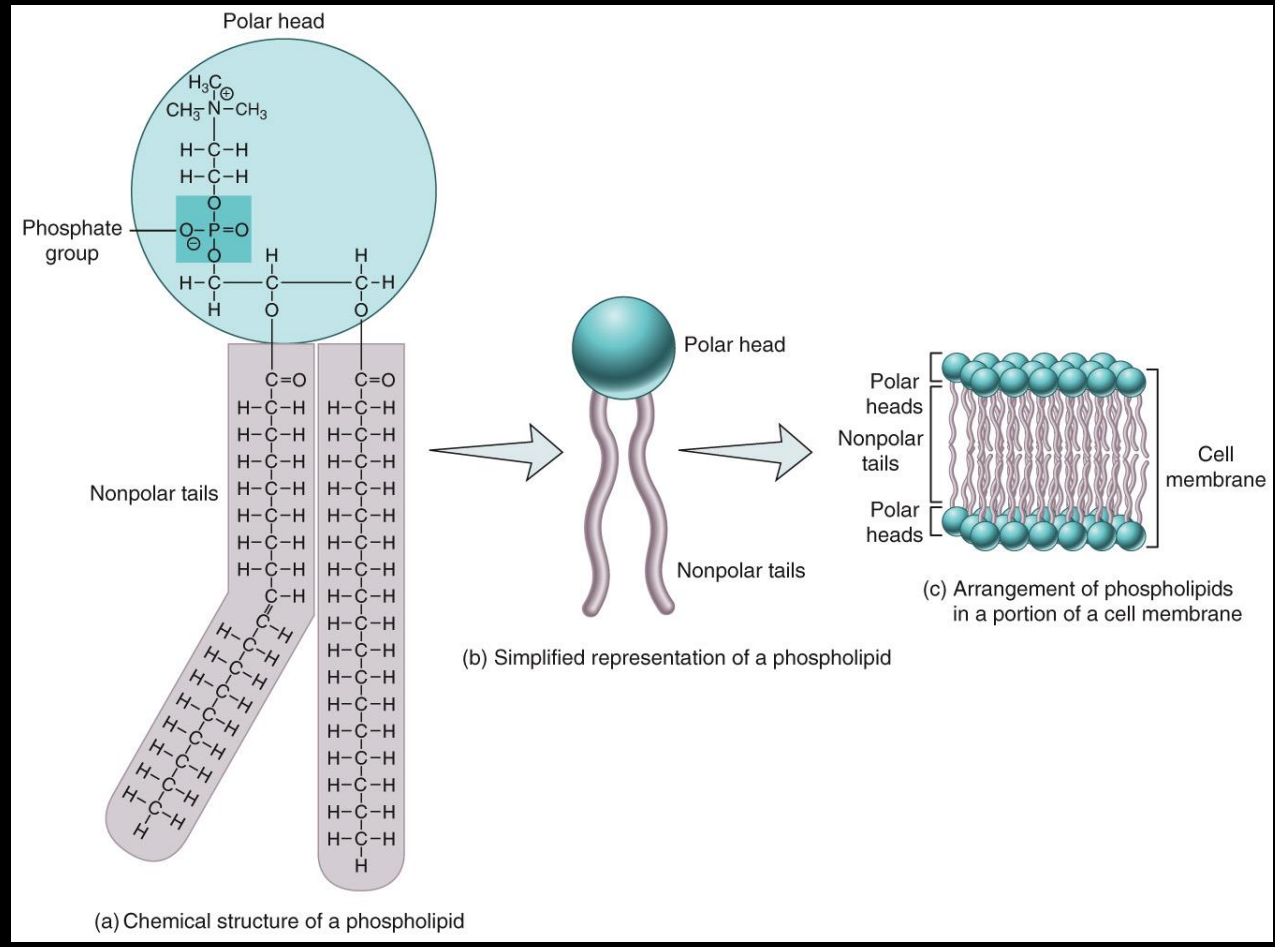
- Membranes are ~50% phospholipids
- They automatically form into a bilayer with the fatty acid ends attracted to each other





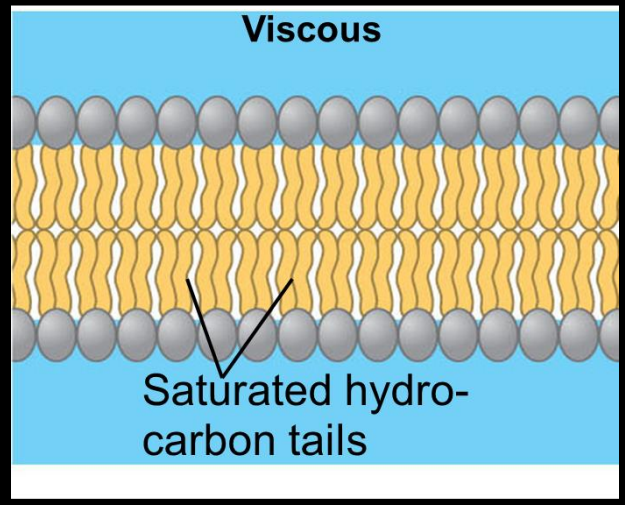
Phospholipids

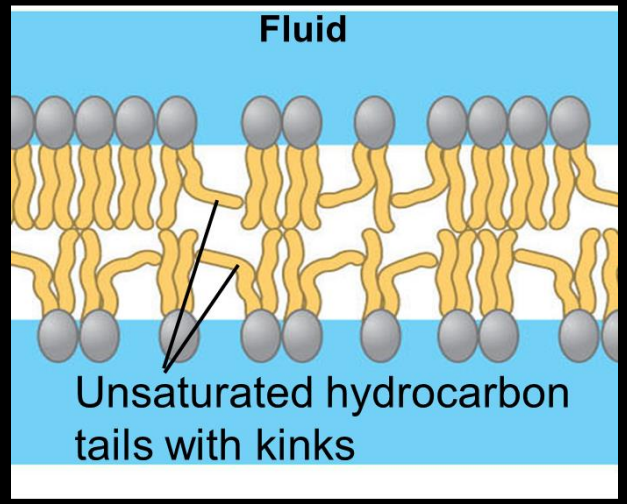
- **Phospholipids**: a lipid that has two nonpolar tails and a polar head
- When in water phospholipids will automatically create a **bilayer**.
  - The nonpolar lipid tails will face each other to stay away from the water
  - The polar heads will face away from the tails and toward the water



Membrane fluidity

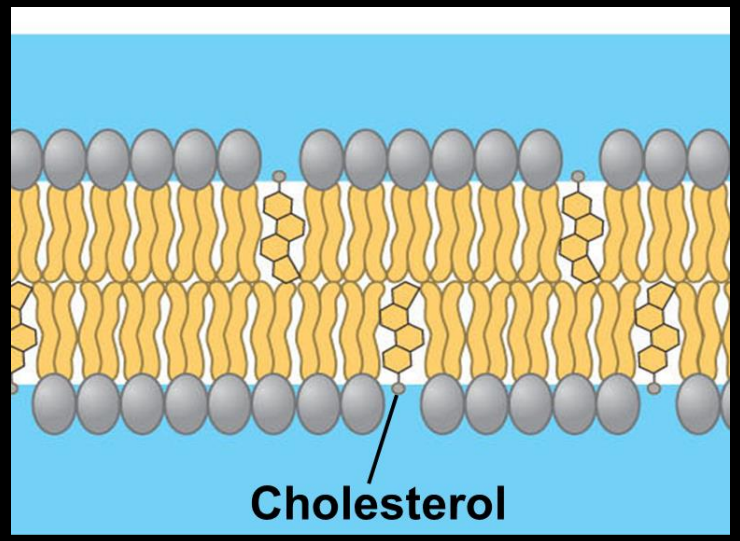
- The fluidity of the membrane is impacted by:
  - Temperature
    - cold temperatures make the membrane less fluid than warm temperatures
  - Level of saturation of the fatty acid tails
    - saturated fatty acids make the membrane less fluid than unsaturated fatty acids





Cholesterol

- The steroid cholesterol is hydrophobic and can help keep membranes fluid in certain organisms (e.g. mammals) by “breaking up” the lipids, particularly at low temperature



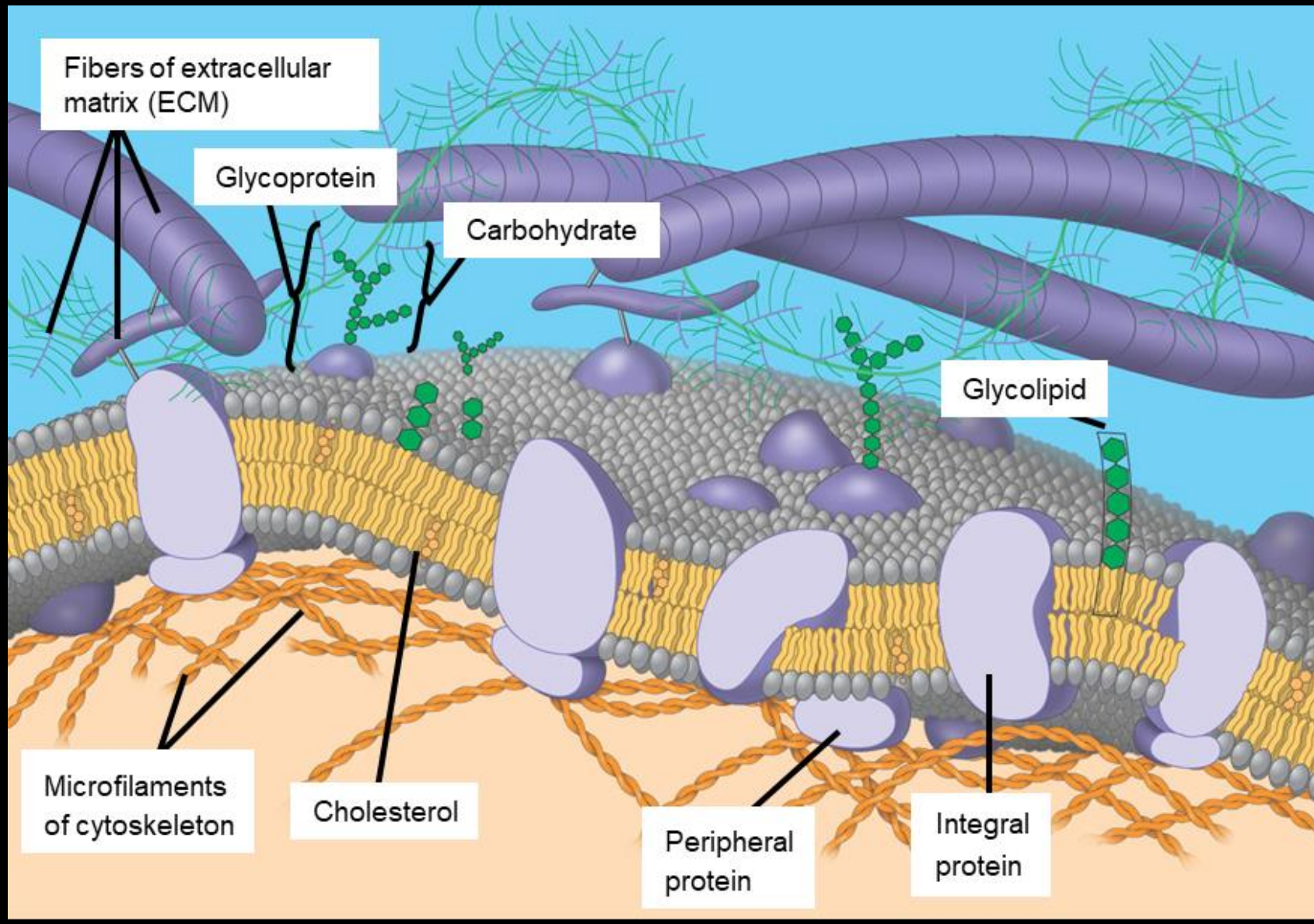
Membrane proteins

Membranes are also ~50% proteins with various functions

The proteins in the membrane can be:

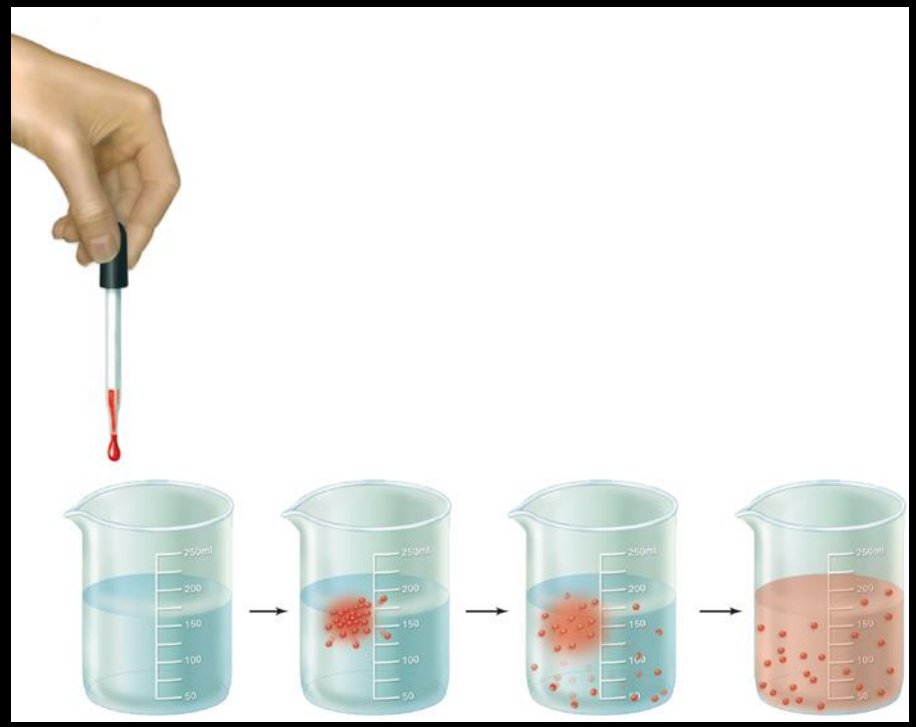
Peripheral: on cytoplasmic or extracellular side

Integral: span the membrane



Diffusion

- Diffusion is the movement of molecules from high to low concentration
- Amount of substance in a defined space/volume
- Diffusion moves down the concentration gradient



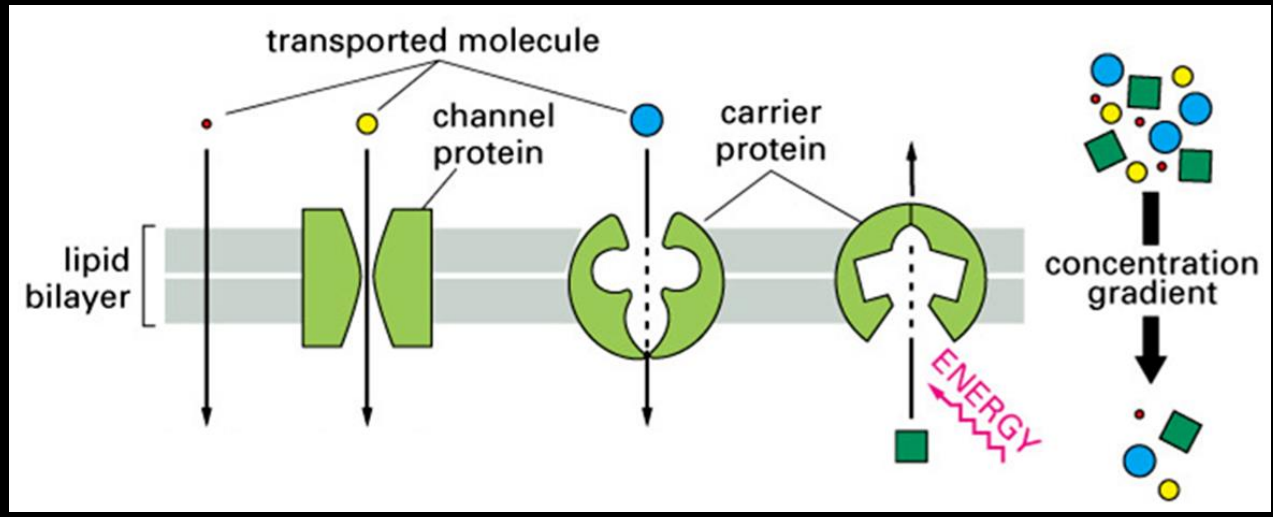
Movement across Membranes

- Molecules that can diffuse directly across the lipid bilayer are small and nonpolar molecules
  - O_2, CO_2

- Larger polar molecules and ions must use transport proteins to get across the membrane

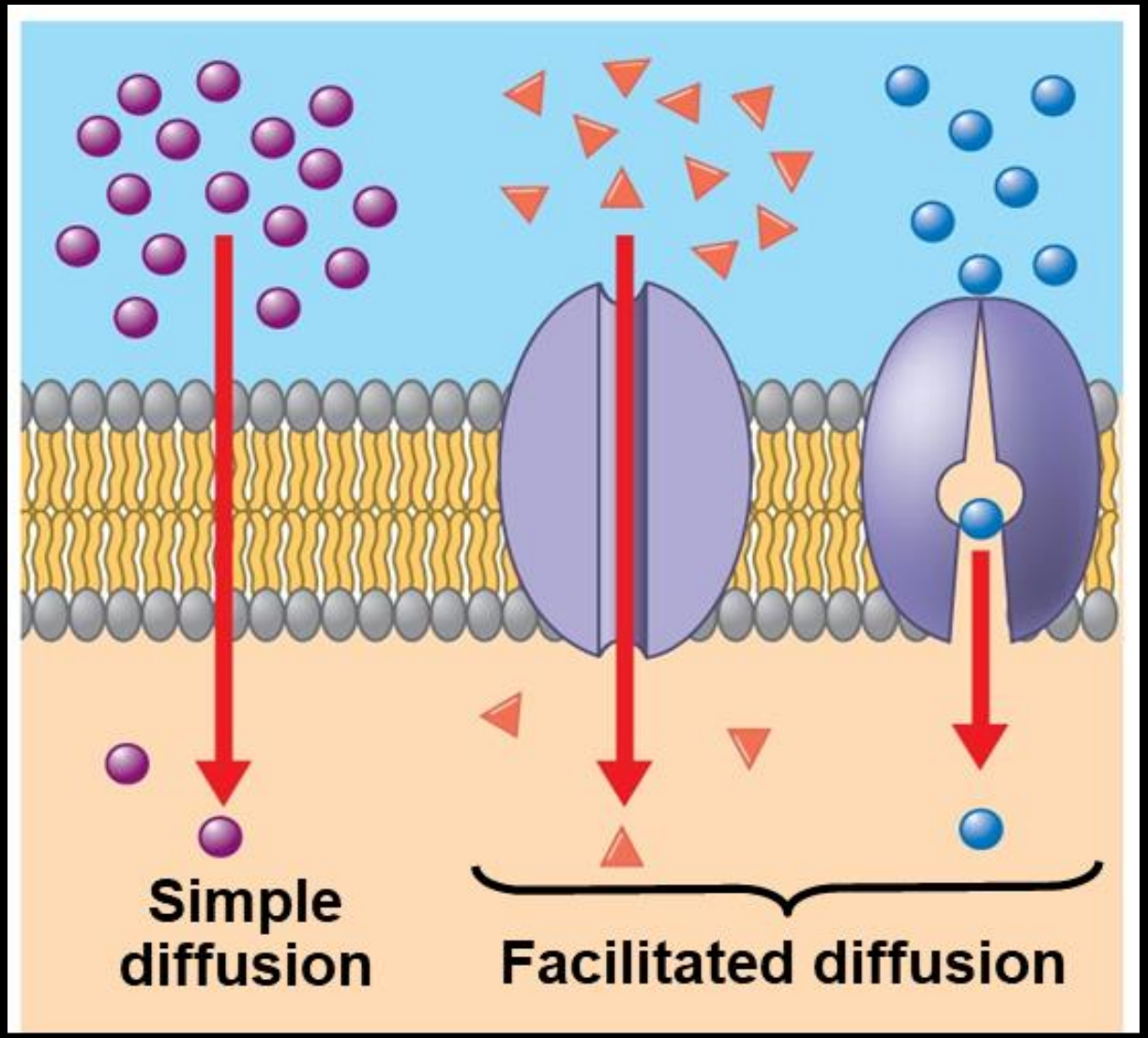
Membrane transport

- For a molecule to cross the membrane, it has to either:
- Directly cross through the lipids
- Cross through a protein



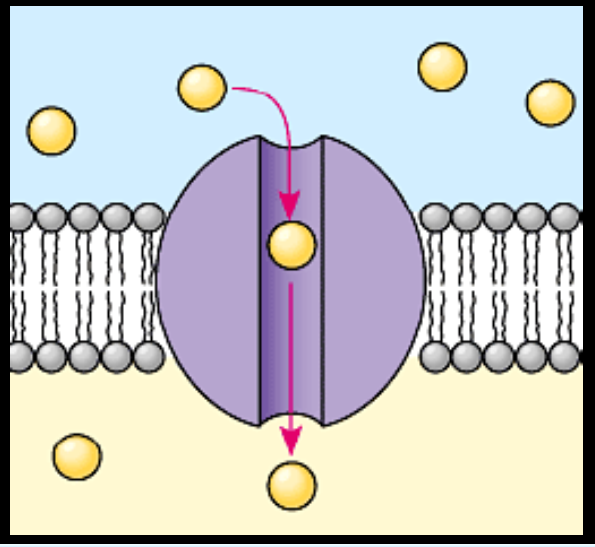
Passive transport

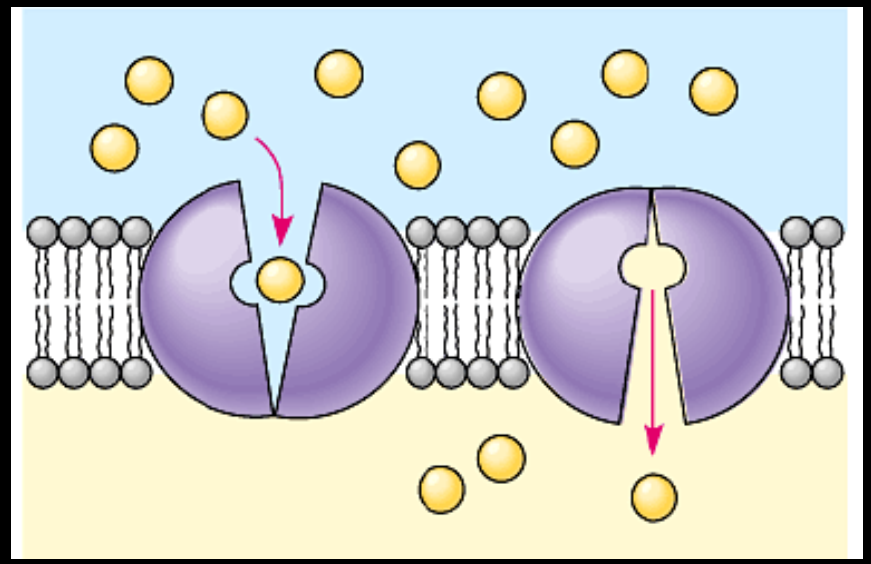
- Passive transport can be either simple diffusion or facilitated diffusion
- **Simple diffusion**: uncontrolled movement across the membrane
- **Facilitated diffusion**: makes use of a channel or carrier protein
  - This type of transport protein allows a specific molecule or ion to cross the membrane based on its size and shape



Facilitated diffusion proteins

- **Channel proteins** allow fast transport
- **Carrier proteins** are very specific for their transport molecule
- Reminder…no energy required for either of these when used in passive transport





Active transport proteins

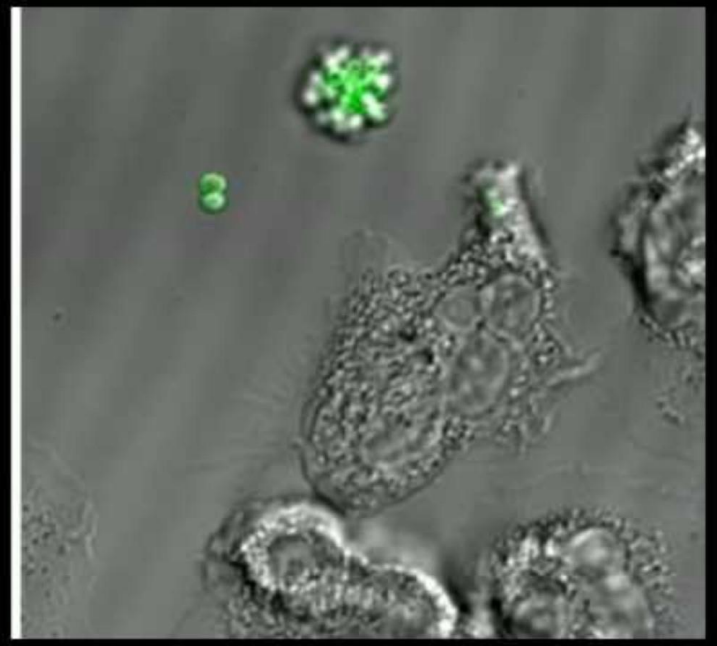
- Specialized proteins used in active transport include:
- uniporters – move one molecule at a time
- symporters – move two molecules in the same direction
- antiporters – move two molecules in opposite directions

- Greek:
- Uni- = singular
- Sym- = together
- Anti- = against or opposed
- *porta* = gate or door

Bulk Transport

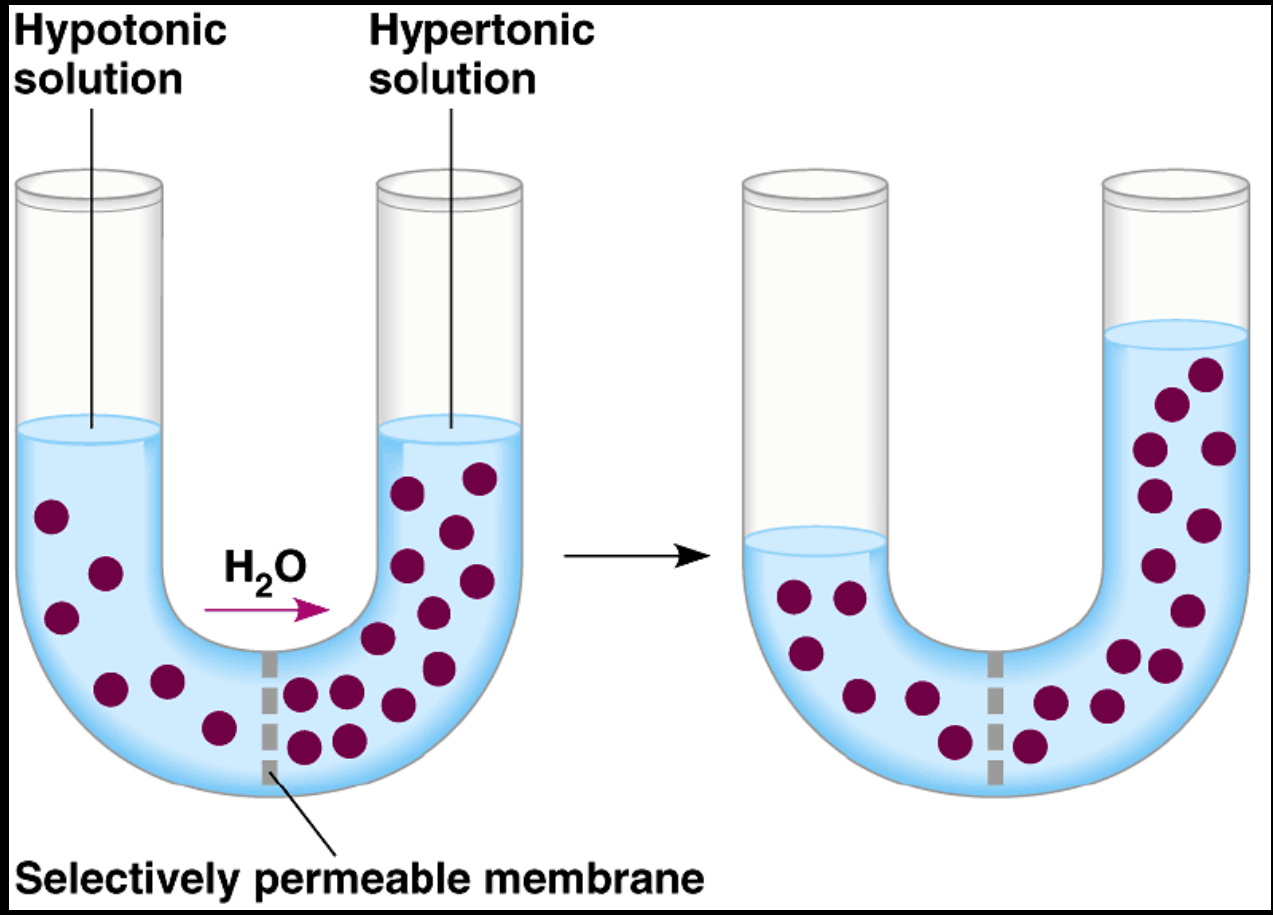
- Bulk transport of substances is accomplished by
- endocytosis – movement of substances into the cell (e.g. phagocytosis)
- exocytosis – movement of materials out of the cell
- Requires ATP

- Greek:
- endo- = within
- exo- = out
- -cyto = hollow place, cell
- -osis = condition of (Latin)

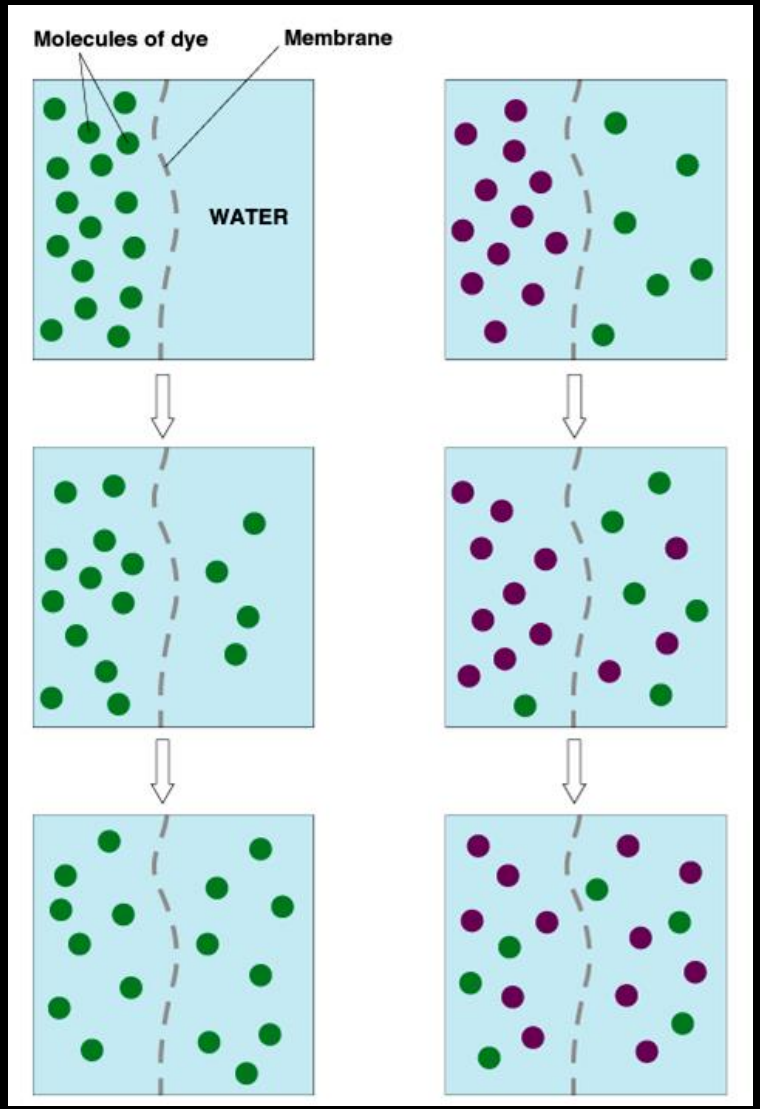


Osmosis

- **Osmosis**: the transport of water across a membrane is called
- The water will always travel to where there are more solutes (sugar, salt, etc.) and less water
- If the solutes cannot pass the membrane, the water will move to make the concentrations equal via osmosis

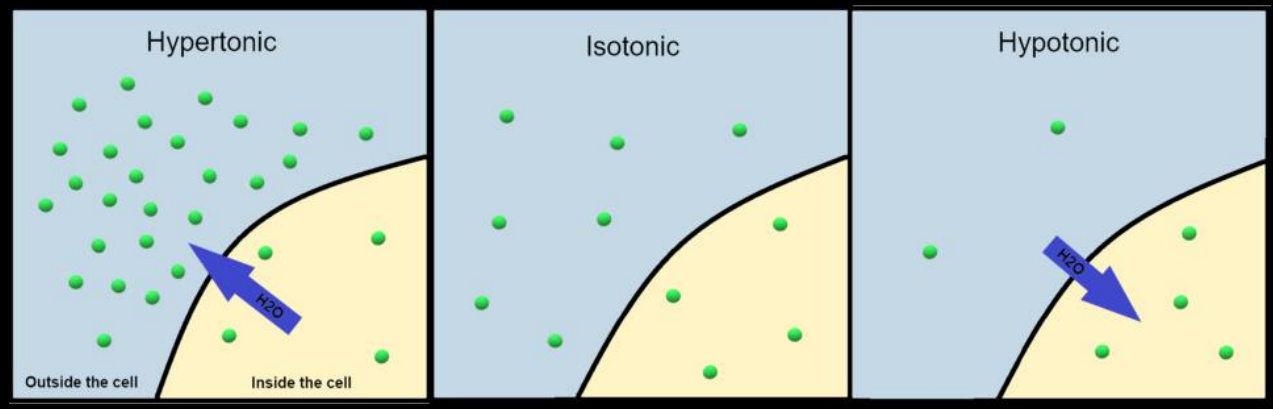


- The direction of osmosis is determined only by a difference in total solute concentration
- The kinds of solutes in the solutions do not matter
- When two solutions have equal solutes, there is still movement, but no net osmosis



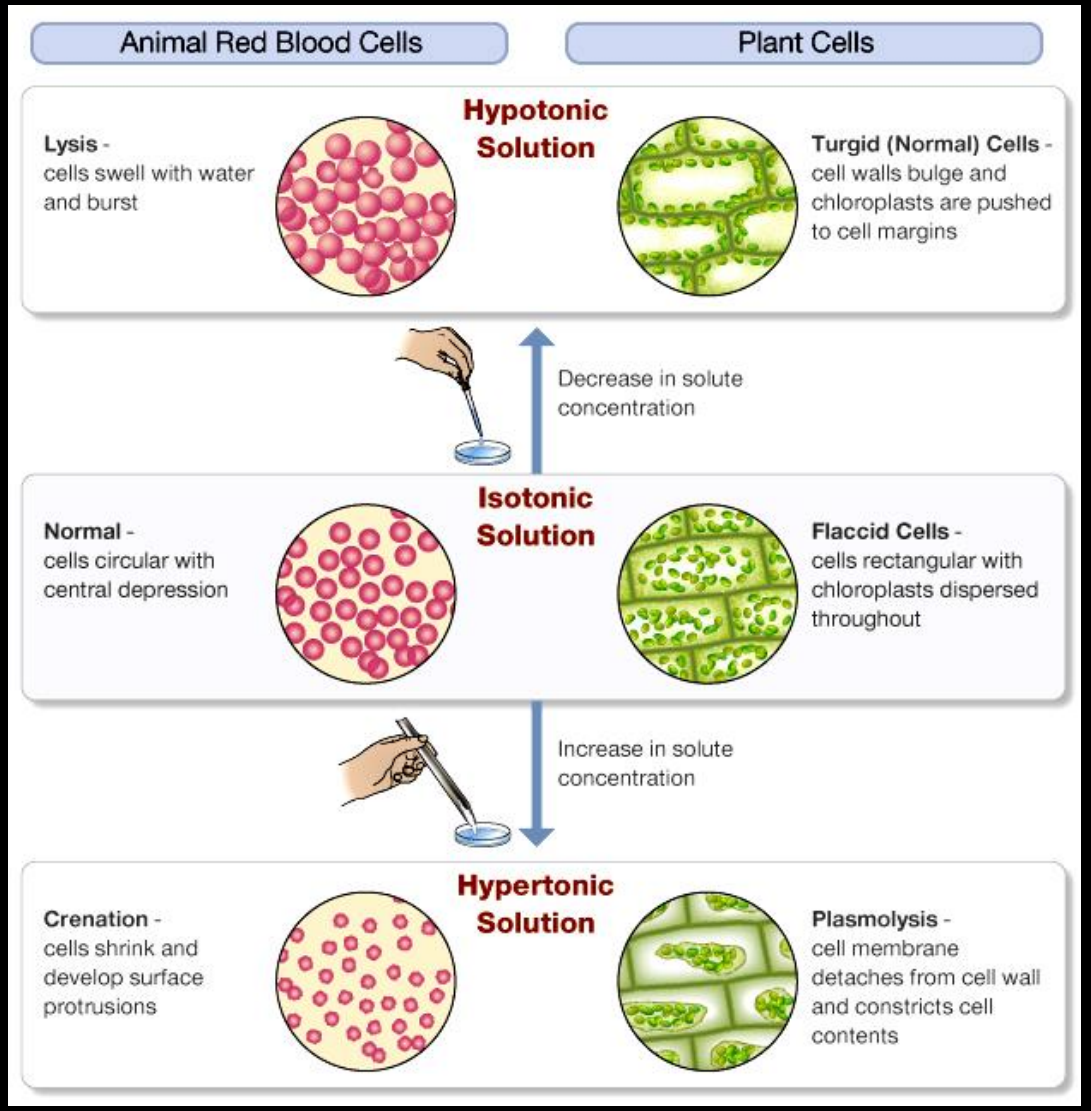
Tonicity

- Two solutions on either side of a membrane can have three possible names regarding osmosis:
- **Hypertonic:** this solution has more solutes
- **Hypotonic:** this solution has less solutes
- **Isotonic:** this solution has the same number of solutes as the solution on the other side of the membrane



Swelling and Shrinking of Cells

- Cell size depends on the surrounding solution
- **Lysis**: animal cells swell so much they burst, occurs in hypotonic environments
- **Crenation**: animal cells shrink in hypertonic environments

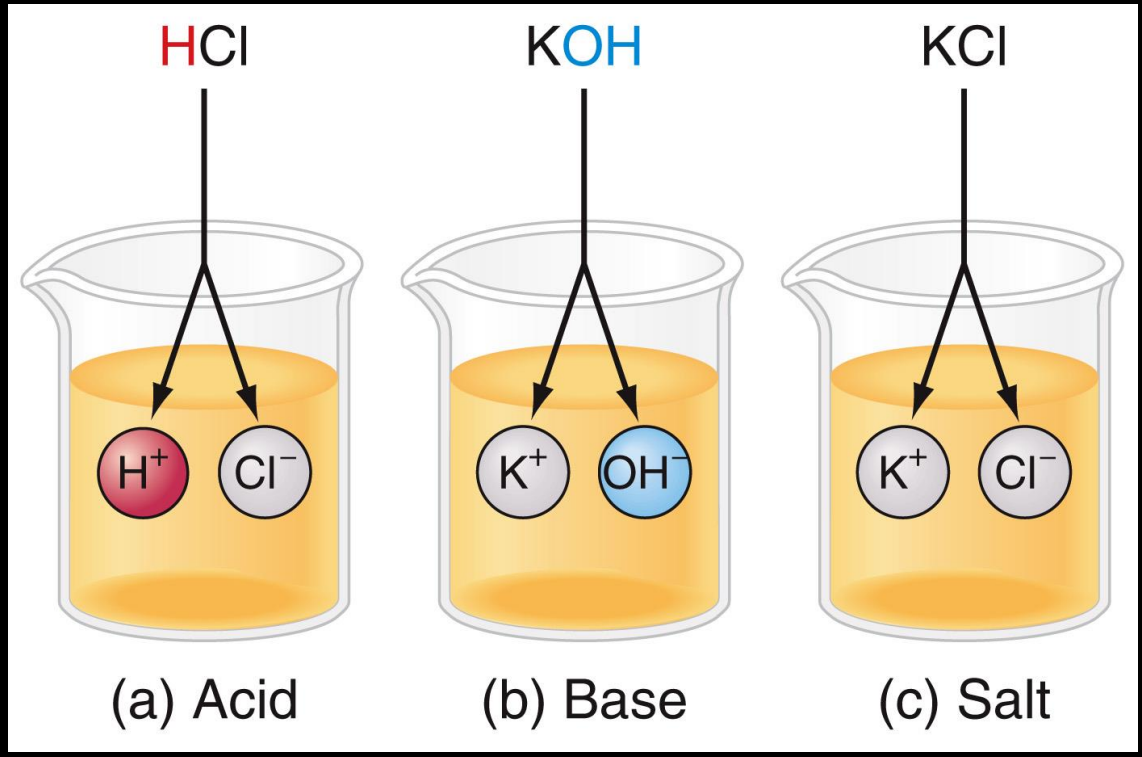


IV Fluids

- IV fluids affect water movement in and out of cells
- The salt concentration of an IV matters
  - Isotonic IV (Normal Saline, 0.9% NaCl) for stability
  - Hypotonic IV used when patient is dehydrated
  - Hypertonic IV used to reduce swelling

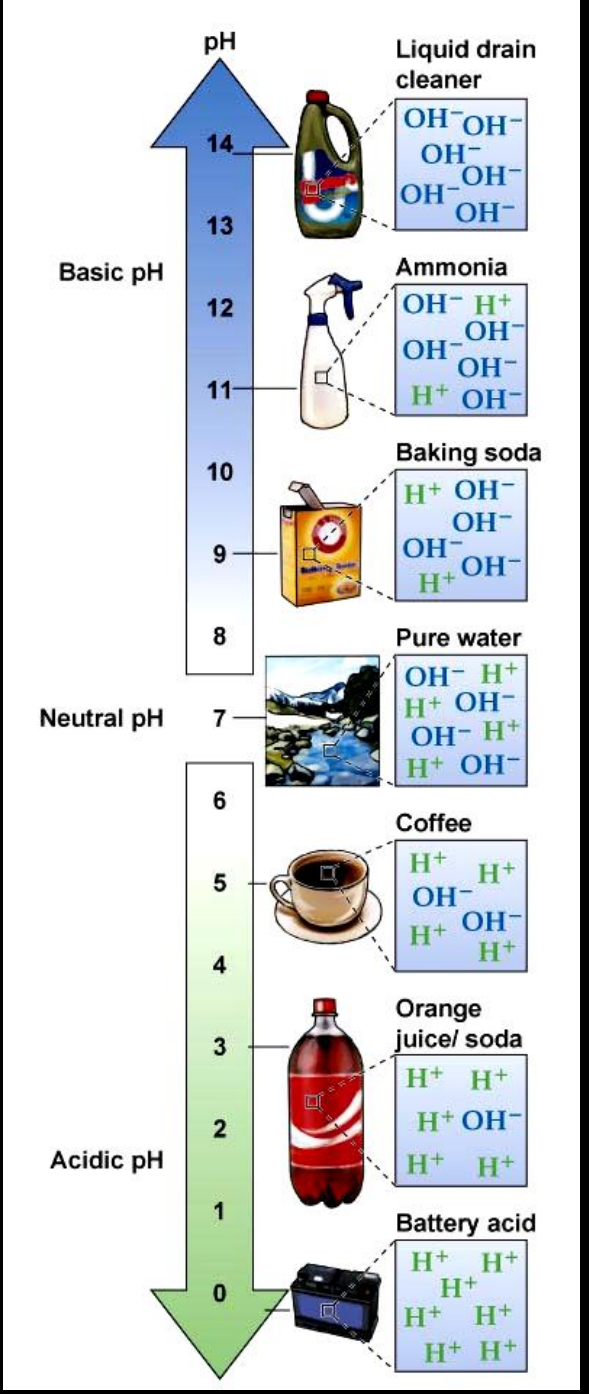
Acids, Bases, and Salts

- When molecules dissolve in water some dissociate and separate into ions in solution
- Acid: substance that dissociates and adds one or more hydrogens ions (H+) into solution; proton donor
- Base: substance that dissociates and adds one or more hydroxide ions (OH-) into solution (or removes a proton; proton acceptor
- Salt: dissociates into cations and anions, neither of which is H+ or OH-

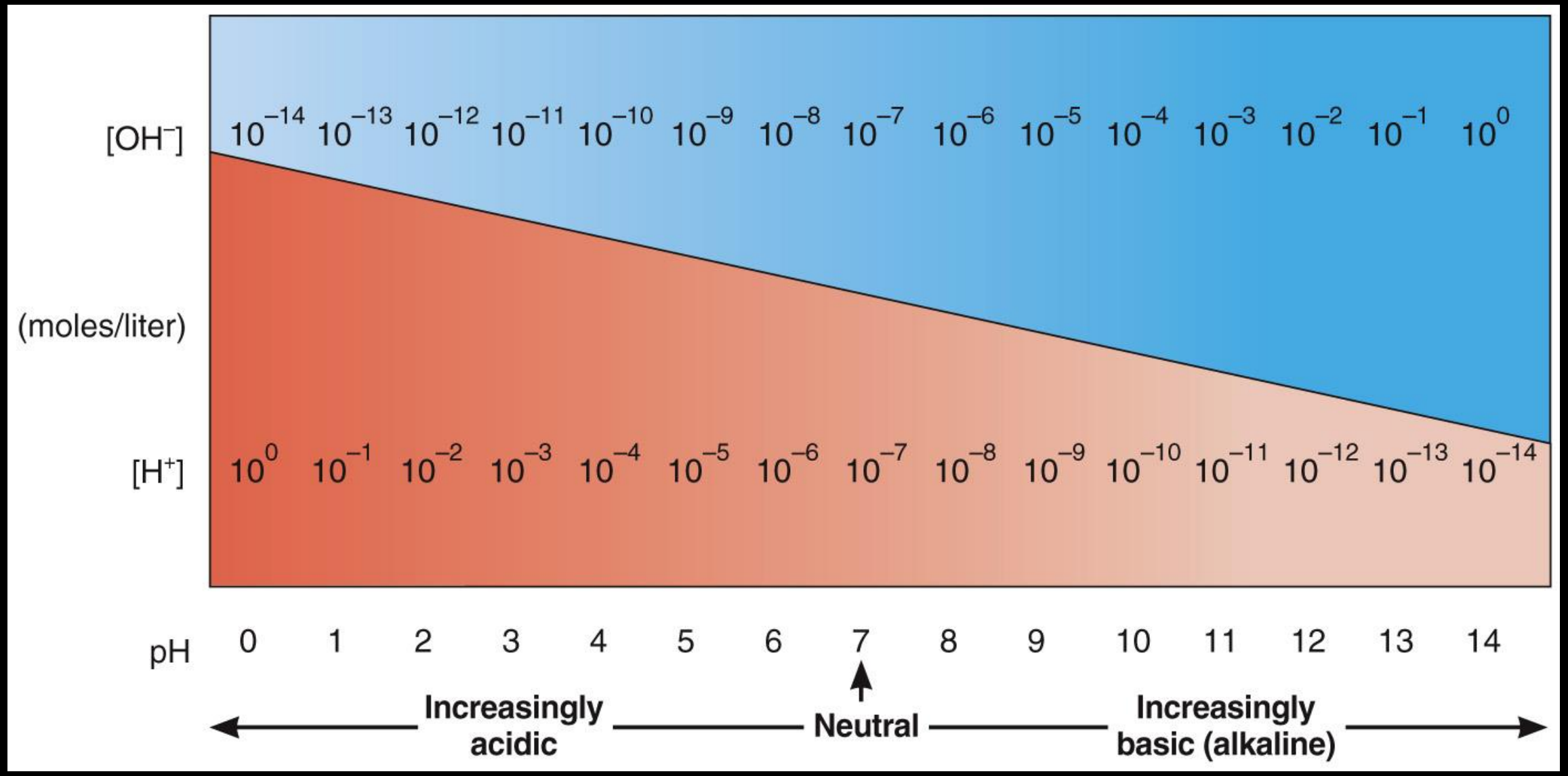


pH

- **<u>pH scale</u>: the amount of H+ in solution and represents a** solution's acidity or alkalinity
  - Logarithmic scale from 0-14
  - Calculation pH = -log[H+]
  - 0–6 is acidic
  - 7 is neutral
  - 8–14 is basic
- Blood pH normal range = 7.35-7.45

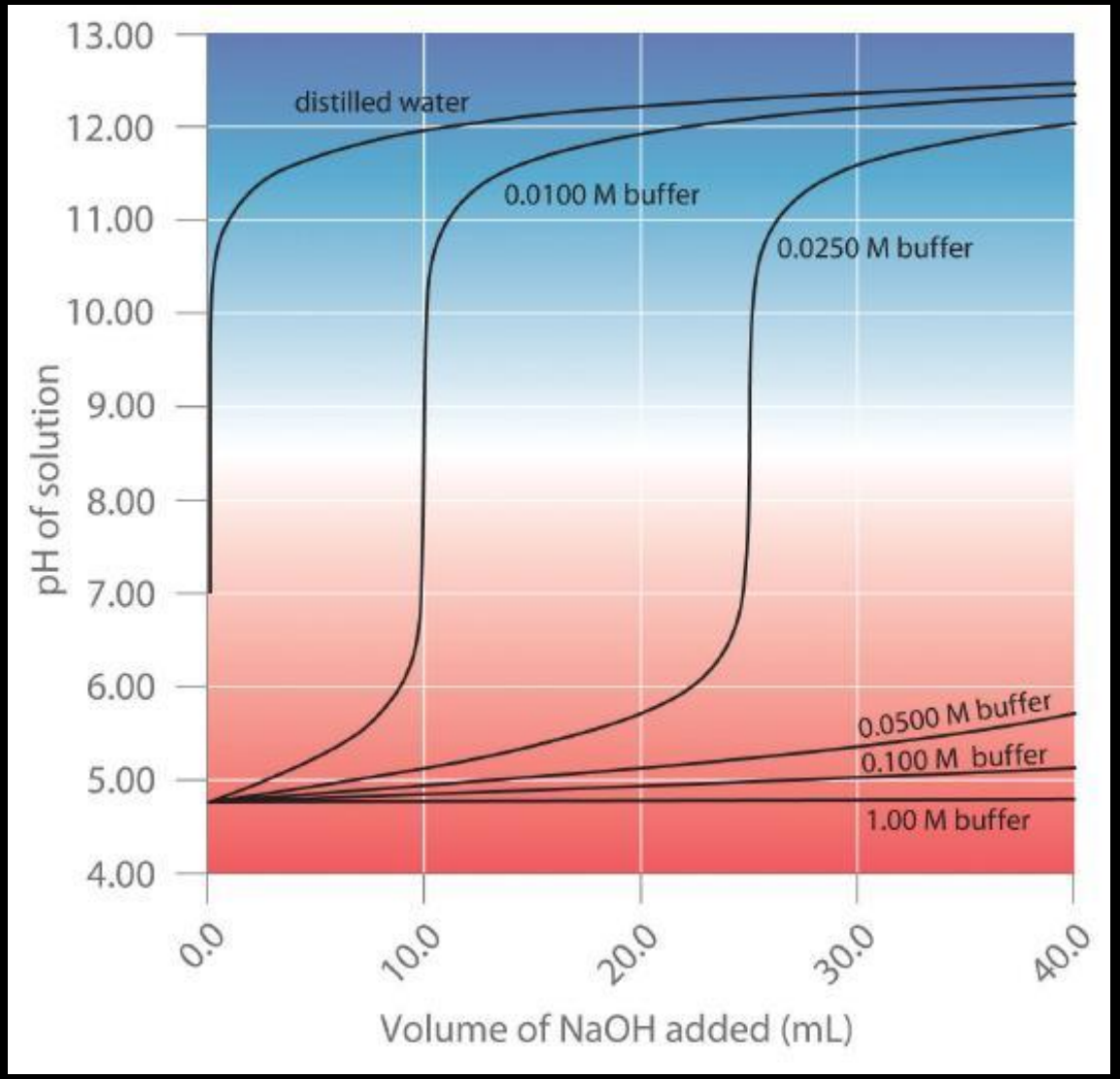


pH Scale


[OH⁻]
(moles/liter)
[H⁺]
10⁻¹⁴ 10⁻¹³ 10⁻¹² 10⁻¹¹ 10⁻¹⁰ 10⁻⁹ 10⁻⁸ 10⁻⁷ 10⁻⁶ 10⁻⁵ 10⁻⁴ 10⁻³ 10⁻² 10⁻¹ 10⁰
10⁰ 10⁻¹ 10⁻² 10⁻³ 10⁻⁴ 10⁻⁵ 10⁻⁶ 10⁻⁷ 10⁻⁸ 10⁻⁹ 10⁻¹⁰ 10⁻¹¹ 10⁻¹² 10⁻¹³ 10⁻¹⁴
pH
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Increasingly acidic
Neutral
Increasingly basic (alkaline)

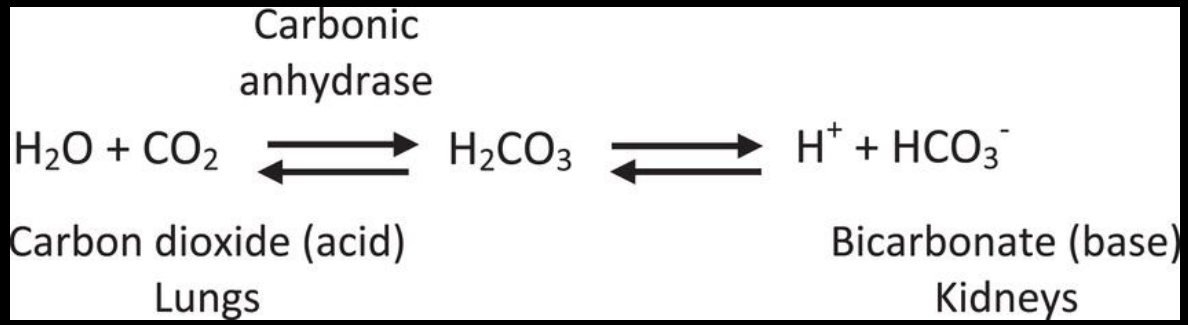
Buffers

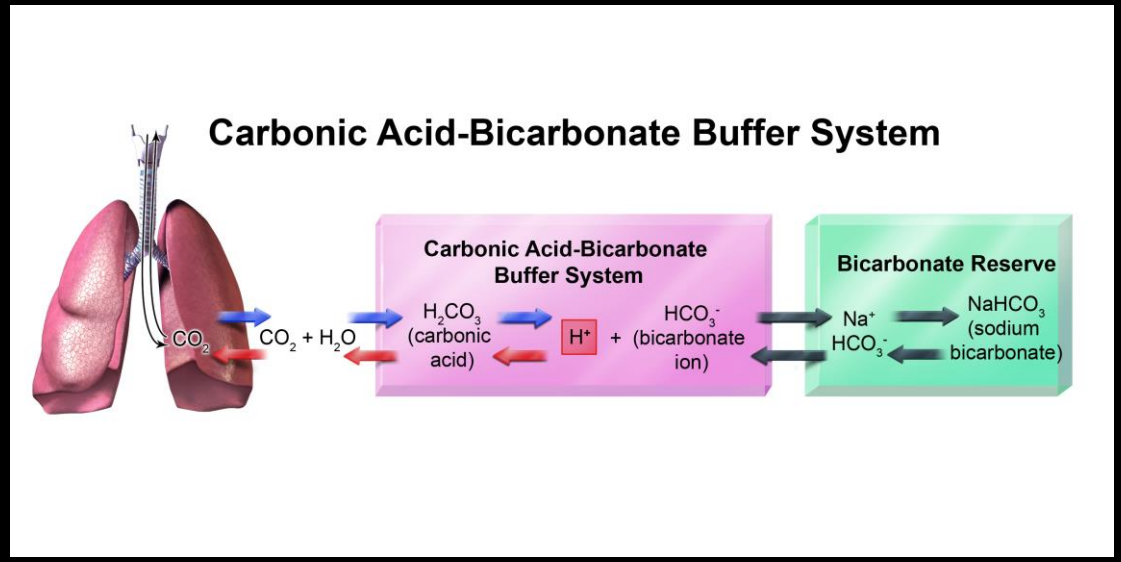
- even though strong acids and bases are continually taken into and formed by the body, the pH of fluids inside and outside of cells remains almost constant
- Buffer system: an aqueous solution that resists significant changes in pH



Blood Buffers

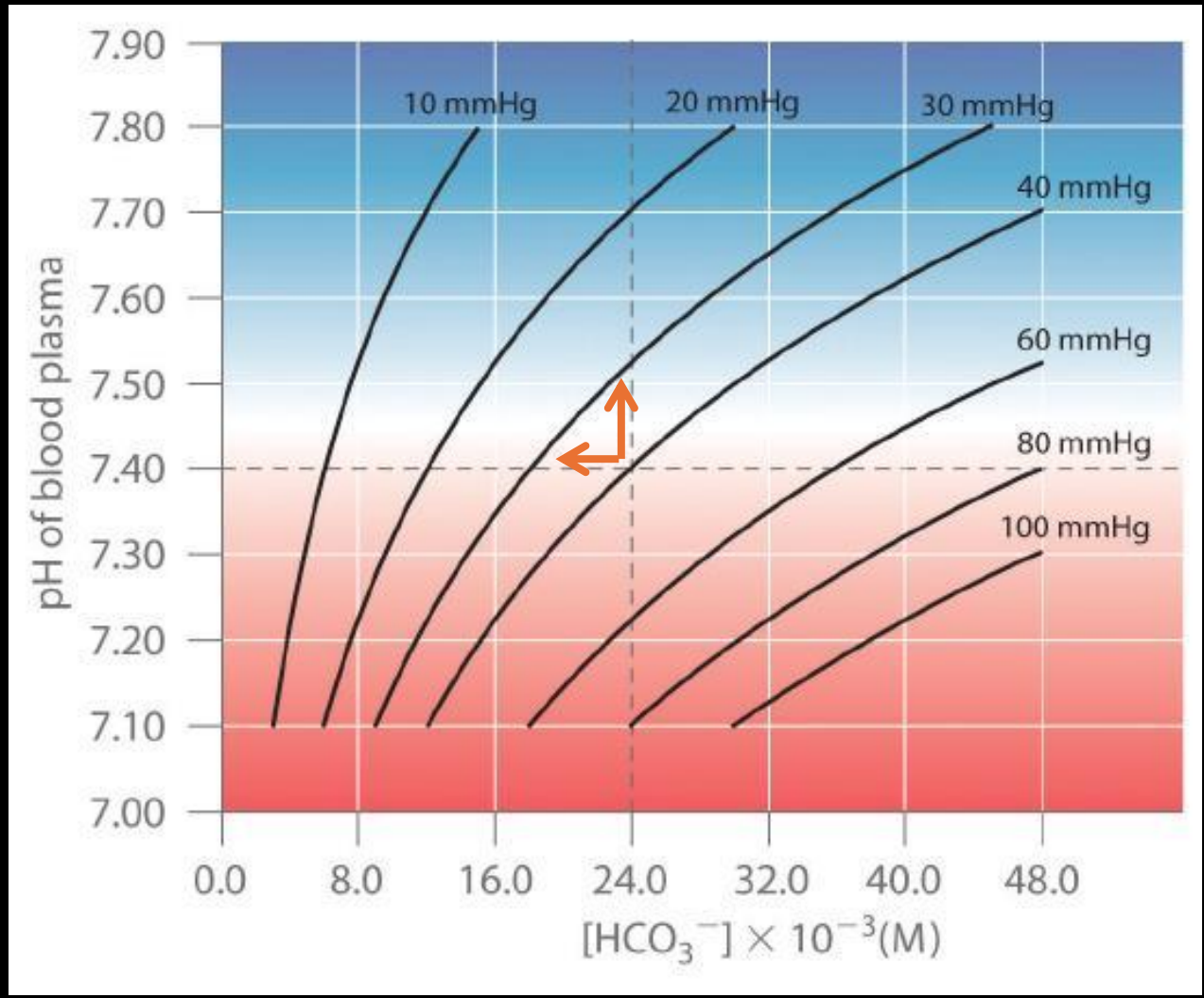
- Carbonic acid – bicarbonate buffer system: main buffering system of blood
- carbonic acid (H_2CO_3) is a weak acid
- bicarbonate (HCO_3-) is a weak base





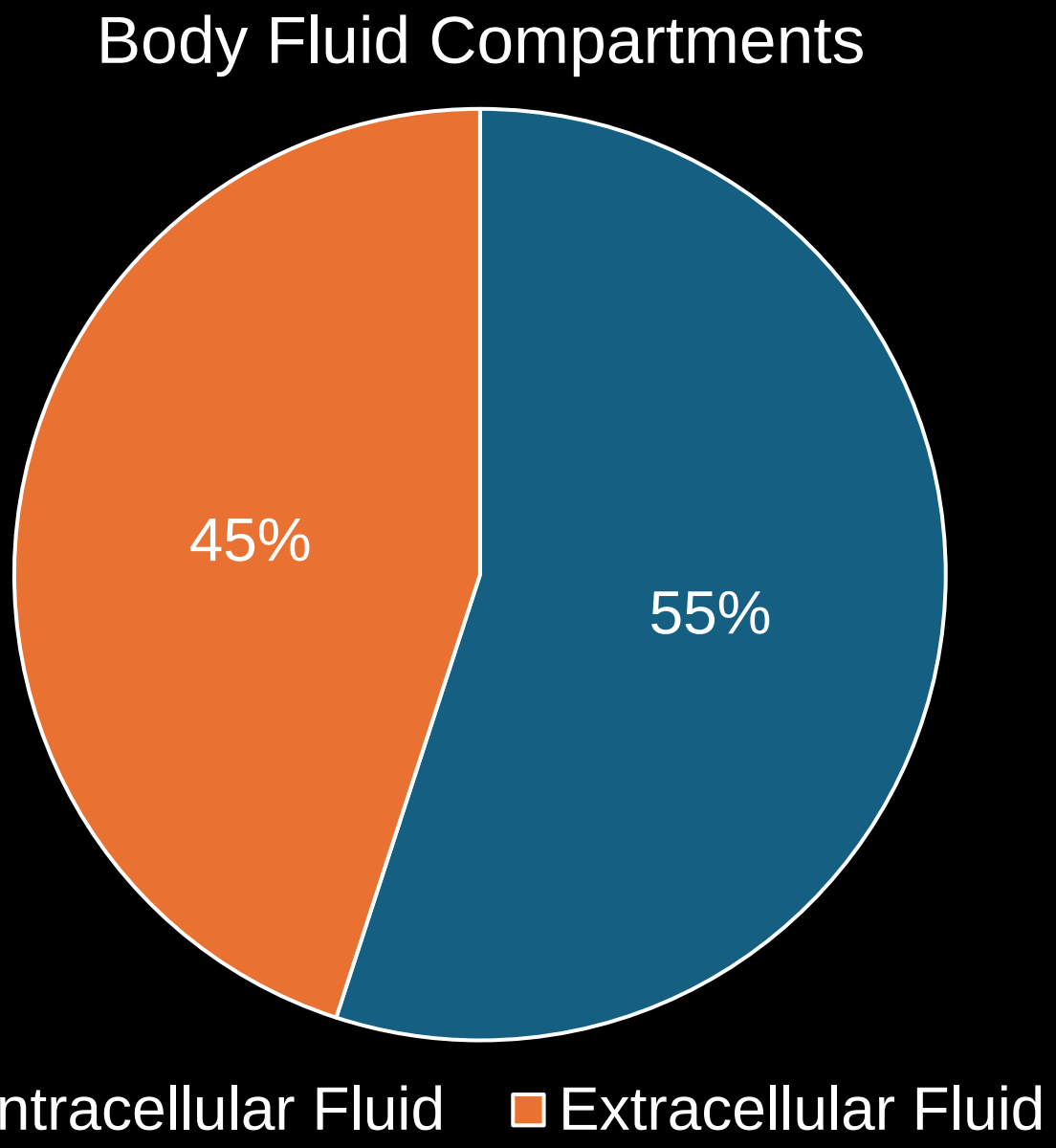
Altitude Sickness

- **Buffering in Blood:**
- pH versus carbonic acid concentration [HCO_3^-]
- Curves shown for different atmospheric pressures
- Denver, Colorado pressure ~30 versus ~40 mmHg at sea level causes a decrease in carbonic acid and an increase in blood pH
- Responsible for the general malaise that many people experience at high altitudes



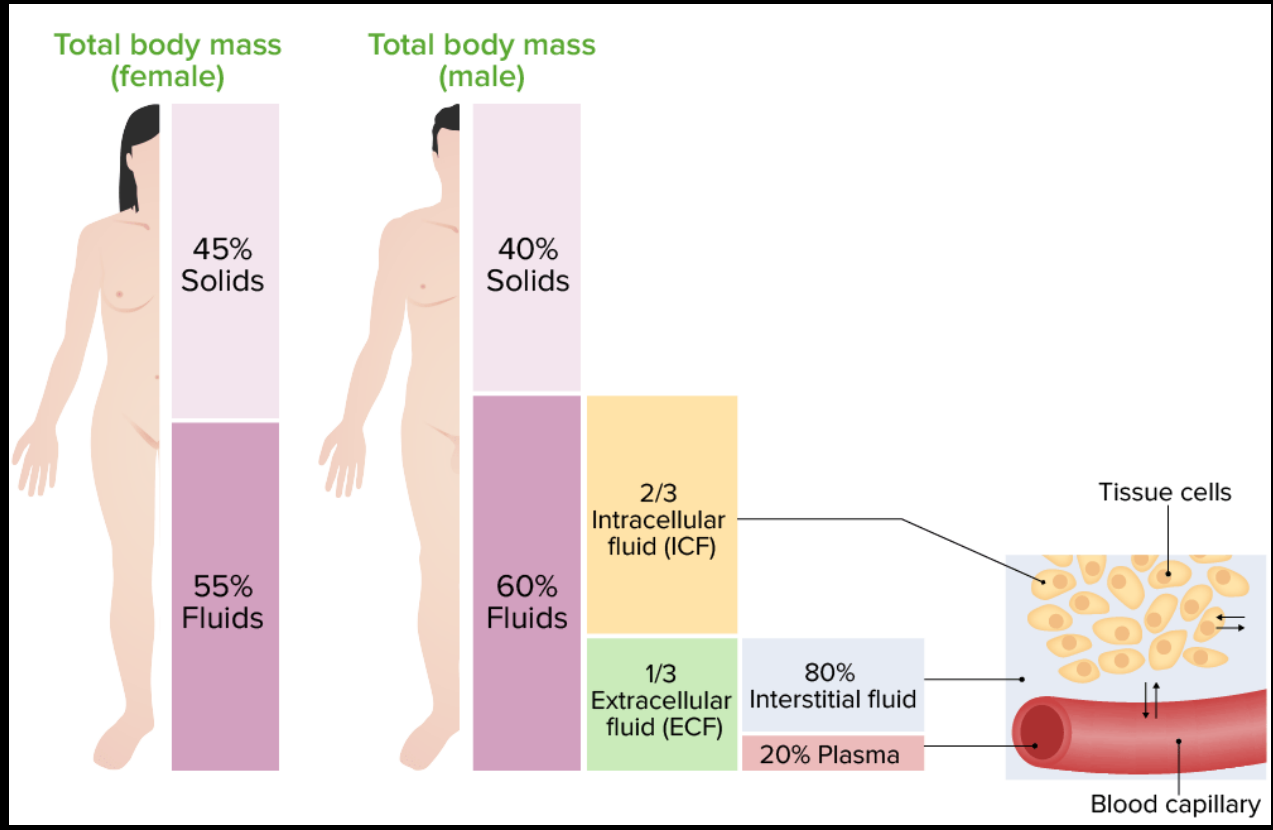
Extracellular Fluid (ECF)

- Extracellular Fluid (ECF): all body fluid that is found outside of cells.
- Cells constantly exchange materials with ECF
- Surrounds and supports cells
- Provides nutrients and oxygen and removes wastes
- Helps maintain pH and ion balance



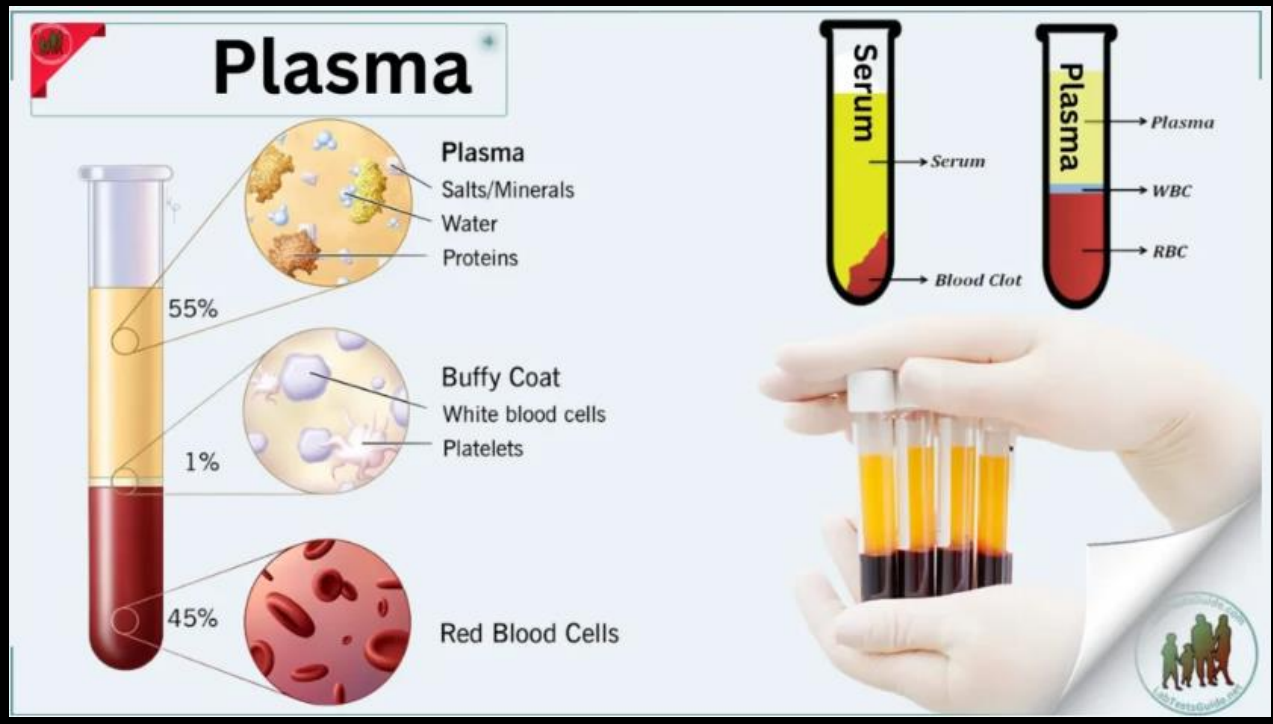
Interstitial Fluid

- Interstitial Fluid: a type of ECF that fills the spaces between tissue cells.
- Formed from plasma leaving capillaries
- Bathes and surrounds cells
- Allows exchange of: Oxygen, Nutrients, Wastes



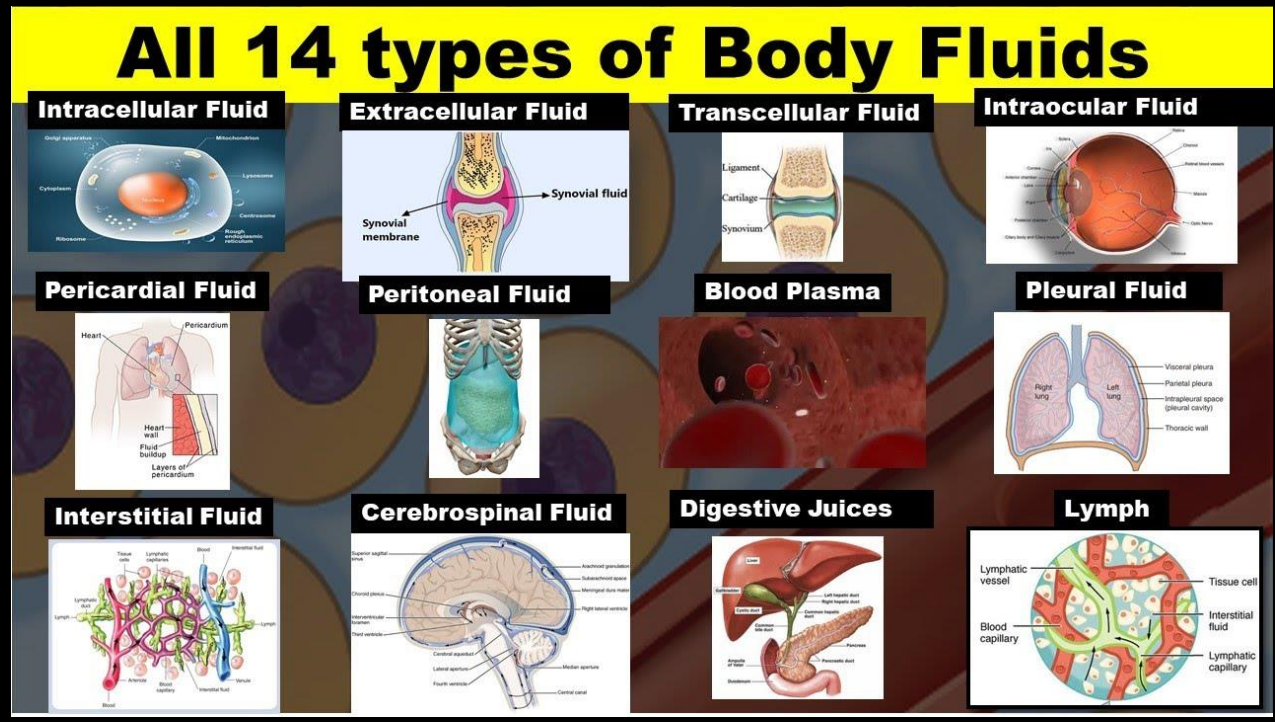
Plasma

- **Plasma**: the liquid portion of blood that carries cells, nutrients, hormones, and wastes.
- Makes up about 55% of blood volume
- Contains: Water, Proteins, Glucose, Electrolytes, Hormones, Wastes,
- Functions: Transports substances, maintains blood pressure, and helps regulate pH



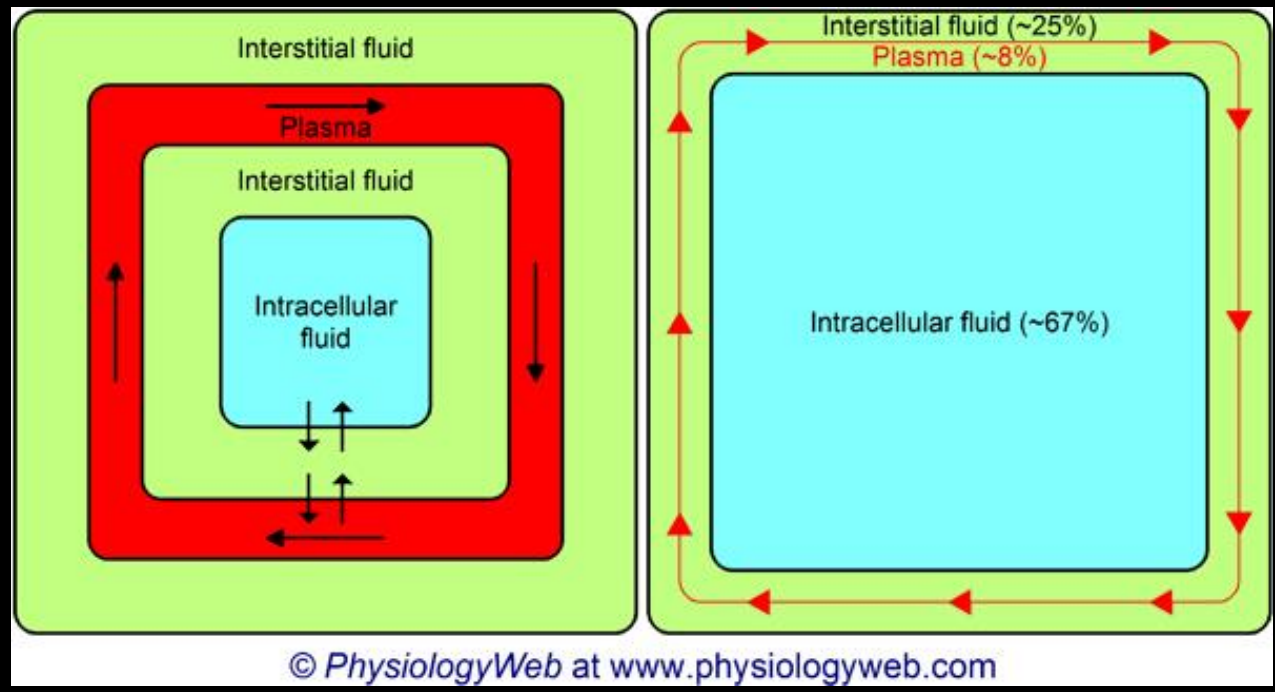
Specialized Body Fluids

- Cerebrospinal Fluid (CSF): Surrounds the brain and spinal cord to cushion and protect nervous tissue
- Synovial Fluid: Found in joints, reduces friction and absorbs shock
- Aqueous & Vitreous Humors: Found in eyes, maintain eye shape, and support vision
- Lymph: Found in lymphatic vessels, returns fluid to bloodstream and supports immune system



How Body Fluids Work Together

- Fluid Compartments Work as a System
- Constant exchange occurs between plasma, ECFs, interstitial fluids and cells
- Balance is tightly regulated
- Problems with balance can cause: swelling (edema), eehydration, low blood pressure, organ stress



Resources

- Dingess, Paige (2025)
- Grammarly. (2026). Grammarly (Version 14.1268.0) [Software]. https://www.grammarly.com/
- OpenAI. (2026). ChatGPT (GPT-5) [Large language model]. https://chat.openai.com/

Creation and Copyright Information

- Last updated: Jan 29, 2026
- Last updated by: Heather Talbott
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