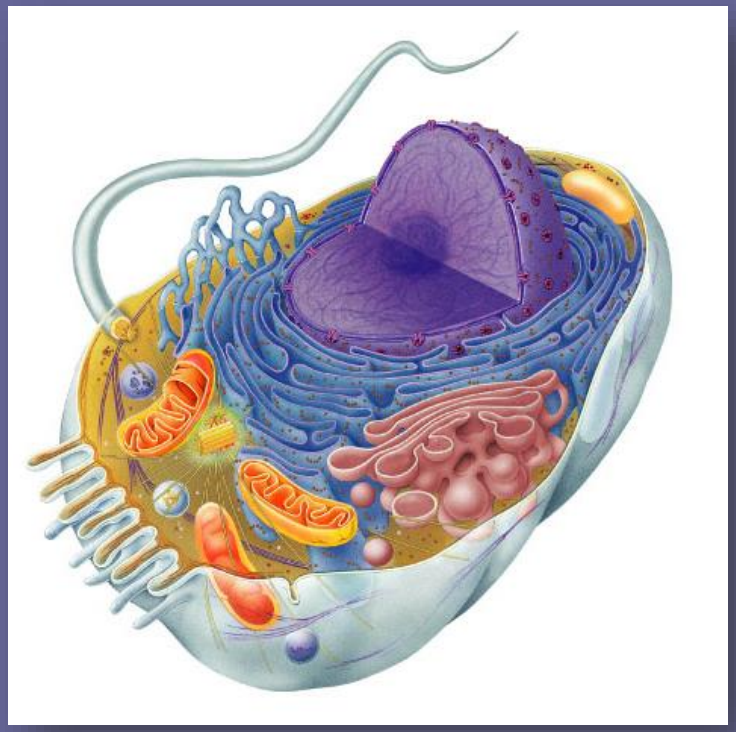
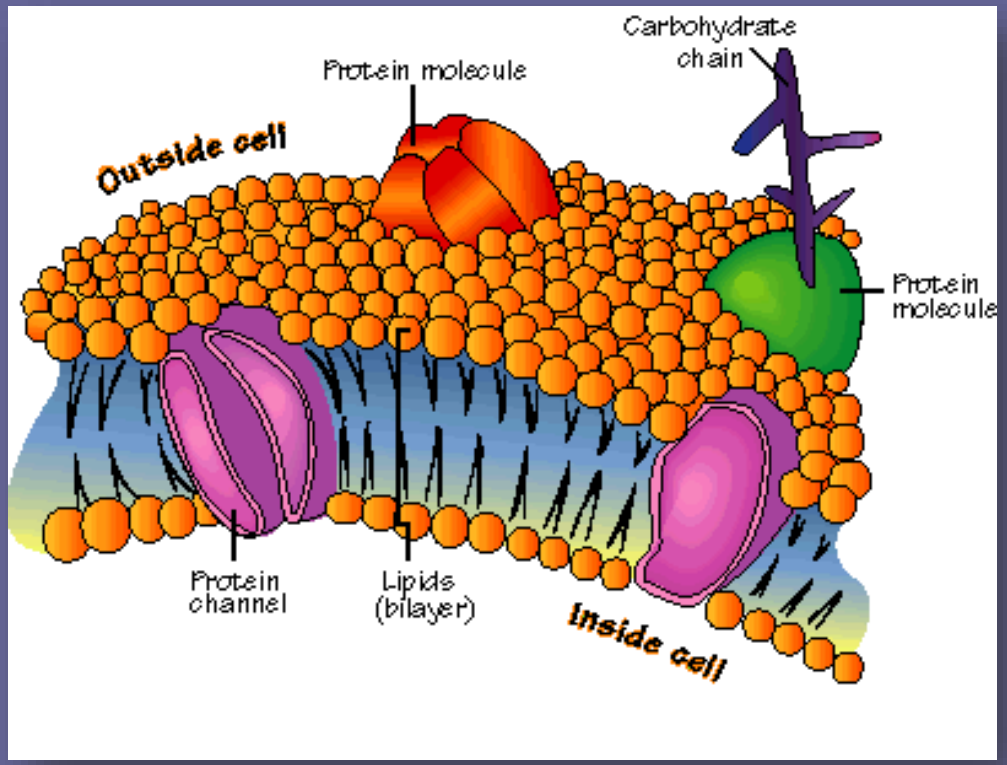




Cell Transport

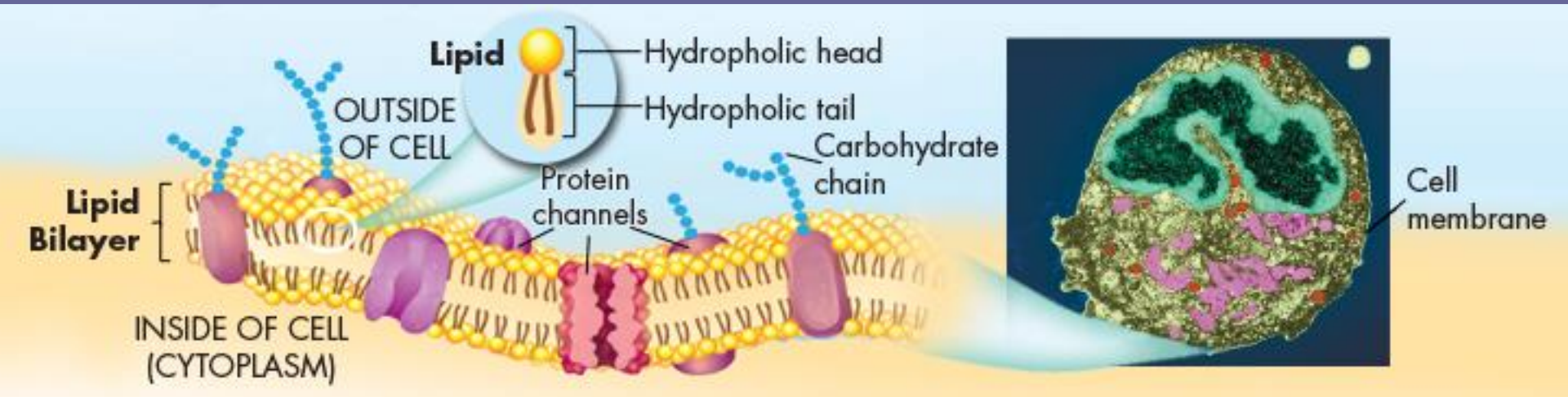
Cell Membranes

&

Movement Across Them

Cell Boundaries

- The cell membrane regulates what enters and leaves the cell and provides support and protection
  - Composed of a phospholipid bilayer that contains carbohydrates, proteins, and lipids
- In plant, fungi, and bacterial cells, the cell wall provides support and protection

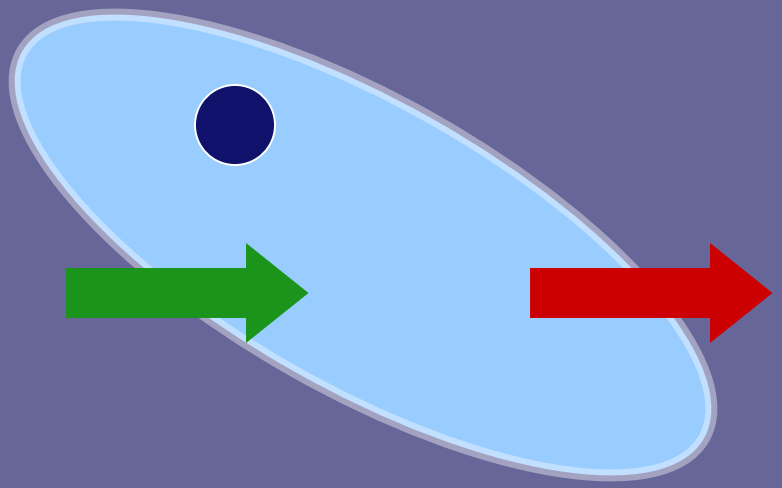


Cell (Plasma) Membrane

- Cells need an inside & an outside…
  - separate cell from its environment
  - cell membrane is the boundary

IN
food
- **sugars**
- **proteins**
- **fats**

salts
O_2
H_2O



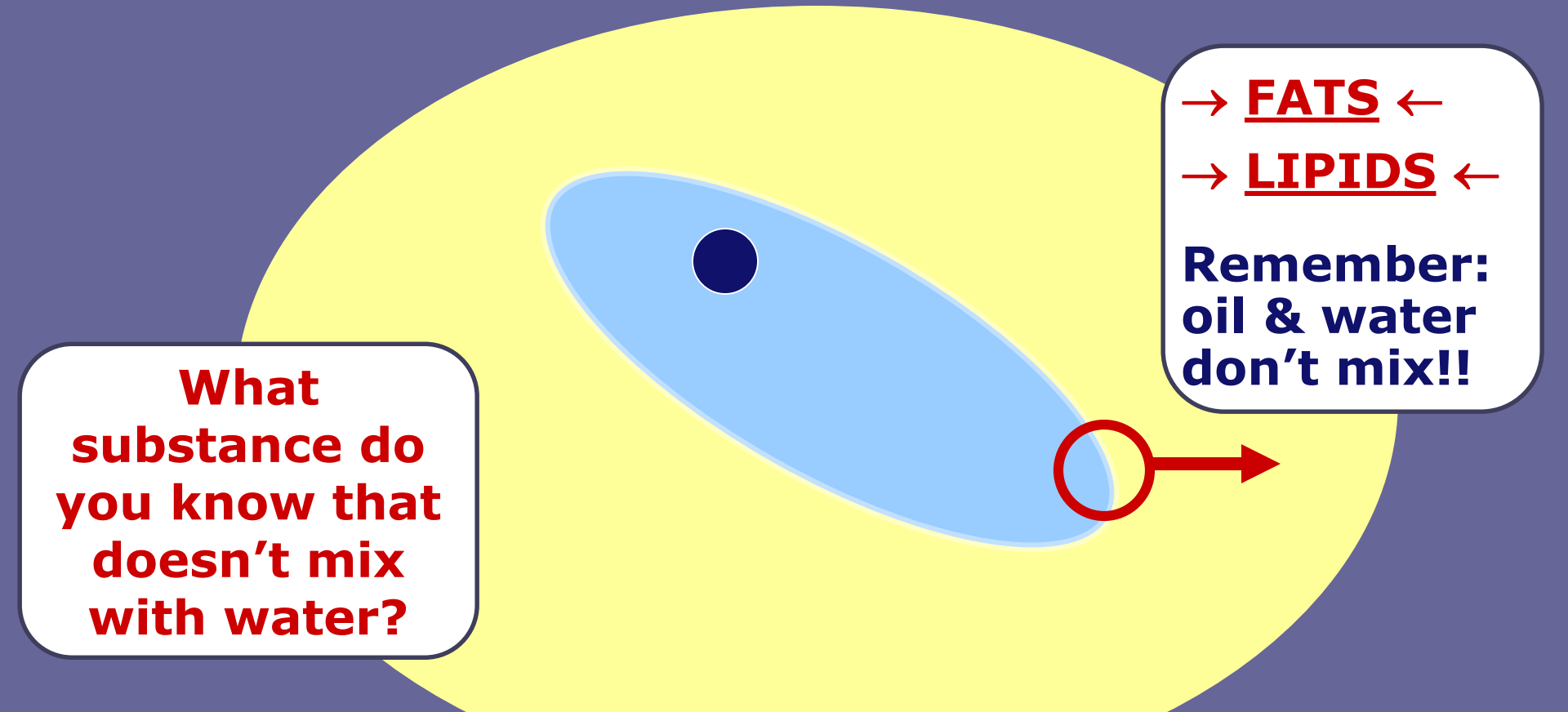
OUT
waste
- **ammonia**
- **salts**
- **CO_2**
- **H_2O**

products
- **proteins**

cell needs materials in & products or waste out

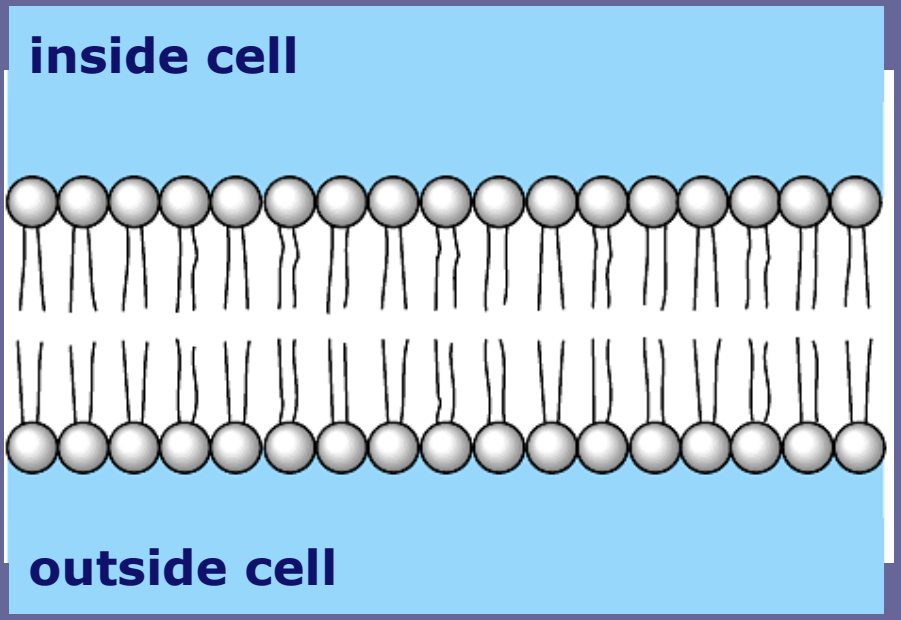
Building a Membrane

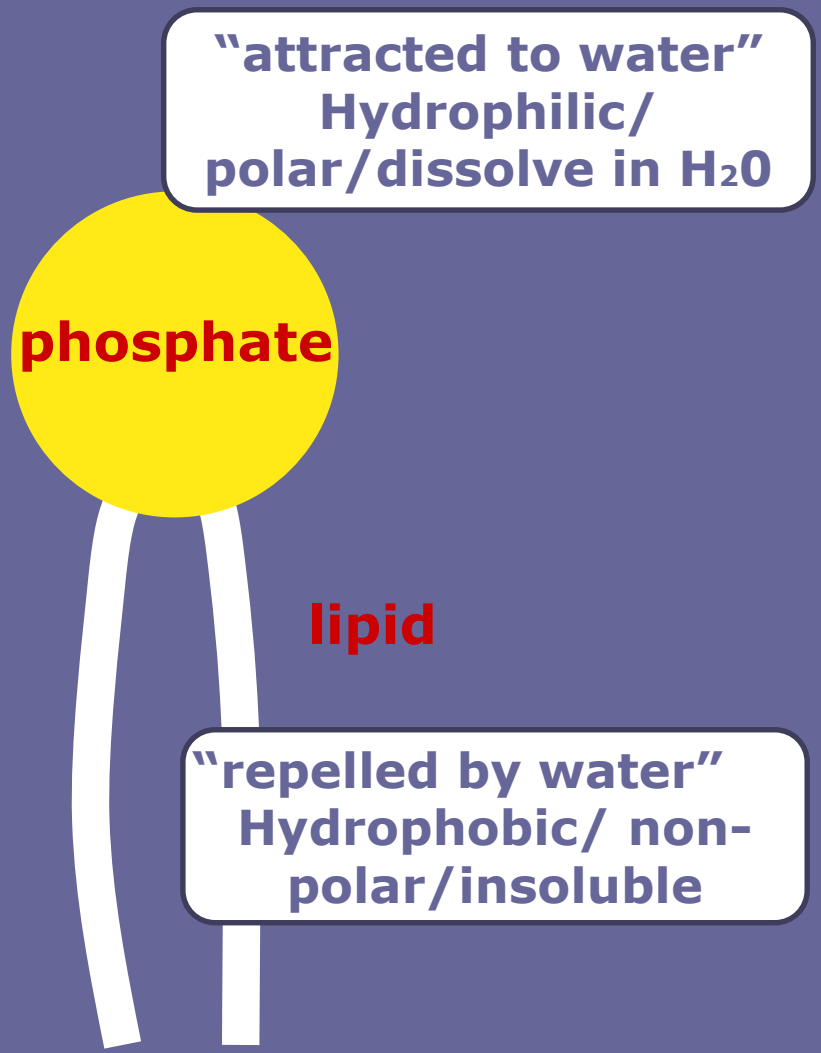
- How do you build a barrier that keeps the watery contents of the cell separate from the watery environment?



Lipids of Cell Membrane

- Membrane is made of special kind of lipid
  - phospholipids
  - "split personality"
- Membrane is a double layer
  - phospholipid bilayer



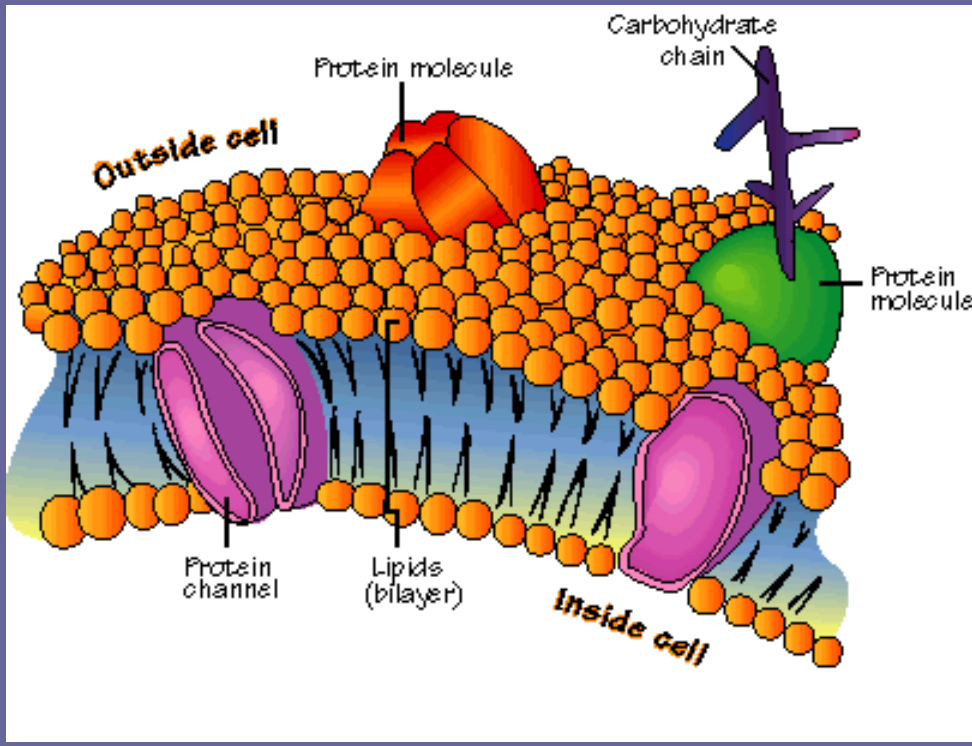


What makes up the Plasma Membrane?

Protein – proteins channels for **transport**

Carbohydrates – identification markers- can be attached to phospholipid or to protein

Cholesterol – **stabilizes** the membrane



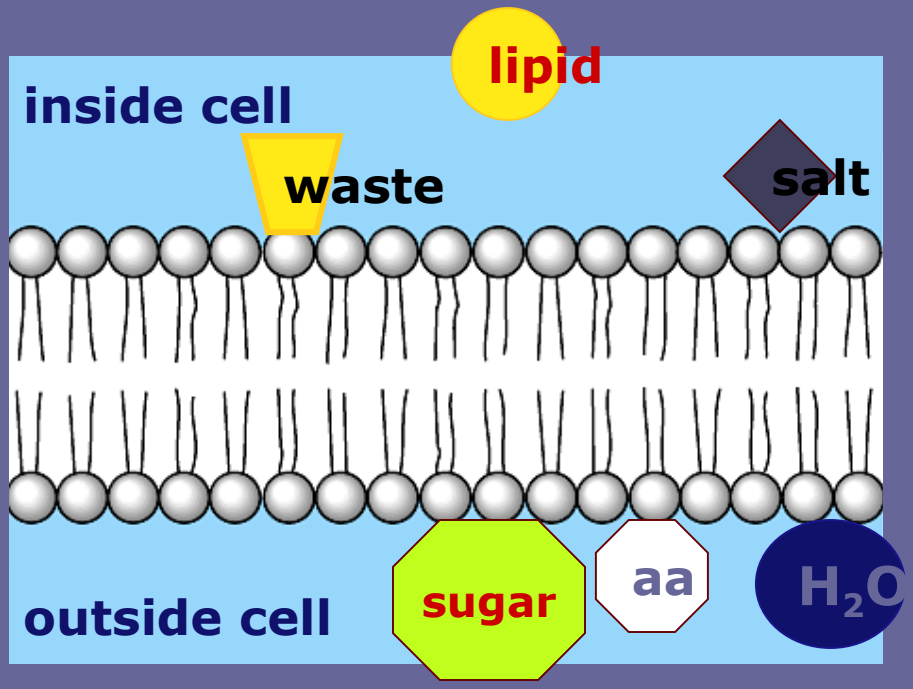
Selectively Permeable Membrane

- The membrane is **selectively or semi-permeable** – some materials can pass thru, others cannot.
- Acts like a “bouncer” – controls who enters and leaves

- Permeability depends on:
  - Particle size
  - **Shape** of molecules – some will need a protein channels to go through if too large or irregularly shaped
  - Charge of ions (some ions are repelled)

Crossing the cell membrane

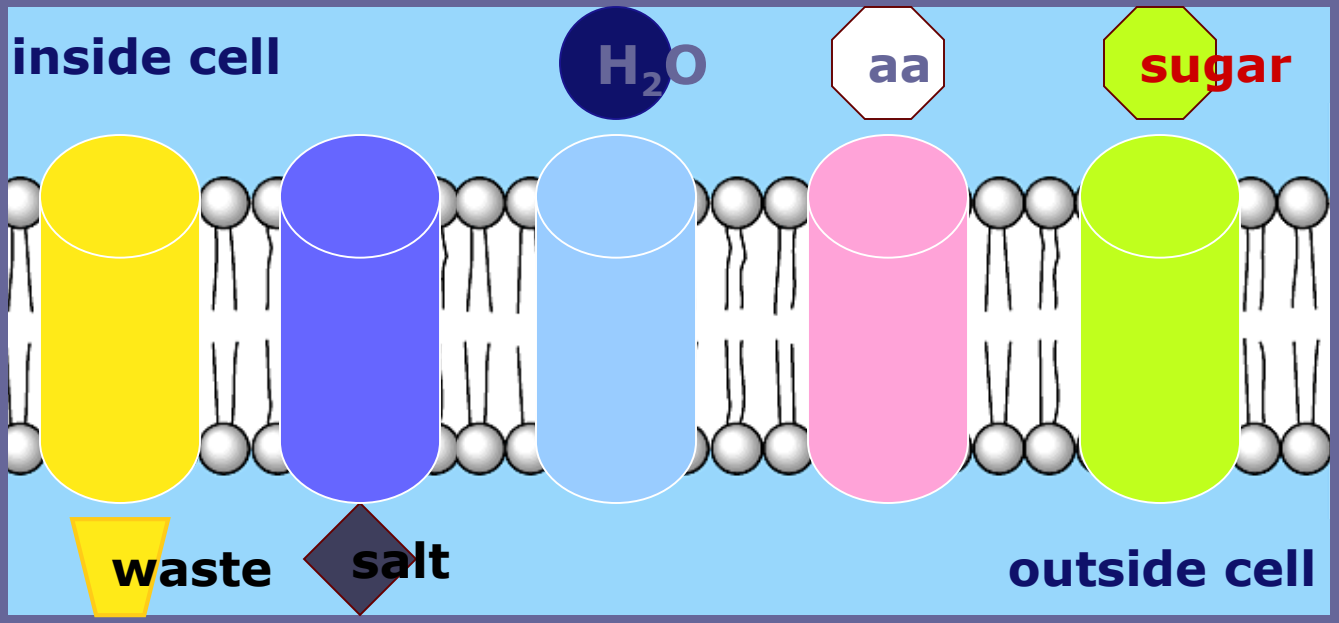
- What molecules can get through the cell membrane directly?
  - Fats, nonpolar (hydrophobic), gases, small molecules, and oils can pass directly through

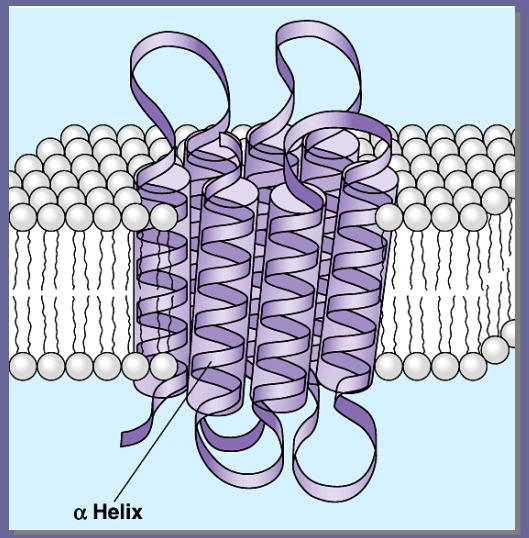


**but…
what about
other stuff?**

Cell Membrane Channels

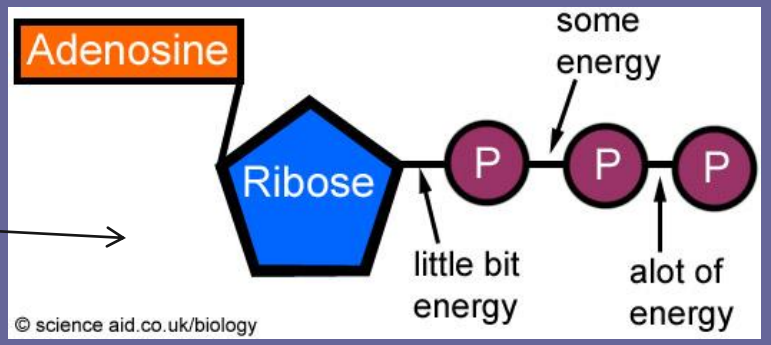
- Need to make “doors” through membrane
  - protein channels allow substances in & out
    - specific channels allow specific material in & out
    - H_2O channel, salt channel, sugar channel, etc.
    - A transmembrane protein is a type of membrane protein that is permanently attached and goes through the entire membrane



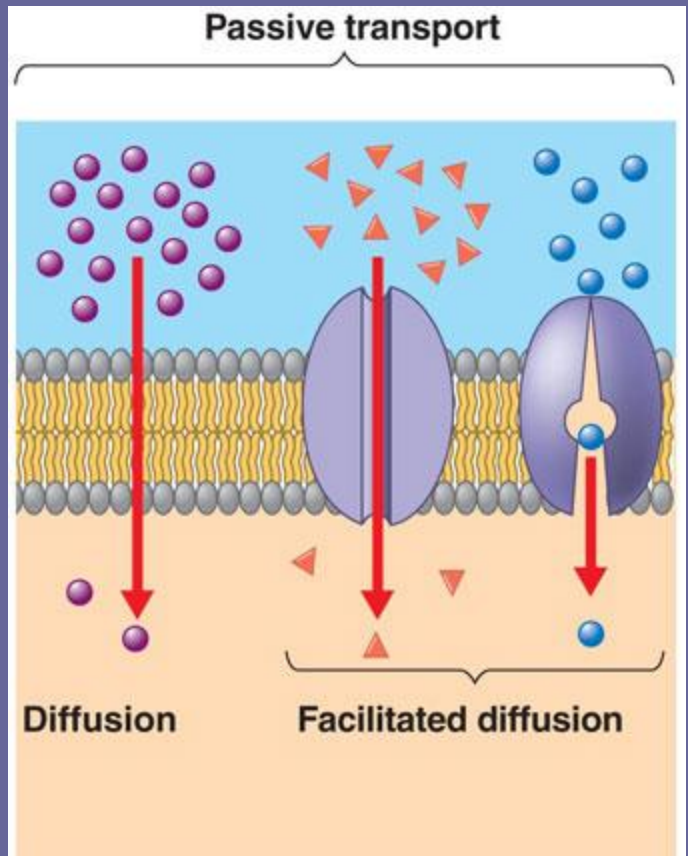


Passive Transport

- Does NOT require Energy (E)
  - ATP (adenosine triphosphate) is E molecule



- Goes **with/down** concentration gradient - molecules will move from **a high to low** concentration across the cell membrane until equilibrium is reached



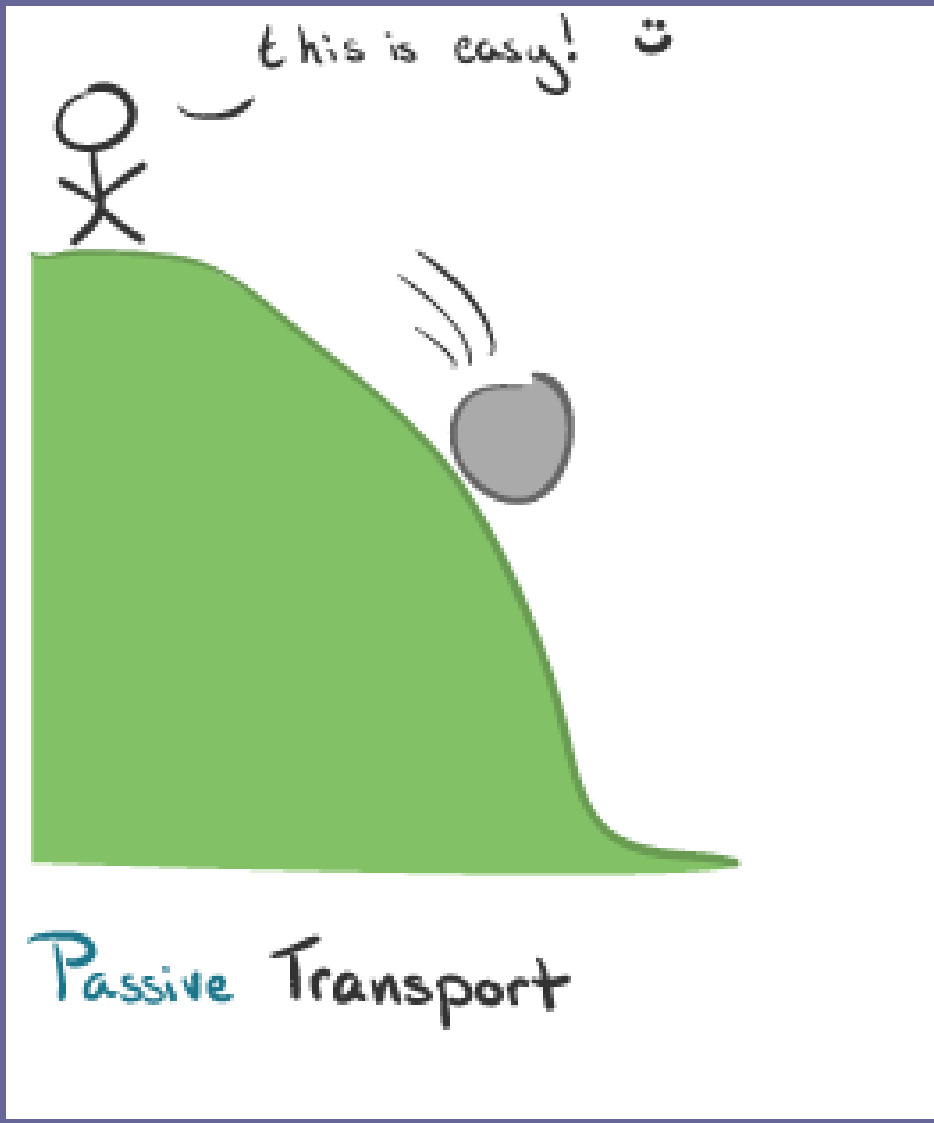
- Molecules are constantly moving, so they will move naturally with concentration gradient.

Passive Transport:

-Goes with/down the concentration gradient

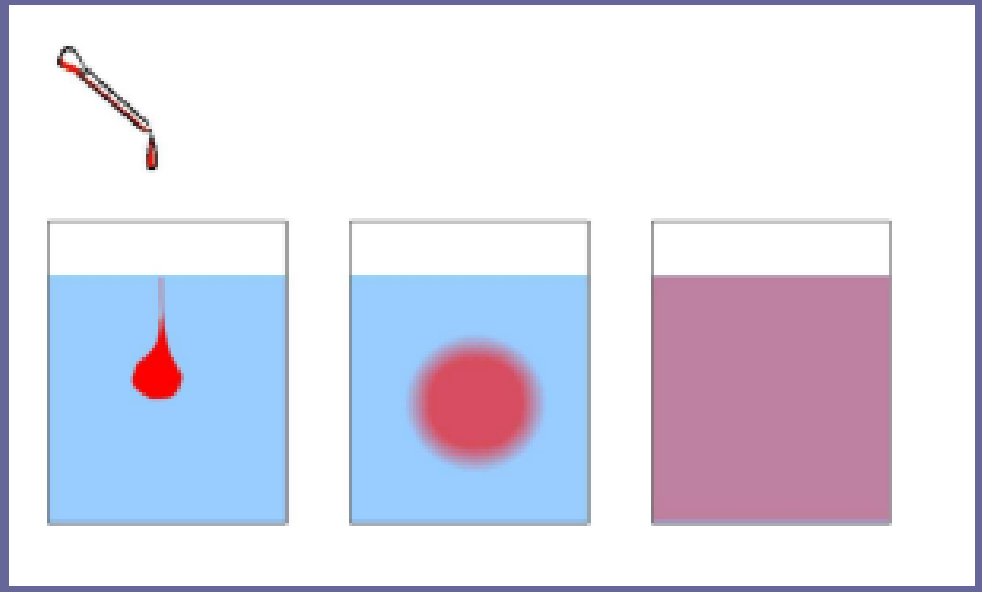
-From high to low concentration

-NO energy required

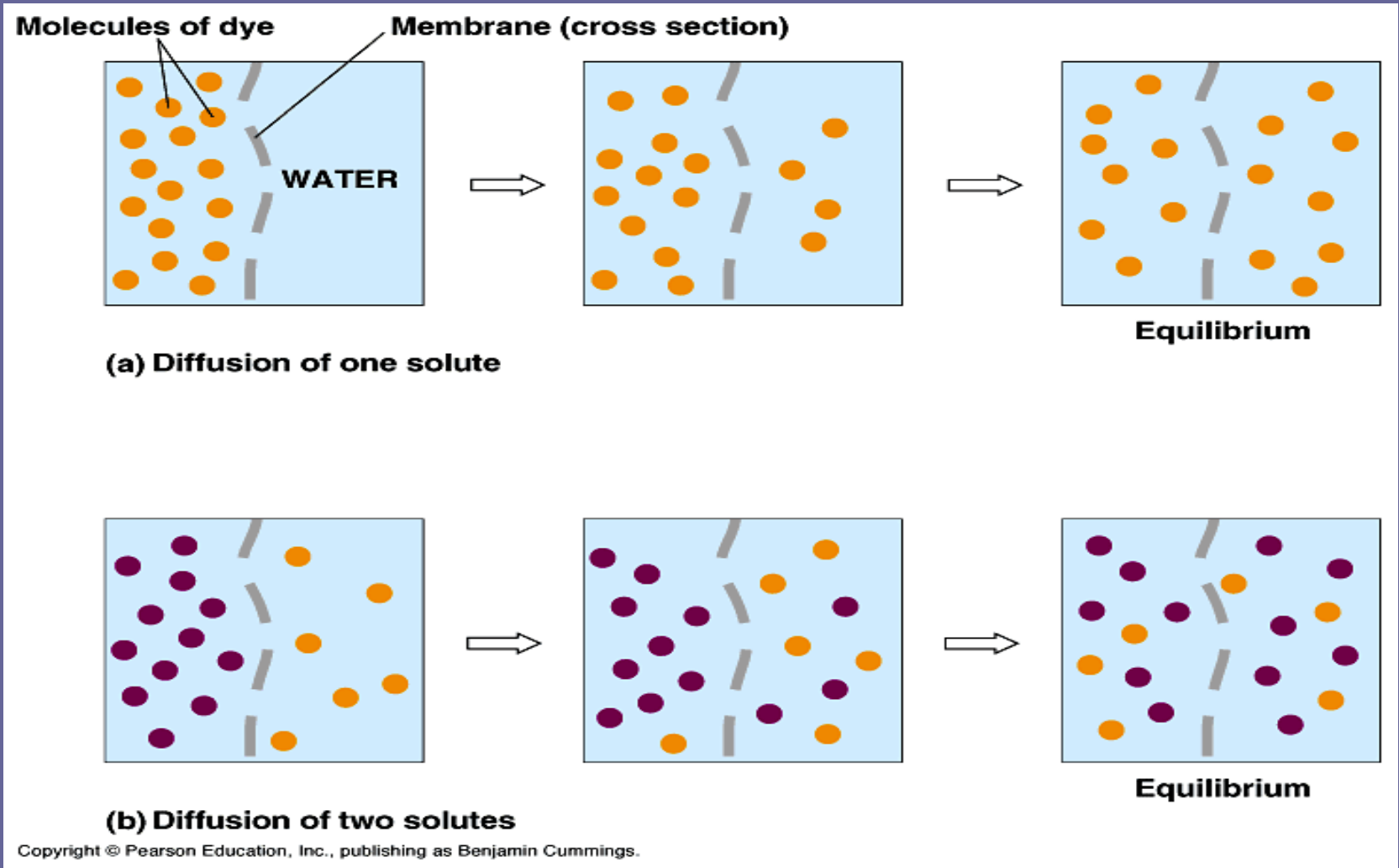


3 Types of Passive Transport

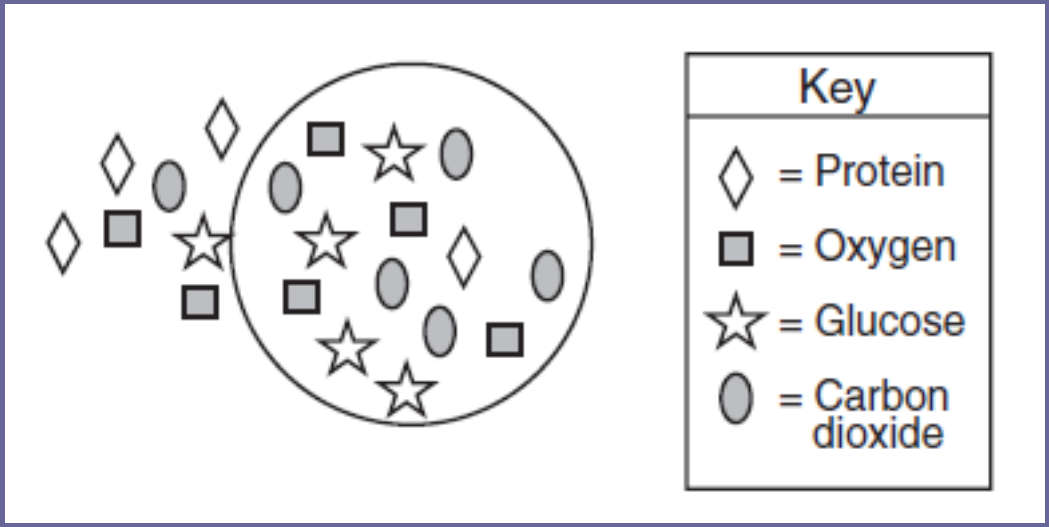
1. **Simple Diffusion** – any material, except H_2O moving from high to low concentration through bilayer until it reaches equilibrium (equal on both sides- homeostasis)



Simple Diffusion



Which way will the molecules diffuse?



Molecules will diffuse until the concentration is at equilibrium (some concentration outside of cell and inside of cell)

Diffusion of protein: will diffuse **into** the cell

Diffusion of oxygen(a gas): will diffuse out of the cell

Diffusion of glucose: will diffuse out of cell

Diffusion of carbon dioxide (a gas): will diffuse out of cell

Factors that Affect Rate of Diffusion

1. Amount of Substance
   - Unequal amt → movement
   - Dynamic Equilibrium → equal concentration with movement
2. Temperature
   - Hot molecules move faster
   - Cold molecules move slower
3. Permeability of Membrane
   - Permeable: molecules pass freely
   - Impermeable: NO molecules can pass
   - Selectively (Semi) Permeable*: allows some molecules to pass freely and not others

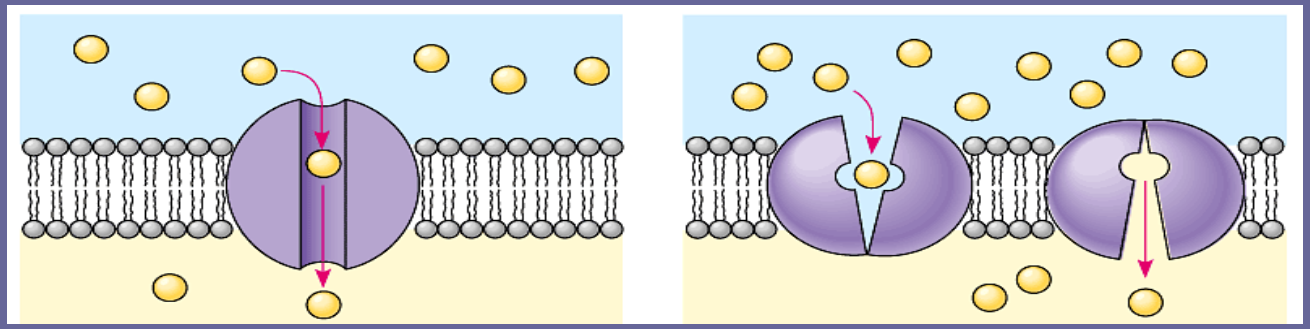
Passive Transport – Facilitated Diffusion

2. **Facilitated Diffusion** – uses protein channels to enter/leave cells

- Facilitator = "helper" → NO ENERGY REQUIRED!

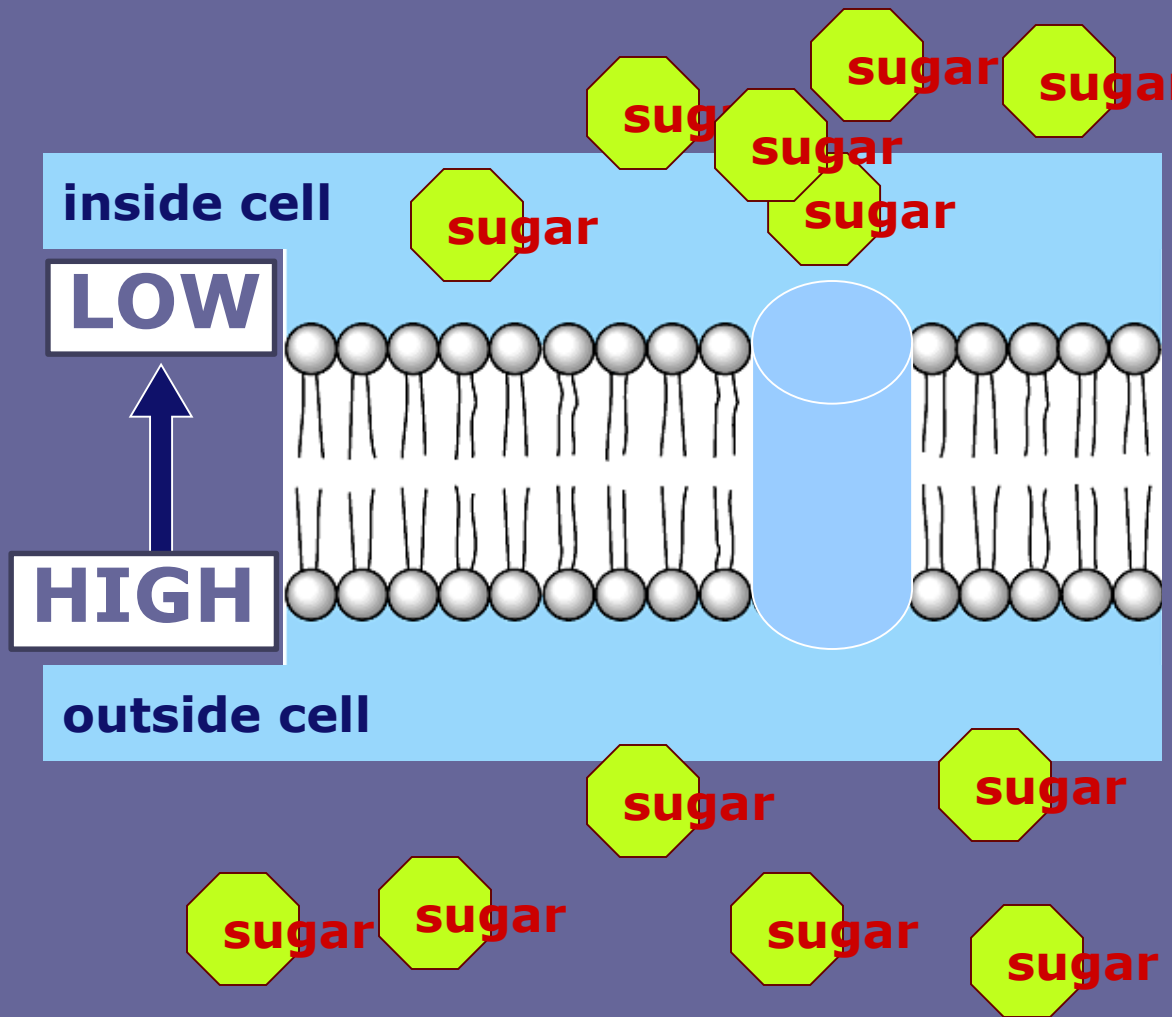
– These are molecules that cannot diffuse across the cell's lipid bilayer on their own instead resort to this process

- These molecules include:
  - Polar (hydrophilic)
  - Water
  - Large molecules, ex. glucose, proteins
  - Ions (positively or negatively charged atoms), ex. Cl^-



Facilitated Diffusion

- Move from HIGH to LOW through a channel



Passive Transport – Osmosis

3. **Osmosis** – the diffusion of **H_2O** across the cell membrane

   – **Water** moves from high to low concentration until equilibrium is reached

   – **Osmotic pressure** – pressure exerted on membrane when water moves across

   – Water diffuses slowly across a cell membrane.

Lettuce & Osmosis

- Placing wilted lettuce in cold water will make the lettuce crisp again.

- The lettuce is able to restore its original condition because water enters the cells of the lettuce through osmosis and will reach equilibrium (equal amounts of water inside lettuce cells and outside of cells).

Lettuce & Osmosis

- If you add salt to lettuce in a salad, the lettuce will eventually begin wilting.

- Wilting occurs because water is released in the presence of salt = the water will move OUTSIDE of the cell.

Another Example

- What happens to marine plants when they are removed from their environment & placed in distilled (pure) water?

Answer: The plant cells will swell because the concentration of water is higher outside of the cells than inside, therefore the water will move into the cells

  - High→ Low

Another Example

- When you have swollen gums you can rinse your mouth with warm salt water, and the swelling decreases.
- Why?
- The water in the gums has moved from a higher concentration (swollen gums) to a lower concentration (out of the gums into mouth).

Tonicity

- The ability of an extracellular solution to make water move into or out of a cell by osmosis is know as its tonicity.
- A solution's tonicity depends on the concentration of all solutes in the solution.

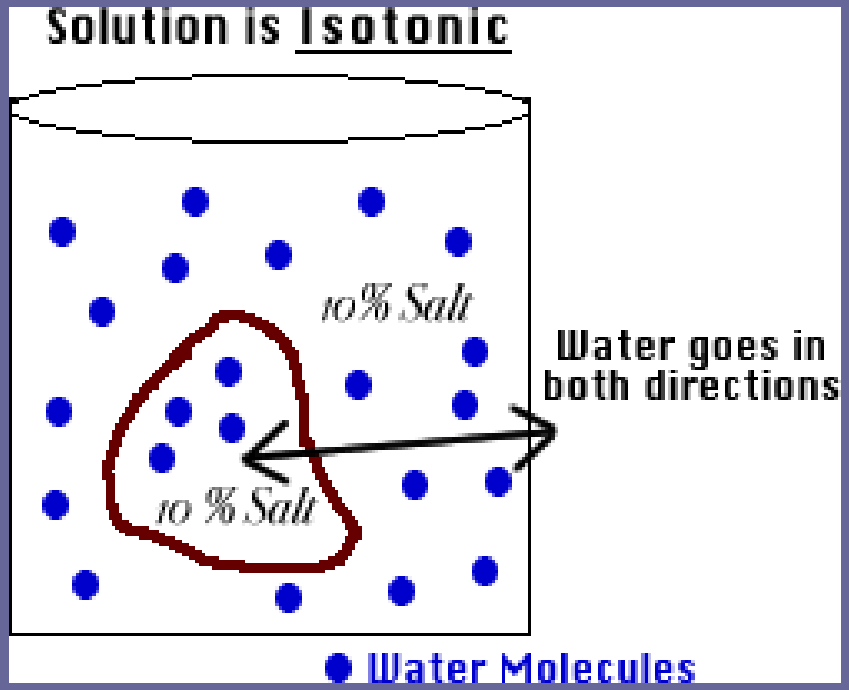
Tonicity/Solutions

1. **Isotonic** – equal concentration of solute molecules on either side of membrane

   -no net (overall) movement of water

   -in dynamic equilibrium (constant movement of water in and out of the cell)

   -equal solute (particles), equal water

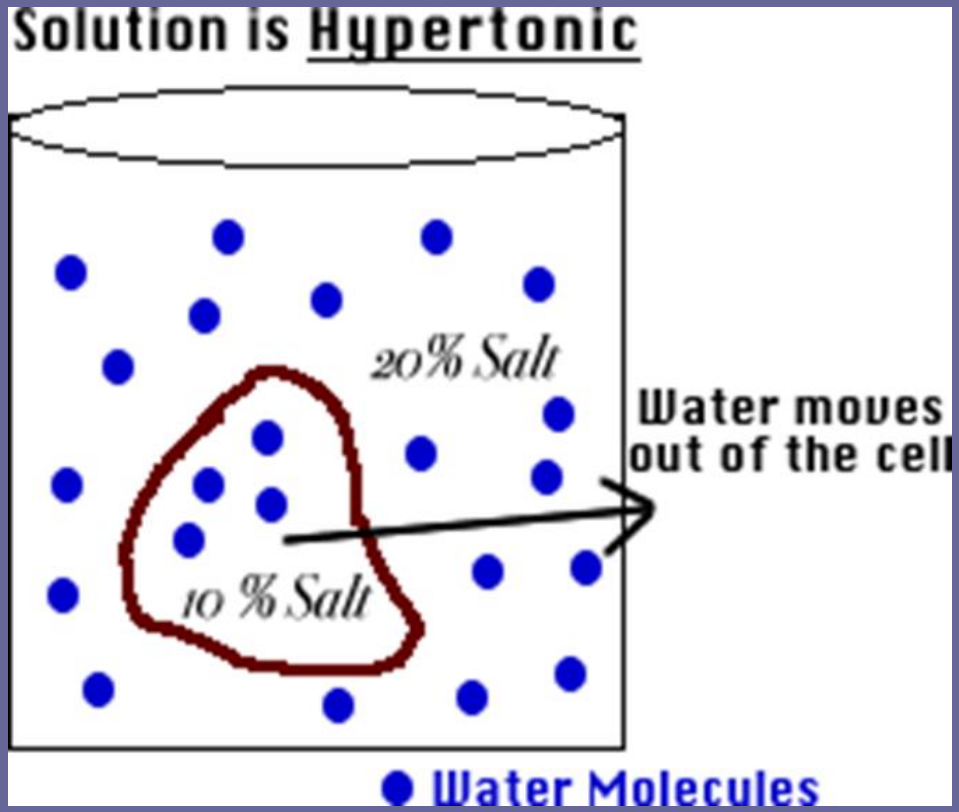


Tonicity/Solutions

2. **Hypertonic** – more solute outside of cell (high solute outside of cell),

   -water moves out of cell, cell shrinks

   -more solute, less water

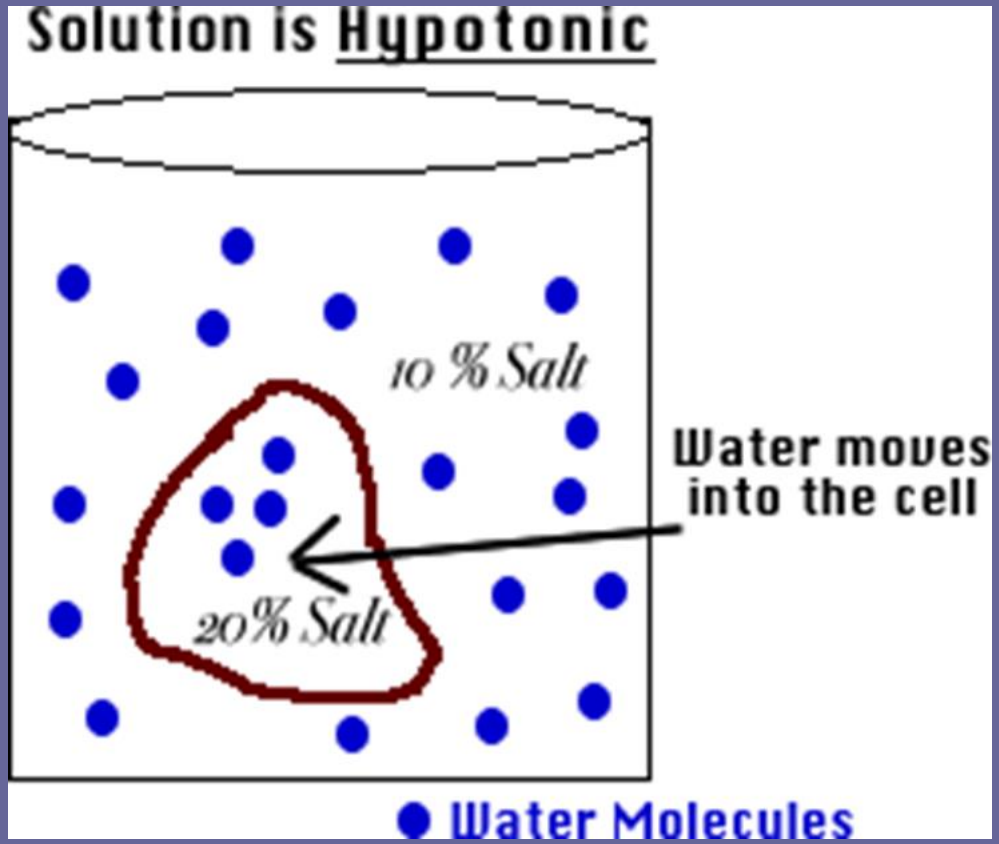


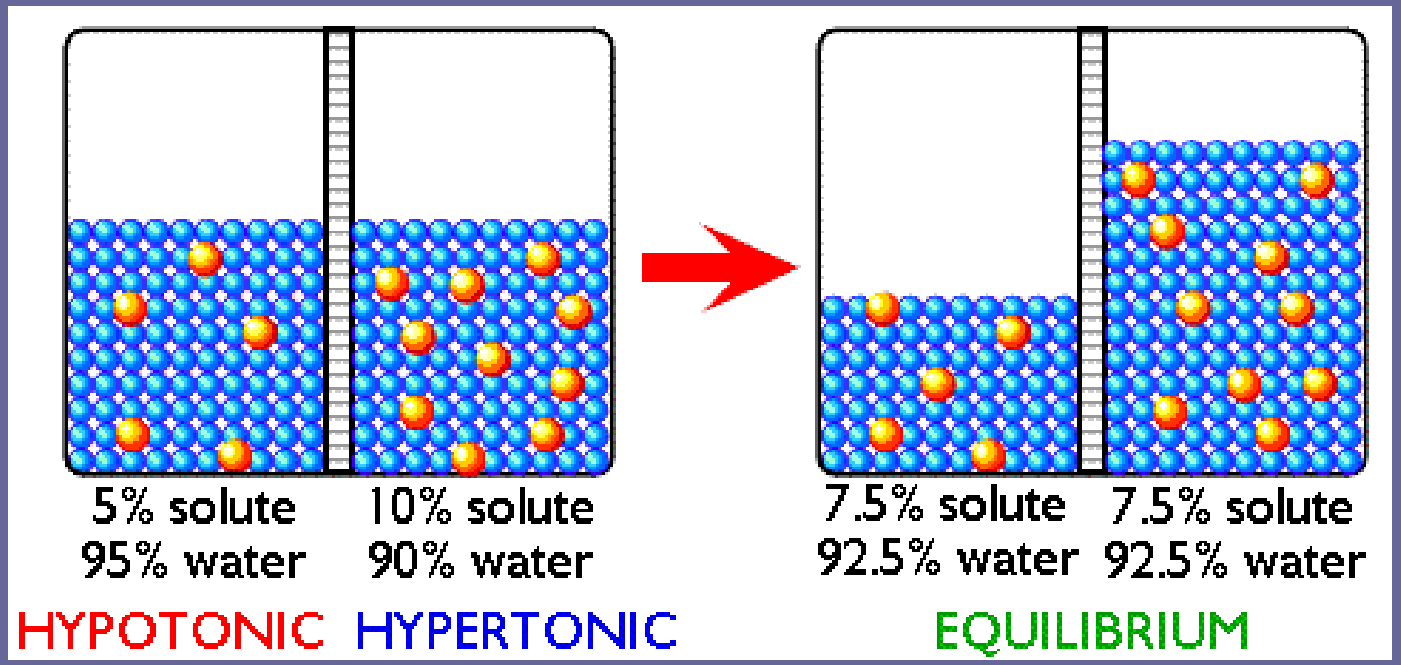
Tonicity/Solutions

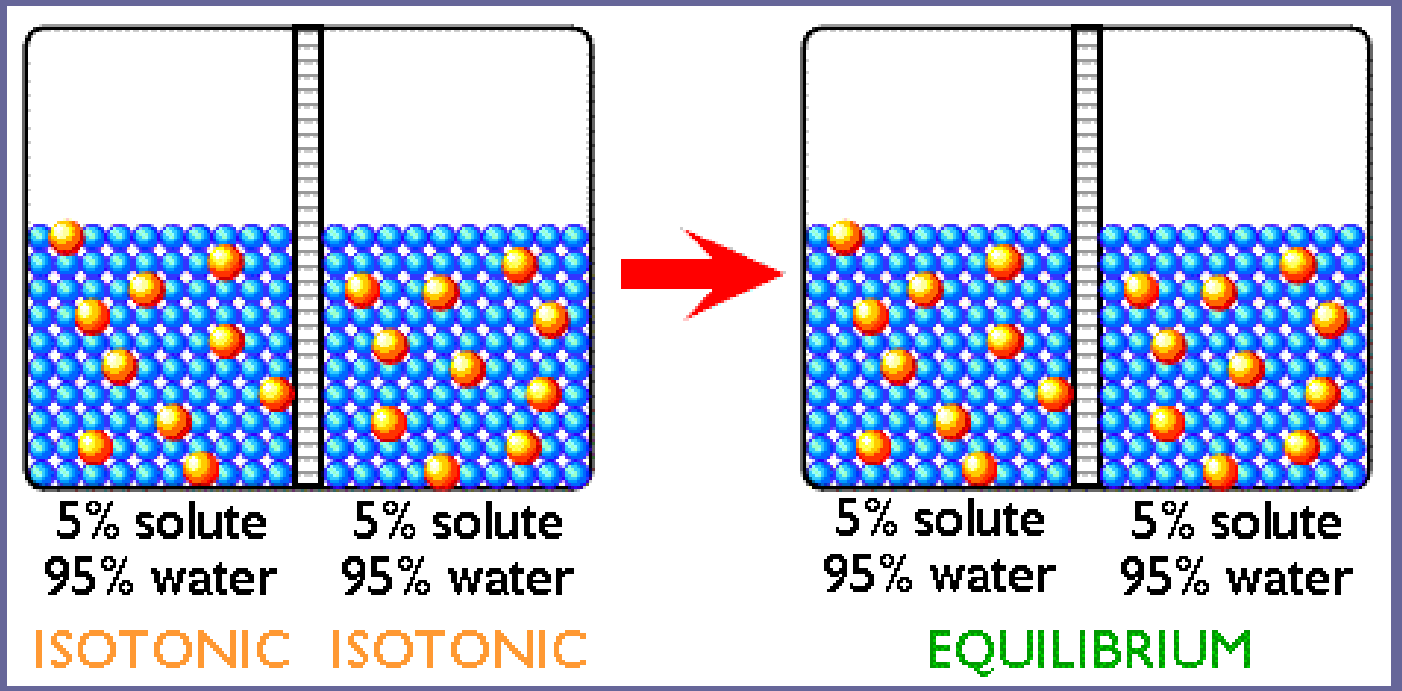
3. **Hypotonic** – less solute outside of cell (low solute outside of cell)

   -water enters cell, cell swells and could burst

   -less solute, more water

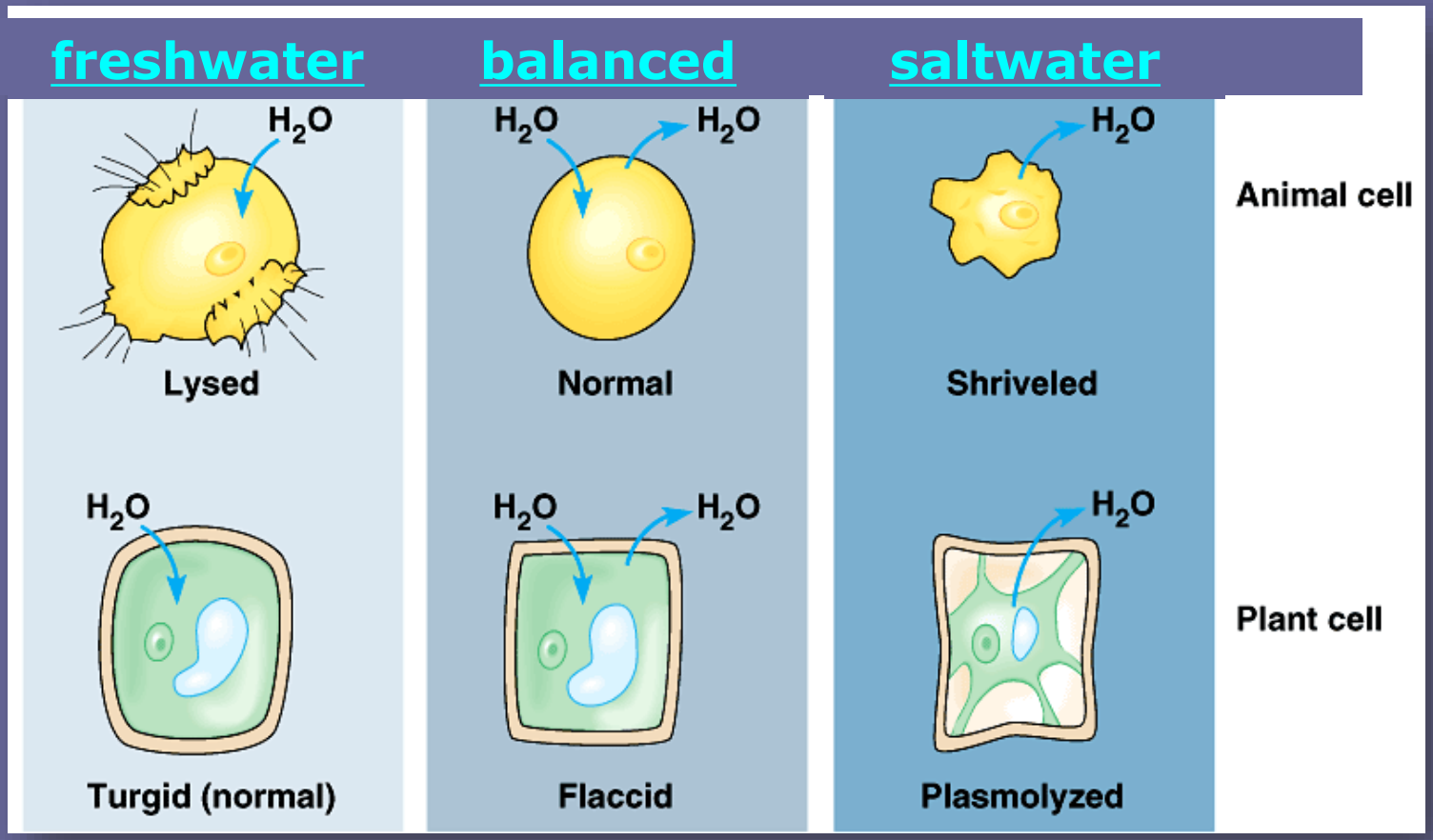



5% solute
95% water
10% solute
90% water
7.5% solute
92.5% water
7.5% solute
92.5% water
HYPOTONIC
HYPERTONIC
EQUILIBRIUM


5% solute
95% water
5% solute
95% water
5% solute
95% water
5% solute
95% water
ISOTONIC
ISOTONIC
EQUILIBRIUM

Keeping Water Balance

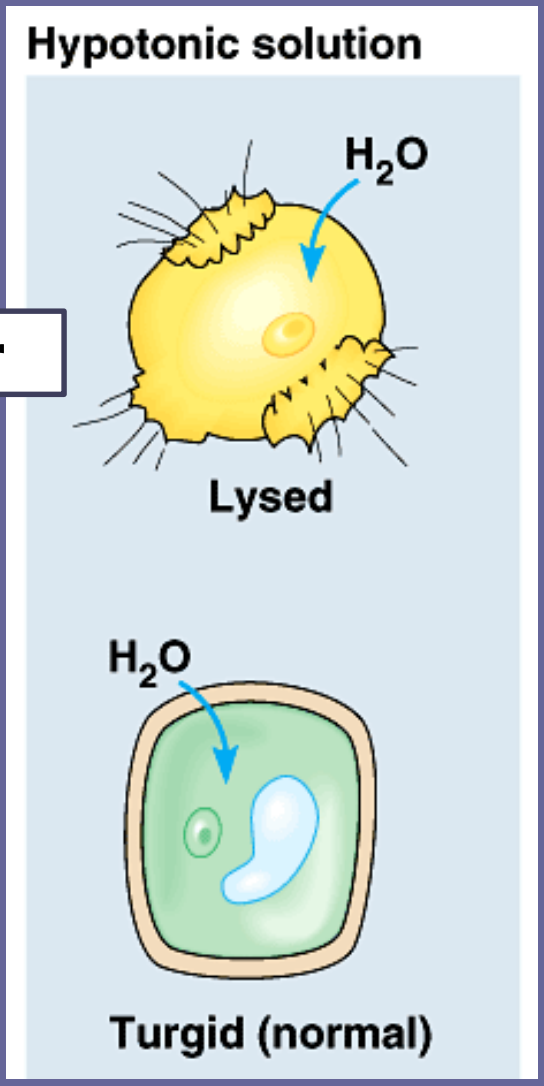
- Cell survival depends on balancing water uptake & water loss



1

Keeping the right amount of water in the cell

- Freshwater
  - a cell in fresh water
  - high concentration of water around cell
    - cell gains water
    - example: *Paramecium*
    - problem: cells gain water, swell & can burst
    - **Cytolysis or lysis** occurs when a cell bursts due to an osmotic imbalance that has caused excess water to move into the cell
      - water continually enters *Paramecium* cell
    - solution: contractile vacuole
      - pumps water out of cell



freshwater

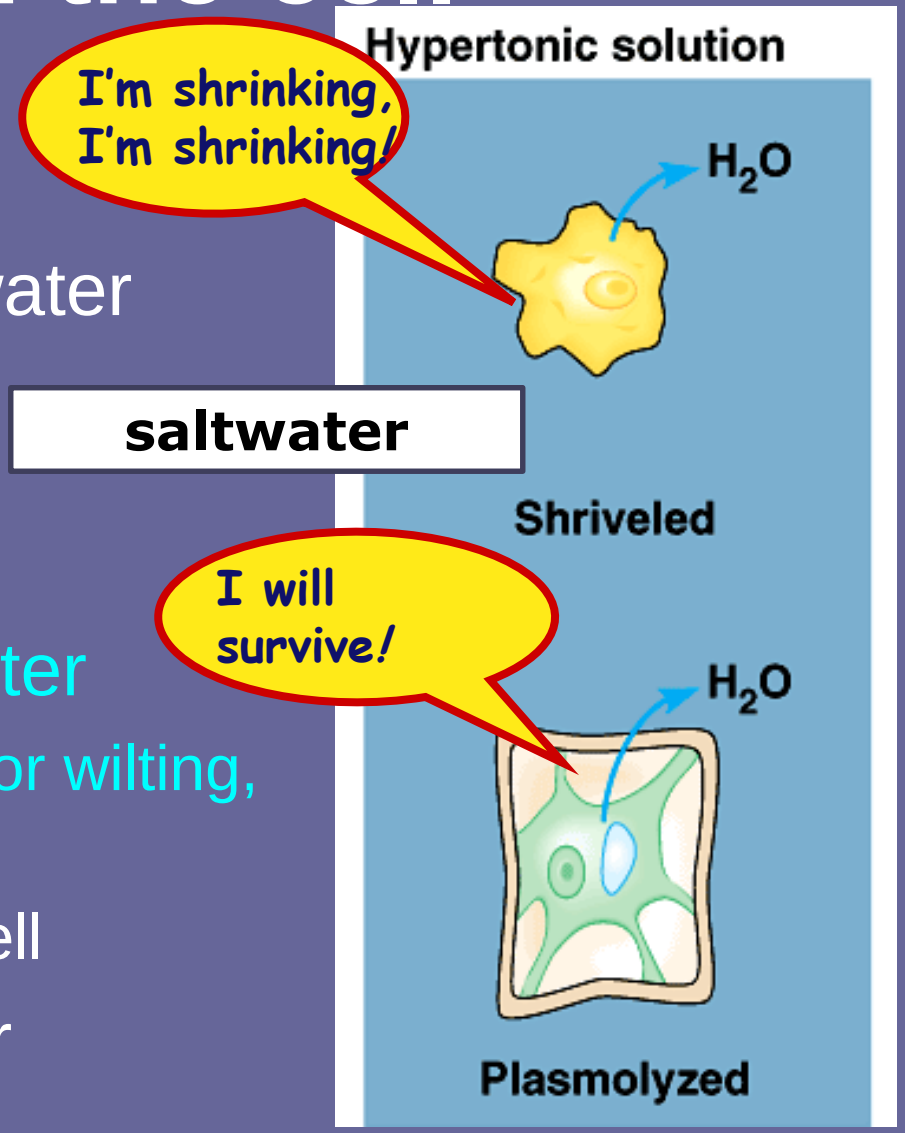
Controlling H_20 Concentrations

- Contractile vacuole in *Paramecium*

2

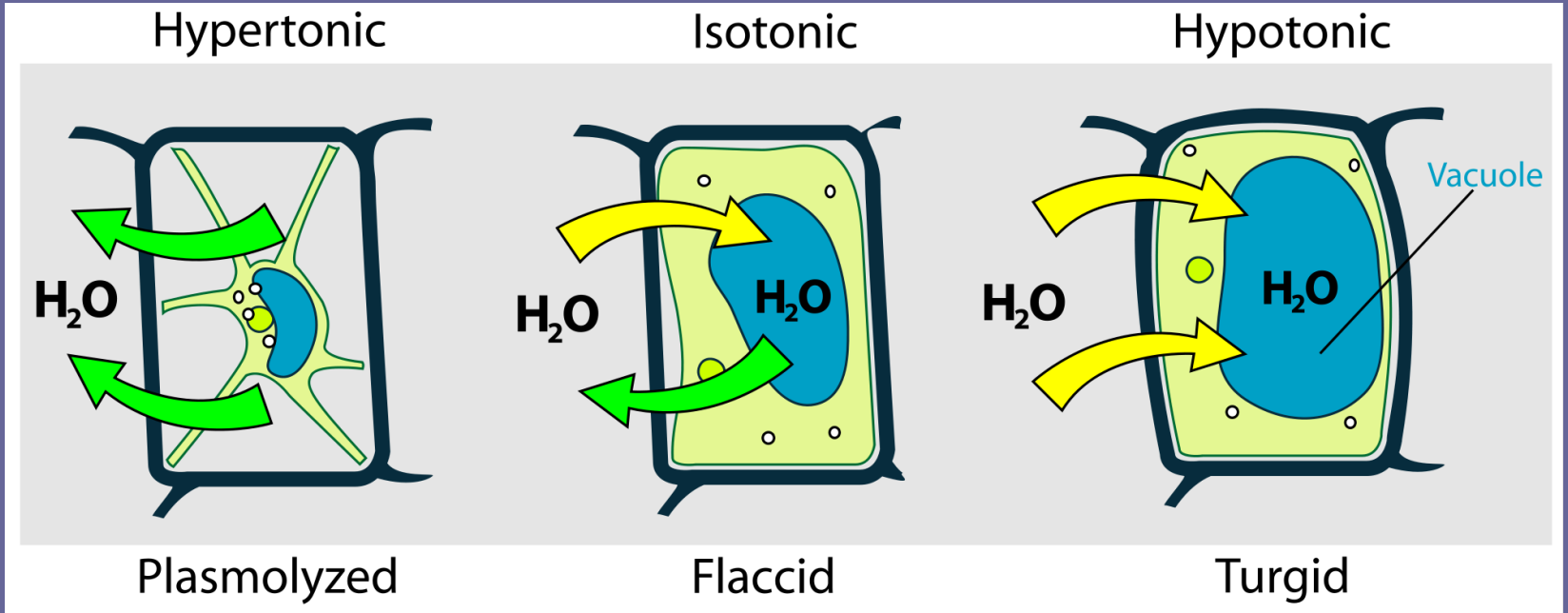
Keeping the right amount of water in the cell

- Saltwater
  - a cell in salt water
  - low concentration of water around cell
    - cell loses water
  - example: shellfish
  - problem: cell loses water
    - in plants: plasmolysis, or wilting, flaccid
    - in animals: shrinking cell
  - solution: take up water

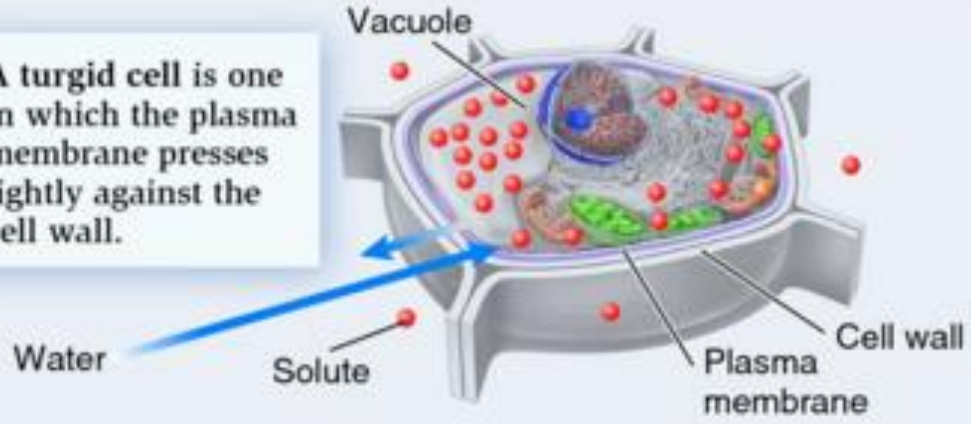


Plasmolysis

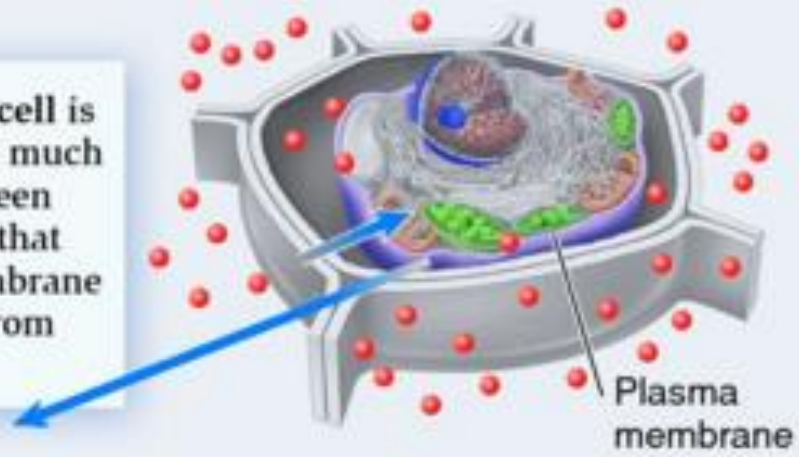
- **Cytoplasm** pulls away from the cell wall
- Loss of **water** from a plant cell resulting in a drop in osmotic (turgor) pressure
- Results in a **gap** between cell membrane and cell wall



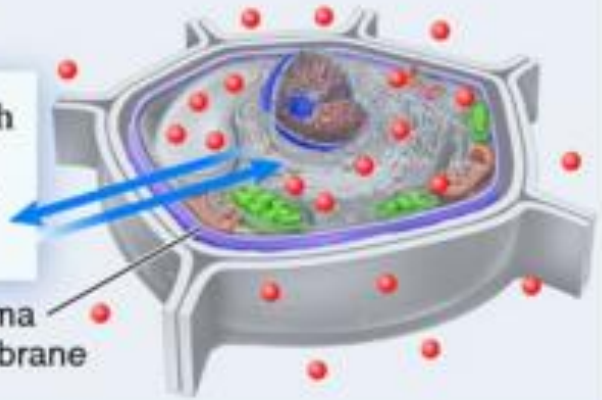
A turgid cell is one in which the plasma membrane presses tightly against the cell wall.



A plasmolyzed cell is one in which so much cell water has been lost by osmosis that the plasma membrane contorts away from the wall.

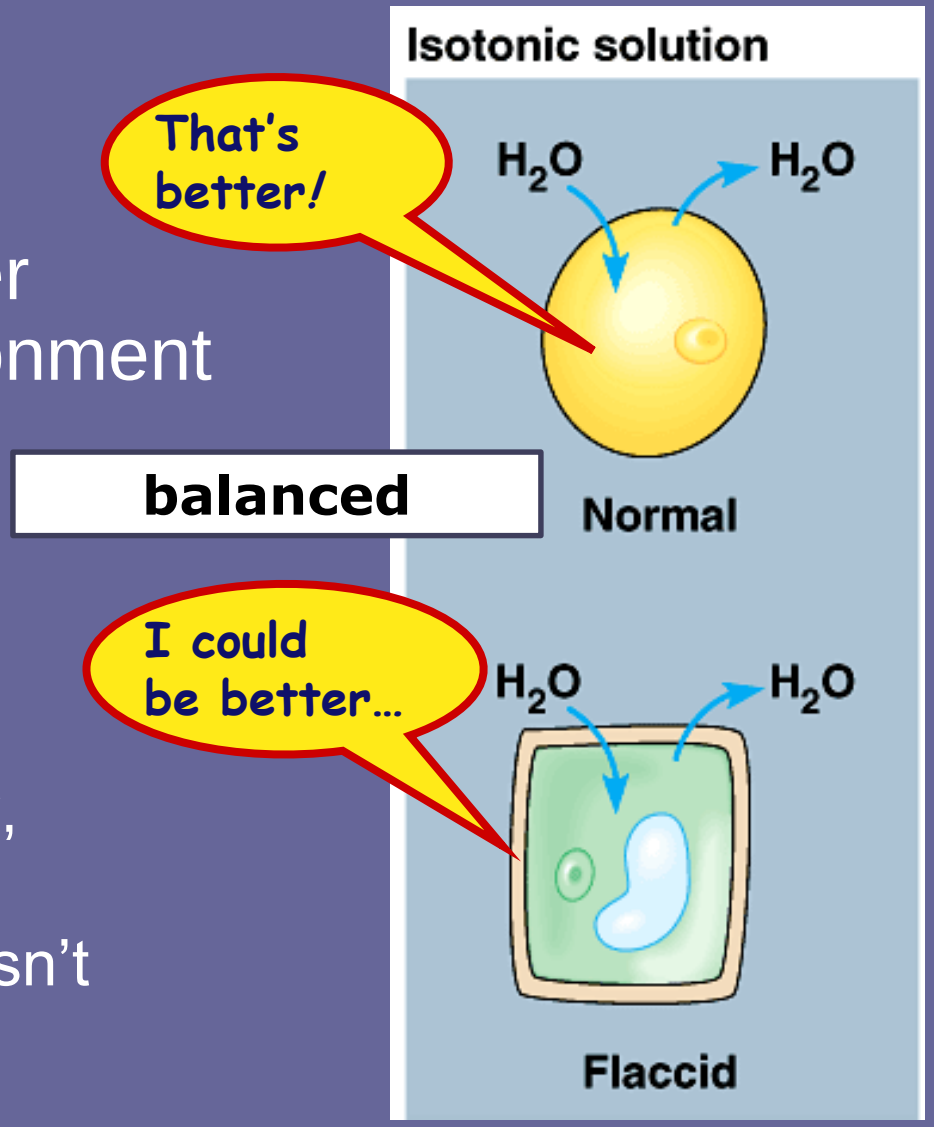


A flaccid cell is one in which the plasma membrane does not press tightly against the cell wall.



3 Keeping the right amount of water in the cell

- Balanced conditions
  - no difference in concentration of water between cell & environment
    - cell in equilibrium
    - example: blood
    - problem: none
      - water flows across membrane equally, in both directions
      - volume of cell doesn't change

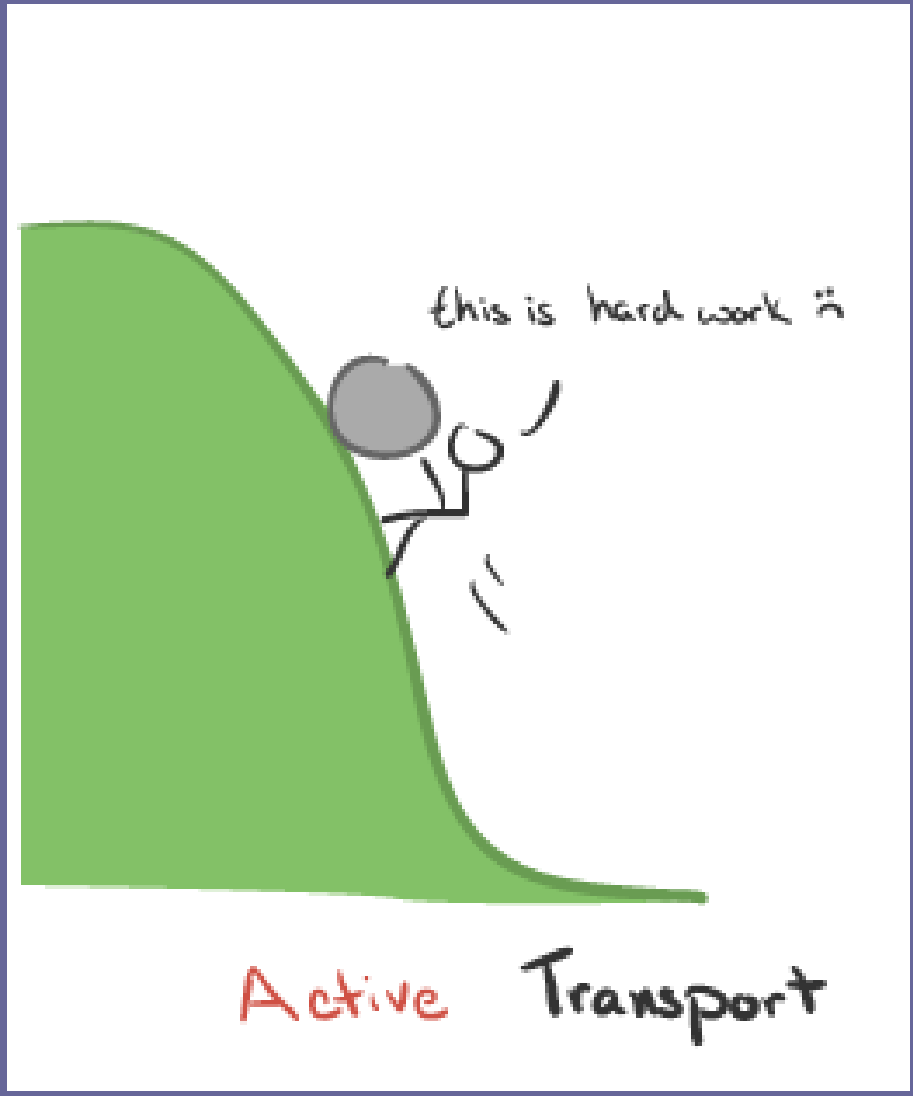


Active Transport:

-Goes against the concentration gradient

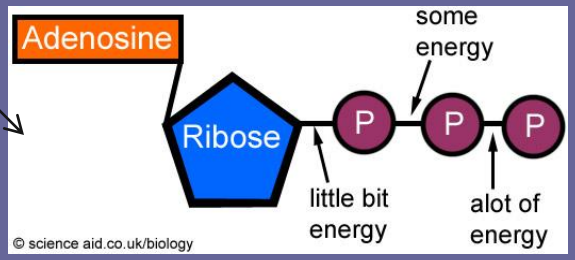
-From low to high concentration

-Energy (ATP) required!



Active Transport

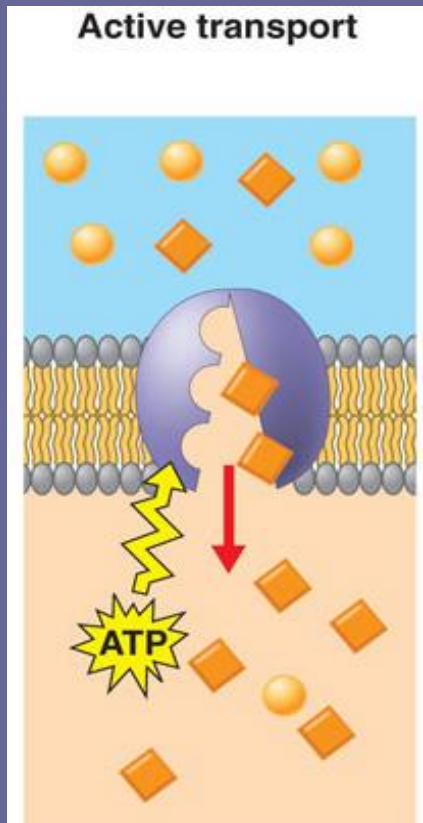
- Carrier proteins:
  - Help molecules move **against** concentration gradient- from a low concentration to a high concentration
  - Help to move ions through the membrane
    - **Requires Energy** (ATP)



Sodium- Potassium Pump

- Made of protein
- 3 Na+ are shipped **out**,
  2 K+ go **in** (very important for nervous signals)

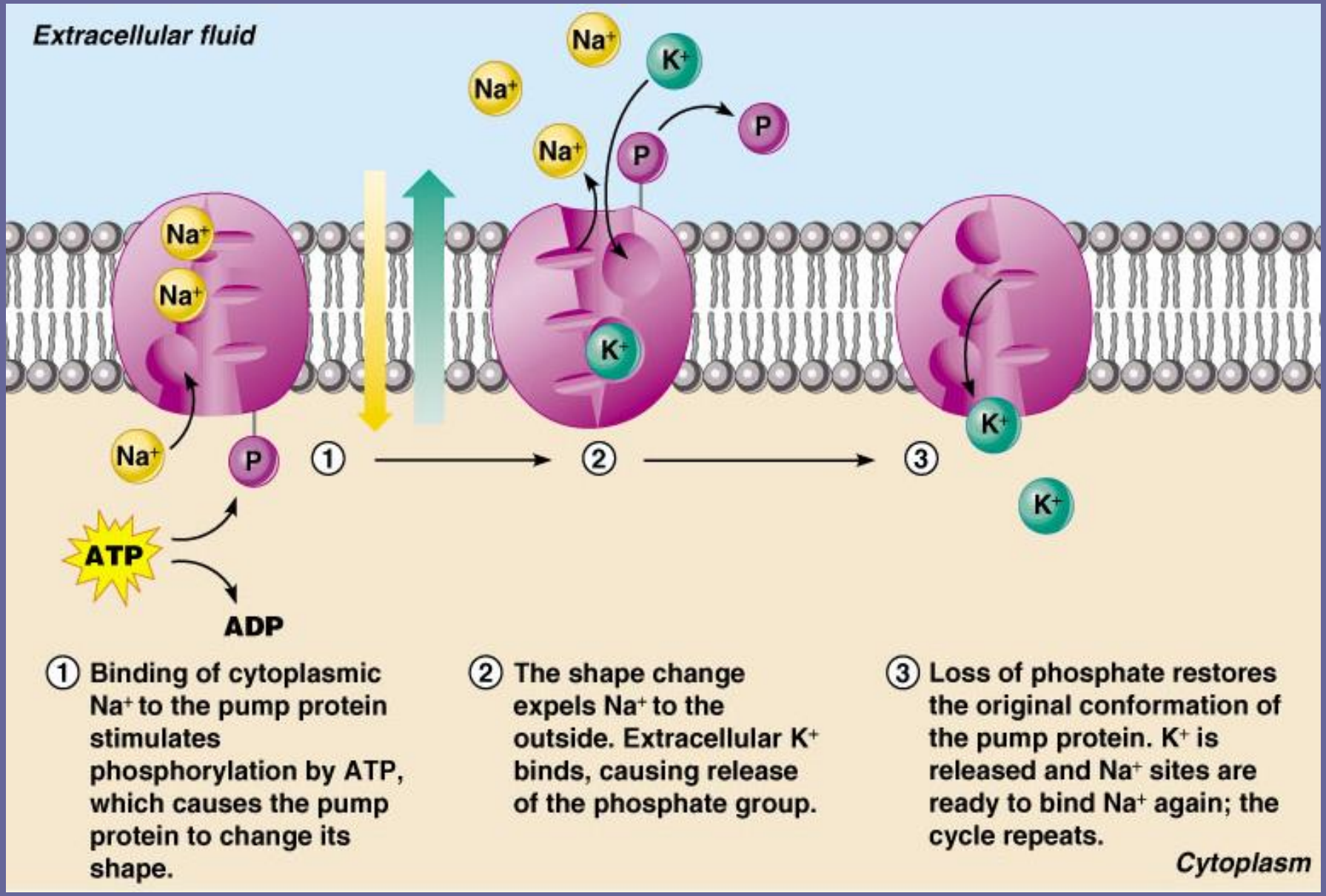
Sodium & Potassium are ions that cannot move through the membrane. Why?



Ions & Active Transport

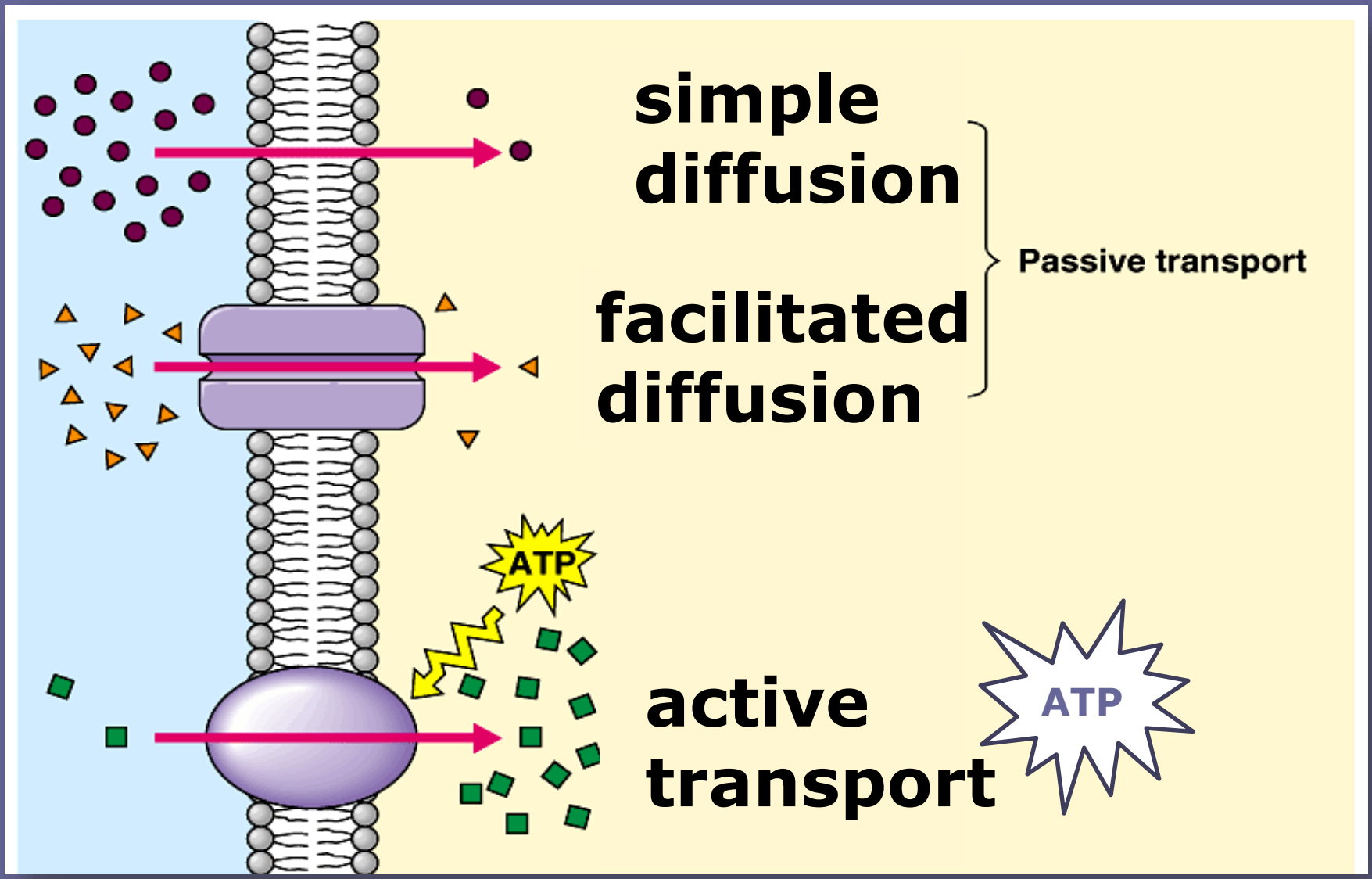
An ion must cross the cell membrane through active transport instead of passive transport **BECAUSE of the hydrophobic lipid tails.**

Sodium-Potassium Pump



1. Binding of cytoplasmic Na^+ to the pump protein stimulates phosphorylation by ATP, which causes the pump protein to change its shape.
2. The shape change expels Na^+ to the outside. Extracellular K^+ binds, causing release of the phosphate group.
3. Loss of phosphate restores the original conformation of the pump protein. K^+ is released and Na^+ sites are ready to bind Na^+ again; the cycle repeats.

Cell Transport Summary



Bulk Transport – Vesicles/Vacuole

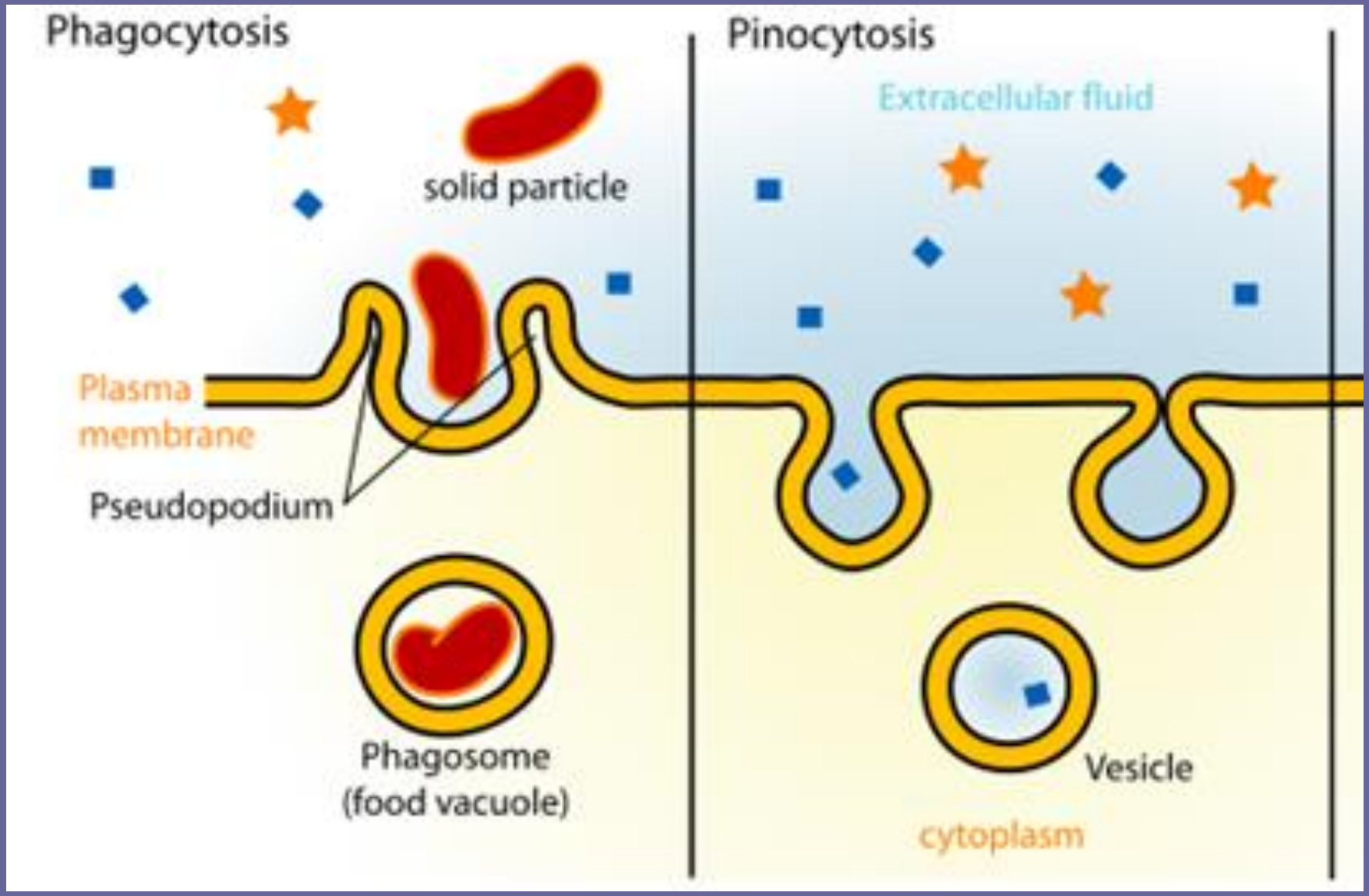
- **Endocytosis** – cells take **in** particles by membrane forming vesicle/vacuole
  - Endo = in

- Two types of **Endocytosis**:

1. **Phagocytosis** = cellular **eating**;
   - WBC engulfing bacteria, amoeba eating paramecium

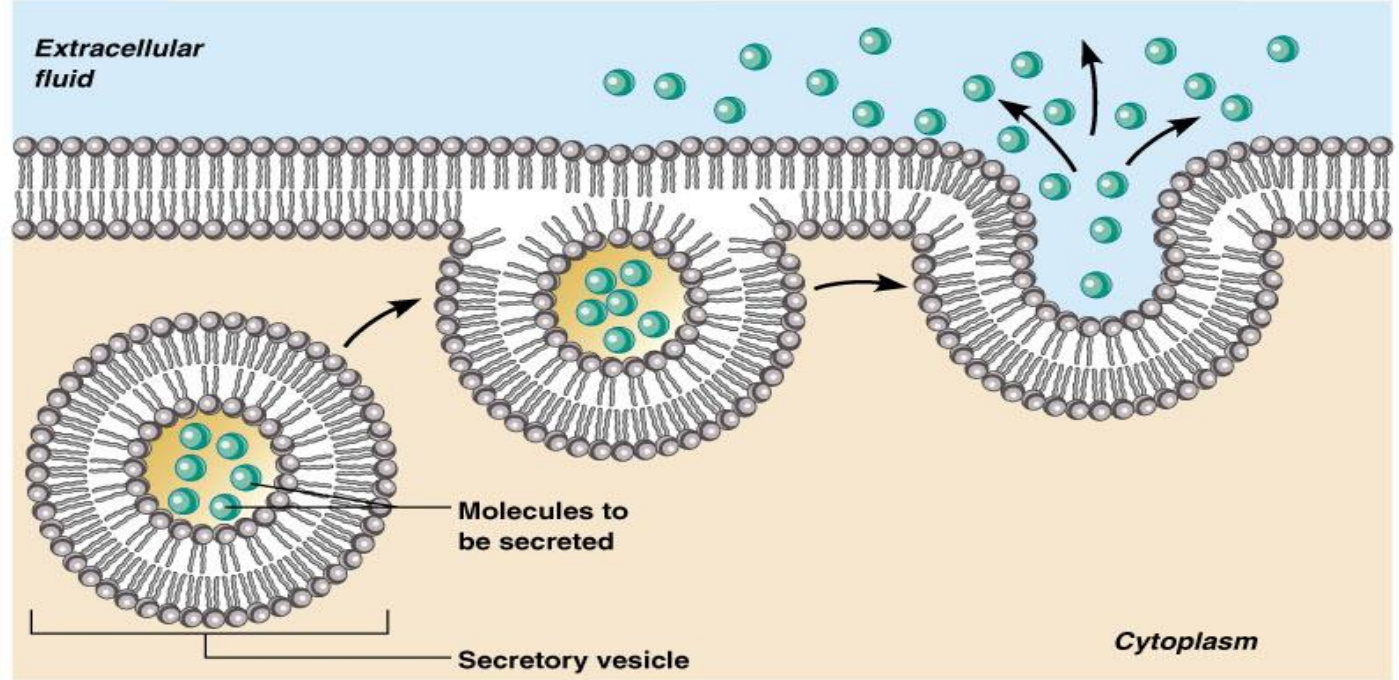
2. **Pinocytosis** = cellular **drinking**
   - Cells take in liquid with material dissolved in vesicle

Endocytosis



Exocytosis

- **Exocytosis** – releasing materials from cells in vesicles that fuse with membrane
  - Exo = out
  - Ex: vesicles of hormones, enzymes, wastes- move out of cell
  - Ex: vacuoles removing water or wastes – contractile vacuole in protist pump out extra water



Wrap-UP

- Cells use passive and active transport to move materials across cell membranes in order to maintain a constant internal environment = HOMEOSTASIS!
  - Example: In humans glucose is kept in balance in the bloodstream by insulin.