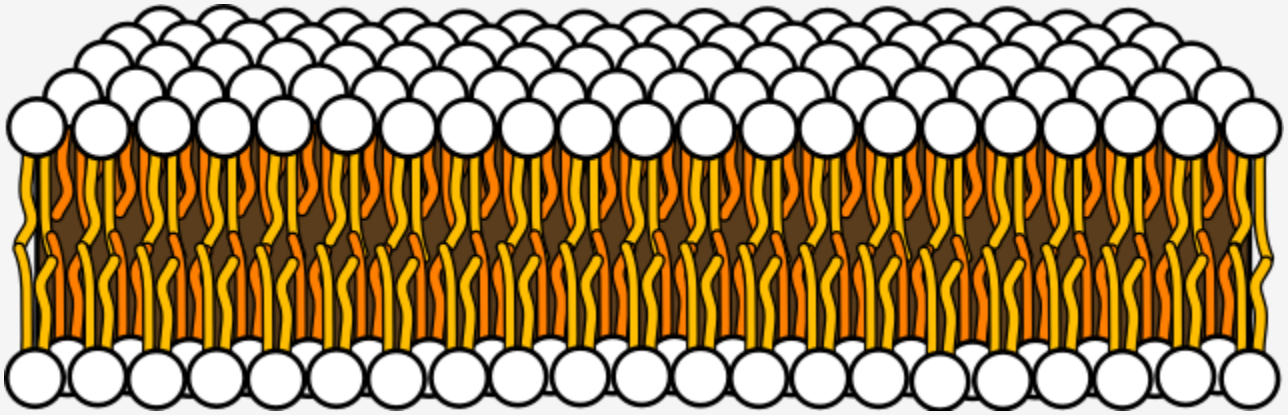
MORE ABOUT CELL MEMBRANES

Because they are important!

U1:L3

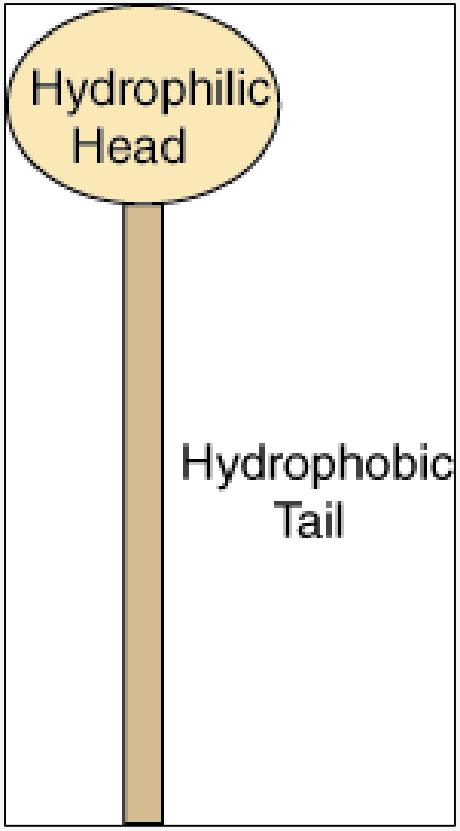


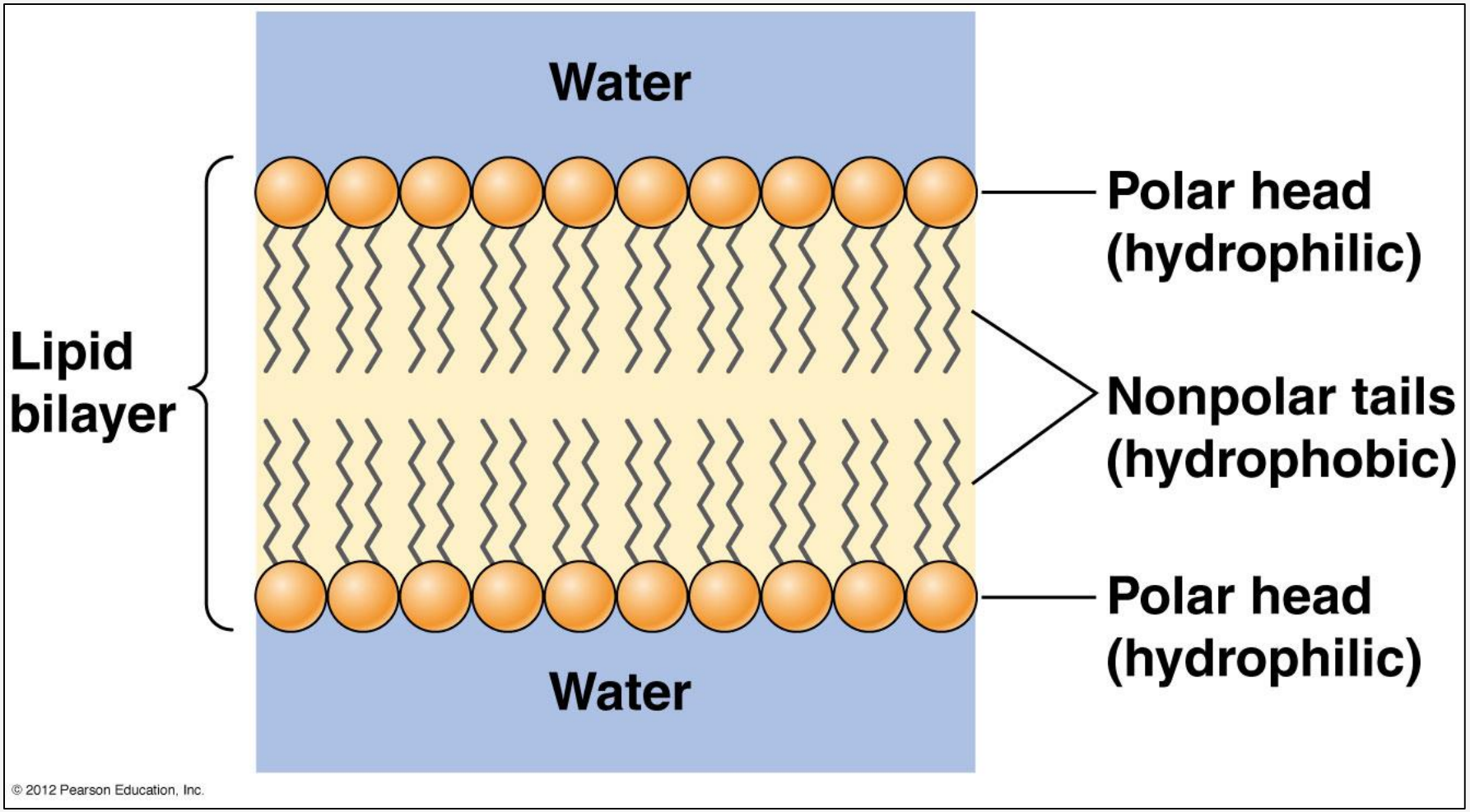
The lipid bilayer is a universal component of all cell membranes. Its role is critical because its structural components provide the barrier that marks the boundaries of a cell.

The structure is called a "lipid bilayer" because it is composed of ***two*** layers of ***fat*** cells organized in two sheets.

Lipids are fats, like oil, that are insoluble in water.
Each lipid molecule contains:

1) a hydrophilic region (a polar head region)
2) a hydrophobic (nonpolar tail region)

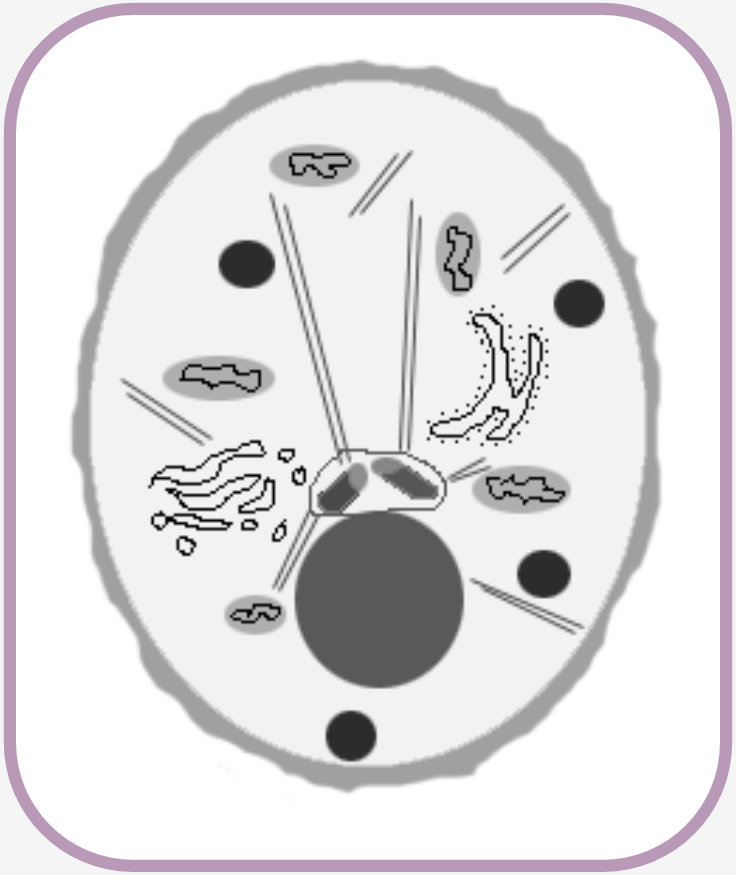




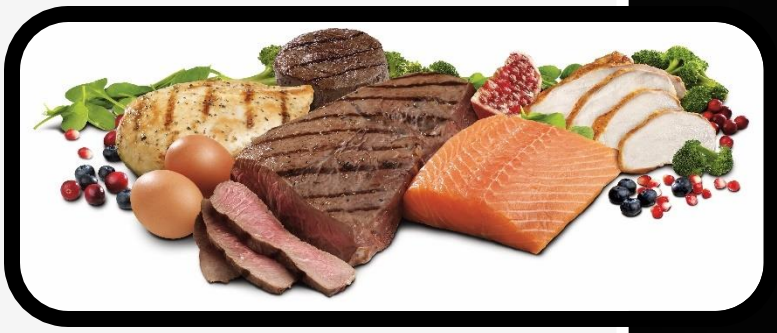
Only water and gases can easily pass through the bilayer.

This means that large molecules and small polar molecules cannot cross the bilayer, and thus the cell membrane, without the assistance of other structures.

Identify the lipid bilayer in the following diagram of a cell.

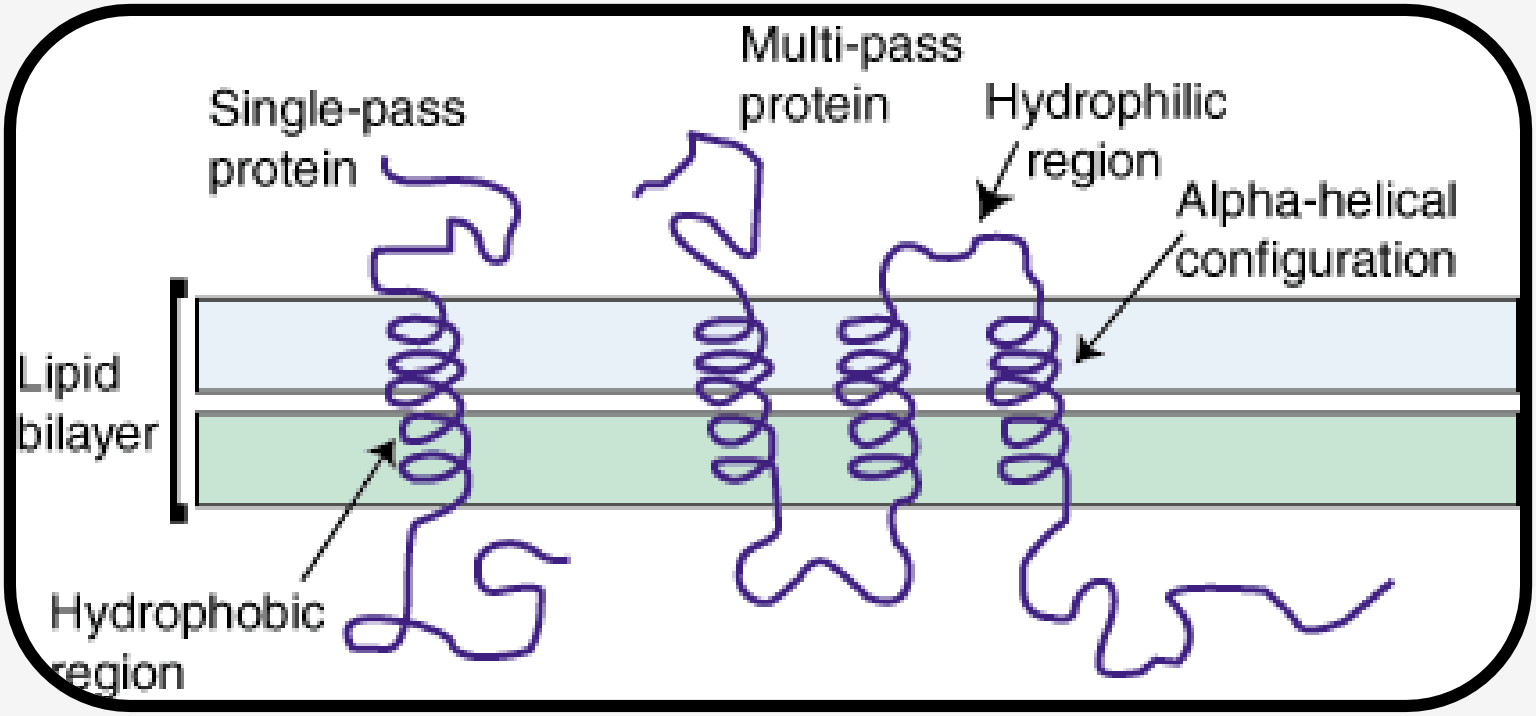


In addition to the lipid bilayer, the cell membrane also contains a number of **proteins.**

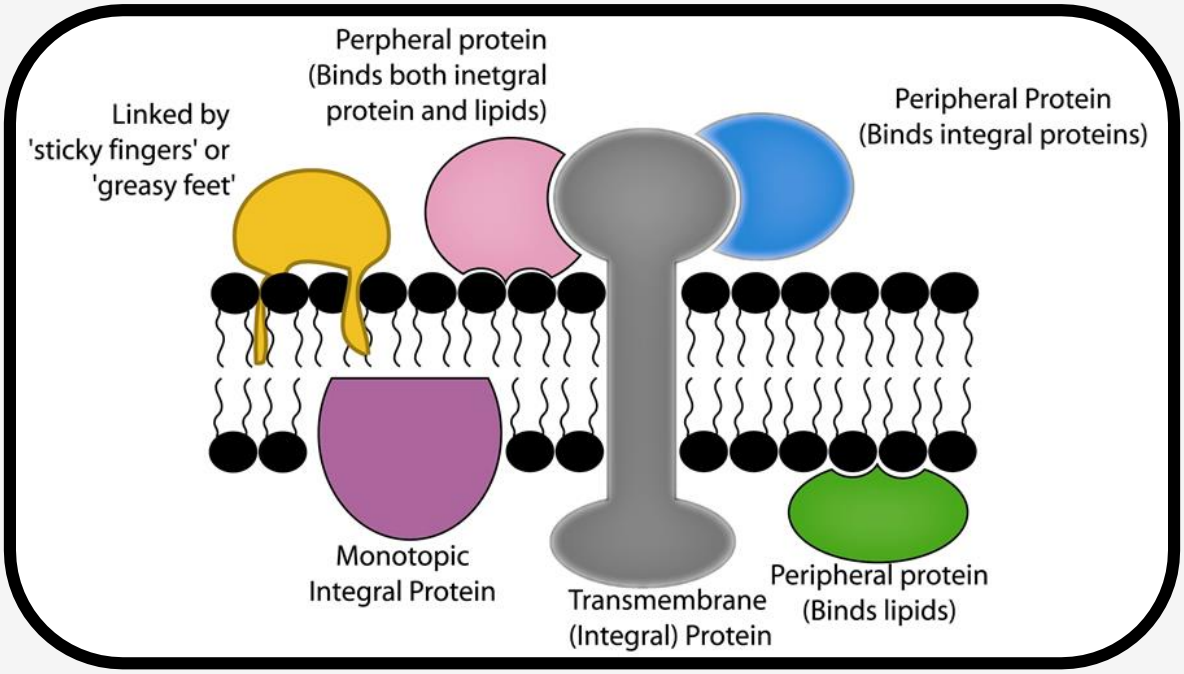


While the lipid bilayer provides the structure for the cell membrane, membrane proteins allow for many of the interactions that occur between cells.

Proteins are generally broken down into the smaller classifications of integral proteins, peripheral proteins, and lipid-bound proteins.



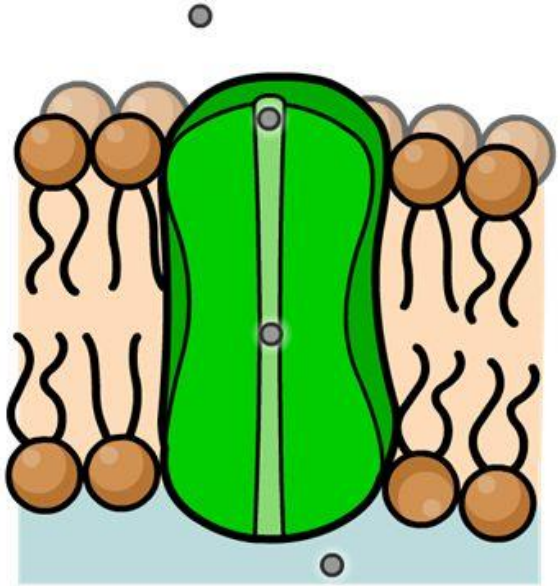
- Integral proteins are embedded within the lipid bilayer.
- They cannot easily be removed from the cell membrane without the use of harsh detergents that destroy the lipid bilayer.
- Integral proteins float freely within the bilayer.
- One end of the integral protein contacts the interior of the cell and the other touches the exterior.

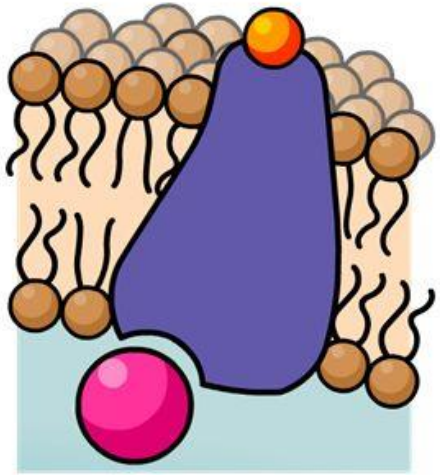


Integral proteins

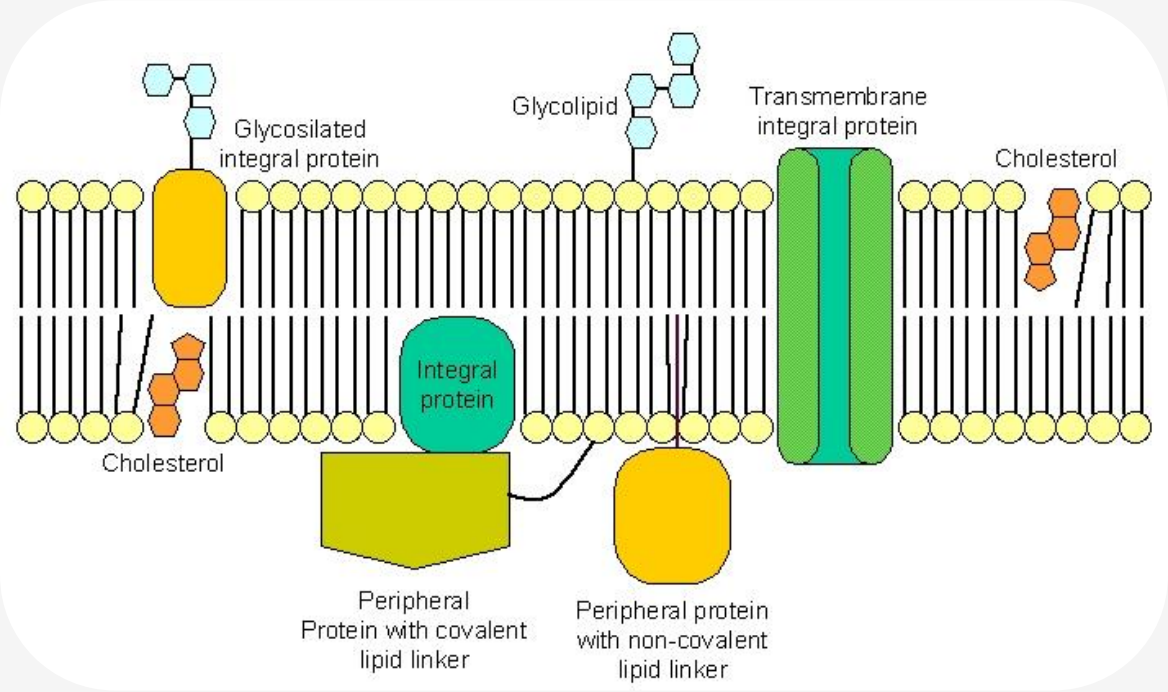
Many integral proteins are **carrier proteins** or **channels**.

These help transport substances, such as ions, sugars and amino acids, that cannot diffuse across the membrane but are still vital to a cell's functioning.





Other integral proteins are receptors for hormones and neurotransmitters, or enzymes for catalyzing reactions.



PERIPHERAL PROTEINS are attached to the exterior of the lipid bilayer. They are easily separable from the lipid bilayer, able to be removed without harming the bilayer in any way. Peripheral proteins are less mobile within the lipid bilayer.

Functions of Membrane Proteins

- Peripheral proteins help stabilize the shape of the cell membrane.
- Integral proteins can be of five types:
  - **Channel proteins** – allow substances to move freely across the cell membrane.
  - **Carrier Proteins** – combine with a substance to help it move across the cell membrane
  - **Receptor Proteins** – shaped so that a specific molecule can bind to it and bring about a cellular response
  - **Enzymatic proteins** – catalyze a specific reaction
  - **Recognition proteins** – acts as a fingerprint or barcode. Become important for blood and organ donation.

What is the difference between a peripheral protein and an integral protein?

Things we know so far:

- Lipid bilayers are selectively permeable (they only let a few things in)
- Mostly this selectivity is GOOD, because it allows the cell to maintain its integrity.

BUTTTTTTTTTTT…

cells *do* need to move certain large, polar molecules such as amino acids, sugars, and nucleotides across their membranes.

As a result, cell membranes require specific structures that allow for the transport of certain molecules.

Some processes of moving these molecules is **ACTIVE** because it requires energy to do this, while other are **PASSIVE** because…ITS EASY!

DIFFUSION

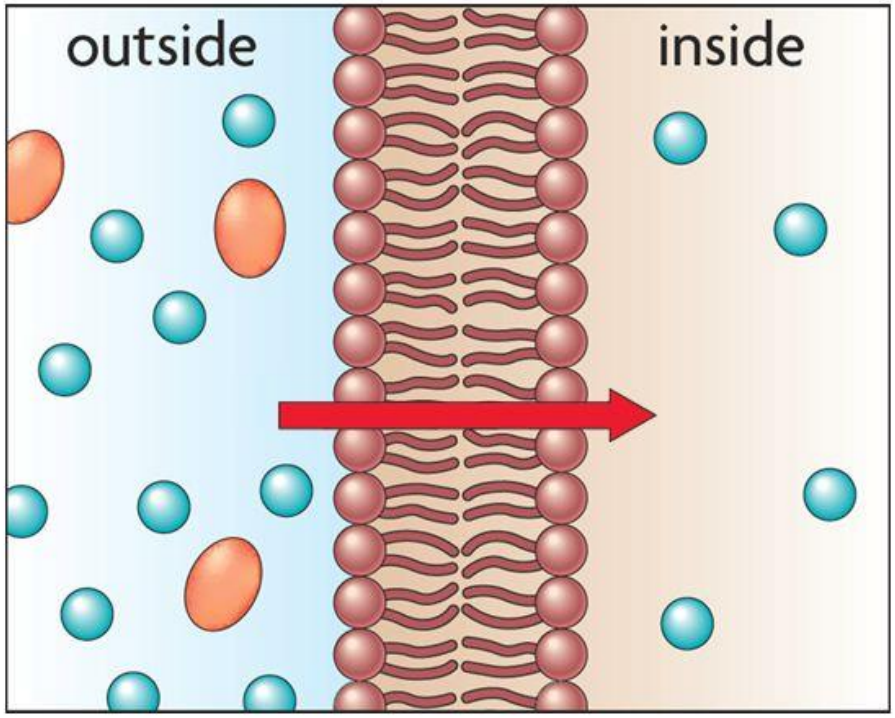
U1L2

The Cell Membrane

- Review:
  - Semi permeable
  - Participates in Passive and Active Transport
  - Passive Transport – Diffusion, Osmosis and Facilitated Diffusion.
  - Active Transport – Exocitosis and Endocitosis

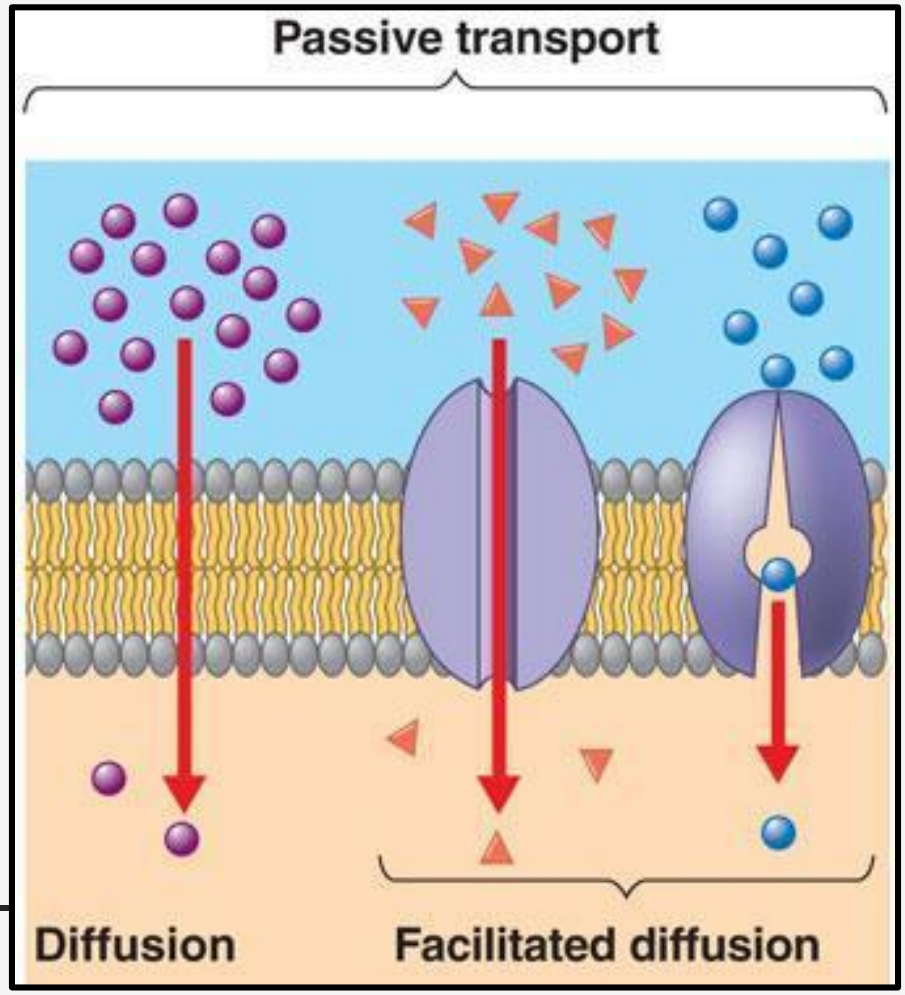
Diffusion refers to the process by which molecules intermingle as a result of their kinetic energy of random motion

Selective Permeability



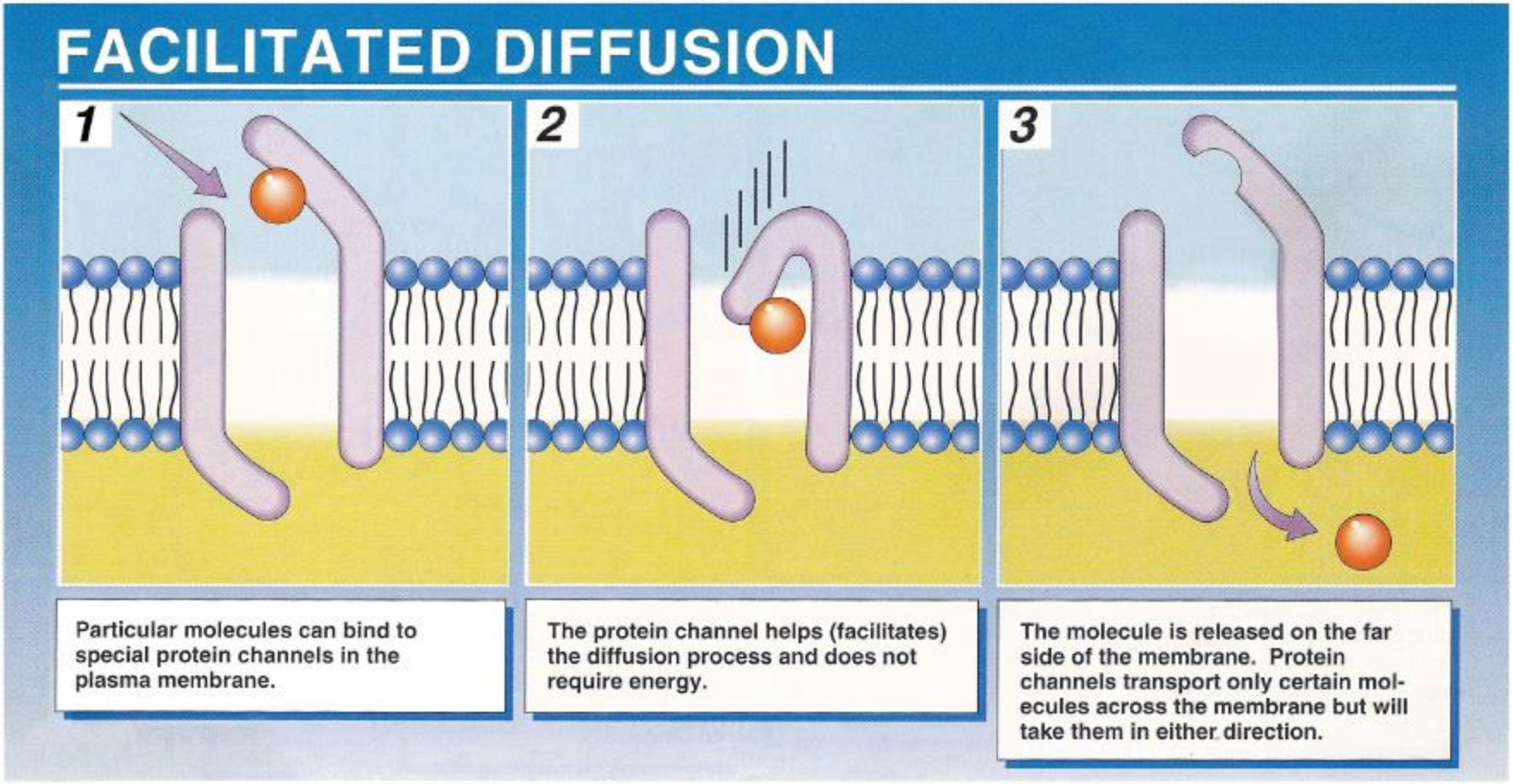
Some molecules can cross the membrane while others cannot.

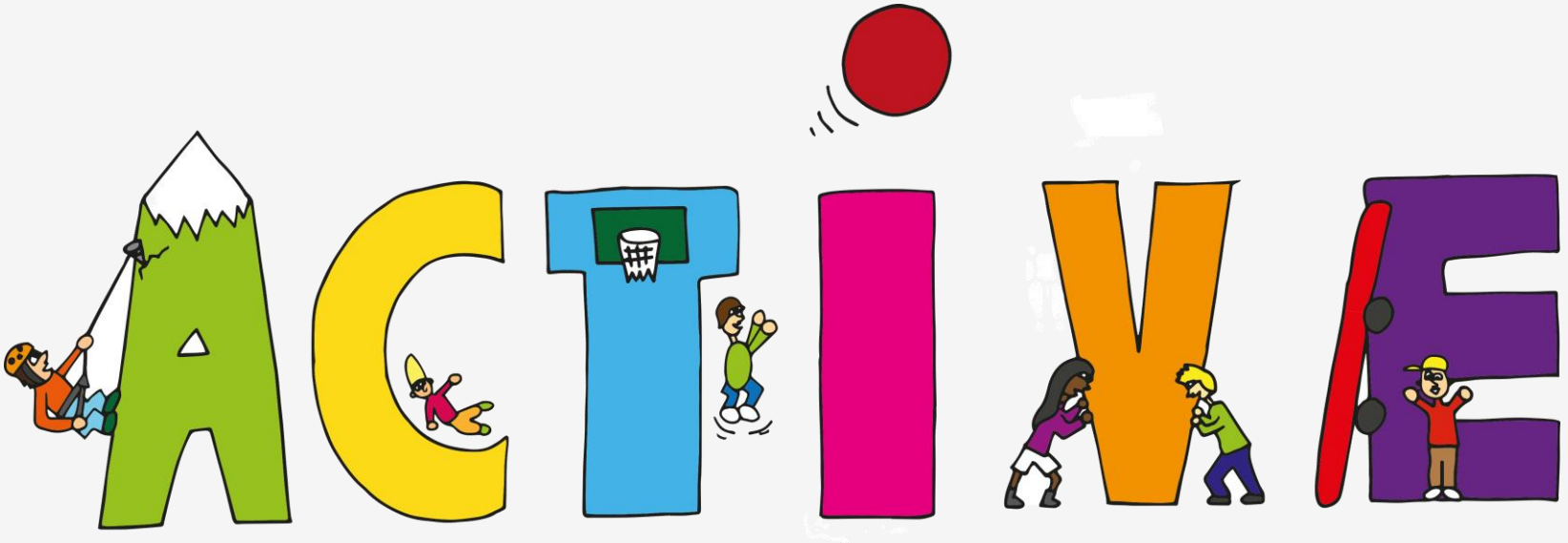
PASSIVE TRANSPORT is a movement of molecular substances across cell membranes **without** need of energy input.



The molecule most likely to be involved in simple diffusion is water - it can easily pass through cell membranes. When water undergoes simple diffusion, it is known as **osmosis**.

One form of passive transport is **facilitated diffusion**



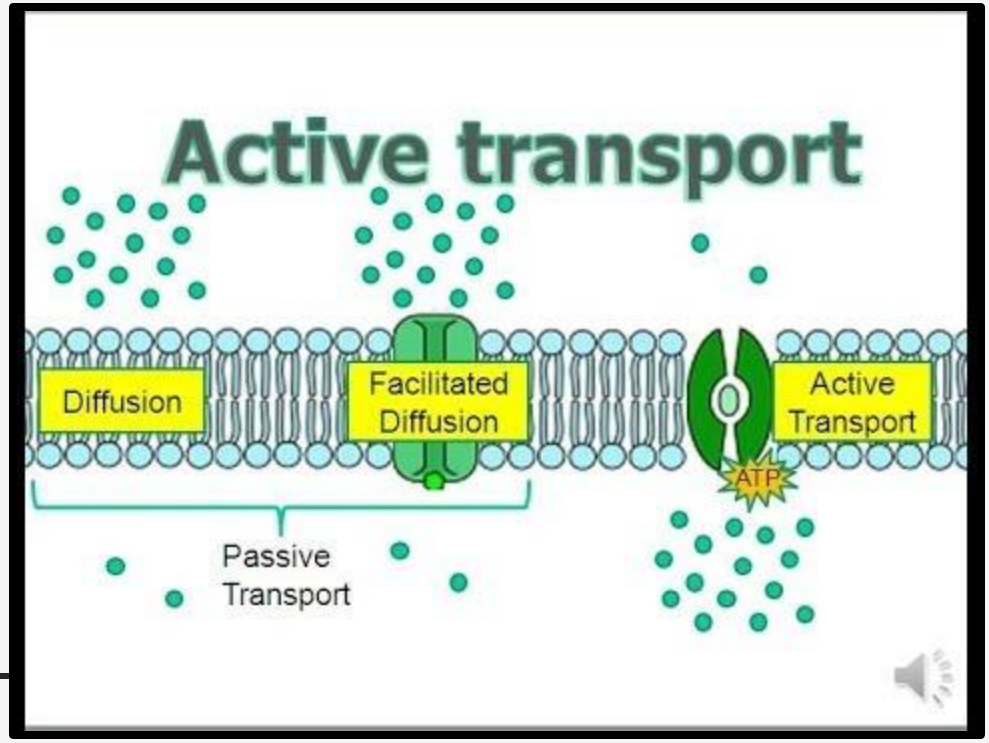


Carrier proteins – embedded proteins change shape to open and close passages across the membrane.

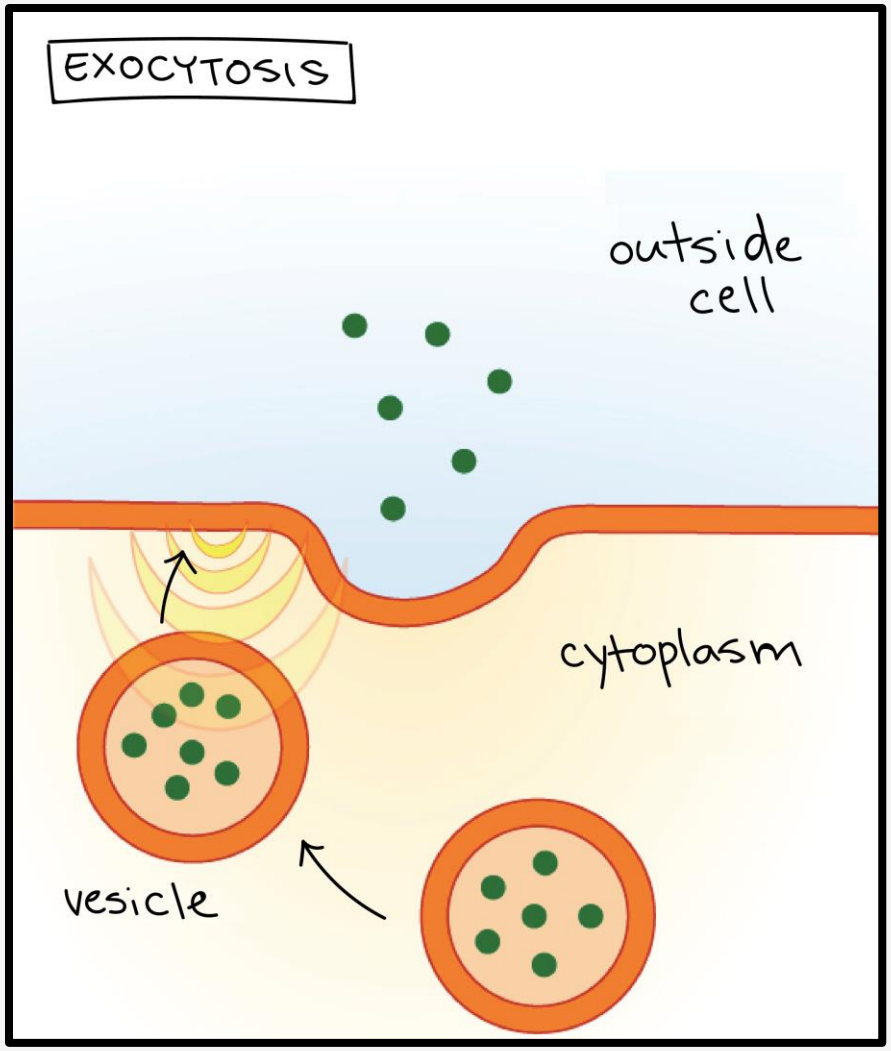
Endocytosis – taking something into the cell.

Exocytosis – expelling something from the cell.

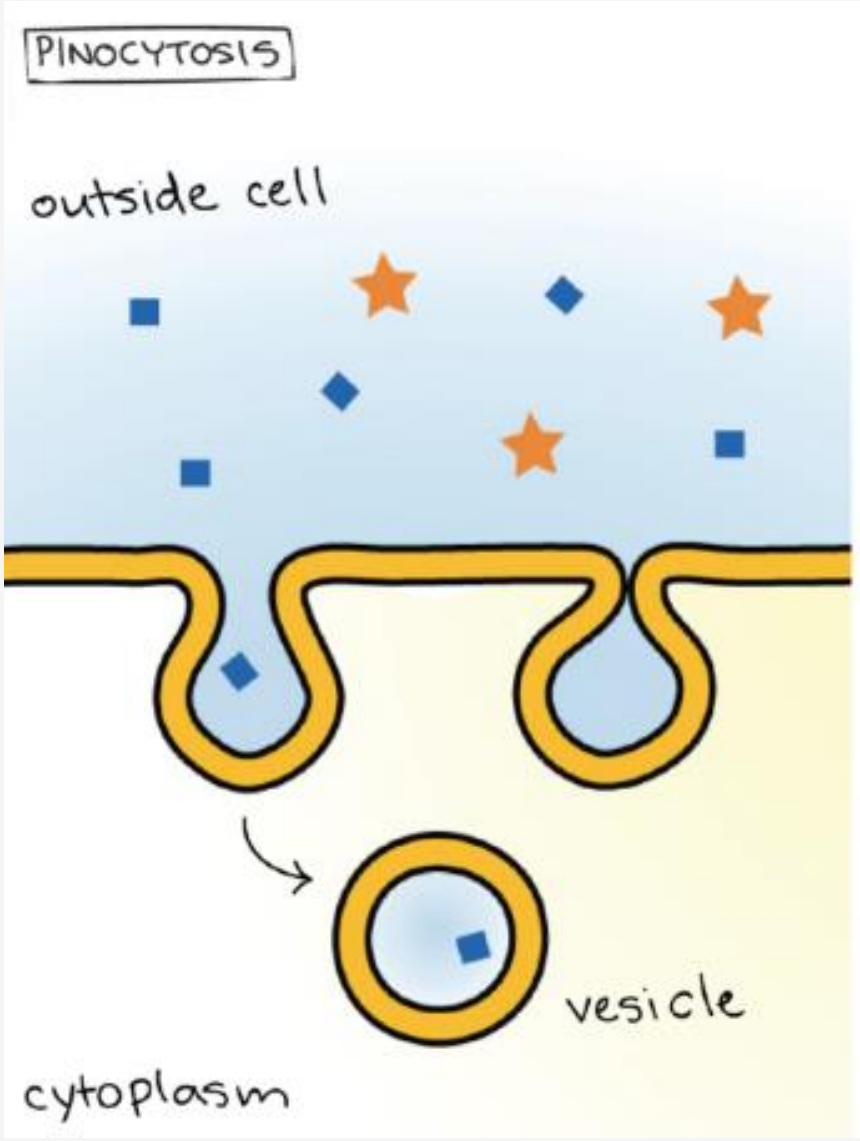
ACTIVE TRANSPORT is the movement of molecules across a cell membrane from a region of their lower concentration to a region of their higher concentration—in the direction against some gradient or other obstructing factor (often a concentration gradient).



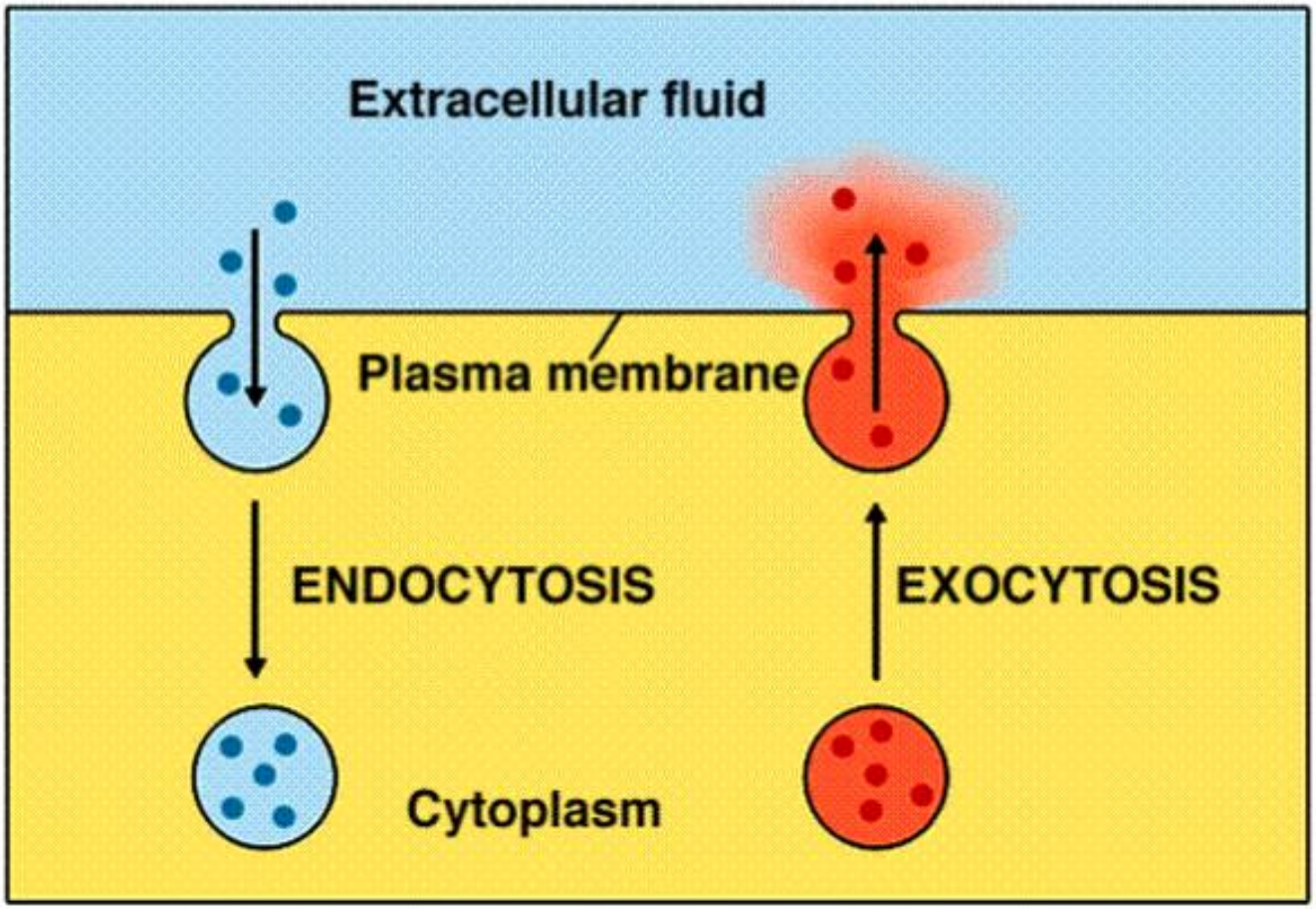
Exocytosis is a process by which a cell transports secretory products through the cytoplasm to the plasma membrane. Secretory products are packaged into transport vesicles (membrane-bound spheres).

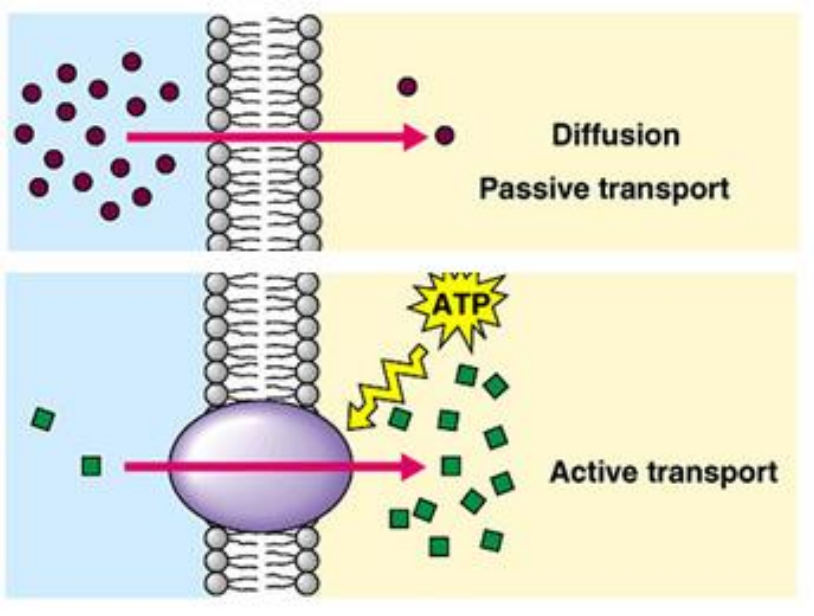


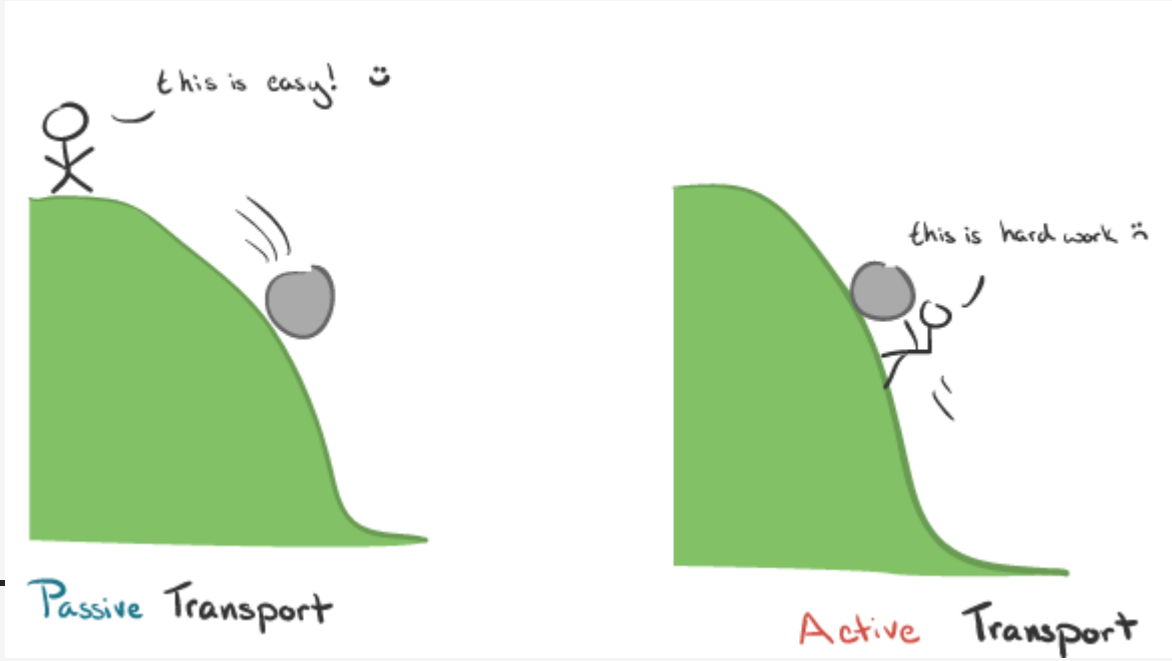
ENDOCYTOSIS



Endocytosis and Exocytosis




Diffusion
Passive transport
ATP
Active transport

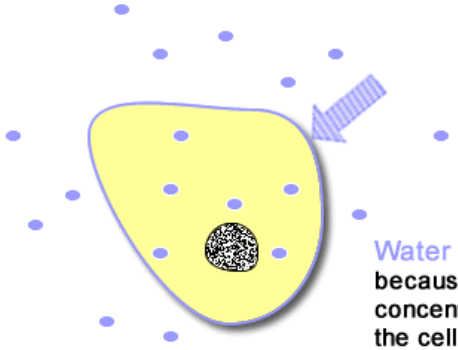

this is easy!
this is hard work
Passive Transport
Active Transport

3 FACTORS WHICH AFFECT DIFFUSION

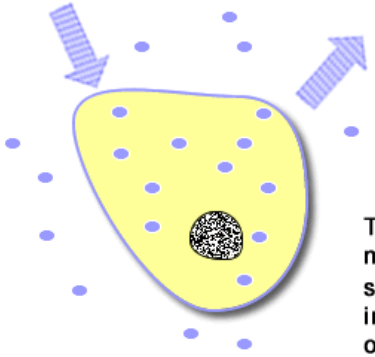
Factor 1: Concentration Gradient

- The **greater the difference** in concentration from one side of the membrane to the other, the **faster** the rate of diffusion across that membrane.

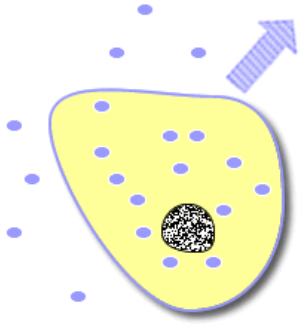
Water Molecule



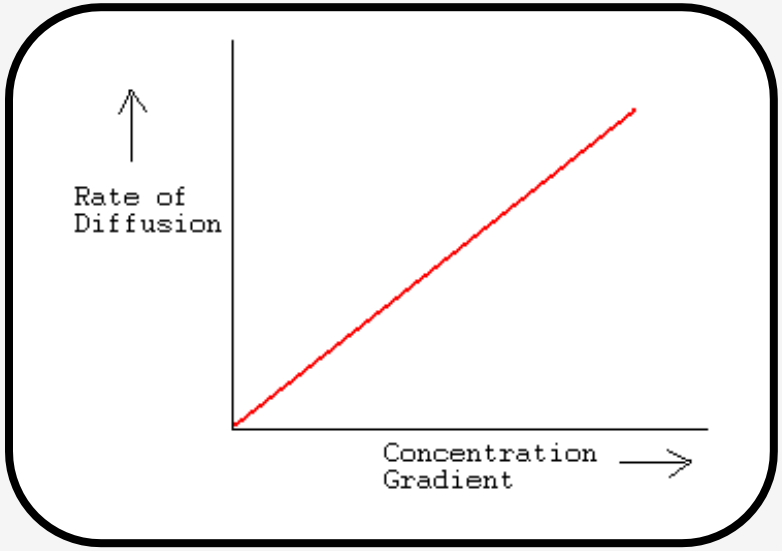
Water will move INTO of this cell because there is a greater concentration of water outside the cell.

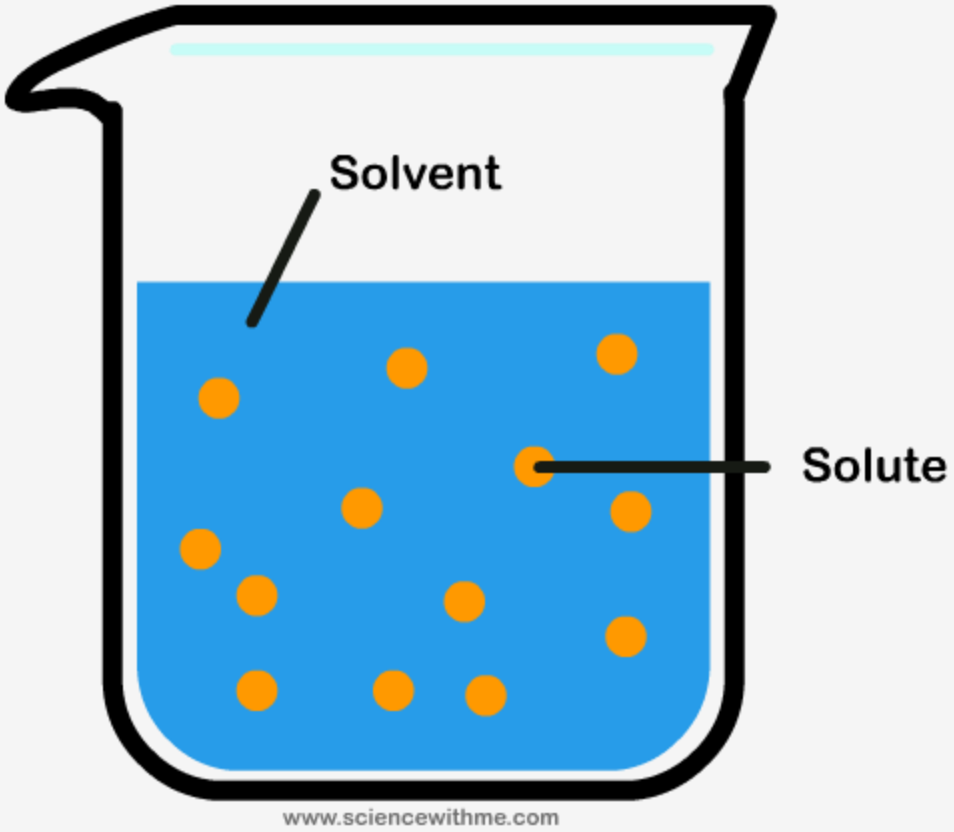


This cell is in equilibrium. Since molecules are always moving, some water molecules will move into the cell and others will move out.



Water will move OUT of this cell because there is a lower concentration of water outside the cell.





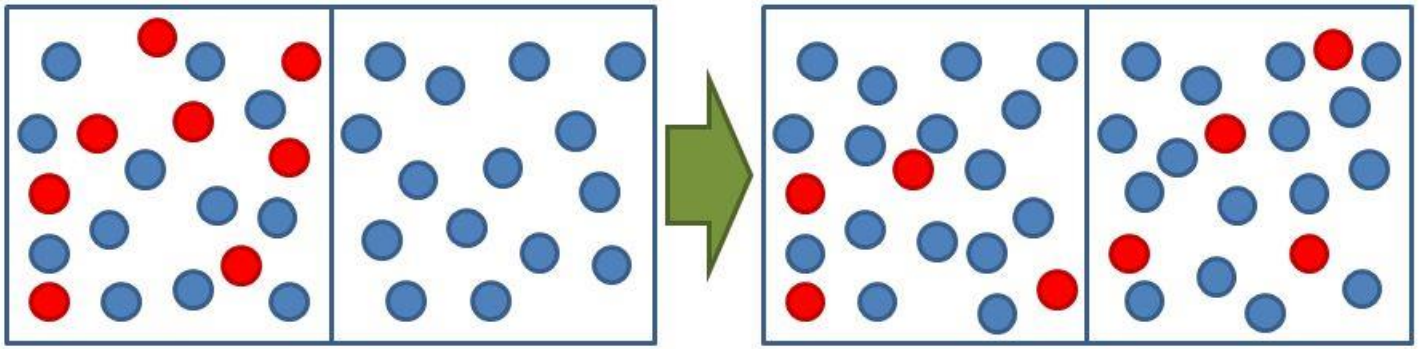
Solution

CELL CONCENTRATIONS

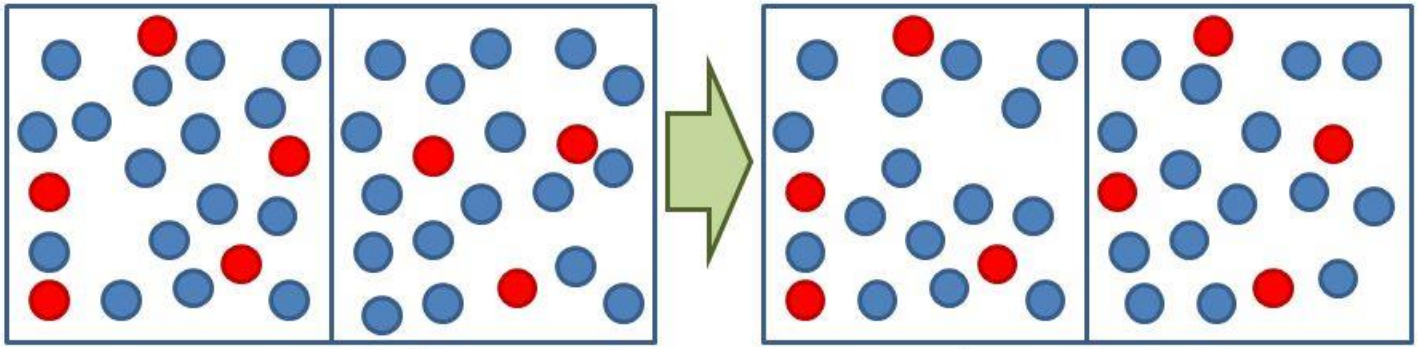
- Isotonic solutions –A solution with equal amounts of solute and water as inside the cell. If a cell is placed in isotonic solution there is no net gain or loss of water.
- Hypertonic solutions – A solution with more solute and less water than inside the cell. If a cell is placed in hypertonic solution, water will leave the cell and the cell will shrink or shrivel
- Hypotonic solutions – A solution with less solute and more water than inside the cell. If a cell is placed in hypotonic solution water enters the cell and the cell swells and can even burst.

Rate of diffusion

Diffusion increases if there is a steeper gradient…



Steep concentration gradient



Shallow concentration gradient

Factor 2: Surface Area-to-Volume Ratio:

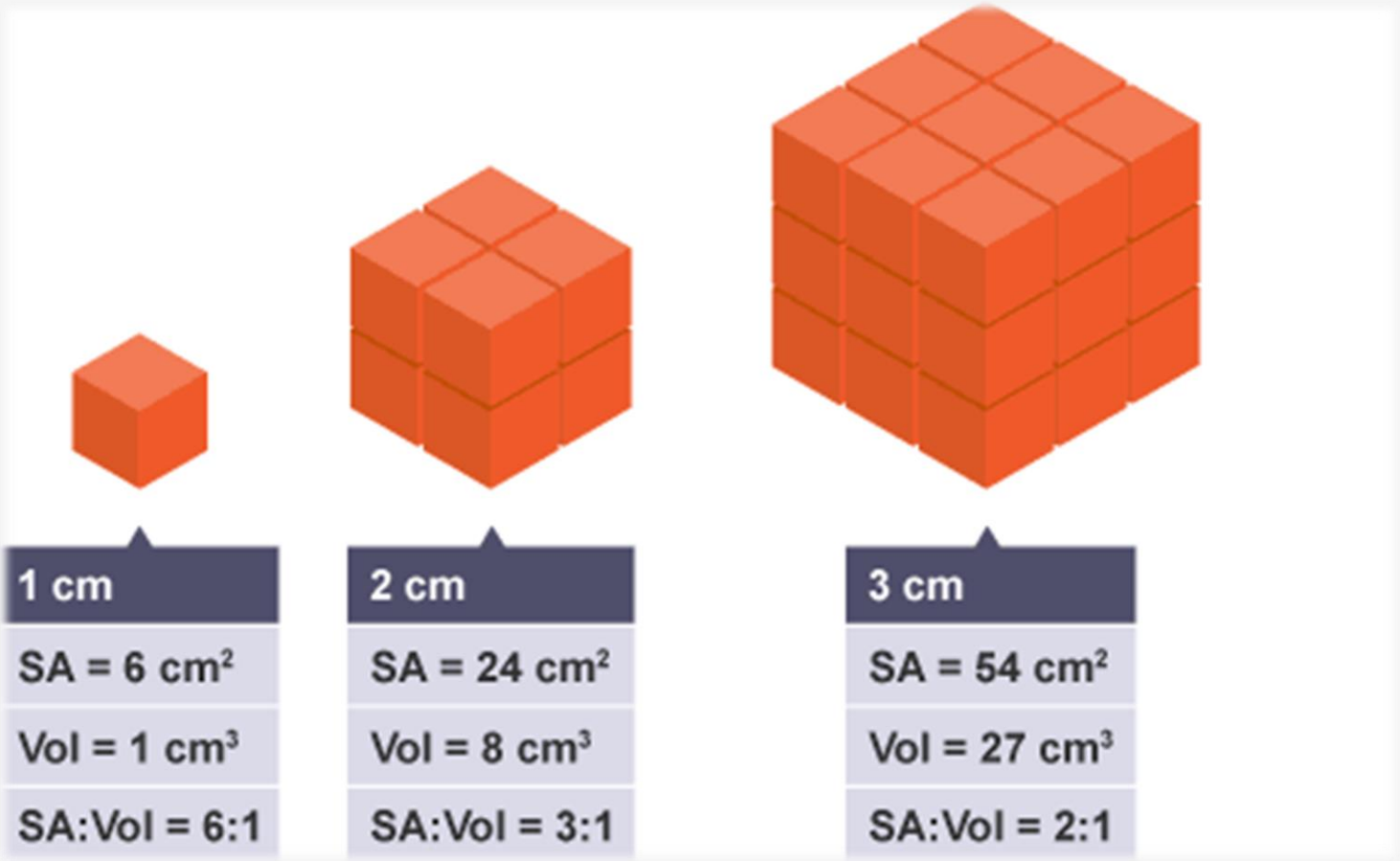
- The **more surface area** there is for a given amount of cell volume (i.e. the larger the surface area-to-volume ratio) the **faster** the rate of diffusion because the cell can exchange more materials with its environment in a given amount of time.
- Small cells have a large surface area-to-volume ratio which means that all parts of the cell are close to the external environment.

- As cell size increases, the surface area-to-volume ratio becomes smaller and many parts of the cell are farther from the external environment making the rate of exchange between internal and external environments more difficult (diffusion rate is slower).
- As a cell increases in size its volume increases proportionately more than its surface area

sides = 3
surface = 3^2 x 6 = 54
volume = 3^3 = 27

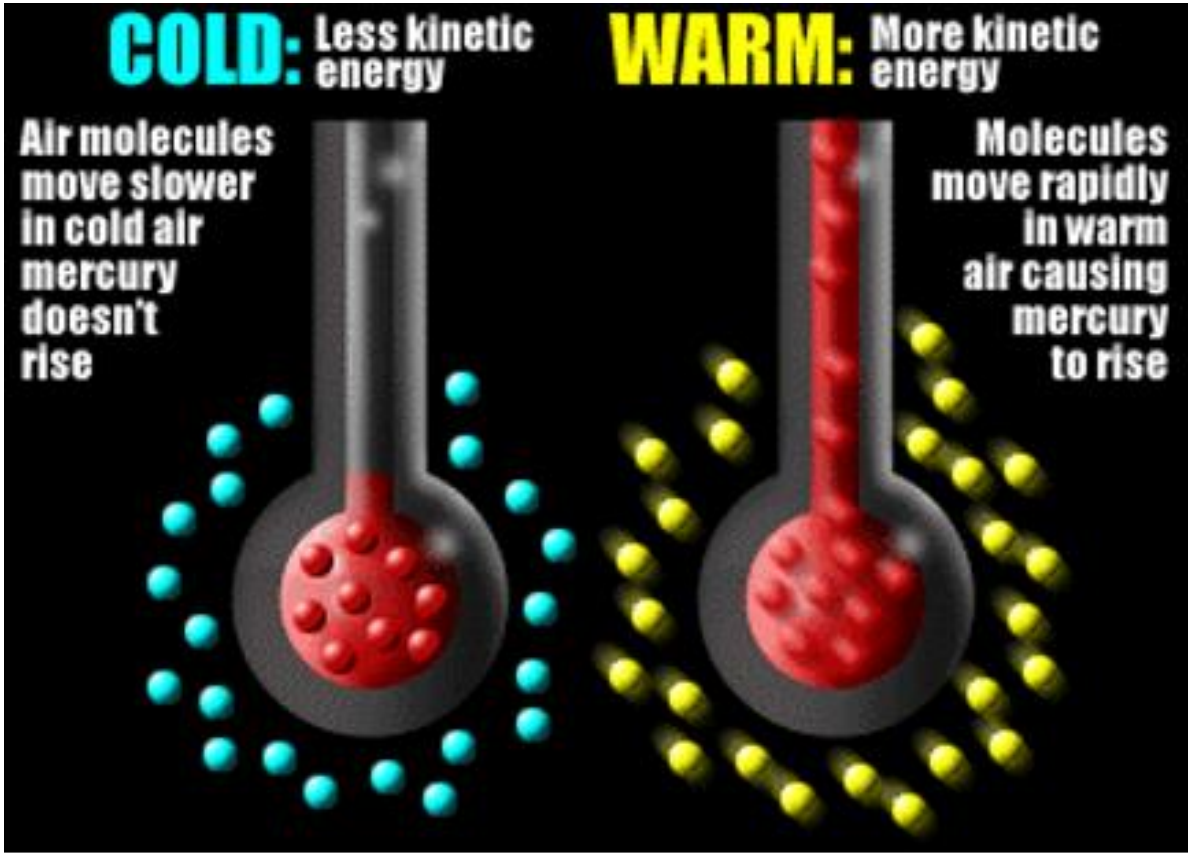
sides = 2
surface = 2^2 x 6 = 24
volume = 2^3 = 3

sides = 1
surface = 1^2 x 6 = 6
volume = 1^3 = 1

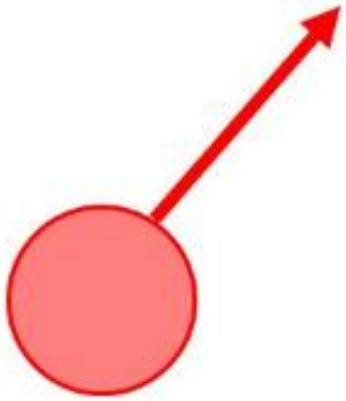

1 cm
SA = 6 cm²
Vol = 1 cm³
SA:Vol = 6:1
2 cm
SA = 24 cm²
Vol = 8 cm³
SA:Vol = 3:1
3 cm
SA = 54 cm²
Vol = 27 cm³
SA:Vol = 2:1

Factor 3: Temperature

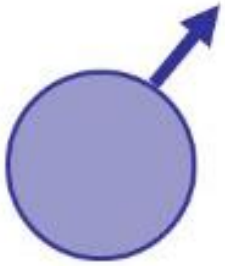
- An increase in temperature causes an increase in the rate of diffusion.
- Particles increase their kinetic energy when they are heated up, meaning that they increase their movement.
- If particles are moving more quickly, they will cross the membrane more quickly.


COLD: Less kinetic energy
WARM: More kinetic energy
Air molecules move slower in cold air mercury doesn't rise
Molecules move rapidly in warm air causing mercury to rise

Temperature is Average Kinetic Energy



"HOT"
Fast



"COLD"
Slow