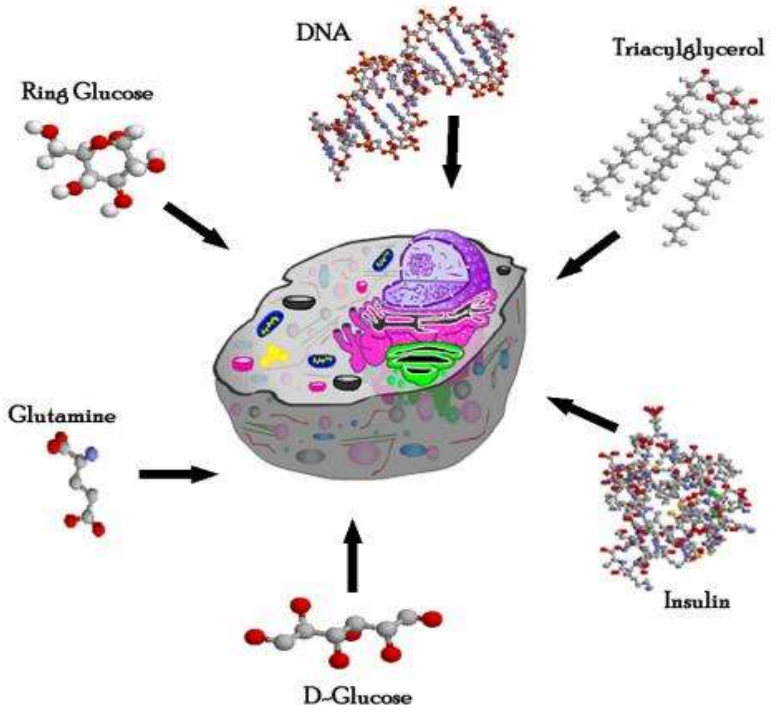
SBI4U
UNIT #1: BIOCHEMISTRY
LECTURE #5 (CELL STRUCTURE AND FUNCTION)



MOVEMENT OF MOLECULES ACROSS THE PLASMA MEMBRANE

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TRANSPORT ACROSS MEMBRANES

Membrane Structure and Function: The plasma membrane regulates the passage of molecules into and out of the cell. It is made up of a bilayer of **phospholipids.**

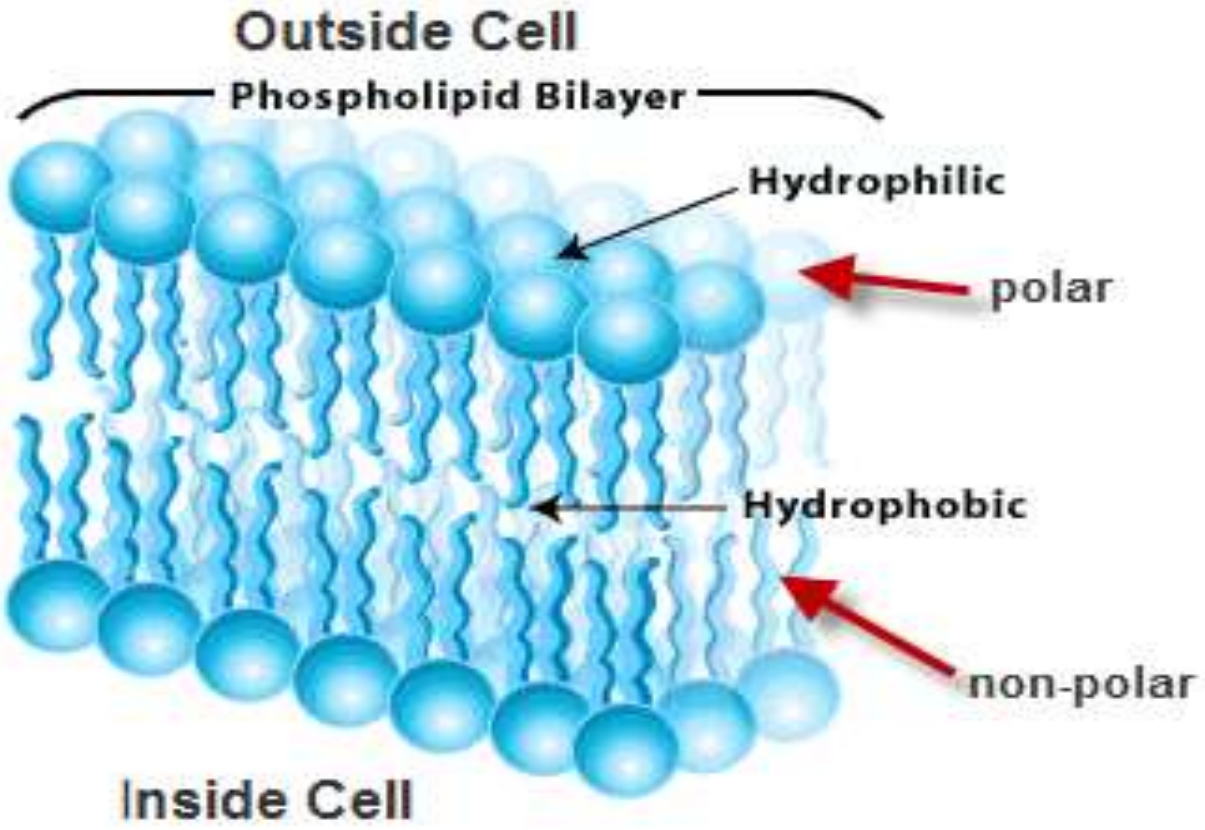

Fig. Plasma membrane

THE FLUID MOSAIC MODEL

Definition: the cell surface membrane in which proteins move about within a bed of semi-fluid lipids. It was proposed in 1972 by S. Singer and G. Nicolson, and is supported by electron micrographs.

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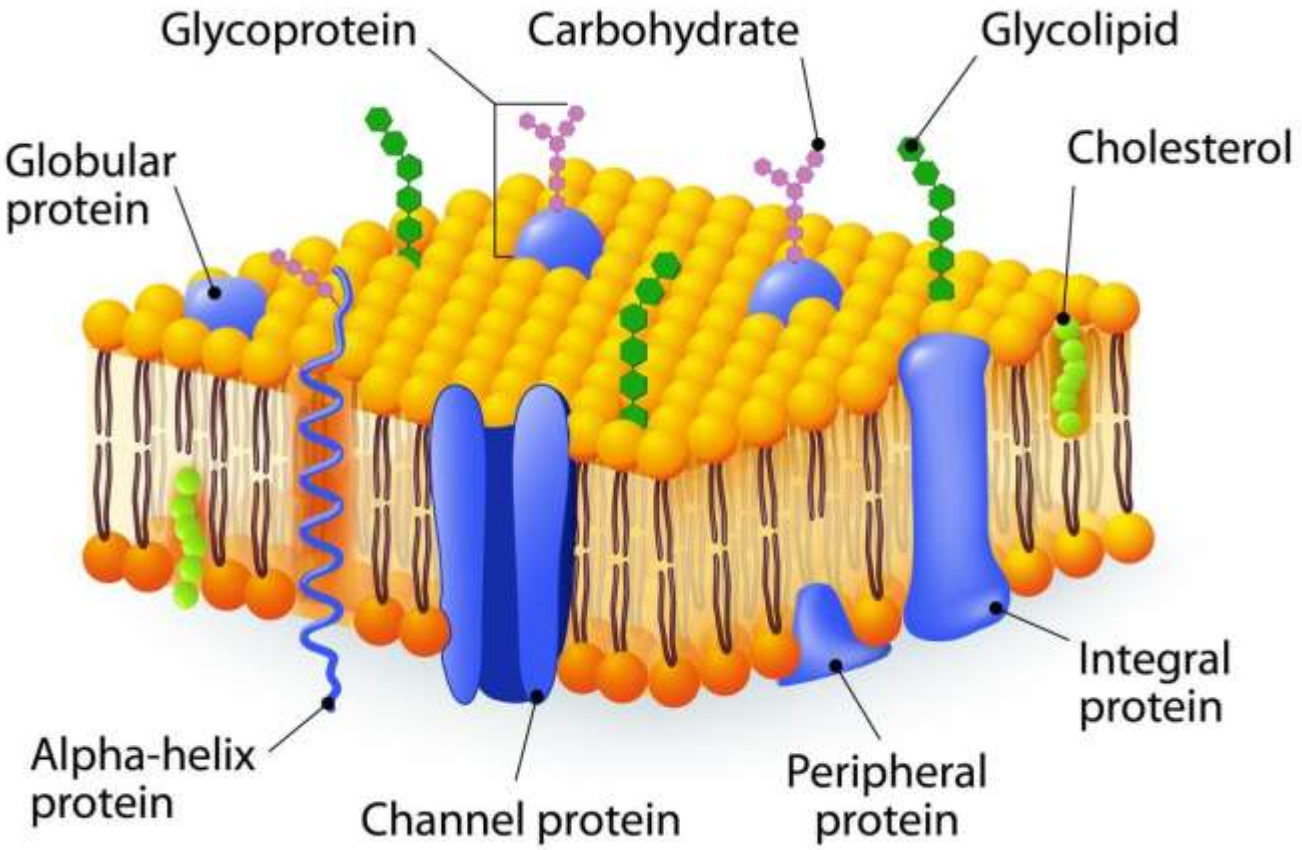


Fig. Fluid Mosaic Model of Cell Membrane

THE FLUID MOSAIC MODEL

- **The phospholipid bilayer:** forms a **hydrophobic** impermeable barrier that prevents the movement of polar molecules through the membrane.

- **Cholesterol:** makes the membrane more impermeable to biological molecules. E.g charged molecules, enter the cell through protein channels.

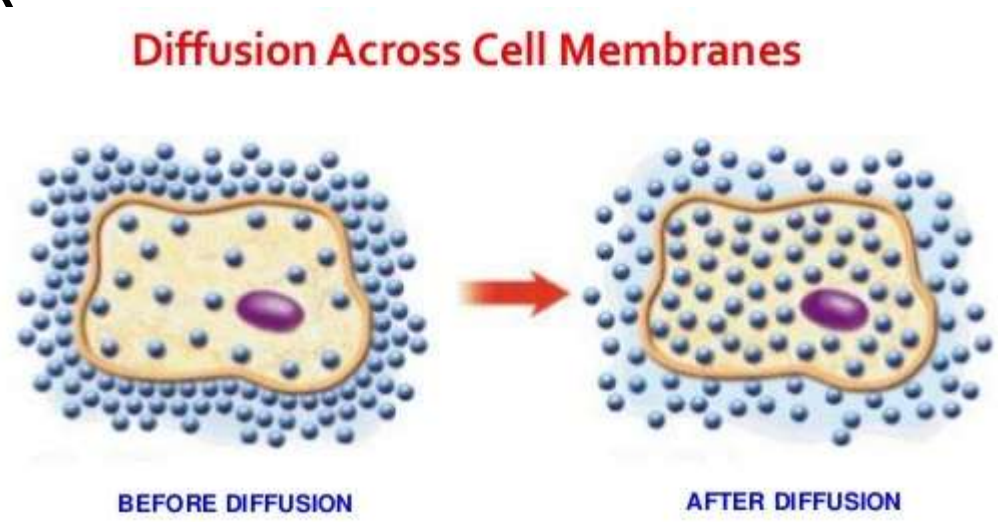
- **Glycolipids:** thought to be cell markers, identifying a cell to be part of an individual. Also thought to regulate the action of plasma membrane proteins involved in the growth of the cell, and may have a role in the occurrence of cancer.

- **Glycoproteins/glycolipids**: thought to make cell-to-cell recognition possible.

MOVEMENT OF MOLECULES ACROSS THE PLASMA MEMBRANE

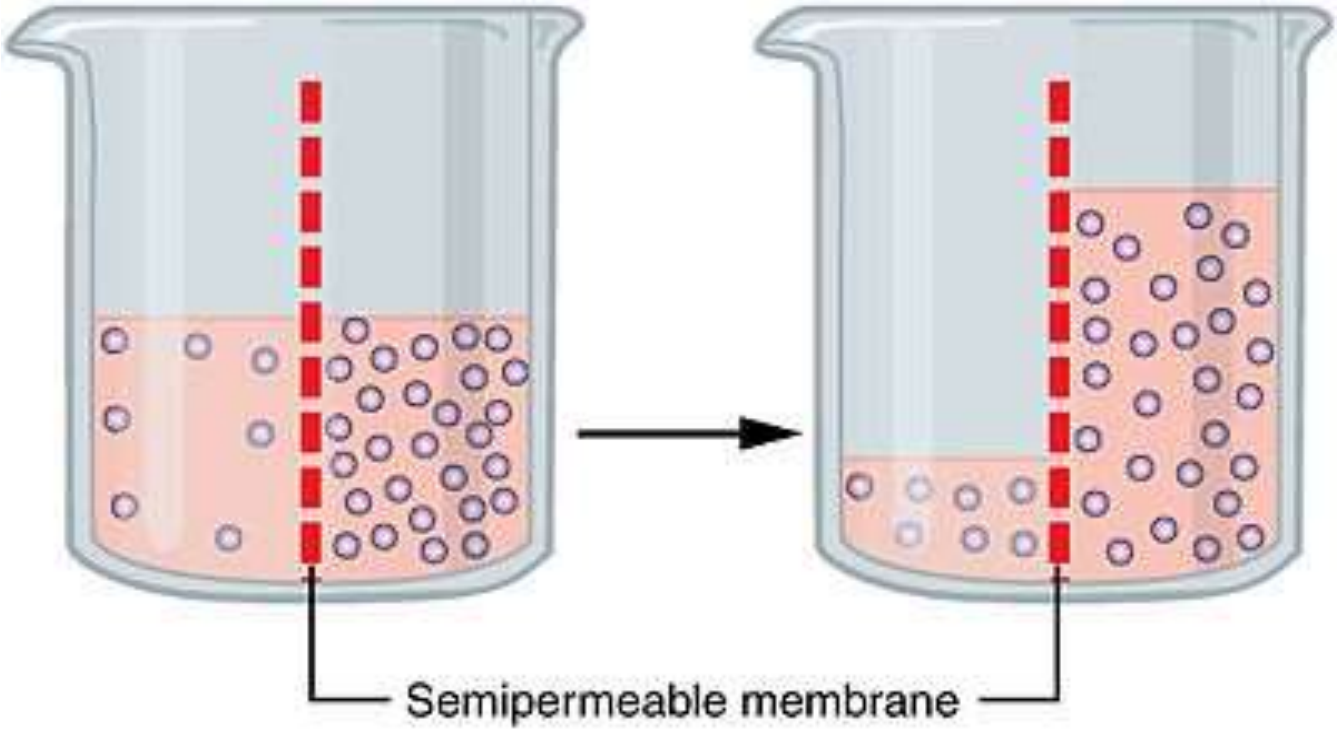
The plasma membrane/ selectively permeable membrane: it has special mechanisms to regulate the passage of most molecules in and out of the cell.

- **Diffusion:** is the movement of molecules from an area of greater concentration to an area of lesser concentration.
  - Diffusion is spontaneous and does not require an input of energy for it to occur.
  - It does require a **concentration gradient (difference in concentration`**

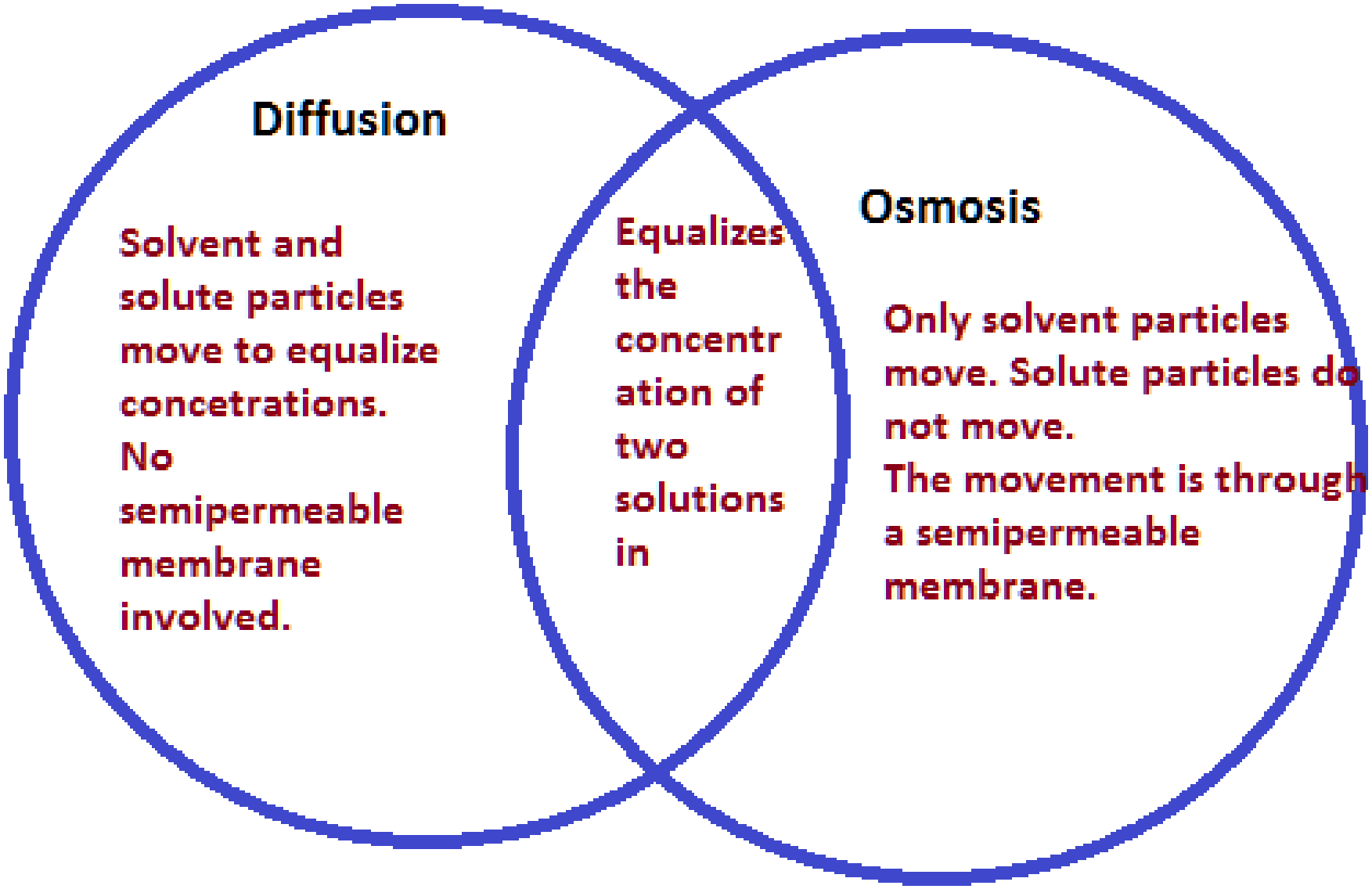


❑**Osmosis:** a process by which molecules of a solvent tend to pass through a semi permeable membrane from a less concentrated solution into a more concentrated one, thus equalizing the concentrations on each side of the membrane. So, it is the diffusion of water across a concentration gradient.

❑ **Dynamic equilibrium**: the state in which continuous action results in balanced conditions.

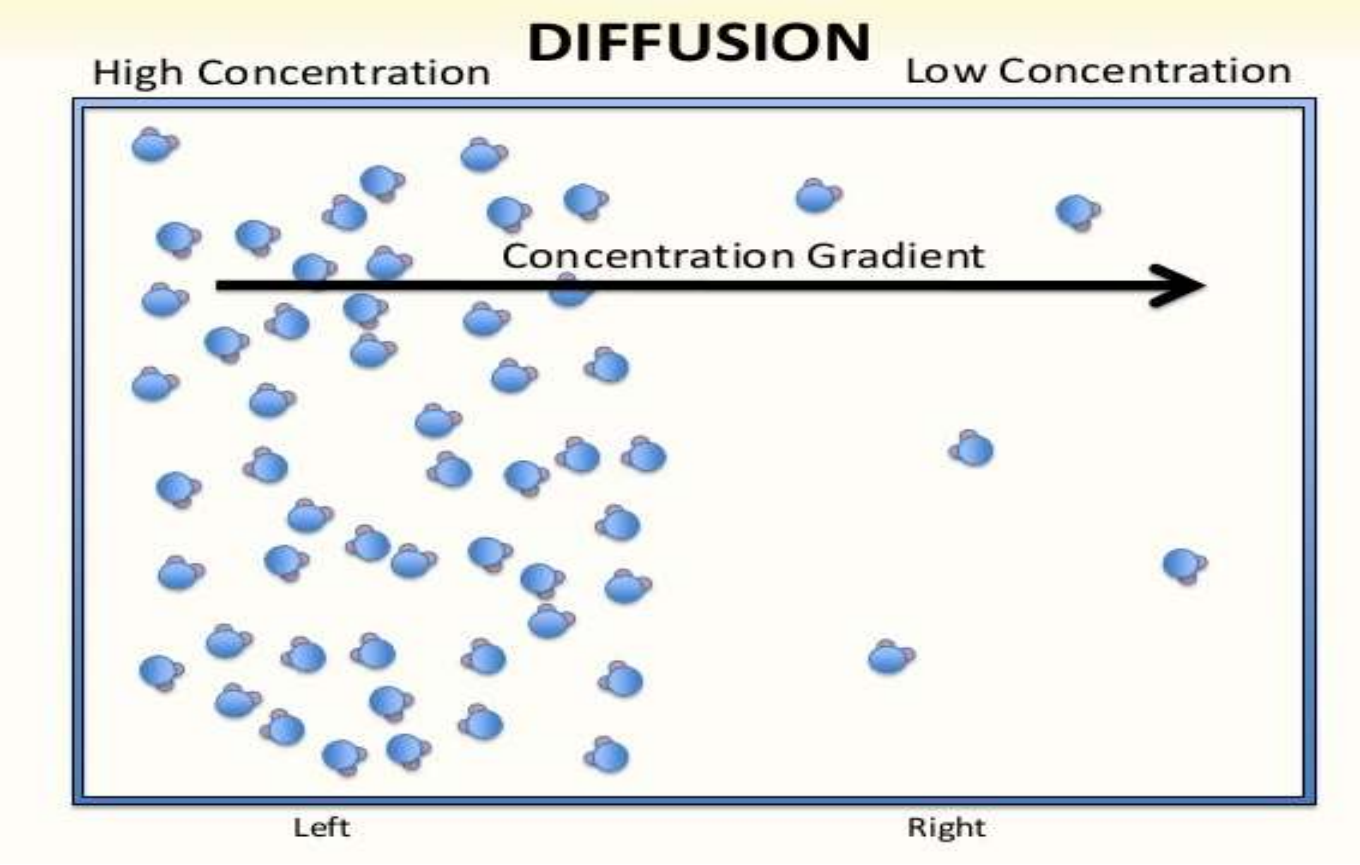


DIFFUSION VS. OSMOSIS



CONCENTRATION GRADIENTS

Definition: is the process of particles, which are sometimes called solutes, moving through a solution or gas from an area with a higher number of particles to an area with a lower number of particles. The areas are typically separated by a membrane.



SOLUTIONS

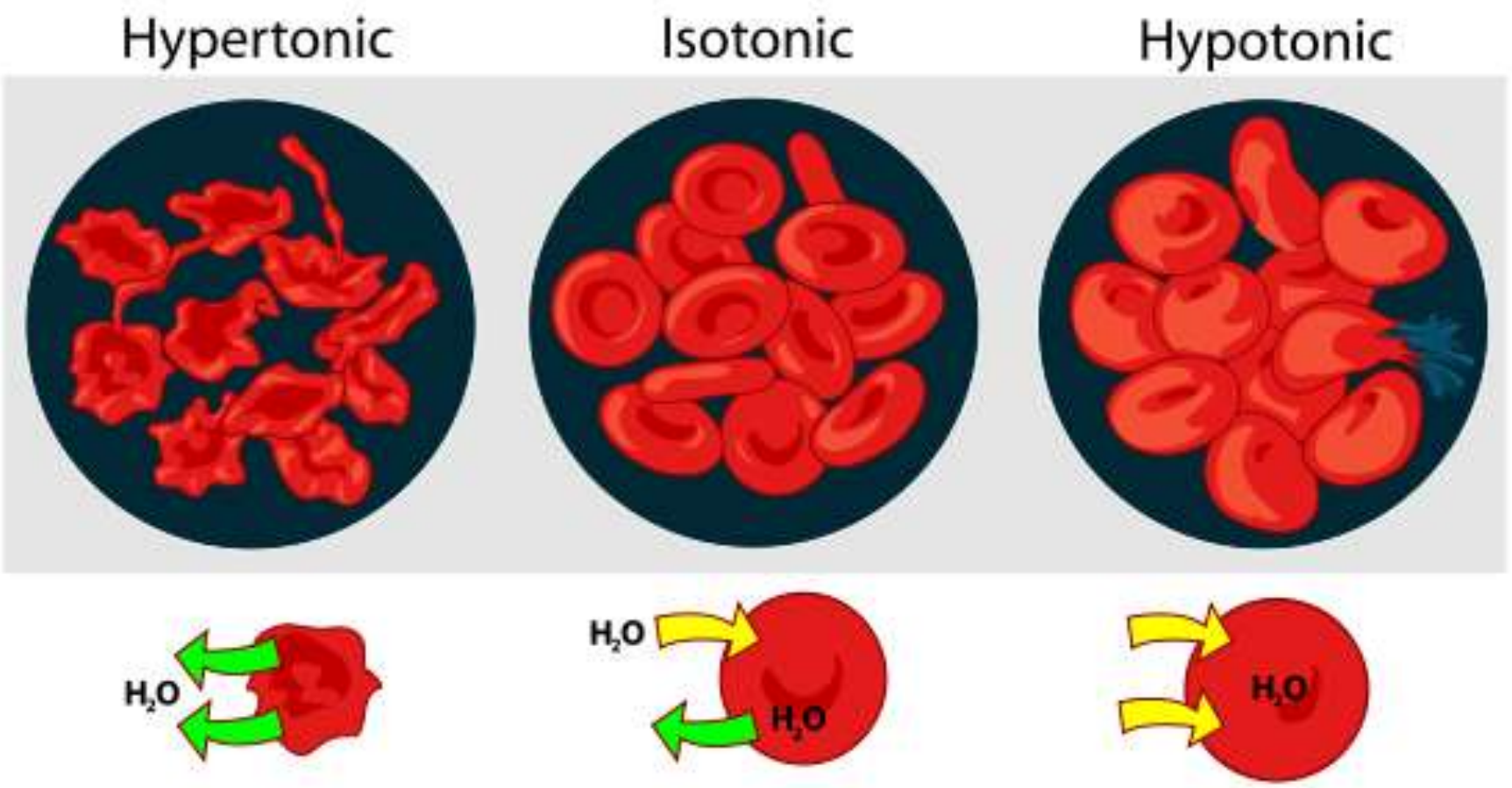
Solutions can be considered either isotonic, hypotonic or hypertonic

- **Hypotonic solution:** the property of a solution that has a **lower solute** concentration than another solution.

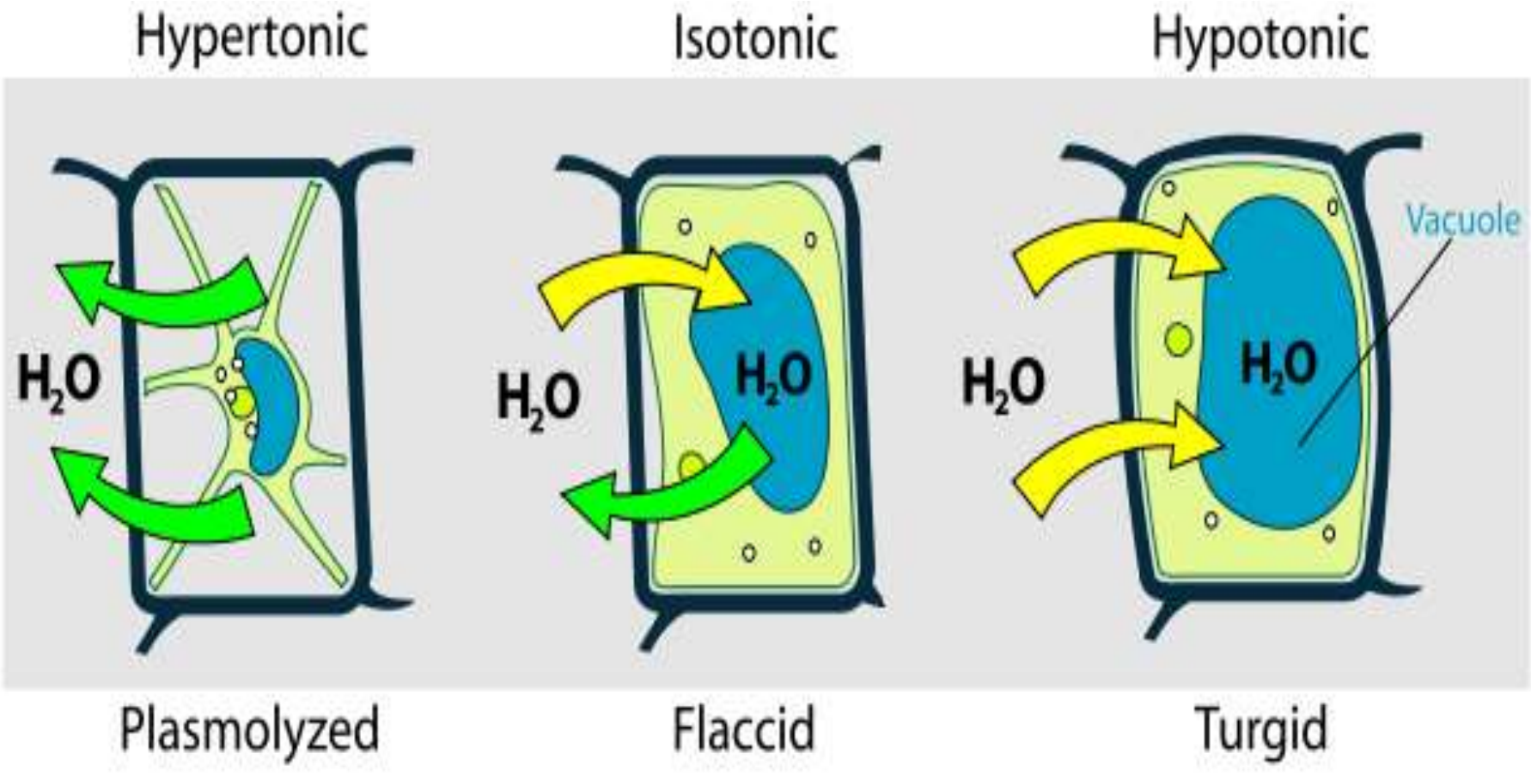
- **Isotonic solution**: the property of a solution that has the same solute concentration as another solution

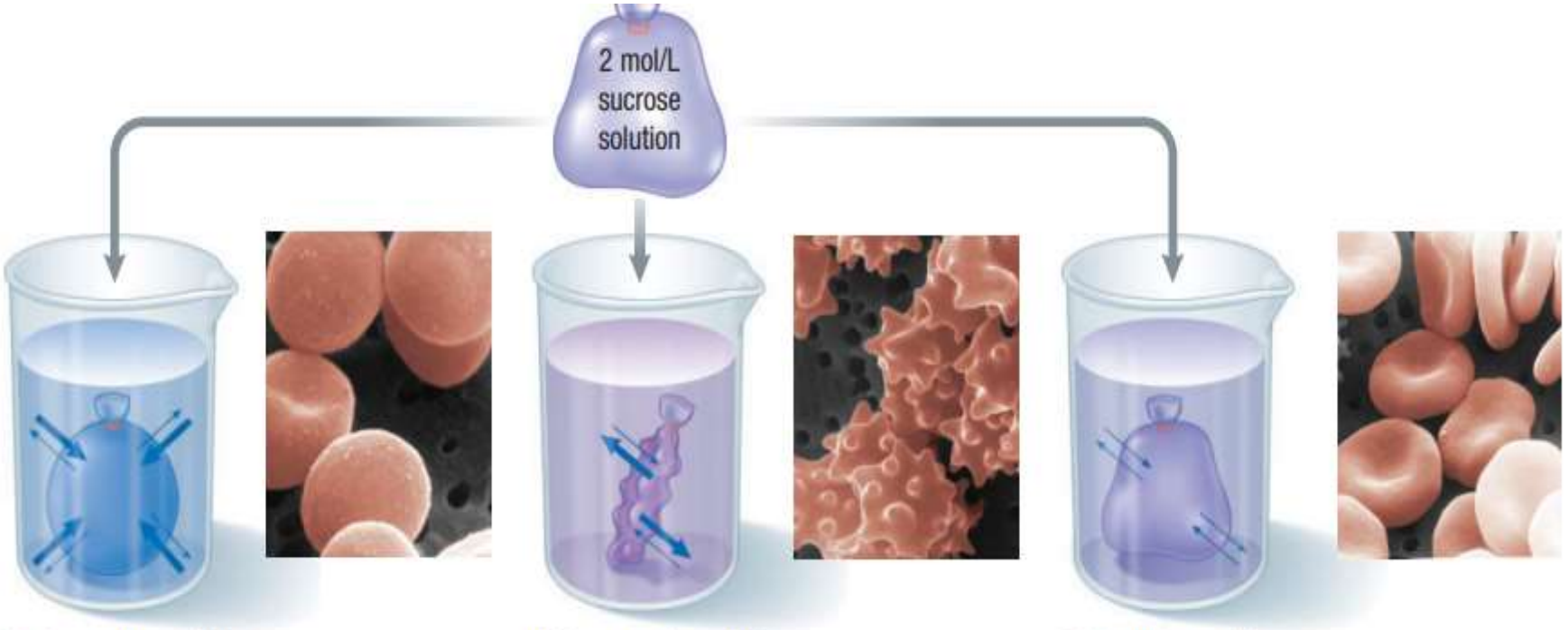
- **Hypertonic solution**: the property of a solution that has a **higher solute** concentration than another solution.

ANIMAL CELLS IN ISOTONIC, HYPOTONIC OR HYPERTONIC SOLUTION



A PLANT CELL IN ISOTONIC, HYPOTONIC OR HYPERTONIC SOLUTION





(a) hypotonic conditions:
The distilled water is hypotonic to the solution in the bag; net movement of water is into the bag; cells swell.

(b) hypertonic conditions:
The 10 mol/L solution is hypertonic to the solution in the bag; net movement of water is out of the bag; cells shrink.

(c) isotonic conditions:
The solutions inside and outside the bag are isotonic; there is no net movement of water into or out of the bag; no change in cell size or shape.

TRANSPORT BY CARRIERS

Carrier proteins help biological molecules that are unable to diffuse across the plasma membrane get into the cell. Carrier proteins are very specific and can only bind with certain molecules.

- **PASSIVE TRANSPORT** involves the transport of molecules from regions of high concentration to regions of low concentration. No energy is used in this process.

- **ACTIVE TRANSPORT** involves the transport of molecules from regions of low concentration to regions of high concentration. Energy is needed for this type of transport.

PASSIVE TRANSPORT

1. SIMPLE DIFFUSION: the ability of small and non-polar substances to move across a membrane unassisted.

2. FACILITATED (HELPED) DIFFUSION: the facilitated transport of ions and polar molecules through a membrane via protein complexes (e.g integral membrane protein).

a) Channel protein

b) Carrier protein:

3. OSMOSIS: the passive diffusion of water across a semi permeable membrane.

CHANNEL PROTEIN

Channel protein: a hydrophilic pathway in a membrane that enables water and ions to pass through.

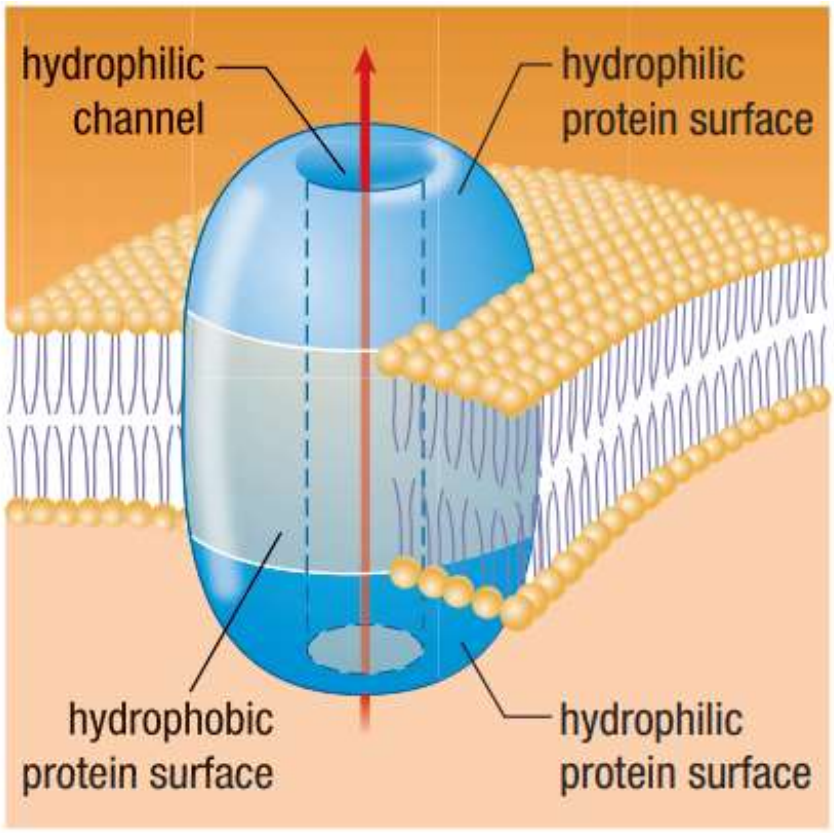
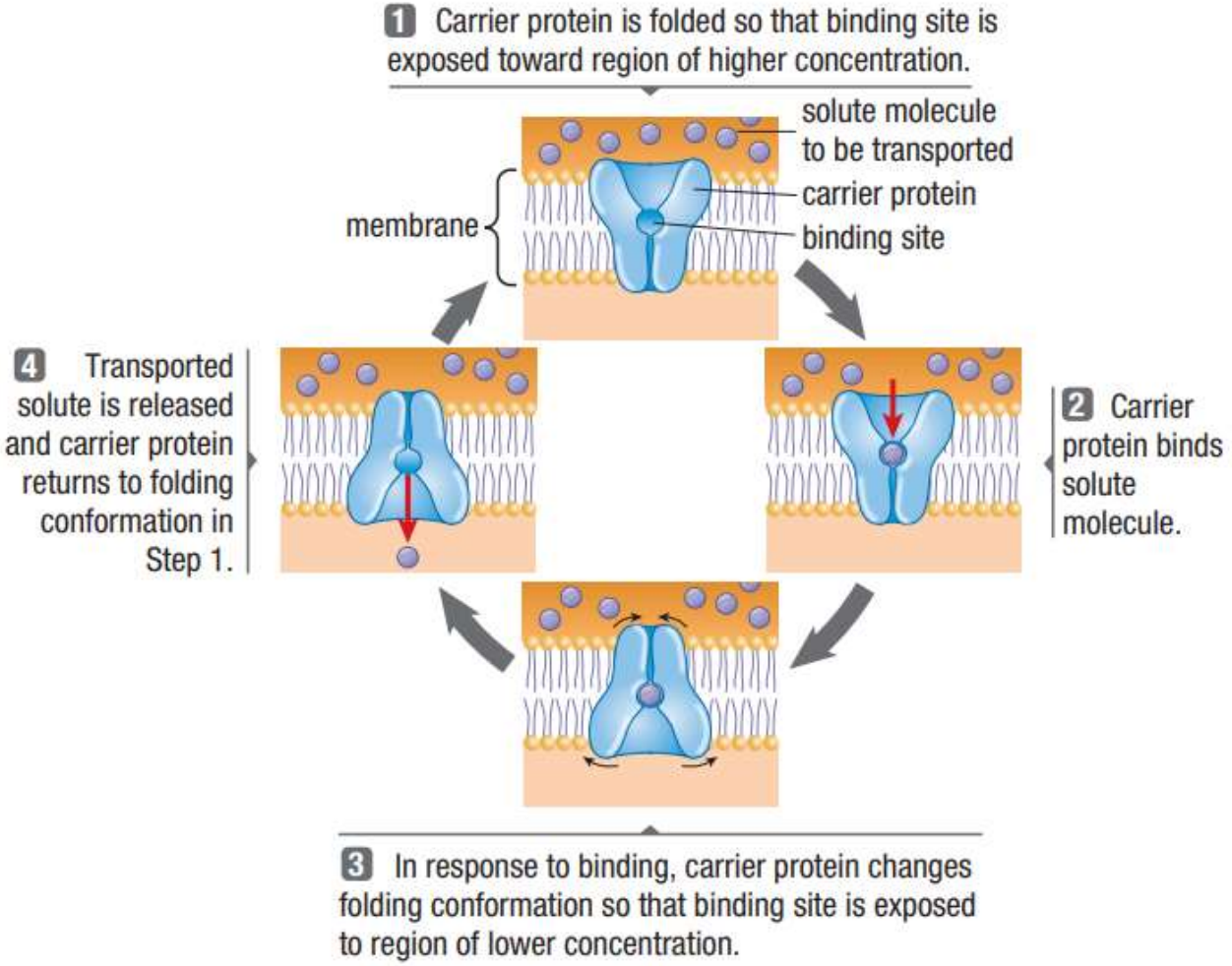


Fig. **Channel proteins**

CARRIER PROTEIN

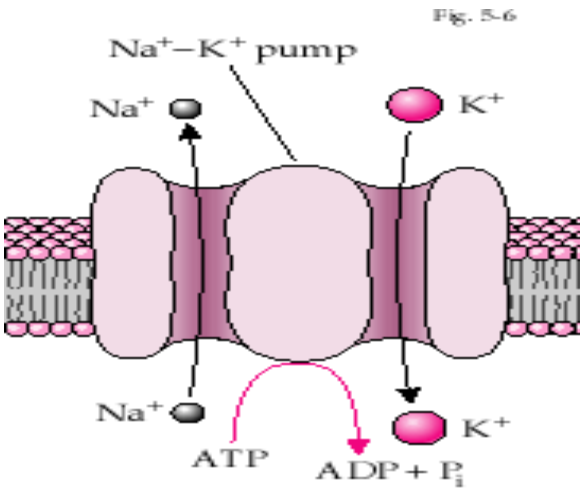
Carrier protein: a protein that binds to a molecule and transports it across the lipid bilayer.



ACTIVE MEMBRANE TRANSPORT

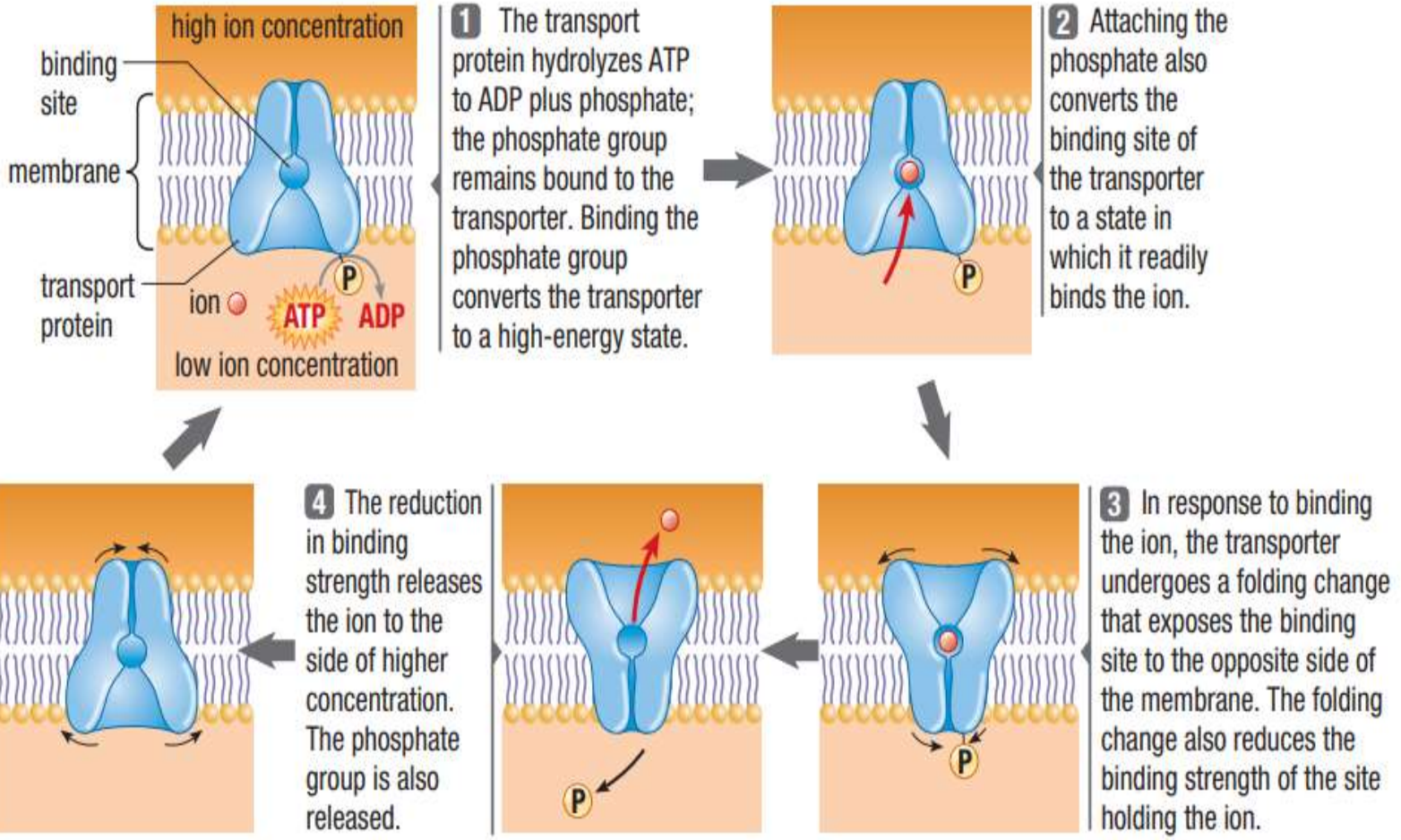
Definition: the movement of substances across membranes against their concentration gradient (transport of molecules from regions of low concentration to regions of high concentration) using pumps. Energy is needed for this type of transport.

a) **Primary Active Transport pump:** move positively charged ions, such as H^+, Ca^{2+}, Na^+, and K^+ across membranes. H^+ pump is called a proton pump; Na-K pump.

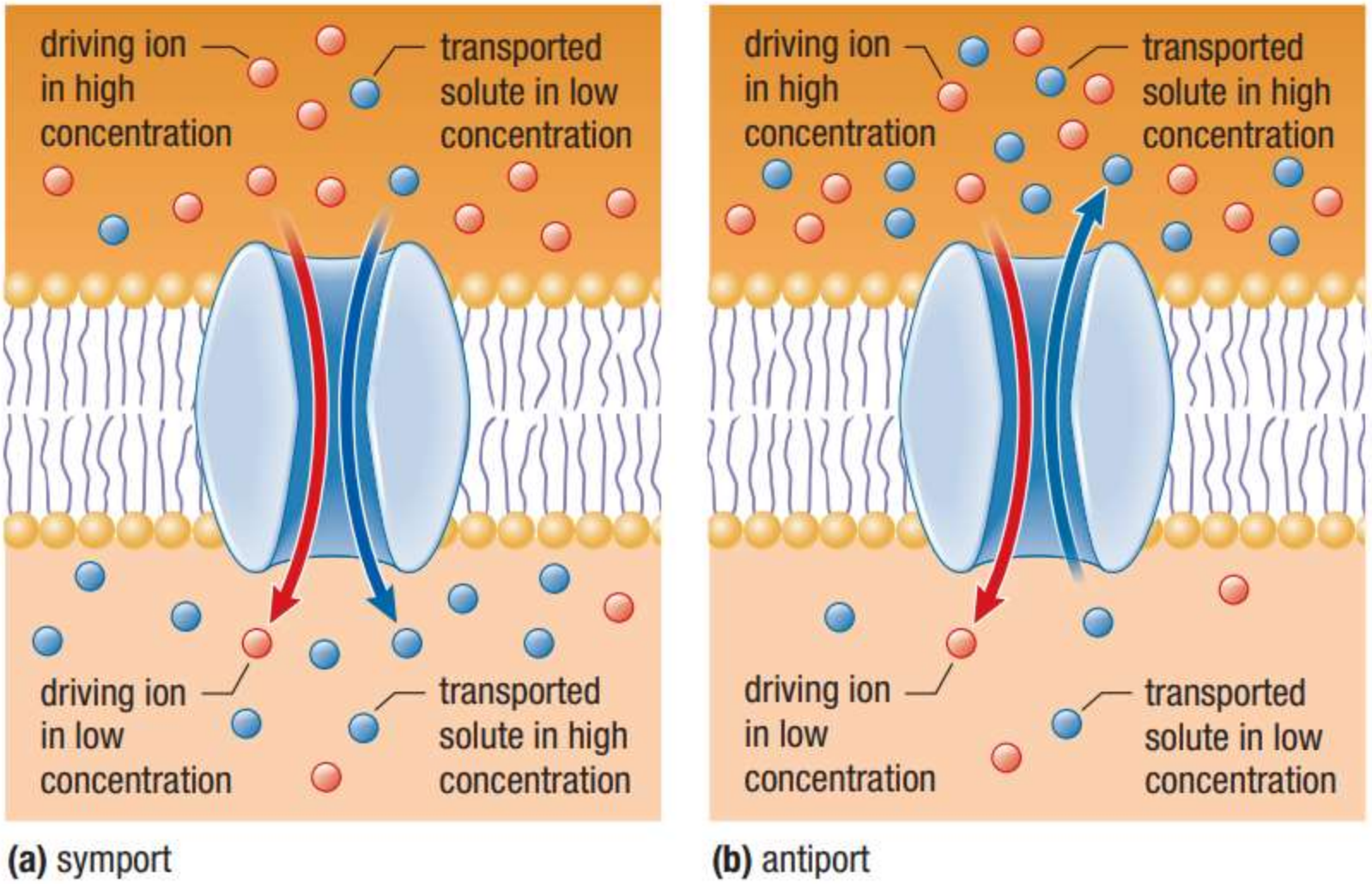


a) **Secondary Active Transport pump:** it uses the concentration gradient of an ion, established by a primary active pump.

PRIMARY ACTIVE TRANSPORT



SECONDARY ACTIVE TRANSPORT



COMPARISON OF PASSIVE AND ACTIVE TRANSPORT

Table 1 Characteristics of Transport Mechanisms

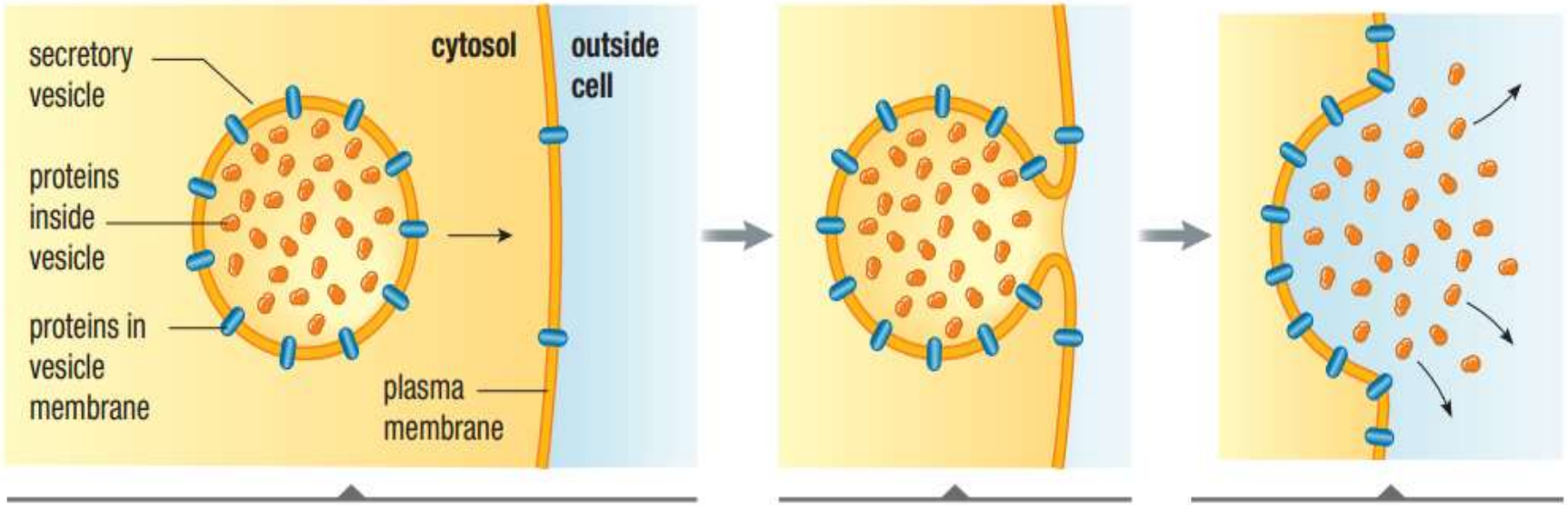
Characteristic	Passive transport		Active transport
	Simple diffusion	Facilitated diffusion	
Membrane component that is responsible for influencing transport	lipids	proteins	proteins
Binding to transported substance	no	yes	yes
Energy source	concentration gradients	concentration gradients	ATP hydrolysis or concentration gradients
Direction of transport	with gradient of transported substance	with gradient of transported substance	against gradient of transported substance
Specificity for molecules or molecular classes	non-specific	specific	specific
Saturation at high concentrations of transported molecules	no	yes	yes

Q/A

https://www.youtube.com/watch?v=ufCiGz75DAk

https://www.youtube.com/watch?v=AcrqIxt8am8

EXOCYTOSIS AND ENDOCYTOSIS

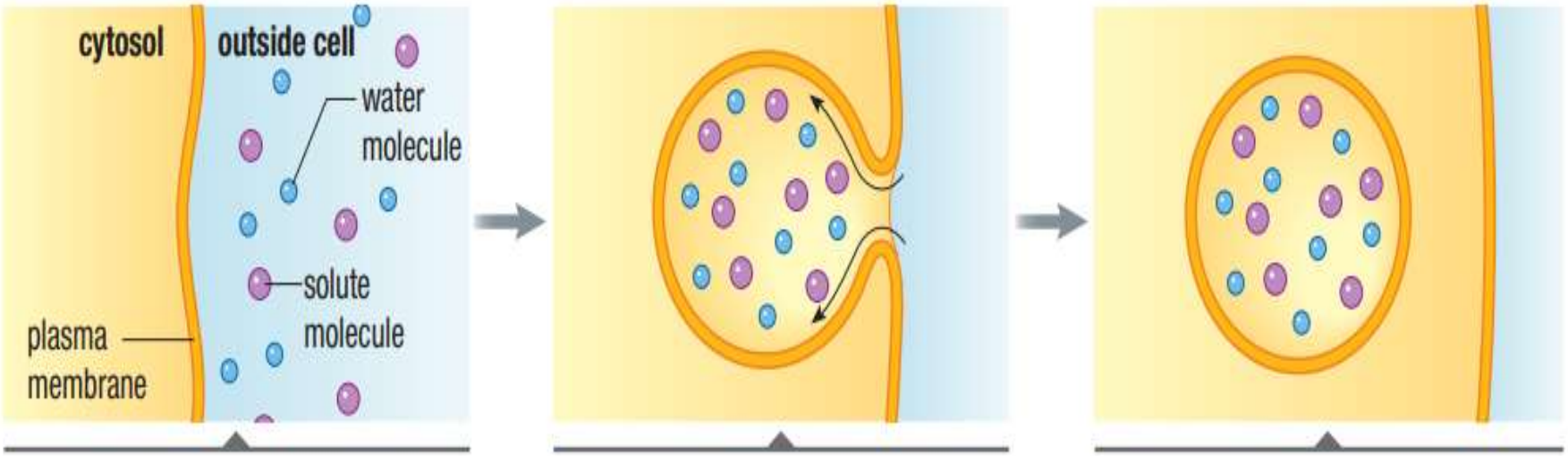


1 The secretory vesicle approaches the plasma membrane.

2 The vesicle fuses with the plasma membrane.

3 Proteins inside the vesicle are released to the cell exterior; proteins in the vesicle membrane become part of the plasma membrane.

EXOCYTOSIS AND ENDOCYTOSIS



1 Solute molecules and water molecules are outside the plasma membrane.

2 The membrane folds inward, enclosing solute and water molecules.

3 The pocket pinches off as an endocytic vesicle.

EXOCYTOSIS AND ENDOCYTOSIS

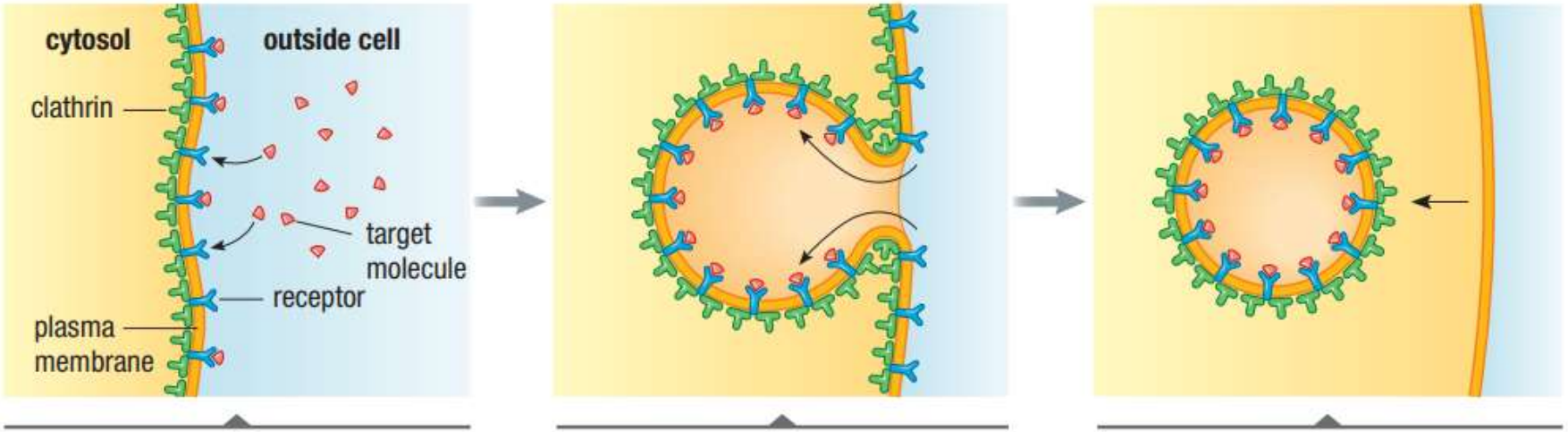


Figure Receptor-mediated endocytosis

ACTIVITY# Q/A

Answer the questions:

1. How does diffusion differ from osmosis

2. What happens when you put an animal cell in a hypotonic and hypertonic solution? Why?

3. What happens when you put a plant cell in a hypotonic and hypertonic solution? Why?


THE END