

BIOENERGETICS

Transport across membranes

MEMBRANE STRUCTURE

AND FUNCTION

Membranes are a fluid mosaic of phospholipids and proteins

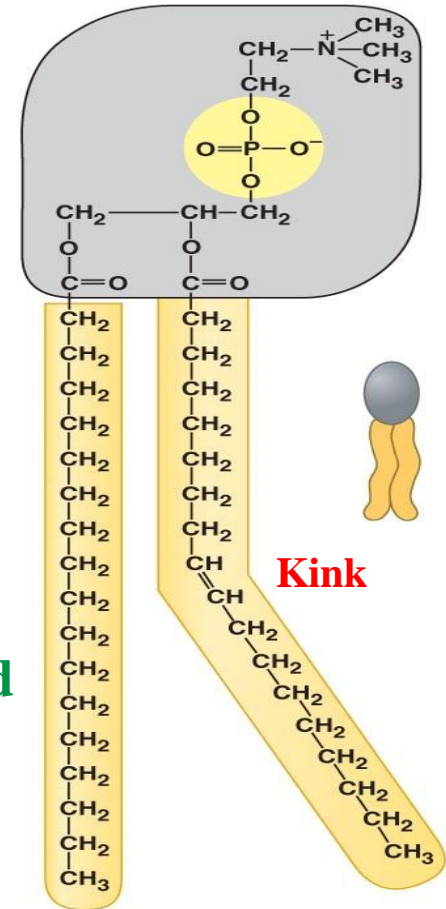
- Membranes are composed of **phospholipids** bilayer and **proteins**
- Many phospholipids are made from **unsaturated fatty acids** that have **kinks** in their tails that keep the membrane fluid phospholipid Contains 2 fatty acid chains that are nonpolar
- Are **nonpolar** and Head is **polar** & contains a **-PO₄** group & glycerol

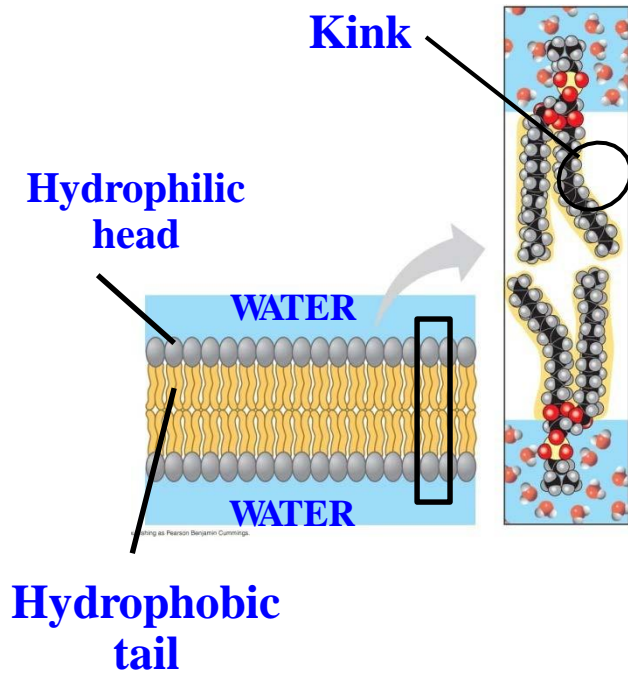
Membranes are commonly described as a fluid mosaic

FLUID- because individual phospholipids and proteins can move side-to-side within the layer, like it's a liquid.

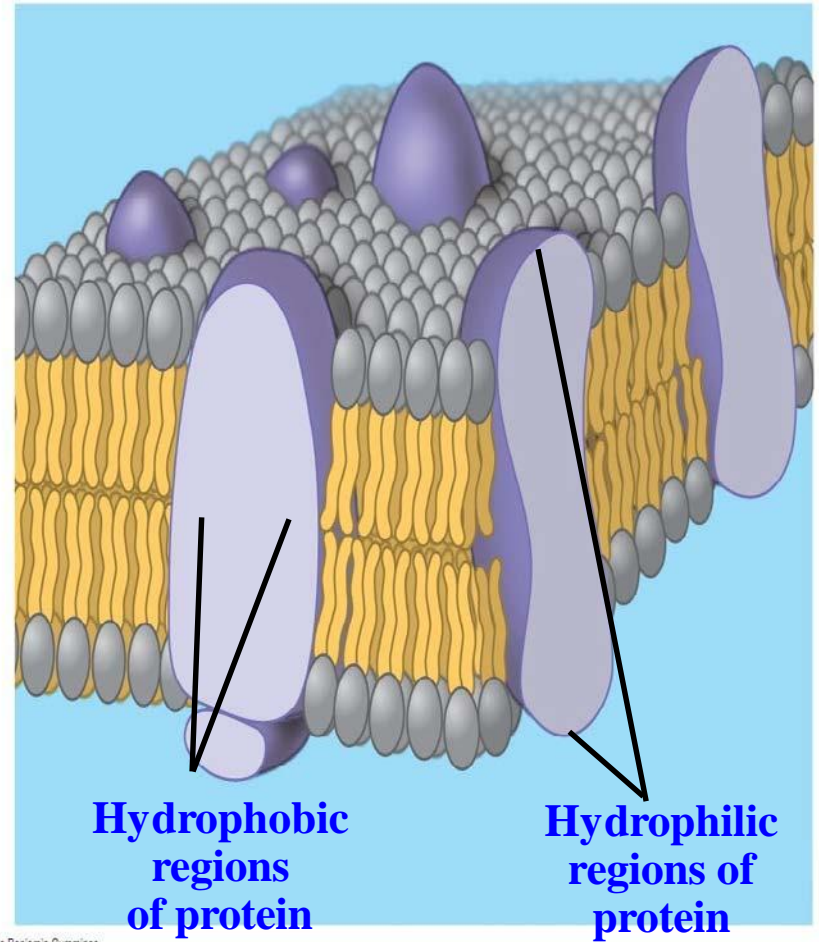
The fluidity of the membrane is aided by cholesterol wedged into the bilayer to help keep it liquid at lower temperatures.

MOSAIC- because of the pattern produced by the scattered protein molecules embedded in the phospholipids when the membrane is viewed from above.





**Phospholipid
Bilayer**



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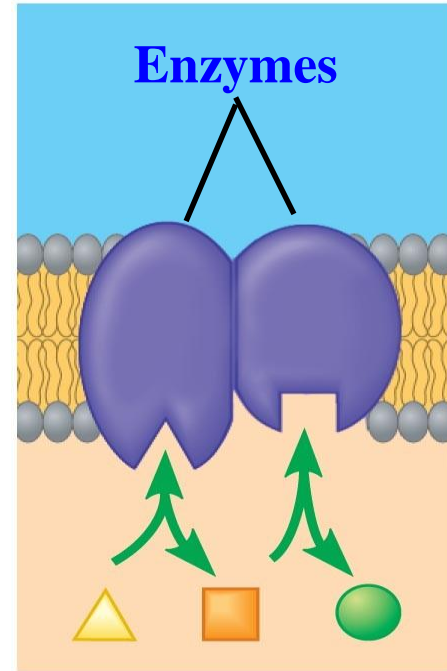
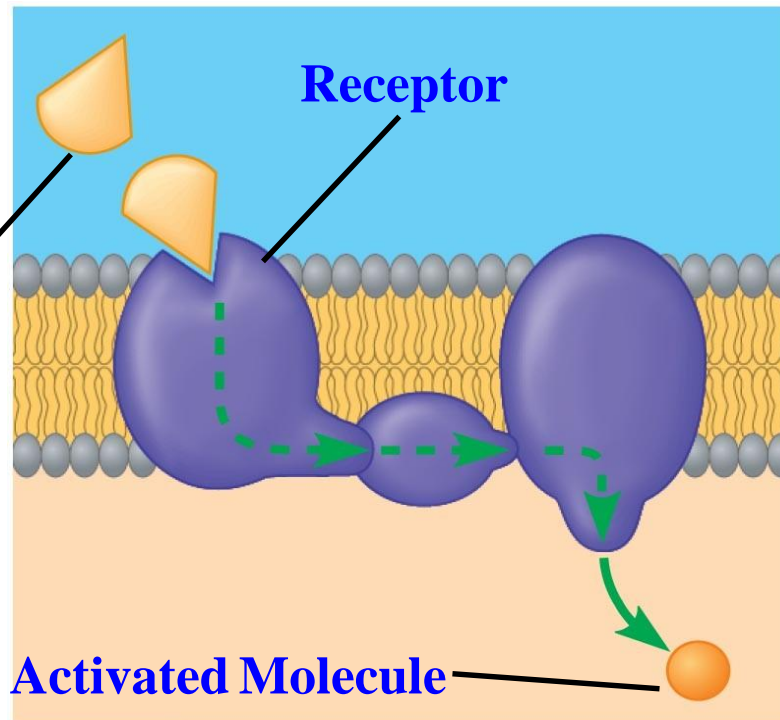
**Phospholipid bilayer
(cross section)**

**The fluid mosaic model
for membranes**

Functions of Plasma Membrane

Many membrane proteins function as:

- Enzymatic activity
- Transport
- Bind cells together (**junctions**)
- Protective barrier
- Regulate transport in & out of cell (**selectively permeable**)
- Allow cell recognition
- Signal transduction



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Enzyme activity

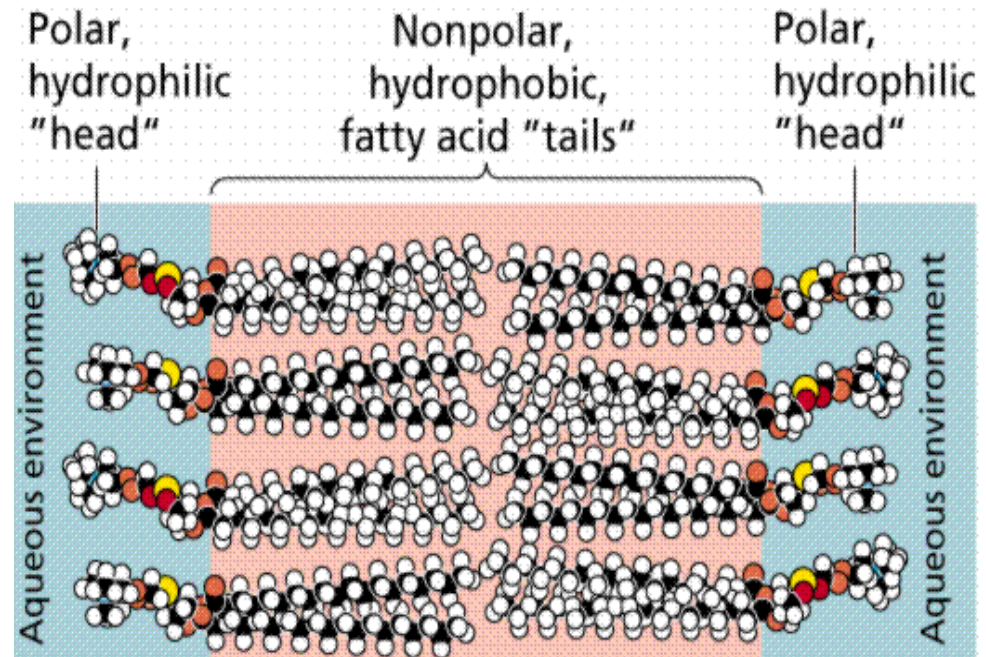
Signal transduction

Membranes are a **fluid mosaic** of **phospholipids** and **proteins**

- Because membranes allow some substances to cross or be transported more easily than others, they exhibit **selective permeability**.

Nonpolar hydrophobic molecules, Materials that are soluble in lipids can pass through the cell membrane easily.

- **Small molecules** e.g. O_2 , CO_2 , H_2O move through easily.
- **Ions, Polar hydrophilic molecules larger than water** (glucose, other sugars and amino acids) do not cross easily **on their own**.



Types of Transport Across Cell Membranes

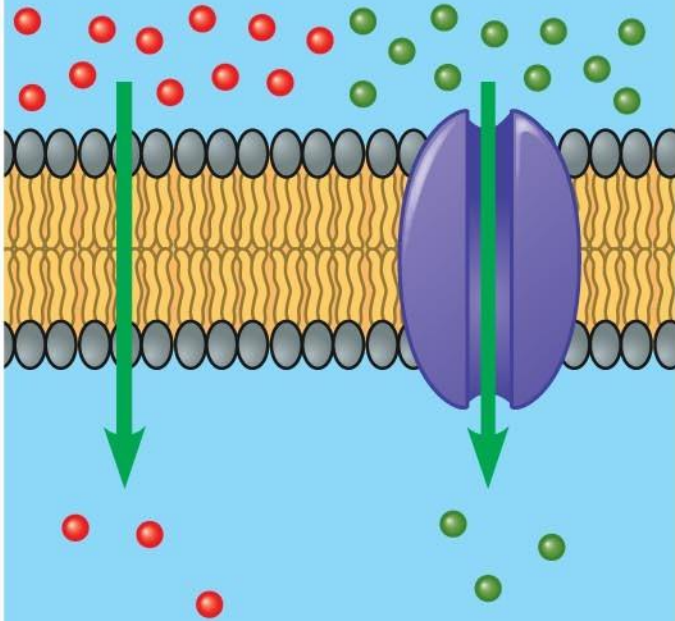
Requires no energy

Passive transport

Diffusion

Facilitated diffusion

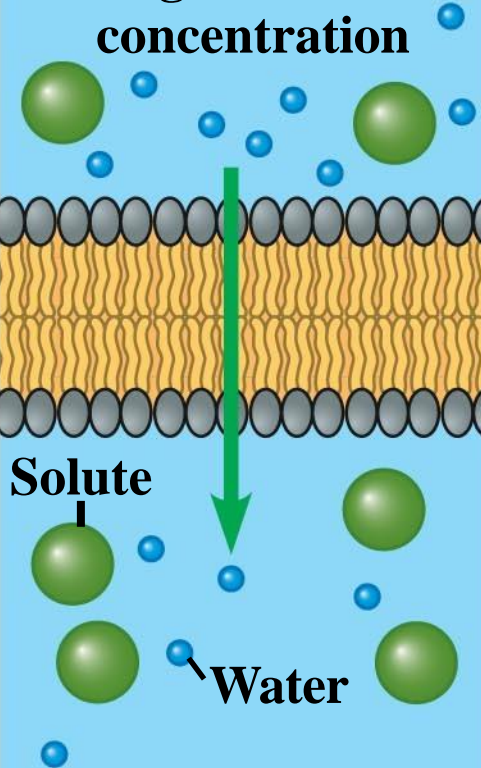
Higher solute concentration



Lower solute concentration

Osmosis

Higher water concentration

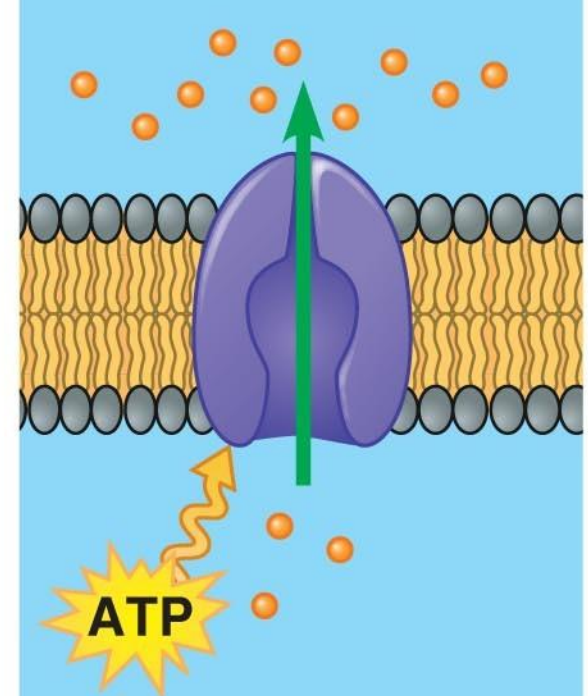


Lower water concentration

Requires energy

Active transport

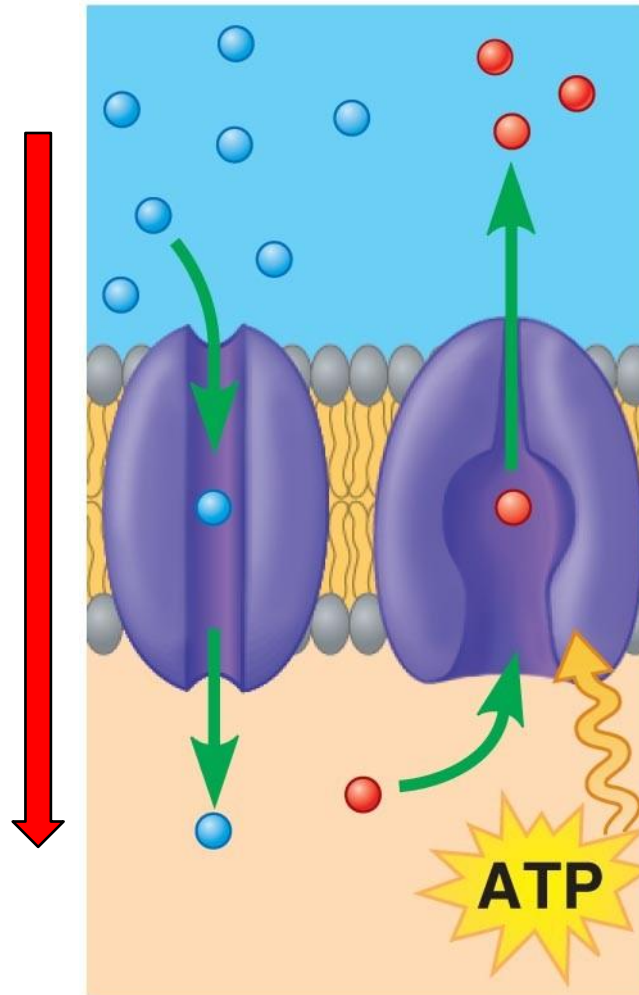
Higher solute concentration



Lower solute concentration

Concentration Gradient

**Passive
Transport**
From a region of
higher to lower
concentration



**High
Concentration**

**Active Transport
(against
concentration
gradient)**

**Low
Concentration**

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Transport

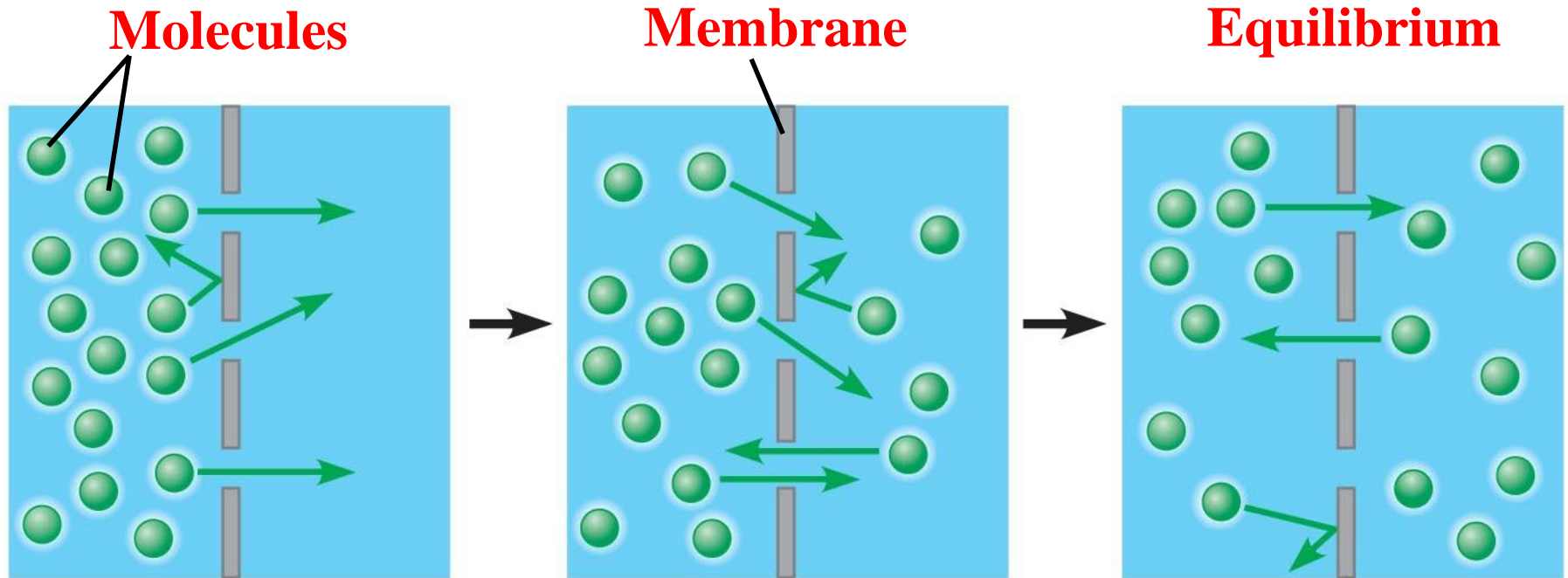
Passive transport is diffusion across a membrane with no energy investment

- **Diffusion** Net movement of substance down its **concentration gradient**
 - from region of greater concentration to region of lower concentration
 - **Does not use direct metabolic energy**
 - Is a process in which particles spread out evenly in an available space—
- This means that particles diffuse down their **concentration gradient**, molecules move because they have a natural **KINETIC ENERGY**
- Eventually, the particles reach **equilibrium** where the concentration of particles is the same throughout

Passive transport is diffusion across a membrane with no energy investment

- **Passive transport**
- Diffusion across a cell membrane **does not** require energy, so it is called passive transport
 - The concentration gradient itself represents potential energy for diffusion
 - **Passive transport could be:**
 - 1) **Simple diffusion:** Example: Oxygen or water diffusing into a cell and carbon dioxide diffusing out.
 - 2) **Facilitated diffusion:** Uses transport proteins to move high to low concentration
 - Examples: Glucose or amino acids moving from blood into a cell

Passive transport (simple diffusion)



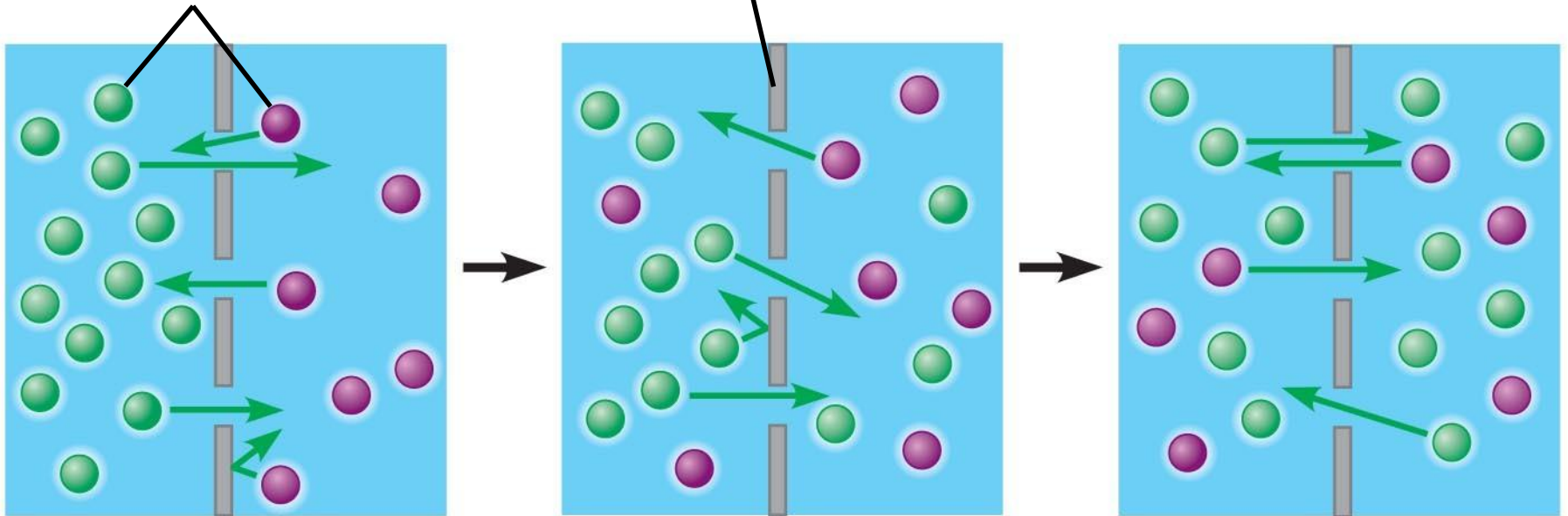
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Passive transport of one type of molecule

**Two different
Substances**

Membrane

Equilibrium

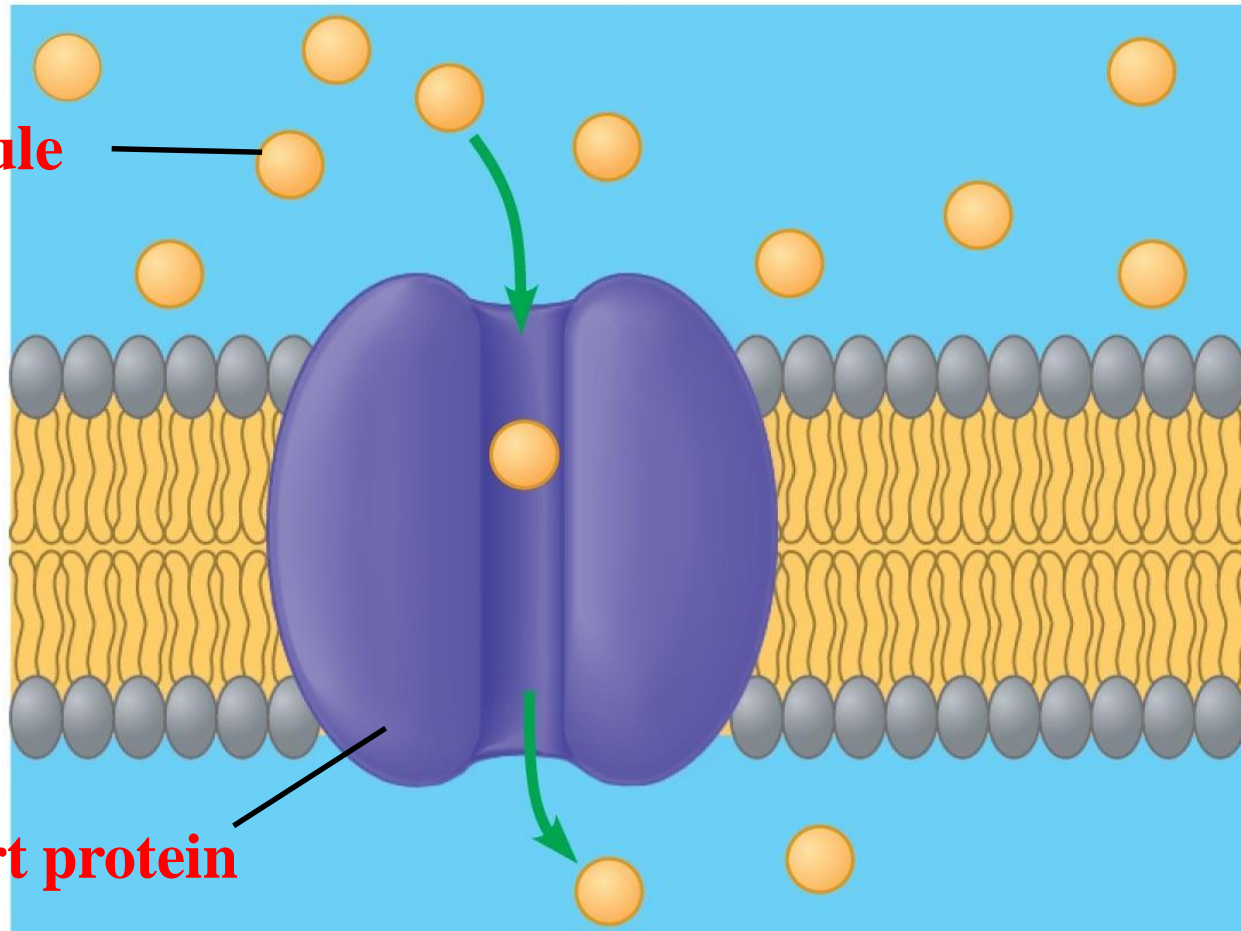


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Passive transport of two types of molecules

Passive transport Facilitated diffusion

Solute molecule



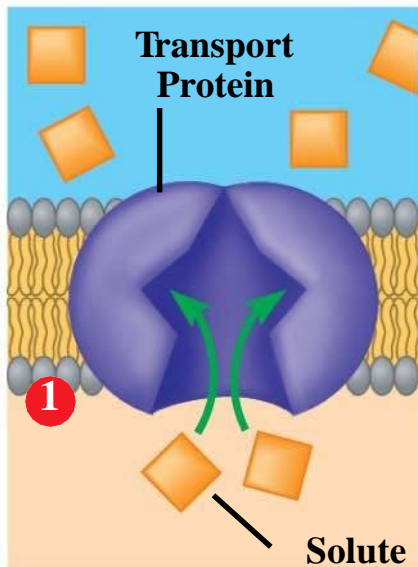
Transport protein

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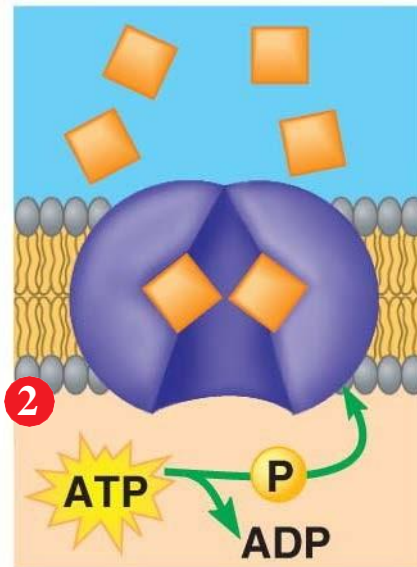
Transport protein providing a channel for the diffusion of a specific solute across a membrane

Active Transport

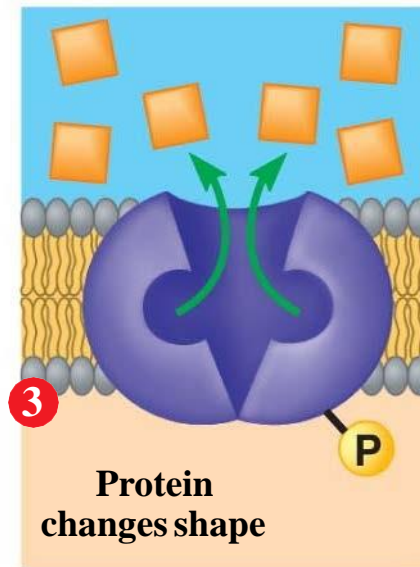
- ❖ Requires energy or ATP
- ❖ Moves solute from **LOW** to **HIGH** concentration **AGAINST** concentration gradient.
- ❖ The mechanism alters the shape of the membrane protein through phosphorylation using **ATP**.



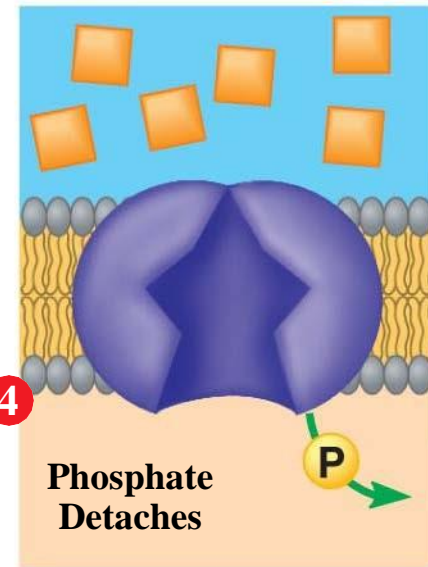
Solute binding



Phosphorylation



Transport



Protein reversion

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Active transport of a solute across a membrane

Moving the “Big Stuff”

Exocytosis and endocytosis transport large molecules across membranes

- A cell uses two mechanisms for moving large molecules across membranes
 - Exocytosis is used to export bulky molecules, such as proteins or polysaccharides
 - Endocytosis is used to import substances useful to the livelihood of the cell
- In both cases, material to be transported is packaged within a vesicle that fuses with the membrane
- There are three kinds of endocytosis
 1. Phagocytosis is the engulfment of a particle by wrapping cell membrane around it, forming a vacuole
 2. Pinocytosis is the same thing except that fluids are taken into small vesicles
 3. Receptor-mediated endocytosis is where receptors in a receptor-coated pit interact with a specific protein, initiating formation of a vesicle

EXTRACELLULAR FLUID

Pseudopodium

CYTOPLASM

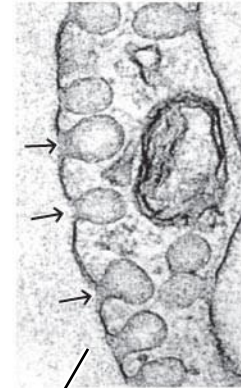
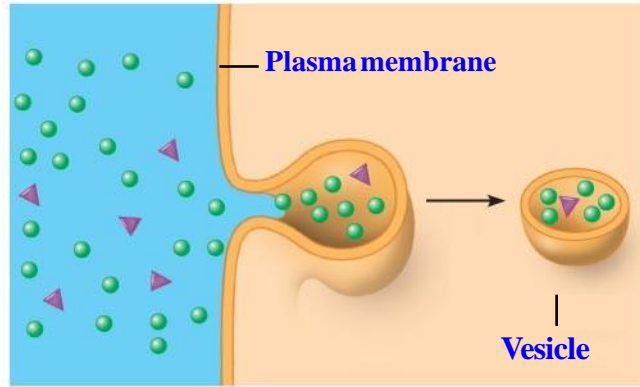
"Food" or other particle

Food vacuole

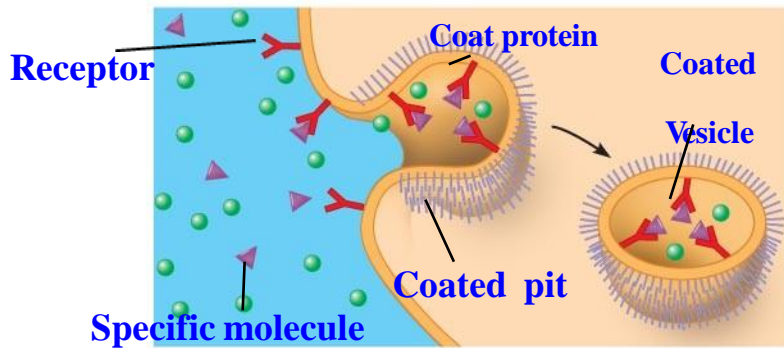


Phagocytosis

Three kinds of endocytosis



Pinocytosis



Receptor-mediated endocytosis

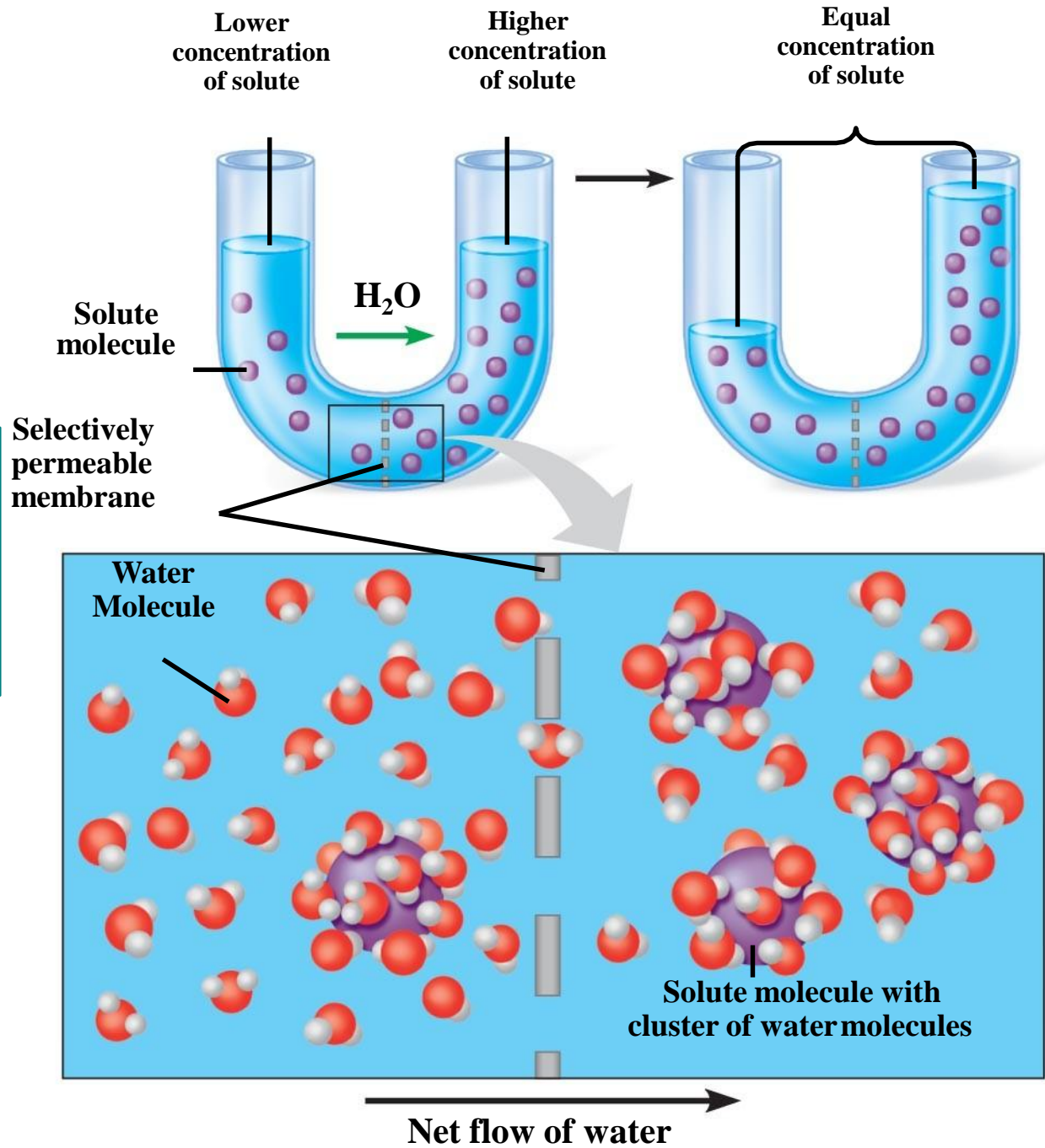
Material bound to receptor proteins

Osmosis

Osmosis is the diffusion of water across a membrane

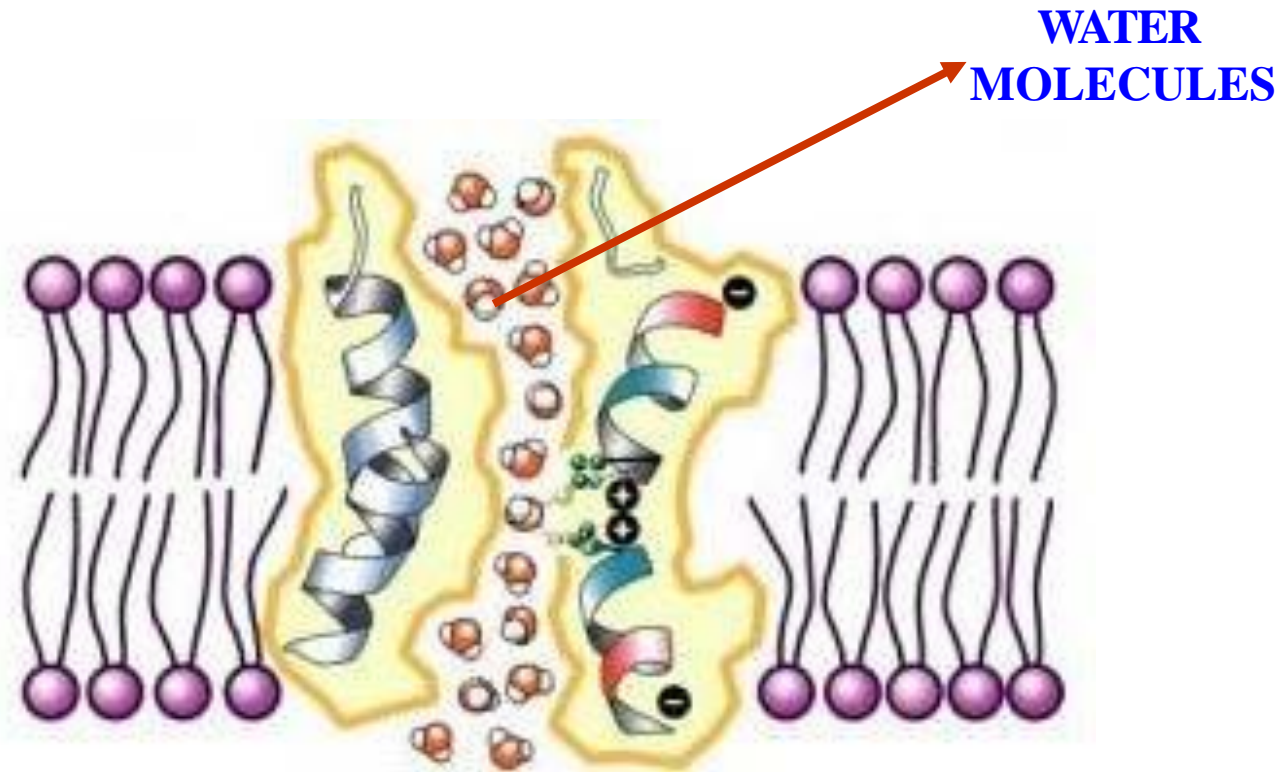
- Osmosis will move water across a membrane **down** its **concentration gradient** until the concentration of solute is **equal** on both sides of the membrane (**equilibrium**).
- Moves from **HIGH water potential** (low solute) to **LOW water potential** (high solute)

Osmosis,
the diffusion of
water across
a membrane



Aquaporins

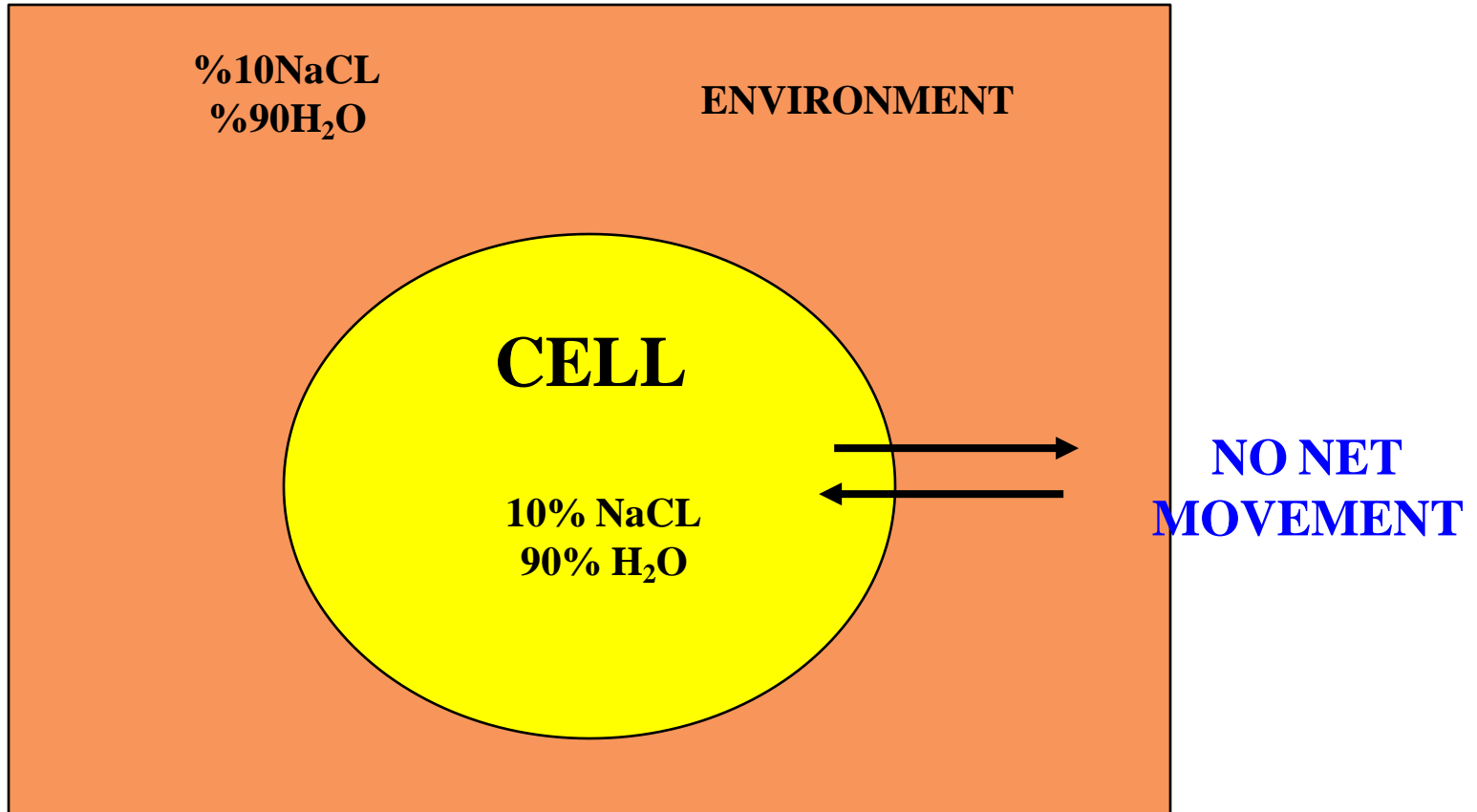
- **Water Channels**
- **Protein pores used during OSMOSIS**



Water balance between cells and their surroundings is crucial to organisms

- **Tonicity** is a term that describes the ability of a solution to cause a cell to gain or lose water
 - Tonicity is dependent on the concentration of a non-penetrating solute on both sides of the membrane
 - **Isotonic** indicates that the concentration of a solute is the same on both sides
 - **Hypertonic** indicates that the concentration of solute is higher outside the cell
 - **Hypotonic** indicates a higher concentration of solute inside the cell

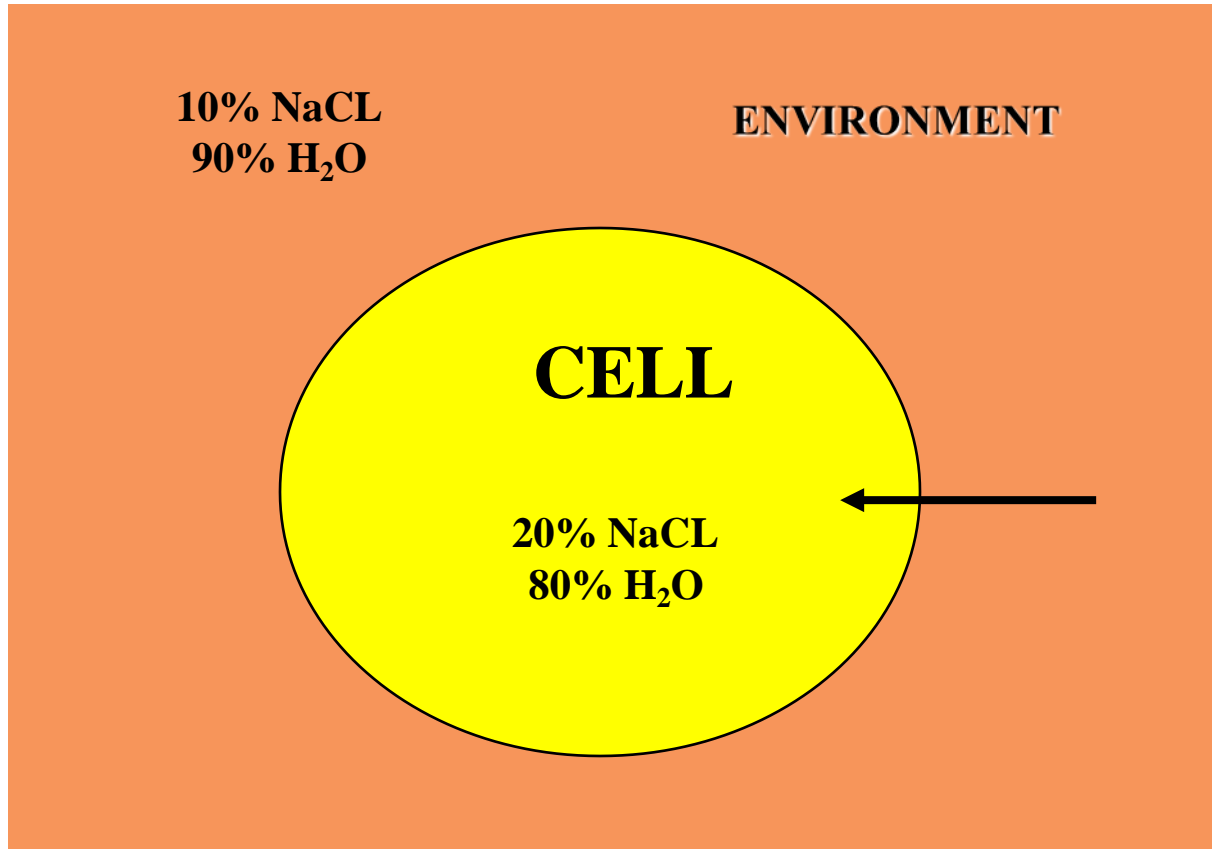
Cell in **Isotonic** Solution



What is the direction of water movement?

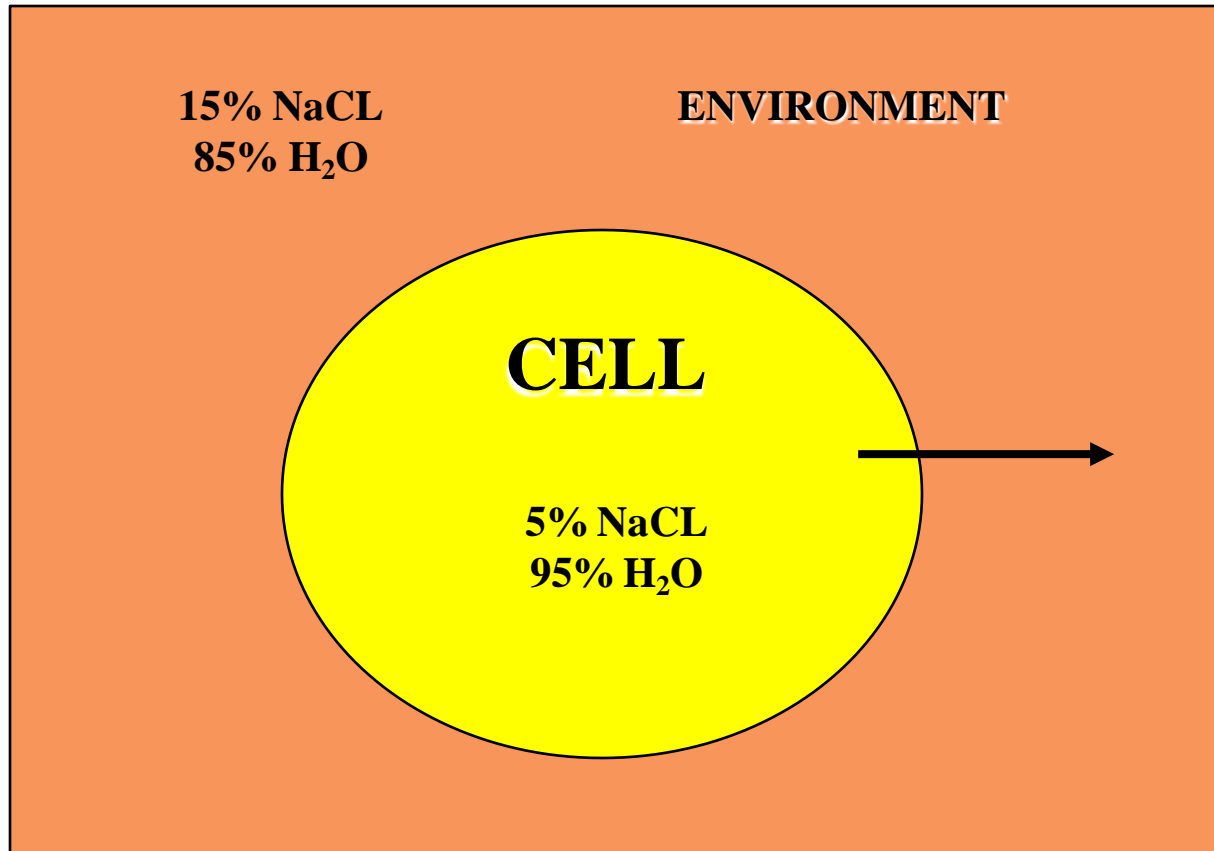
The cell is at equilibrium.

Cell in **Hypotonic** Solution



What is the direction of water movement?

Cell in **Hypertonic** Solution



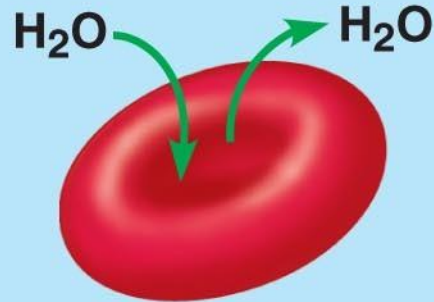
What is the direction of water movement?

Isotonic solution

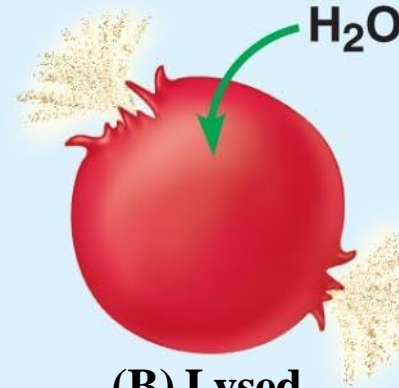
Hypotonic solution

Hypertonic solution

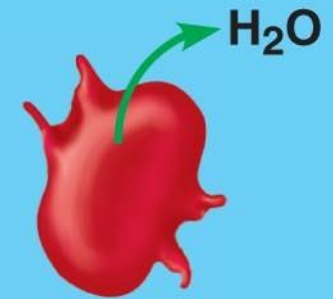
Animal cell



(A) Normal

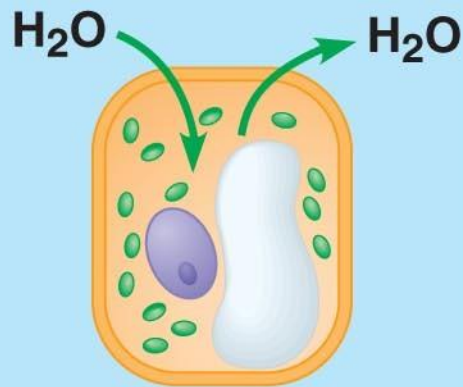


(B) Lysed

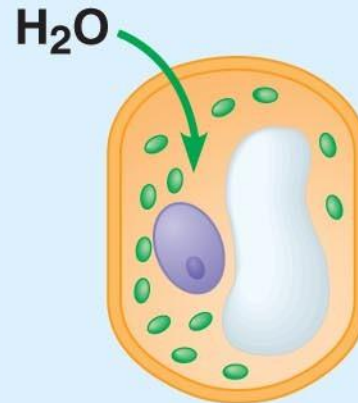


(C) Shriveled

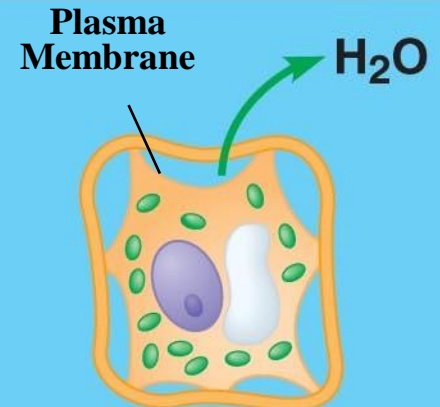
Plant cell



(D) Flaccid



(E) Turgid



(F) Shriveled
(plasmolyzed)

How animal and plant cells behave in different solutions