

# **Cell Membranes**

## **Diffusion, Osmosis & Osmotic Pressure**

# Functions of Membranes

- 1. Protect cell**
- 2. Control incoming and outgoing substances**
- 3. Maintain ion concentrations of various substances**
- 4. Selectively permeable - allows some molecules in, others are kept out**

# Solutions

- **Solutions are made of solute and a solvent**
- **Solvent - the liquid into which the solute is poured and dissolved. We will use water as our solvent today.**
- **Solute - substance that is dissolved or put into the solvent. Salt and sucrose are solutes.**

# Methods of Transport Across Membranes

**1. Diffusion**

**2. Osmosis**

**3. Facilitated Diffusion**

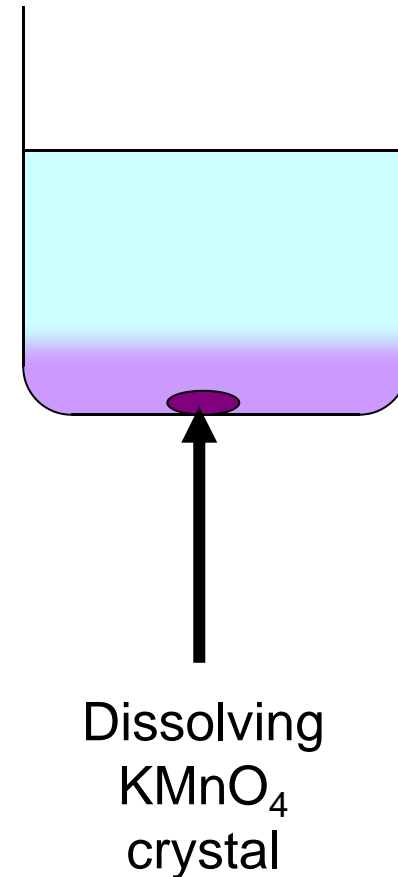
**4. Active Transport**

# **Methods of Transport Across Membranes**

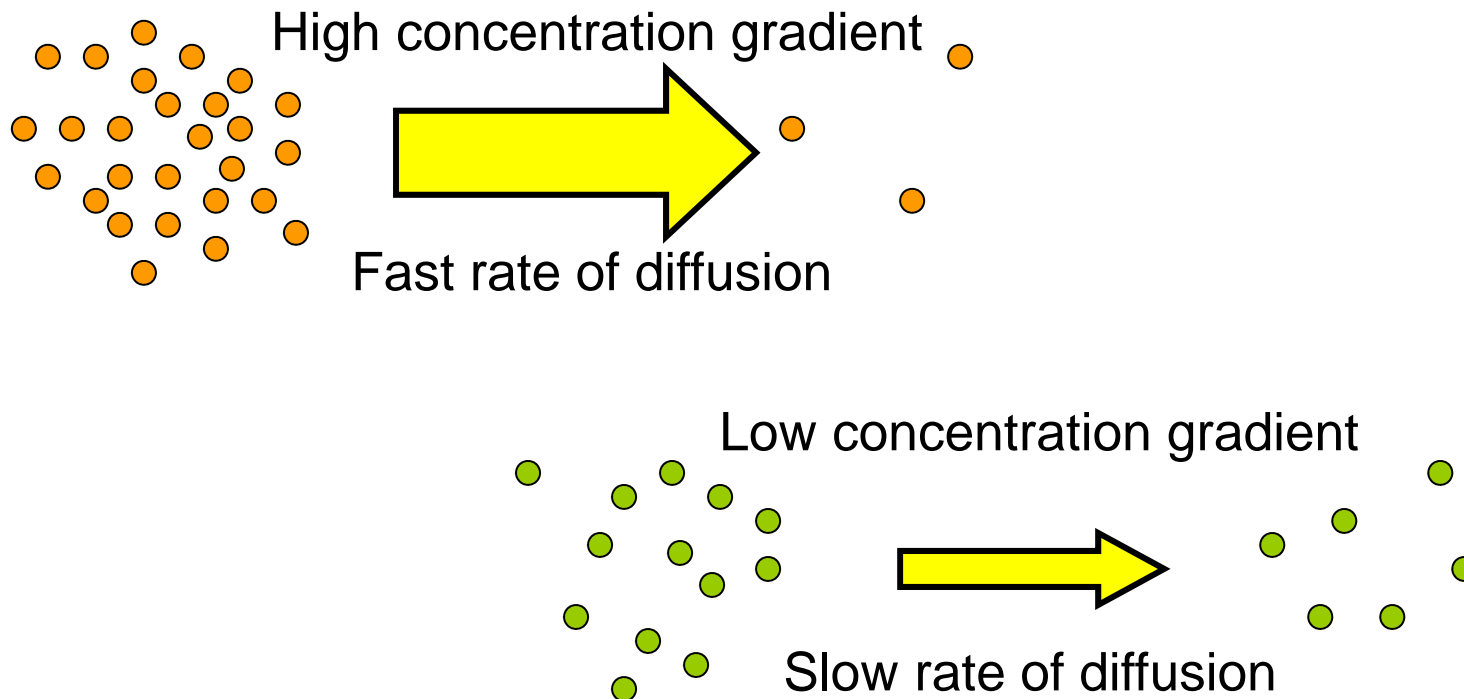
- 1. Diffusion -passive transport - no energy expended**
- 2. Osmosis - Passive transport of water across membrane**
- 3. Facilitated Diffusion - Use of proteins to carry polar molecules or ions across**
- 4. Active Transport- requires energy to transport molecules against a concentration gradient – energy is in the form of ATP**

# Diffusion

- Particles in a liquid or gas spread out...
- ... *from* regions of *high* concentration...
- ... *to* regions of *low* concentration...
- ...until the particles are *evenly* spread out.



- The *difference* between the regions of high concentration and low concentration is called the *concentration gradient*
- The *steeper* the concentration gradient, the *faster* diffusion takes place

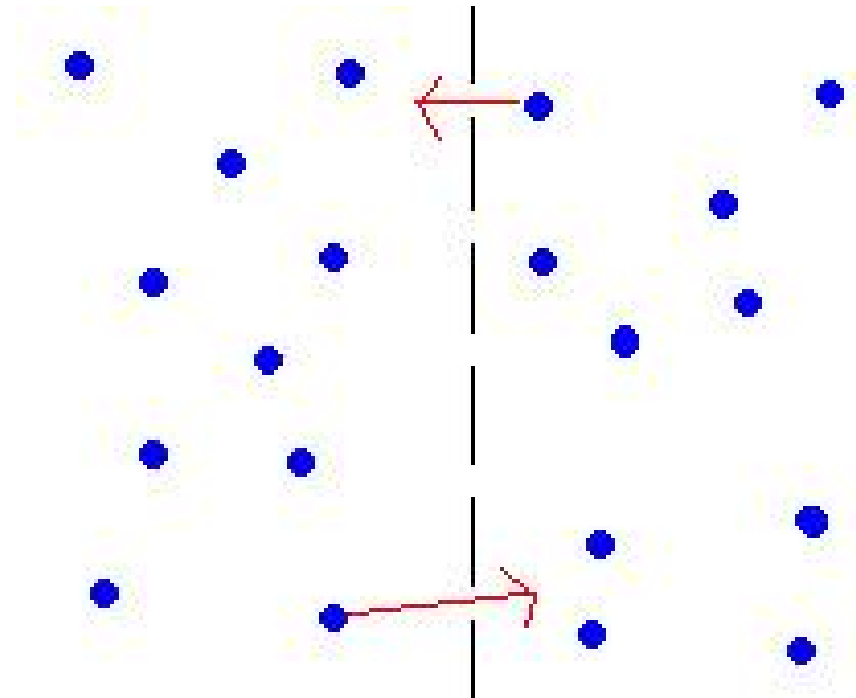


## Osmosis

- Osmosis is the diffusion of free water molecules...
- ... *from* a region of *high* concentration of free water molecules...
- ... *to* a region of *low* concentration of free water molecules...
- ...across a *partially-permeable membrane*...
- ...until they are evenly spread out.



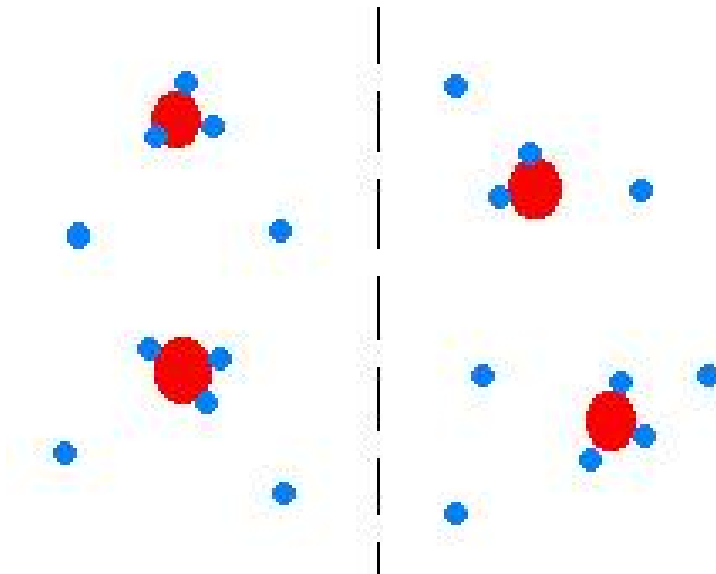
Distilled water separated by a partially-permeable membrane:



**Water molecules are moving from one side of the membrane to the other but there is NO NET OSMOSIS**

If a substance is dissolved in water, the kinetic energy of the water molecules is **LOWERED**.

This is because some water molecules aggregate on the surfaces of the other molecules...



# **Tonicity is a relative term**

- **Hypotonic Solution - One solution has a lower concentration of solute than another.**
- **Hypertonic Solution - one solution has a higher concentration of solute than another.**
- **Isotonic Solution - both solutions have same concentrations of solute.**

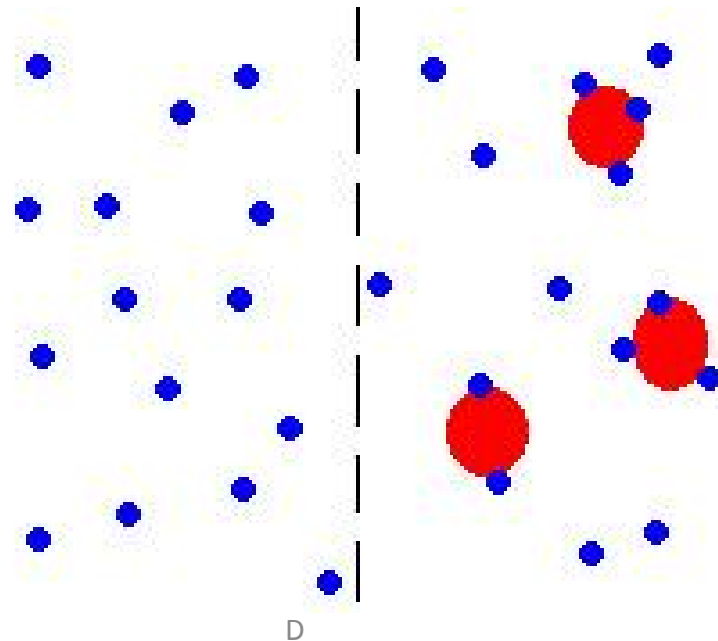
For osmosis we talk about the potential water molecules have to move – the **OSMOTIC POTENTIAL**.  
Distilled water has the highest potential (zero).

When water has another substance dissolved in it, the water molecules have less potential to move. The osmotic potential is **NEGATIVE**.

Water molecules always move from less negative to more negative water potential.

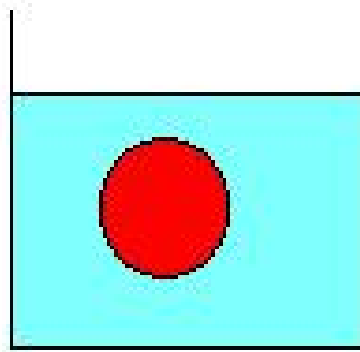
## NET OSMOSIS

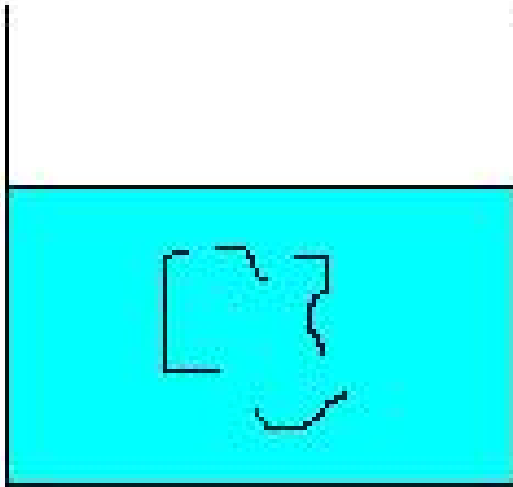
$$= LN \Rightarrow MN$$



The osmotic potential of a cell is known as its **WATER POTENTIAL**. For animal cells, the water potential is the osmotic potential of the cytoplasm.

An animal cell with water potential  $-50$  is placed in a solution...



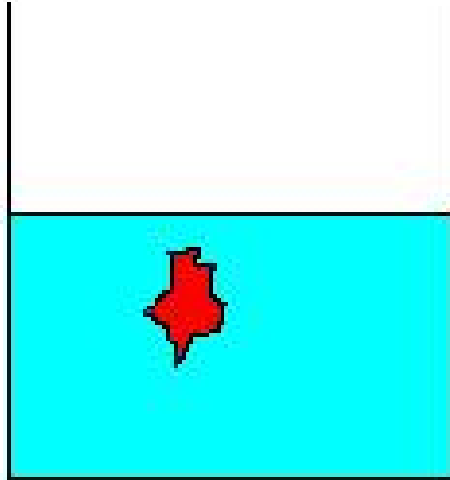


Water potential of  
cytoplasm = -50

Osmotic potential of  
solution = -20

**If the osmotic potential of the solution is LESS NEGATIVE than the water potential of the cytoplasm (the solution is HYPOTONIC), net ENDOSMOSIS will occur, i.e. water will move into the cell from the solution. The result will be HAEMOLYSIS (the cell will burst)**

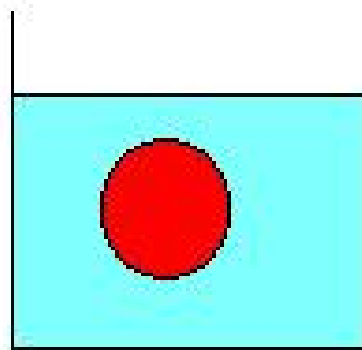




Water potential of  
cytoplasm = -50

Osmotic potential of  
solution = -80

**If the osmotic potential of the solution is MORE NEGATIVE than the water potential of the cytoplasm (the solution is HYPERTONIC), net EXOSMOSIS will occur. The result will be CRENATION (the cell will shrivel up)**



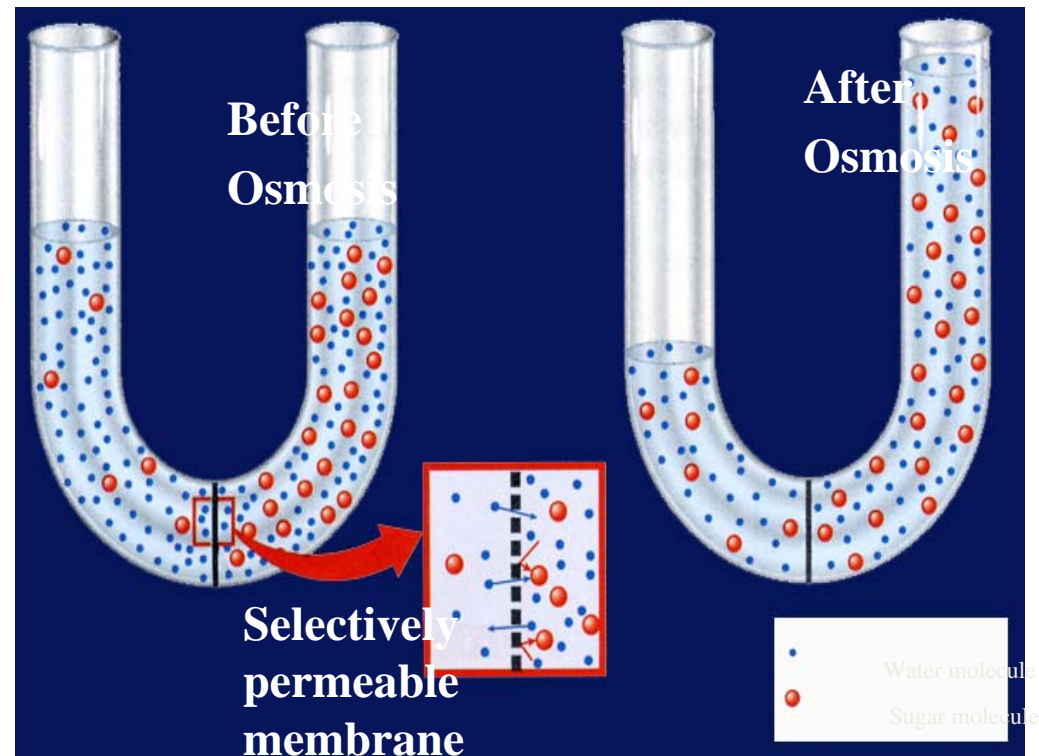
Water potential of  
cytoplasm = -50

Osmotic potential of  
solution = -50

**If the  
osmotic  
potential of  
the solution  
is **THE SAME**  
as the water  
potential of  
the  
cytoplasm  
(the solution  
is **ISOTONIC**),  
there will be  
**NO NET  
OSMOSIS.****

# What controls osmosis?

- Unequal distribution of particles, called a **concentration gradient**, is one factor that controls osmosis.

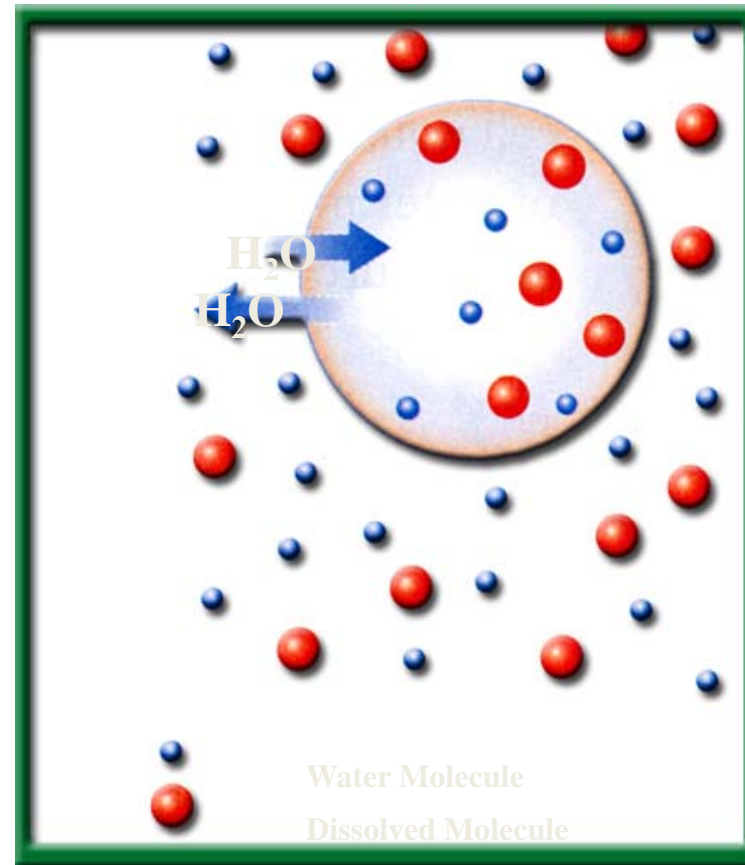


# **Osmosis: Diffusion of Water**

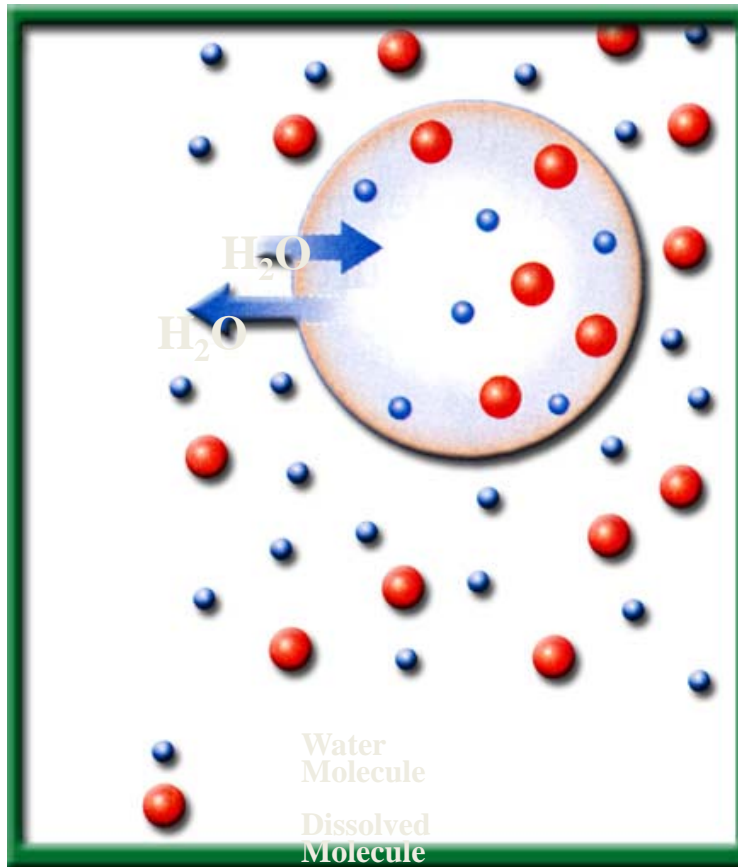
- Most cells whether in multicellular or unicellular organisms, are subject to osmosis because they are surrounded by water solutions.

# Cells in an isotonic solution

- **isotonic solution-**
- *(= concentrations)*
- the concentration of dissolved substances in the solution is the same as the concentration of dissolved substances inside the cell.



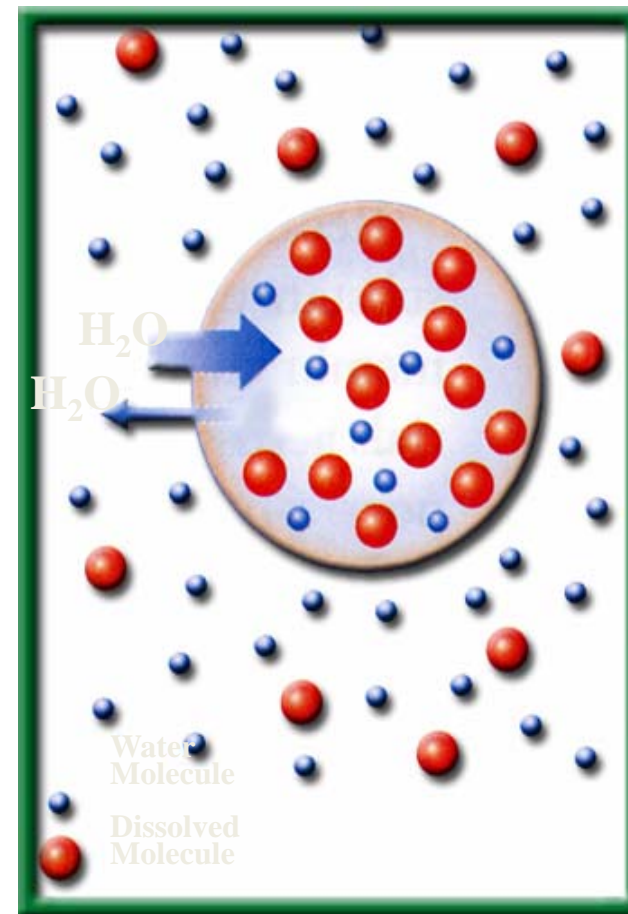
# Cells in an isotonic solution



- water molecules move into and out of the cell at the same rate, and cells retain their normal shape.

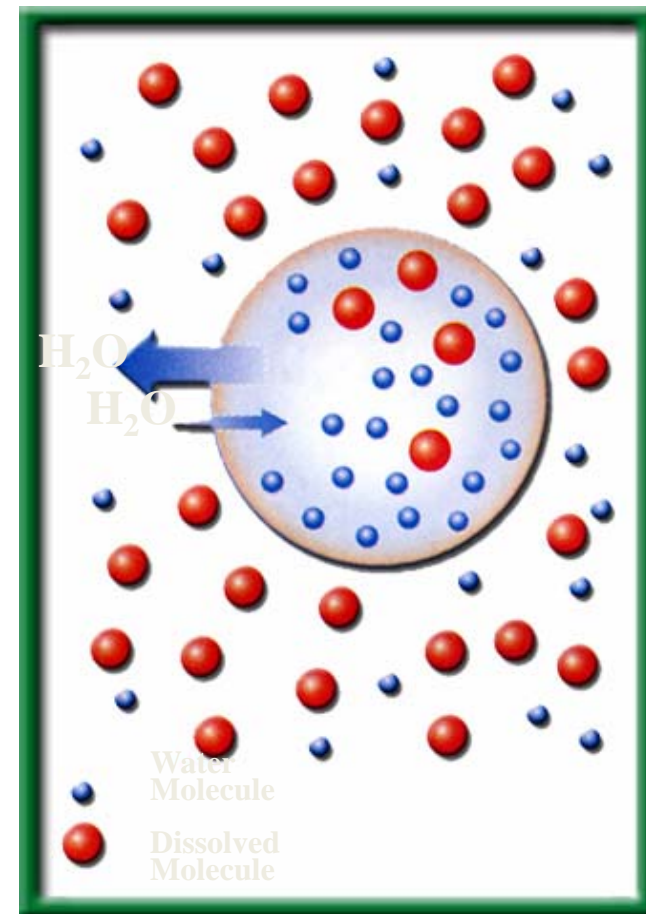
# Cells in a hypotonic solution

- hypotonic solution: dilute solution thus low solute concentration
- In a hypotonic solution, water enters a cell by osmosis, causing the cell to swell.



# Cells in a hypertonic solution

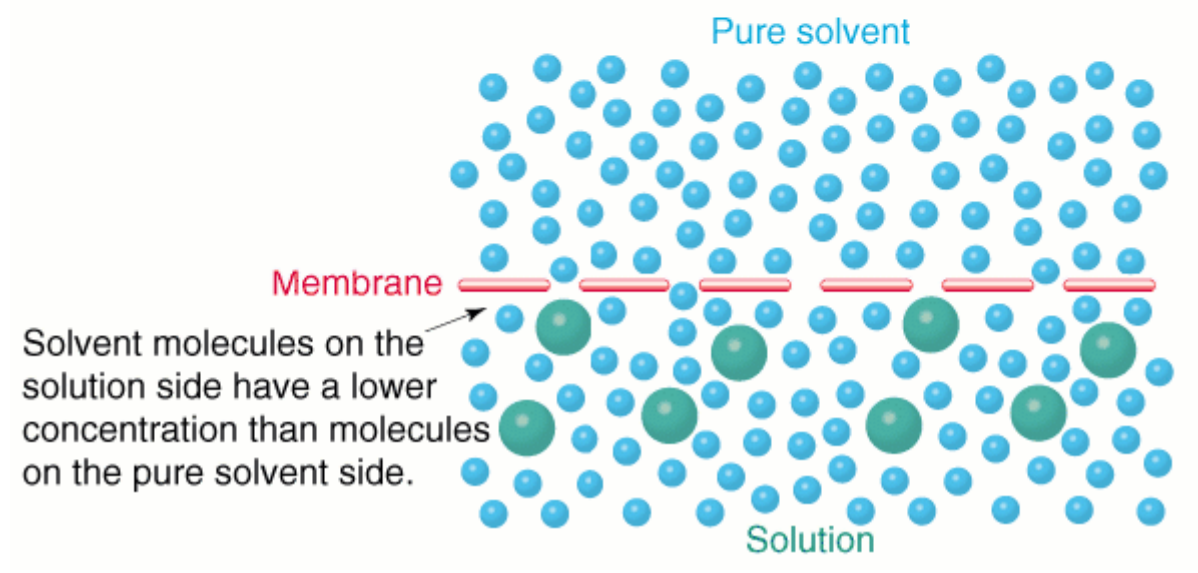
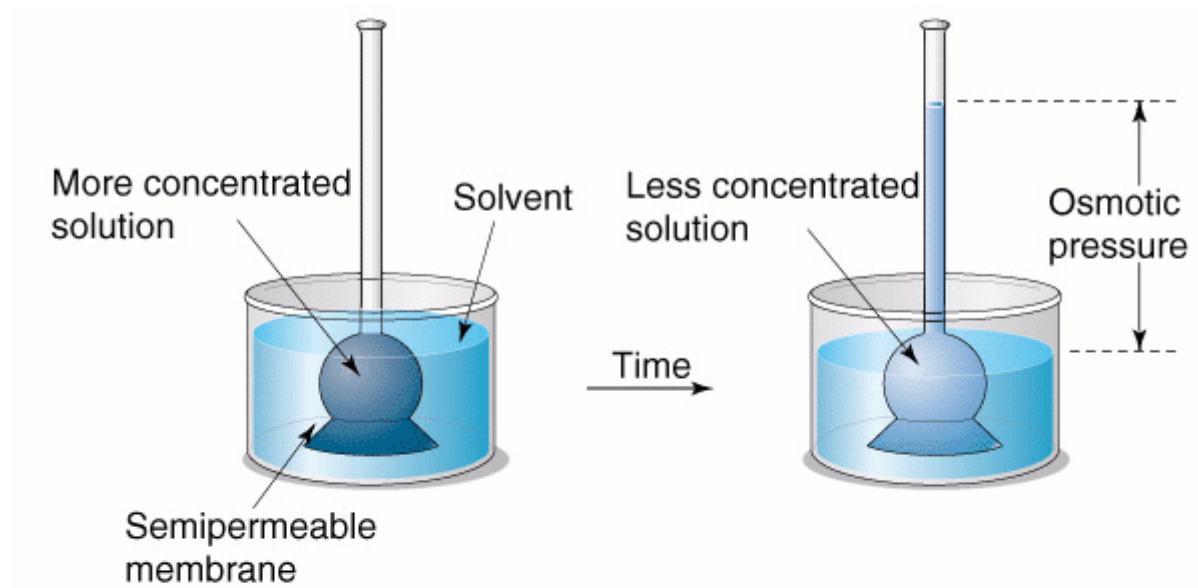
- **hypertonic solution:**  
concentrated solution, thus  
a high solute  
concentration
- In a hypertonic solution,  
water leaves a cell by  
osmosis, causing the cell  
to shrink



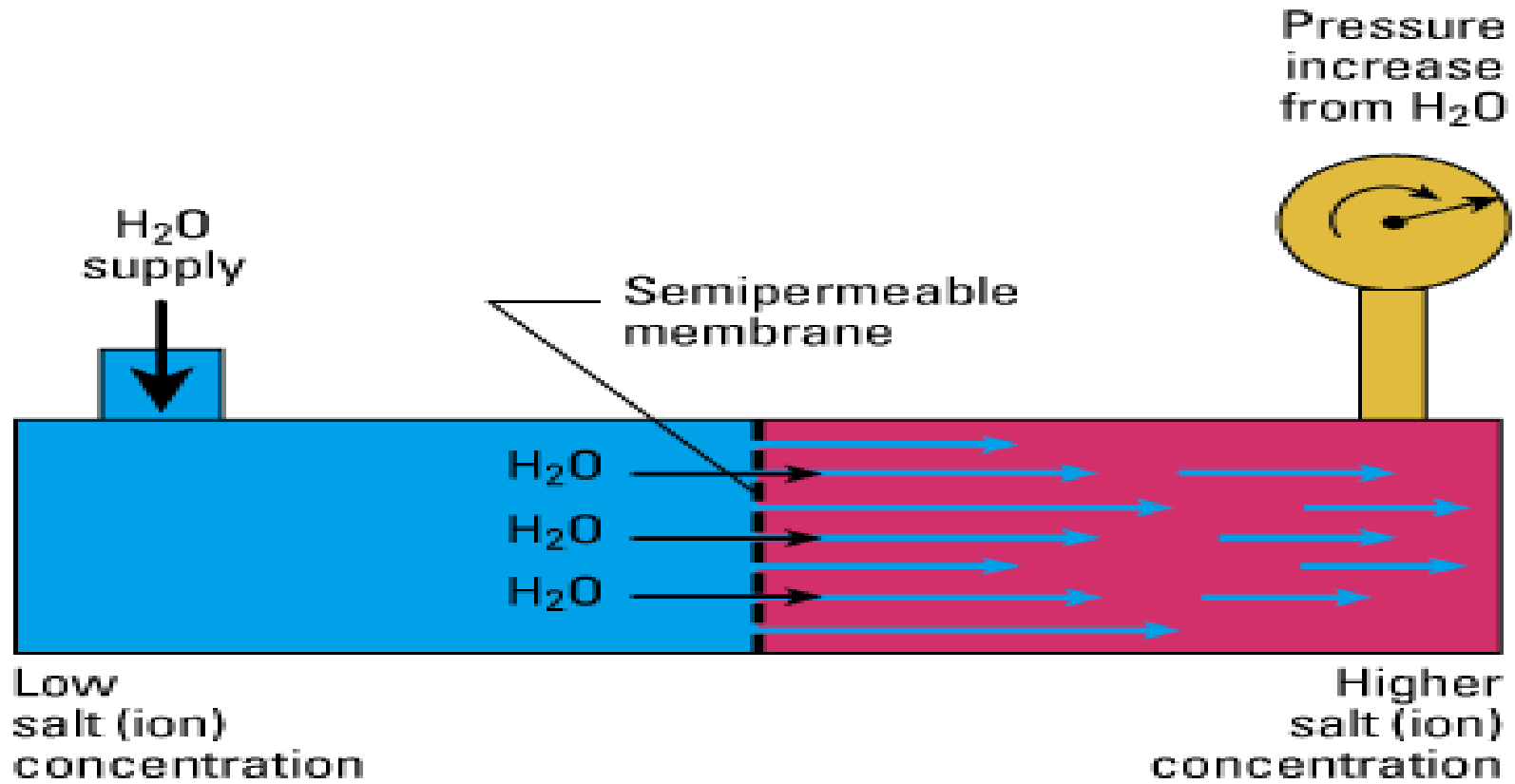


# Osmotic Pressure

- **For the phenomenon of osmosis, a membrane separates salt/water inside a chamber from pure water in the container. Water passes through membrane from dilute to more concentrated. As water rises into tube, it creates a pressure. Eventually this pressure (osmotic pressure) prevents further passage of water through the membrane**
- **Osmotic pressure is force per area that prevents water from passing through membrane!**



# Diagram of osmotic pressure cell.



Osmotic Pressure Cell

# Osmotic Pressure

- Methods for the determination of osmotic pressure are
  1. Pfeffer's method
  2. Freezing point determination method.  
Decrease in freezing point of the solution when its osmotic pressure is equal to one osmole.

# Osmotic Pressure

- **Laws of Osmotic Pressure :**
  - 1. The Osmotic Pressure is directly proportional to the concentration of the solute.**
  - 2. The Osmotic Pressure is directly proportional to the absolute temperature.**

# Osmotic Pressure

- Importance of osmotic pressure of plasma proteins:
  1. The plasma proteins form a colloidal solution and are the chief colloid of the plasma.
  2. The oncotic pressure of the plasma proteins is the main force which tends to keep the plasma water within the blood vessels.
  3. If concentration of plasma proteins decreases, water will leak into tissue spaces and will lead to development of edema.