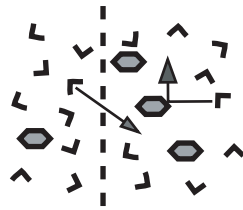


Osmosis

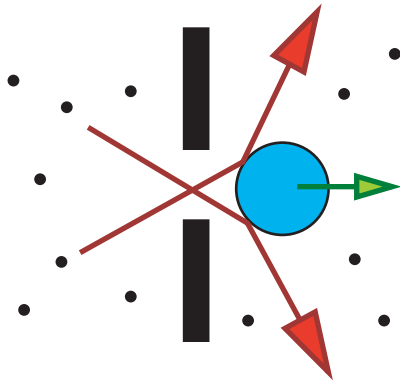
An Introduction to
Mechanisms of Osmosis
and its effect on
Water Balance



By Noel Ways

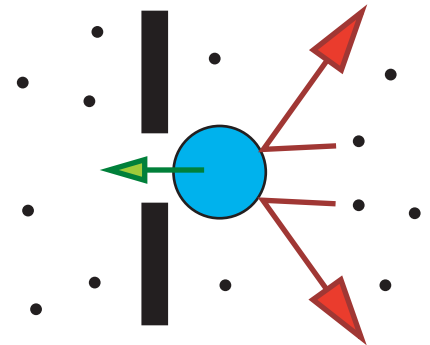
Osmosis

Osmosis is the movement of a solvent through a semi-permeable membrane into a region of higher solute concentration. To understand this, it must be first understood that any such system is in constant motion. Water molecules, as well as the solute, are in constant movement and this random movement increases when the temperature increases.

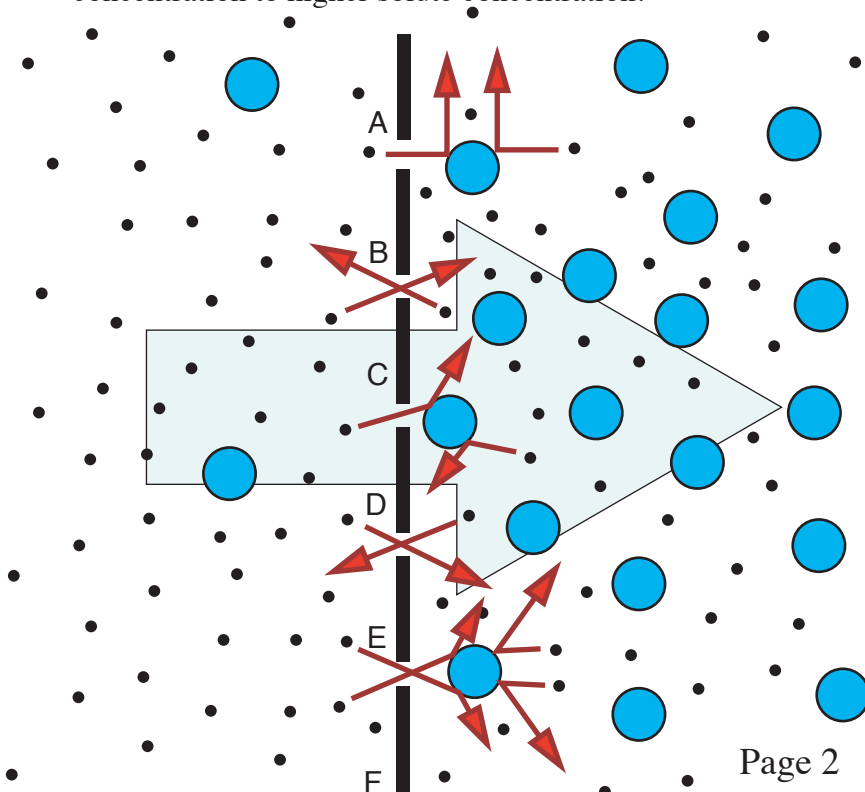


Consider the diagram at left. A solute molecule in close proximity to a pore permits water to pass through the pore into the other side of the membrane. The solute will also move in such manner so as to allow additional water to pass to the right.

In the diagram to the right, water molecules heading for the same pore hit a solute molecule and bounce off of it, and are not permitted to pass through. Furthermore, the solute moves toward the pore and will make more difficult the passage of any other water molecules from right to left.



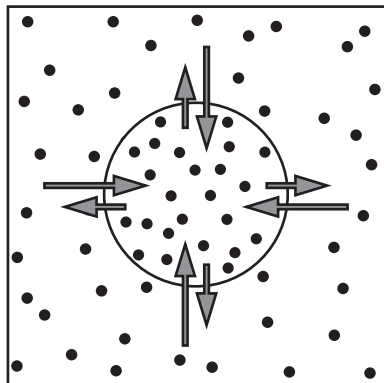
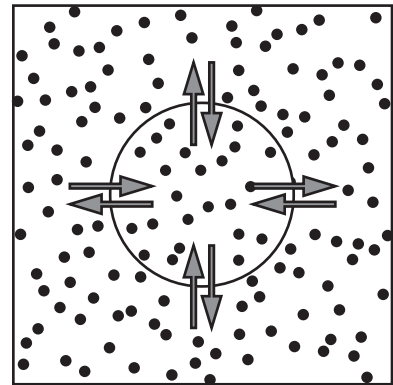
In short, the pore-solute system is acting like a one-way valve. It is important to realize that all movement is random, and indeed some water will slip in the other way. But for certain, the net movement of water (the solvent) will always proceed from lower solute concentration to higher solute concentration.



In the diagram at left, the higher solute concentration is clearly on the right side and the many "one-way valves" cause a net movement of water from the left to the right. Although there may be "one-way valves" on both sides of the semi-permeable membrane, the side with the greater concentration will see a greater movement of water to that side.

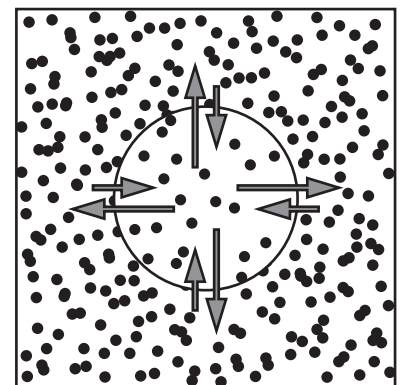
In the illustrations below, the dots represent solute molecules dissolved in water. The water is not seen, but inferred.

"Osmotically active substances" are solutes that cause osmosis. If the concentration of osmotically active substance is equal on either side of the membrane, then the *solution surrounding the cell* is said to be *isotonic*. The osmotic pressure will be equal on either side of the membrane. This is a stable situation in this model.

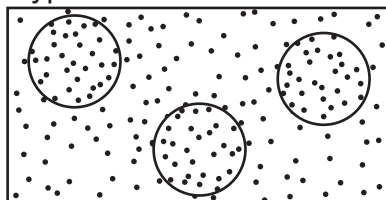


If the solution surrounding the cell has a lower concentration of osmotically active substances, then the solution is said to be *hypotonic*. Here, there is a greater osmotic pressure drawing water into the cell. If the osmotic pressure is great enough, the cell will burst. If the cell is a red blood cell, the term *hemolysis* is used.

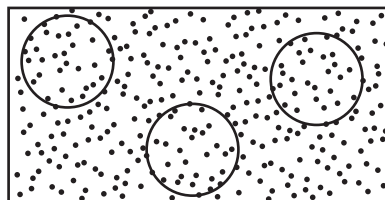
If the solution surrounding the cell has a greater concentration of osmotically active substances, then the solution is said to be *hypertonic*. Now the osmotic pressure will be greater outside the membrane and water will be drawn out of the cell, and the cell will shrivel up. When red blood cells are under consideration process is called *crenation*.



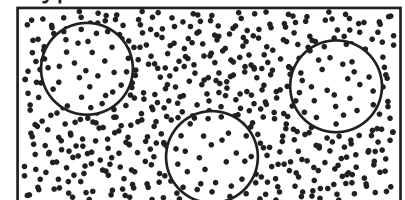
Hypotonic Solution




Isotonic Solution

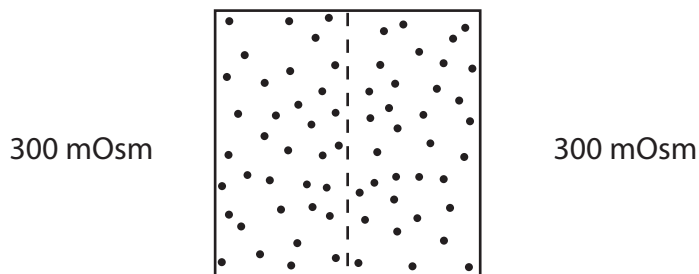
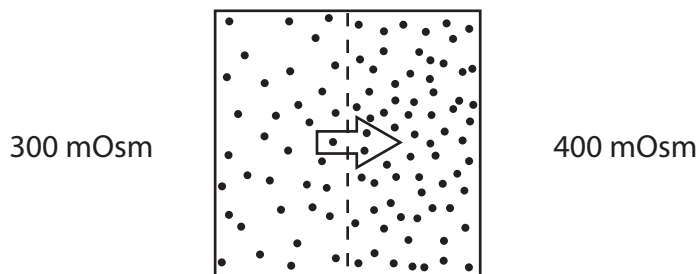
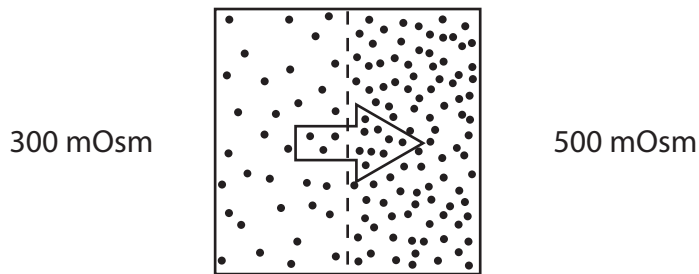
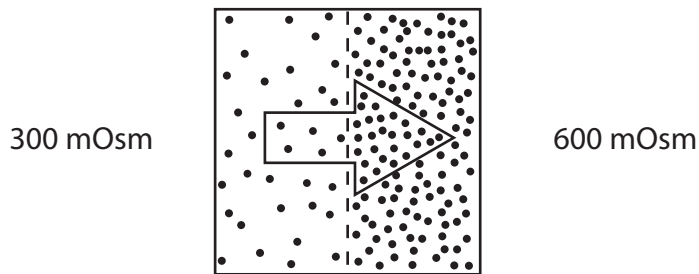


Hypertonic Solution



The movement of water will continue to move to the area through a semipermeable membrane into the area of higher concentration until the solute concentration is the same on either side of the membrane. At that point, a state of equilibrium has been reached.

Osmotically active substances are measured in units of osmoles, which reflects the concentration of the solute. As the concentrations are small in physiological applications, milliosmoles (mOsm) is the typical unit used. When the milliosmoles increases, the osmotic pressure increases. When the milliosmoles decrease, the osmotic pressure decreases. In the illustration below the net movement of water  is moving into the area of higher solute concentration (area with higher milliosmoles) until the system becomes isotonic.



Sodium and Potassium in Water Balance

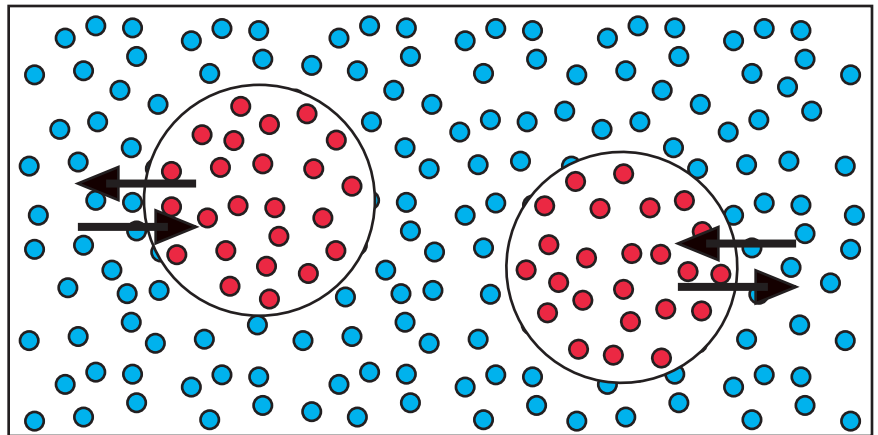
"Osmotically active substances" can be different on either side of a membrane

- Sodium
- Potassium

Both sodium and potassium are osmotically active ions. Potassium is found within intracellular fluids and helps create osmotic pressure to draw water into the cell from interstitial fluid or plasma.

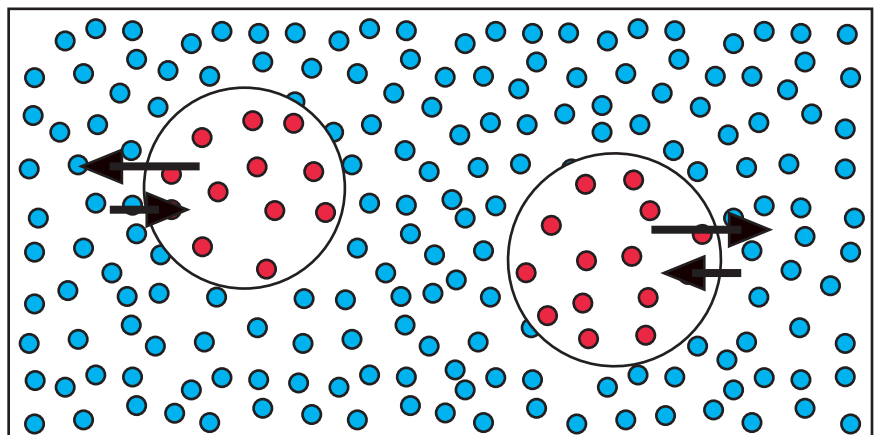
Sodium is found in extracellular fluids (plasma and interstitial fluid) where it helps create osmotic pressure to draw water out of cells and into the interstitial fluid and plasma.

If the milliosmoles of osmotically active substances on either side of a semipermeable membrane (ie., cell membrane) are equal, the condition is isotonic, and water will move at equal rates in both directions.



If water is to be moved across the membrane, it is adjustments to the relative concentrations of Na and K that will do the job.

Should there be insufficient water within the plasma resulting in low blood pressure, the kidneys will adjust the location of water by altering the relative concentration of both Na and K. By retaining Na and excreting K in the urine, this will soon create a hypertonic condition, and water now leaves the cells and enters the plasma and blood pressure raises.



If blood pressure is excessive, then sodium may be excreted in the urine and potassium retained. This will soon create a hypotonic condition and water will move from the plasma into cells and blood pressure will lower.

