Chapter 8 Solutions

Water that makes the most common solutions

→ CO 8.1

Ocean water is a solution in which many different substances are dissolved.

Steve Allen/Peter Arnold, Inc.

Solutions keep properties of both: Solvent and the solute

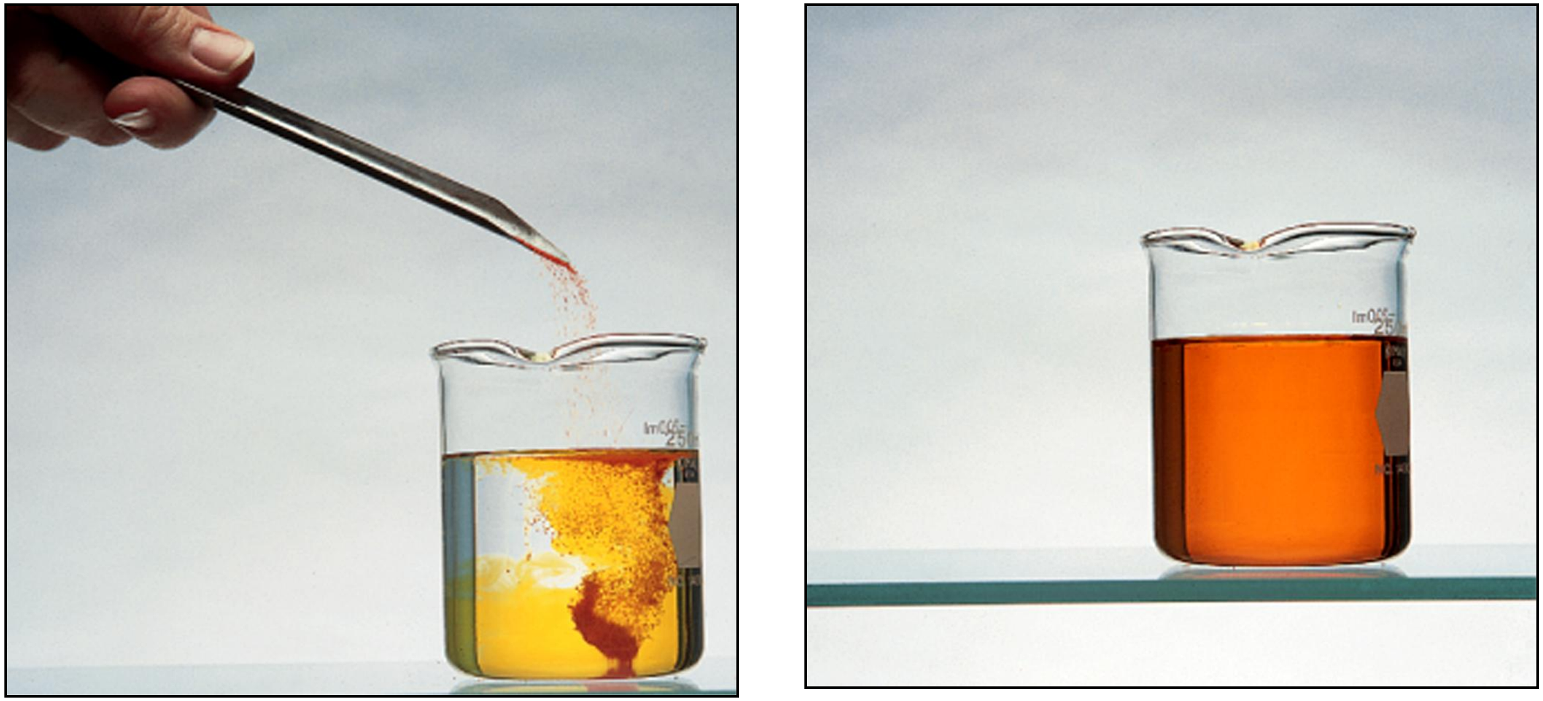


Fig. 8.1

The colored crystals are the solute, and the clear liquid is the solvent. Stirring produces the solution.

Solutions could be sold solutions

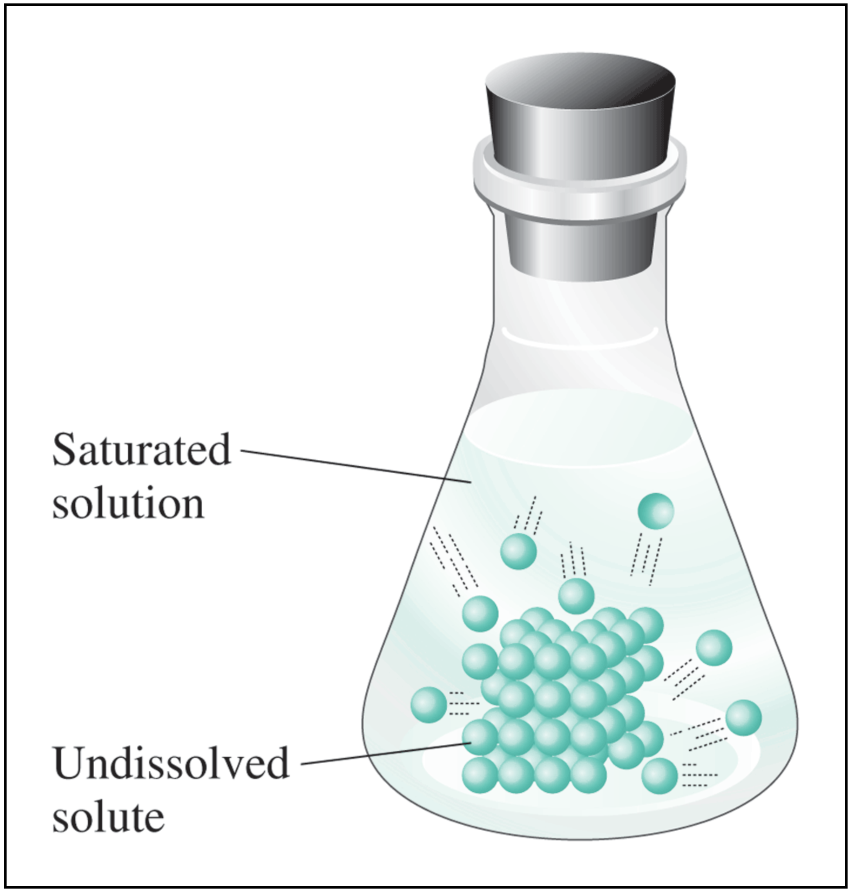
→ Fig. 8.2
Jewelry often involves solid solutions in which one metal has been dissolved in another metal.

Solubility is different

Solute	Solubility (g solute/100 g H_2O)		
	0°C	50°C	100°C
lead(II) bromide ($PbBr_2$)	0.455	1.94	4.75
silver sulfate (Ag_2SO_4)	0.573	1.08	1.41
copper(II) sulfate ($CuSO_4$)	14.3	33.3	75.4
sodium chloride (NaCl)	35.7	37.0	39.8
silver nitrate ($AgNO_3$)	122	455	952
cesium chloride (CsCl)	161.4	218.5	270.5

Table 8.1

Saturated solutions



← Fig. 8.3

In a saturated solution, the dissolved solute is in dynamic equilibrium with the undissolved solute.

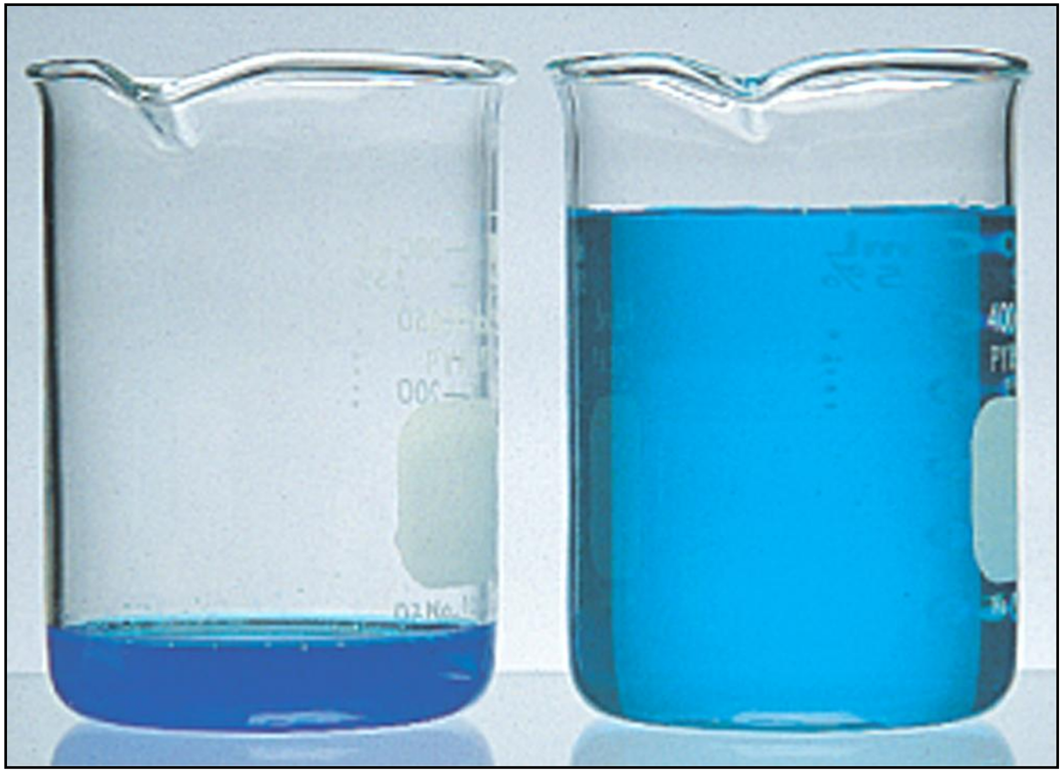
Gas in liquids: solutions

← C.C. 8.1
Carbon dioxide escaping from an opened bottle of a carbonated beverage.

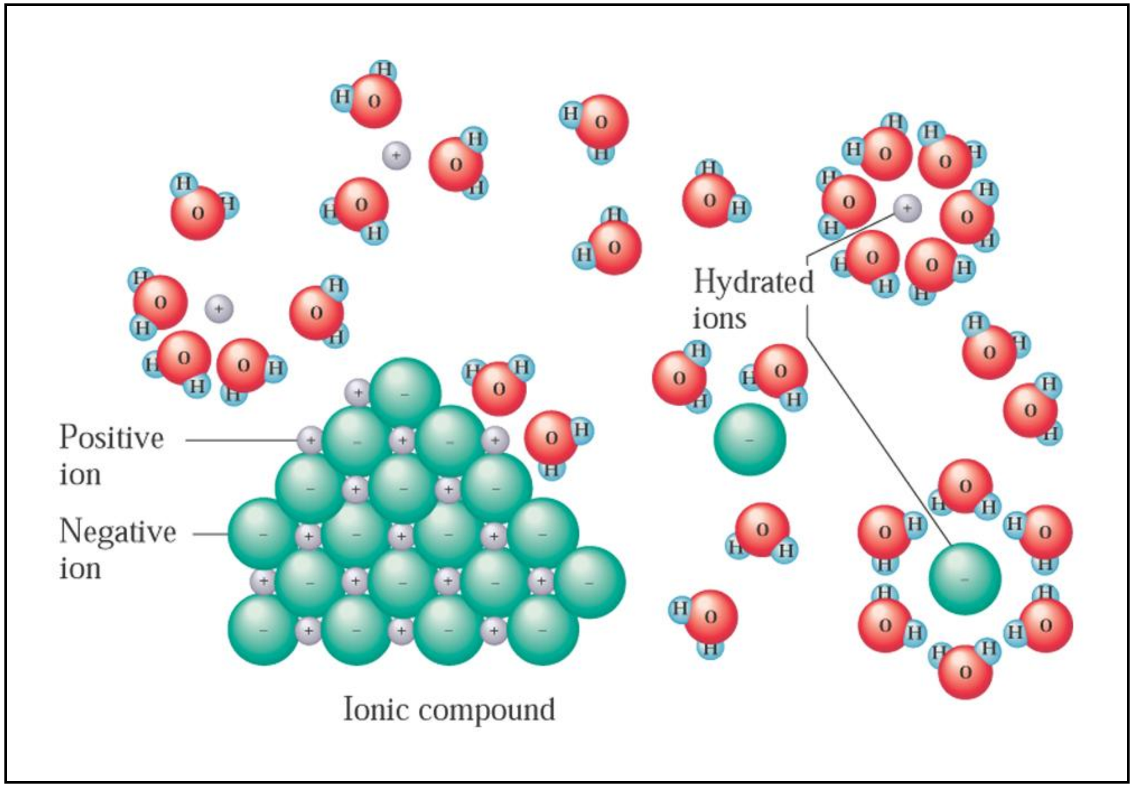
Concentrated vs. dilute olutions

→ Fig. 8.4

Both solutions contain the same amount of solute. A concentrated solution (left) contains a relatively large amount that could dissolve. A dilute solution contains a relatively small amount of solute compared with the amount that could dissolve.



Ionic solids breaks into ions in solutions



← Fig. 8.5
When an ionic solid, such as sodium chloride, dissolves in water, the water molecules hydrate the ions.

Immiscible liquids can be separated

→ Fig. 8.6
Oil spills can be contained to some extent by using trawlers and a boom apparatus because oil and water, having different polarities, are relatively insoluble in each other.

David Woodfall/Getty Images

Solubility rules for ionic solids

Soluble Compounds	Important Exceptions
Compounds containing the following ions are soluble with exceptions as noted.	
Group IA (Li^+, Na^+, K^+, etc.)	none
Ammonium (NH_4^+)	none
Acetate ($C_2H_3O_2^-$)	none
Nitrate (NO_3^-)	none
Chloride (Cl^-), bromide (Br^-), and iodide (I^-)	Ag^+, Pb^{2+}, Hg_2^{2+}
Sulfate (SO_4^{2-})	Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

Insoluble Compounds[a]	Important Exceptions
Compounds containing the following ions are insoluble with exceptions as noted.	
Carbonate (CO_3^{2-})	group IA and NH_4^+
Phosphate (PO_4^{3-})	group IA and NH_4^+
Sulfide (S^{2-})	groups IA and IIA and NH_4^+
Hydroxide (OH^-)	group IA, Ba^{2+}, Sr^{2+}, Ca^{2+}

[a]All ionic compounds, even the least soluble ones, dissolve to some slight extent in water. Thus the "insoluble" classification really means ionic compounds that have very limited solubility in water.

← Table 8.2

Solubility of vitamins

CC 8.2 **Solubility of Vitamins**

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Polarity plays an important role in the solubility of many substances in the fluids and tissues of the human body. For example, consider vitamin solubilities. The 13 known vitamins fall naturally into two classes: fat-soluble and water-soluble. The fat-soluble vitamins are A, D, E, and K. Water-soluble vitamins are vitamin C and the eight B vitamins (thiamine, riboflavin, niacin, vitamin B_6, folic acid, vitamin B_{12}, pantothenic acid, and biotin). Water-soluble vitamins have polar molecular structures, as does water. By contrast, fat-soluble vitamins have nonpolar molecular structures that are compatible with the nonpolar nature of fats.

Vitamin C is water-soluble. Because of this, vitamin C is not stored in the body and must be ingested in our daily diet. Unused vitamin C is eliminated rapidly from the body via bodily fluids. Vitamin A, on the other hand, is fat-soluble. It can be, and is, stored by the body in fat tissue for later use. If vitamin A is consumed in excess quantities (from excessive vitamin supplements), illness can result. Because of its limited water solubility, vitamin A cannot be rapidly eliminated from the body by bodily fluids.

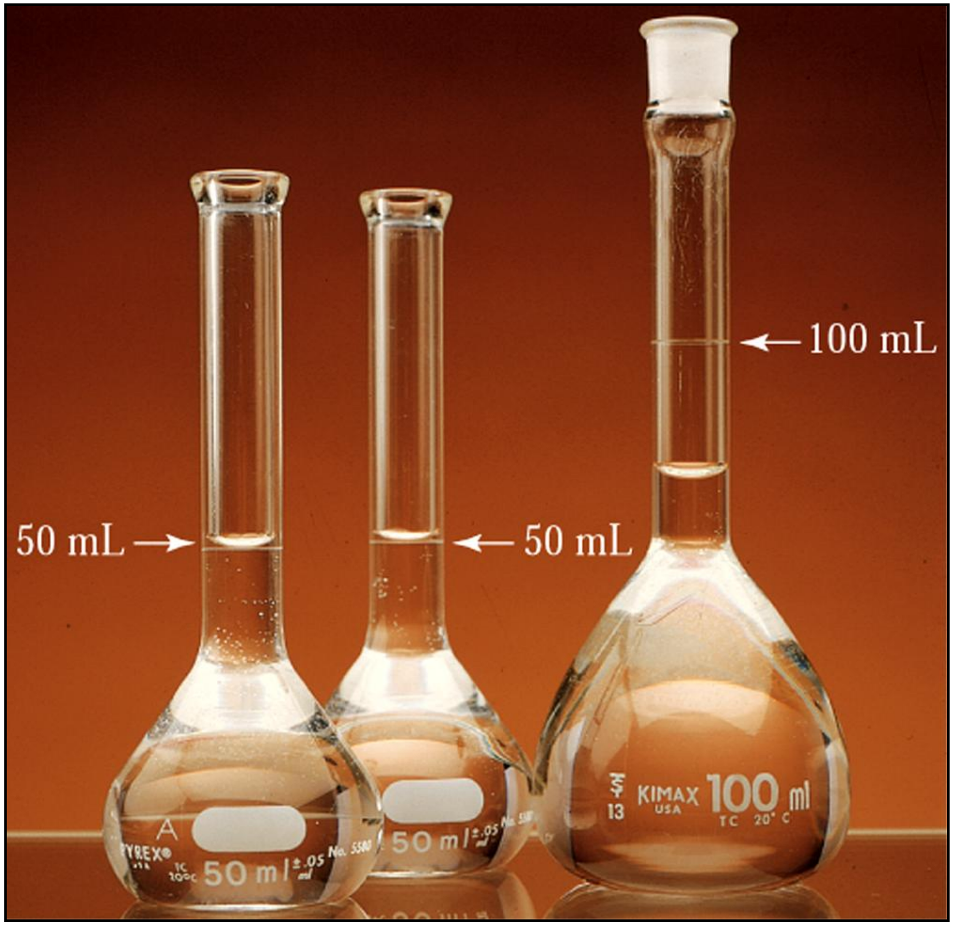
The water-soluble vitamins can be easily leached out of foods as they are prepared. As a rule of thumb, you should eat foods every day that are rich in the water-soluble vitamins. Taking megadose vitamin supplements of water-soluble vitamins is seldom effective. The extra amounts of these vitamins are usually picked up by the extracellular fluids, carried away by blood, and excreted in the urine. As one person aptly noted, "If you take supplements of water-soluble vitamins, you may have the most expensive urine in town."

Total volume don't add up

Fig. 8.7 **When volumes of two different liquids are combined, the volumes are not additive.**

Measuring volume of solutions

→ Fig. 8.8
Identical volumetric flasks are filled to the 50.0-mL mark with ethanol and with water. When the two liquids are poured into a 100mL volumetric flask, the volume is seen to be less.

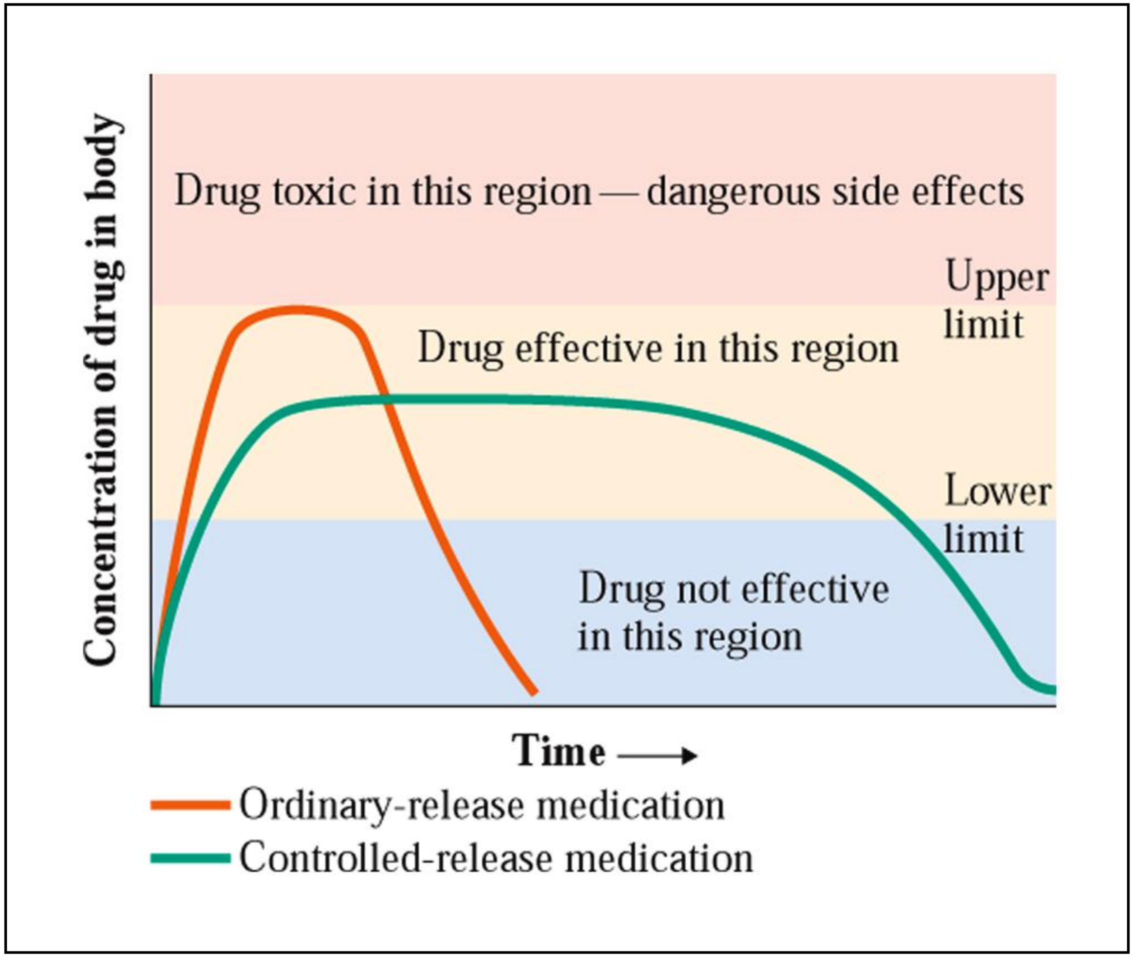


Orange juice is it a homogenous solutions?

← Fig. 8.9
Frozen orange juice concentrate is diluted with water prior to drinking.

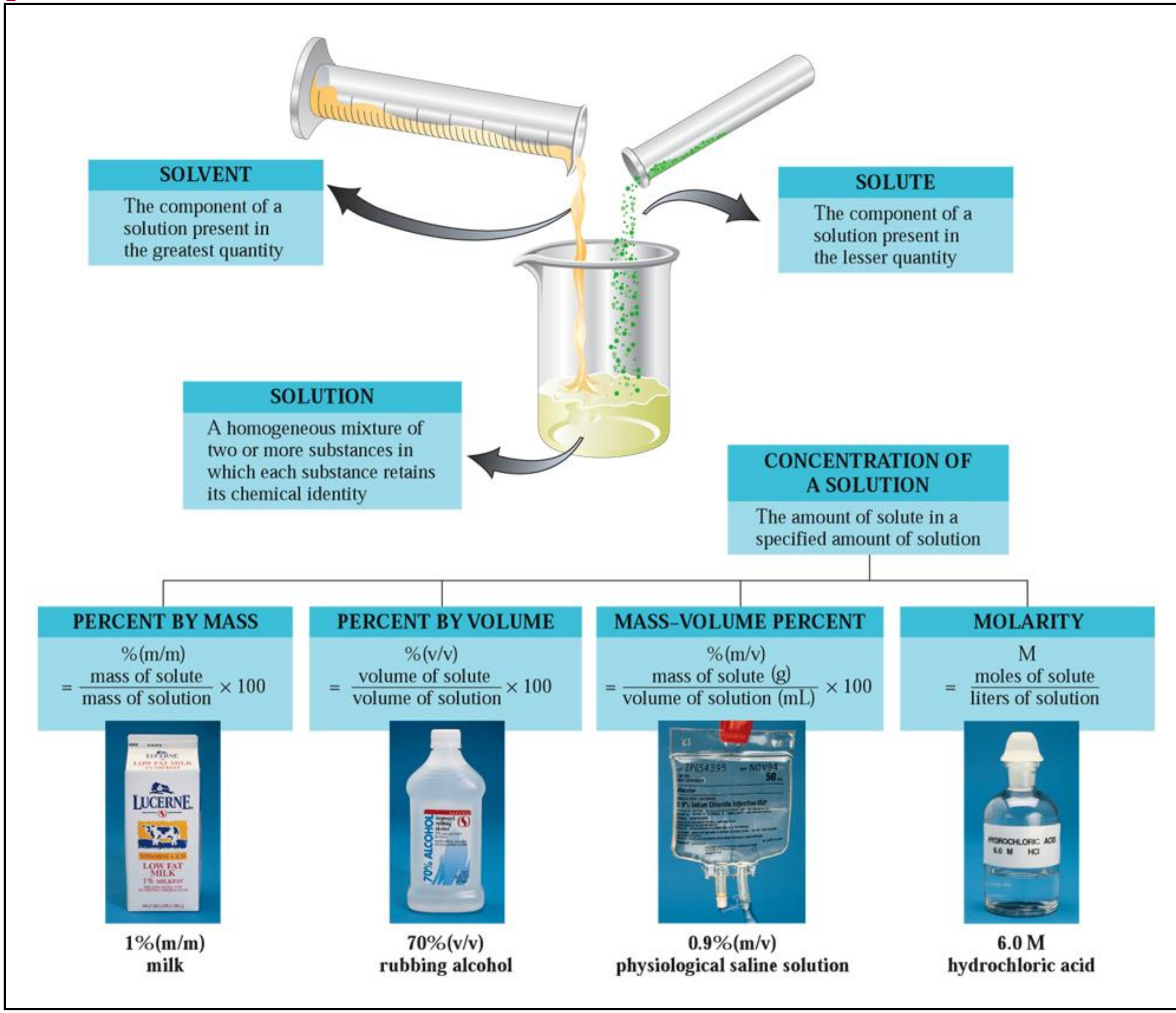
Concentration of drugs in solution

→ CC 8.3



Different types of solutions

→ CAG 8.1



Does the light pass through solutions

→ Fig. 8.10
A beam of light travels through a true solution without being scattered. This is not the case for a colloidal dispersion.

Solute lowers the vapor pressure

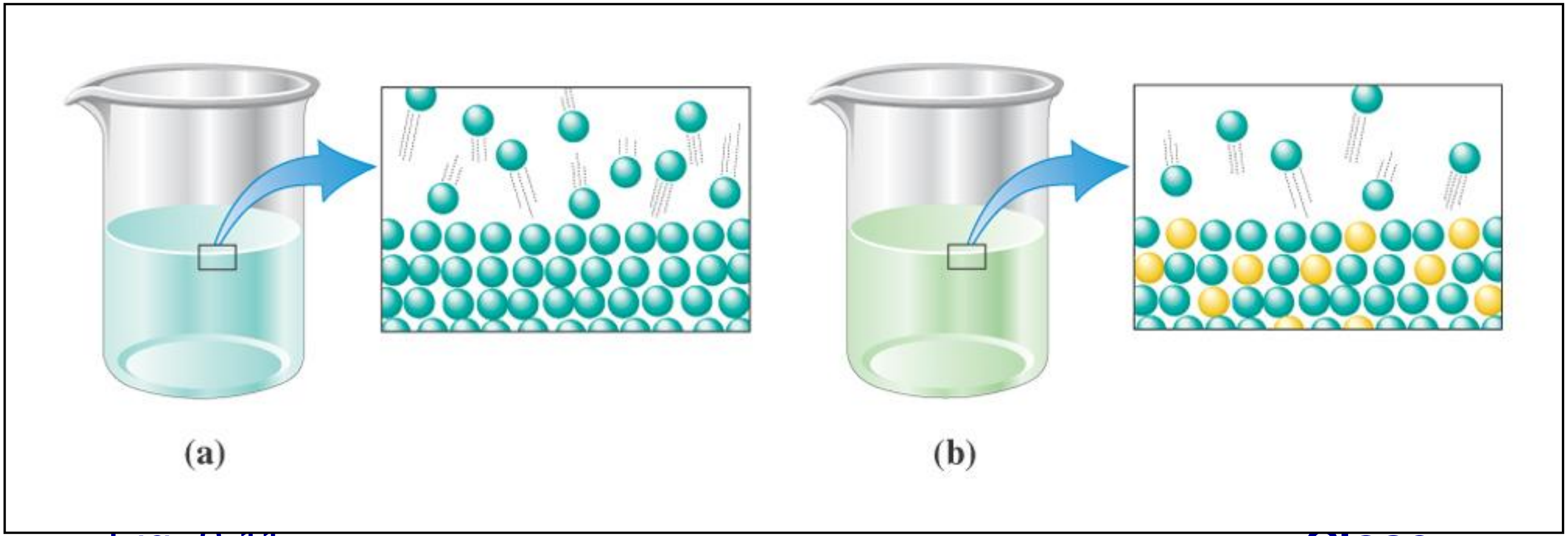


Fig. 8.11 **Close-ups of the surface of a liquid solvent before and after solute has been added.**

Solute lowers the freezing point

→ Fig. 8.12
A water-antifreeze mixture has a higher boiling point and lower freezing point than pure water.

Solute increase the osmotic pressure

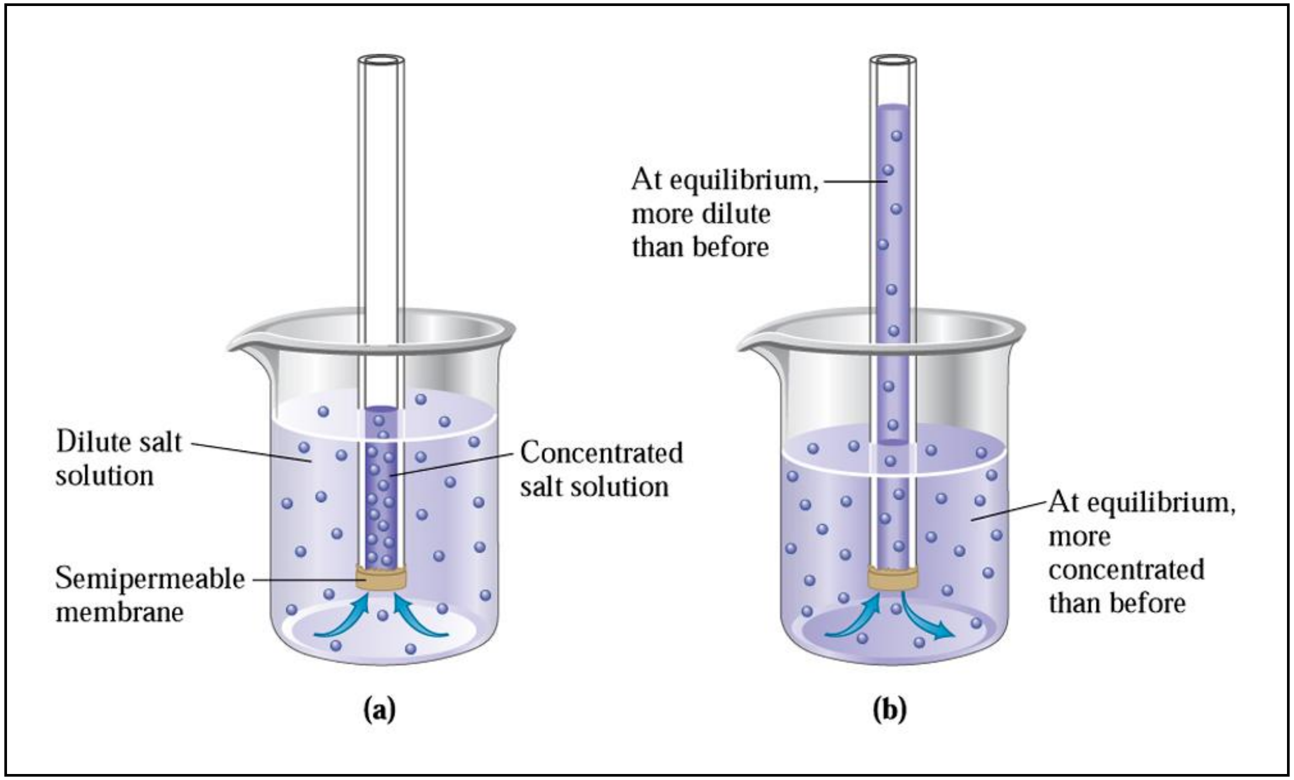


Fig. 8.13

(a) Osmosis can be observed with this apparatus. (b) The liquid level in the tube rises until equilibrium is reached.

Semi permeable memebreane only allows the solvent molecules to pass

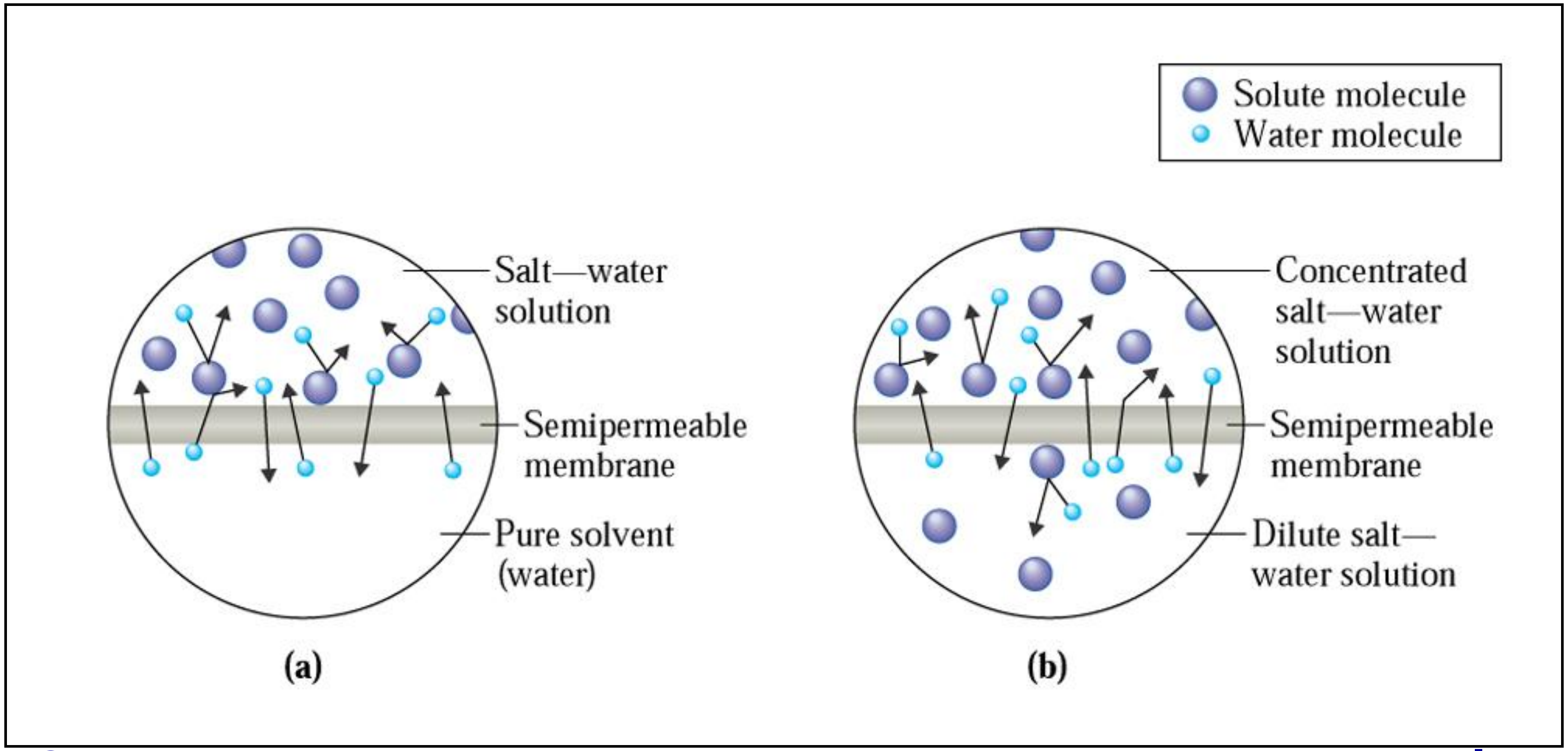
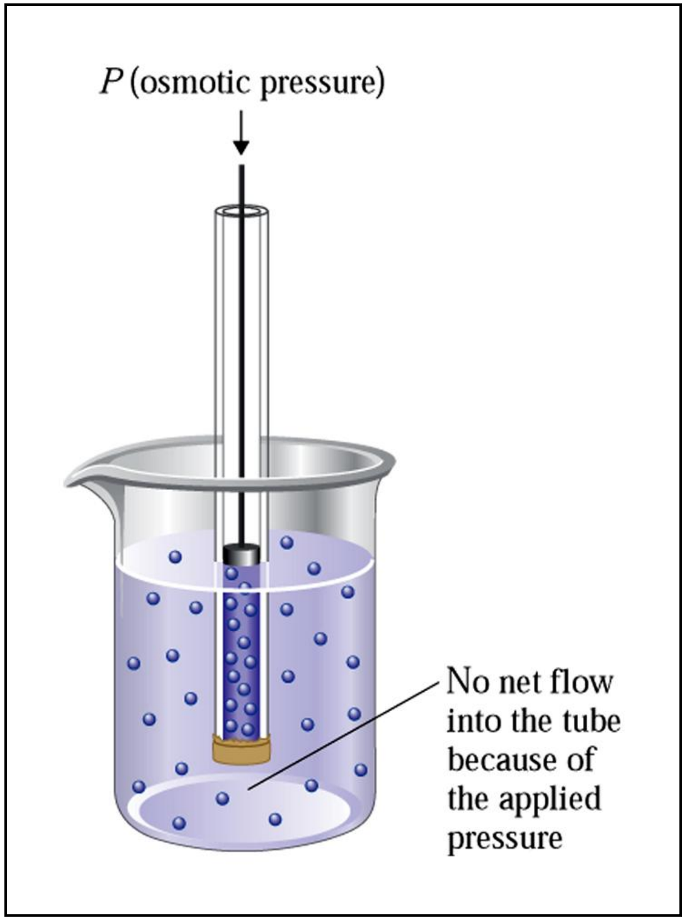


Fig. 8.14 **Enlarged views of a semi-permeable membrane separating (a) pure water and a salt-water solution, and (b) a dilute salt-water solution.**

Osmotic pressure

→ Fig. 8.15
Osmotic pressure is the amount of pressure needed to prevent the solution in the tube from rising as a result of the process of osmosis.



Water can move up through capillary action

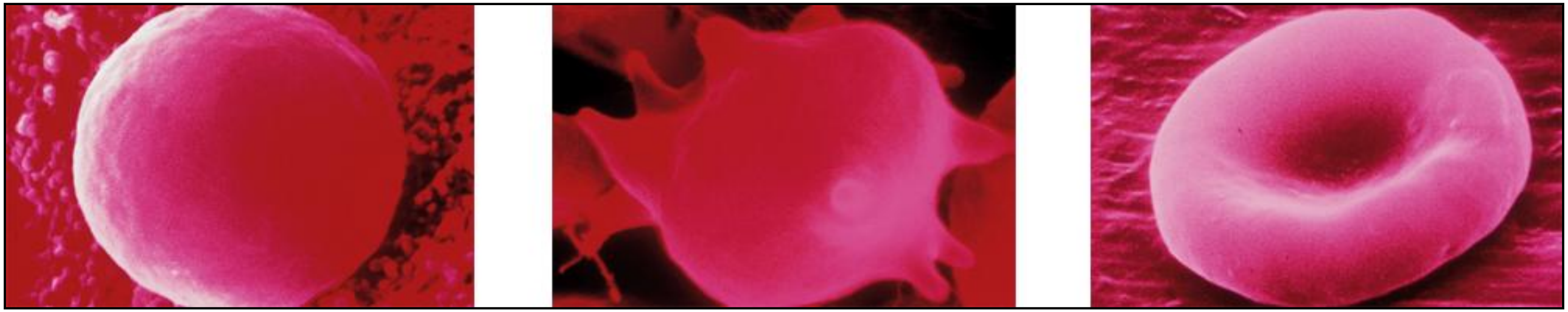
John Mead/Photo Researchers

← Fig. 8.16

The dissolved substances in tree sap create a more concentrated solution than the surrounding ground water.

Would the blood cell survive?

Figs. 8.17 a-c



(a) **Hyptonic solution**

(b) **Crenation in concentrated sodium chloride solution.**

(c) **Cells neither swell nor shrink in physiological saline solution.**

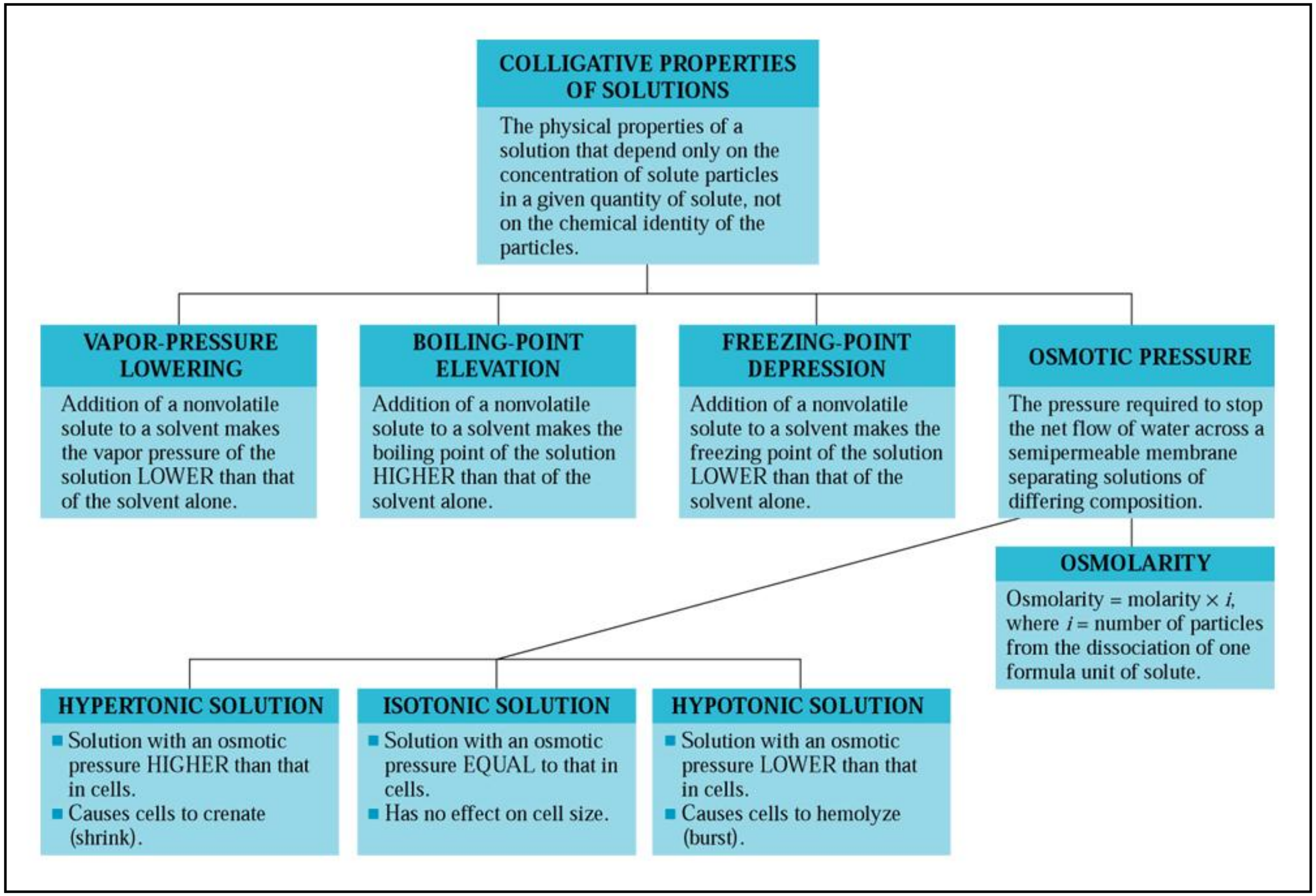
Three types of solutions

	Type of Solution		
	Isotonic	Hypertonic	Hypotonic
osmolarity relative to body fluids	equal	greater than	less than
osmotic pressure relative to body fluids	equal	greater than	less than
osmotic effect on cells	equal water flow into and out of cells	net flow of water out of cells	net flow of water into cells

Table 8.3

Colligative properties of solutions

→ **CAG 8.2**



How does dialysis work?

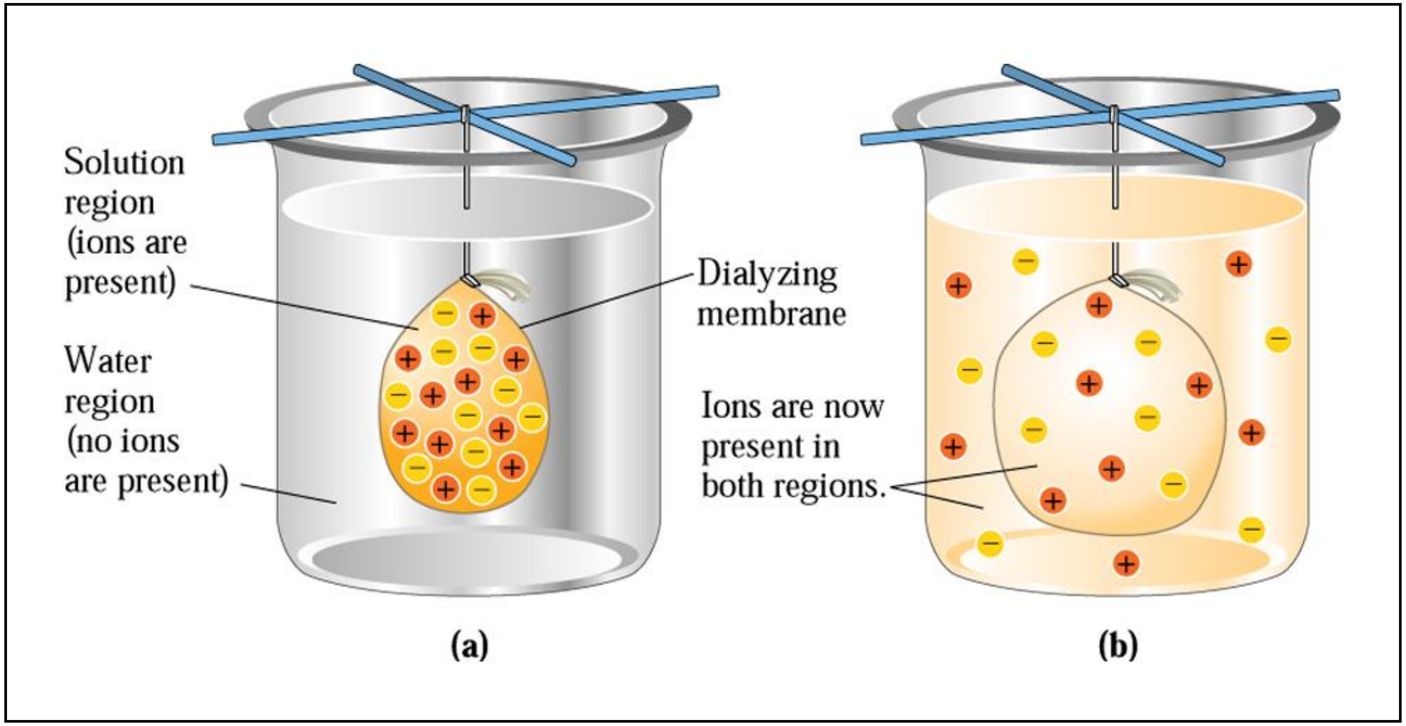
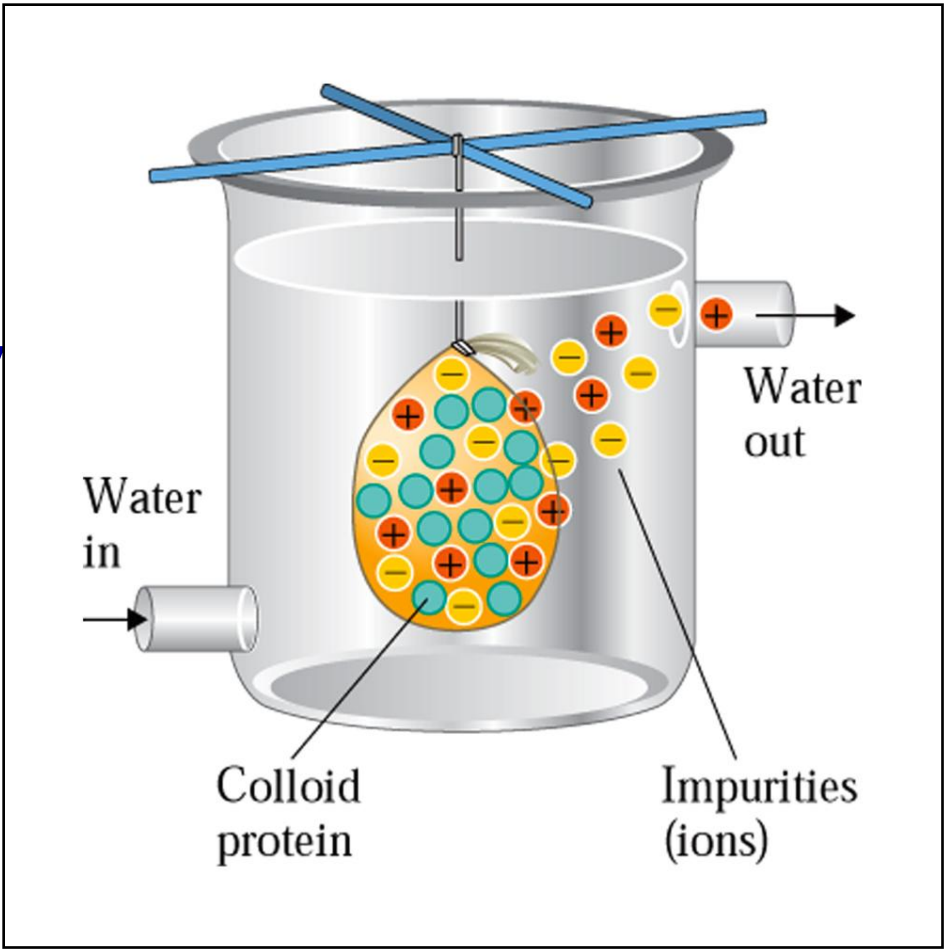


Fig. 8.18 **In dialysis, there is a net movement of ions from a region of higher concentration to a region of lower concentration.**

Removing impurities through dialysis

→ Fig. 8.19
Impurities can be removed from a colloidal dispersion by using a dialysis procedure.



Dialysis machine a life saver

→ CC 8.4