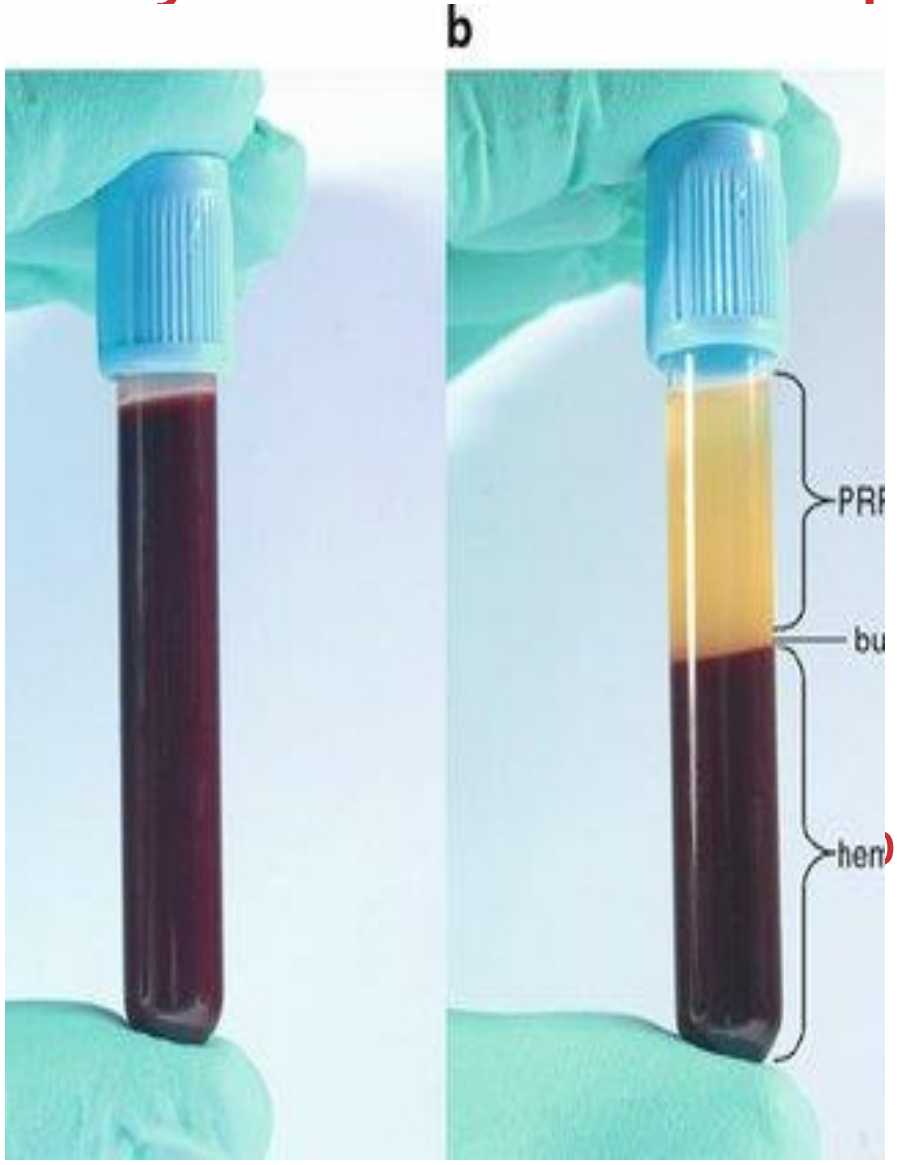
SOLUTIONS
why solutions are important in medicine



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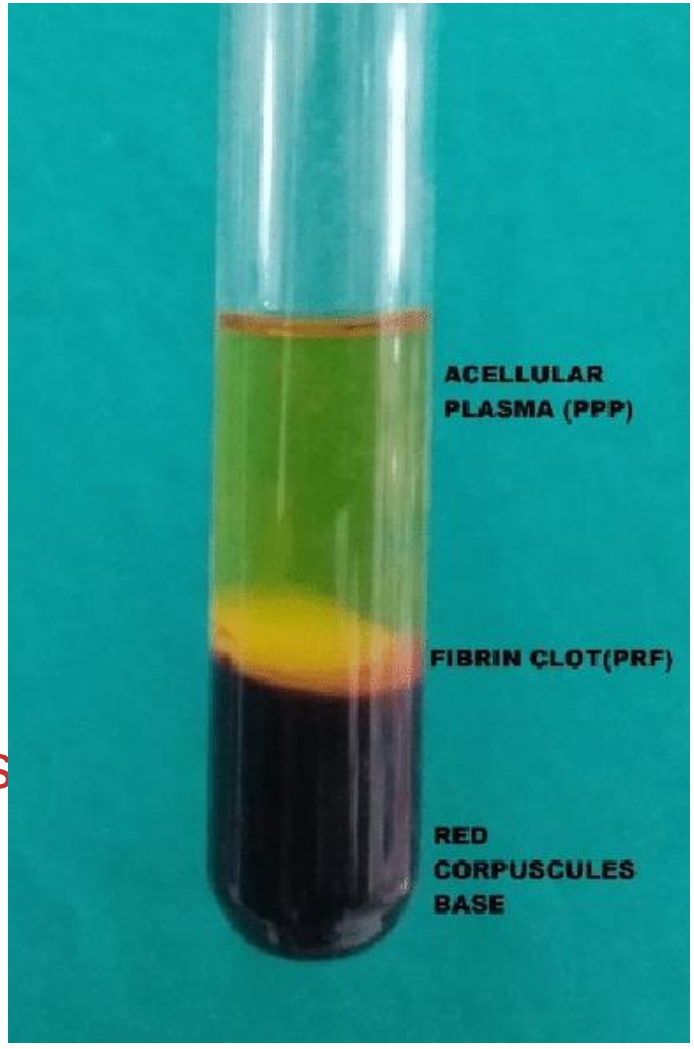
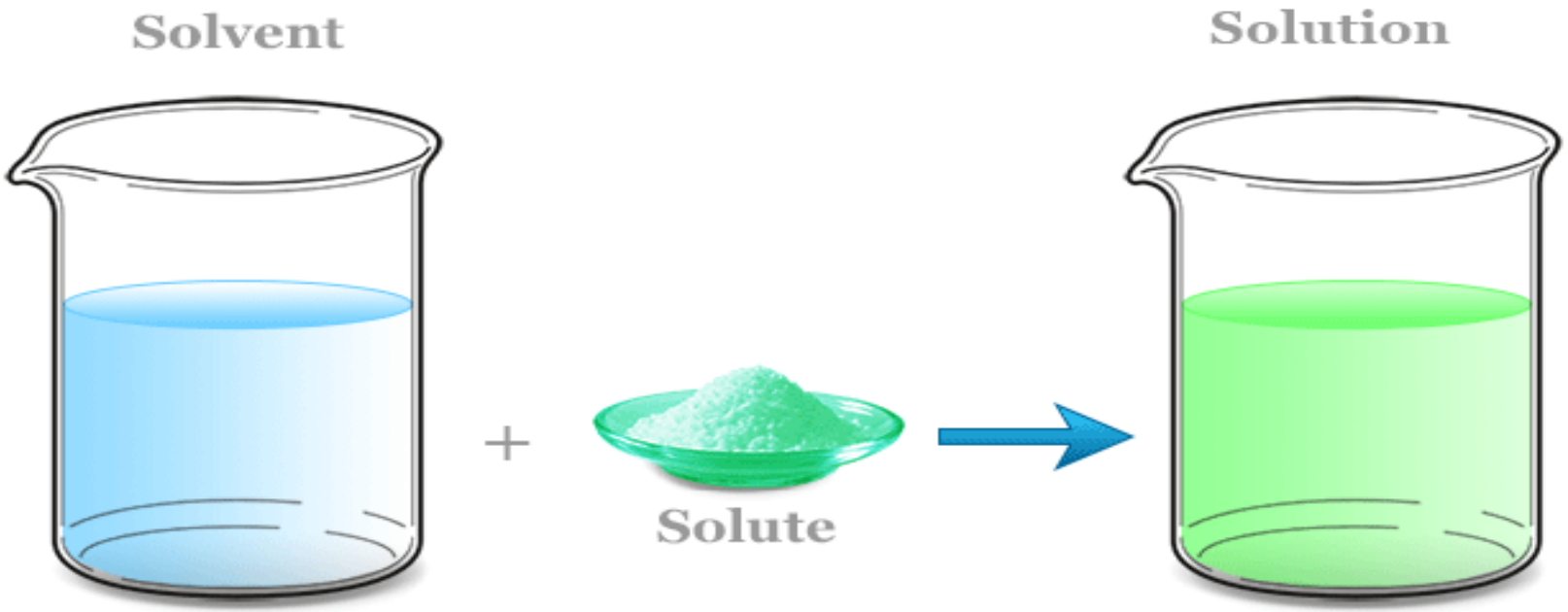
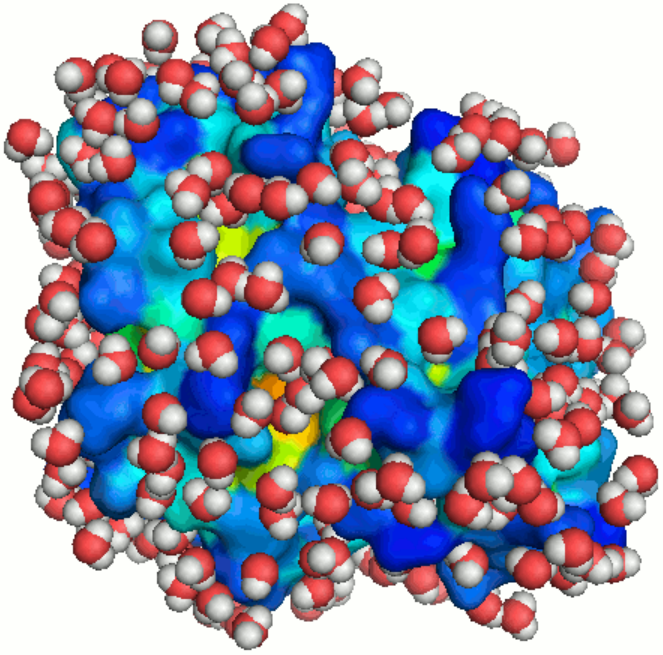
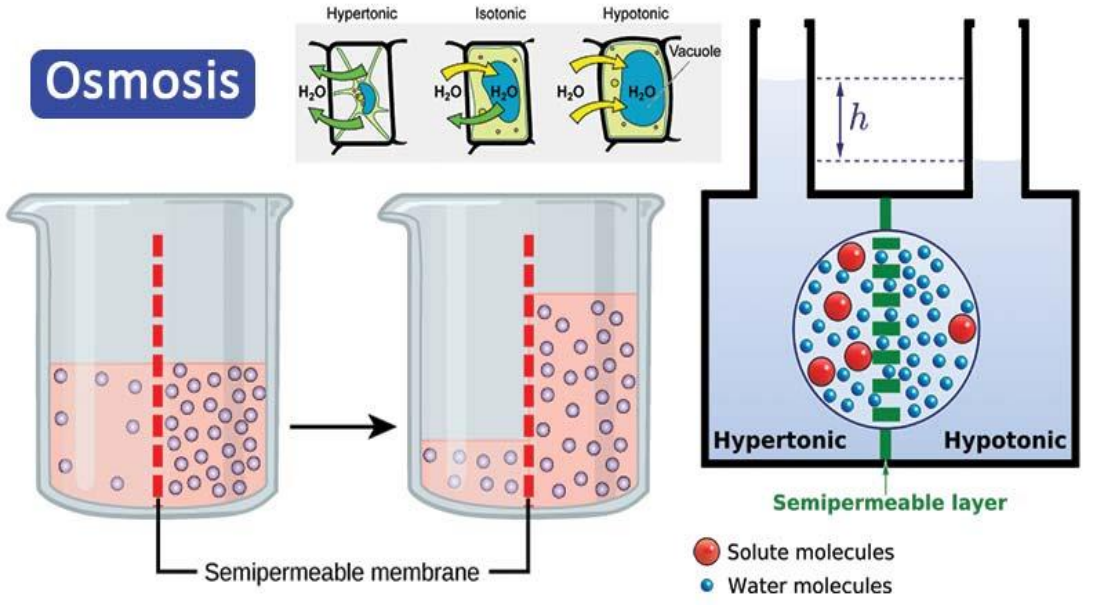


Solution Definition

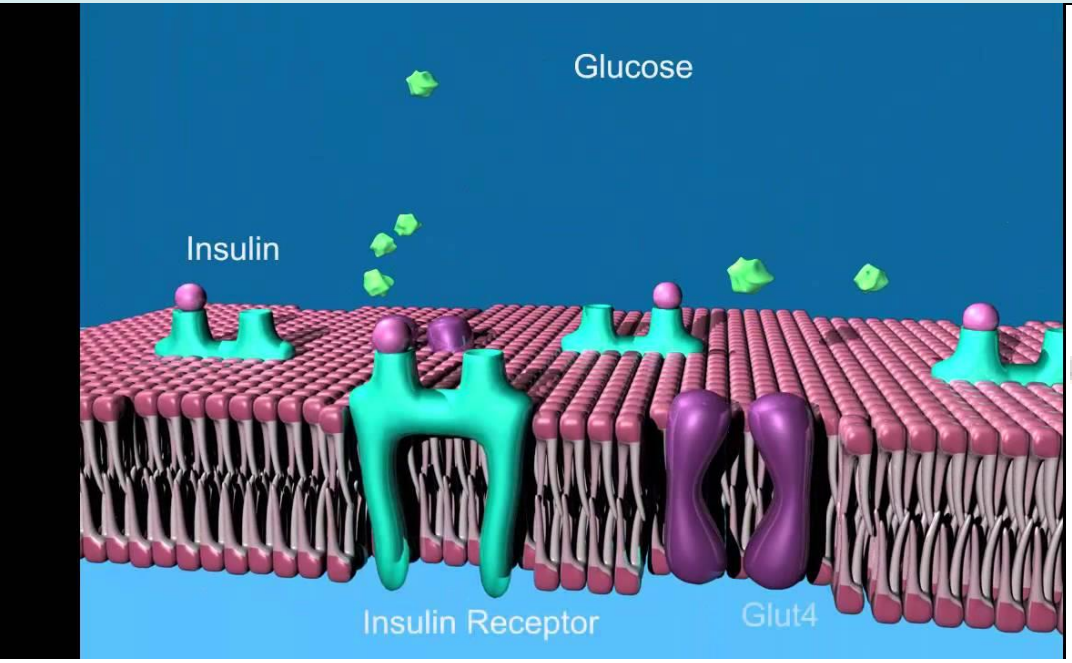
A Solution in science
is a homogenous mixture of two or more substances.

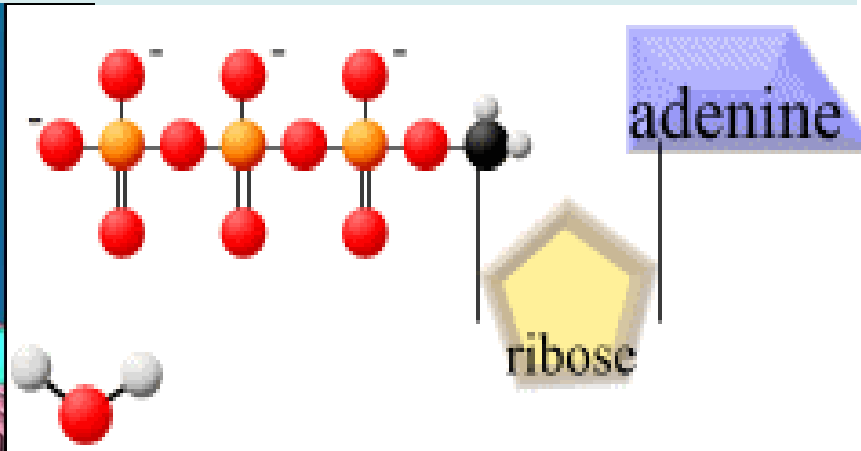


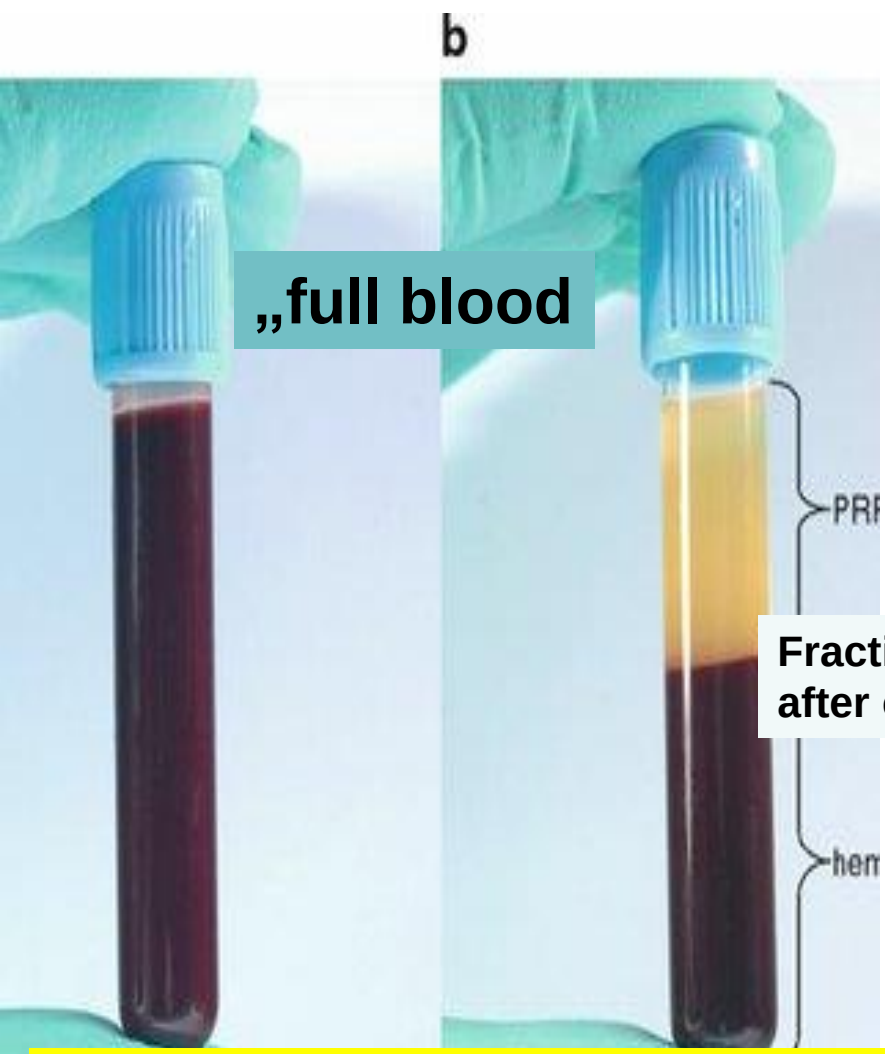




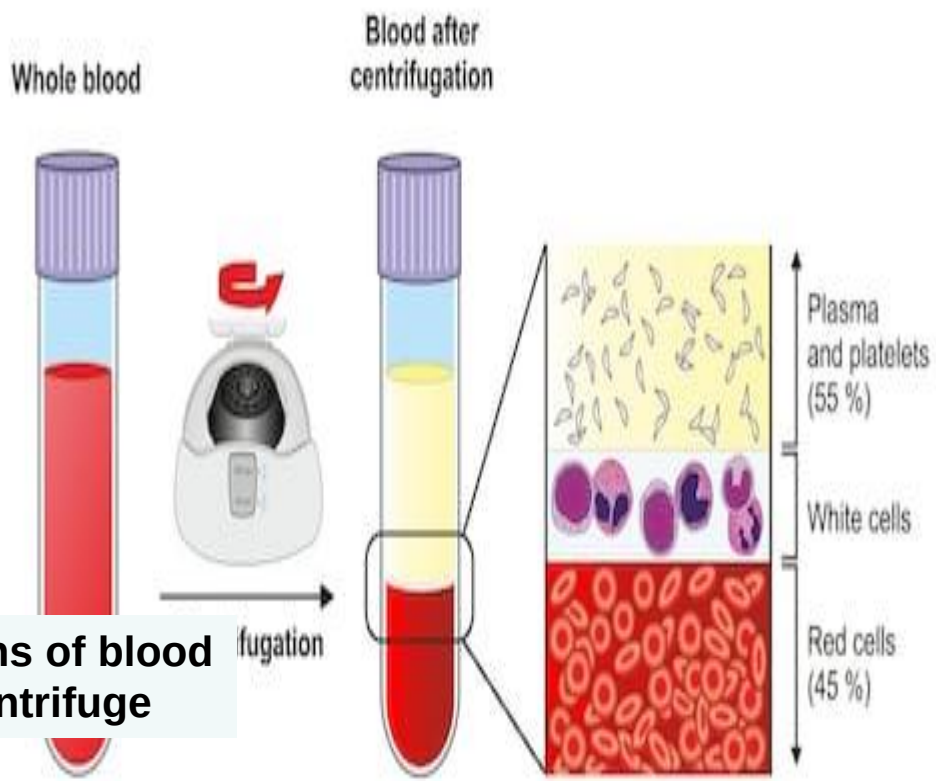
All processes in living organisms take place from solutions!!!



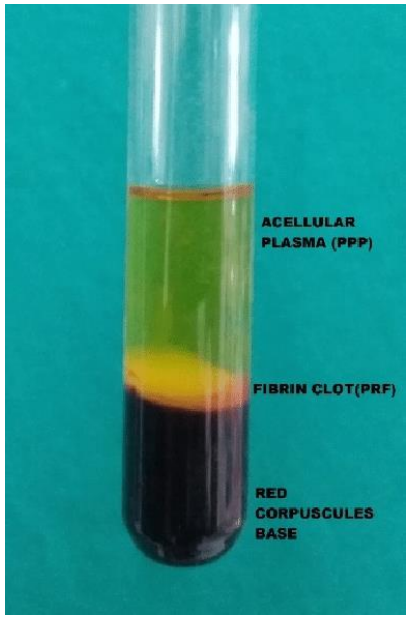




„full blood



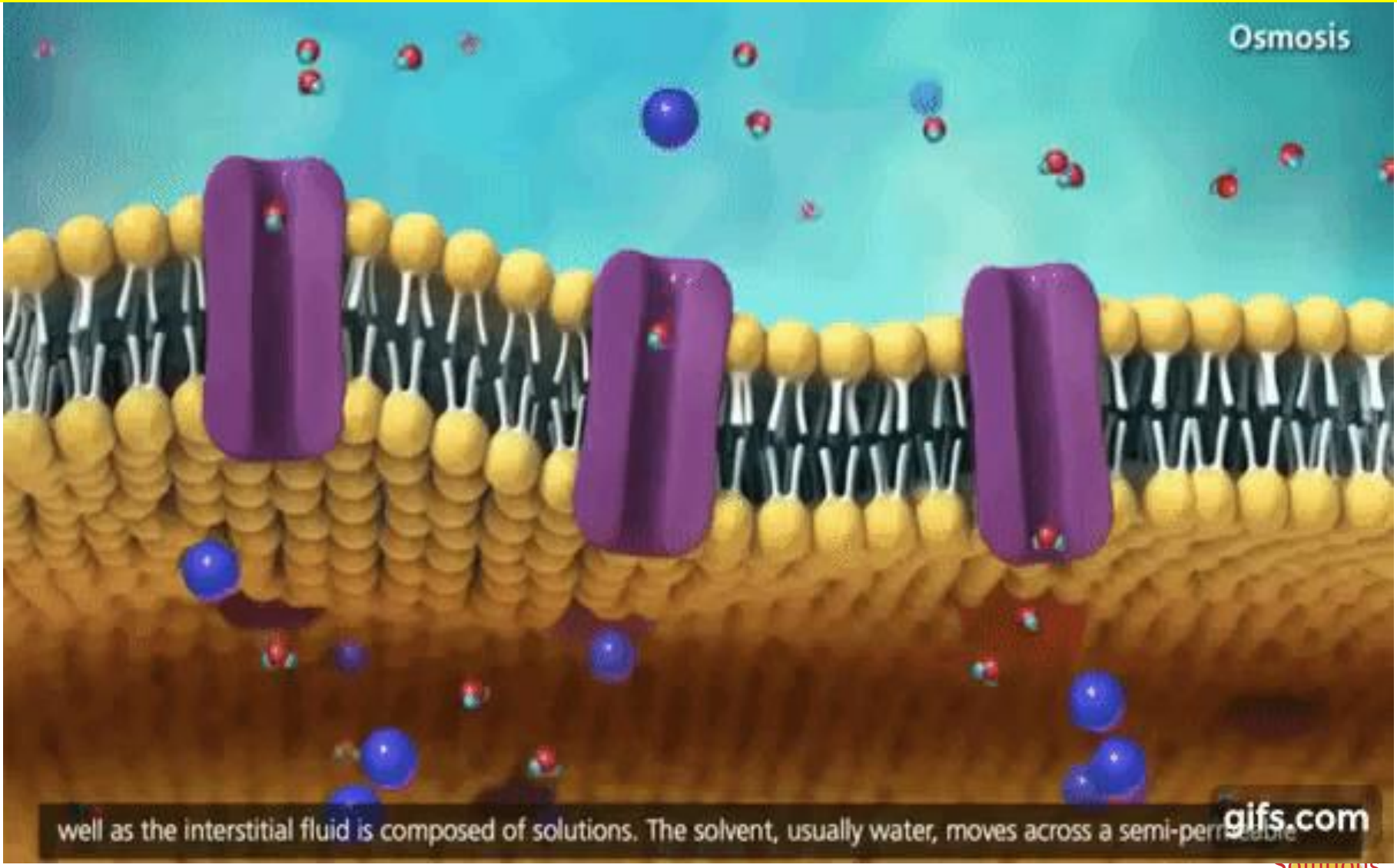
Fractions of blood after centrifuge



Blood is an ideal solution in which Different important systems (glucose, Cholesterol, enzyme, ions Na+, Ca2+, RBC, hemoglobin…) are dissolved

Solutions

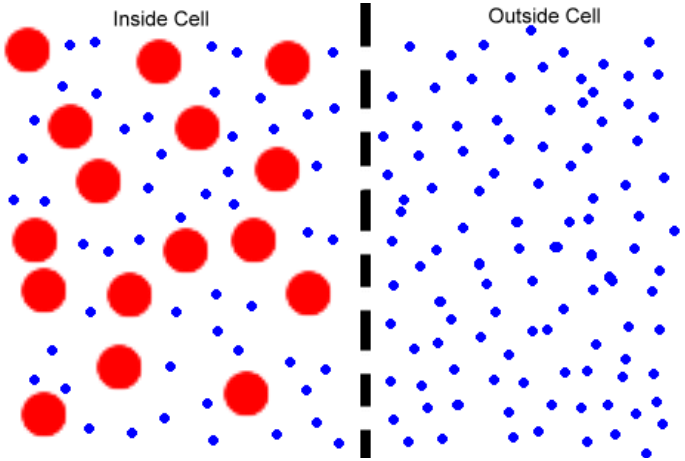
Cell Membrane is a Barrier that allows only specific substances to get in the cytosol or to get out of the cytosol of the cell

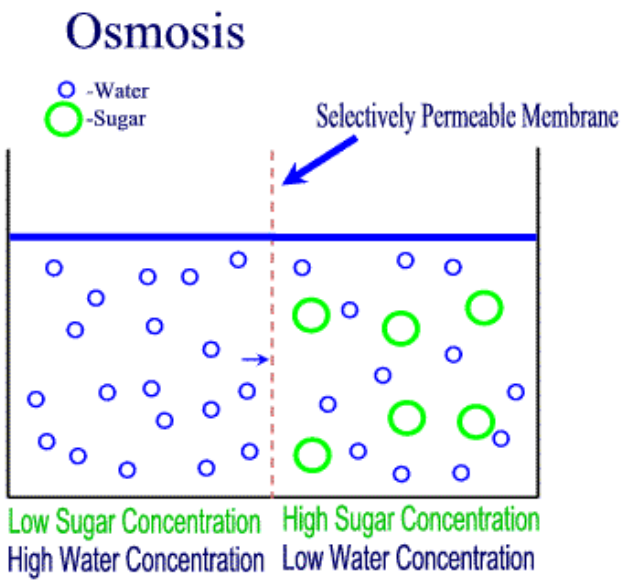


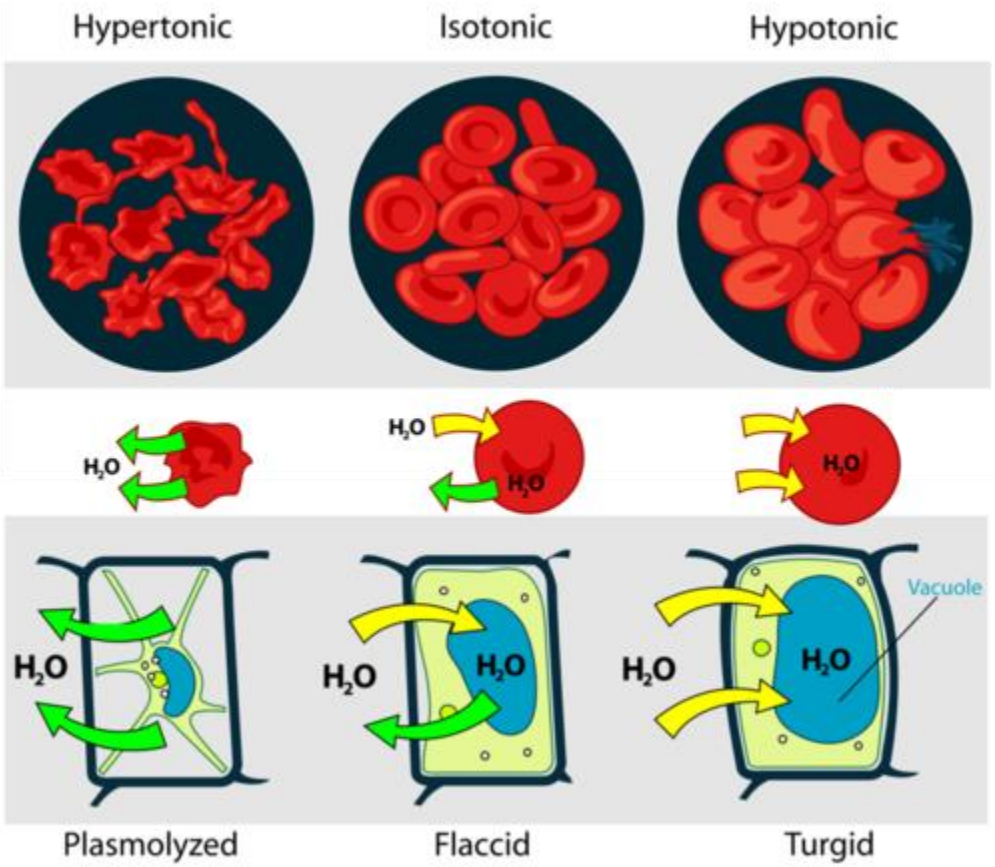
Solutions

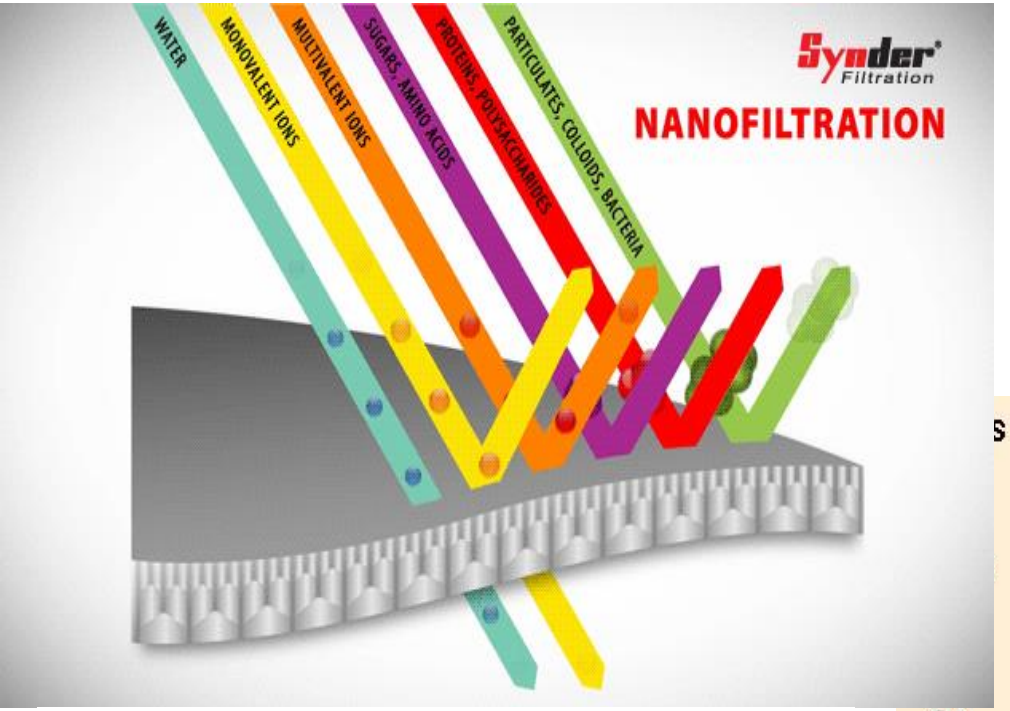
Solutions-importance in biological systems

-in osmosis processes-movement of water across membrane
-in buffers-systems keeping constant pH in blood, in cells
-solutions are medium in which all biochemical processes take place

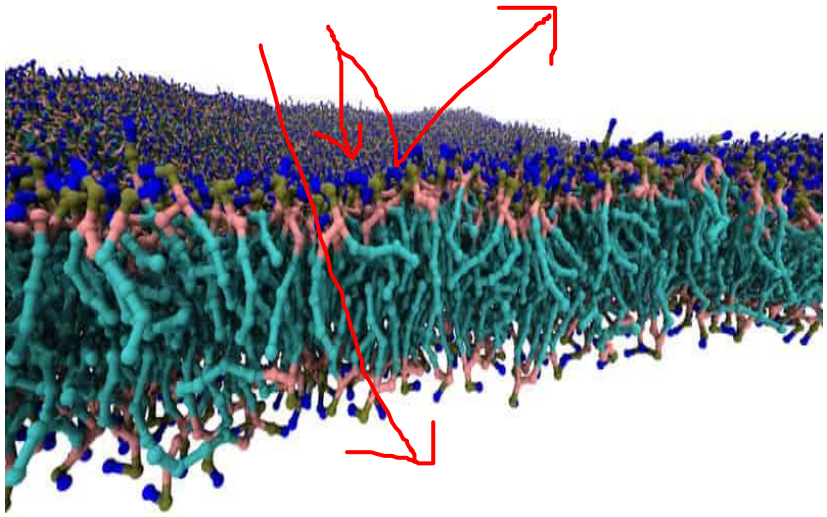


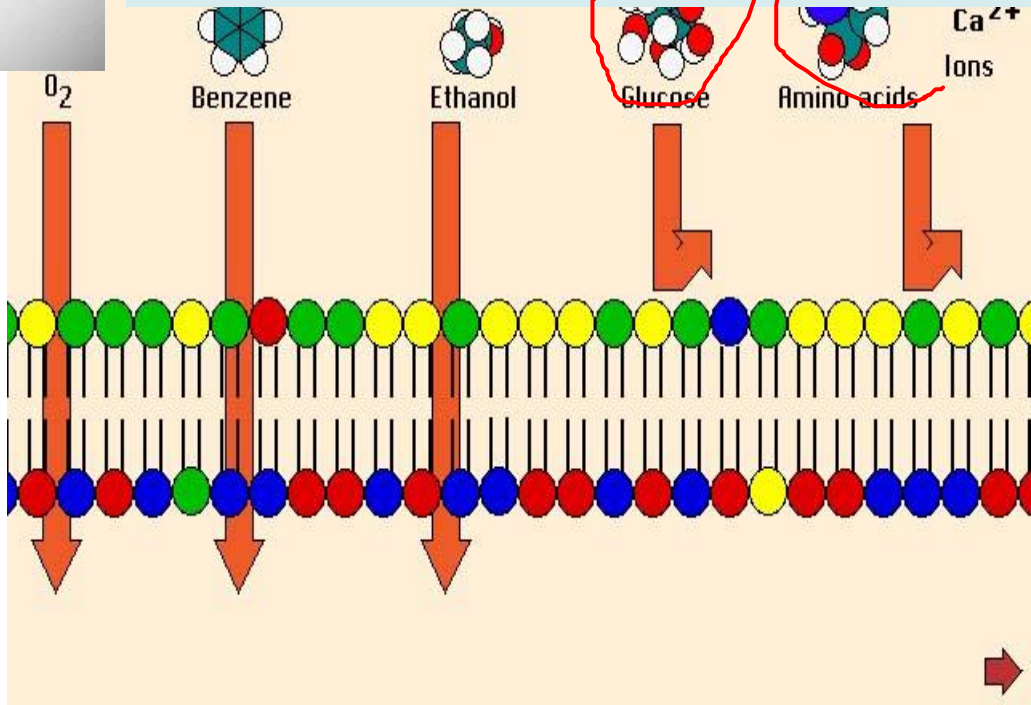




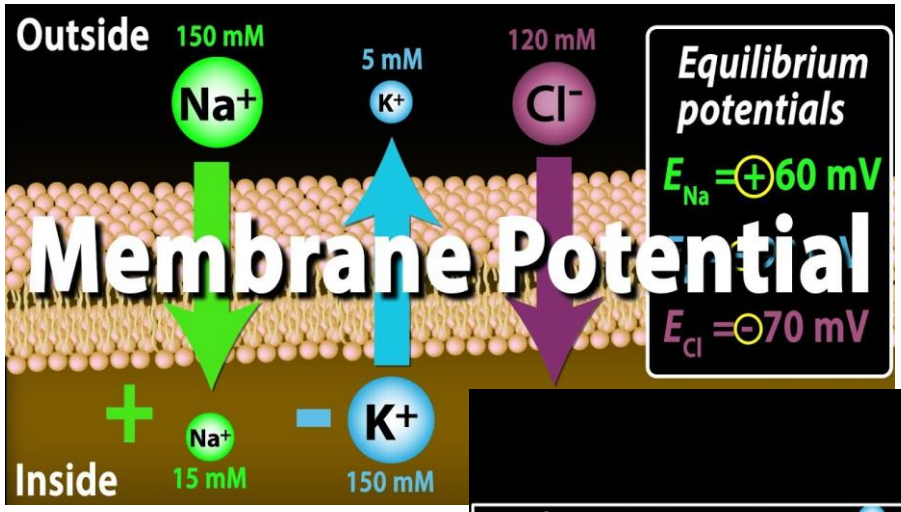


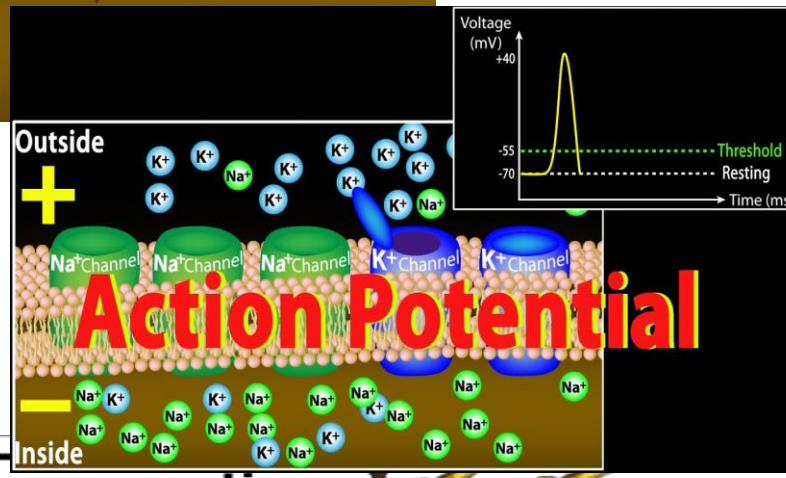
Transfer of substances across cell membranes... Membrane is a barrier of the Cells that permits only defined substances to get in Cell and to get out of cell

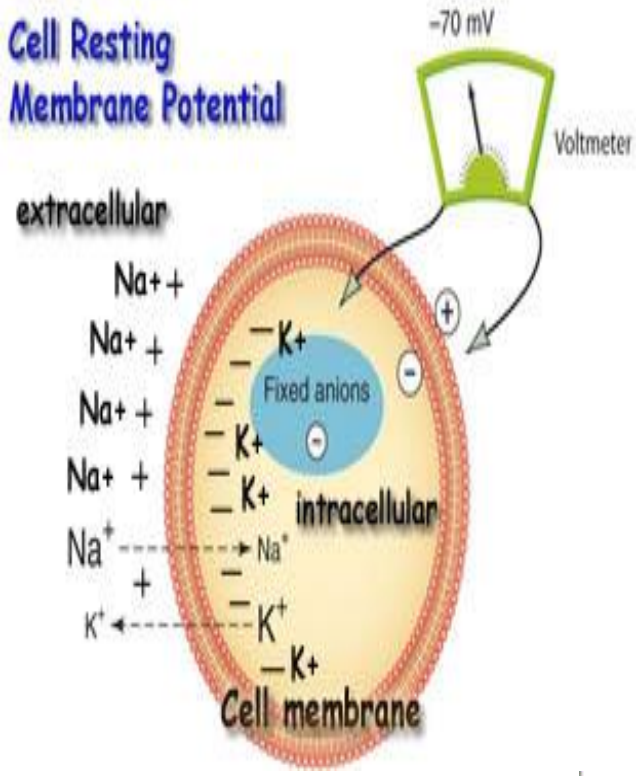


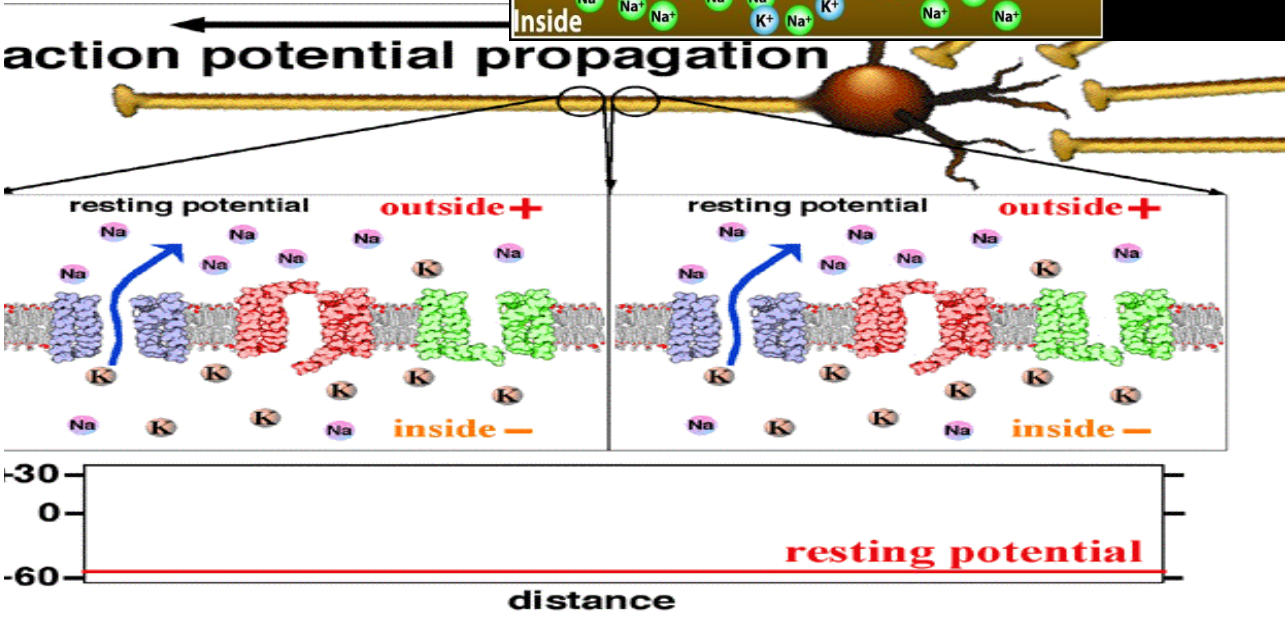


Ions of Na+ are responsible for Increased blood Pressure…
Ions of K+
Regulate the intake of Na+ and Cl-
Ions inside the cell







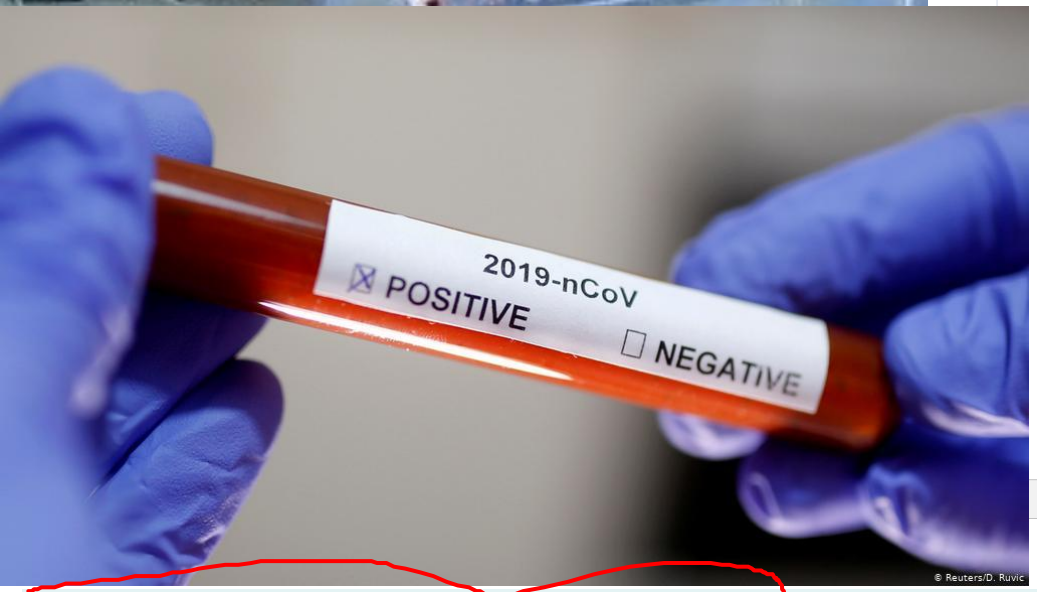


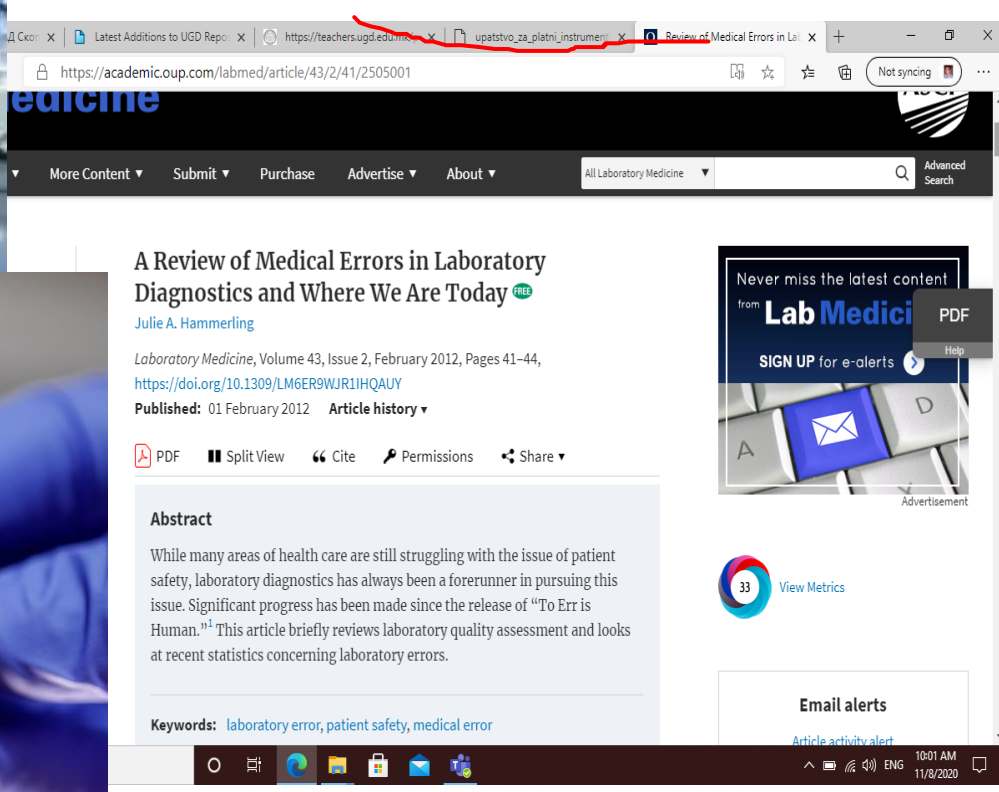
Solutions used in medicine on daily base

Saline, glucose, Iodine…

WE MUST HAVE EXACT concentration of solute in each Solutions we apply in medicine!!!

5% of all mistakes in Medicine Are due to wrong solutions

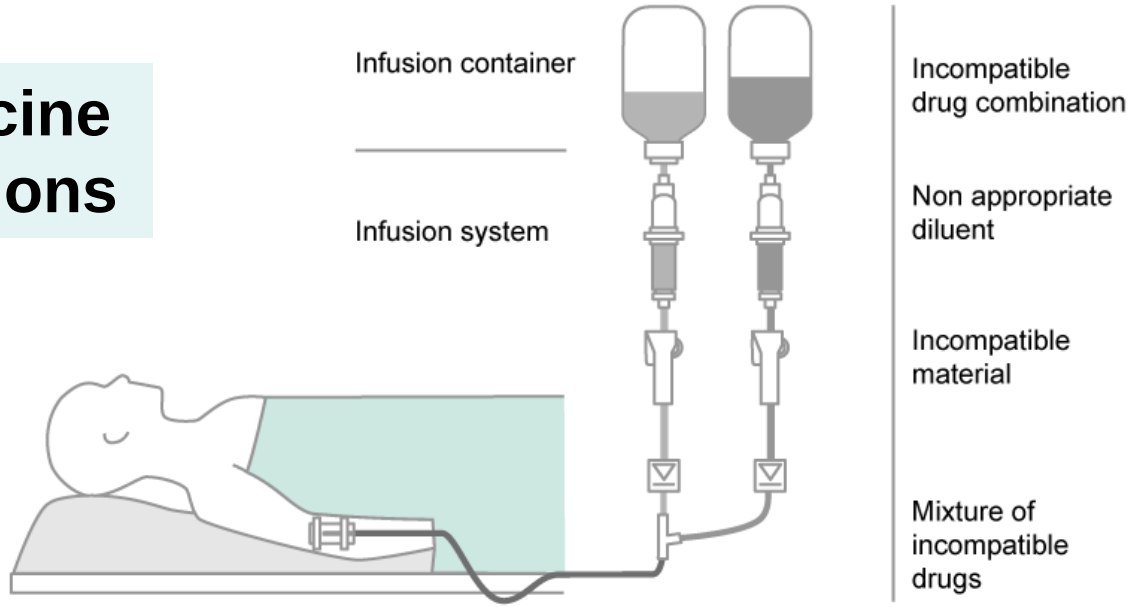


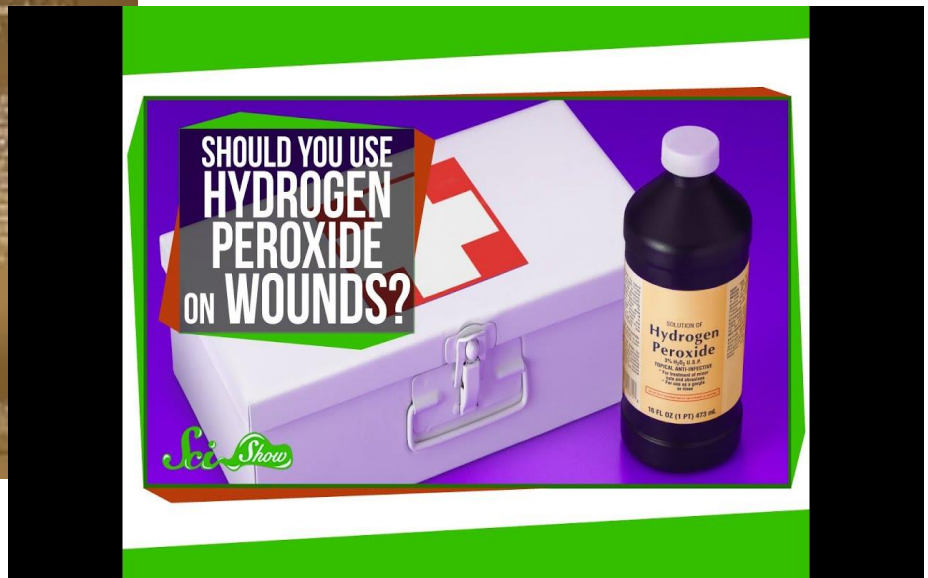


10% of COVID-19 tests globally are wrong!!!

Solutions

Many Mistakes in medicine Are due to wrong solutions





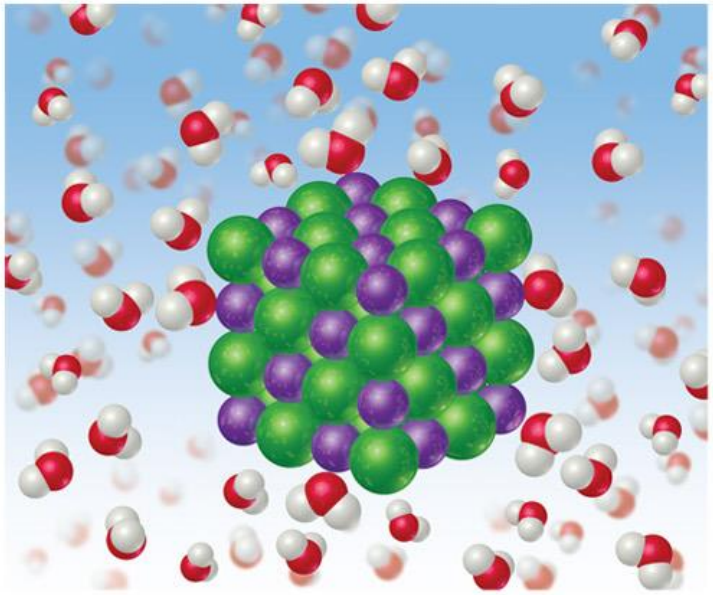
Definitions of Solutions

- Solutions are homogeneous mixtures of two or more pure substances.
- In a solution, the solute (commonly is a substance present in smaller amount) is dispersed **uniformly** throughout the solvent (water)

State of Solution	State of Solvent	State of Solute	Example
Gas	Gas	Gas	Air
Liquid	Liquid	Gas	Oxygen in water
Liquid	Liquid	Liquid	Alcohol in water
Liquid	Liquid	Solid	Salt in water
Solid	Solid	Gas	Hydrogen in palladium
Solid	Solid	Liquid	Mercury in silver
Solid	Solid	Solid	Silver in gold

Solutions

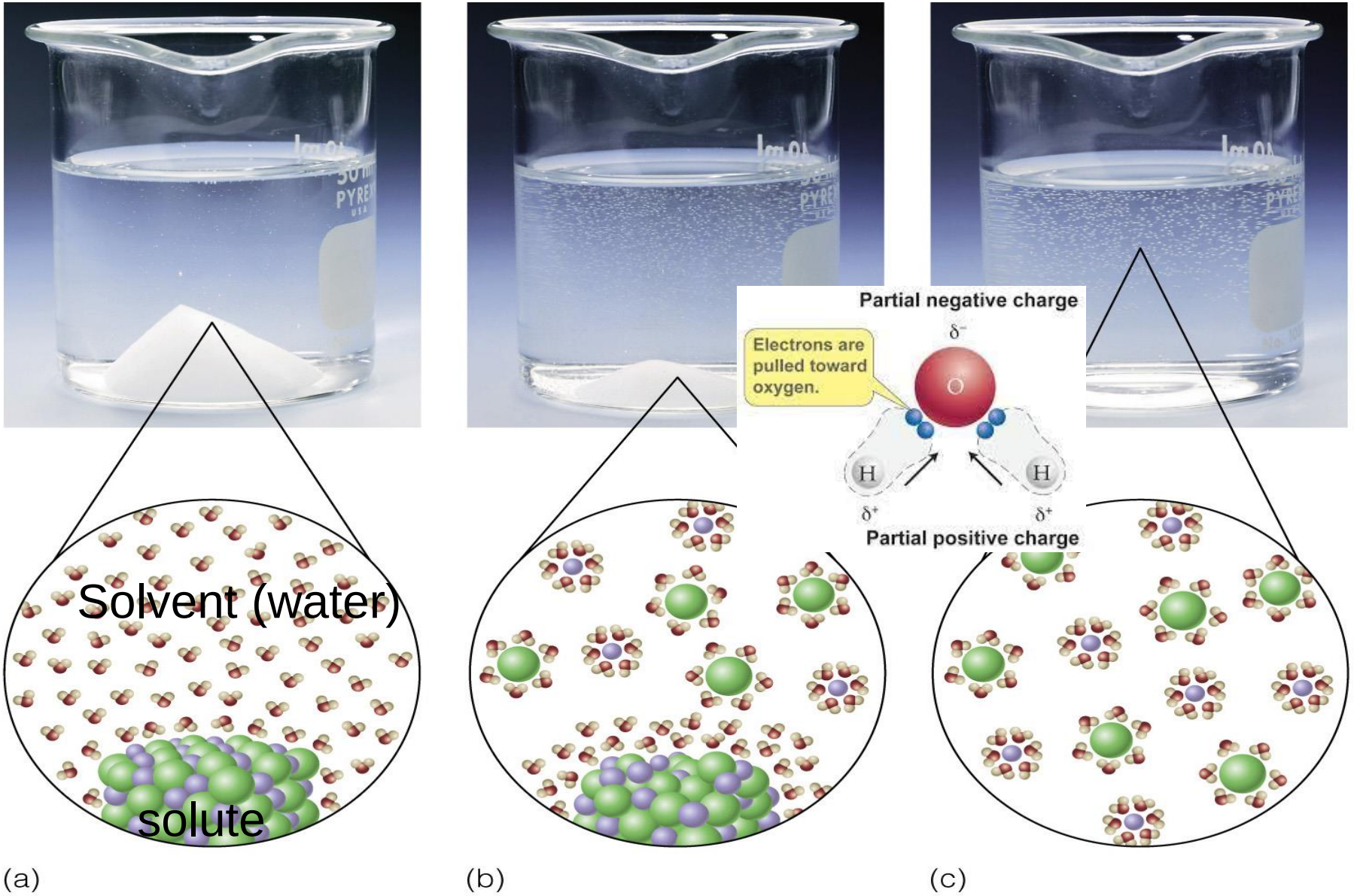
The intermolecular forces between solute particles and solvent particles must be strong enough in order given solute to be dissolved in given solvent (water is the most important solvent)



SOLVENT we are mainly interested in---is the WATER

How Does a Solution Form?

Remember: water is a polar molecule (+ -)

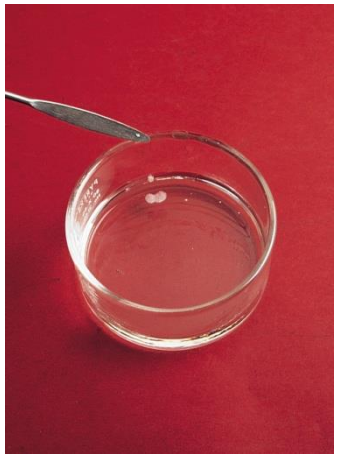


A ***saturated solution*** contains the maximum amount of a solute that will dissolve in a given solvent at a specific temperature.

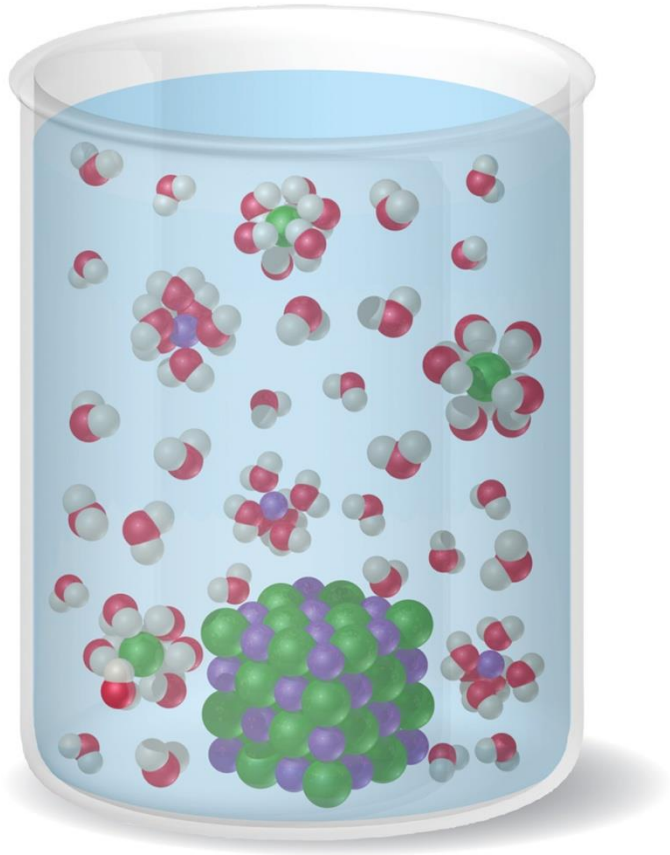
An ***unsaturated solution*** contains less solute than the solvent has the capacity to dissolve at a specific temperature.

A ***supersaturated solution*** contains more solute than is present in a saturated solution at a specific temperature.

Sodium acetate crystals rapidly form when a seed crystal is added to a supersaturated solution of sodium acetate.



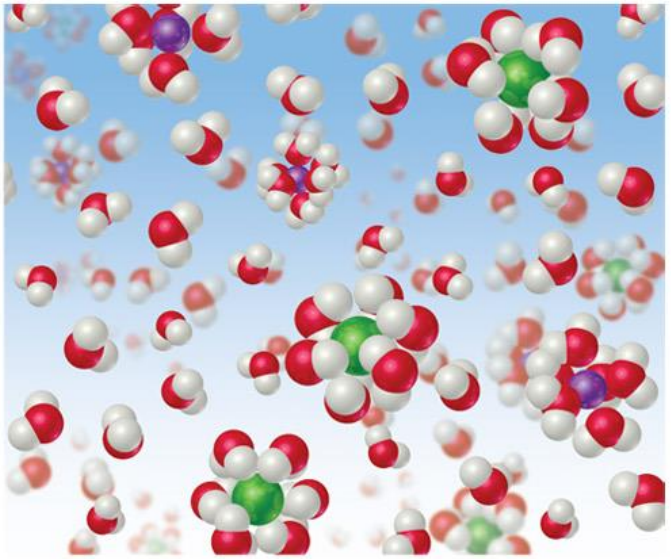
Types of Solutions



- Saturated
  - Solvent holds as much solute as is possible at that temperature.
  - Dissolved solute is in dynamic equilibrium with solid solute particles.

Types of Solutions

- Unsaturated
  - Less than the maximum amount of solute for that temperature is dissolved in the solvent.



Types of Solutions



- **Supersaturated** ? Are these solutions? hmmmm
  - Solvent holds more solute than is normally possible at that temperature.
  - These solutions are unstable; crystallization can usually be stimulated by adding a “seed crystal” or scratching the side of the flask.

Factors Affecting Solubility

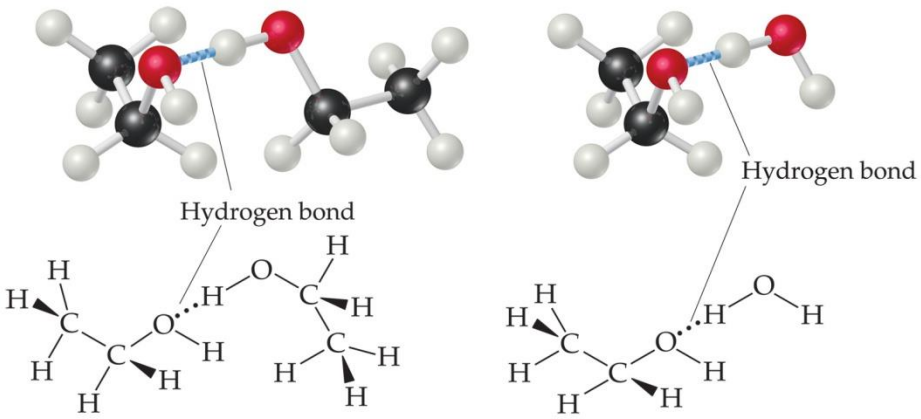
- Chemists use the axiom "like dissolves like":
  - Polar substances tend to dissolve in polar solvents.
  - Nonpolar substances tend to dissolve in nonpolar solvents.

TABLE 13.3 Solubilities of Some Alcohols in Water and in Hexane*

Alcohol	Solubility in H_2O	Solubility in C_6H_{14}
CH_3OH (methanol)	∞	0.12
CH_3CH_2OH (ethanol)	∞	∞
$CH_3CH_2CH_2OH$ (propanol)	∞	∞
$CH_3CH_2CH_2CH_2OH$ (butanol)	0.11	∞
$CH_3CH_2CH_2CH_2CH_2OH$ (pentanol)	0.030	∞
$CH_3CH_2CH_2CH_2CH_2CH_2OH$ (hexanol)	0.0058	∞
$CH_3CH_2CH_2CH_2CH_2CH_2CH_2OH$ (heptanol)	0.0008	∞

*Expressed in mol alcohol/100 g solvent at 20°C. The infinity symbol indicates that the alcohol is completely miscible with the solvent.

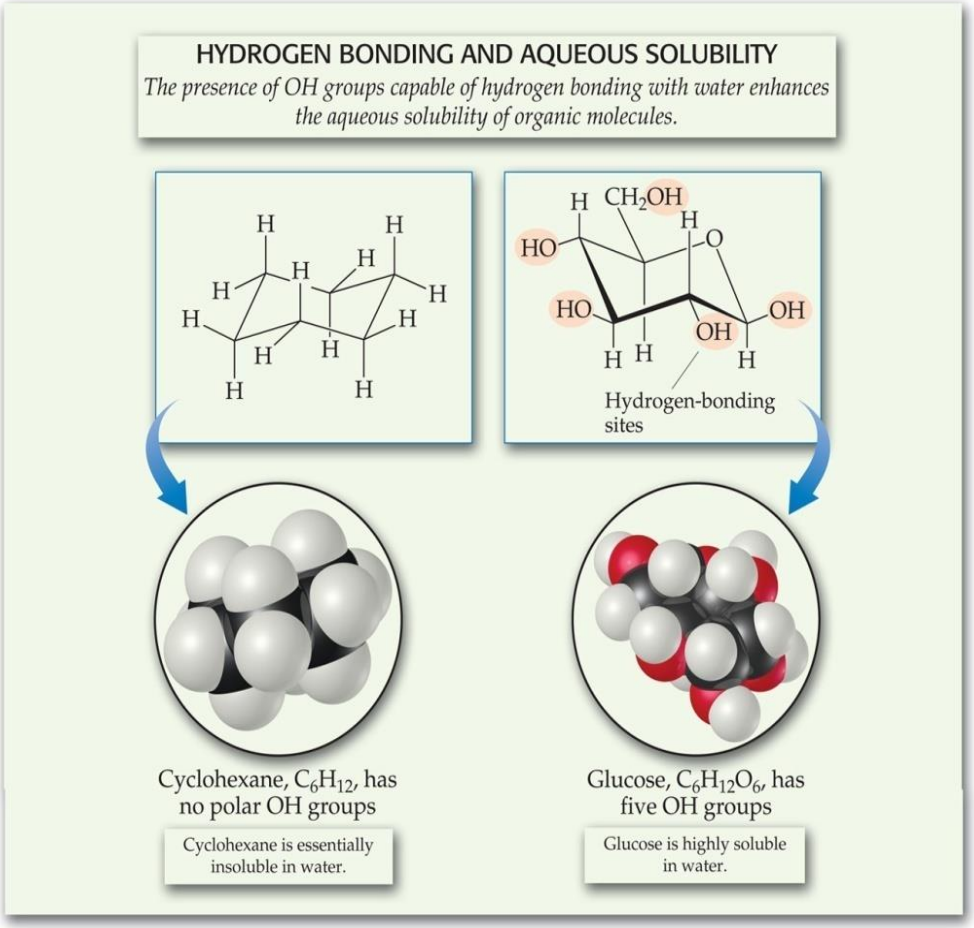
Factors Affecting Solubility



The more similar the intermolecular attractions, the more likely one substance is to be soluble in another.

Factors Affecting Solubility

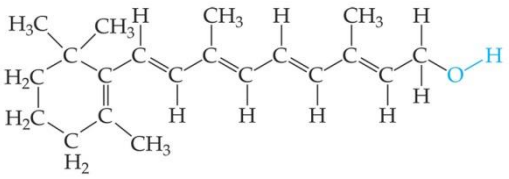
Glucose (which has groups that can make hydrogen bonding) is very soluble in water, while cyclohexane (which only has dispersion forces) is not.



Solutions

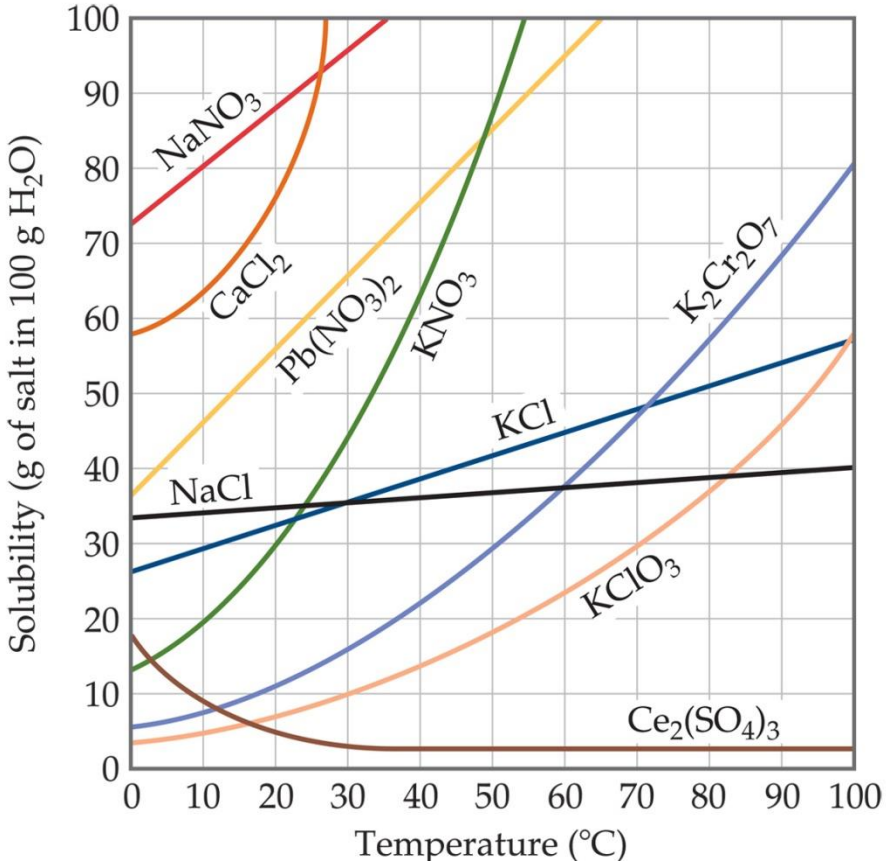
Factors Affecting Solubility

- Vitamin A is oil-like substance and is soluble in nonpolar compounds (like fats).
- Vitamin C is polar substance and it is soluble in water.



Vitamin A

Temperature



Generally, the solubility of solid solutes in liquid solvents increases with increasing temperature.

Gases in Solution

- In general, the solubility of gases in water increases with increasing mass.
- Larger molecules have stronger dispersion forces.

TABLE 13.2 Solubilities of Gases in Water at 20°C, with 1 atm Gas Pressure

Gas	Solubility (*M*)
N_2	0.69×10^{-3}
CO	1.04×10^{-3}
O_2	1.38×10^{-3}
Ar	1.50×10^{-3}
Kr	2.79×10^{-3}

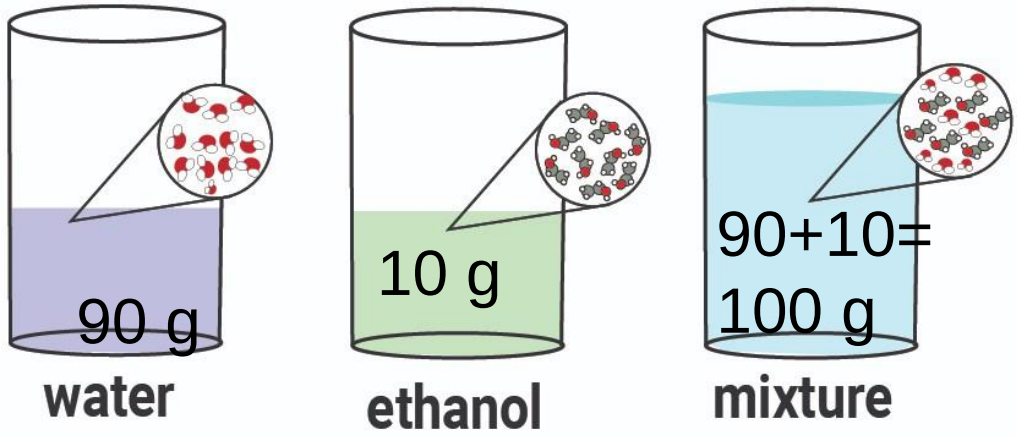
Ways of Expressing Concentration of SOLUTE (assigned with “B”) in Solutions

- mass percentage of “B” w(B)
- **mass concentration (*y(B)*)**
- **molar concentration (*c(B)*)**

- The concentration of a solute is the amount of solute present in a given quantity of solvent or solution

Mass Percentage (w) of solute "B"→ w(B)

$$\text{Mass \% of B or w(B)} = \frac{\text{mass of B in solution}}{\text{total mass of solution}} \times 100$$



w(ethanol) =

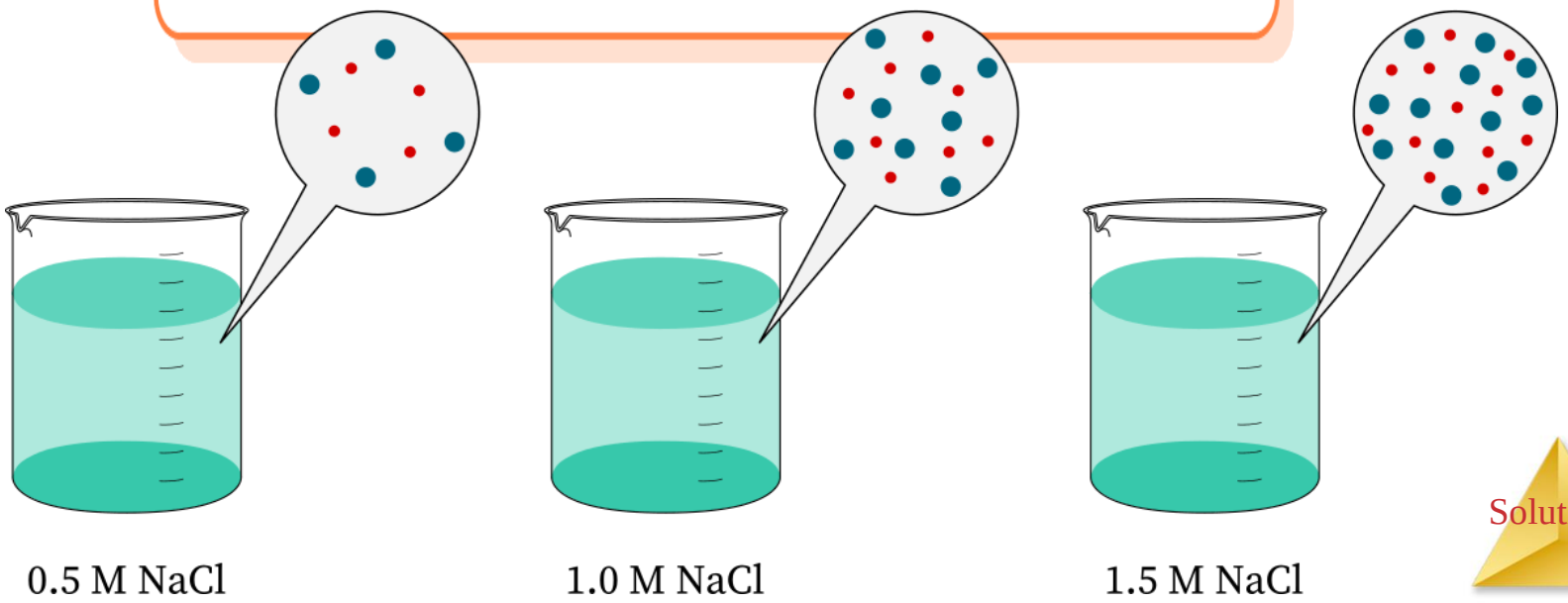
$$= \frac{\text{m(ethanol)}}{\text{m(solution)}} \times 100$$

Task: In 180 grams of water, we dissolve 5 grams of Vitamin C and 15 grams of glucose.
→Estimate what is the mass percentage of Vitamin C and the mass percentage of glucose in this solution?

Molar concentration (*c(B)*) (also known as "molarity")

$$c(B) = \frac{n\,(\text{moles of solute})}{V\,(\text{volume of solution})}$$

Units are mol/L
Sometimes we find mol/L = M

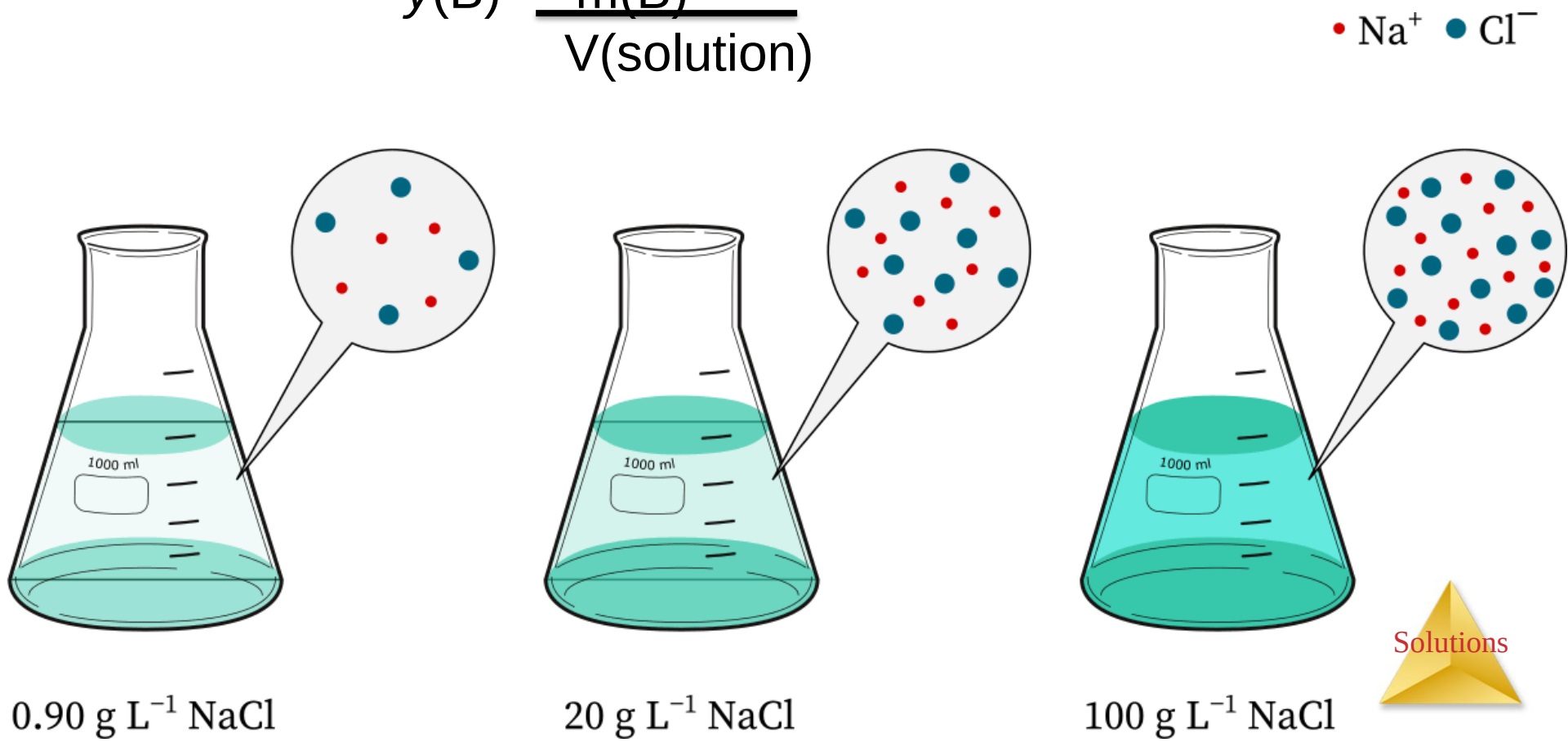


Mass concentration of B or *y*(B)

$$y(\mathrm{B}) = \frac{\text{mass of B in solution}}{\text{total volume of solution}}$$

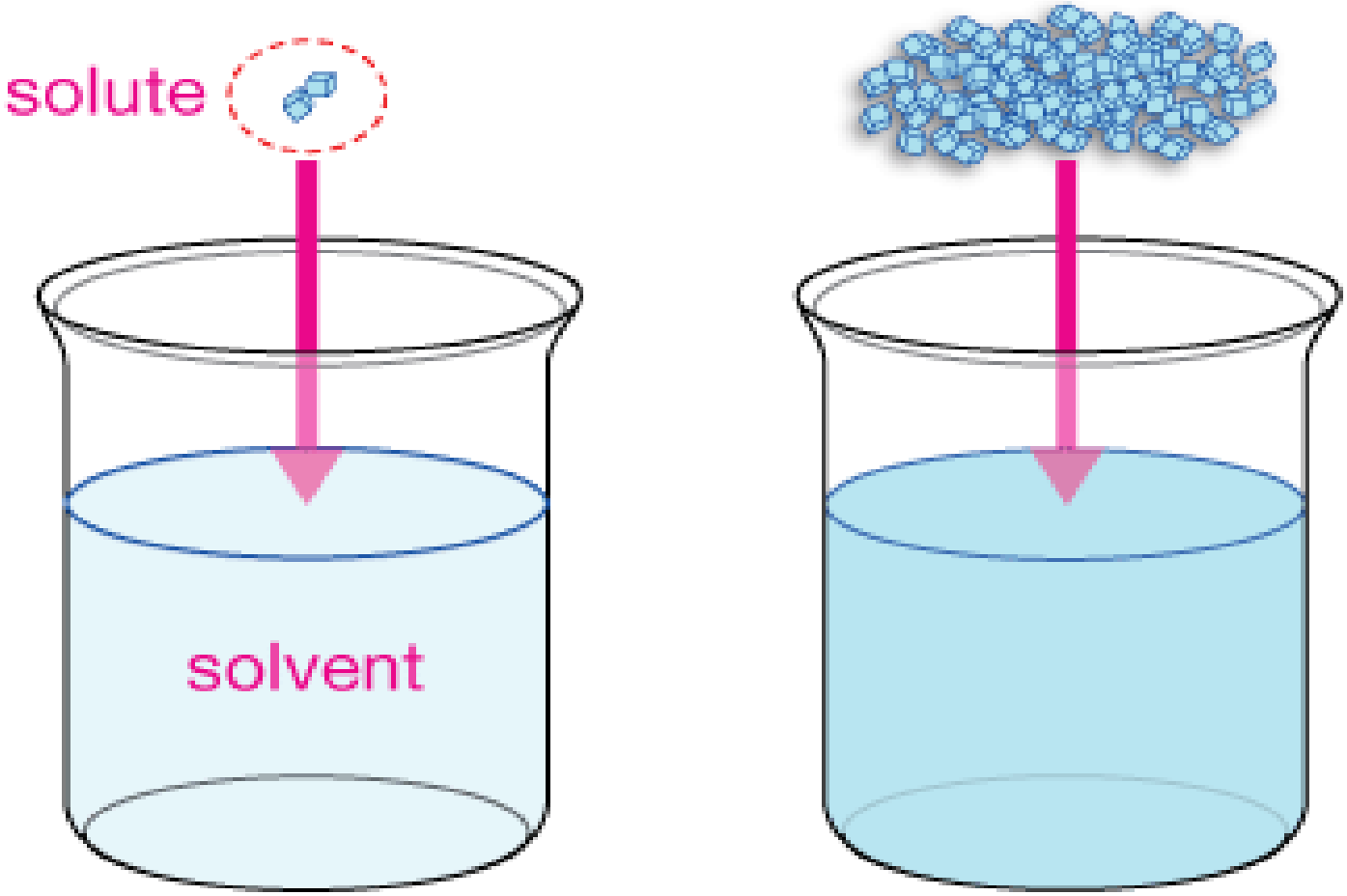
Units are g/L

$$y(\mathrm{B}) = \frac{m(\mathrm{B})}{V(\text{solution})}$$



a little bit of solute

a lot of solute

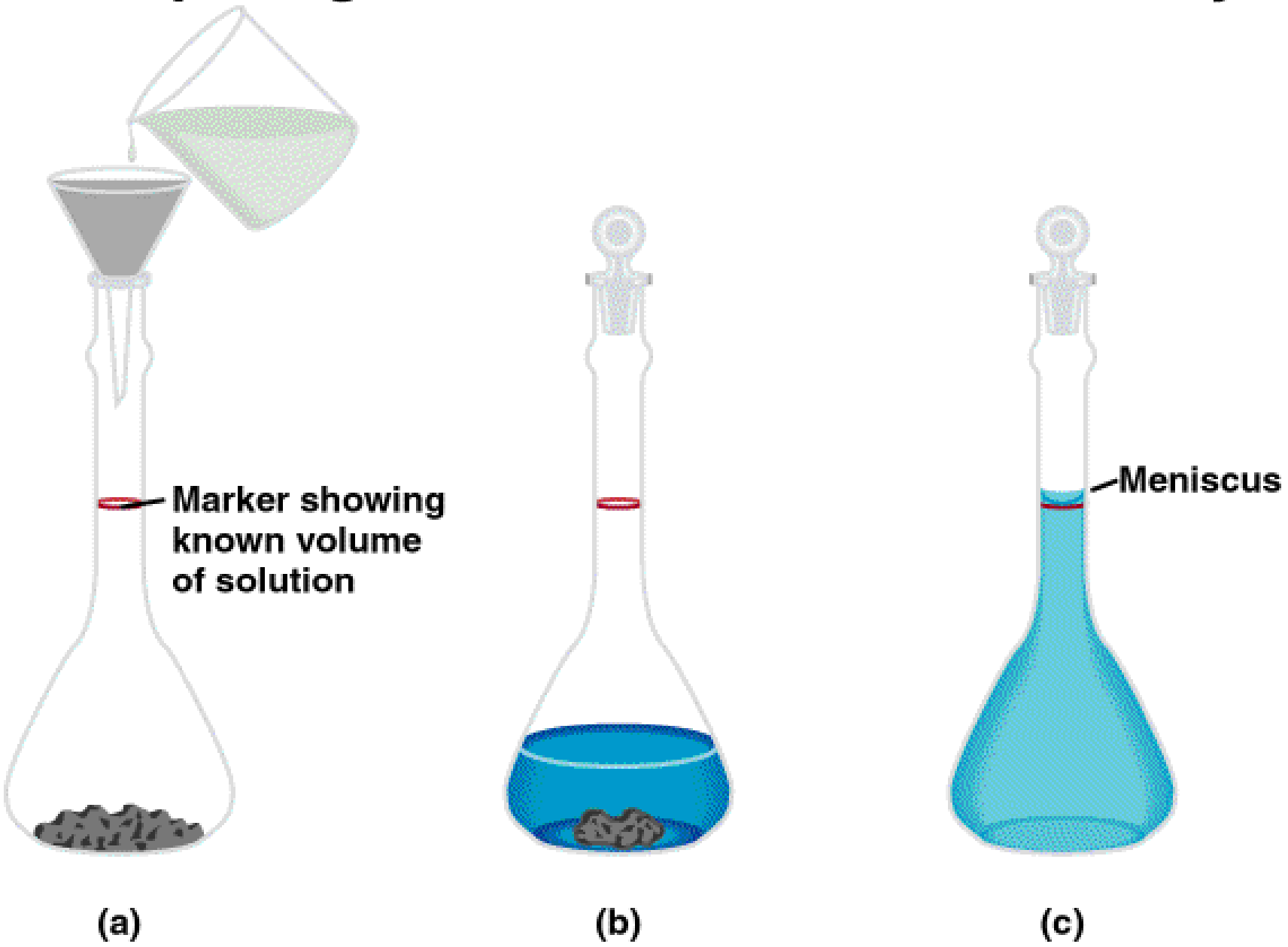


Diluted solution

Concentrated solution

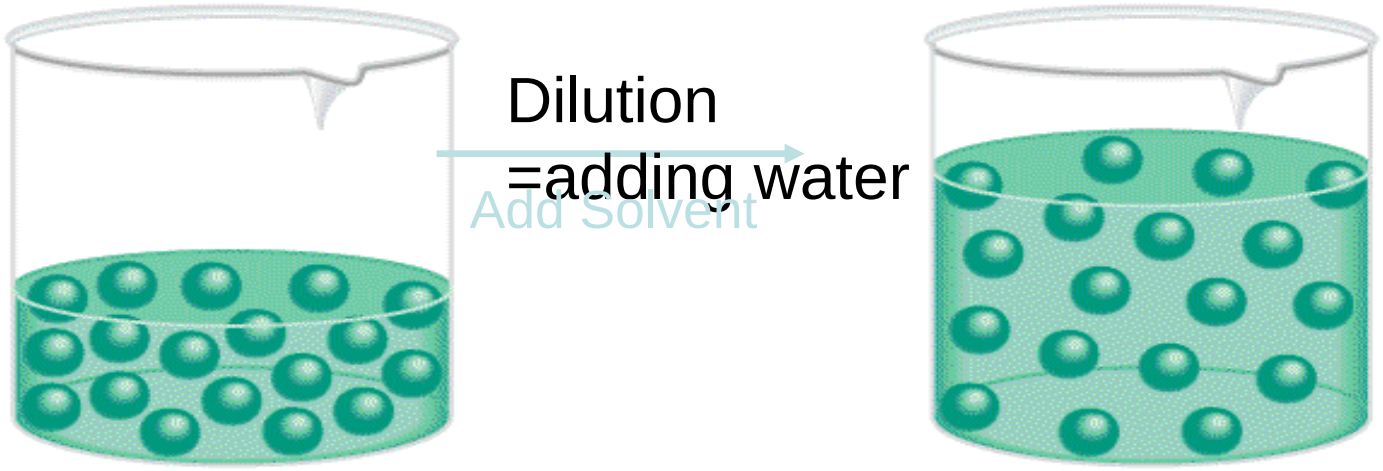
Solutions

Preparing a Solution of Known Molarity



Dilution is the procedure for preparing a less concentrated solution from a more concentrated solution.

In dilution process the condition is that the mass (or moles n_i) of solute "B" before dilution MUST BE EQUAL to the mass (or moles nf) of solute "B" AFTER the dilution or $\mathbf{n_i = n_f}$



Moles of solute $\mathbf{n_i}$ before dilution (**i**=initial) $=$ Moles of solute $\mathbf{n_f}$ after dilution (**f**=final)

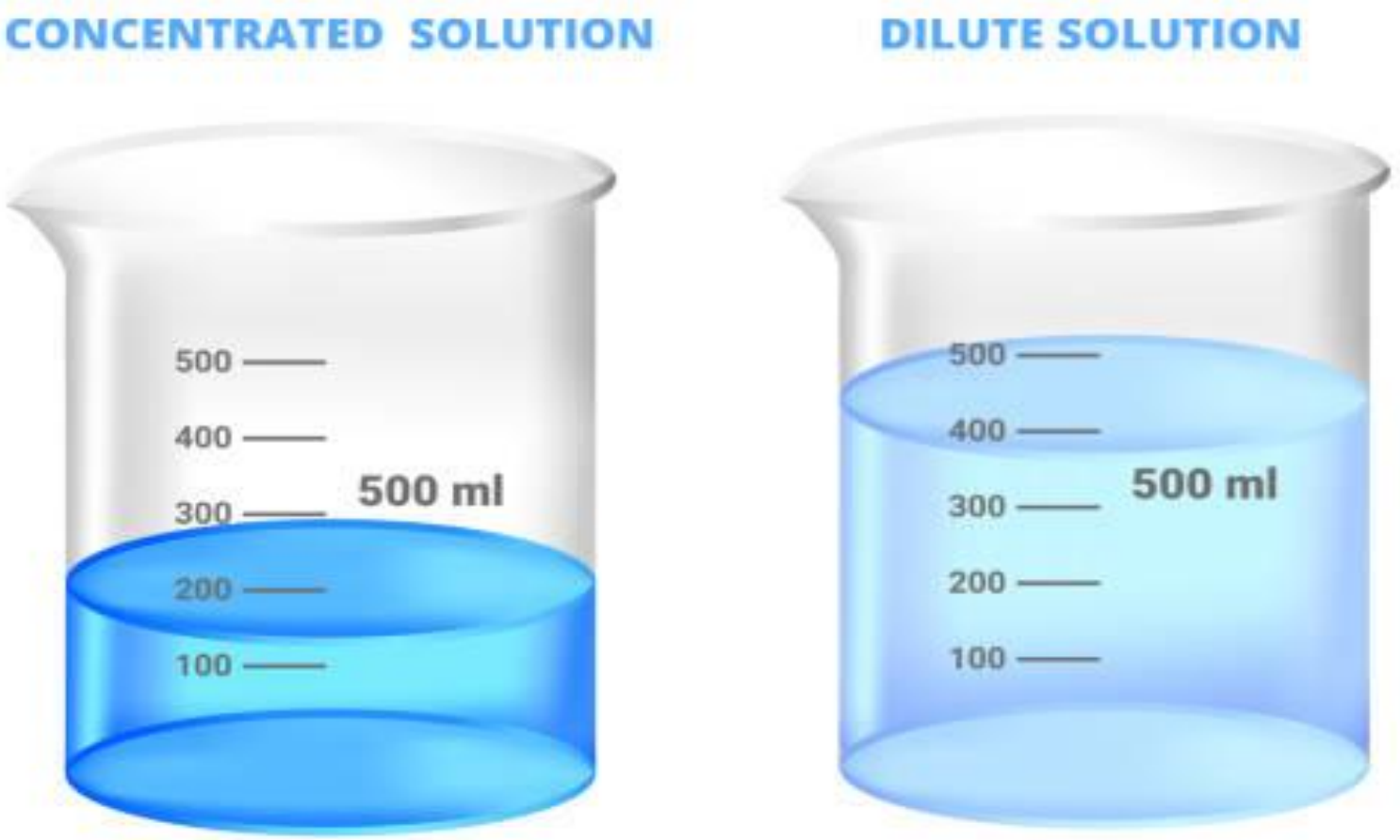
REMEMBER: this is formula for dilution

$$Ci_{(B)}\text{Vi(solution)} = Cf_{(B)}\text{Vf(solution)}$$

or…

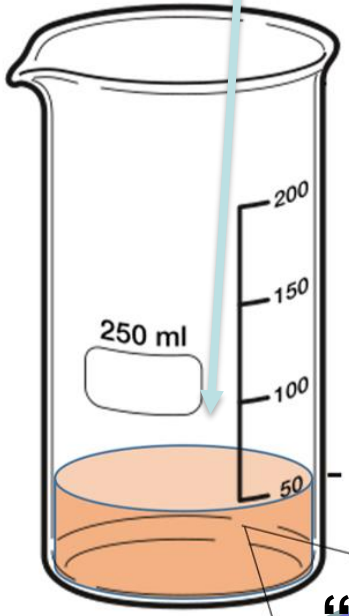
DILUTION

$$c_1 \cdot V_1 = c_2 \cdot V_2$$



Remember: **Dilution** means addition of defined volume of water to the initial volume of solution

Before dilution

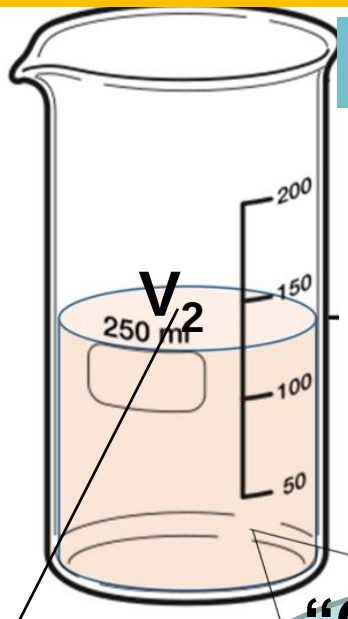


- lower volume V_1

Formula for dilution

$$c_1 \cdot V_1 = c_2 \cdot V_2$$

after dilution



V_2 –final volume after dilution

V_2 must be > V_1

"C_1" is initial molar concentration of solute "B" BEFORE we add water

Remember $C_1 > C_2$

"C_2" is final molar concentration of solute "B" AFTER we add water

$V_2 = V_1 + V$(added water)

olutions

Task: How would you prepare 60.0 mL of 0.2 *mol/L* HNO_3 from a stock solution of 4.00 *mol/L* HNO_3? How much volume of stock solution should I get?

c_i = 4.00 mol/L

c_f = 0.200 mol/L

V_f = 0.06 L $\qquad$ V_i = ? L

Formula for dilution is:

$$c_i V_i = c_f V_f$$

$$V_i = \frac{c_f V_f}{c_i} = \frac{0.200 \text{ mol/L} \times 0.06 \text{ L}}{4.00 \text{ mol/L}} = 0.003 \text{ L} = 3 \text{ mL}$$

3 mL of acid + 57 mL of water = 60 mL of solution

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Solutions