Solutions and Colloids

Learning Outcomes

1. Describe the relationship between the following terms: solute, solvent, solution.

2. Describe the change in solubility for most solids and gases when the temperature either increases or decreases.

3. Do the following calculations:

$$\text{Concentration} = \frac{\text{amount}}{\text{volume}}$$

$$(\text{w/v})\,\% = \frac{\text{g solute}}{\text{mL solution}} \times 100$$

$$(\text{v/v})\,\% = \frac{\text{mL solute}}{\text{mL solution}} \times 100$$

$$\text{M} = \frac{\text{mol solute}}{\text{L solution}}$$

Common Mass/Volume Relationships for Human Health: $\frac{\text{mg}}{\text{dL}}$, $\frac{\mu\text{g}}{\text{dL}}$, and $\frac{\text{ng}}{\text{dL}}$

4. Explain what it means to dilute a solution

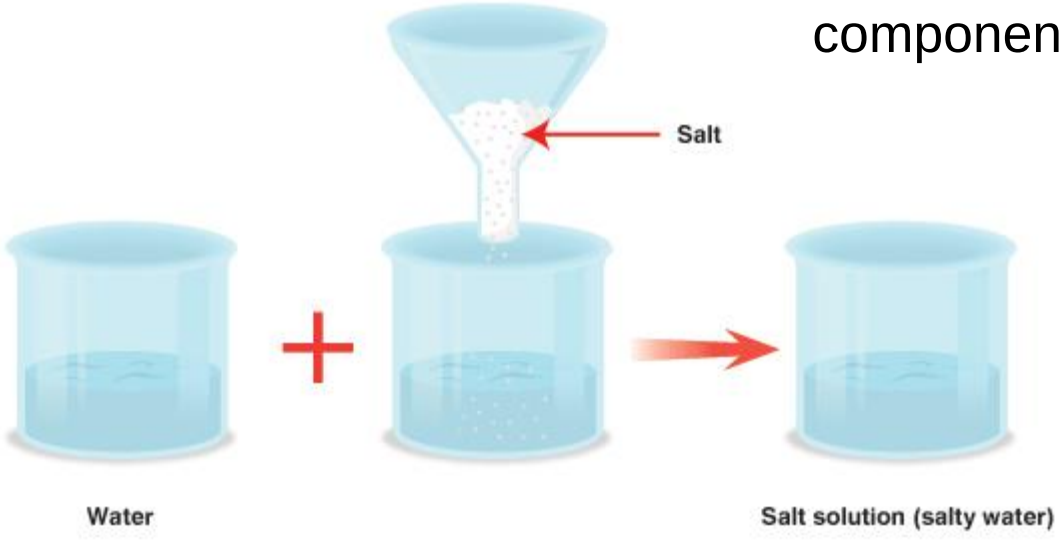
5. Calculate the concentration of a diluted solution.

Solutions Are A Homogeneous Mixture of Two or More Substances

Solute: Minority Component(s)

Solvent: Majority Component

For a salt-water solution which component is the solute and the solvent?



Problem 1

Which of the following are solutions? For a solution define the solute(s) and solvent.

(a) Atmospheric Air
(b) 100% Ethanol
(c) Lemoncello
(d) Yellow Brass (70% copper and 30% zinc alloy)
(e) Simple Syrup [1 cup sugar (200 g) and 1 cup water (237 g)]
(f) Elemental Gold
(g) 18 k Rose Gold (75% Au, 20% Cu, and 5% Ag alloy)

Problem 1 - Solutions

(a) Atmospheric Air

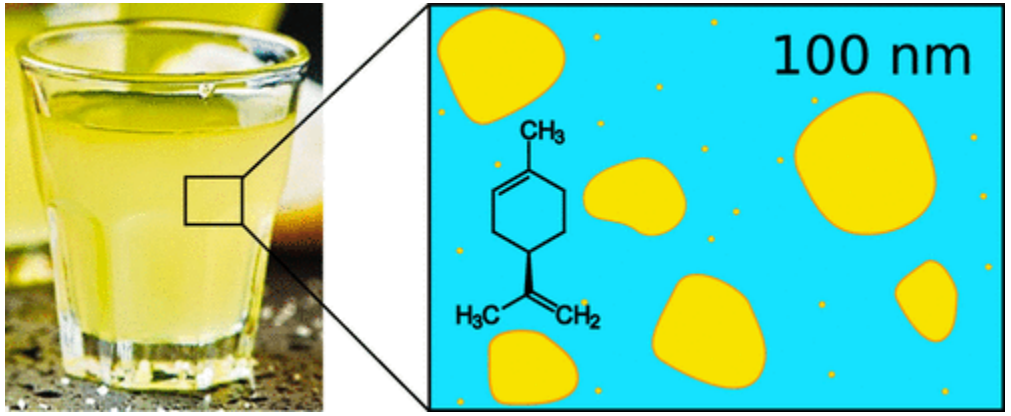
Component	Percent (%)
N_2	78.084
O_2	20.946
Ar	0.9340
CO_2	0.041332
Ne	0.001818
He	0.000524
CH_4	0.000187
Kr	0.000114

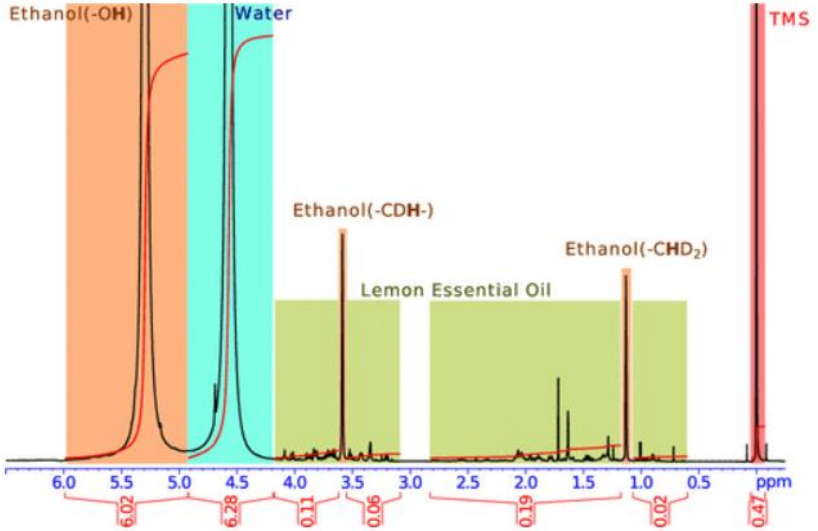
Problem 1 - Solutions

(b) 100% Ethanol

Problem 1 - Solutions

(c) Lemoncello

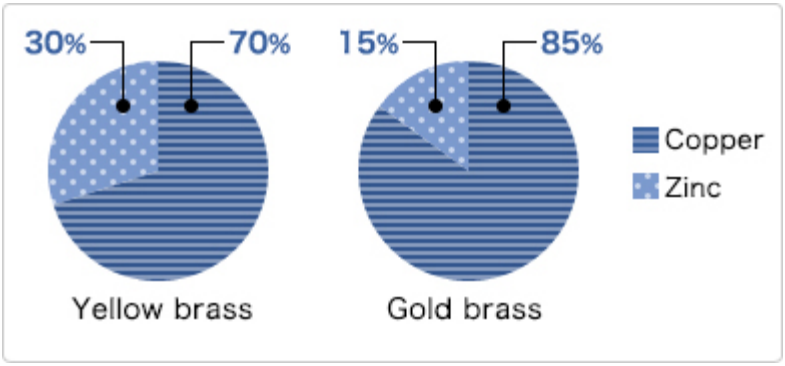




Problem 1 - Solutions

(d) Yellow Brass

(alloy of 70% copper and 30% zinc)



Problem 1 - Solutions

(e) Simple syrup

[1 cup sugar (200 g) and 1 cup water (237 g)]

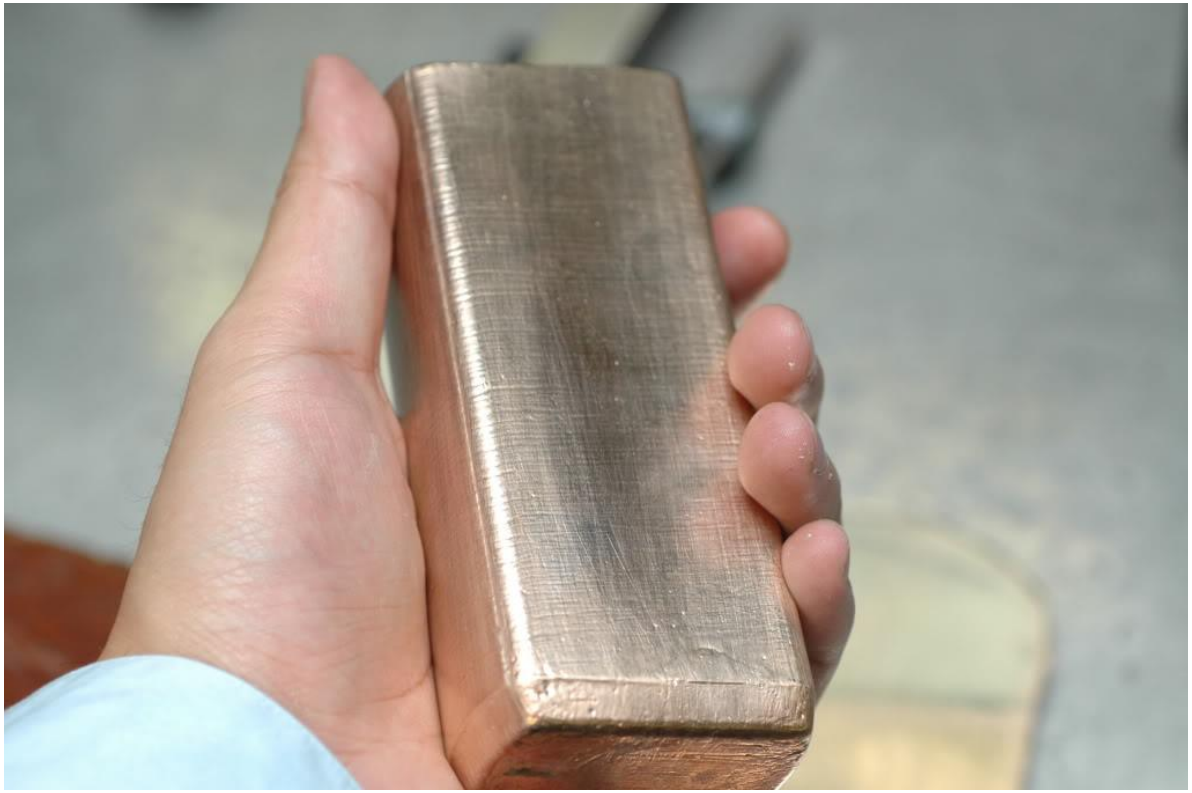
Problem 1 - Solutions

(f) Elemental Gold

Problem 1 - Solutions

(g) 18 k Rose Gold

(75% Au, 20% Cu, and 5% Ag alloy)

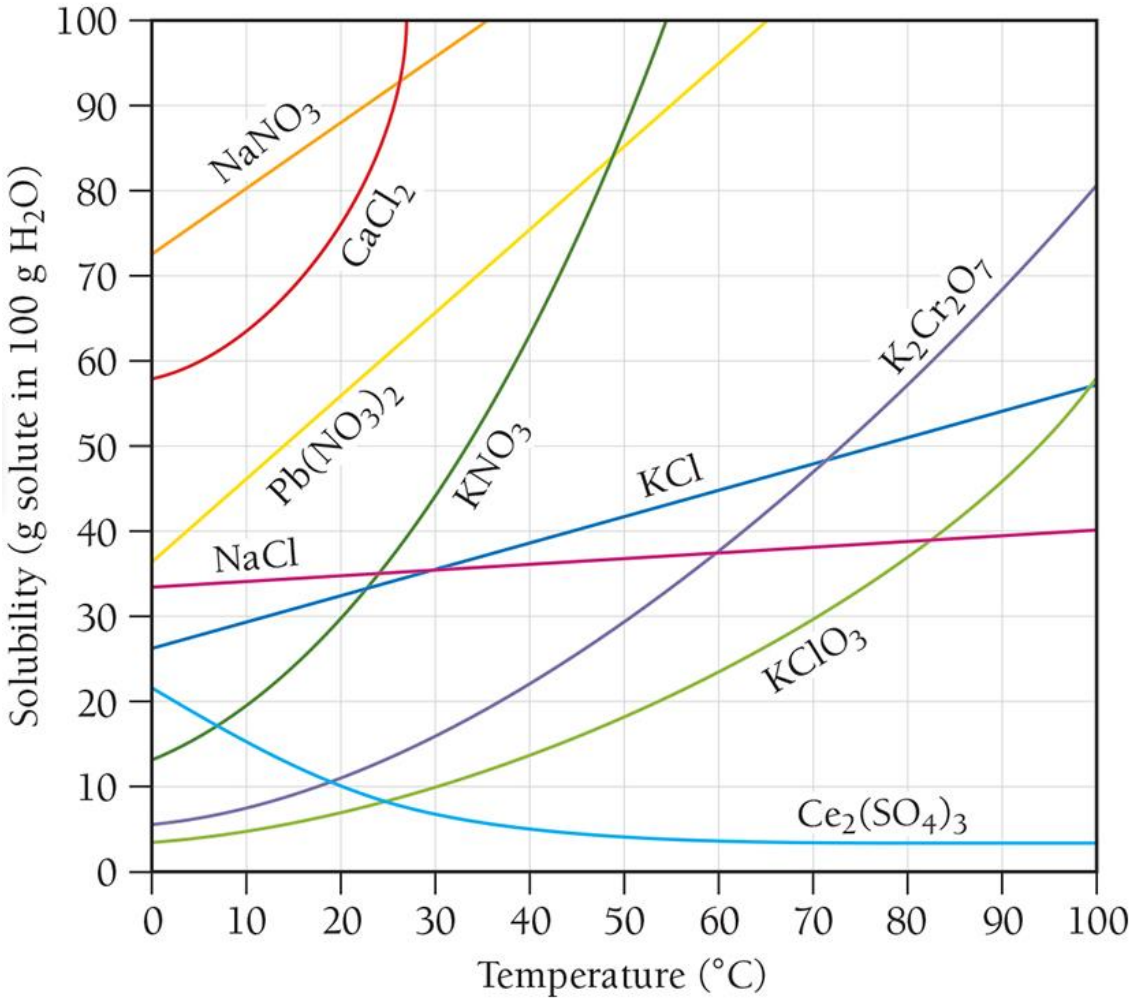


Solutions

TABLE 13.1 Common Types of Solutions

Solution Phase	Solute Phase	Solvent Phase	Example
gaseous solutions	gas	gas	air (mainly oxygen and nitrogen)
liquid solutions	gas	liquid	soda water (CO_2 and water)
	liquid	liquid	vodka (ethanol and water)
	solid	liquid	seawater (salt and water)
solid solutions	solid	solid	brass (copper and zinc) and other alloys

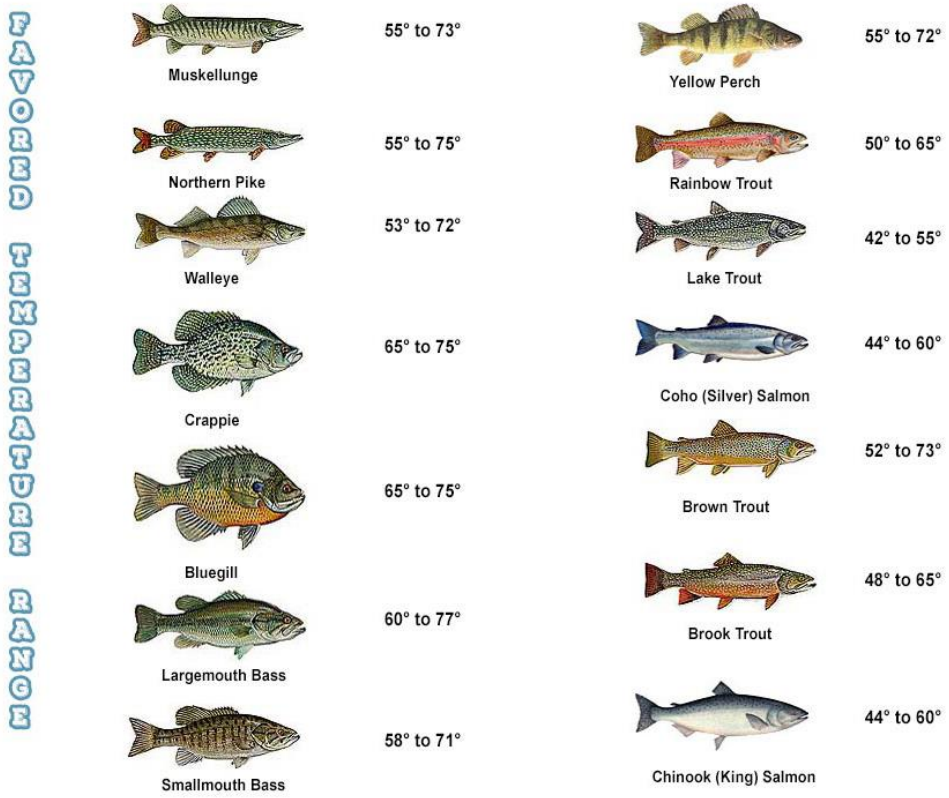
Solubility of Liquids
In General Increases with Temperature



Think-Pair Share

Does the solubility of gas molecules increase or decrease with temperature?

Hint, what is the worst time to go fishing?



Champaign Bubbles

More bubbles = higher temperature!

Concentration

What does it mean when a solution is more concentrated? What ideas do you have about representing a concentration mathematically?

Concentration Units

$$\text{Concentration} = \frac{\text{amount}}{\text{volume}}$$

$$(\text{w/v})\,\% = \frac{\text{g solute}}{\text{mL solution}} \times 100$$

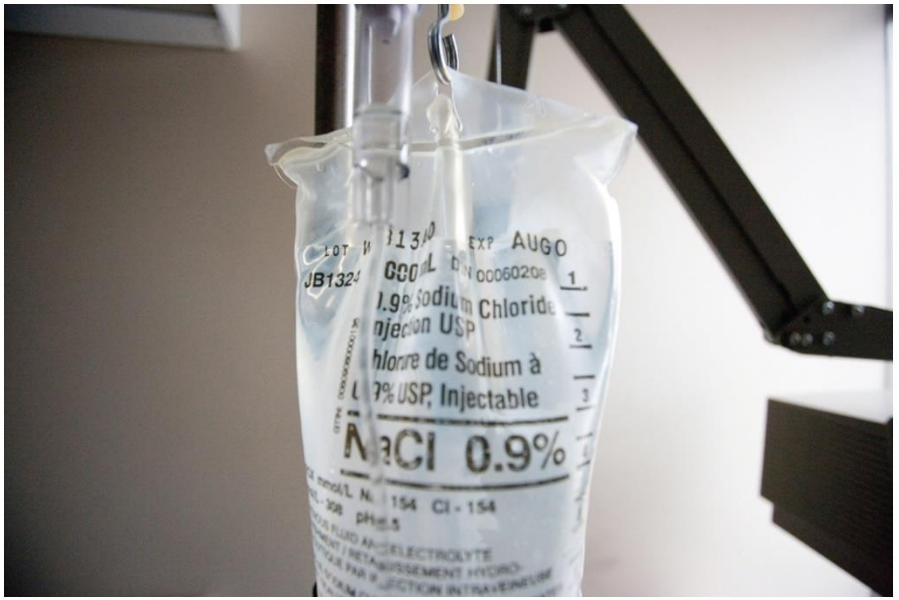
$$(\text{v/v})\,\% = \frac{\text{mL solute}}{\text{mL solution}} \times 100$$

$$\text{M} = \frac{\text{mol solute}}{\text{L solution}}$$

Common Mass/Volume Relationships for Human Health: $\frac{\text{mg}}{\text{dL}}$, $\frac{\mu\text{g}}{\text{dL}}$, and $\frac{\text{ng}}{\text{dL}}$

Problem 2

A common saline solution for IVs is often prepared by dissolving 9.00 g of salt in 1 L of water. Calculate the concentration in molarity. Note, ρ_{water}= 1.00 g/mL.



Problem 2 - Solution

$$\mathrm{M_{NaCl}} = \frac{n_{\mathrm{NaCl}}}{V_{\mathrm{solution}}}$$

$$\mathrm{M_{NaCl}} = \frac{9\ \mathrm{g\ NaCl} \times \frac{1\ \mathrm{mol\ NaCl}}{58.44\ \mathrm{g\ NaCl}}}{1\ \mathrm{L}}$$

$$\mathrm{M_{NaCl}} = \frac{0.154\ \mathrm{mol\ NaCl}}{1\ \mathrm{L}}$$

$$\mathrm{M_{NaCl}} = 0.154\ \frac{\mathrm{mol}}{\mathrm{L}}$$

$$\mathrm{M_{NaCl}} = 0.154\ \mathrm{M}$$

Problem 3

If 6 g of NaCl is dissolved in enough water to make 300. mL of solution, what is the w/v percent of NaCl?

Problem 3 - Solution

$$(\mathrm{w/v})\,\% = \frac{\text{g solute}}{\text{mL solution}} \times 100$$

$$(\mathrm{w/v})\,\% = \frac{6.0\ \text{g}}{300\ \text{mL}} \times 100$$

$$(\mathrm{w/v})\,\% = 0.02 \times 100$$

$$(\mathrm{w/v})\,\% = 2\%\ (\mathrm{w/v})$$

Problem 4

A vodka manufacturer prepares a vodka product by mixing 80. mL ethanol and 120. mL water. Calculate the v/v percent ethanol.

Problem 4 - Solution

$$(\text{v/v})\,\% = \frac{\text{mL solute}}{\text{mL solution}} \times 100$$

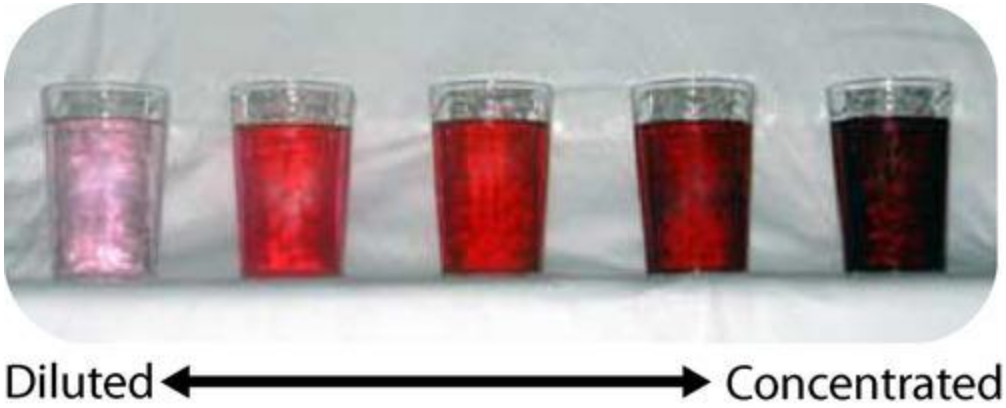
$$(\text{v/v})\,\% = \frac{\text{80. mL ethanol}}{\text{80. mL ethanol +120. mL water}} \times 100$$

$$(\text{v/v})\,\% = \frac{\text{80. mL ethanol}}{\text{200. mL solution}} \times 100$$

$$(\text{v/v})\,\% = 0.40 \times 100$$

$$(\text{v/v})\,\% = 40.\%\ (\text{v/v})$$

Dilution



Problem 5

A 0.20 M NaCl solution has a volume of 5 mL. What must the total volume be for the solution to have a concentration of 0.10 M?

Dilution Math

$$M_1 V_1 = M_2 V_2$$

Term	Physical Meaning	Notes
M_1	Starting concentration	For a dilution, this is the higher concentration.
M_2	Final Concentration	For a dilution, this is the lower concentration.
V_1	Starting Volume	For a dilution,this is a smaller volume.
V_2	Final Volume	For a dilution, this is a larger volume since the added solvent dilutes the solution.

Problem 6

A 5 mL of a 0.20 M NaCl solution is diluted to a final volume of 18 mL. What is the concentration of the diluted solution?

Learning Outcomes

1. Describe, at the atomic/molecular level, what occurs when water-soluble ionic and molecular compounds dissolve in water.

2. Explain what makes a solution an electrolyte.

3. ***Qualitatively*** describe diffusion, osmosis, and dialysis.

4. **Chemical Connections: Electrolyte solutions in body and intravenous fluids**

5. **Chemical Connections: Hemodialysis**

Why Do Some Materials Dissolve While Other Do Not?

vs.

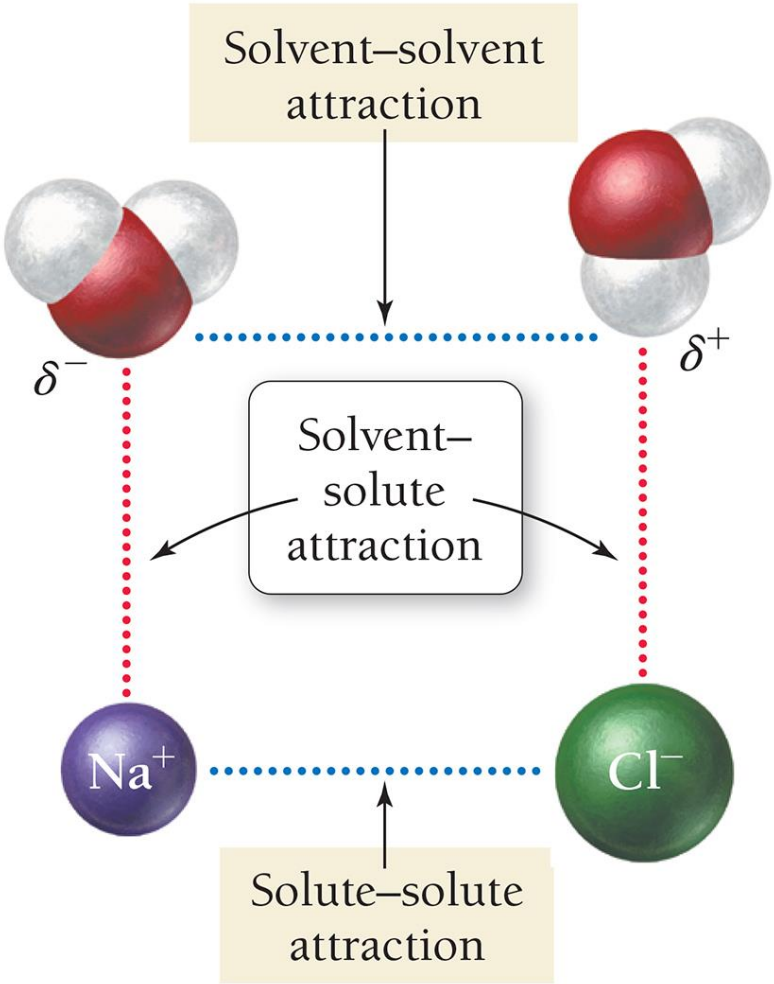
Person-Netflix Interaction > Person-Yardwork Interaction

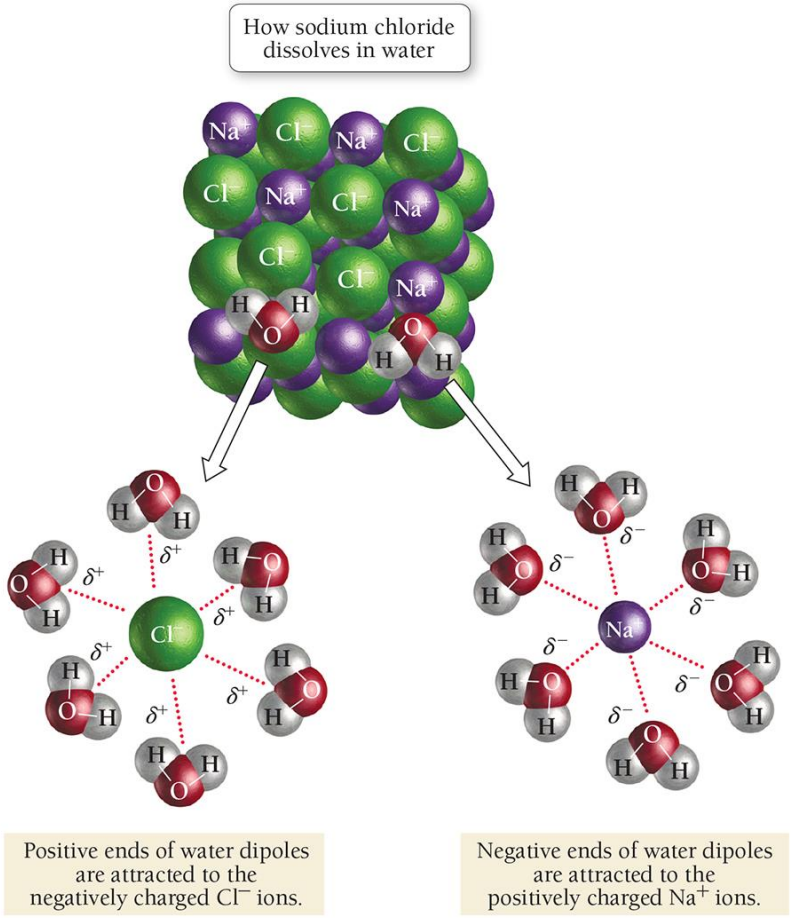
Why Do Some Materials Dissolve While Other Do Not?

vs.

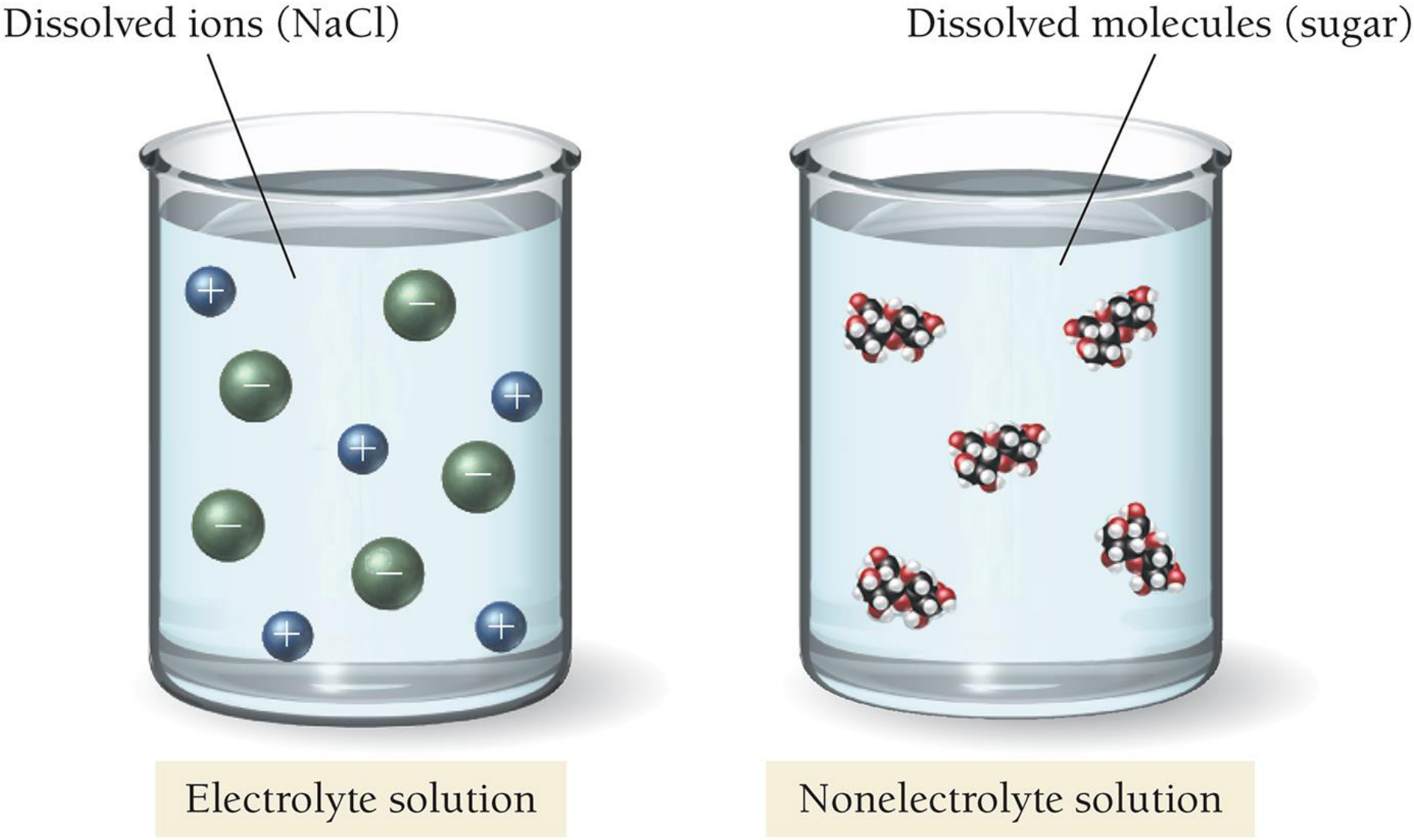
Person-Dessert Buffet Interaction > Person-Netflix Interaction

Why Do Some Materials Dissolve While Other Do Not?



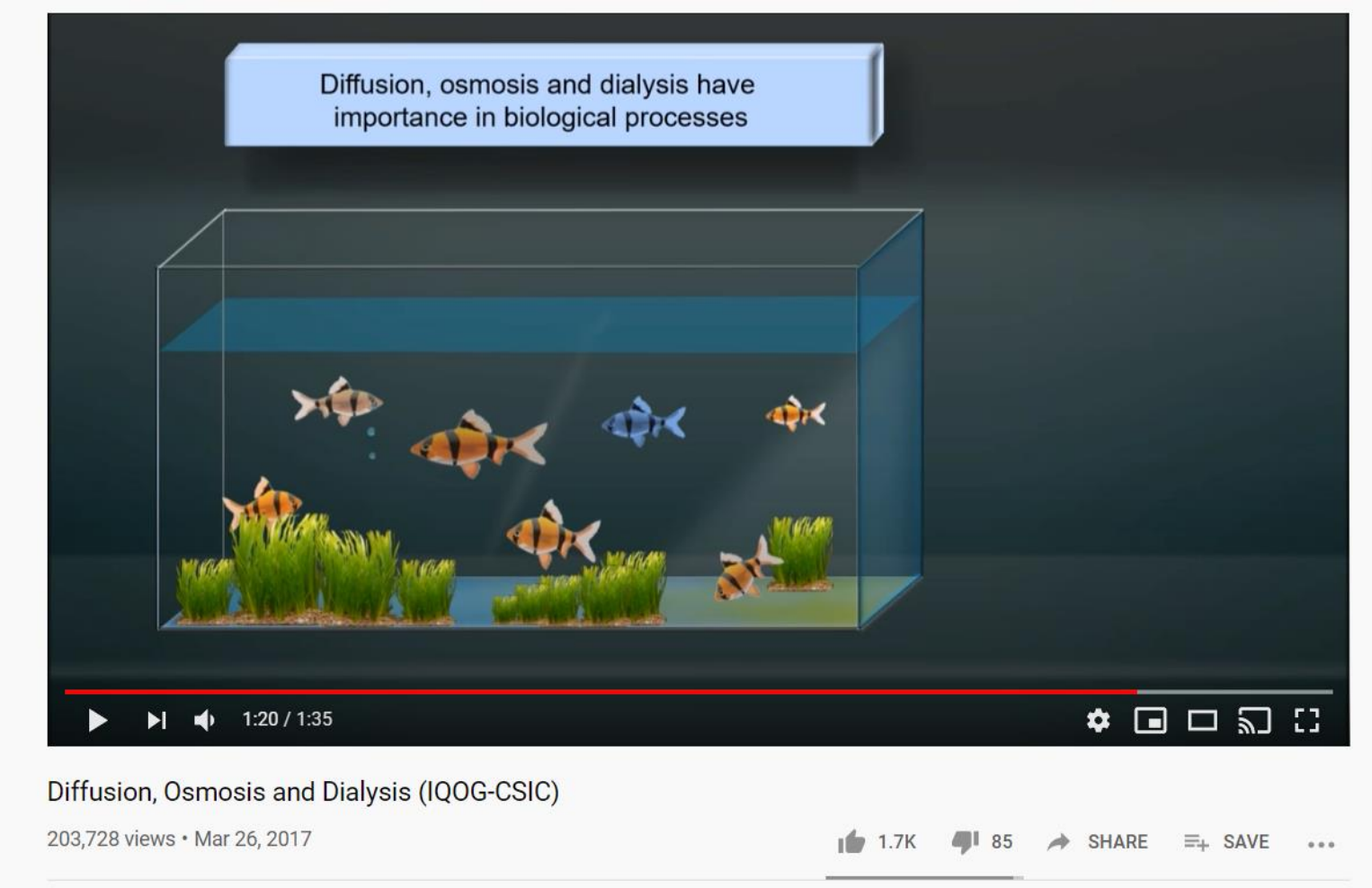


Electrolyte (Ionic) vs. Nonelectrolyte (Nonionic) Solutions



Diffusion, Osmosis, and Dialysis

https://www.youtube.com/watch?v=tHzkRtzVmUM



Diffusion

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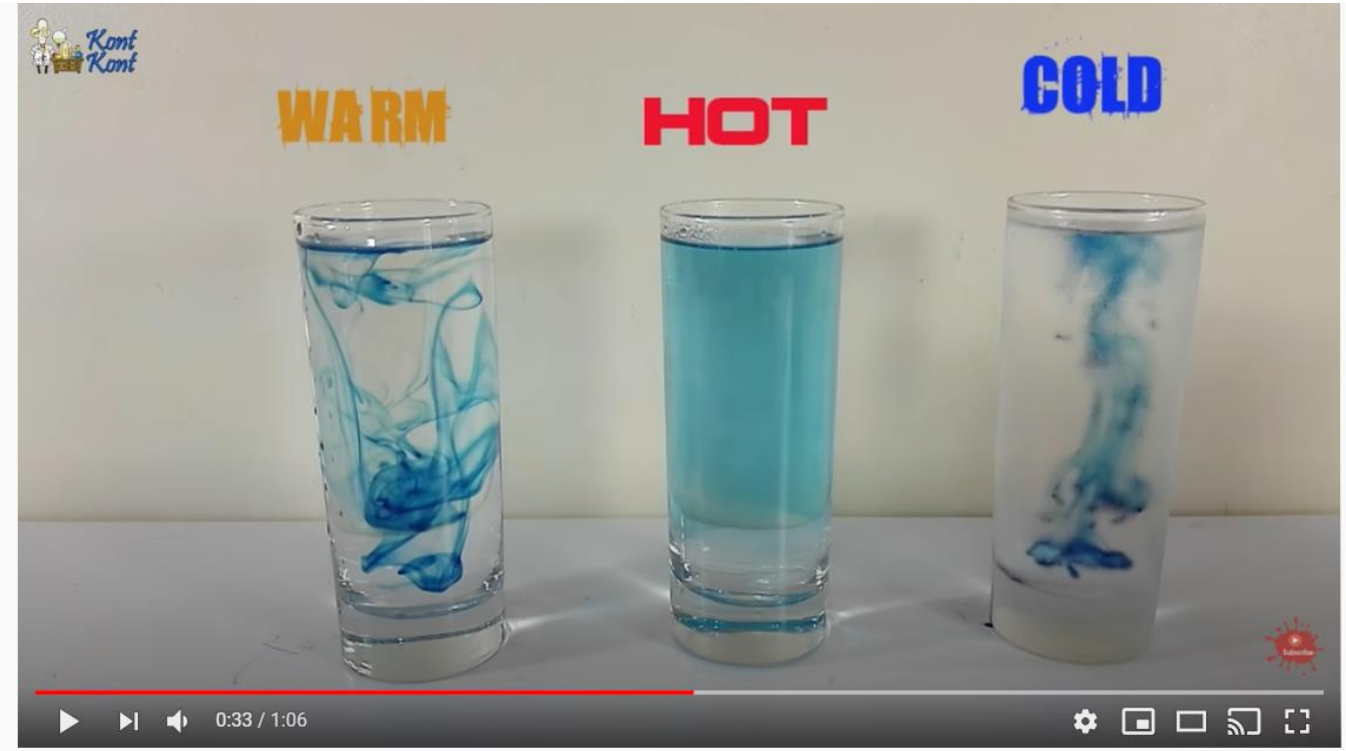
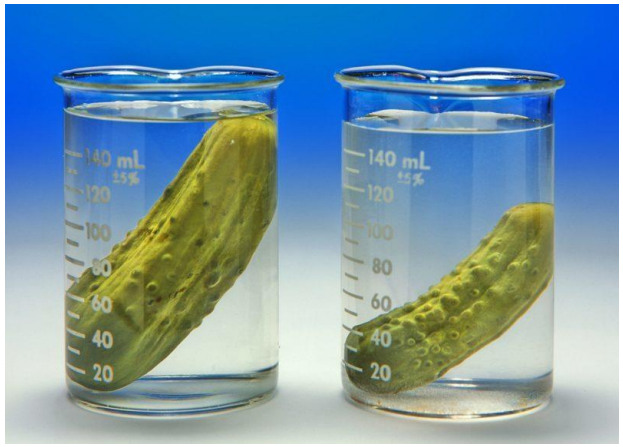


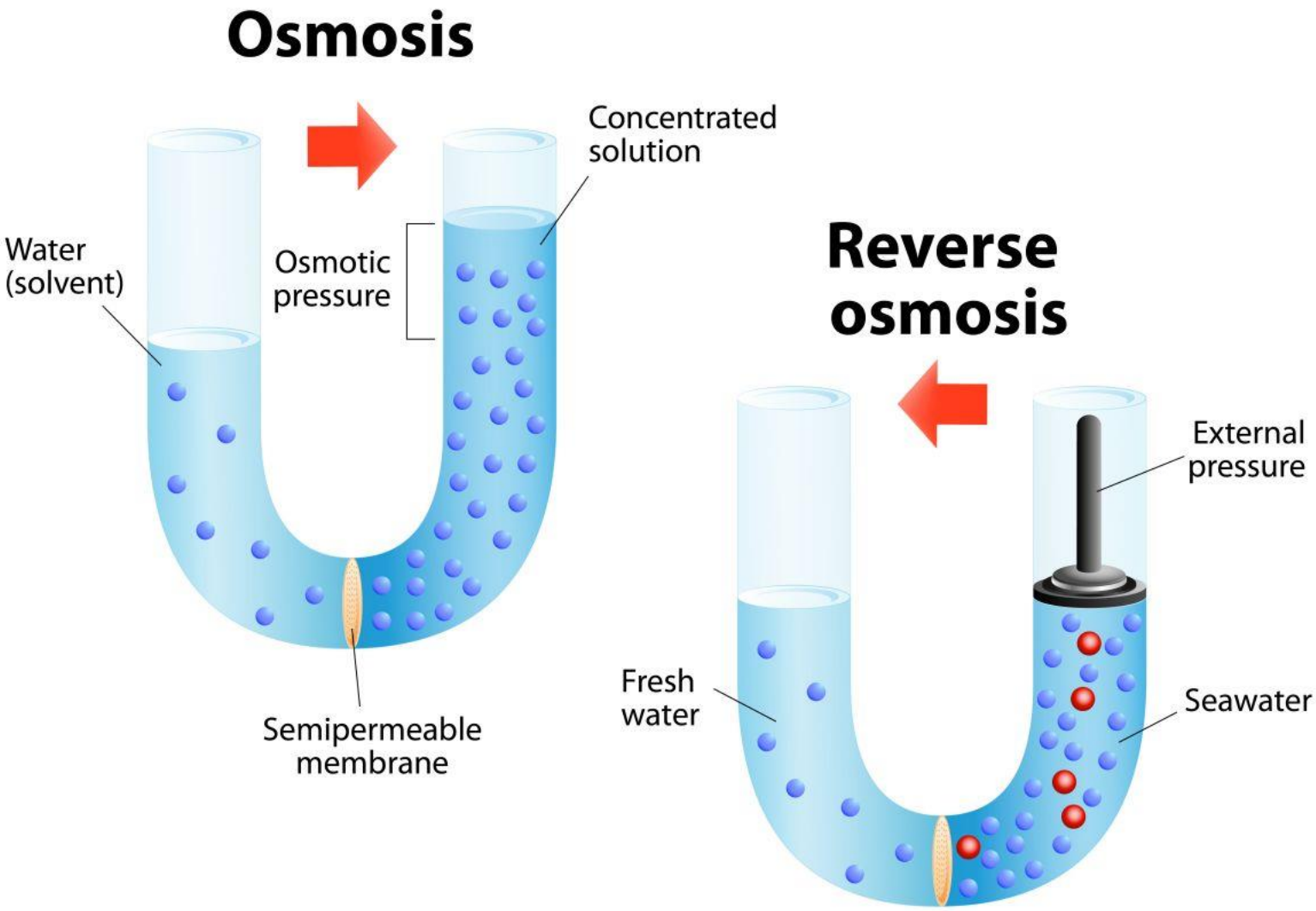
Cucumber Science

https://www.youtube.com/watch?v=dD9dGFrFcoo

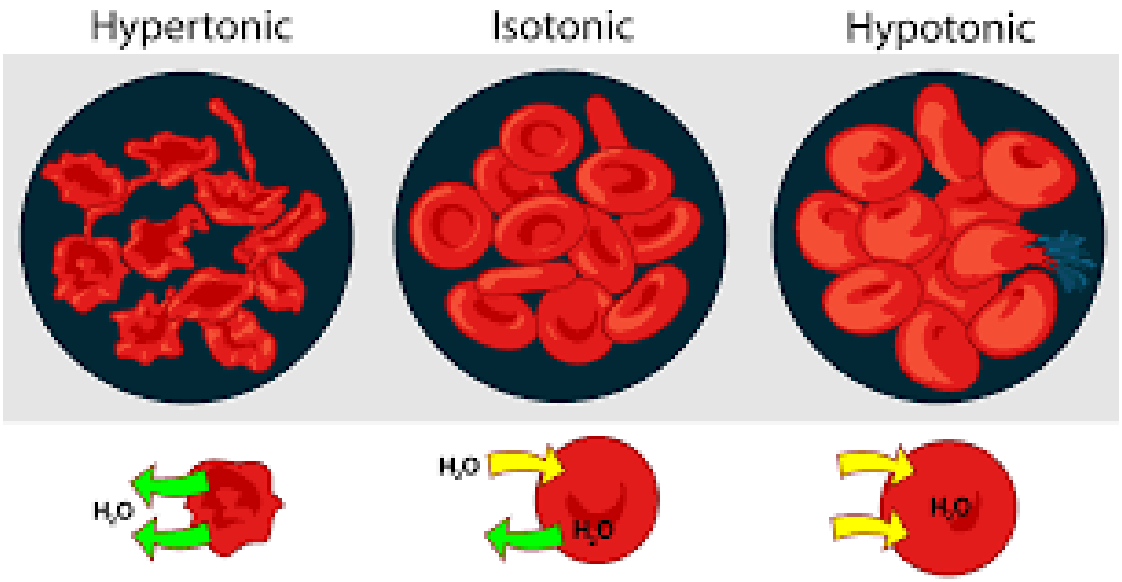
Cucumbers and Osmosis



Osmosis


Osmosis
Concentrated solution
Water (solvent)
Osmotic pressure
Semipermeable membrane
Reverse osmosis
External pressure
Fresh water
Seawater

Red Blood Cells and Osmosis



NaCl>RBC	NaCl=RBC	NaCl<RBC
Salty Water	0.9% NaCl	Distilled Water
>0.9% NaCl		0% NaCl

RBC = Red Blood Cell

Dialysis

https://www.youtube.com/watch?v=9KZHowze7lg