Lab 1: Solution and colloidal system

Why we study the solution?

The various physiological activities of the cell take place in a medium of water. They actually operate in dilute aqueous solutions suspensions and colloidal phases. A study of the properties of solutions, suspensions and colloidal system is therefore, necessary for a better understanding of the different physiological processes like protoplasm which found in complex colloidal system.

Solution

The solution known as homogeneous mixture composed of two or more substances related each together physically and chemically which have some chemical composition and physical properties. In such a mixture, a **solute** is dissolved in another substance, known as a **solvent.** After the solute is put in the solvent, it breaks to an atomic, ionic or molecular level and can no longer be seen as a separate entity. For example, mixing the solid material salt into the liquid water results in the salt dissolving into water and creating the salt water solution. The salt breaks into Sodium ($\mathbf{Na}^{+}$) and Chlorine ($\mathbf{Cl}^{-}$) ions within the water solvent.

If we solvent the some sugar in water or adding the alcohol to the water it causes to produce homogenous mixture called solution.

The term (**solvent**) refer to the substances that presents in large amounts, and other substances or (material) called as (**solute**).

For Example when we add the small amount of alcohol to large amount of water, the water are(solvent) and small amount of alcohol are(solute), and in different case which adding the small amount of water into the large amount of alcohol, The water are (Solute) And Alcohol Known as (Solvent).

Colloid= when the solid particles in the liquid are suspended (heterogeneous).
Solution= when the solid particles in the liquid are totally dissolved (homogenous).

The nature of solution

Dilution and Saturated

1. When a solution contains a relatively small amount of solute (polar and non-polar) such as salt and sugar, the ions of sugar and salt (Na^{+} and Cl^{-}) dissolved gradually and equal between the water molecules, In this state, the (sugar and salt) act as solute and water act as solvent, in this case which solves the small

amount of sugar and salt in water are caused to produce dilute solution, said to be dilute (unsaturated) solution.

2. On the other hand, a solution with a relatively large amount of solute is said to be saturated or concentrated, in fixed and equal temperatures and pressures.

3. If we add more solute substance to the saturated solution the crystal of this substances precipitate in button of tube at this time the solution in super saturated state, the solution that contain larger amount of solute than the amount which is require to saturation.

Type of solution

A- According to the type of solute and solvent. There are 9 types:

Solute	Solvent	Example
Gas	Liquid	(CO_2) in (H_2O) carbon dioxide in water.
Liquid	Liquid	Alcohol in water
Solid	Liquid	Salt or sugar in water
Gas	Gas	CO_2 in air or O_2 in air
liquid	Gas	Very small drops of water in air
Solid	Gas	Smoke in air
Gas	Solid	Air in soil or air in chalk part
Liquid	Solid	Absorption of water in wood or ink through the paper
Solid	Solid	Mixture of soil and sand

B- According to the size of (atoms or molecules or ions) of solute material in solution

1. **True solution**: The dispersed practical are generally less than (0.001) micron and can not seen his molecule by microscope or other tools. True solution characterized by stability which are not precipitate by time periods (Sugar and salt in water), can't differentiate between the solute and solvent molecules even at the microscopic level and it is completely homogeneous.

2. Suspension and Emulsions: The solute particles don't dissolve in solvent but they are distributing in solvent, if the solute material are solid so it is called Suspension (ex: soil particle in water) but if the solute material are liquid so it is called Emulsions such as (oil in water). The size of its particle greater than (0.1) micron can be seen by the naked eye. It is unstable solution, fast precipitate and large size particles.

3. Colloidal system: When particle substance is distributed throughout water in a stable manner the system is called colloidal. The size of the particles as well as the properties of the system is intermediate between true solutions and

suspensions. Like suspension, the dispersed particles are not in the molecular form but are present as aggregates of molecules, which are not so large as to settle down. The particle remains stable throughout the liquid like true solutions. In general the dispersed particle of a colloidal system is between 0.001- 0.1 micron in diameter.ex: enzymes, proteins, stains, cytoplasm of cells.

Properties of Colloids

1- Colloidal solution consist of two phases, one of them including solute particle and termed as dispersal phase (discontinuous phase) and other including solvent termed as dispersion medium (continuous phase).
2- It possesses wide surface area for their particles.
3- The particles of a colloid selectively absorb ions and acquire an electric charge. All of the particles of a given colloid take on the same charge (either positive or negative) and thus are repelled by one another. If an electric potential is applied to a colloid, the charged colloidal particles move toward the oppositely charged electrode; this migration is called electrophoresis. If the charge on the particles is neutralized, they may be precipitate out of the suspension. A colloid may be precipitated by adding another colloid with oppositely charged particles; the particles are attracted to one another, coagulate, and precipitate out.
4- The colloidal solution are generally electrically neutralized (equivalent), because every charge faced by opposite and equal charge through distribution media. Thus every particle surrounded by two layers of charges and called electric double layer.
5- The particles have other characteristics: Brownian movement, viscosity, adsorption and Tyndall phenomenon,

Classification of colloidal solutions:

A- Based on the physical nature:

1. Sol: A sol has high degree of fluidity and appears like solutions, distribution media are liquid and distributed particle are solid. Examples: (starch solution and protein solution) and SO_4 and gold solution in water.

2. Gel: The gel is almost solid. A colloidal system which is the distribution media is solid and distributed particles are liquid. Example (cheese and gelatin).

When the sol cooled it converted to the gel and the process called gelation and by heating the gel will converted to the sol and the process called solation.

B- Based on the relation between the solvent particles (dispersion medium) &the solute particles (dispersal phase):

1- Lyophilic colloidal system:

When the water is dispersion medium the system is called hydrophilic colloidal system. In this system there is affinity between dispersion medium and dispersed particles (they are attracted to each other). e.g. (agar, protein, starch, gelatin) + water are lyophilic colloidal system. The water molecules are adsorbed on the surface of these substances.

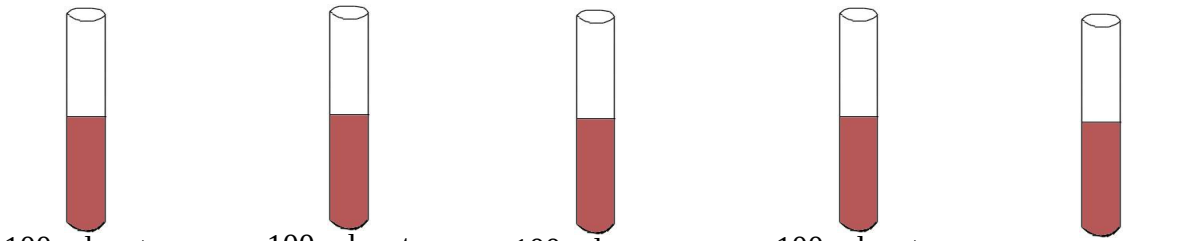
2- Lyophobic colloidal system:

When the water is dispersion medium the system is called hydrophobic colloidal system. This system is luck such affinity to water (the dispersion medium and the dispersed phase repel each other). Like ferric chloride (5 ml) is mixed with (500 ml) hot water, a dark red colloidal suspension of ferric hydroxide is results:

$FeCl_3 + 3H_2O$ ---------- $Fe(OH)_3 + 3H^+ + 3Cl^-$

Practice part:

1. Preparation of true solution
2. Preparation of emulsion
3. Preparation of suspension.
4. Preparation of lyophilic colloidal solution
5. Preparation of lyophobic colloidal solution



100 ml water + 2 gm salt or sugar	100 ml water + 2 ml oil	100 ml water + Amount of chalk powder	100 ml water + 2 gm gelatin or agar	100 ml water + Mud particle or 2 gm $feCl_3$

- The test tubes shake well, put on the holder, and write your notices.
- In which tube the particles precipitate? Can you see the solutes particles? In which tube? Notice the place of oil's layer.

6. Prove appearance of the charges on the colloidal particles.
   a. By electrophoresis.
   b. By ash less paper (Filter paper) → Water → Rain off → drops of stain → Suffranin, Methyl blue, Light green, Eosin

Duty questions:

1. The colloidal state facilitated the chemical reactions conditions? Why?
2. What are the functions of emulsifying agents?
3. What are differs between aqueous & non aqueous solutions?