L - Colloidal system

Colloidal system

Fluids in living system are complex mixtures of colloids, ions and molecules. The behavior of these fluids in the body is vital life .

Colloidal systems are essential to life. They function in every body cell, in the blood, and in all body fluids, especially the intercellular fluids. All life processes take place in a colloidal system, and that is true both of the normal fluids and secretions of the organism, and of the bacterial toxins, as well as, in large measure, of the reactions, which confer immunity.

Solutions are homogeneous mixtures of two or more components.

- Solute = a substance dissolved in solvent to form solution; usually the smaller portion.

Solvent = The dissolving medium of a solutionn; usually the greater portion.

- Solubility: Is an ability of a substance to dissolve. In the process of dissolving.

- Colloidal consists of a dispersed phase and dispersion medium.

-The **dispersed phase** consists of the colloidal particles, comparable to **the solute** in a solution.

-The **dispersion medium** is the substance in which the colloidal particles are distributed, comparable to **the solvent** in a solution.

TYPES OF COLLOIDS

Colloids may be grouped according to the phase (solid, liquid and gas) of the dispersed substance and the dispersion medium.

-A gas may be dispersed in a liquid to form foam (shaving lather) or in a solid to form solid foam (Styrofoam or marshmallow).

-A liquid may be dispersed in a gas to form an aerosol (fog or aerosol spray), in another liquid to form a gel (jellies or cheese).

-A solid may be dispersed in a gas to form a solid aerosol (dust or smoke in air), in a liquid to form a sol (ink or muddy water), or in a solid to form a solid sol(certain alloys).

- You can prepare eight types of colloids.

Colloids are usually classified according to:

1- The original states of their constituent parts

Dispersed phase	Dispersion medium	Colloidal system	Examples
Solid Solid	Solid Liquid	Solids sols Sols	-Minerals, gem stones, glass, alloys. Paints, Gold -muddy water, starch in water, proteins in water, gelatin in water, cell fluids.
Solid Liquid Liquid	Gas Solids Liquid	Aerosols of solid Sol Emulsion	-Smoke, dust storm . -Butter, jellies, boot polish, cheese, jams Milk medicines, shampoo, creams emulsified Oils
Liquid Gas Gas	Gas Solid Liquid	Aerosols of liquids Solid foam Foam, Froth	Fog, mist, clouds, insecticide sprays pumice stone, foam rubber Soda water, whipped cream, froth, soap lather

Colloidal systems in which a solid is dispersed in a liquid are frequently referred to as colloidal solutions or simply sols and depending upon the nature of the dispersion medium, colloidal solutions are sometimes given specific names.

For example

Dispersion medium	Name of colloidal solution
Water	Hydrosol
Alcohol	Alcosol
Benzene	Benzosol

In order to be classified as a colloid, the substance in the dispersed phase must be larger than the size of a molecule but smaller than what can be seen with the naked eye. This can be more precisely quantified as one or more of the substance's dimensions must be between 1 and 1000 nanometers. If the dimensions are smaller than this the substance is considered a solution and if they are larger than the substance is a suspension.

A common method of classifying colloids is based on the phase of the dispersed substance and what phase it is dispersed in. The types of colloids includes sol, emulsion, foam, and aerosol.

1-Sol is a colloidal suspension with solid particles in a liquid.

2-Emulsion is between two liquids.

3-Foam is formed when many gas particles are trapped in a liquid or solid

4-Aerosol contains small particles of liquid or solid dispersed in a gas.

When the dispersion medium is water, the colloidal system is referred to as a hydrocolloid. The particles in the dispersed phase can take place in different phases depending on how much water is available. For example, Jello powder mixed in with water creates a hydrocolloid. A common use for hydrocolloids is in the creation of medical dressings.

2-The nature of interaction between dispersed phase and dispersion medium

Type of colloid solution

(a) **Lyophilic colloids**: These are the colloidal solutions in which the particles of the dispersed phase have great affinity (love) for the dispersion medium.

In case water acts as the dispersed phase, the lyophilic colloid is called hydrophilic colloid.

These are generally stable due to the strong attractive forces operating between the two phases. These are reversible in nature. On evaporating the sol, the dispersed phase obtained can be easily reconverted into the solution by simply agitating it with the dispersion medium. Gums, gelatin and starch form lyophilic (hydrophilic) sols

(b) **Lyophobic sols:** These are the colloidal solutions in which particles of the dispersed phase have no affinity for the dispersion medium. Such solutions are relatively less stable and are not easily prepared. These can be easily precipitated by heating the sol or on adding small amount of electrolyte to it. These are irreversible.

The solid obtained by precipitation cannot be reconverted into colloidal solution by simply shaking it with the dispersion medium.

Gold, silver, $Fe(OH)_3$, As_2S_3 etc Colloidal solutions of are lyophobic.

Lyophobic sols need stabling agents for their preservation.

CHARACTERISTICS OF LYOPHILIC AND LYOPHOBIC SOLS

Some features of lyophilic and lyophobic sols are listed below.

(1) **Ease of preparation:** Lyophilic sols can be obtained straightaway by mixing the material (starch, protein) with a suitable solvent. Lyophobic sols are not obtained by simply mixing the solid material with the solvent.

(2) **Charge on particles:** Particles of a hydrophilic sol may have little or no charge at all. Particles of a hydrophobic sol carry positive or negative charge which gives them stability.

(3) **Solvation:** Hydrophilic sol particles are generally solvated. That is, they are surrounded by an adsorbed layer of the dispersion medium which does not permit them to come together and coagulate. Hydration of gelatin is an example. There is no solvation of the hydrophobic sol particles for want of interaction with the medium.

(4) **Viscosity:** Lyophilic sols are viscous as the particle size increases due to solvation, and the proportion of free medium decreases. Warm solutions of the dispersed phase on cooling set to a gel e.g., preparation of table jelly. Viscosity of hydrophobic sol is almost the same as of the dispersion medium itself.

(5) **Precipitation** Lyophilic sols are precipitated (or coagulated) only by high concentration of the electrolytes when the sol particles are dissolved. Lyophobic sols are precipitated even by low concentration of electrolytes, the protective layer being absent.

(6) **Reversibility** The dispersed phase of lyophilic sols when separated by coagulation or by evaporation of the medium, can be reconverted into the colloidal form just on mixing with the dispersion medium. Therefore this type of sols are designated as Reversible sols. On the other hand, the lyophobic sols once precipitated cannot be reformed merely by mixing with dispersion medium. These are, therefore, called Irreversible sols.

(7) **Tyndall effect** On account of relatively small particle size, lyophilic sols do not scatter light and show no Tyndall effect. Lyophobic sol particles are large enough to exhibit tyndall effect. Colloidal suspensions can scatter rays of light . This phenomenon is known as the Tyndall effect .

(8) **Migration in electronic field** Lyophilic sol particles (proteins) migrate to anode or cathode, or not at all, when placed in electric field.

PREPARING COLLOIDS

1-Preparation of Lyophilic colloids

(i) The lyophilic colloids have strong affinity between particles of dispersed phase and dispersion medium.
(ii) Simply mixing the dispersed phase and dispersion medium under ordinary conditions readily forms these colloidal solutions.
(iii) For example, the substance like gelatin, gum, starch, egg, albumin etc. pass readily into water to give colloidal solution.
(iv) They are reversible in nature become these can be precipitated and directly converted into colloidal state.

(2) Preparation of Lyophobic colloids :

Lyophobic colloids can be prepared by mainly two types of methods.
(i) Condensation method : In these method, smaller particles of dispersed phase are condensed suitably to be of colloidal size. This is done by the following methods.
(a) By oxidation
(b) By reduction
(ii) **Dispersion methods** : In these methods, larger particles of a substance (suspensions) are broken into smaller particles.

Applications of colloidal solutions:

1- **Therapy---** Colloidal system are used as therapeutic agents in different areas.
Silver colloid-germicidal
Copper colloid-anticancer
Mercury colloid-Anti syphilis

2- **Stability---**lyophobic colloids prevent flocculation in suspensions.
Colloidal dispersion of gelatin is used in coating over tablets and granules which upon drying leaves a uniform dry film over them and protect them from adverse conditions of the atmosphere.

3- **Foods--** Many of our foods are colloidal in nature. Milk is an emulsion of butterfat in water protected by a protein, casein. Salad dressing, gelatin deserts, fruit jellies and whipped cream are other examples. Ice cream is a dispersion of ice in cream. Bread is a dispersion of air in baked dough.

4- **Medicines --** Colloidal medicines being finely divided, are more effective and are easily absorbed in our system. Halibut-liver oil and cod-liver that we take are, in fact, the emulsions of the respective oils in water. Many ointments for application to skin consist of physiologically active components dissolved in oil and made into an emulsion with water. Antibiotics such as penicillin and streptomycin are produced in colloidal form suitable for injections.

5- Absorption As colloidal dimensions are small enough, they have a huge surface area. Hence, the drug constituted colloidal form is released in large amount.

- Sulphur colloid gives a large quantity of sulphur and this often leads to sulphur toxicity

6-Targeted Drug Delivery Liposomes are of colloidal dimensions and are preferentially taken up by the liver and spleen.

7- Photography:

A colloidal solution of silver bromide in gelatine is applied on glass plates or celluloid films to form sensitive plates in photography.

8- Clotting of blood:

Blood is a colloidal solution and is negatively charged.

On applying a solution of Fecl3 bleeding stops and blood clotting occurs as Fe+3 ions neutralize the ion charges on the colloidal particles.

9-Smoke screen:

In warfare smoke screens are used which are nothing but colloidal dispersion of certain substances in the air.

10-Rubber industry:

Latex is a colloidal solution of negatively charged rubber particles. From latex, rubber can be obtained by coagulation. Rubber plated articles are prepared by depositing negatively charged rubber particles over the article to be rubber plated by making that article an anode in a rubber plating bath.

11-Cleansing action of soaps: Soaps solution is colloidal in nature and removes dirt and oil from clothes by forming water soluble emulsion as explained earlier.

12- Artificial Kidney machine

The human kidneys purify the blood by dialysis through natural membranes. The toxic waste products such as urea and uric acid pass through the membranes, while colloidal-sized particles of blood proteins (hemoglobin) are retained. Kidney failure, therefore, leads to death due to accumulation of poisonous waste products in blood . Now-a-days, the patient's blood can be cleansed by shunting it into an 'artificial kidney machine'. Here the impure blood is made to pass through a series of *cellophane tubes* surrounded by a washing solution in water. The toxic waste chemicals (urea, uric acid) diffuse across the tube walls into the washing solution. The purified blood is returned to the patient. The use of artificial kidney machine saves the life of thousands of persons each year.