

1- Colloids

Colloids are the dissolved state of substances that either do not pass, or pass very slowly through a parchment paper or animal membrane. A few examples of colloids are starch, glue and gelatin.

A colloid is not a substance, but it depicts a particular state of a substance that depends upon the size of its particles. The size of a particle in a colloidal system is between 1-100 nm. A colloidal system is a two phase heterogeneous system in which one phase is called the dispersed phase and the other is called the dispersion medium.

Dispersed phase: It is the component present in a small proportion.

Dispersion medium: It is the component present in excess.

For example, in a colloidal solution of silver in water, silver is the dispersed phase and water is the dispersion medium.

Types of colloids

Based on the physical state of the dispersed phase and dispersion medium, colloids can be classified into different types.

One important class of colloidal system is sols. In sols, the dispersed phase is solid and dispersion medium is liquid.

Depending upon the nature of the interaction between the dispersed phase and dispersion medium sols can be classified into two types.

1. Lyophilic sols
2. Lyophobic sols

b- Preparation of a Lyophobic Colloid. ✕

Procedure:

- 1- Take 1 mL 30% Ferric Chloride solution and add to 5 mL boiling dist. Water.
- 2- Shake well, observe and comment.

Observation:

A deep brownish- red colour of lyophobic sol. of ferric hydroxide is formed.

Lab. Photo:

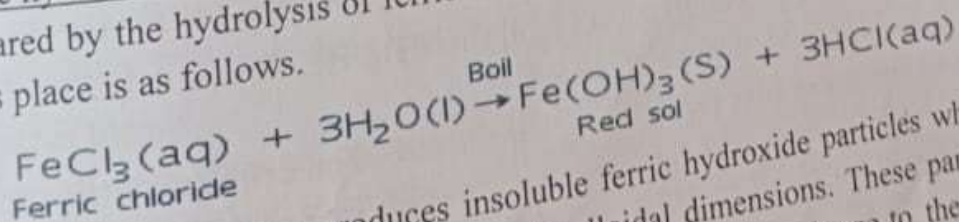


Comment:

The word lyophobic means 'liquid-hating'. That means in these sols, there is little or no interaction between the dispersed phase and the dispersion medium ie, dispersed phase has little affinity for dispersion medium. These sols are easily precipitated by the addition of small amounts of electrolyte, by heating or by shaking, therefore these sols are relatively less stable than lyophilic sols. They need stabilizing agents for their preparation. If water is used as the dispersion medium, lyophobic sols are called hydrophobic sols. Examples of lyophobic sols include sols of metals and their insoluble compounds like sulphides and oxides.

Ferric Hydroxide Sol.

Ferric hydroxide forms lyophobic sols on treatment with water. Ferric hydroxide sol is prepared by the hydrolysis of ferric chloride with boiling distilled water. The reaction takes place is as follows.



The hydrolysis reaction produces insoluble ferric hydroxide particles which undergo aggregation to yield bigger particles of colloidal dimensions. These particles absorb Fe^{+3} ions preferentially from the solution to give positive charge to the sol particles. Stability of sol is due to the charge on the sol particles. Hydrochloric acid produced during hydrolysis must be removed from the sol because it destabilizes the sol. HCl can be removed from the sol by dialysis process otherwise sol will not be stable.

a- Preparation of a Lyophilic Colloid.

Procedure:

- 1- Make a paste of starch in a little amount of cold water (1 g starch dissolve in 5 mL cold water).
- 2- Boil about 100 ml of water in beaker and slowly add the starch paste to it.
- 3- Cooling, observe and comment.

Observation:

A starchy-white colour of lyophilic sol. is formed.

Lab. Photo:

Comment:

The word meaning of lyophilic means 'liquid-loving' or 'solvent-attracting'. This means that in this colloidal solution there is a strong attraction between the dispersed phase and dispersion medium, i.e., the dispersed phase has great affinity for the dispersion medium that results in the extensive solvation of the colloidal particles. In such solids, the dispersed phase does not easily precipitate and the sols are quite stable. These sols are reversible in nature. The dispersed phase obtained by the evaporation can be easily converted to the sol state by simply agitating it with the dispersion medium. Additional stabilisers are not required during their preparation. If water is used as the dispersion medium, lyophilic sols are called hydrophilic sols. Starch, gum, gelatin, egg albumin etc. are examples of lyophilic sols. Starch forms lyophilic sol. when water is used as the dispersion medium. The formation of sol is accelerated by heating. A white starch sol can be prepared by heating it and water at 100 °C. It is quite stable and is not affected by the presence of any electrolytic impurity.

b- Preparation of a Lyophobic Colloid.

Procedure:

- 1- Take 10 mL of water in a beaker.
- 2- Add 1 mL of 1% solution of sodium chloride to it.

Observation:

A deep brown colour is formed.

Lab. Photo:

Comment:

The word lyophobic means 'liquid-fearing' or 'solvent-repelling'. This means that in this colloidal solution there is no interaction between the dispersed phase and dispersion medium. The dispersed phase has no affinity for the dispersion medium that results in the extensive solvation of the colloidal particles. In such solids, the dispersed phase does not easily precipitate and the sols are quite stable. These sols are reversible in nature. The dispersed phase obtained by the evaporation can be easily converted to the sol state by simply agitating it with the dispersion medium. Additional stabilisers are not required during their preparation. If water is used as the dispersion medium, lyophilic sols are called hydrophilic sols. Starch, gum, gelatin, egg albumin etc. are examples of lyophilic sols. Starch forms lyophilic sol. when water is used as the dispersion medium. The formation of sol is accelerated by heating. A white starch sol can be prepared by heating it and water at 100 °C. It is quite stable and is not affected by the presence of any electrolytic impurity.

Ferric Chloride Sol

Ferric Hydroxide Sol

Preparation of Ferric Hydroxide Sol

Procedure:

Observation:

Comment:

Lab. Photo:

The h

aggre

Fe³⁺

Stabi

durin

can

c- Electrical Charges on Colloidal Particles.

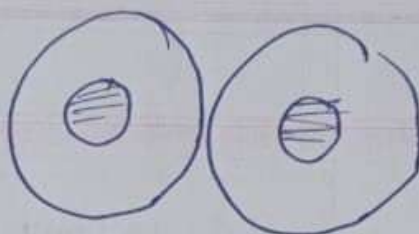
Procedure:

- 1- Take two filter paper Whattman no 1.
- 2- Add to the first one drop of Methylene blue solution.
- 3- Add to the other filter paper drop of Congo red solution.
- 4- After some time (1-2 hours) observe the two drops.

Observation:

Methylene blue does not spread leaving only water to diffuse.
Congo red spreads together with water.

Lab. Photo:



Comment:

Colloidal particles possess a definite type of electrical charge. In a particular colloidal solution, all the colloidal particles carry the same type of charge, while the dispersion medium has an equal but opposite charge. Thus, the charge on colloidal particles is balanced by that of the dispersion medium and the colloidal solution as a whole is electrically neutral. For example, in a ferric hydroxide sol, the colloidal ferric hydroxide particles are positively charged, while the dispersion medium.

Based on the nature of charge, the colloidal sols may be classified as positively charged and negatively charged sols. Some common examples of these sols are given below.

Positively charged sols:

Metallic hydroxide sols e.g., $\text{Fe}(\text{OH})_3$, $\text{Al}(\text{OH})_3$, $\text{Cr}(\text{OH})_3$, etc., TiO_2 sol, haemoglobin, sols of basic dyes such as Methylene blue etc.

So particles of methylene blue (+ve charge) are adsorbed on cellulosic filter paper (-ve charge) and hence not spread, while water only spreads by capillarity.

Negatively charged sols:

Metal sols e.g., Au, Ag, Cu, Pt etc. sols, metal sulphide sols e.g., As_2S_3 , CdS etc. sols; starch sol, cellulose, sols of acid dyes such as Congo red etc.

So particles of Congo red (-ve charge) are not adsorbed on cellulosic filter paper (-ve charge) and hence spread together with water.

e- Dialysis.

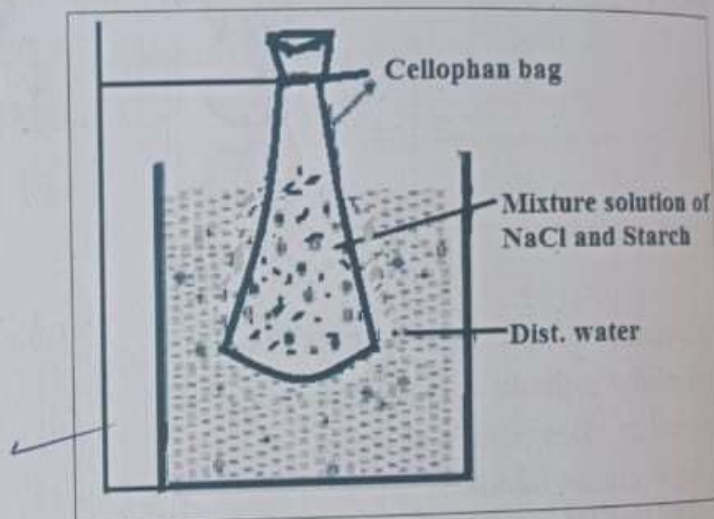
Procedure:

- 1- Prepare mixture solution of starch and NaCl then half fill a Cellophane bag.
- 2- Closed the bag and hang the cellophane bag in beaker containing dist. water
- 3- Leave the apparatus for some times (3-5 hrs)
- 4- Test the external solution with iodine and silver nitrate respectively.
- 5- Observe the two tests.

Observation:

- 1- White ppt.... in silver nitrate tube.
- 2- No blue colour...in iodine tube.

Lab. Photo:



Comment:

The process of separating particles of colloid from that of the crystalloid by means of diffusion through a suitable membrane is called dialysis. Colloidal particles cannot be passed through a parchment membrane and Cellophane bag, but the ions of the electrolyte can pass through it. This property is used in dialysis. The apparatus used in this method is called dialyzer.

- 1- The NaCl ions, being a crystalloids possesses a small ions which slowly diffused out of the bag leaving behind the pure colloidal solution, so it appears in outside water. So NaCl ions react with silver nitrate forming a white ppt. of silver chloride.
- 2- Starch, being a colloid, possesses larger particles which cannot diffuse out of the bag, so it not appears in outside water. So iodine solution does not form a blue colour due to absence of starch.

d- Adsorption.

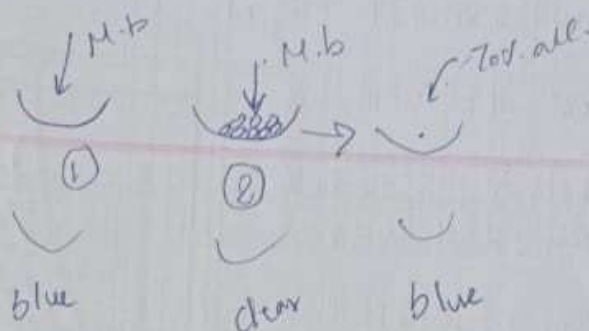
Procedure:

- 1- Filter methylene blue solution through Filter paper Whatman No. 1 in first tube.
- 2- Filter another methylene blue solution through filter paper Whatman No. 1 and on it activated charcoal in the second test tube.
- 3- Wash the filter paper with the charcoal from the previous step with 75% ethanol in the third test tube.

Observations:

- 1- The filtrate is blue. 2- The filtrate is clear. 3- The filtrate is blue.

Lab. Photo:



Comment:

Adsorption is the phenomenon of attracting and retaining the molecules of a substance on the surface of a liquid or solid resulting into a higher concentration of molecules on the surface. The substance adsorbed on the surface is called adsorbate and the substance on which it is adsorbed is called adsorbent. The surface where the process takes place is called interface.

- 1- The particles of methylene blue dye solution diffuse through filter paper and so the filtrate is blue.
- 2- The activated charcoal possesses the power of adsorption of particles of methylene blue dye on its surface, so cannot pass through filter paper while water passes only and so the filtrate is clear.
- 3- By adding ethanol alcohol, the attraction between ethanol and methylene blue particles is greater than that between charcoal and methylene blue dye, hence the adsorbed particles of MB are released and so the filtrate appears blue.

b- Rate of Diffusion of ions.

Procedures:

- 1- Prepare 10% hot gelatin in test tubes
- 2- add 2ml of NaOH, Pottasium ferrocyanide ($K_4[Fe(CN)_6]$) and drops of Ph.
- 3- Let the tube solidify
- 4- Add to the tube 2ml of $FeCl_3$ solution
- 5- Incubate the tube over night and observe the tube after incubation

Observation:

A colourless zone followed by a blue zone appears slowly following on another respectively.

Lab. Photo:

Comment:

Diffusion is the net movement of molecules or atoms from a region of high concentration to a region of low concentration, depending on size and mass of diffusing ions. $FeCl_3$ solution ionizes into Fe^{+++} and Cl^- , both ions can diffuse through gelatin but the rate of diffusion depends upon their sizes and masses. So Cl^- being smaller in size and lighter in mass than Fe^{+++} and hence diffuse faster forming a colourless zone due to neutralization of NaOH. While Fe^{+++} being bigger in size and heavier in mass than Cl^- and hence diffuse slower forming a blue zone due to reaction with Pottasium ferrocyanide $K_4[Fe(CN)_6]$ forming a blue Ferric ferrocyanide $Fe_4[Fe(CN)_6]_3$.

2- Diffusion ✓

Diffusion is the net movement of molecules or atoms from a region of high concentration (or high chemical potential) to a region of low concentration (or low chemical potential). This is also referred to as the movement of a substance down a concentration gradient. A gradient is the change in the value of a quantity (e.g., concentration, pressure, temperature) with the change in another variable (usually distance).

a- Diffusion of Starch and Iodine through Gel.

Procedure:

- 1- Prepare 10% hot gelatin in two test tubes
- 2- The first test tube add 3ml iodine solution
- 3- The second test tube add 3ml starch solution
- 4- Let the tubes solidify
- 5- Add to the first tube starch solution and to the second one add iodine solution
- 6- Incubate the two tubes over night and observe the two tubes after incubation

Observation:

- 1- No blue colour appears, 2- A blue colour appears at the top of gelatin.

Lab. Photo:

Comment:

Diffusion is the net movement of molecules or atoms from a region of high concentration to a region of low concentration, depending on size of diffusing particles. Iodine, being a crystalloid, possesses small molecules which can diffuse rapidly through gelatin giving blue colour with starch which was mixed with gelatin. Starch, being a colloid, has large particles which cannot diffuse through gelatin so no blue colour appears with iodine which was mixed with gelatin.

3- Osmosis

Osmosis is the process whereby water moves across a cell membrane by diffusion. Diffusion takes place when the molecules of a substance tend to move from areas of higher concentration to areas of lower concentration. The process of osmosis must be tightly controlled by cells, otherwise they will die.

In plants, osmosis is just as important. Plants with too little water will wilt. This happens when water moves out of the cells by osmosis. Without this water there is little pressure inside the cells and the plant can no longer support itself against the pull of gravity. However, after watering the plant, the cells become turgid with water and the plant stands upright.

a- Osmosis by Thistle Funnel Osmoscope.

Procedures:

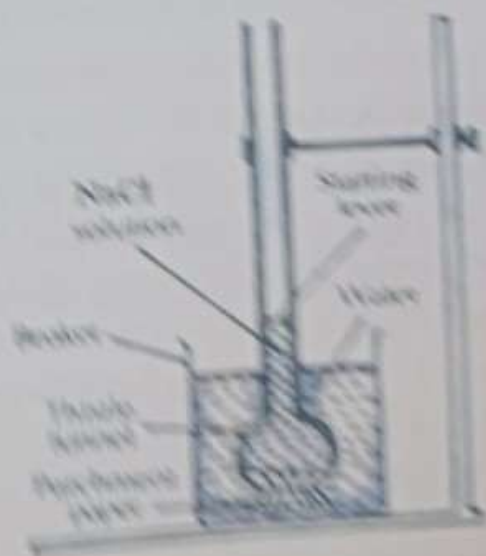
- 1- Close the mouth of Thistle funnel by parchment (or cellophane membrane), then fill the funnel with conc. NaCl solution
- 2- Suspend the funnel in a beaker containing dist. Water
- 3- Leave the apparatus for some time and observe the level of the salt solution inside the funnel during the incubation period.

Observation:

The level of the solution inside the stem of the funnel rises up.

After long time the level of the solution inside the stem of the funnel will fall down.

Lab. Photo:



Draw the change in the level of the salt solution in the funnel during incubation.

c- Osmosis by Tissue Tension.

Procedure:

- 1- Take fresh *Ricinus* petiole and cut longitudinally to equal half (observe that the parts will have curvature toward the pith cells)
- 2- Prepare three different salt solutions (isotonic, hypotonic and hypertonic).
- 3- Put in each of the three solutions parts of the *Ricinus* petiole.
- 4- Incubate overnight and observe the curvature of the *Ricinus* petiole curvature.

Observations:

In hypotonic soln. the curvature of the *Ricinus* petiole increases.

In hypertonic soln. the curvature of the *Ricinus* petiole decreases.

In isotonic soln. the curvature of the *Ricinus* petiole not changes.

Lab. Photo:

Comment:

Osmosis is the process whereby water moves across a cell membrane by diffusion from areas of higher concentration to areas of lower concentration.

In hypotonic soln., the curvature of the *Ricinus* petiole increases owing to further expansion of the parenchyma cells due to the diffusion of water into them by endosmosis.

In hypertonic soln. the curvature of the *Ricinus* petiole decreases so that they become straight or may reversed. The osmotic pressure of such soln. is greater than the suction force of the parenchyma cells of pith leading to water lost by exosmosis.

In isotonic soln. the curvature of the *Ricinus* petiole not changes owing to the osmotic pressure of such soln. is equal to the suction force of the parenchyma cells of pith leading to no movement of water.

Permeab
the membra
The cell wa
and cutin b
The plasma

a- Effe Proced

- 1- Cu
- 2- Ri
- 3- Pi
- 4- U
- 5- C
- 6- S

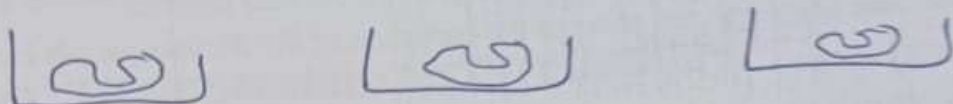
Ob

- 1- Col
 - 2- Lig
 - 3- De
- Lab.

Co

P
the
Per
inc
red
inc
as
di

Lab. Photo:



Comment:

Osmosis is the process whereby water moves across a cell membrane by diffusion from areas of higher concentration to areas of lower concentration.

In cube 1: NaCl crystals will dissolve in diffused cell sap to form a hypertonic soln. as the outer soln and so the water move out the cube by exosmosis. The cube becomes flaccid and the cavity filled with cell sap.

In cube 2: NaCl crystals will dissolve in diffused cell sap to form a hypertonic soln. so the water move out the cube to the salt cavity. While the outer soln. is hypotonic and so water move into the cube by endosmosis. The cube size not changes or slightly increase in size and the cavity filled with cell sap.

In cube 3: There is no NaCl soln. and the cavity and outer soln. is hypotonic (water only) and so water move into the cube by endosmosis from outside water. The cube becomes turgid and the cavity not filled with cell sap.

4- Permeability

Permeability is a property of membranes which determines the capacity with which the membranes allow materials to pass through them.

The cell wall considered to be permeable unless it contains large proportion of supran and cutin both of which are relatively impermeable to water and solutes.

The plasma membranes are considered to be selectively semi permeable.

a- Effect of Temperature on Permeability.

Procedures:

- 1- Cut the cylinders of beetroot into thin discs of about 3 mm thick.
- 2- Rinse the beetroot discs in running water to wash off pigment that leaked out as a result of cutting.
- 3- Pipette 5 cm³ of water into 3 test tubes and labeled as room temperature, 45°C and boiling.
- 4- Use a water bath to adjust the temperature of the test tubes.
- 5- Gently lower 5 pieces of beet root discs into the tubes and leave the tubes for 20 minutes.
- 6- Shake the tubes well and compare the intensity of red color in each tube.

Observation:

- 1- Colourless soln. at room temperature
- 2- Light Red soln. at 45°C
- 3- Deep red soln. at boiling.

Lab. Photo:

Comment:

Permeability is a property of membranes which determines the capacity with which the membranes allow materials to pass through them.

Permeability is increase with increasing the temperature within certain limits as increasing temperature till 45°C is reversible, thus allowing a slow diffusion of the red colour pigment (Anthocyanin) of beet root cells through plasma membrane. While increasing temperature more than 50°C, increase of permeability become irreversible as it cause denaturation of the plasma membrane components, thus allowing a rapid diffusion of the red colour pigments.

b- Effect of Anaesthetics on Permeability.

Procedures:

- 1- Cut the cylinders of beetroot into thin discs of about 3 mm thick.
- 2- Rinse the beetroot discs in running water to wash off pigment that leaked out as a result of cutting.
- 3- Prepare two test tubes the first contains cotton piece saturated with chloroform the other one contains cotton piece saturated with water
- 4- Hang in each tube disc of beet root and closed the tubes with cork
- 5- Observe the color of the cotton piece in the two tubes

Observation:

- 1- Red colour of the cotton piece + Chloroform
- 2- No change of the color of cotton piece + Water.

Lab. Photo:

Comment:

Permeability is a property of membranes which determines the capacity with which the membranes allow materials to pass through them.

Very low concentrations of anaesthetic decrease the permeability and this is reversible, while high concentration of anaesthetic cause increase the permeability and if this effect is left for long time this increase will be irreversible as high concentration of anaesthetic dissolve the lipids components of the plasma membrane. Color the cotton piece wetted with Chloroform take red colour due to Chloroform vapour cause an irreversible increase in permeability of the red colour pigment (Anthocyanin) of beet root cells.

c- Effect of Antagonism on Permeability.

Procedures:

- 1- Cut the cylinders of beetroot into thin discs of about 3 mm thick.
- 2- Rinse the beetroot discs in running water to wash off pigment that leaked out as a result of cutting.
- 3- Prepare 3 test tubes the first contain NaCl solution, the second contain CaCl_2 solution and the third contain mixture of the two previous solutions.
- 4- Gently lower 5 pieces of beet root discs into the tubes and leave the tubes for 20 minutes.
- 5- Shake the tubes well and compare the intensity of red color in each tube.

Observation:

- NaCl solution, and CaCl_2 solution in tubes 1 and 2 take red colour
- Mixture of NaCl and CaCl_2 solutions in tube 3 take colourless .

Lab. Photo:

Comment:

Permeability is a property of membranes which determines the capacity with which the membranes allow materials to pass through them.

Antagonism is the phenomenon in which certain substance encounter (antagonize) the effect of the other substance.

A solution of single salt of either monovalent or divalent ions (Na^{+1} or Ca^{+2}) increase permeability of plasma membrane to red colour pigment (Anthocyanin) of beet root cells, so tube 1 and 2 take red colour.

A solution of double salts of monovalent and divalent ions (Ca^{+2} and Na^{+1}) are considered to have antagonism effect on each other on permeability, so no change in sol. colour. This can be explained as monovalent ions act on the decreasing the binding forces between adjacent components of the plasma membranes while di- or polyvalent ions act on the reverse way, binding adjacent components of the plasma membrane more closely. Also monovalent ions cause liquification of the protoplasm while the others cause solidification of the protoplasm.

5- Transpiration

Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers. Water is necessary for plants but only a small amount of water taken up by the roots is used for growth and metabolism and the excess is lost by transpiration.

Leaf surfaces are dotted with pores called stomata, and in most plants they are more numerous on the undersides of the foliage. The stomata are bordered by guard cells and their stomatal accessory cells (together known as stomatal complex) that open and close the pore.

a- Determination of absorption and transpiration rates by Potometer.

Procedure:

- 1- Use a sharp razor blade to cut a leafy shoot under water to avoid air bubbles in water stream.
- 2- Insert the leafy shoot through the hole of the stopper provided with the potometer.
- 3- Fill the potometer with water and fit the stopper holding the leafy shoot to the apparatus.
- 4- Use vaseline to seal all the connections of the apparatus.
- 5- Weight the apparatus at the beginning of the experiment (W_1) and define the level of water in the capillary tube (a).
- 6- Leave the apparatus in suitable conditions for 24 hours.
- 7- Observe the weight of apparatus (W_2) and define the level of water in the capillary tube (b).

