PHYSICAL PHARMACEUTICS-II

UNIT 1 NOTES

COLLOIDAL DISPERSION

- CLASSIFICATION OF DISPERSED SYSTEM
- CLASSIFICATION PF COLLOIDS
- GENERAL PROPERTIES OF COLLOIDS
- OPTICAL, KINETIC AND ELECTRICAL PROPERTIES
- EFFECT OF ELECTROLYTES
- COACERVATION
- PEPTIZATION
- COACERVATION

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Colloidal Dispersion

- A Colloidal Dispersion is a mixture in which small particles of one substance are evenly distributed throughout other substance.
- The dispersed particles are not dissolved but remain suspended due to their small size & interaction with dispersion medium.
- The size of particles ranging from 1 nm to 1 um.
- It consist of two phases :

① Dispersed Phase : The substance that is dispersed in the mixture.

② Dispersion Medium : The substance in which dispersed phase is distributed.

Classification Of Dispersed System

- Dispersed Systems are classified based on the size of dispersed particles.
- The three main type of dispersed system are as follows :

① Molecular Dispersion
② Colloidal Dispersion
③ Course Dispersion

① Molecular Dispersion

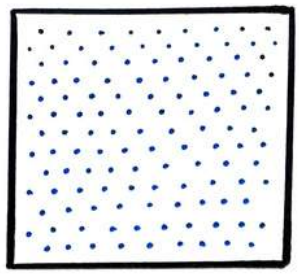
- Molecular Dispersion are true solutions.
- Particle size in molecular dispersion are less than 1 nm.
- They are Homogenous nature.
- In this particles are not visible even under electron microscope.
- Example : Salt Solution, Sugar Solution.

② Colloidal Dispersion

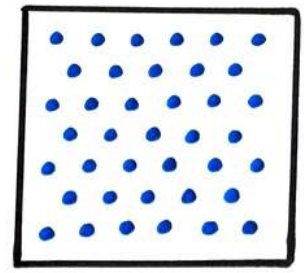
- Colloidal Dispersion are micro - heterogenous dispersed systems.
- Particle size ranges from 1 nm to 1000 nm.
- They are Heterogenous but appeared homogenous with naked eyes
- Particles are not visible to naked eyes but can be seen under electron microscope.
- Example : Milk, Fog.

③ Coarse Dispersion

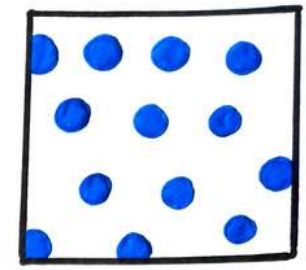
- Coarse dispersion are heterogenous dispersed systems.
- In coarse dispersion particle size are greater than 1000 nm.
- In this particles size are large enough to be seen with naked eyes and tend to settle over time.
- Example : Pharmaceutical Emulsions & Suspensions.



Molecular Dispersion



Colloidal Dispersion



Coarse Dispersion

Difference Between Molecular, Colloidal & Coarse Dispersion

Properties	Molecular	Colloidal	Coarse
Particle Size	Less than 1 nm	1 nm - 1000 nm	Greater than 1000 nm
Visibility	Invisible even under Electron Microscope	Visible under Electron Microscope	Easily Visible
Diffusion	Undergo rapid diffusion	Diffuse very slowly	Do not diffuse
Sedimentation	Do not settle down	Settle Under high Centrifugation	Fast Sedimentation
Filtration	No Residue	No Residue	Residue Formed

Classification Of Colloids

Colloids can be classified on the basis of following 2 parameters :

- Based on state of Dispersed Phase & Dispersion Medium .
- Based on interaction between phases

Based On State Of Dispersed Phase & Dispersion Medium

Dispersed Phase	Dispersion Medium	Type Of Solution	Example
Solid	Solid	Solid Solution	Gemstones
Solid	Liquid	Sol	Paints
Solid	Gas	Aerosol of Solids	Smoke , Dust in Air
Liquid	Solid	Gel	Jelly , Butter
Liquid	Liquid	Emulsion	Milk
Liquid	Gas	Aerosol	Mist , Fog
Gas	Solid	Solid Foam	Foam Rubber
Gas	Liquid	Foam	Shaving Cream

Based On Interaction B/W Phases

On the basis of interaction between ph dispersed phase & dispersion medium, it can be classified into following 3 types:

① Lyophilic Colloids
② Lyophobic Colloids
③ Association Colloids

① Lyophilic Colloids

- Lyophilic Colloids are colloidal systems in which the dispersed phase has a strong affinity for the dispersion medium.
- The term 'Lyophilic' is derived from two greek words 'Lyo' means 'dissolve' and 'philic' means 'loving'.
- The strong interaction between the dispersed phase & solvent make these colloids stable and easy to form.
- Example: Gelatin in water
  Starch in water
  Cellulose derivatives in water

② Lyophobic Colloids

- Lyophobic Colloids are colloidal systems in which the dispersed phase has very little or no affinity for the dispersion medium.
- The term 'Lyophobic' is derived from two greek words 'Lyo' means 'dissolve' & 'phobic' means 'fear'
- Because the dispersed phase has poor interaction with dispersion medium, these colloids are thermodynamically unstable and tend to coagulate or precipitate with time
- Example: Gold & Silver in Water.

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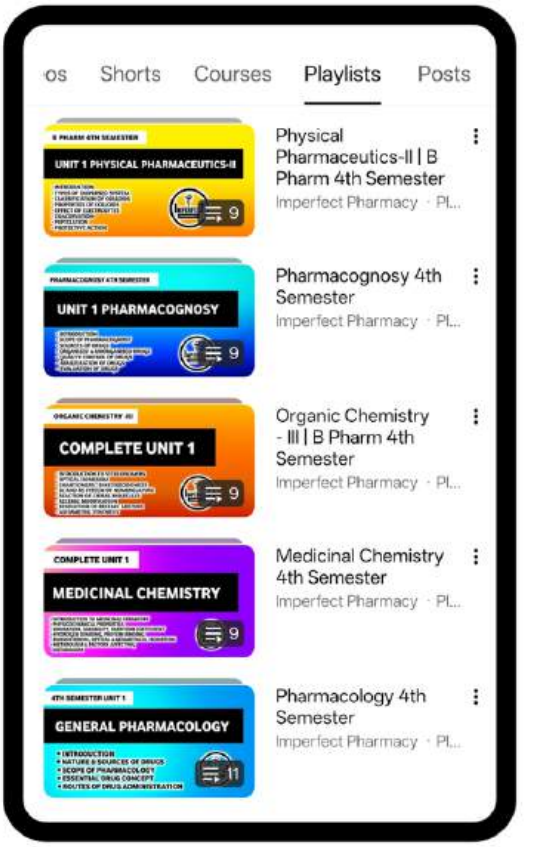

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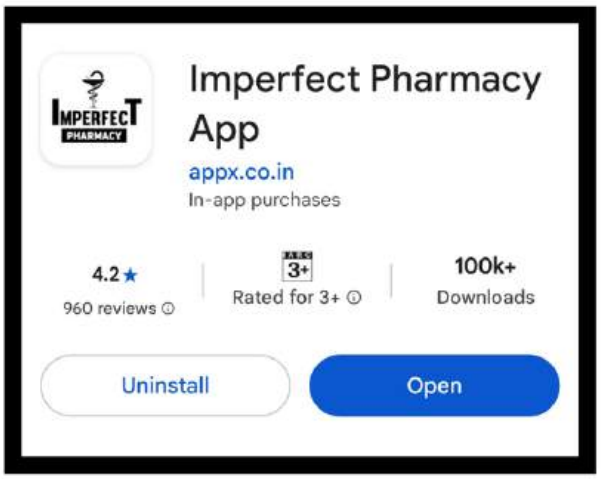


③ Association Colloids

- Association Colloids are a type of colloidal system in which the dispersed phase consists of aggregates of molecules or ions (called micelles) formed by the association of smaller molecules in a solvent.
- These smaller molecules are typically surface-active agents that have both hydrophilic and hydrophobic parts
- The formation of association colloids occurs when the concentration of surfactants exceeds a critical value called the Critical Micelle Concentration.
- Below the CMC, the surfactant molecules exist as individual molecules, but above the CMC, they aggregates to form Micelles, leading to the formation of a colloidal system.

PROPERTIES OF COLLOIDS

Properties of Colloids can be divided into 3 categories :

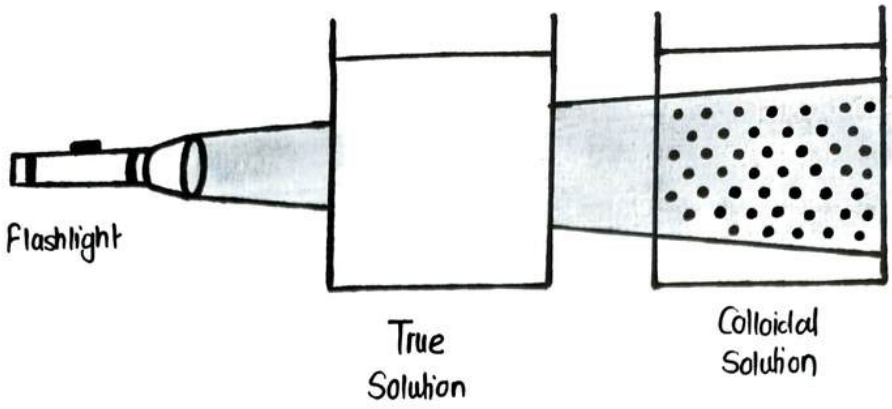
① Optical Properties
② Kinetic Properties
③ Electrical Properties

① OPTICAL PROPERTIES

- Optical properties of colloids refer to how colloidal particles interact with light, including how they reflect, refract, scatter and absorb light.
- These properties are important for understanding the appearance, stability and behaviour of colloidal system.
- Optical Properties include :

ⓐ Tyndall Effect
ⓑ Absorption of light
ⓒ Fluorescence
ⓓ Opalescence

ⓐ **Tyndall Effect** :
- The tyndall Effect in colloids is the phenomenon where beam of light becomes visible when it passes through a colloidal solution due to scattering of light by dispersed particles
- This effect is not observed in true solutions because their particles are too small to scatter light.
- A common example of tyndall effect is when sunlight streams through a dusty room or fog making the light path visible.



TYNDALL EFFECT

② Absorption of Light :
- Colloids can selectively absorb light at specific wavelengths depending on the nature of dispersed phase and dispersion medium.
- Metal sols, such as gold & silver, display distinct colors due to absorption of specific wavelength of light.

③ Fluorescence :
- Some colloids exhibit fluorescence when exposed to light of certain wavelength.
- Fluorescent Colloids absorb light at one wavelength and emit it at a longer wavelength.

④ Opalescence :
- Opalescence is the milky or pearly appearance of a colloidal solution due to scattering and interference of light.

② KINETIC PROPERTIES

- Kinetic properties of colloids refer to the movement & behaviour of colloidal particles in a dispersion medium due to their small size & interaction with surrounding medium.
- These properties include :

ⓐ Brownian Motion
ⓑ Diffusion
ⓒ Sedimentation
ⓓ Viscosity

ⓐ **Brownian Motion** :
- Brownian motion is the random, zigzag movement of tiny particles suspended in a liquid or gas.
- This happens because the particles are constantly hit by invisible molecules of dispersion medium.
- It was first observed by Robert Brown in 1827

ⓑ **Diffusion** :
- Diffusion is the movement of colloidal particles from a region of higher concentration to a region of lower concentration due to brownian motion.

ⓒ **Sedimentation**
- Sedimentation refers to the settling of colloidal particles under the influence of gravity or centrifugal force.
- It occurs only when particle size large enough to settle.

ⓓ Viscosity :

- Viscosity in colloids refers to how thick or sticky a colloidal solution is when it flows.
- It depends on size, shape & concentration of dispersed particles.

③ ELECTRICAL PROPERTIES

- Electrical Properties of colloids refer to how colloidal particles carry an electric charge & how they behave when exposed to electrical forces.
- These properties Includes :

ⓐ Electrical Double Layer
ⓑ Zeta Potential
ⓒ Electrophoresis

ⓐ **Electrical Double Layer** :
- When a colloidal particles gets charged, it attracts opposite charges from the surrounding medium, forming two layers around it
- It has two parts :

① Inner layer (fixed layer)
② Outer layer (diffuse layer)

ⓑ **Zeta Potential** :
- Zeta Potential is the measure of how strongly the charges in the electrical double layer keep particles from sticking together.
- High zeta potential → Strong Repulsion → Stable Colloid.
- Low Zeta Potential → Weak Repulsion → Particles stick together & form clumps.

© Electrophoresis : When an electric field is applied, charged colloidal particles move toward the oppasite electrode.

- Positively charged particles → Move toward the negative electrode
- Negatively charged particles → Move toward the positive electrode

EFFECT OF ELECTROLYTES

Effect of Electrolytes in colloidal dispersion refers to how the addition of electrolytes (salts, acids or bases) influences the stability and behaviour of colloidal particles.

Precipitation Of Colloids by Electrolytes

- Colloidal Particles carry a charge (positive or negative), which creates repulsion between them & keeps them dispersed.
- Electrolytes release oppositely charged ions in the solution, which get attracted to the charged surface of colloidal particles.
- This reduces or cancels out the surface charge, lowering the zeta potential.
- Reduced charge decreases repulsion → Particles come closer → Coagulation (clumping) occurs.

Example

Adding NaCl to a negatively charged clay sol reduces the charge and causes the particles to aggregate.

COACERVATION

- When two oppositely charged hydrophilic colloids are mixed, a colloidal rich layer separates which is known as **Coacervate**.
- And the phenomenon in which separation takes place on mixing two colloidal dispersion is known as **Coacervation**.

Example

- Gelatin is positively charged and acacia having negatively charged particles. When these two are mixed together, two layers are formed
- The upper layer of low viscosity having a poor concentration of colloidal material and a lower layer of higher viscosity containing high concentration of colloidal material.

PEPTIZATION

- Peptization is the process by which precipitated particles are converted back into a stable colloidal dispersion by adding a suitable electrolyte or peptizing agent.
- In simple terms, it's the reverse of coagulation.

Example

- Silver Chloride Sol is peptized by adding a small amount of NaCl

PROTECTIVE ACTION

- Protective Action in colloids refers to the ability of a Lyophilic Colloid to prevent the coagulation of a Lyophobic Colloid when an electrolyte is added.

How It Works ?

- A small amount of lyophilic colloid is added to lyophobic sol.
- The protective colloid forms a thin protective layer around the lyophobic particles.
- The layer creates a barrier that prevents direct contact between the particles, reducing the effect of electrolytes.
- The entire colloid started behaving like a ~~hydrophi~~ Lyophilic Colloid.
- The colloid that helps to stabilize the other colloid is known as Protective Colloid.

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