PHYSICAL PHARMCEUTICS - II

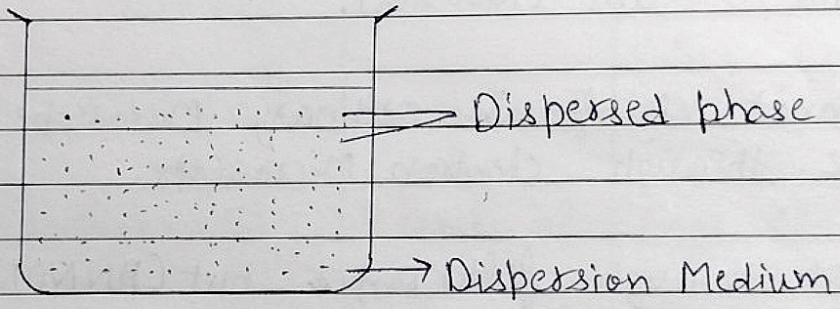
Unit - 1st

* Colloidal dispersion :- "It is a heterogenous System, which is made up of dispersed phase & dispersion Medium.

In this, one substance is dispersed as very fine particles in another substance called dispersion Medium.

The particles size of dispersed phase range from "1nm to 1um".) (1nm - 1000nm)

E.g. Glue, starch, Gelatin.



Colloidal Dispersion.

- Some other definations - [Basic types of dispersed Medium]

- Molecular dispersion → These are those dispersion in which particle size of dispersed phase is less than 1nm (nanometer).

- These are invisible in electron Microscope
- Their particles also pass through Semipermeable Membrane. Eg:- oxygen, glucose etc
  Nitrogen & other gases

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* Coarse dispersion → These are those dispersion, in which particle size of dispersed phase is More than 1 μm (micrometer / Micron)

- easily visible in ordinary Microscope.
- also retain in Normal filter paper.
- Particles also settle down under gravity.

e.g:- Suspension etc.

* Colloidal dispersion → [Colloids]
These are those dispersion, in which particle size of dispersed phase is within the range 1nm - 1 μm (1000 nm).

- Cannot visible in ordinary Microscope, but can be see through electron Microscope
- Pass through filter paper but CANNOT Pass through semi-permeable Membrane.

eg:- Milk, fog etc.

** Classification of Dispersed System

On the basis of their dispersion phase & dispersion Medium [Acc. to physical state]

- They are of eight types.

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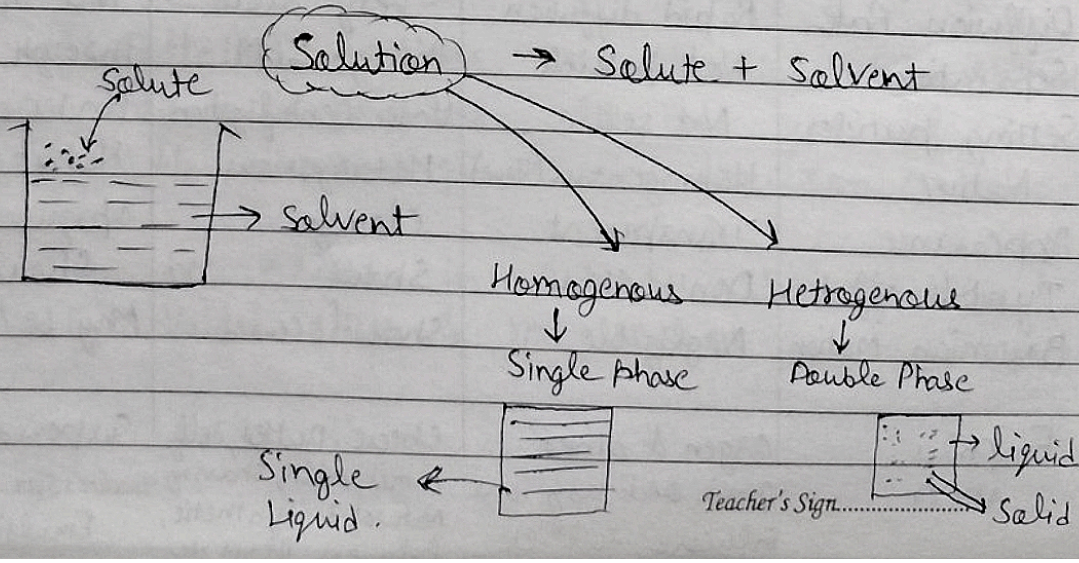
S.NO	Dispersed Phase	Dispersion Medium	Name/ System	Examples.
1	Solid (S)	Solid (S)	Solid. sol.	Colloidal gold
2	Liquid (L)	Solid (S)	Gels	Wax, gels
3	Gas (G)	Solid (S)	Solid foam	Foam Rubber.
4	Solid (S)	Liquid (L)	Solution.	Moist Paints, Proteins.
5	Liquid (L)	Liquid (L)	Emulsions	Milk
6	Gas (G)	Liquid (L)	Foam	Soap lather, Soda Water
7	Solid (S)	Gas (G)	Aerosols of solids	Smoke, Dust Storm
8	Liquid (L)	Gas (G)	Aerosols of Liquid	Fogs, Clouds.

- Gas in Gas is not formed, because Gas Mixed in gas homogeneously and Colloidal dispersion are always heterogeneous.



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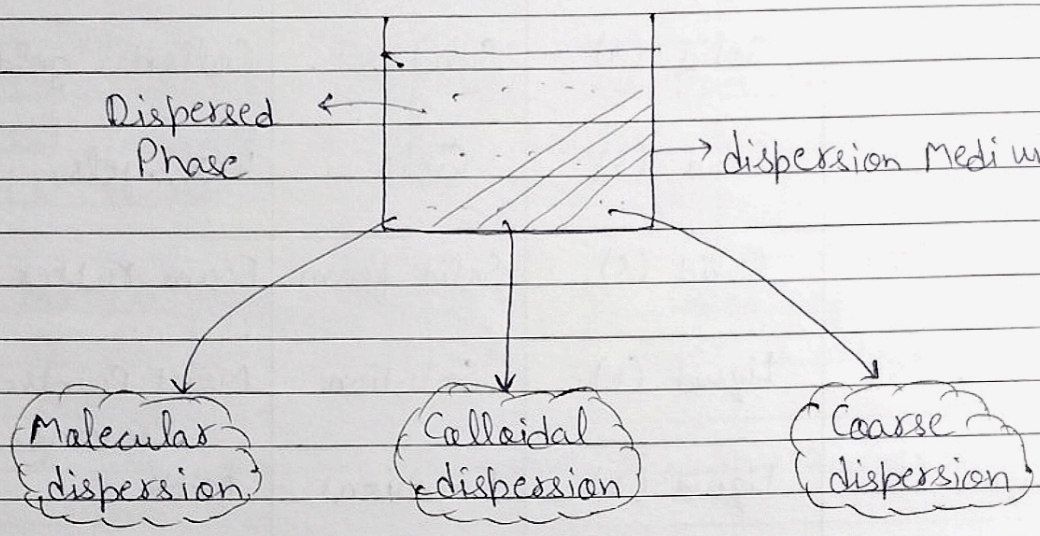
What if size More & Less than [1nm - 1μm]
<1 - 1000 <



Less than 1nm or <1nm

(1nm - 1000nm) (1nm - 1μm)

More than 1 μm >1μm or 1 Micron

General characteristics

Characteristics/ Properties	Molecular Dispersion	Colloidal Dispersion	Coarse Dispersion.
Particle size Range	Less than 1nm	1nm to 1000nm	More than 1μm
Visibility	Invisible in E.M	Visible under E.M	Visible under Normal M
Diffusion Rate	Rapid diffusion	Very slow	Not diffuse
Separation	Not possible	through S.P.M	through filter paper
Setting particles	Not settle	Under Centrifugation	under gravity
Nature	Homogenous (True)	Heterogenous	Heterogenous
Appearance	Transparent	cloudy	opaque (cloudy)
Tyndall effect	Don't Show	Show	Show
Brownian Motion	Negligible	Show (occured.	May be / may not
Examples.	oxgen & other gases ordinary ions Glucose sol^n etc	Cheese, Butter, Jelly paints, Milk, shaving Natural & Synthetic, Polymers, Blood etc	Suspension, Grains of sand Emulsions.

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Size & shapes of Colloidal properties.

- Particle size:- ACC. to particle size, they are of three types.
  (1) Molecular dispersion (less than 1nm)
  (2) Colloidal dispersion (range b/w 1nm - 1000nm)
  (3) Coarse dispersion (More than 1μm)

- Particle size influence the color of a dispersion. it is because wavelength of light is absorbed by particles.
  So, the larger the particles, shorter the wave length transmitted.

  E.g. Gold (Colloidal dispersion) → Red Colour
  Gold (Coarse dispersion) → Blue Colour

- Decreasing in particle size tend to increase surface area & large surface area enhance solubility.

  Eg:- Platinum Colloids.

Particle Shape

- Shape of Colloidal particles are depending upon Method by which they are prepared and the type of interaction b/w dispersed phase with dispersion Medium.

- They May be exists in Cubical, Spherical, Spiral thread, Cylindrical, disc & rod shaped.

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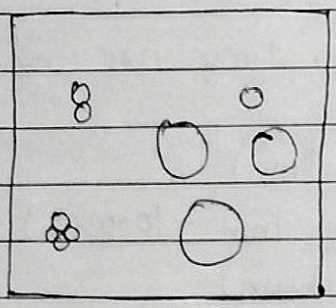
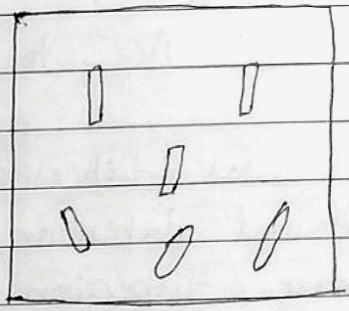
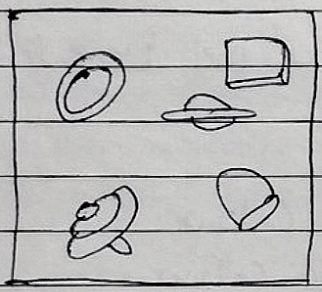
→ It visible in electron Microscope & look like as :-



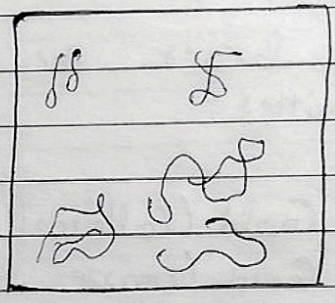
→ Spheres & globules- Surfactants



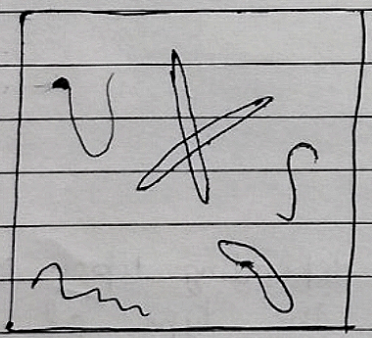
→ Short rods & Prolate ellipsoids.



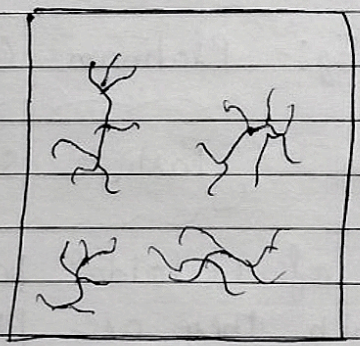
Oblate ellipsoids & flakes [Kaolin]



Loosely Coiled threads



Long rods and threads [tabacco Mosaic Virus]



Branched thread Cellulose, [Asbestos]

→ It also influenced the Color of Particles

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E.g:- Gold [Spherical Shape] → Red Color
Gold [Disc like Shape] → Blue Color

Classification of Colloids & Comparative account of their general properties

Based on nature of Interaction (affinity) b/w dispersed phase & dispersion Medium.

Three types.

1 Lyophillic Colloids
2 Lyophobic Colloids
3 Association Colloids.

Lyophilic Colloids.

(Lyo) → Solvent , (Philic) → Loving

- Also called as solvent loving Colloids.

• These are those soln, in which the dispersed phase has great attraction for the dispersion Medium.

Types

Hydrophilic
- When dispersion Medium is water
Eg:- Acacia, Albumin & Gelatin in Water

Lipophilic
- When dispersion Medium is oil (other than water)
Eg:- Rubber, Polystyrene in non-aqueous (e.g. Benzene)

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- these are thermodynamically stable (high stability)
- Viscocity of these soln generally increase on addition of dispersed Phase.

Lyophobic Colloids

Lyo → Solvent , Phobic - Hating

- Also termed as Solvent hating Colloids.

- In which the dispersed phase has very less intraction [no - affinity] for the dispersion Medium
- They are thermodynamically unstable [low stability]
- Viscocity of these soln does not increase on addition of dispersed phase
- If the dispersion Medium is water then they also called as Hydrophobic colloids.

Eg:- Metal such as Gold, silver in water.

Association Colloids.

Also Known as Amphiphilic Colloids.

- Molecules / Ions have both Polar & Non-Polar group.
- They exists separately at low Concentration.
- They associate at CMC (Critical Micelle Concentration) to form Micelle of Colloidal size.

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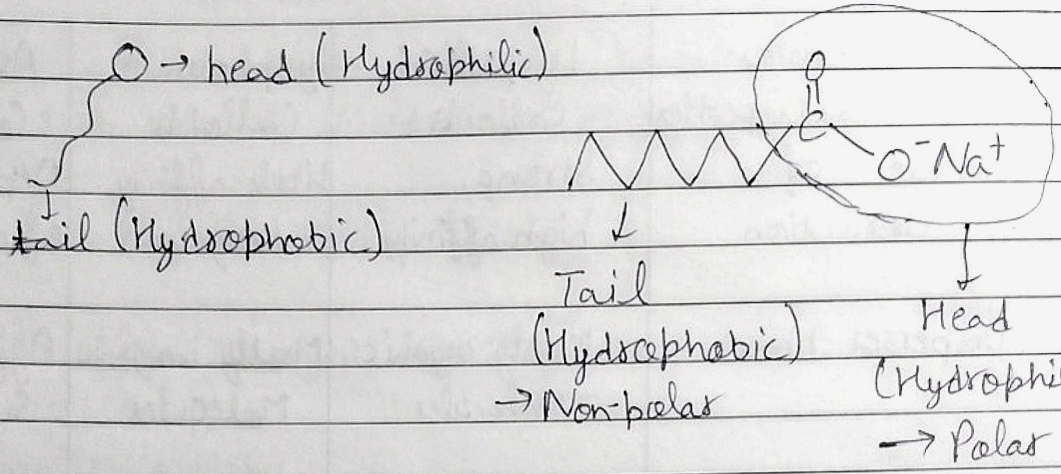
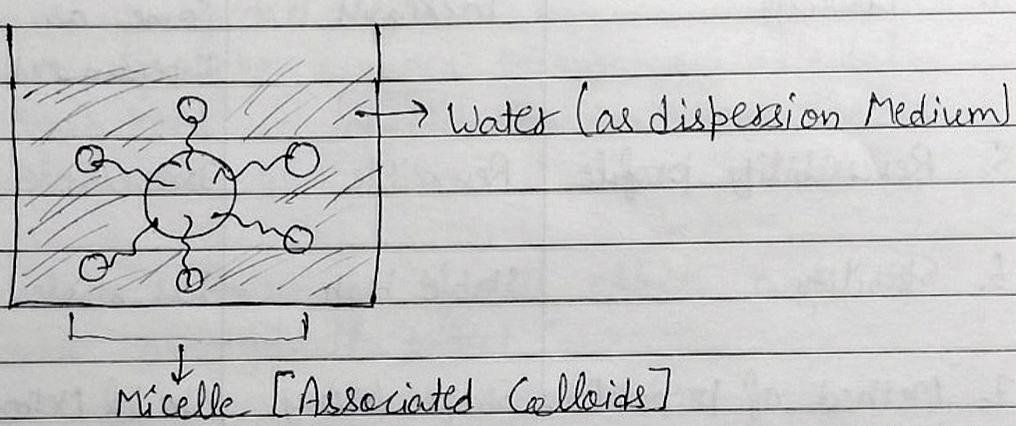
- They are also thermodynamically stable



* CMC [Critical Micelle Concentration] →
The Minimum Conc. at which Micelles are formed.



- These amphiphiles also known as surfactants.
- Viscocity increases with addition of amphiphiles.

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Comparative account of their general properties

Characteristic features / Properties	Lyophilic Colloids	Lyophobic Colloids	Association Colloids
1 Nature of Interaction	Strong, High affinity	Little affinity (very low)	Depend on type of dispersion Medium
2 Dispersed phase	Mostly organic Molecules	Mostly inorganic Molecules	Aggretion of Surfactants
3. Size	Small	large	Small
4. Visocity	increased	Same as dispersion Medium	increases
5. Reversibility profile	Reversible	Irreversible	Reversible
6. Stability	Stable high	Less stable	Stable
7. Method of preparation	Simple & Easy	Special Method Required	Depends on CMC

Optical, Kinetic & Electrical Properties

① - optical properties
2. Kinetic properties
3. Electric properties.

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Optical properties of Colloids

These properties helps helps to known about size, shape, structure & Molecular weight of Colloids.

these are followings:-

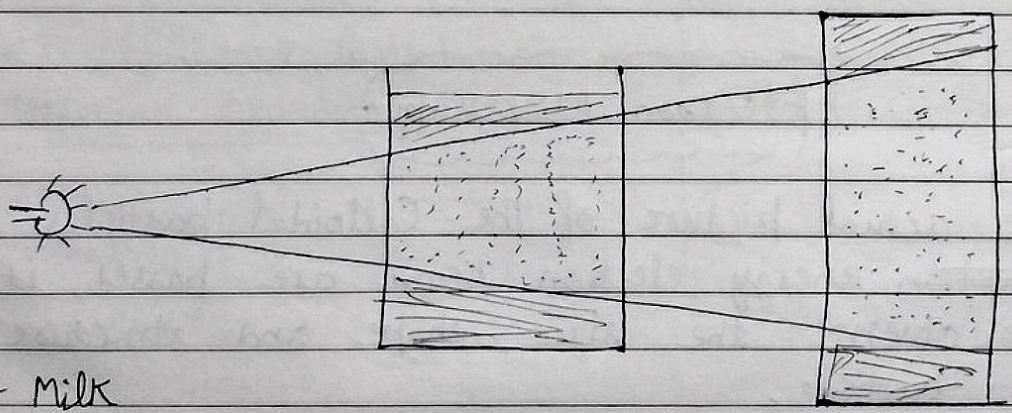
1) Tyndall effects [Light Scattering]
2) Ultramicroscopy
3) Electron Microscopy
4) Turbidity.

Tyndall effects:-

When a beam of light is passed through a Colloidal Soln (dispersion) kept in dark, the path of the beam get illuminated with blue color.

This phenomena is known as tyndall effect. and the path is known as tyndall ~~effect~~ Cone.

- The tyndall effect is due to the Scattering of light by Colloidal particles.



eg:- Milk

Colloidal dispersion

Dark Background

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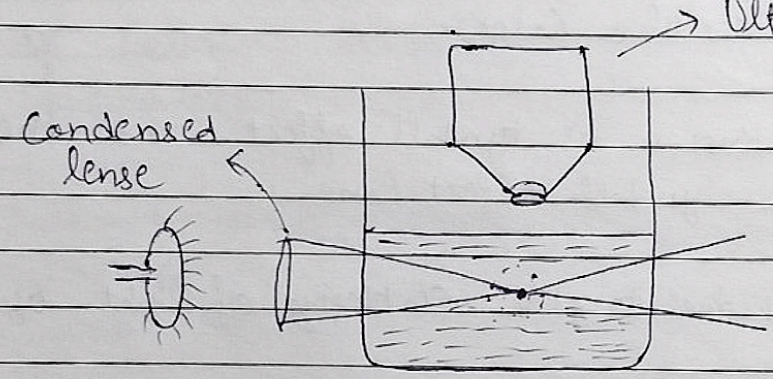
- True (Homogenous) Solution does not show this, they have small particle size.

- Heterogenous [Colloidal] dispersion show this.
  Lyophobic - Show More
  Lyophilic - Show less (no effect)

Ultra Microscopy.

When a intense light beam is passed through the Sol (Colloidal dispersion) against a dark background at right angles to the plane of observation.
The particles will appear as the bright spot which can be observed & counted.



Electron Microscopy

- It give actual picture of the Colloidal particles.
- High ~~electron~~ energy electron beam are passed, it is used to observe the size, shape and structure of Colloid particle.
- Useful in lyophilic.

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(iv) Turbidity:- All Colloidal dispersion show turbidity accosding to Molecular weight of Colloids particles Spectrophotometer are used to check this.

Turbidity ∝ Molecular weight.

② Kinetic properties of Colloids

These properties helps to Known about the Motion of Colloidal particles in Colloidal dispersion.

1 Brownian Motion (movement)
2 Diffusion
3 Sedimentation
4 Viscocity.

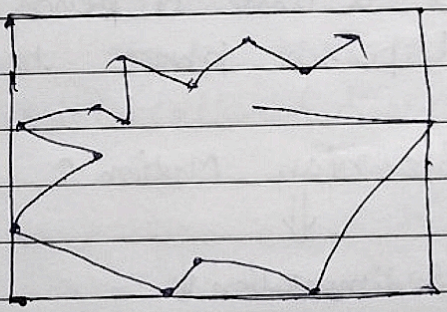
① Brownian Movement (Motion):- It is the zig-zag Motion of Colloidal particles in Colloidal dispersion in Continously random manner.

- It is given by Scientist Robert Brown.
- Particles Continous strike to each other and to the wall of Container.

- Velocity ↑ ⟶ Particle size ↓
- Brownian Movement ↑

⇓

Stability ↑



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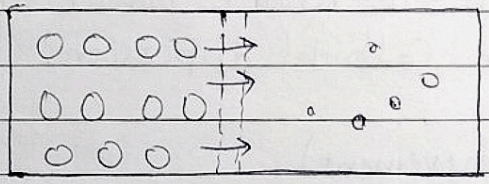
② Diffusion

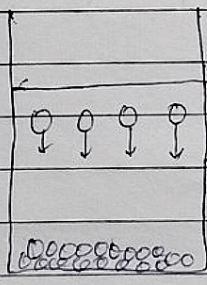
- It is the Movement of particles from an area of higher Concentration to the lower Concentration area.
- It is based on fick's first law, that particles diffuse Continously until equilibrium reached.



High Conc^{n} → Low Conc.

Sedimentation

- It is the Settling down of dispersed phase particles into dispersion Medium due to gravity.
- It is depends upon mol. weight of Colloidal particles [Mol. weight ↑ = Sedimentation]
- It is also depends upon the density difference of dispersed phase to the dispersion Medium.
- Brownian Motion ↑ ⇓ Sedimentation ↓



→ Stoke's law Used to determine Sedimentation

Sedimentation ↑ ⇒ Stability ↓

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Viscocity

- It is the resistance to fluid to flow under an applied stress.

- It is depend upon
  - Shape, size, Molecular weight
  - Interaction b/w dispersed phase & dispersion Medium

- Molecular weight ∝ Viscocity.

- Einstein describe an eqn of flow to dilute Colloidal dispersions of spherical particles.

$$\eta = \eta_0 (1 + 2.5\phi)$$

where, η_0 = Viscocity of dispersion Medium
η = Viscocity of dispersion
ϕ = Volume fraction.

Electrical properties of Colloids →

- These properties helps to known about the change on Colloidal particles in dispersion (colloidal dispersion).

(1) Electrophoresis
(2) Electrical double layer.

1) ~~Electrophor~~.

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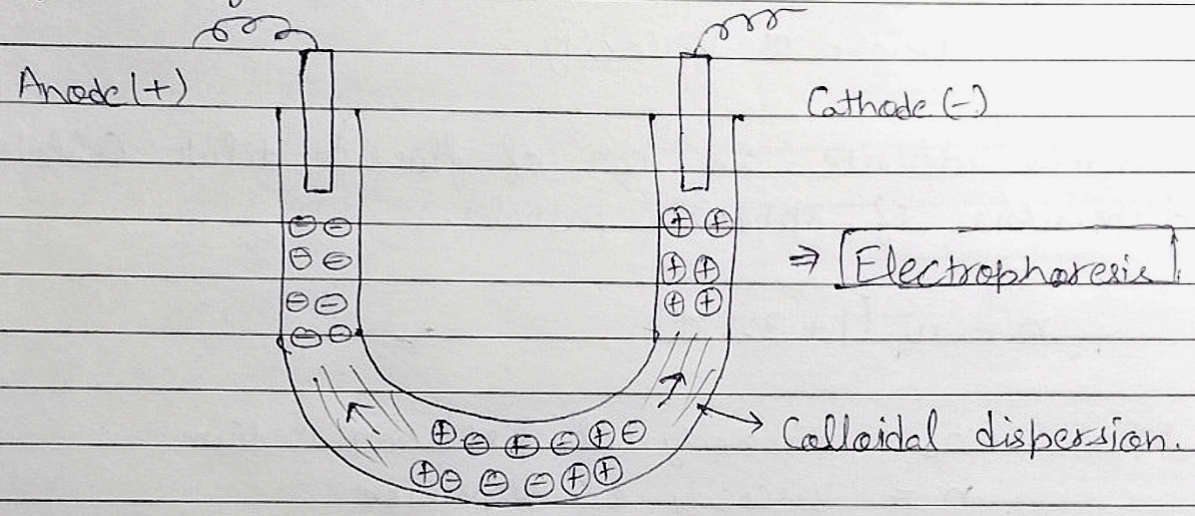
1) Electrophoresis:- When a electric field is applied on colloidal dispersion, then the particles carrying charged move towards opposite charge electrode i.e.

- Negative charged particle move towards anode (Kaoline, Sulphur)
- Positive (+) ve charged particle move towards cathode (ferric Hydroxide)



2) Electrical double layer :-
Helmholtz
Helmholtz explain it in 1879.

In this theory, at the first layer charge is imported to the surface of particles which is immovable also known as static layer [or helmholtz layer].
an the second layer consists of diffused mobile ions (adj. to first layer)

- The charge develop (present) on both the layer are equal.

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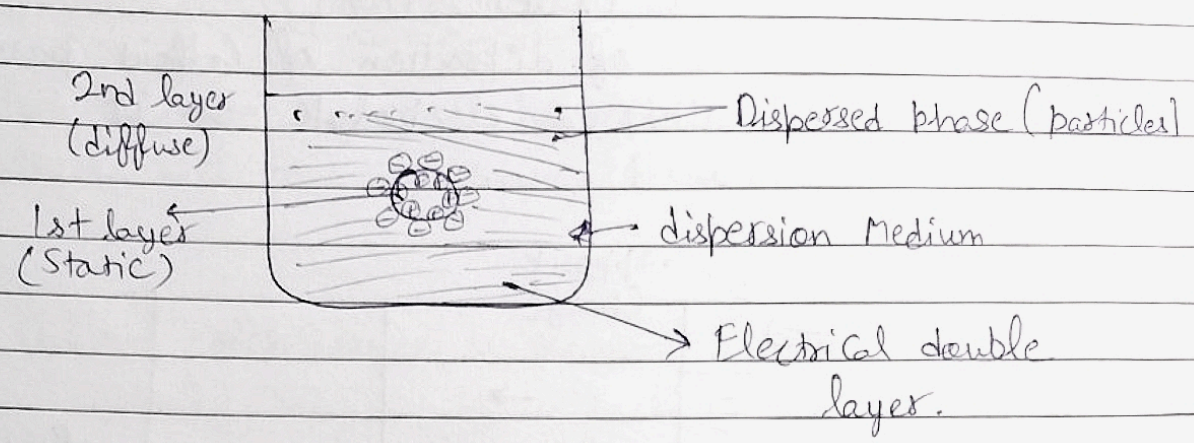


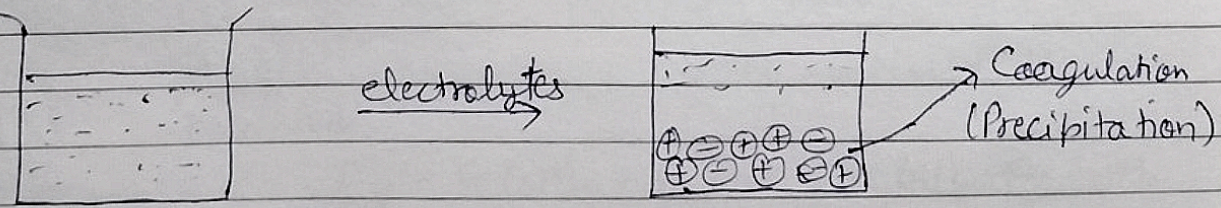
- The potential difference b/w two layer i.e. Static and diffuse layer is called Zeta potential or ElectroKinetic potential.

1) Effect of electrolytes
2) Coacervation
3) Peptization
4) Protective ~~act~~ action.

Effect of Electrolytes:

On addition or removal of electrolyte in Colloidal dispersion may affect the stability of Colloids.

- On addition of excess of electrolytes, particles of Colloidal dispersion precipitate due to accumulation of oppositely charge particles. [stability decreases]



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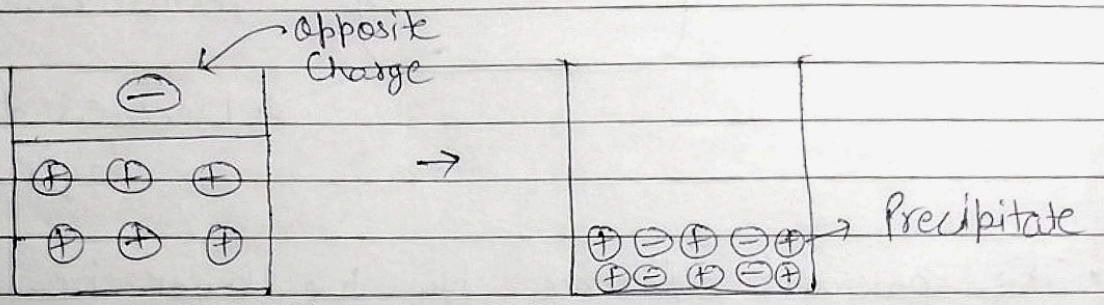
- Hardy Schulze law (rule)
  - The phenomena of deposition of Colloid particles when oppositely charged electrolyte on it [stability decreases]

e.g



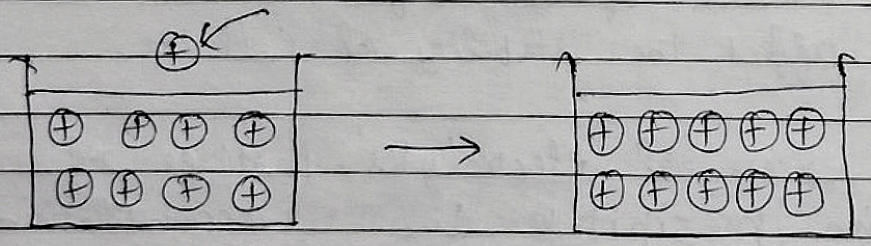
[Colloidal dispersion]

Charge on Cation / anion ∝ Coagulation / precipitation

eg:- $Al^{+3} > Mg^{2+} > Na^{+}$

$PO_4^{-3} > SO_4^{-2} > Cl^{-}$

- But If we add same charged particles then particles and electrolytes repel each other and ~~to~~ increase stability of Colloidal dispersion.



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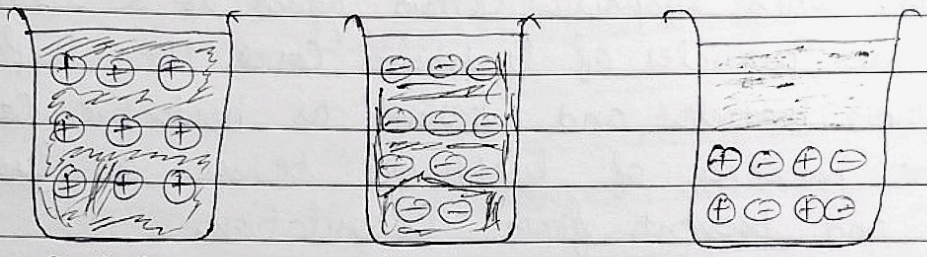
Coacervation

When two opposite charged hydrophilic colloids are mixed, then there will be separation of the colloids rich layer.

- The colloid-rich layer is known as Coacervate

This phenomenon is called Coacervation.

Eg:



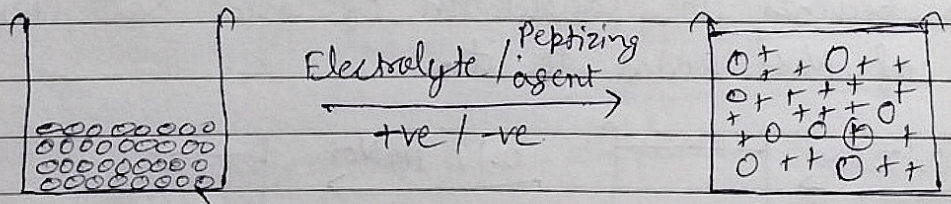
Gelatin Acacia ~~Con~~ Coacervate

[Hydrophilic Colloids]

(3) Peptization:- It is used for the formation of Stable Colloidal dispersion.

"It is the process of converting a precipitate into Colloidal dispersion.

- by shaking it with dispersion Medium in the presence of small amount of electrolyte / Peptizing agents".



Unstable Colloidal dispersion

freshly precipitate.

Stable Colloidal dispersion

Eg:- $Fe(OH)_3 + Fe^{3+}$ $Fe(OH)_2$ $Fe(OH)_2$

Precipitate electrolyte

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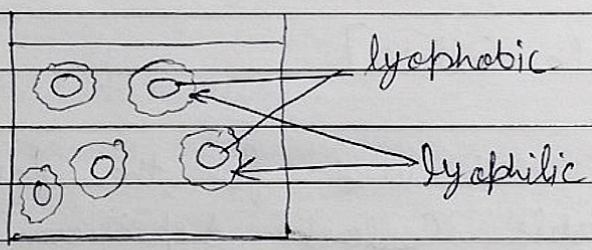
Protective action

The addition of lyophilic Colloidal solution into a lyophobic Colloidal solution prevents a lyophobic sol. from Coagulation.

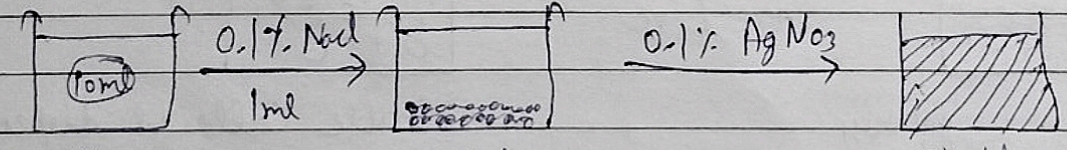
This Phenomena is known as protective action and the lyophilic Colloid used for this purpose is known as protective Colloids.

- Mechanism :- When lyophilic Colloid added to a lyophobic Colloid, the particles of lyophilic cover the surface of lyophobic particle and behave as protective colloids.
- and the particles of lyophobic behave as lyophilic Colloids and prevents from Coagulation.



[Colloidal dispersion]

⊗ Gold Number :- The amount of protective Colloids in mg, which prevents the Coagulation of Gold Sol^{n} (10ml) when 1ml of NaCl added to it.



Stable Colloid | Unstable Colloid | Stable Colloids.

APCO ⊗ Amount of 0.1% $AgNO_3$ to Make it stable.

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