MEDICAL CHEMISTRY
GENERAL CHEMISTRY

University Of Fallujah

College Of Medicine

Lecture : Medical Chemistry (6) (Colloids & Emulsions)

Stage : 1st Stage

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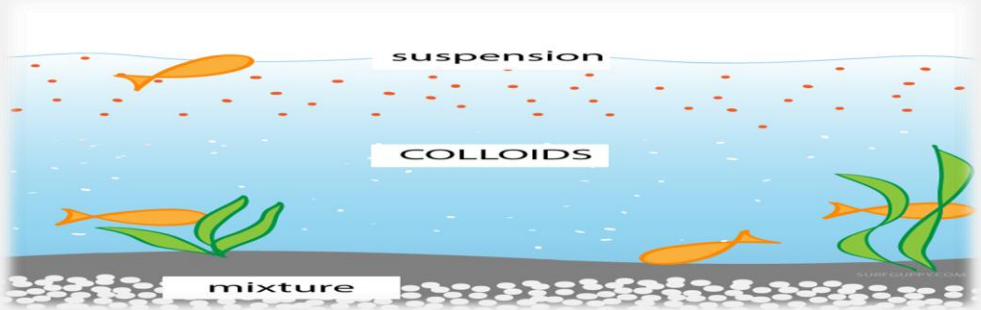
Department: Chemistry and Biochemistry department

Date: 17 / 12 / 2025

Learning Objective :

- Define colloids and differentiate them from true solutions and suspensions.
- Identify the properties and classifications of colloids based on interaction with the medium.
- Describe the preparation methods for colloids, including dispersion and condensation techniques.
- Define emulsions and Identify the factors affecting the stability of emulsions and their destabilization processes.
- Understand the functions and types of emulsifying agents in stabilizing emulsions.
- Examine the role of colloids in environmental applications like wastewater treatment and soil stabilization.
- Analyze the medical applications of colloidal systems in diagnostics, drug delivery, and therapy.

COLLOIDS & EMULSIONS



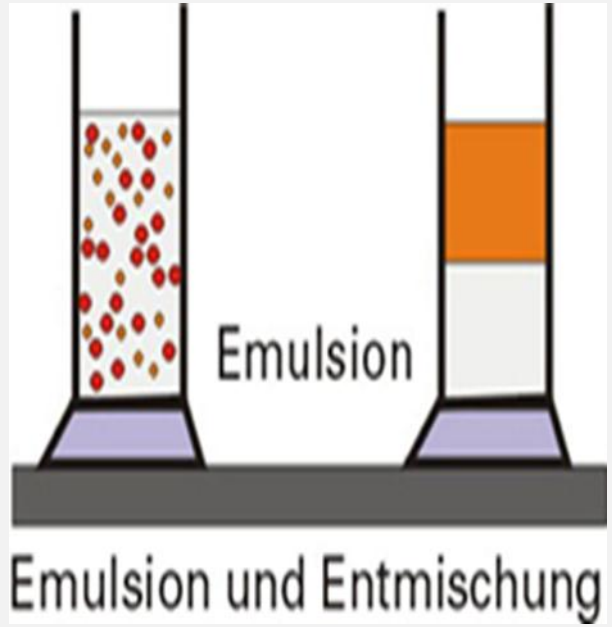
- **Introduction :**
- Definition of Colloids :- A colloid is a mixture where one substance is dispersed in another without dissolving. It consists of a two-phase system prepared by combining two immiscible liquids, one of which is dispersed uniformly throughout the other.

- Internal phase = the dispersed phase,

- External phase or dispersion medium = continuous phase.

- Characteristics:
  - Particle size ranges between 1 nm and 1 µm.
  - Displays the Tyndall effect (scattering of light).

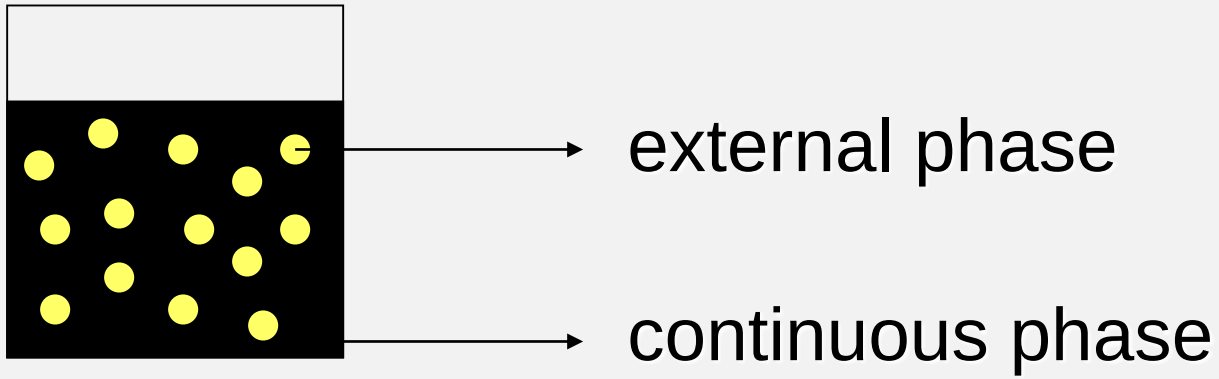
- Types of Colloids:
  -Sols, gels, emulsions, aerosols.



COLLOIDS & EMULSIONS

- The liquid that is dispersed into small droplets is called the dispersed phase or internal phase or discontinuous phase .

- The other liquid is the dispersion medium



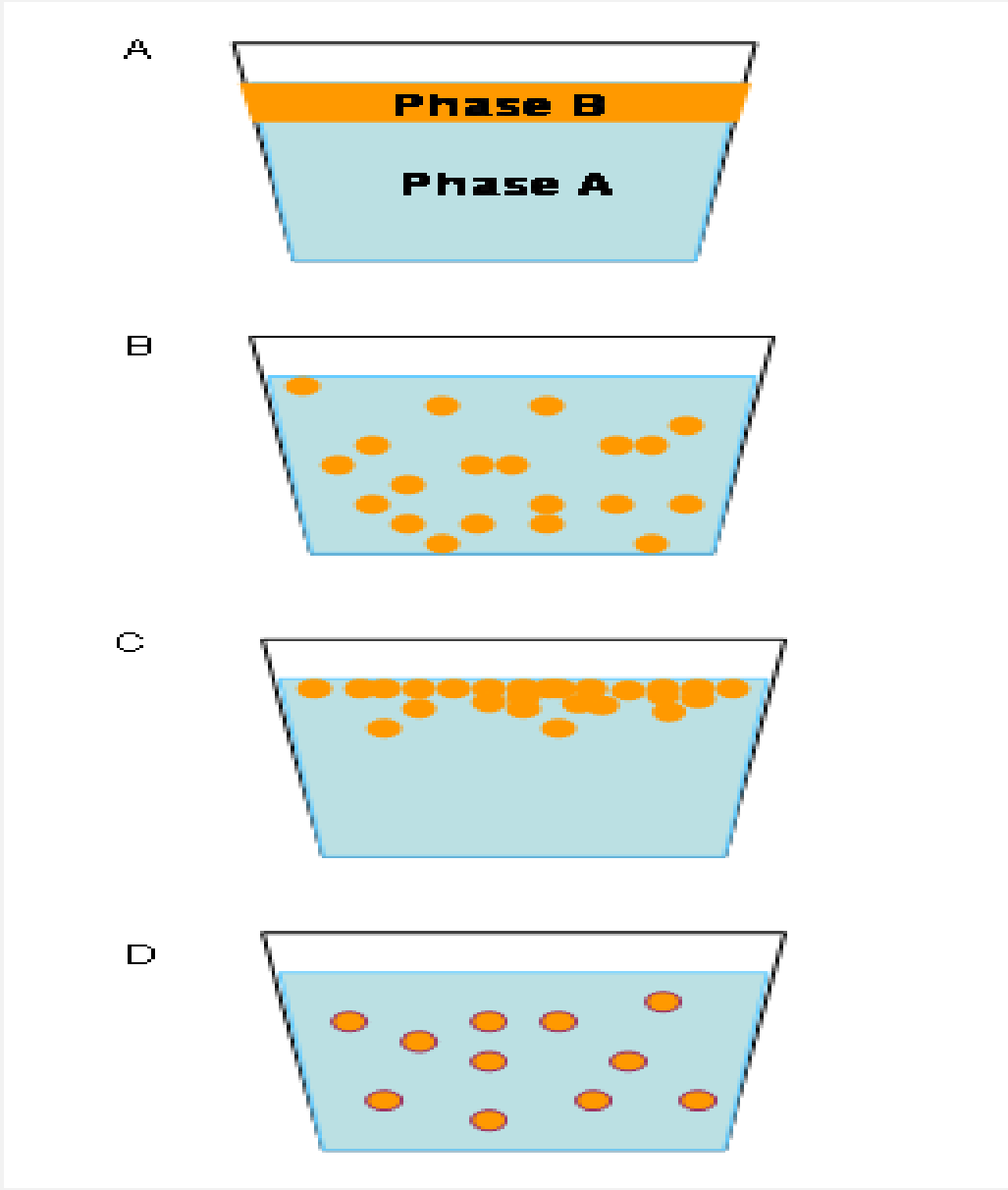
COLLOIDS & EMULSIONS

A. Two immiscible liquids, not emulsified.

B. An emulsion of Phase B dispersed in Phase A.

C. The unstable emulsion regressively separates.

D. The surfactant positions itself on the interfaces between Phase A and Phase B, stabilizing the emulsion.



COLLOIDS & EMULSIONS

- **Types of Colloids :**

1. Sol:

- Solid particles dispersed in a liquid (e.g., paint).

2. Gel:

- Liquid dispersed in a solid (e.g., jelly).

3. Emulsion:

- Liquid dispersed in another liquid (e.g., milk).

4. Aerosol:

- Solid or liquid dispersed in gas (e.g., fog, smoke).

Dispersed phase	Dispersion medium	Type of colloid	Example
Solid	Solid	Solid sol	Some coloured glasses, and gem stones
Solid	Liquid	Sol	Paints, cell fluids
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Aerosol	Fog, mist, cloud, insecticide sprays
Gas	Solid	Solid sol	Pumice stone, foam rubber
Gas	Liquid	Foam	Froth, whipped cream, soap-lather

COLLOIDS & EMULSIONS

- **Properties of Colloids :**

1. Optical Properties:

   - Tyndall Effect: Scattering of light by colloidal particles.

2. Kinetic Properties:

   - Brownian motion: Random movement of particles due to collisions.

3. Electrical Properties:

   - Colloidal particles carry charges, leading to stability.

4. Stability:

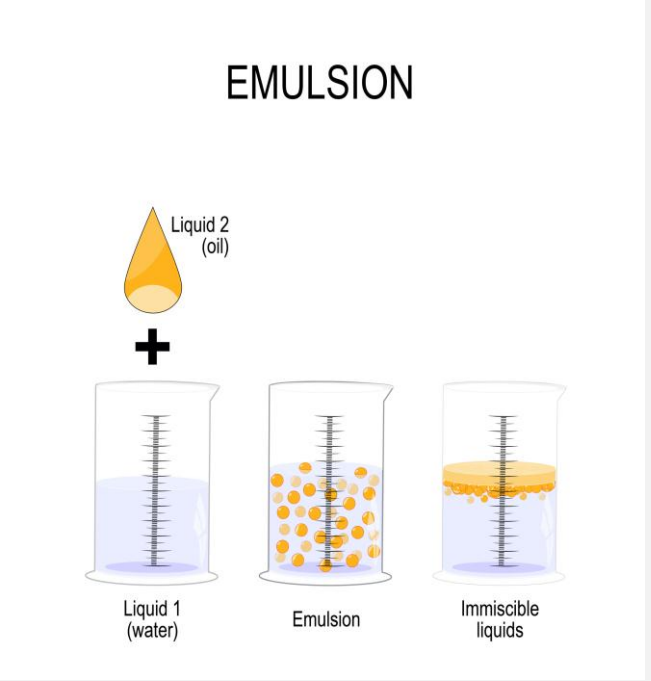
   - Stabilized by electrostatic or steric effects.

COLLOIDS & EMULSIONS

- **Introduction :**
- Definition of Emulsions :- A type of colloid where two immiscible liquids are mixed.
- Emulsions are unstable because: **the globules of the dispersed liquid tend to coalesce to form large globules until all of the dispersed globules have coalesced.**
- Types of Emulsions :

- Oil-in-water (O/W): Oil droplets in water (e.g., milk).
- Water-in-oil (W/O): Water droplets in oil (e.g., butter).

- Applications:
- – Used in food, cosmetics, and pharmaceuticals.



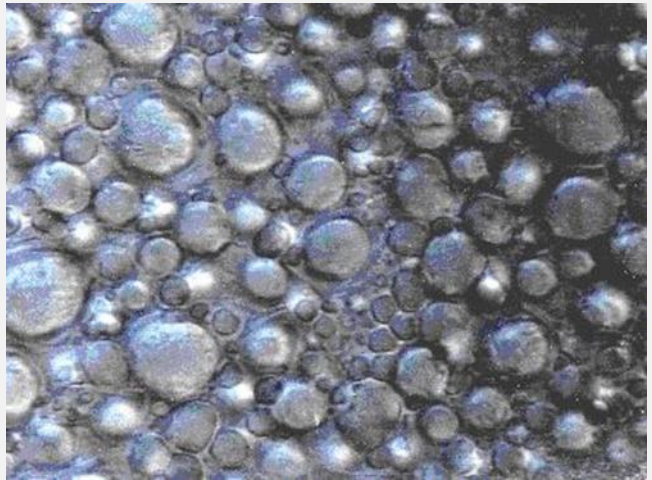
COLLOIDS & EMULSIONS

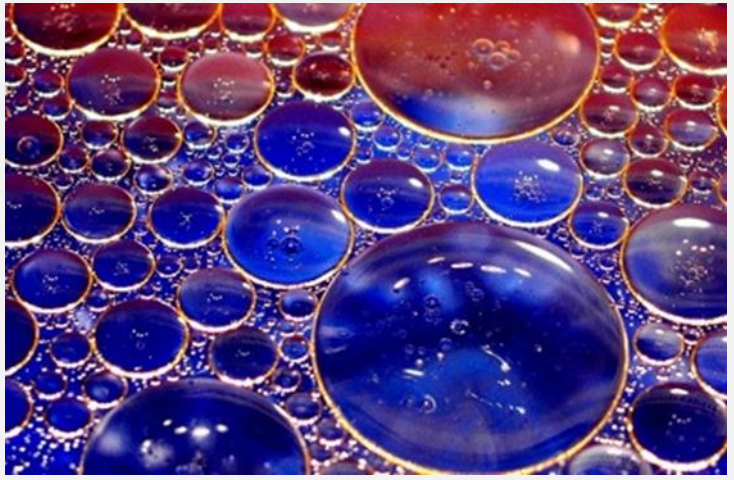
1- When oil is the dispersed phase and an aqueous solution is the continuous phase, the system is designated as **an oil-in-water (O/W) emulsion.**

Uses : Oil-in-water (O/W) emulsion used for oral and intravenous administration .

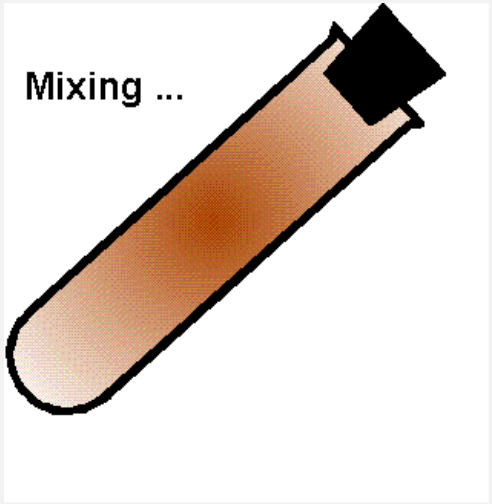
2- Conversely, where water or an aqueous solution is the dispersed phase and oil or oleaginous material is the continuous phase, the system is designated **as water-in-oil (W/O) emulsion.**

Uses : Water-in-oil (W/O) emulsion used for intramuscular injections for a depot effect (extended release or long acting effect).

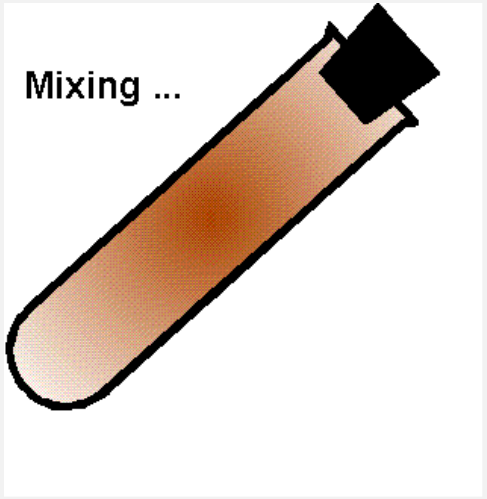




- **Oil-in-water (O/W) emulsion :**



- **Water-in-oil (W/O) emulsion :**



COLLOIDS & EMULSIONS

- Why would you want an o/w emulsion instead of a w/o emulsion for an oral dosage form ?

- The continuous water phase would be more palatable to the mouth and the liquid consistency would be easier to flow through the mouth and down the throat.

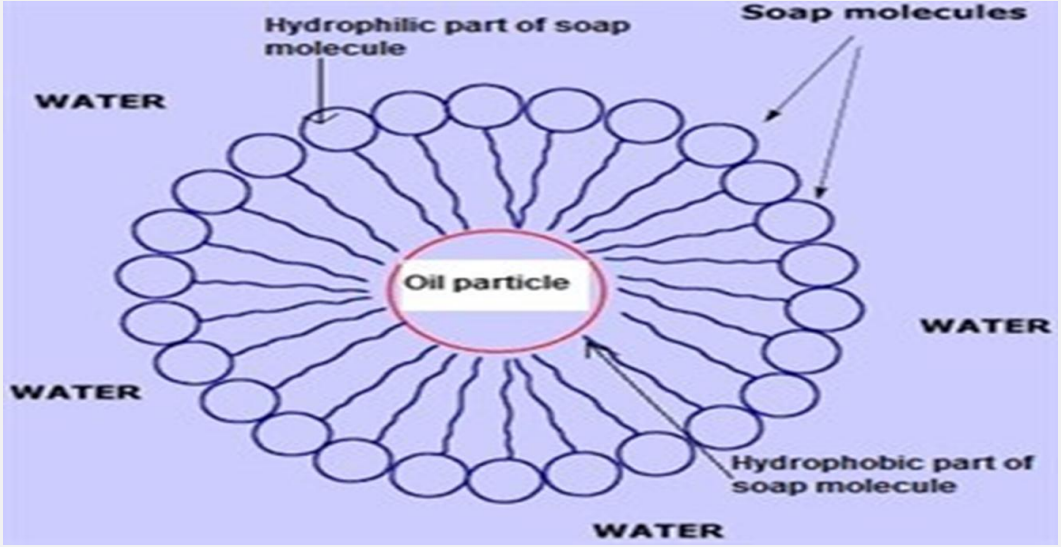
- By dispersing a foul tasting or smelling drug in the oil phase, your taste buds and your sense of smell will be unaware of the agent passing by.

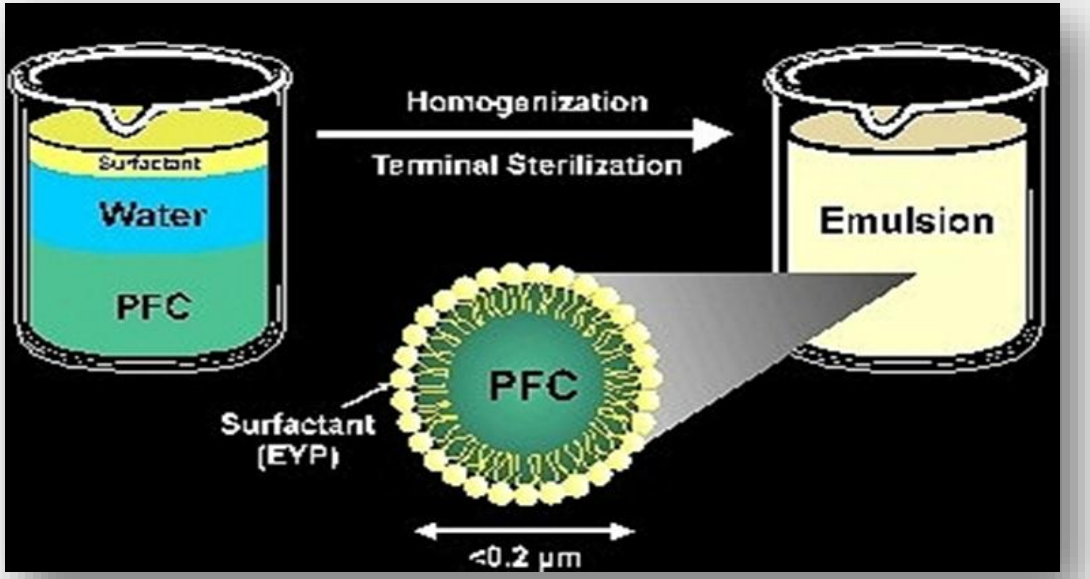
- In addition, in the o/w emulsion the manufacturer can add sweeteners and flavors to the continuous phase which will be experienced by the taste buds as the medication passes over them.

COLLOIDS & EMULSIONS

- **Emulsifying Agents :**
- Definition of Emulsifying Agents :- Substances that stabilize emulsions by reducing surface tension. are usually added to the system to prevent the coalescence of the globules and maintain the integrity of the individual globules of the dispersed phase.
- Types of Emulsifying Agents :
  - Natural: Lecithin, gelatin.
  - Synthetic: Soaps, detergents.

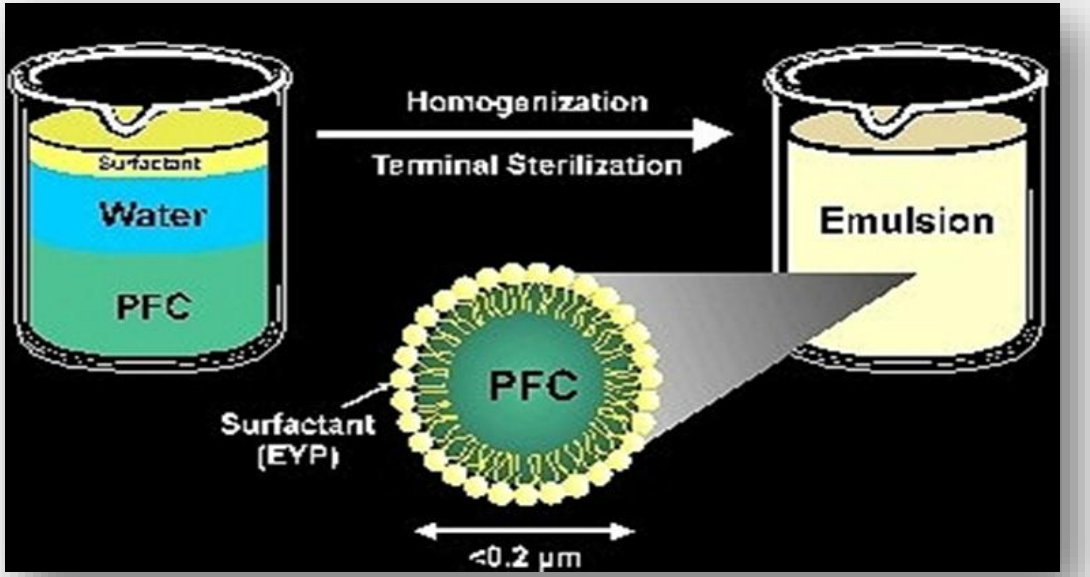
- Mechanism:
- – Form a protective layer around dispersed droplets to prevent coalescence.





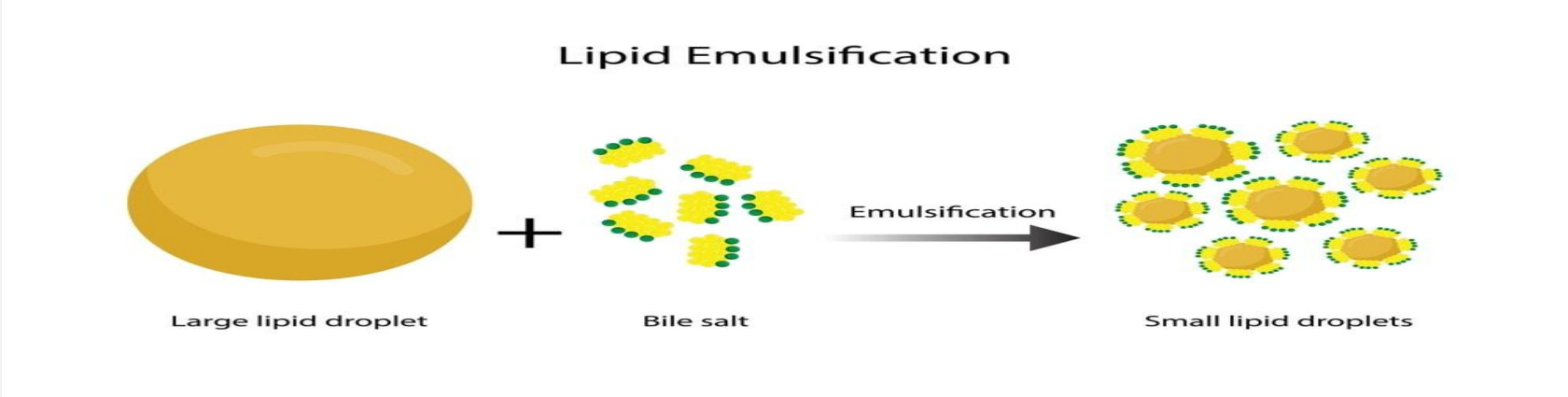
COLLOIDS & EMULSIONS

- ## Emulsifying Agents :
- Definition of Emulsifying Agents :- **other colloids are stabilized in water by the action of a third substance called an emulsifying agents .**
- **An example is a mixture of oil and water . Oil is immiscible with water. However , if we add soap to the mixture , the oil is emulsified by the soap . The soap is the emulsifying agent.**
- **The soap breaks up the oil into small drops.**
- **The soap molecules form a negatively charged layer on the surface of each oil drop.**
- **This causes the oil drops to repel each other , and they disperse throughout the water .**



COLLOIDS & EMULSIONS

- ## Emulsifying Agents :
- Bile salts as emulsifying agent :- **Bile salt are another example of an emulsifying agent.**
- **These salts break up the fats we eat into small globules that can be more effectively digested**



COLLOIDS & EMULSIONS

- **Emulsifier :**
- **An emulsifier (or surfactant)** is a substance which stabilizes an emulsion.
- Detergents are another class of surfactant, and will chemically interact with both oil and water, thus stabilizing the interface between oil or water droplets in suspension.
- This principle is exploited in soap to remove grease for the purpose of cleaning.
- A wide variety of emulsifiers are used in pharmacy to prepare emulsions such as creams and lotions.

COLLOIDS & EMULSIONS

- **Advantages of emulsions over other liquid forms :**

1- The unpleasant taste or odor of an oil can be masked partially or wholly, by emulsification .

2- The solubility of many drugs is increased when they are incorporated into emulsions .

3- The stability of many drugs which are unstable in aqueous solutions is increased when incorporated into an emulsion .

4- Prolonged drug action and increased bioavailability are often obtained when drugs are incorporated into emulsions .

5- The appearance of oleaginous materials intended for topical applications is usually improved when formulated in an emulsified form .

COLLOIDS & EMULSIONS

- **Applications of Colloids :**

1. Medical Field:

   - Colloidal silver as an antiseptic.

   - Drug delivery systems (e.g., liposomes).

2. Food Industry:

   - Stabilizers in mayonnaise and ice cream.

3. Industrial Applications:

   - Paints, inks, and adhesives.

COLLOIDS & EMULSIONS

- **Colloids vs. True Solutions :**

1. Particle Size:

   - Colloids: 1 nm to 1 µm.

   - True Solutions: Less than 1 nm.

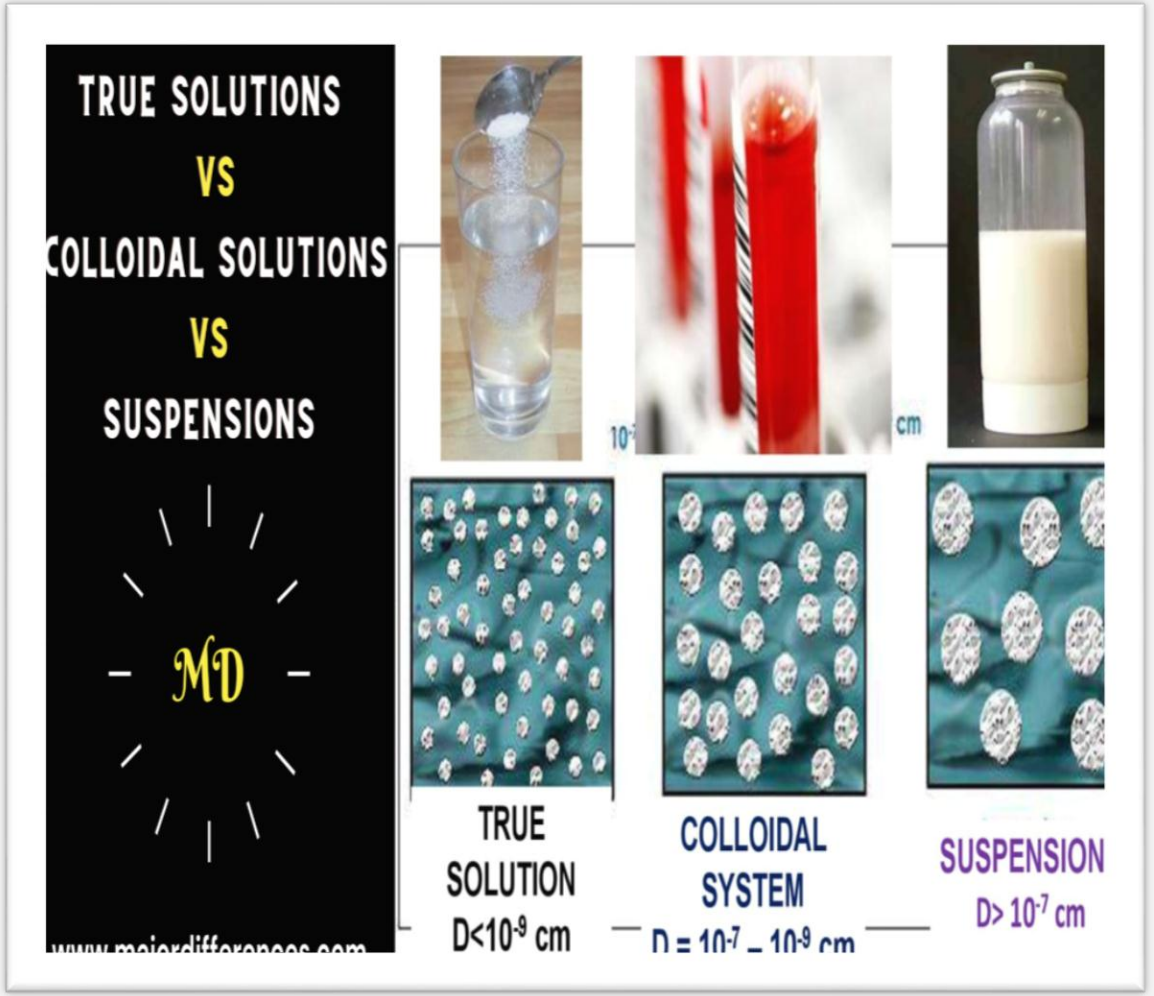
2. Visibility:

   - Colloids scatter light (Tyndall effect).

   - True solutions are transparent.

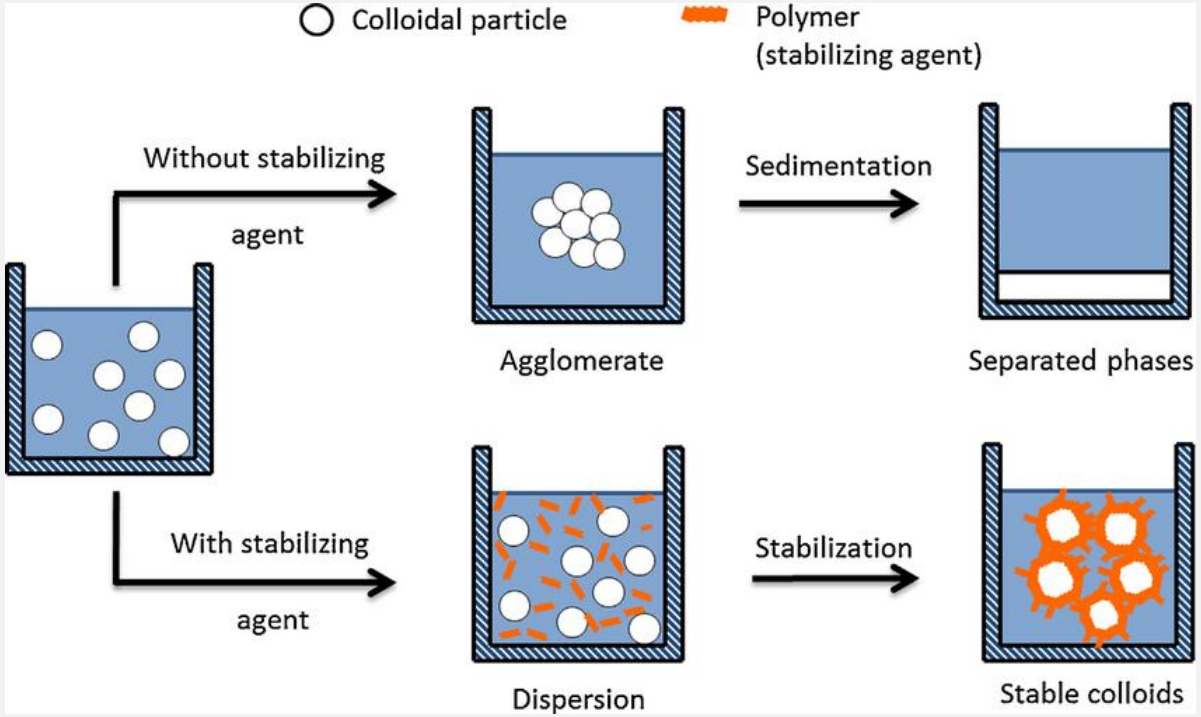
3. Stability:

   - Colloids are stable; true solutions may settle under certain conditions.



COLLOIDS & EMULSIONS

- ## Stability of Colloids :



1. Factors Affecting Stability:

   - Charge on particles.

   - Presence of electrolytes.

2. Coagulation:

   - Addition of electrolytes can destabilize colloids, causing particles to aggregate.

3. Protective Colloids:

   - Substances like gelatin enhance colloid stability.

COLLOIDS & EMULSIONS

- **Classification of Colloids Based on (Interaction) :**

1. Lyophilic Colloids (Solvent-loving):

- Particles have an affinity for the dispersion medium.

- Stable and reversible (e.g., gum, starch).

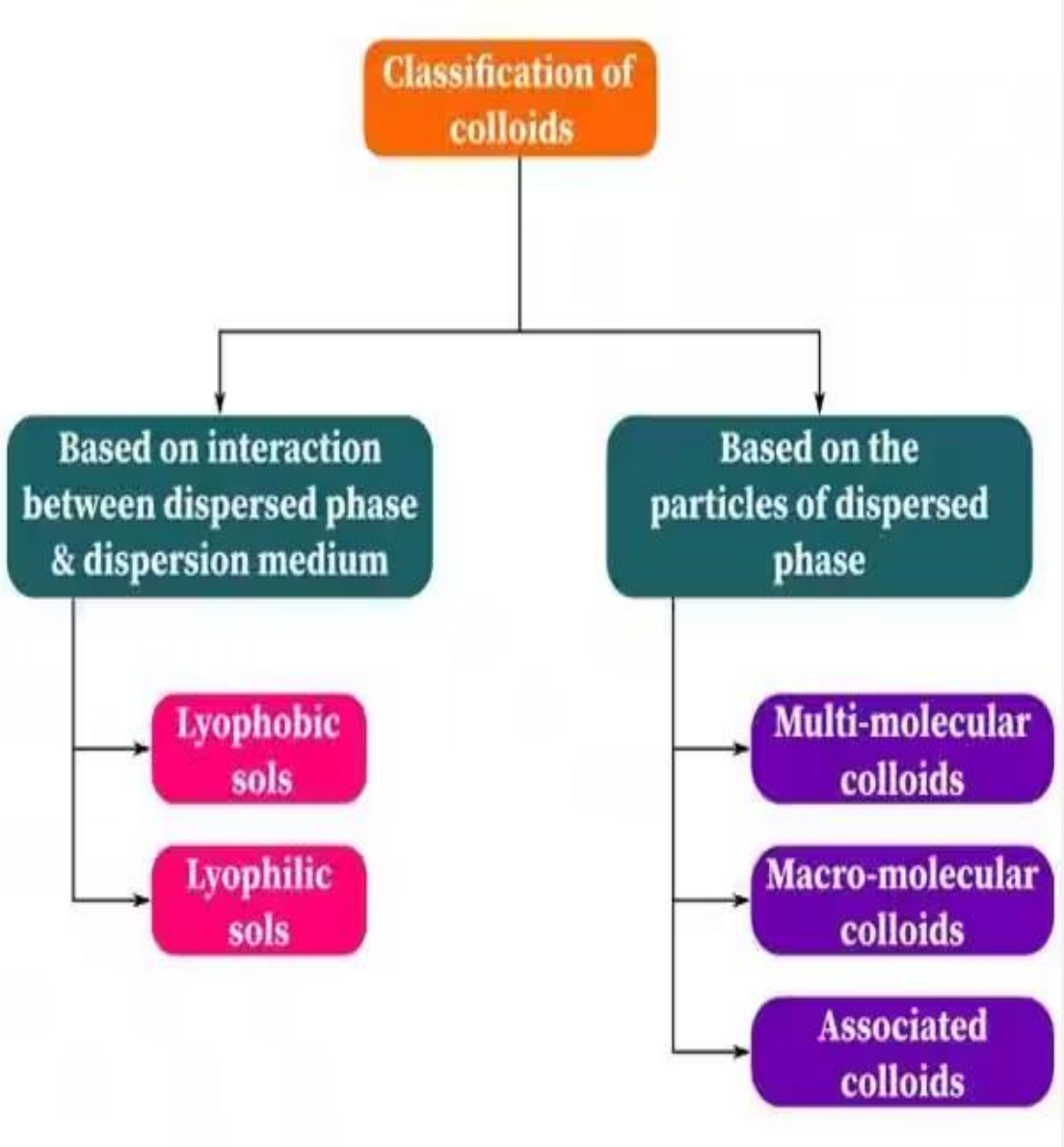
2. Lyophobic Colloids (Solvent-hating):

- Particles do not have an affinity for the medium.

- Require stabilizers; less stable (e.g., gold sol).

3. Association Colloids:

- Formed by the aggregation of amphiphilic molecules (e.g., micelles).



COLLOIDS & EMULSIONS

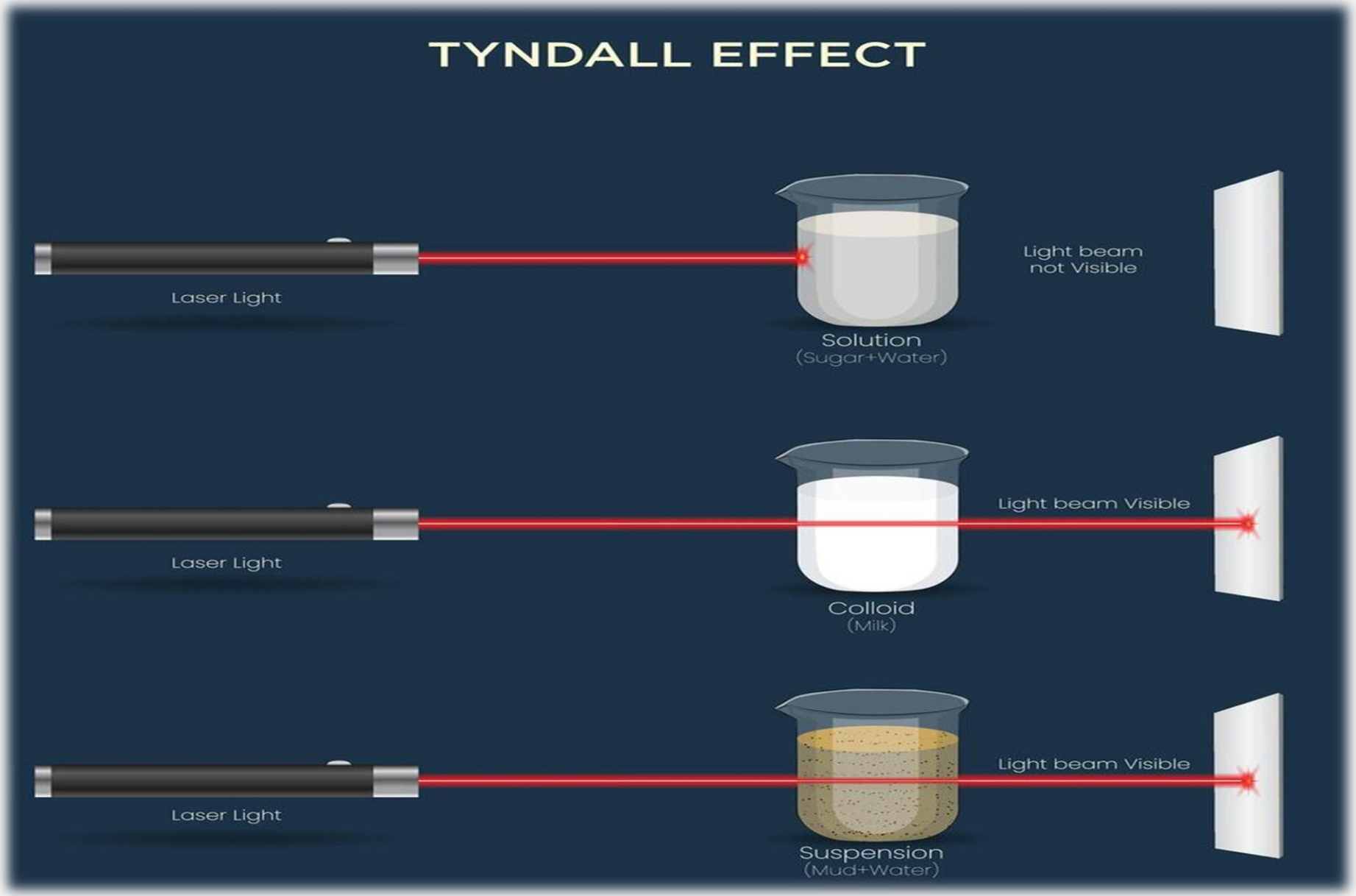
- **Tyndall Effect in Colloids :**
- Definition of Tyndall Effect :- Scattering of light by colloidal particles, making the beam visible.
- Applications :

- Used to distinguish between colloids and true solutions.

Examples :

- - Visible light beam in fog or dust-laden air.

TYNDALL EFFECT IN COLLOIDS



COLLOIDS & EMULSIONS

- **Preparation of Colloids :**

1. Dispersion Methods:

   - Mechanical dispersion: Using colloid mills.

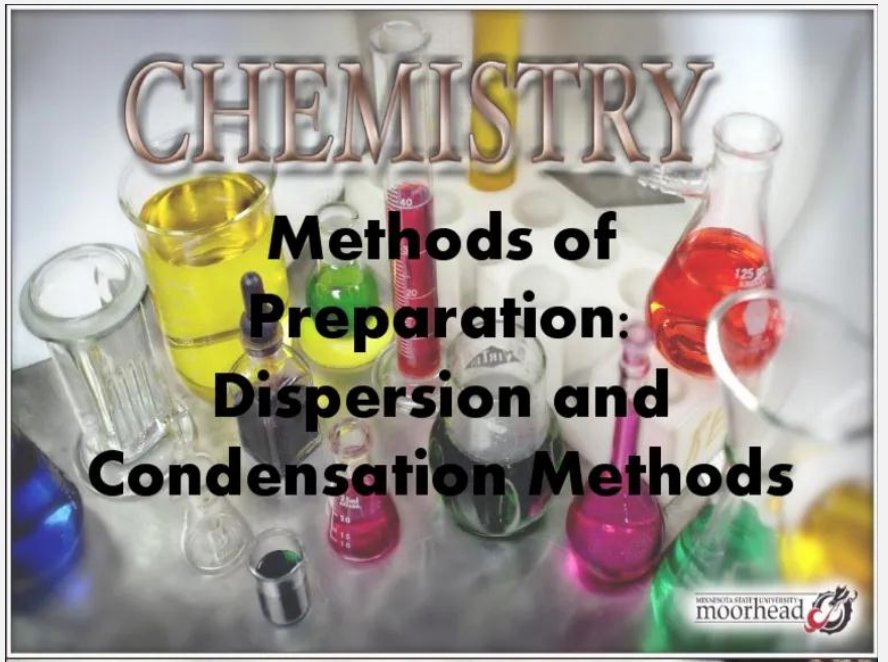
   - Peptization: Breaking down precipitates

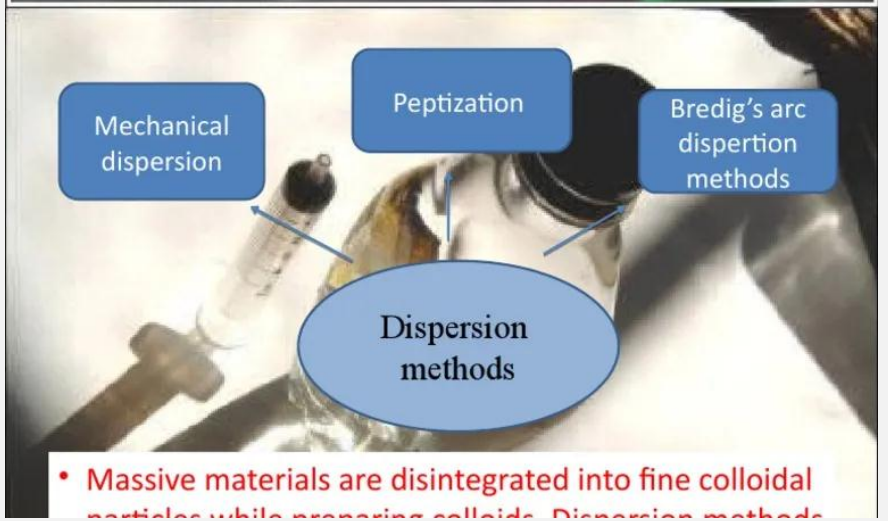
into colloidal particles.

2. Condensation Methods:

   - Chemical reactions: Oxidation, reduction, hydrolysis.

   - Change of solvent: Precipitation from a solution.





COLLOIDS & EMULSIONS

• Emulsion Stability :

1. Factors Enhancing Stability:

   - Use of suitable emulsifying agents.

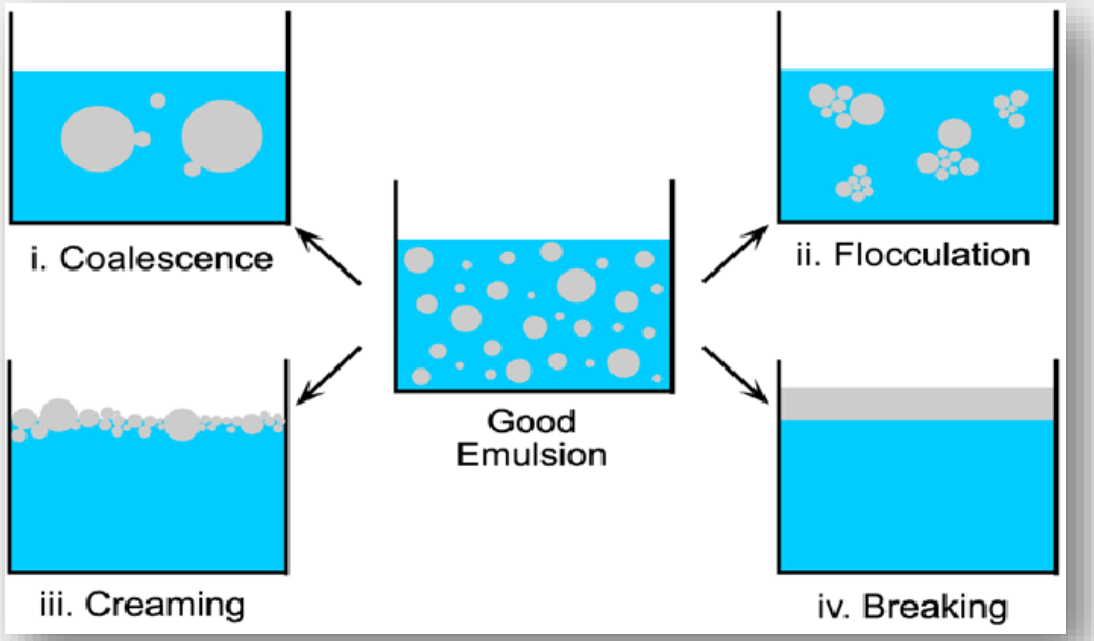
   - Controlling temperature and viscosity.

2. Destabilization Processes:

   - Coalescence: Merging of dispersed droplets.

   - Creaming: Separation of the dispersed phase.

   - Phase inversion: Swapping of continuous and dispersed phases.



COLLOIDS & EMULSIONS

- **Role of Emulsifying Agents in Industry :**

1. Food Industry:

   - Stabilizers in products like margarine, salad dressings.

2. Cosmetics:

   - Used in creams, lotions, and shampoos for smooth texture.

3. Pharmaceuticals:

   - Help in drug delivery systems for poorly soluble drugs.

COLLOIDS & EMULSIONS

- **Colloidal Systems in Medicine:**

1. Diagnostic Uses:

   - Contrast agents in imaging (e.g., barium sulfate).

2. Drug Delivery:

   - Liposomes and nanoparticles enhance targeted drug delivery.

3. Therapeutic Uses:

   - Colloidal silver and gold for antibacterial and anti-inflammatory purposes.

COLLOIDS & EMULSIONS

- **Future Trends in Colloids and Emulsions :**

1. Nanotechnology:

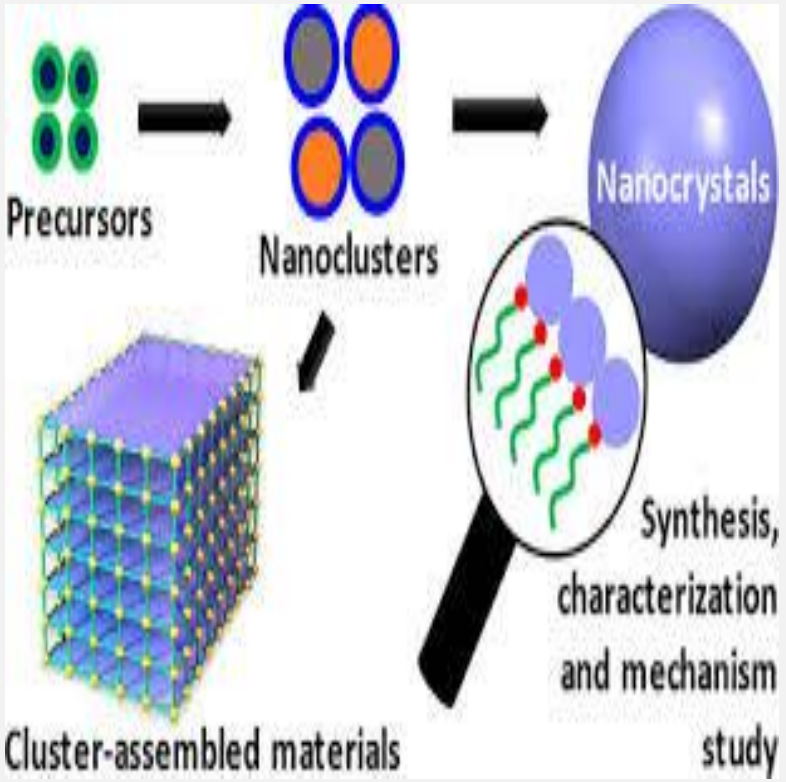
- Development of nanoscale colloids for advanced applications.

2. Sustainable Products:

- Eco-friendly emulsifiers and stabilizers.

3. Biomedical Advances:

- Use of colloids in precision medicine and diagnostics.

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