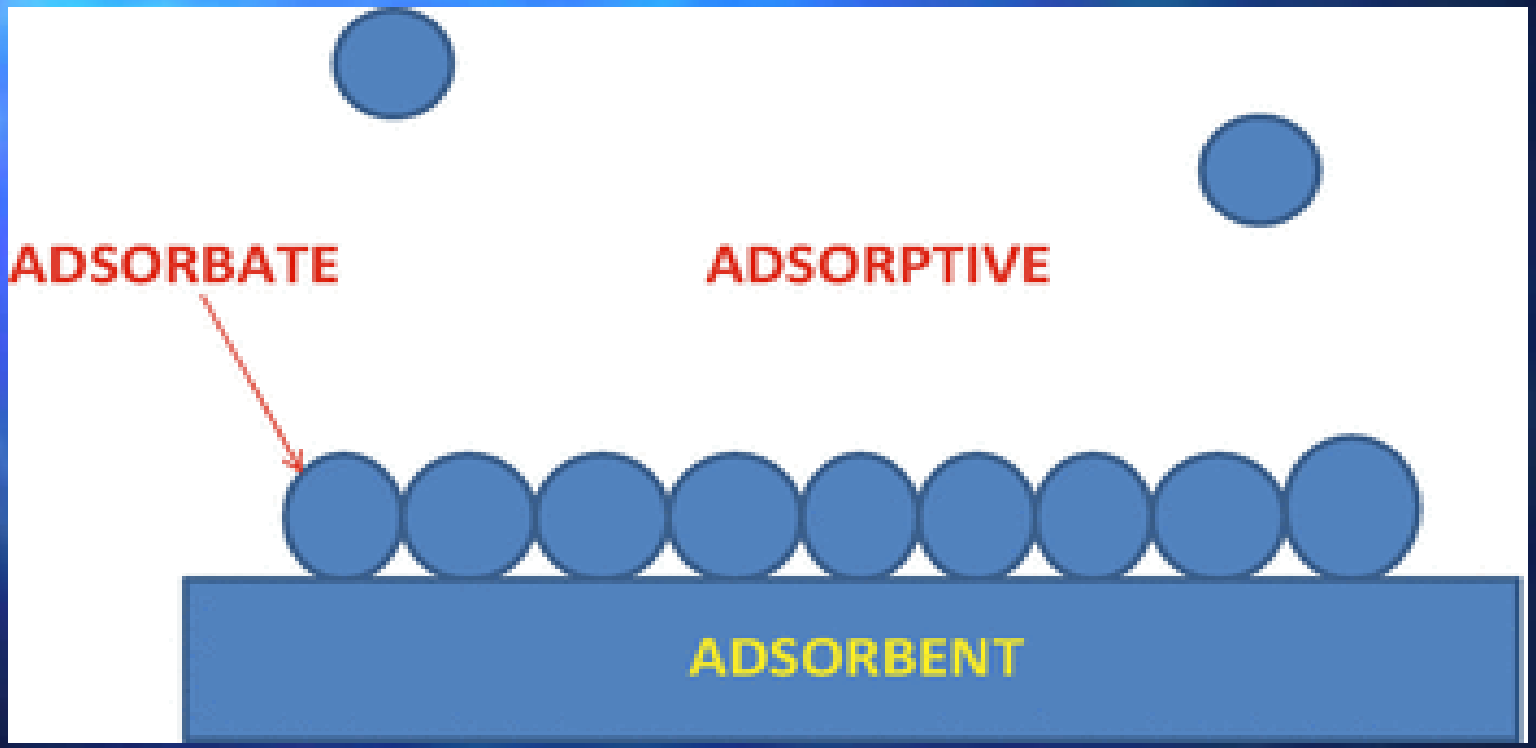
ADSORBTION



DEFINITION

- It is a surface phenomenon.
- It is the process of accumulation of a substance (adsorbate)on the surface of another substance(adsorbent).It is a reversible phenomenon.
- Adsorption differs from absorption, as the later involves the diffusion into the interior of the material.
- The capacity of an adsorbent depends on the surface area,therefore porous substances serve as better adsorbent.

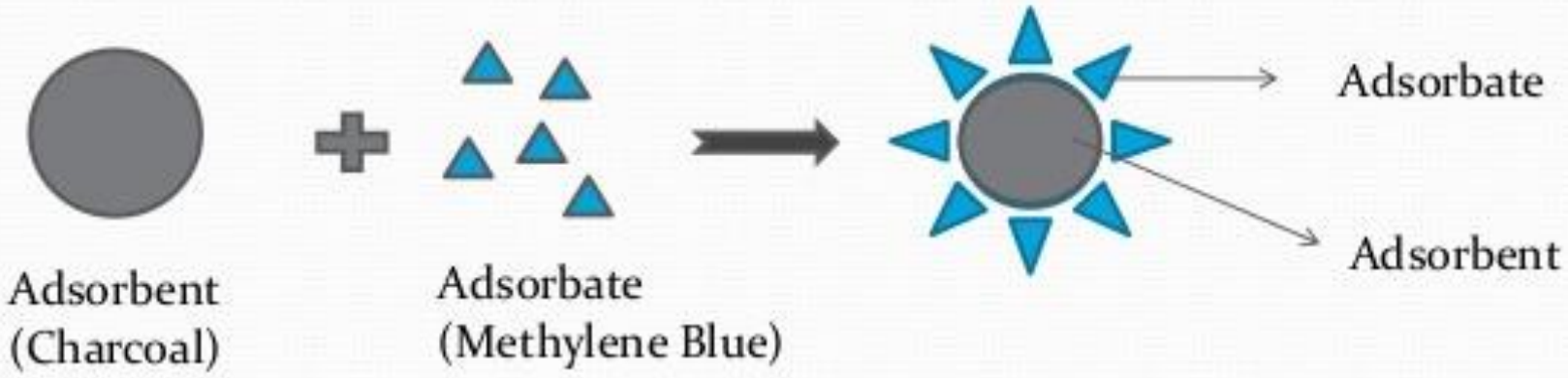
Adsorbate

- It is the substance which is adsorbed at the surface of another substance examples are: gases, dyes, water vapors etc.

Adsorbent

- It is the substance which adsorbs the other substance at its surface.
- Examples are:
- activated charcoal, clay, silica gel, colloids, metals, bone charcoal, alumina, ion exchange resin etc

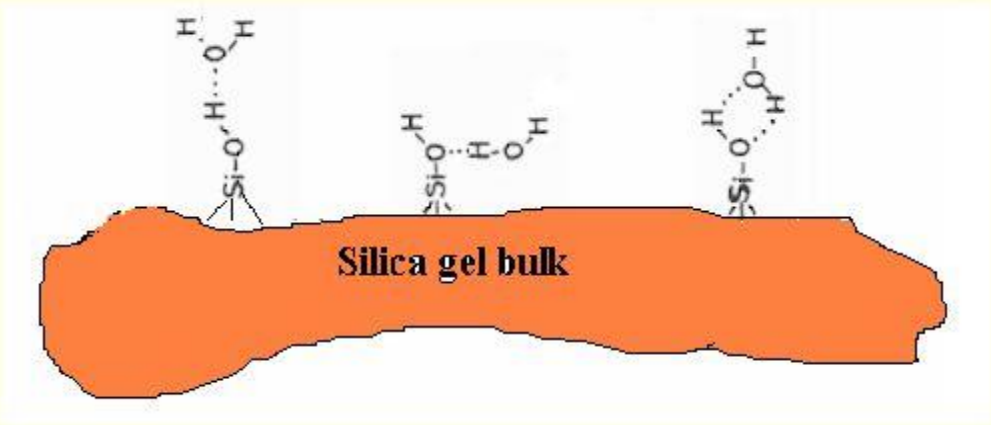
Mechanism of Adsorption



Adsorbent atoms or molecules are not surrounded by atoms or molecules of their kind and they have unbalanced attractive forces on the surface which can hold adsorbate particles.

Example: Silica gel, Alumina

Water adsorption on Silica gel



Types of Adsorption

- The process can take place by two means:
- Physical adsorption
- Chemical adsorption

Physical Adsorbtion

- This phenomenon involves the use of weak Van der Waal forces by means of which gas molecules get adsorbed on a solid surface.

Characteristics of physical adsorbtion

- There is no specificity as any gas can be adsorbed onto the surface.
- It has been observed that highly liquefiable gases are physically adsorbed more strongly.e.g
- It is reversible in nature and is dependent on pressure as well as temperature. An increase in pressure decreases the volume of gas and thus increases the adsorption of gas molecules. Conversely, a decrease in pressure will cause the removal of gas molecules from the solid surface.

Con…

- Increase in temperature increases physisorption. Similarly, a decrease in the temperature will decrease the rate of physisorption.
- Porous substances are better adsorbents as an increased surface area promotes adsorption.
- Does not require energy for activation.

Chemical Adsorption or Chemisorption

- We can characterize it by the involvement of chemical bonds between the adsorbate molecules and the adsorbent surface Moreover, it results in a unimolecular layer.

The characteristics of chemisorption are

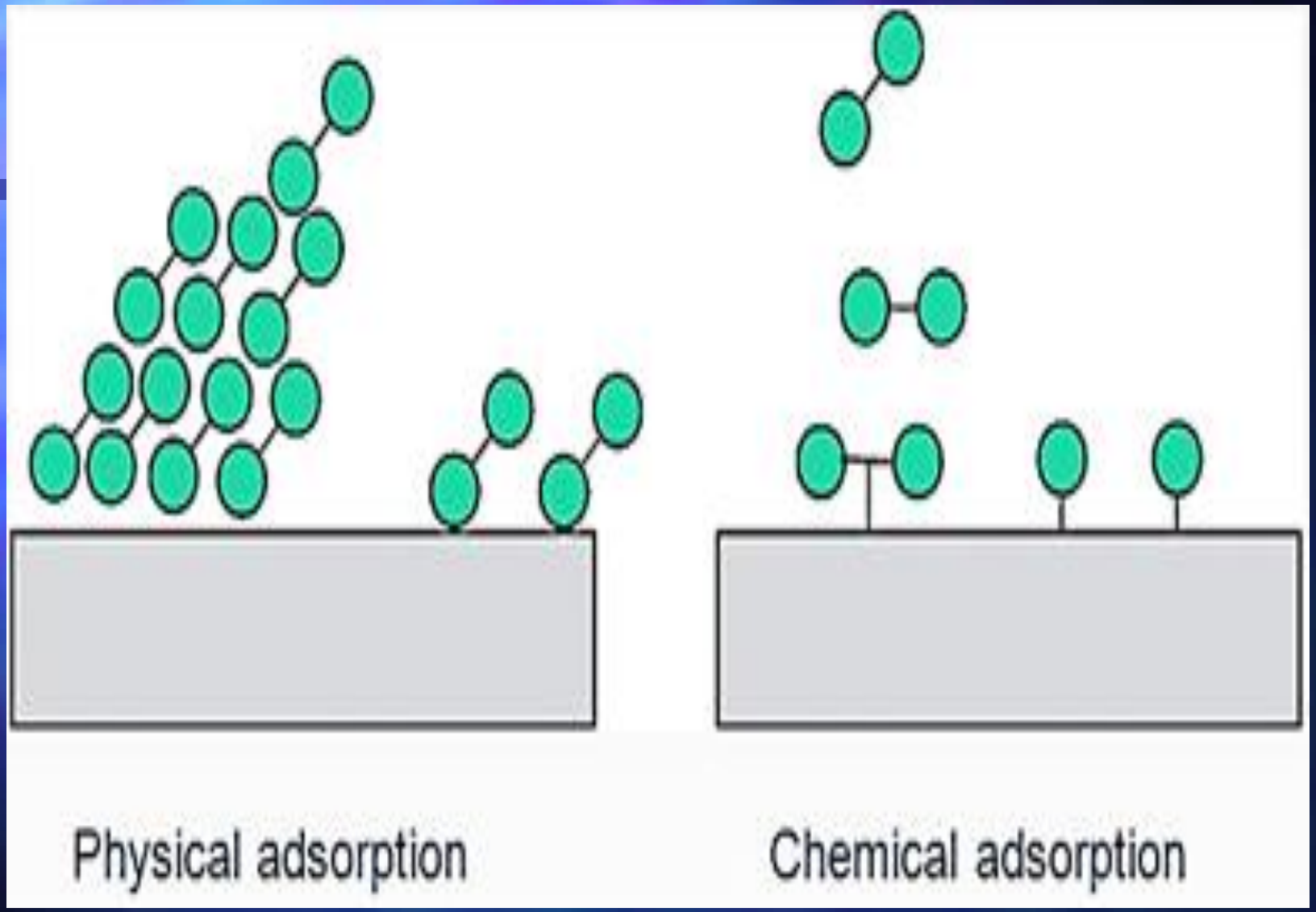
- The process specific in character means that it will occur only if there is a chemical bond formation between the adsorbent and adsorbate.
- The process is irreversible in nature.

Con…

- It is an exothermic process and the process is accompanied by an increase in temperature.
- It occurs slowly at low temperature and occurs at a higher rate with increase in pressure.

Con...

- Just as in case of physisorption, chemisorption is directly proportional to surface area and thus increases with increase in surface area.
- Since the process involves chemical bond formation, the enthalpy in high.
- It requires a certain energy of activation.


Physical adsorption
Chemical adsorption

Comparison between Physisorption and Chemisorption

Physisorption	Chemisorption
Forces of attraction are vander Waals' forces	Forces of attraction are chemical bond forces
Low enthalpy of adsorption (20 - 40 k.J/mole)	High enthalpy of adsorption (200 - 400 k.J/mole)
This process is observed under conditions of low temperature	This process takes place at high temperatures
It is not specific	It is highly specific
Multi-molecular layers may be formed	Generally, monomolecular layer is formed
This process is reversible	This process is irreversible

Enthalpy (amount of heat that gets evolved when one mole of the adsorbate is adsorbed on adsorbent is known as enthalpy)

Factors effecting the adsorption

- Solubility of adsorption
- Nature of Adsorbate
- Nature of adsorbent
- Concentration of adsorbent
- Pressure
- Temperature
- pH
- Affinity between adsorbent and adsorbate
- Stirring

Applications of Adsorption

- The phenomenon of adsorption finds a number of applications. Important ones are listed here:
- 1. **Production of high vacuum**: The remaining traces of air can be adsorbed by charcoal from a vessel evacuated by a vacuum pump to give a very high vacuum.

Pharmaceutical application

- In the preparation of gas masks using activated charcoal to avoid poisonous gases like CO, CH_4
- Adsorption helps in desiccation process for example silica gel bags are used to protect the drug from moisture and other unfavorable environment.
- Adsorption chromatography is used to purify and separate pigments, hormones etc.

In the treatment of diseases:

A number of drugs are used to kill germs by getting adsorbed on them.

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Adsorption indicators:

Surfaces of certain precipitates such as silver halides have the property of adsorbing some dyes like eosin, fluorescein, etc. and thereby producing a characteristic colour at the end point.

EMULSION AND EMULSIFIER

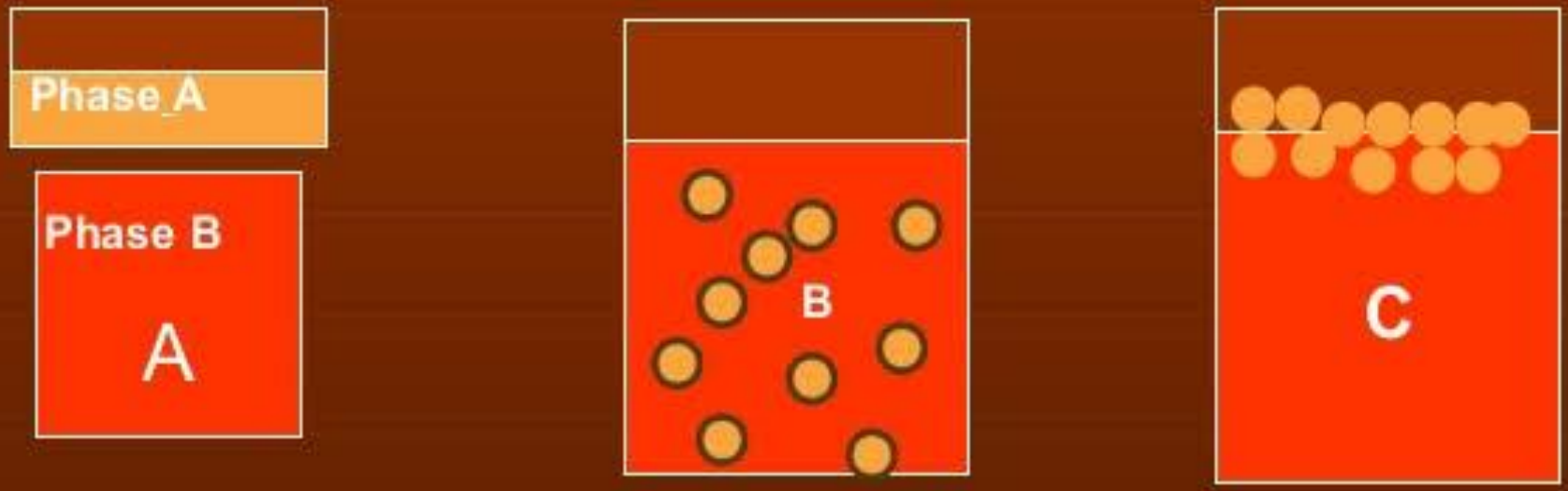
Emulsions

- The word "emulsion" comes from the Latin word for "to milk".
- An emulsion is a mixture of two or more liquids that are normally immiscible (nonmixable or unblendable).

Emulsions

- An emulsion is a thermodynamically unstable system consisting of at least two immiscible liquid phases one of which is dispersed as globules in the other liquid phase stabilized by a third substance called emulsifying agent. The droplet phase is called the dispersed phase or internal phase and the liquid in which droplets are dispersed is called the external (continuous phase).

Emulsions



A.: Two immiscible liquids not emulsified

B. An emulsion of phase B dispersed in Phase A

C. Unstable emulsion slowly separates.

Emulsions

Emulsions are part of a more general class of two-phase systems of matter called colloids.

Emulsion should be used when both the dispersed and the continuous phase are liquids. Examples of emulsions include vinaigrettes, milk, mayonnaise, and some cutting fluids for metal working.

- Emulsification is the process of formation of emulsion.
- Emulsifying agents are the substance which causes emulsification e.g. alkyl sulfonic acid , phospholipids and bile salts.

Properties of Emulsions

- Emulsion particles unavoidably form dynamic inhomogeneous structures on small length scale.
- Emulsions are highly unstable systems and require an emulsifying agent or emulsifier.
- Emulsions are prepared by continuous mixing or agitation of the two phases
- When kept for longer periods of time or in case of absence of an emulsifying agent, the phases in the emulsion tend to separate, resulting in "cracking of emulsion" or " phase inversion".

Mechanisms of Emulsification

- A number of different chemical and physical processes and mechanisms can be involved in the process of emulsification.
- **Surface tension theory**

According to this theory, emulsification takes place by the reduction of interfacial tension between two phases.

Mechanisms of Emulsification

- **Repulsion theory**
- The theory proposes that the emulsifying agent creates a film over one phase that forms globules, which repel each other. This repulsive force causes them to remain suspended in the dispersion medium.

Mechanisms of Emulsification

- **Viscosity modification**
- Certain emulgents such as acacia, tragacanth, carboxymethylcellulose, polyethylene glycol, etc increase the viscosity of the medium, which helps create and maintain the suspension of globules of the dispersed phase.

Purpose of emulsions and of emulsification:

- 1.Facilitate the preparation of relatively stable and homogenous mixtures of two immiscible liquids.
- 2. Permits administration of a liquid drug in the form of minute globules rather than in bulk.
- 3. Reduced particle size of the oil globules may render the oil more digestible and more readily absorbed.

ADVANTEGES OF EMULSION

EMULSIONS are simple, have few Ingredients and are cheap.
Reaction medium is mostly water therefore it easily penetrates in the skin. Beside these advantages following are certain uses of the emulsions.

Wide use in the food industry
E .g. Vinaigrette, mayonnaise & milk

Medicinal Use:- Emulsions that are more liquid may be used as oral medicine & cream based emulsions are best for topical application.

Used in beauty products e.g.. Creams nd

lotions.

Used as polymerization e.g. paints and coatings.

Pharmaceutical use…

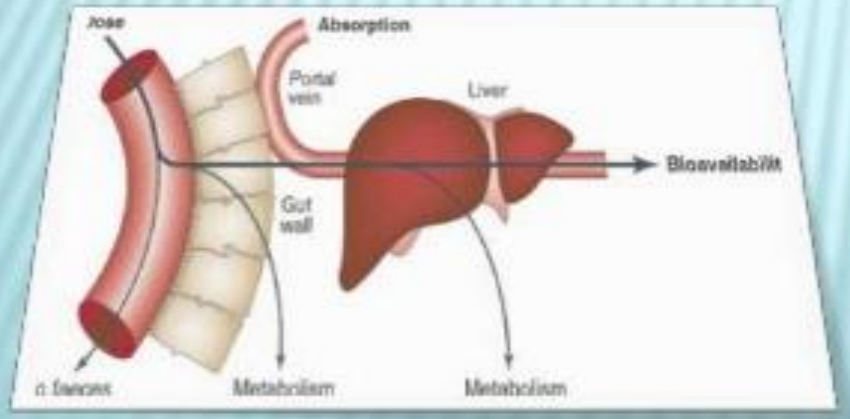
1) Emulsion can be used to administer orally unpleasant tasting drugs

2) O/W type emulsion has intravenous

ls oils and fats

Pharmaceutical use…

3) Bio availability of certain poorly soluble drugs can also be improved by dissolving them in oil and emulsifying



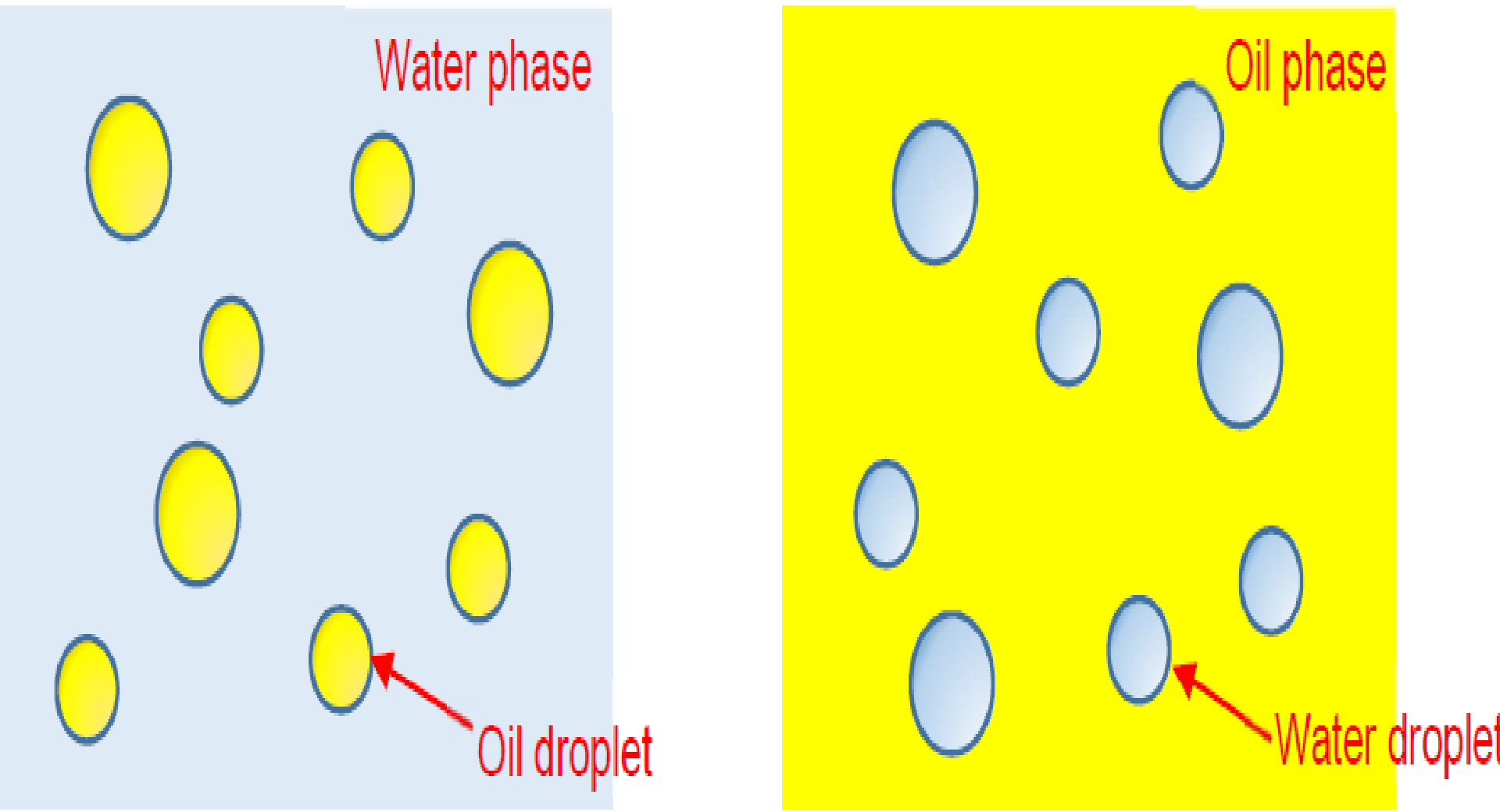
4)Emulsion of both O/W and W/O types has extensively been used to prepare pharmaceutical preparation for external use and cosmetic preparation such as screen and lotions

Types of Emulsion:

- Emulsions are of two types,
- **1) oil-in-water (O/W)**
- **The emulsion in which** oil is present as the dispersed phase and water as the dispersion medium **(continuous phase)** is called an oil-in-water emulsion. Milk is an example of the oil-in-water type of emulsion. In milk liquid fat globules are dispersed in water. Other examples are, vanishing cream etc.

Types of Emulsion

- **2)water-in-oil (W/O)**
- The emulsion in which water forms the dispersed phase, and the oil acts as the dispersion medium is called a water-in-oil emulsion.
- These emulsion are also termed **oil emulsions.**
- **Butter** and **cold cream** are typical examples of this types of emulsions.



Oil-in-Water(O/W) Emulsion

Water-in-Oil (W/O) Emulsion

Figure 1 Types of emulsions

Preservation of emulsions

- **Microbial contamination may occur due to:**
- contamination during development or production of emulsion or during its use.
- Usage of impure raw materials
- Poor sanitation conditions
- Contamination by the consumer during use of the product..

- **Precautions to prevent microbial growth ;**
- Use of uncontaminated raw materials
- Careful cleaning of equipment.
- **Addition of anti microbial agent**

Factors affecting type of emulsion

- Type of emulsifying agent used
- Phase volume ratio
- Viscosity of each phase

Emulsifying agents

- An emulsifying agent is a compound that concentrates at the interface of two immiscible phases, usually an oil and water.
- It lowers the interfacial free energy, reduces the interfacial tension between the phases, and forms a film or barrier around the droplets of the immiscible, discontinuous phase as they are formed.

DESIRABLE PROPERTIES OF EMULSIFYING AGENTS

- Molecular structure

Although emulsifying agents must contain both hydrophilic and lipophilic parts.

- The emulsifier must produce a stable film at the interface.

Some surface-active agents are capable of producing emulsions, but the emulsions separate on standing or storage.

Con…

- The emulsifying agent should be stable to chemical degradation.
- The emulsifying agent should be reasonably inert and should not interact chemically with any of the other ingredients in the formulation.
- If the emulsifier is liable to microbiological attack, adequate precautions must be taken.

Con…

- The substance should be nontoxic and nonirritating to skin or mucous membranes.
- Depending on its use, it should be relatively odorless, tasteless, and colorless.
- It should have a reasonable cost

Classification of emulsifying agents

The emulsifying agents can be classified as shown below.

- 1. Natural emulsifying agents from vegetable sources
- Acacia
- Tragacanth
- Agar
- Pectin
- Starch

Classification of emulsifying agents

- 2. Natural emulsifying agents from animal sources
- a. Gelatin
- b. Egg yolk
- c. Wool fat

Classification of emulsifying agents

- 3. Semi-synthetic polysaccharides
  a. Methyl cellulose
- b.Sodium carboxymethyl cellulose.
- 4. Synthetic emulsifying agents
- a. Anionic
- b. Cationic
- c. Non-ionic

Classification of emulsifying agents

- Anionic:- • It is used good emulsifing agents for those emulsions which are applicable for external purpose.
- various alkali soaps, metallic soaps, sulphated alcohols & sulphonates are used as emulsifing agents.
- It produce O/W type of emulsion.
- Sulphated salts, sodium lauryl sulphate is commonly used as emulsifing agent in topical preparation.
- Dioctyl sodium sulphsuccinate is e.g. of sulphonates used internally for soften the stools.

Classification of emulsifying agents

- Cationic:- • They are used emulsifing agent in O/W type of emulsions.
- Quaternary ammonium compounds are only group that extensively used emulsifying agent.
- They have shown anti bacterial properties, so it is used as disinfectant.

Classification of emulsifying agents

- **Non-Ionic:-**
- Non-ionic surfactant are widely used in the pharmaceutical emulsion.
- Those emulsions are stable over a wide range of pH.
- It's not affected by addition of acids & electrolytes.
- The most commonly used surfactant are glyceryl monostearate, polyoxyethylene glycol esters & ethers & sorbitan monopalmitate

DIACETYL TARTARIC ACID ESTER: (Non ionic)

- DATEM is used to strengthen the dough by building a strong gluten network. It is an emulsifier used in baking. It is used in enlarging the physical volume of bread, improve the structure of tissue , prolong shelf life and increase the soft feeling and pliability
- It is used in crusty bread, chewy texture, biscuits, coffee whitener, ice cream, salad dressing.

Classification of emulsifying agents

Additive Class	Function	Chemical substance	Foods in which used
Emulsifiers 	Prevent the separation of oil and water. Provide surface wetting, lubrication and viscosity change. In combination with thickeners and fats, they give a smooth pleasing sensation in the mouth.	Ammaonium phospatides, lecithin, Sorbitous and polyoxyethylenes in combination with fatty acids	Chocolate making, cheese making

THANK YOU