Program	B. Pharmacy
Semester	1st semester
Subject /Course	Pharmaceutics-1
Subject/Course ID	BP 103T
Module No.	III
Module Title	Monophasic Liquids and Biphasic Liquids Dosages form
Course coordinator	Dr. Neelam Sharma

Learning Outcome of Module

LO	Particular
103.4	To know the definitions and preparations of Gargles, Mouthwashes, Throat Paint, Eardrops, Nasal drops, Enemas, Syrups, Elixirs, Liniments and Lotions.
103.4	To know the Preparation of suspensions and stability problems and methods to overcome. Identification of type of Emulsion, Methods of preparation and stability problems and methods to overcome.

Module Content Table

No.	Topic
1.	Monophasic Liquids:Definitions and preparations of Gargles, Mouthwashes, Throat Paint, Eardrops, Nasal drops, Enemas, Syrups, Elixirs, Liniments and Lotions.
2.	Biphasic Liquids: Suspensions: Definition, advantages and disadvantages, classifications, Preparation of suspensions; Flocculated and Deflocculated suspension and stability problems and methods to overcome.
3.	Emulsions: Definition, classification, emulsifying agent, test for the identification oftype of Emulsion, Methods of preparation and stability problems and methods to overcome.

Monophasicliquiddosageforms

A monophonic liquid contains only one phase i.e., solutes which is completely soluble in solvents. Monophasicliquids are homogenous systems of dosage forms containing either miscible liquids or solids which arecompletelysolubleinwater, intendedforinternaluseor external use.

Classification/typeofMonophasicliquids:

1.Monophasicliquidmeantforinternaluse:

Ex:solutions,mixtures,syrups,elixirs,linctusetc.

1.Mixtures:

Amixtureisaliquidpreparationcontainingmedicamentsmeantforinternaluse.Itcontainsseveraldoses
.

I. Mixturecontainingsolublesubstances:

Ex: Carminativemixture

Formula: $NaHCo_3$ Compound tincture of cardamomAromaticspiritofammonia

Weaktinctureof ginger

Spiritof chloroform Peppermintwater

Procedure:

1. Dissolvethesolidsubstancesinlittlequantityofvehicle.Ex-$NaHCO_3$inPeppermintoil.
2. If anyforeignparticleappearsfilterit.
3. Add anyliquidingredient.
4. Volatileliquidsareaddedattheendjustbeforeadjustingthefinalvolumewithvehicle.
5. Finalvolumeisadjusted withremainingvehicle.

Storage: Itisstoredinawell-closedgreenishtintedgraduatedbottle.

Uses: It isusedascarminative,$NaHCo_3$actasantacid.

II. Mixturecontainingin-diffusiblesolids

In-diffusible solids are insoluble in water. So a suitable suspending agent should be included in the formula toincreasethedispersionofinsolublesolids.**Ex:**$CaCo_3$mixture

Formula:

$CaCo_3$

Compound powder of tragacanthTincture catechu Purifiedwater

Procedure:

1. Finely powder the indiffusible solids with diffusible or soluble solids and compound tragacanthpowder in a motor. Measure three quarters of vehicle and add a portion of it with trituration toform smoothcream.
2. The content in the motor is examined for the presence of foreign particle if any that can beremovedwiththehelpof glassrodorpassingthroughmuslincloth in ameasuringcylinder.
3. Addthe liquid ingredientif anyand volumeismadeupbyaddingvehicle.
4. Themixtureistransferredintoabottle.Corked,polishedtoremovefingermarksandlabelled.
5. Thelabelshouldbemention“shake wellbeforeuse”

Storage: Itisstoredinawellclosedgreenishtintedgraduatedbottle.

Uses: It is used in the treatment of diarrhoeal, $CaCo_3$ and tincture catechu acts as anti-diarrhoeal agent.Compoundpowderoftragacanth acts assuspending agent.

III. Mixturescontainingdiffusiblesolids:

Diffusible substances are slightly or partially soluble but diffuse uniformly on shaking for enough time tomeasurethedosesosuspendingagentisnotnecessaryintheformulation.

Formula:

$MgSo_4$
Light magnesium
water
carbonatePeppermi
ntwater

$MgCo_3$isadiffusiblesolid while$MgSo_4$issolublein water.

1. Finley powder diffusible solid in a motor with soluble solid if any measure three quarter of

the vehicle andpour a portion of it with trituration to form smooth cream. Then gradually add the remainder of the vehicle.StageIIIII andIVaresimilar tomixturecontainingin-diffusiblesolids.

Storage: It is stored in a well closed greenish tinted graduated bottle. Whole thing is to be taken at a timeshouldbewrittenonthelabel.

Use: It is used in the treatment of constipation $MgCo_3$ acts as a saline purgative, light $MgCo_3$ acts as an antacidandlaxativepeppermintwateractsasflavouredvehicles.

IV. Mixturecontainingppt.formingliquids:

Certain liquid preparations contain resinous matter, when mixed with water, the resin is precipitated whichmay adhere to the sides of the bottle or form a clotted precipitate which will not re-diffuse upon shaking. Topreventthiscompound tragacanthpowderortragacanth mucilageareused.

Formula:	Potassiumiodide	2.0g
	Tincturelobeliaether	4.0ml
	Tincturestramonium	16.0ml
	Chloroformwateraddupto	90.0ml

Procedure:

1. Mix20.0mlof mucilageoftragacanth withequalvolumeof water.
2. Measuretincturelobeliaetherandtincturestramoniumseparatelyinadrymeasureandpour slowlyintothecentreof themucilagewithconstantstirring.
3. Dissolvepotassiumiodideinwaterandmixitwith abovemixture.
4. Strainthemixturethroughmuslinpieceifforeignparticlesarepresent
5. Addmoreofchloroformwatertoproducetherequiredvolume.
6. Transferthemixtureintothebottle,cork,labelanddispense.

V. Mixturecontainingslightlysolubleliquids:

Ex: Paraldehyde mixture: On shaking the slights soluble liquids with the solutions of other ingredients andliquids. It readily mixes with them and distributed throughout the liquid for sufficient time to ensure uniformdistributionin each dose.

Formula: Paraldehyde SyrupLiquidextract ofliquorice Water

Procedure

Triturateheparaldehyde,liquidextractofliquorice,syrupandwaterinamotor.Transferto a bottleandshakewell.

Storage: Itisstoredinawellclosedcontainer.

Uses: Paraldehydemixtureisusedtocontrolconvulsionsininfants.

Paraldehydeisusedassedative.

Liquid extract of liquorice and syrup act as sweetening agent.Water actsas vehicle.

Formulation of mixtures: The following are the additives or excipients which included in the preparationofmixtures.

1. **Vehicles:Ex:**Water,aromaticwater,syrupvehicle.
2. **Medicament:Ex:**$CaCo_3$,$MgSo_4$
3. **Antioxidants:Ex:**SodiumMetabi-sulphate
4. **Flavours:Ex:**Lemon spirit,Orangesyrup.
5. **Preservatives:Ex:**$CHCl_3$,benzoicacid

2. Linctus:

Linctus is sweet viscous liquid preparations containing medicament meant for internal use. Linctus arecommonly used in the treatment of cough. To obtain the maximum effect, they should be taken in smalldoses, sippedand swallowedslowly withoutaddition ofwater.

Uses:Theseusedinthetreatmentofcough.Thesehavesedativeorexpectorantanddemulcentproperty.

Ex: CodeinelinctusB.P.C

3. Draught:

Itisaliquidmedicamentintendedforinternalusewhichconsistsofone doseonly.

Container: Narrowmouthed,screwcapped,colourlessplainbottle.

Use: Usedinemergencytreatmentasemeticsinpoisoning.

Ex: Ipecacemeticdraught,Paraldehydedraught

4. Elixirs:

Elixirs are clear, flavoured sweetened hydro-alcoholic liquid preparations for oral administration. Elixirscontain medicament, syrup, glycerol, water, flavouring agent and

preservatives. Elixirs are commonly used asflavouredvehicle.Elixirsmaybesimpleelixirs withoutmedicamentandmedicatedelixirs.

Auxiliarylabel: Storeindarkplace

Uses: Usedasflavouredvehicle.

5. Syrup:

Syrup are sweet, viscous concentrated solution of sucrose. The concentration of sucrose in syrup is 66.7%. Ifpurifiedwaterisusedaloneforpreparingsyrup,isknown assimplesyrup,whenthesyrup containssome

medicinal substance it is known as medicated syrup. Syrups are used as sweetening agent, flavoured vehicle asdemulcentandas apreservative.

Storage: Syrups should be freshly prepared unless special precautions have been taken to preventcontamination.

Uses:1.Actassweeteningagent.

2. Actaspreservative.
3. Theyincreasethe viscosityofthesolution.

2.Monophasicliquidmeantforexternaluse:

Ex: Gargles,mouthwashes,throatpaints,eyedrops,eyelotion,eardropsetc.

1.Mouthwashes:

Mouth washes are simple aqueous intended to clean & deodorize the buccal cavity. Mouth washes used for itsdeodorants, rinsing, refreshing & antiseptic action. The vehicle may be water or combination of water &alcohol. Mouth washes generally contain astringent & antibacterial. Medicated mouth washes containingastringent anti-bacterial agents, Protein precipitants or other agents are also used but they must be usedunder the supervision of the dentist. A very simple preparation like compound Nacl mouth wash containing$Nacl\&NaHCo_3$ in peppermint water is commonly used by a normal person. The continuous use may proveharmful.

Container:

Narrowmouthed,colouredflutedbottleclosedwithplasticscrewcap.

Label:

1. Diluteitwithanequalvolumeofwarmwaterbeforeuse.

2. Rinsethemouth 3-4timesdailyasrequired.

Storage:Preserveinawellclosedcontainerstoreinacoolplace.

2. Gargles:

Gargles are aqueous clear solutions used for the treatment of an infection of the throat. Gargles are generallydispensed in concentrated form. They must be diluted with warm water before use. Gargles are highlymedicatedthanthemouthwashes. Gargles arepleasantlyflavoured&having P^Hof5-9.5.

Gargles are used by forcing the air from the lungs through the gargles which is in held in the throat. Thegargles are brought into intimate contact with the mucous membrane of the throat & allowed to remain therefor afewmomentsafterwhichtheyarethrownout ofthemouth.

Container: Narrowmouthed,colourlessflutedbottles&screwcapped.

Label: Mustbediluted with warmwaterbeforeuse.

Storage: Preserveinawellclosedcontainer.

Use:Totreatthroatinfections.

3. Throatpaint:

Throat paints are liquid preparations applied to the mucous membrane of buccal cavity. These are used totreatmouth&throatinfections,throatpaintscontainsantisepticastringent &analgesicproperty.

They may contain volatile solvent that evaporates quickly to leave a dry resinous film of medicaments.Throat paints are more viscous due to high content of glycerin. These are sticky & adheres to the affected site& prolongtheactionof themedicaments.

Container:-Widemouthedscrewcappedcolouredbottleswithbrush.

Labeling:-Forexternaluse only.

Storage:-Itshouldbestoredin airtightcontainers&placedinacool.

4. EARDROPS:

Ear drops are liquid preparations that are installed in to the ear.These are usually solutions or suspension. Itcontains one or more medicaments that are dissolved or suspended in a suitable vehicle. 15ml of ear dropsshouldbedispensed.

Vehicle:-Water,alcohol,glycerine,propyleneglycol,hexyleneglycol.

Medicaments:-Thefollowingmedicamentsareused inthe eardrops,dependingonthepurpose.Theyare

1. Boricacid
2. H_2O_2
3. Phenol
4. Chloromphenicol

Container:-Colouredflutedglassbottlewithdropper.

Label:-Nottobetaken

Nottobediluted

For

Uses:

1. Cleaningtheear
2. Dryingweepingsurfaces
3. Softeninginthewax
4. Treatingmildinfections

5. Nasaldrops:

Nasal drops are usually aqueous solutions intended for installation into the nostrils by means of dropper. Theyarecommonlyusedfortheirantiseptic,anti-inflammatory,anti-histamine&localanaestheticproperties.

At one time, oily preparations containing liquid paraffin or vegetable oils as vehicles were used to prolong theaction of the drug but now the use of oily vehicles in the preparation of nasal drops is discouraged because onprolong use the oil retards the capillary action of the nasal mucous or drops of oil may enter the trachea &causelipoidpneumonia.Thereforetheaqueousvehicleisadvisablefornasal drops.

Container:Flutedcolouredglassbottlewithplasticscrewcap& dropper.

Label:Forexternaluseonly.

Storage:Storeinacoolplace.

6. Liniments:

Liniments are solutions or suspensions or emulsions applied for external application. They are generallyapplied with massage. They posses analgesic, rubifacient, counter irritant & stimulating properties. These arenot applied to broken skin. Liniment contain volatile ingredients so cool storage necessary & keep away fromflame50 mloflinimentbe dispensed.Two types of vehicles are used for preparation of liniments. Theyarealcoholand oils.

Container:Narrowmouthed,colouredflutedbottle withscrewcapped.

Storage: Stored inwell–filledwellclosed,airtightcontainers&placein aplace.

Use: Counter–irritant,Rubifacient&analgesic.

7. Lotions:

Lotions are liquids suspensions or dispersion used for external application to the skin. They are applied to theskin without rubbing. This is applied with the help of cotton wool. Cotton wool is soaked in the lotion andapplied on the affected part. These lotions are applied on broken skin.Lotion may be employed for localcooling, soothing, protecting and moisturizing purpose. Dermatologists frequently prescribe lotion forantiseptic, anti-inflammatory, localanaesthetics&antifungalaction.

Container: Flutedbottle,closedwithplasticscrewcap

Storage: Preserveinawellinawell-closecontainer.

Use:protective.

Differencebetweenelixirsandsyrups:

Elixirs	Syrups
Elixirsareclearsweetenedaromatichydro-alcoholicliquid.	Syrupsareconcentratedornearlysaturated solutionofSucroseinpurifiedwater.

In elixirs the main ingredient used as ethylalcoholanditisConcentratedis5.40%w/w.	In syrup the main ingredient used as sugaranditsconc.is66.7%.

Differencebetweenlotionandliniments:

Liniments	Lotion
1.Appliedwithfriction	Appliedwithoutfriction
2.It isnot appliedtobroken skin	It isappliedtobrokenskin
3.Itisappliedwithbrush	Itappliedwithabsorbentmaterial
4.It makecontain camphor	Itdon'tcontaincamphor
5.It actascounter–irritantandrubefacient	It act as anti - septic, anti - inflammatory andcooling effect

Suspension

The suspension is a biphasic **liquid dosage form**, which contains two phases. One is the disperse phase and another is the continuous phase. The disperse phase is that phase that uniformly dispersed

into the continuous phase.

Examples of Suspension:

- Milk of magnesia
- Carboxymethyl Cellulose

Pharmaceutical Applications of suspensions:

- Some drugs are insoluble or partially soluble, there is the application of suspension. **Example**- Prednisolone.
- Some of the drugs are very bitter or unpleasant taste. Suspension helps to mask the unpleasant taste of the drug. **Example**- Chloramphenicol palmitate suspension.
- Suspension prevents degradation or improves the stability of the drug. **Example-** Oxytetracycline suspension.
- Parenteral suspensions are also applicable in order to control the rate of drug absorption, **Example**- penicillin procaine.
- In the cosmetic industry, there are huge applications of suspension. **Example**- Lotions contain insoluble solid particles to spread a thin coating of medicament on the skin. Like- calamine lotion, etc.

Classification of Suspensions:

1. Classification of suspension depending on the route of administration:

- **Oral suspension:** Those suspensions which administered through the oral route. **Example:** Paracetamol suspension, Aluminum Hydroxide, and Magnesium Hydroxide Suspension.
- **Parenteral suspension:** Those suspensions administered through the intravenous and intramuscular routes. **Example:** Sodium benzylpenicillin suspension.
- **Ophthalmic suspension:** This type of suspension is used for the eyes. The particle size should very fine, non-irritant, sterile, and isotonic.
- **Topical suspension:** Those suspensions for topical or external uses. **Example:** Calamine lotion.

2. Based on Proportion of Solid Particles:

- **Dilute suspension:** It contains 2 to10% solid in weight per volume(w/v). **Example:** Cortisone acetate, Prednisolone acetate, etc.

- **Concentrated suspension:** It contains 50% solid in weight per volume(w/v). **Example:** Zinc oxide suspension, etc.

3. Based on Size of Dispersed Particles:

- **Molecular Dispersion:** In this type of suspension particle size is less than 1 nm.
- **Colloidal Dispersion:** In this type of suspension particle size is between 0.1-0.2 µm.
- **Coarse Dispersion:** In this type of suspension particle size is greater than 0.2 µm.

Ideal Properties of a Suspension:

- The particle sedimentation should be slow.
- Re-dispersion of sedimented particles should be rapid on shaking of the container.
- Cake formation of sedimented particles is not allowed.
- The dispersed particle size should be small and uniform in size.
- It should be physically and chemically stable.

Advantages of a Suspension:

- A suspension is a dosage form that can improve the chemical stability of certain drugs. Like Procaine penicillin G.
- Suspension can improve the taste of various unpleasant/bitter tastes of the drug by masking them. Example Chloramphenicol
- The drug in suspension exhibits a higher rate of bioavailability than other dosage forms.
- Duration and onset of action can be controlled. For example Protamine Zinc-Insulin suspension.

Disadvantages of a Suspension:

- Sedimentation of the particle is one of the disadvantages of this dosage form.
- The formulation is quite difficult than other dosage forms.
- 100% uniform and accurate dose are not possible.

Methods For Formulation of Suspension:

1. Precipitation method of suspension
   - Organic solvent precipitation
   - Precipitation by pH
   - Double decomposition
2. Dispersion Method
3. Controlled flocculation
4. Structured vehicle

Additives or excipients used in the preparation of suspension:

1. **Suspending agents:** Already discussed.
2. **Wetting Agents:** Hydrophilic materials are wetted by water but hydrophobic materials are not wetted by water, it's wetted by non-polar liquids.
3. **Surfactants: Example-** Polysorbate 80
4. **Hydrophilic colloids:** Example- acacia, tragacanth, alginates, guar gum.
5. **Solvents: Example-** alcohol, glycerin, polyethylene glycol, and polypropylene glycol.
6. **Buffers: Example-** buffers are salts of weak acids such as carbonates, citrates, gluconates, phosphate
7. **Preservatives:** Preservatives are those ingredients used for the preservation or for the protection of the formulation from the attack of microorganisms. **Example-** Propylene glycol, Benzalkonium chloride, Benzoic acid.
8. **Flavoring Agents:** Acacia, Ginger, Sarsaparilla syrup, Anise oil, Glucose, Spearmint oil.
9. **Coloring Agents**: Colouring agents are used in the suspension to improve the acceptance of consumers**. Example**- Brilliant blue, Indigo carmine(blue), Tartrazine (yellow), Titanium dioxide (white), Amaranth (red),
10. **Sweetening Agents**: Sweetening agents are used to overcoming the unpleasant taste of the formulation. **Example-** xylose, ribose, glucose, mannose.
11. **Humectants:** It absorbs moisture to prevent the degradation of active pharmaceutical ingredients by moisture. **Example-** Propylene glycol, glycerol.
12. **Antioxidants: Example-** ascorbic acid, erythorbic acid, glycerol, cytosine, acetylcysteine, etc.

Evaluation of the stability of suspension:

1. Sedimentation Method
2. Rheological Method
3. Electrokinetic Method
4. Micromeritic Method

Stability Considerations for Pharmaceutical Suspensions

A suspension is a heterogeneous system consisting of two phases. The dispersed or internal phase is made up of particulate matter that is essentially insoluble in but uniformly dispersed throughout, the continuous or external phase, which is generally a liquid.

The formulation of suspensions for oral administration requires consideration of the physical properties of both the therapeutic agent and the excipients required to ensure that the formulation is physically stable and suitable for administration to patients.

The factors to be considered during the formulation of pharmaceutical suspensions can be broadly classified into

1. Stability considerations
2. Rheological considerations
3. Theoretical considerations

Apart from the above, other important formulation considerations for suspensions include

4. Dose of the active pharmaceutical ingredient (API)
5. Route of administration
6. Patient population
7. Physicochemical characteristics of the API (e.g. solubility)
8. Biopharmaceutical properties of the API
9. The physicochemical properties of the other components of the formulation

In this article, we will discuss stability considerations for pharmaceutical suspensions. Rheological considerations and theoretical considerations for pharmaceutical suspensions

Stability Considerations for Pharmaceutical Suspensions

General chemical stability considerations apply to suspensions as much as to any other formulation. The drug must remain chemically stable over the intended shelf-life of the product. Physical stability is equally important for suspension formulations.

To obtain a suspension that is chemically and physically stable, the following have to be taken into consideration.

1. Settling/Sedimentation rate of the suspended particles
2. Limitations of Stokes' Law
3. Sedimentation in flocculated and deflocculated systems
4. Controlled flocculation
5. Effects of particle size on suspension stability
6. Crystal growth

7. Use of structured vehicles

1. Settling/Sedimentation rate of the suspended particles

Settling or sedimentation is a very important issue in suspension stability. It is a general trend to reduce the rate of settling, although an inordinately slow rate of settling in a deflocculated suspension may cause the particles to settle as compact residue at the bottom of the container.

Sedimentation of particles in a suspension is governed by a variety of factors:

i. particle size
ii. density of the particles
iii. density of the vehicle and
iv. viscosity of the vehicle

The relationship between the velocity of sedimentation of particles, the diameter of the particle, the acceleration of gravity, density of the suspended particle, density and viscosity of the vehicle in a suspension can be determined by using the Stokes' law which is mathematically stated as

$V = d^2 (\rho_1 - \rho_2) g / 18 \eta$

Where:

V = velocity of sedimentation, d = diameter of the particle, g = acceleration of gravity, ρ_1 = density of the particle, ρ_2 = density of the vehicle, η = viscosity of the vehicle.

From the above equation (Stoke's equation), the velocity of sedimentation of particles in a suspension has a direct relationship with particle diameter and the difference of the densities of both the particles and the vehicle.

The velocity of sedimentation can be reduced by decreasing the particle size and also by minimizing the difference between the densities of the particles and the vehicle. Since the density of the particles is constant for a particular substance and cannot be changed, the changing of the density of the vehicle close to the density of the particle would minimize the difference between the densities of the particles and the vehicle.

The density of the vehicle of a suspension can be increased by adding polyethylene glycol, polyvinyl pyrrolidone, glycerin, sorbitol, and sugar either alone or in combination.

2. Limitations of Stokes' Law

Stokes' law is a generalized equation that describes how certain factors affect the rate of settling in dispersed systems. The implication is that, as the average particle size of suspended particles is increased, there is a dramatic effect on the resultant rate of sedimentation.

Stokes' law is based upon several assumptions, which may not always hold true for pharmaceutical suspensions. The law is valid for diluted pharmaceutical suspensions that are composed of no more than 2% solids. In a diluted suspension, the solid particles settle without interference from one another in what is termed free settling. In a concentrated suspension, this interference may occur and may hinder the settling results.

Particle shape and size are also important in Stokes' equation. This equation assumes spherical and monodisperse particles, which may not be encountered in real systems. The limitations to Stoke's law include:

- Negative density difference in Stoke's equation
- High content of dispersed solids
- Dielectric constant
- Brownian movement

3. Sedimentation in flocculated and deflocculated systems

Flocculated suspensions as discussed in the theoretical considerations show rapid sedimentation creating loose sediment; whereas, deflocculated suspensions show slow, but compact, sedimentation. A deflocculated system has an advantage in that their sedimentation rate is slow, thereby allowing uniform dosing. However, if settling occurs, the sediment can be compact and difficult to redisperse. On the other hand, flocculated suspensions are stilted because the particles separate quickly. Rapid sedimentation may cause inaccurate dosing but redispersion can occur, even after long storage since the sediment is loose. An intermediate condition known as controlled flocculation can be created to obtain the most acceptable product.

The extent of flocculation of a system can be redefined by the extent of sedimentation by using two commonly important sedimentation parameters;

1. **The sedimentation volume, F**, which is the ratio of the equilibrium volume of the sediment, V_u to the total volume of the suspension, V_o used for that purpose with the value of F normally ranging from 0 to 1. The above statement can be stated mathematically as

$F = V_u / V_o$

If the sedimentation volume is 0.8, 80% volume of the suspension is occupied by the loose flocs as the sediment. The F value of a deflocculated suspension is usually relatively small, about 0.2. A pharmaceutical suspension with F value 1 is the ideal system and such a system is said to be flocculated. There is no sedimentation or caking in such a system and it is also aesthetically elegant since there is no visible clear supernatant.

A pharmaceutical suspension with F value 1 can also be said to be in flocculation equilibrium. It is possible to have F values greater than 1 when the ultimate volume of the sediment is greater than the original volume of the suspension.

2. The degree of flocculation, β. This is a more applicable parameter for flocculation and it is the sedimentation volume of the flocculated suspension, F, to the sedimentation volume of the suspension when it is deflocculated, F_∞. This is expressed mathematically as

$\beta = F / F_\infty$

The sedimentation volume of the deflocculated suspension can be shown by the following equation

$F_\infty = V_\infty / V_o$

Where

F_∞ = sedimentation volume of the deflocculated system

V_o = ultimate volume of the sediment

The degree of flocculation is a more useful parameter because it compares the suspension under investigation to a standard: the deflocculated state of the system.

4. Controlled Flocculation

A suspension in which all the particles remain discrete would, in terms of the DLVO theory, be considered to be stable. Flocculation should be carefully controlled, and the viscosity should not be too high to make redispersion difficult.

Controlled flocculation can be achieved by a combination of control of particle size and the use of flocculating agents. The most common categories of flocculating agents are electrolytes, surfactants, and polymers.

i. Electrolytes

Electrolytes act by reducing the zeta potential, which brings the particles together to form loosely arranged structures. The flocculating power increases with the valency of the ions. Calcium ions having two valency electrons are more powerful than sodium or potassium ions with one valency electron. Trivalent ions are less commonly used because of their toxicity. The zeta potential decreases slowly when electrolytes are added to a positively charged deflocculated suspension.

At a certain stage, upon persistent addition, it becomes zero. Beyond that limit, zeta potential becomes negative. As zeta potential decreases, the sedimentation volume increases sharply up to a point. The sedimentation volume reaches its maximum value and remains relatively constant within a certain range of zeta potential, where it changes from low positive potential to low negative potential. When the potential becomes too negative, the sedimentation volume decreases again.

ii. Surfactants

Both ionic and nonionic surfactants according to can be used as flocculating agents. Ionic surfactants cause flocculation by neutralizing the charge on particles. Because of long structure, nonionic surfactants are adsorbed onto more than one particle, thereby, forming a loose flocculated structure.

iii. Polymers

Linear and branched-chain polymer form a gel-like network that adsorbs onto the surface of dispersed particles, holding them in a flocculated state. Moreover, hydrophilic polymers can also function as protective colloids. In this capacity, flocs are sterically prevented from adhering to one another resulting in the formation of loose sediments.

At low polymer concentrations, when the drug particles are not completely covered by the polymers, the latter can form bridges between multiple particles leading to the formation of flocculation. The particles suspended in a pharmaceutical suspension are fully covered by the polymers, which creates steric stabilization at sufficiently high polymer concentration.

Some polymers, known as polyelectrolytes, can ionize in aqueous medium and the extent of ionization depends on the pH and the ionic strength of the dispersion medium. These polymers are able to act both electrostatically and sterically.

Linear polymers (e.g., sodium carboxymethylcellulose) serve better as flocculating agents; however, coiled polymers (e.g., polyvinylpyrrolidone) are not conducive to flocculation, due to their shape and so they produce steric stability.

5. Effects of particle size on suspension stability

The particle size of any suspension is critical and must be reduced within the range as determined during preformulation study. It is first necessary to ensure that the drug to be suspended is of a fine particle size prior to formulation as this will ensure a slow rate of sedimentation of the suspended particles.

Large particles, if greater than about 5µm diameter, will also impart a gritty texture to the product, and may cause irritation if injected or instilled into the eyes.

6. Crystal growth

Crystal growth also known as Ostwald ripening is a process of aggregation of small-sized particles to produce large-sized particles. It is a phenomenon that may affect pharmaceutical suspensions by influencing the average particle size. Crystal growth sometimes is very important for suspension sedimentation, physical stability, redispersibility, appearance, and bioavailability.

Particles in dispersion may not maintain a constant size throughout its shelf life. One of the reasons for that change would be crystal formation. There is however a range of particle size and not a single value.

The surface free energy on smaller particles is comparatively more than that on larger particles. Therefore, smaller particles are more soluble in the dispersion medium. If the temperature rises, more materials are dissolved from the smaller particles, decreasing their size even more. When the temperature goes down, the drug attempts to recrystallize on the surface of existing particles. The larger particles will increase gradually in size as the smaller particles decrease in size. Thus, a slight change in temperature may cause the particle size spectrum shift to higher values.

This situation is especially true for slightly soluble drugs and can be initially eliminated by using a narrow particle size range. Surface active agents or polymeric colloids can also prevent crystal growth by being adsorbed on the particle surface.

Crystal growth in pharmaceutical suspension may also happen for polymorphic drugs. Metastable (i.e., the least stable form of the drug) is the most soluble and as the metastable form changes to a more stable form, solubility decreases, and crystallization occurs. This problem can be avoided by excluding the metastable form from the dispersion and by using the most stable polymorph of the drug. Amorphous metronidazole was found to convert to the monohydrate form in an aqueous suspension, thus favoring crystal growth. A combination of suspending agents, microcrystalline cellulose and carboxymethylcellulose was found to prevent the conversion.

7. Use of structured vehicles

Structured vehicles are generally aqueous solutions of natural and synthetic polymers, such as methylcellulose, carboxymethylcellulose, sodium carboxymethylcellulose, acacia, gelatin, etc. They are viscosity-imparting agents and basically reduce the rate of sedimentation in dispersed systems. These vehicles are plastic or pseudoplastic in nature. Additionally, some degree of thixotropy is desirable.

For a deflocculated suspension, the shear-thinning property of the structured vehicle will allow easy redistribution of the particles from the small sediment. However, the ultimate sediment in a deflocculated system in a structured vehicle, as in other vehicles, may form a compact cake, which will not be resuspendable by the shear-thinning liquid. Therefore, a structured network, flocculated suspension, in a structured vehicle is preferred. When the shaking is discontinued, the vehicle goes back to its original higher consistency, and that keeps the particles suspended.

A flocculated suspension with no structured vehicle may not look elegant if the sedimentation volume is not close to 1. The concentration of polymer in a structured vehicle depends on the required consistency of the preparation and, therefore, on the particle size and density.

EMULSIONS

DISPERSE SYSTEM

In which one substance is distributed in particulate form throughout another

Two types

Emulsion

Is a biphasic liquid preparation containing two immiscible liquids one of which is dispersed as minute globules into other and 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).

Suspension

Is a two phased system in which a finely divided solid is dispersed in a continuous phase of solid, liquid, or gas.

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).

TYPES OFEMULSIONS:

1. Macroemulsions (Simple Emulsions):

I. Oil in water (o/w): Oil droplets are dispersed in a continuous aqueous phase. This emulsion is generally formed if the aqueous phase constitutes more than 45 % of the total weight and a Hydrophilic emulsifier is used. These are [referred for oral administration and cosmetics. These are useful as water washable drug bases .The globule size is 0.25 to 10 microns.

ii. Water in oil (w/o): Aqueous droplets are dispersed in continuous oily phase. . This emulsion is generally formed if the oily phase constitutes more than 45 % of the total weight and a lipophobic emulsifier is used. These are used for cosmetics. They are employed for treatment of dry skin and emollient applications.

2. Multiple emulsions:

Types of multiple emulsions: w/o/w , o/w/o

They are developed with a view to delay the release of an active ingredient. They have three phases. They may be oil-in-water-in-oil (o/w/o) or of water-in-oil-in-water (w/o/w). An emulsifier is present to stabilize the emulsions and various ionic and nonionic surfactants are available for this purpose. Lipophilic (oil-soluble, low HLB) surfactants are used to stabilize w/o emulsions, whereas

hydrophilic (water-soluble, high HLB) surfactants are used to stabilize o/w systems In these emulsions within emulsions any drug present in innermost phase must now cross two phase boundaries to reach the external continuous phase. Such emulsions also can invert. However, during inversion they form simple emulsions. So a w/o/w emulsion will get inverted to o/w emulsion.

Preparation of multiple emulsions:

Aqueous phase is added to oily phase, containing a lipophilic surfactant. Upon mixing a w/o emulsion is formed. This w/o emulsion is then poured into a second aqueous solution,containza hydrophilic surfactant. Upon mixing multiple emulsion w/o/w is formed.

3. Microemulsions:

They may be defined as dispersions of insoluble liquids in a second liquid that appears clear and homogenous to the naked eye. They are frequently called solubilised systems because on a macroscopic basis they seem to behave as true solutions. Terms as transparent emulsions, micellar solutions, solubilised systems, and swollen micelle have all been applied to the same or similar systems.

These emulsions appear to be transparent to the eye. They have globule radius below the range of 10-75 nm. The appearance of emulsion depends on the wavelength of visible light i.e. globules less than 120 nm do not reflect light and appear transparent to the eye. As in microemulsions the globule size is less than 120 nm, they appear to be transparent.

USES (APPLICATIONS) OF EMULSIONS:

Emulsions can be used for oral, parenteral or topical pharmaceutical dosage forms.

i. Oral Products

Emulsions are used for administering drugs orally due to following reasons:

a. More palatable: Objectionable taste or texture of medicinal agents gets masked.

b. Better absorption: Due to small globule size, the medicinal agent gets absorbed faster.

ii. Topical products:

O/W emulsions are more acceptable as water washable drug bases for cosmetic purposes.

W/O emulsions are used for treatment of dry skin. Emulsions have following advanyages when used for topical purpose:

A. Patient acceptance: Emulsions are accepted by patients due to their elegance, easily
B. washable character,
C. acceptable viscosity,
D. less greasiness.

iii. Parenteral Emulsions:

A. I.v route: Lipid nutrients are emulsified and given to patients by i/v rout. Such emulsions have particle size less than 100 nm.

B. Depot injections : W/o emulsions are used to disperse water soluble antigenic materials in mineral oil for i/m depot injection

iii. Diagnostic purposes:

iv. Radio opaque emulsions have been used in X-ray examination.

Identification test of emulsion

Dilution test:

In this test the emulsion is diluted either with oil or water. If the emulsion is o/w type and it is diluted with water, it will remain stable as water is the dispersion medium" but if it is diluted with oil, the emulsion will break as oil and water are not miscible with each other o/w emulsion can be diluted with water.

w/o emulsion can be diluted with oil.

Conductivity Test

The basic principle of this test is that water is a good conductor of electricity. Therefore in case of o/w emulsion, this test will be positive as water is the external phase. 'In this test, an assembly is used in which a pair of electrodes connected to an electric bulb is dipped into an emulsion. If the emulsion is o/w type, the electric bulb glows.'

Dye-Solubility Test

In this test an emulsion is mixed with a water soluble dye (amaranth) and observed under the microscope. If the continuous phase appears red, it means that the emulsion is o/w type as water is in the external phase and the dye will dissolve in it to give color. If the scattered globules appear red and continuous phase colorless, then it is w/o type. Similarly if an oil soluble dye (Scarlet red C or Sudan III) is added to an emulsion and the continuous phase appears red, then it is w/o emulsion.

Fluorescence Test:

Oils give fluorescence under UV light, while water doesn't. Therefore, O/W emulsion shows spotty pattern while W/O emulsion fluoresces. When a w/o emulsion is exposed to fluorescent light under a microscope the entire field fluorescence. If the fluorescence is spotty, then the emulsion is of o/w-type. However, all oils do not exhibit fluorescence under UV light and thus the method does not have universal application. It is necessary that the results obtained by one method should always be confirmed by means of other methods

Cobalt Chloride Test:

Filter paper impregnated with CoCl2 and dried appear to be blue but when dipped in o/w emulsion changes to pink. This test may fail if emulsion unstable or breaks in presence of electrolyte.

FORMULATION OF EMULSIONS

1. Emulsifying agents (emulsifiers)
2. Antioxidants (Stabilizers)
3. Antimicrobial preservatives
4. Colours and flavourings

Emulsifying agents (emulsifiers):

An emulsifying agent is any material that enhances the stability of an emulsion (i.e. Prevention of coalescence and reducing creaming).The ideal emulsifying agent is colourless, odourless, tasteless, non-toxic, non-irritant and able to produce stable emulsions at low concentrations.

Classification of Hydrocolloid emulsifying agents

- Hydrocolloids.
- Surface active agents (SAA) (surfactants).
- Finely divided solids.
- Auxiliary emulsifiers.

Natural emulsifying agents. :

Natural (Multimolecular films)

Ø From plant origin Polysaccharides (Acacia, tragacanth, agar, pectin, lecithin) o/w emulsions.

Ø From animal origin

Ø Proteins (Gelatin) o/w emulsions.

Ø Lecithin, o/w i/v emulsion

Ø Cholesterol. w/o

Ø Wool fat, w/o

i. Natural emulsifying agents from vegetable sources

These consist of agents who are carbohydrates and include gums and mucilaginous substances. Since these substances are of variable chemical composition, these exhibit considerable variation in emulsifying properties. They are anionic in nature and produce o/w emulsions. They act as primary emulsifying agents as well as secondary emulsifying agents (emulsion stabilizers). Since carbohydrates acts a good medium for the growth of microorganism, therefore emulsions prepared using these emulsifying agents have to be suitable preserved in order to prevent microbial

contamination. E.g. tragacanth, acacia, agar, chondrus (Irish moss), pectin and starch.

Acacia:It is a carbohydrate gum which is soluble over a wide pH range. Tragacanth, pectin and starch are used as auxiliary emulsifying agents.

ii. Natural emulsifying agents from animal source

The examples include gelatin, egg yolk and wool fat (anhydrous lanolin).

Gelatin:

It is a protein .It has two isoelectric points, depending on the method of preparation. Type a gelatin derived from acid treated precursor, has an isoelectric point between pH 7 and 9. Type B gelatin obtained from an alkaline precursor has an isoelectric point around pH 5. . Type A gelatin acts best as an emulsifier around pH 3 where it is-velychaged: On the other hand type B gelatin suitable as emulsifier at pH 8 where it is –vely charged.Type A gelatin (Cationic) is generally used for preparing o/w emulsion while type B gelatin is used for o/w emulsions of pH 8 and above.

Lecithin:

It is an emulsifier obtained from both plant (soyabean) and animal (e.g. egg yolk) sources and is composed of phosphatides. Although the primary component of most lecithins is phosphatidyl choline. But it also contains phosphatidylsrine, phosphatidyl inositol, phosphatdylethanloamine and phosphatidic acid.. It imparts a net –ve charge to dispersed particles. They show surface activity and are used for formulating o/w emulsions. Lecithins are good emulsifying agents for naturally occurring oils such as soy, corn, or safflower. Purified lecithin from soy or egg yolk is used for i/v emulsions.

cholesterol:

It is a major constituent of wool alcohols, obtained by the saponification and fractionation of wool fat. It forms w/o emulsion. It is because of cholesterol that wool fat absorbs water and form a w/o emulsion It is also present in egg yolk.

Wool fat

It is mainly used in w/o emulsions meant for external use. They absorb large quantities of water and form stable w/o emulsions with other oils and fats.

Classification of Surfactant emulsifying agents

Ø Synthetic (Surfactants) (Monomolecular films)

- Cationic
- Quaternary ammonium compounds

Ø Nonionic

- Glyceryl esters
- Sorbitan fatty acid esters
- Polyoxyethylenepolyoxypopylene esters (Macrogels)
- Polyoxyethylene derivatives of sorbitan fatty acid esters (polysorbate)

Preservation :

Once a microbiologically uncontaminated product has been formed, a relatively mild antimicrobial agent is sufficient to protect the product against microbial contamination. The preservative system must be effective against invasion by a variety of pathogenic organisms and protect the product during use by consumer.The preservative must be :Less toxic, Stable to heat and storage, Chemically compatible, Reasonable cost, Acceptable taste, odor and color.Effective against fungus, yeast, bacteria.

Available in oil and aqueous phase at effective level concentration.

- Acids and acid derivatives - Benzoic acid - Antifungal agent
- Aldehydes – Formaldehyde - Broad spectrum
- Phenolics - Phenol - Broad spectrum

  Cresol

  Propyl p-hydroxy benzoate
- Quaternaries -Chlorhexidine and salts - Broad spectrum

Benzalkonium chloride

Cetyltrimethyl ammonium bromide

- Mercurials -Phenyl mercuric acetate - Broad spectrum

Colours and flavorings

Colour is rarely needed in an emulsion, as most have an elegant white colour and thick texture. Emulsions for oral use will usually contain some flavouring agent.

The HLB (Hydrophilic lipophilic balance system):

An HLB number (1-20) represents the relative proportions of the lipophilic and hydrophilic parts of the molecule. High numbers (8-18) indicate a hydrophilic molecule, and produce an o/w emulsion.Low numbers (3-6) indicate a lipophilic molecule and produce a w/o emulsion. Oils and waxy materials have a 'required HLB number' which helps in the selection of appropriate emulsifying agents when formulating emulsions. Liquid paraffin, for example, has a required HLB value of 4 to obtain a w/o emulsion and 12 for an o/w emulsion.

HLB ca. 3.5 to 8: Water-in-Oil Emulsifiers

HLB ca. 1 to 3.5: Antifoams

HLB ca. 7 to 9: Wetting and spreading agents

HLB ca. 8 to 16: Oil-in-Water Emulsifiers

HLB ca. 13 to 16: Detergents

HLB ca. 15 to 40: Solubilizes

Methods of Preparation Of Emulsions

Commercially, emulsions are prepared in large volume mixing tanks and refined and stabilized by passage through a colloid mill or homogenizer. Extemporaneous production is more concerned with small scale methods.

1) Dry Gum Methods

2) Wet Gum Methods

3) Bottle Method

4) Beaker Method.

5) In situ Soap Method

DRY GUM Method (Continental method)

Dry gum method is used to prepare the initial or primary emulsion from oil, water, and a hydrocolloid or "gum" type emulsifier. (4 parts oil, 2 parts water, and 1 part Emulsifier).

Ratio of oil: gum: water in primary emulsion

Fixed oil = 4:1:2

Mineral oil = 3:1:2

Volatile oil = 2:1;2

Procedure: Take mortar, 1 part gum is levigated with the 4 parts oil until the powder is thoroughly wetted; then the 2 parts water are added all at once, and the mixture is vigorously triturated until the primary emulsion formed is creamy white and produces a "crackling" sound as it is triturated. Active ingredients, preservatives, color, flavors are added as a solution to the primary emulsion. When all agents have been incorporated, the emulsion should be transferred to a calibrated vessel, brought to final volume with water.Oil soluble substances in small amounts may be incorporated directly into the primary emulsion. Any substance which might reduce the physical stability of the emulsion, such as alcohol (which may precipitate the gum) should be added as near to the end of the process as possible to avoid breaking the emulsion. When all agents have been incorporated , the emulsion should be transferred to a calibrated vessel, brought to final volume with water, then homogenized or blended to ensure uniform distribution of ingredients.

Wet Gum Method (English method)

(Oil 4 parts + Water 2 parts + Emulsifier 1 parts)

Procedure: In this method, the proportions of oil, water, and emulsifier are the same (4:2:1), but the order and techniques of mixing are different. The 1 part gum is triturated with 2 parts water to form a mucilage; then the 4 parts oil is added slowly, in portions, while triturating. After all the oil is added, the mixture is triturated for several minutes to form the primary emulsion. Then other ingredients may be added as in the continental method. Generally speaking, the English method is more difficult to perform successfully, especially with more viscous oils, but may result in a more stable emulsion.

Bottle Method

This method may be used to prepare emulsions of volatile oils, Oleaginous substances of very low viscosities.This method is a variation of the dry gum method. One part powdered acacia (or other gum) is placed in a dry bottle and four parts oil are added. The bottle is capped and thoroughly shaken. To this, the required volume of water is added all at once, and the mixture is shaken thoroughly until the primary emulsion forms.

Beaker Method

The most appropriate method. Dividing components into water soluble and oil soluble components. All oil soluble components are dissolved in the oily phase in one beaker and all water soluble components are dissolved in the

water in a separate beaker. Oleaginous components are melted and both phases are heated to approximately 70°Cover a water bath. The internal phase is then added to the external phase with stirring until the product reaches room temperature.

Example: Calculate the quantities for a primary emulsion for the following:

Cod liver oil	30 ml
Water	to 100 ml

Answer: Primary emulsion quantities:

Cod liver oil is a fixed oil, therefore the primary emulsion proportions are 4 : 2 : 1 .Hence:

Cod liver oil	30 ml	4
Water	15 ml	2
Powdered acacia gum	7.5g	1

If the proportion of oil is too small, modifications must be made. Acacia emulsions containing less than 20% oil tend to cream readily. A bland, inert oil, such as arachis, sesame, cottonseed or maize

oil, should be added to increase the amount of oil and so prevent this from happening. Care should be taken in selection of the bulking oil because of the increasing incidence of nut allergy. It is often, therefore, advisable to avoid oils such as arachis, especially for children.

Example: Rx Calciferol solution, 0.15 ml per 5 ml dose.

Answer: The percentage of oil in each dose is 3%. The oil content must be made up to at least 20% to produce a stable emulsion. Since 20% of 5 ml = 1 ml the volume of bland oil required is 1-0.15 = 0.85 ml

Formula for primary emulsion (for 50 mL)

Calciferol solution	1.5 ml	4
Cottonseed oil	8.5 ml	
Water	5 ml	2
Acacia	2.5g	1

The primary emulsion may not form and a thin oily liquid is formed instead. Possible causes are: Phase inversion has occurred, incorrect quantities of oil or water were used, and Cross-contamination of water and oil, a wet mortar was used, The mortar was too small and curved or the pestle was too round giving insufficient shear, Excessive mixing of oil and gum before adding water (dry gum method), Diluting the primary emulsion too soon or too rapid dilution of primary emulsion, Poor-quality acacia

Creaming

Creaming is the concentration of globules at the top or bottom of the emulsion. Droplets larger than 1 mm may settle preferentially to the top or the bottom under gravitational forces.Creaming may also be observed on account of the difference of individual globules (movement rather than flocs). It can be observed by a difference in color shade of the layers.It is a reversible process, i.e., cream can be redispersed easily by agitation, this is possible because the oil globules are still surrounded by the protective sheath of the emulsifier. Creaming results in a lack of uniformity of drug distribution. This leads to variable dosage. Therefore, the emulsion should be shaken thoroughly before use. Creaming is of two types, upward creaming and downward creaming

Upward creaming, is due to the dispersed phase is less dense than the continuous phase. This is normally observed in o/w emulsions. The velocity of sedimentation becomes negative.Downward creaming occurs if the dispersed phase is heavier than the continuous phase. Due to gravitational pull, the globules settle down. This is normally observed in w/o emulsions.Since creaming involves the movement of globules in an emulsion, Stokes' law can be applied.

$$\nu = \frac{d2\ (\rho s - \rho 0)g}{18\ \eta 0}$$

ν = terminal velocity in cm/sec,

d is the diameter of the particle in cm,

ρs and ρ0 are the densities of the dispersed phase and dispersion medium respectively,

g is the acceleration due to gravity and

η0 is the viscosity of the dispersion medium in poise.

Creaming is influenced by,

– Globule size

– Viscosity of the dispersion medium

– Difference in the densities of dispersed phase and dispersion medium.

Creaming can be reduced or prevented by:

Reducing the particle size by homogenization. Doubling the diameter of oil globules increases the creaming rate by a factor of four.Increasing the viscosity of the external phase by adding the thickening agents such as methyl cellulose tragacanth or sodium alginate.Reducing the difference in the densities between the dispersed phase and dispersion medium. Adjusting the continuous phase and dispersed phase densities to the same value should eliminate the tendency to cream. To make densities equal, oil soluble substances such as bromoform, β-bromonaphthaleneare added to the oil phase (rarely used technique).

Coalescence

If the sizes of globules are not uniform, globules of smaller size occupy the spaces between the larger globules. A few globules tend to fuse with each other and form bigger globules.This type of closed packing induces greater cohesion which leads to coalescence. In this process, the emulsifier film around the globules is destroyed to a certain extent. This step can be recognized by increased globule size and reduced number of globules.

Coalescence is observed due to:

- Insufficient amount of the emulsifying agent.
- Altered partitioning of the emulsifying agent.
- Incompatibilities between emulsifying agents.

Phase volume ratio of an emulsion has a secondary influence on the stability of the product and represents the relative volume of water to oil in emulsion.At higher ratio (>74% of oil to water), globules are closely packed, wherein small globules occupy the void spaces between bigger globules.Thus globules get compressed and become irregular in shape, which leads to fusion of

adjacent globules.Ostwald and others have shown that if one attempts to incorporate more than about 74% of oil in an o/w emulsion, the oil globules often coalesce and the emulsion breaks. This value known as the critical point, is defined as the concentration of the dispersed phase above which the emulsifying agent cannot produce a stable emulsion of the desired type.

Breaking (cracking)

Separation of the internal phase from the external phase is called breaking of the emulsion. This is indicated by complete separation of oil and aqueous phases, is an irreversible process, i.e., simple mixing fails. It is to resuspend the globules into an uniform emulsion. In breaking, the protective sheath around the globules is completely destroyed and oil tends to coalesce.

Phase inversion

This involves the change of emulsion type from o/w to w/o or vice versa.

When we intend to prepare one type of emulsion say o/w, and if the final emulsion turns out to be w/o, it can be termed as a sign of instability.

It may due to

- By addition of an electrolyte
- By changing Phase-Volume ratio
- By temperature change
- By changing emulsifying agent

Question bank

Very short questions (2 Marks)

1. Define gargle with examples.
2. Define mouthwashes with examples. o and 2-
3. Define ear drops and nasal drops for example.
4. Write the advantages of syrups.
5. What is invert sugar?
6. Define linctuses with examples
7. Define expectorant with examples.
8. Define throat paint with examples.
9. Define elixirs with examples.
10. Define enema with examples.
11. Deine nasal drops with examples.
12. What are structured vehicles? Give examples.
13. Name any two suspending and emulsifying agents.
14. Name any four flocculating agents used in the preparation of suspension.
15. Name any two flocculating and deflocculating agents.
16. What is the phase volume ratio? How it is useful in the preparation of emulsions.
17. What is phase inversion? How it can be prevented.
18. Classify emulsifying agents.
19. Write the primary emulsion formula for fixed oils and mineral oils.
20. Write the primary emulsion formula for oleoresin and volatile oils.
21. Write the primary emulsion formula for fixed oils and volatile oils.
22. Classify emulsions.
23. Classify suspensions.
24. Why emulsifying agent is required in the preparation of emulsions.
25. Define creaming and cracking?
26. Give Griffin's HLB value scale and its application.
27. What should be the HLB of emulsifying agent to give oil in water or water in oil emulsions?
28. Give two examples for wetting agents.
29. Define the wetting phenomenon.
30. Define surfactants with examples.
31. Enlist various identification tests for emulsion.

32. How do differentiate monophasic and biphasic liquid dosage forms for example?

Short Question (5 Marks)

1. Define and classify suspension. Write the advantages and disadvantages of suspension?
2. Differentiate flocculated and deflocculated suspension.
3. Discuss briefly the method of preparation of suspensions containing indiffusible solids.
4. Differentiate mouth washes and Gargles.
5. Differentiate lotions and liniments.
6. Explain controlled flocculation?
7. Discuss various methods of preparation of emulsions.
8. Write the principle and procedure involved in the preparation of syrup 1.P.
9. Differentiate between elixirs and syrups.
10. Write a note on identification tests for emulsions with example.
11. Write a note on why emulsions arc white to creamy white.

Long questions (10 marks)

1. Discuss briefly the stability problems and methods to overcome the suspension.
2. Define suspension. Explain the preparation of suspension containing diffusible and diffusible solids?
3. Define suspension. Write its advantages, disadvantages s and classification suspensions. Differentiate flocculated and deflocculated suspension?

- What is the various instability of emulsion? Discuss them with their cause and precautions to avoid them?
- Define and classify emulsion. Write the various identification tests for emulsion type?