Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 1

Name of topic/lesson – Solubility of drugs

Subtopic: Solubility expressions, mechanisms of solute solvent interactions

Objective: To study solubility expressions and use them for comparing the solubility's of different samples.

Topic Outcomes: At the end of topic you should be

1. Able to define all solubility terms

2. Know the mechanism of solute solvent interaction

Amount of a substance (called the solute) that dissolves in a unit volume of a liquid substance (called the solvent) to form a saturated solution under specified conditions of temperature and pressure. **Solubility** is expressed usually as moles of solute per 100 grams of solvent.

Mechanism of solute slvent interaction:

If the solvent is A & the solute is B, and the forces of attraction are represented by A-A, B-B and A-B, one of the following conditions will occur: 1. If A-A >> A-B The solvent molecules will be attracted to each other & the solute will be excluded. Example: Benzene & water, where benzene molecules are unable to penetrate the closely bound water aggregates. 2. If B-B >> A-A The solvent will not be able to break the binding forces between solute molecules. Example: NaCl in benzene, where the NaCl crystal is held by strong electrovalent forces which cannot be broken by benzene. 3. If A-B >> A-A or B-B, or the three forces are equal. The solute will disperse & form a solution. Example: NaCl in water

References

1. Ashwini Pravin Gowardhane, Nilesh Vishnu Kadam and Saptrishi Dutta, 2014. Review on Enhancement of Solubilization Process. *American Journal of Drug Discovery and Development, 4: 134-152.*

2. Allen, L.V., N.G. Popovich and H.C. Ansel, 2005. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems. Lippincott Williams and Wilkins, USA., ISBN: 9780781746120, pp: 100-101.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 2

Name of topic/lesson – Solubility

Subtopic: Solubility parameter and salvation and association.

Objective: To study Solubility parameter and salvation and association.

Topic Outcomes: At the end of topic you should be

1. Able to define all solubility parameter

2. Know the meaning of salvation and association

The **solubility parameter** is a numerical value that indicates the relative solvency behavior of a specific solvent. It is derived from the cohesive energy density of the solvent, which in turn is derived from the heat of vaporization.

Cohesive energy Density = $(\Delta H - RT) / v$

Solvation: The term solvation refers to the surrounding of each dissolved molecule or ion by a shell of more or less tightly bound solvent molecules. This solvent shell is a result of intermolecular forces between solute and solvent

Solvation is the process of attraction and association of molecules of a solvent with molecules or ions of a solute. As ions dissolve in a solvent, they spread out and become surrounded by solvent molecules.

References

1.http://pharmaview.weebly.com/uploads/1/8/0/0/18009987/solubility_and_distribution_phenomena.pdf

2. Solubility Textbooks: Aulton- 'Pharmaceutics: The Science of Dosage Form Design'.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 3

Name of topic/lesson – Solubility

Subtopic- Quantitative approach to the factors Influencing solubility of drugs.

Objective: To study quantitative approach to the factors Influencing solubility of drugs.

Topic Outcomes: At the end of topic you should be

1. Able to know the factors which affect solubility

Factors affecting solubility are:

Temperature: Basically, solubility increases with temperature. It is the case for most of the solvents. The situation is though different for gases. With increase of the temperature they became less soluble

Polarity: In most cases solutes dissolve in solvents that have a similar polarity. Chemists use a popular aphorism to describe this feature of solutes and solvents: "Like dissolves like". Non-polar solutes do not dissolve in polar solvents and the other way

Pressure:
Solid and liquid solutes: For majority of solid and liquid solutes, pressure does not affect solubility.

Gas solutes: As for gasses the Henry's law states that solubility of gas is directly proportional to the pressure of this gas. This is mathematically presented as: $p = kc$, where k is a temperature dependent constant for a gas.

Molecular size: The larger the molecules of the solute are, the larger is their molecular weight and their size. It is more difficult it is for solvent molecules to surround bigger molecules. If all of the above mentioned factors ale excluded, a general rule can be found that larger particles are generally less soluble. If the pressure, and temperature are the same than out of two solutes of the same polarity, the one with smaller particles is usually more soluble.

Stirring increases the speed of dissolving: Stirring does not have an affect on solubility of a substance, but everyone knows that if he puts sugar in his tea and does not stir, it will not dissolve. Actually, if we left the tea to stand for a long enough time, the sugar would dissolve. Stirring only increases the speed of the process - it increases move of the solvent what exposes solute to fresh portions of it, thus enabling solubility.

References

1. https://www.solubilityofthings.com/basics/factors_affecting_solubility.php
2. Solubility of gases in liquids: a critical evaluation of gas/liquid systems in theory and practice, Pater G, William Gerrard, 2010, 332

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 4

Name of topic/lesson – Solubility

Subtopic: Diffusion principles in biological systems.

Objective: To study release of drug and diffusion principles.

Topic Outcomes: At the end of topic you should be

1. Able to know the concept of diffusion.

Dissolution is the process in which a substance forms a solution. A dissolution test measures the extent and rate of solution formation from a dosage form, such as tablet, capsule, ointment, etc. The dissolution of a drug is important for its bioavailability and therapeutic effectiveness. Dissolution and drug release are terms used interchangeably.

Biological applications of diffusion –

Bacterial metabolism

Permeability of membranes

Membrane potentials

Electrical conductivity of solutions

Diffusion involves Ficks first law and second law of diffusion. And diffusion through various formulations.

References

1. Lecture 11. Diffusion in biological systems Zhanchun Tu
2. Module 2. Concentrations– Biology Dr. Hirrel, Mr. Mimms, and Ms Waggoner Diffusion - agar, cell size, vernier probes Principle of diffusion

Lecture No: 5

Name of topic/lesson – Solubility

Subtopic: Solubility of gas in liquids

Objective: To study solubility of gas in liquids.

Topic Outcomes: At the end of topic you should be

1. Able to study solubility of gas in liquids.
2. Solubility of solid in liquid.

Liquids and solids exhibit practically no change of **solubility** with changes in pressure. **Gases** as might be expected, increase in **solubility** with an increase in pressure. Henry's Law states that: The **solubility** of a **gas** in a **liquid** is directly proportional to the pressure of that **gas** above the surface of the solution.

For many **solids** dissolved in **liquid** water, the **solubility** increases with temperature. The increase in kinetic energy that comes with higher temperatures allows the solvent molecules to more effectively break apart the solute molecules that are held together by intermolecular attractions.

The use of first-aid instant cold packs is an application of this solubility principle. A salt such as ammonium nitrate is dissolved in water after a sharp blow breaks the containers for each. The dissolving reaction is endothermic - requires heat. Therefore the heat is drawn from the surroundings, the pack feels cold.

References

1. https://www.chem.fsu.edu/chemlab/chm1046course/solubility.html

2. Development and applications of solubility a book by TM Letcher

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 6

Name of topic/lesson – Solubility

Subtopic: Solubility of liquids in liquids

Objective: To study solubility of liquid in liquid samples.

Topic Outcomes: At the end of topic you should be

1. Able to know the concept of solubility of liquid in liquid.

Solubility is the property of a solid, **liquid** or gaseous chemical substance called solute to dissolve in a solid, **liquid** or gaseous solvent.

Solubility is the maximum amount of a substance that will dissolve in a given amount of solvent at a specific temperature. There are two direct **factors** that **affect solubility**: temperature and pressure.

Component of ideal solutions are miscible in all proportions.

Such complete miscibility is also observed in some real binary system eg. Ethanol and water.

In case of partially miscible solvents at normal conditions miscibility can be achieved by increase in temperature.

The solubility of polar molecules in polar solvents and of nonpolar molecules in nonpolar solvents indicates “like dissolves like.” The distinction between immiscibility and miscibility is really one of degrees, so that miscible liquids are of infinite mutual solubility, while liquids said to be immiscible are of very low mutual solubility.

References

1. https://chem.libretexts.org

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Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 7

Name of topic/lesson – Solubility

Subtopic: (Binary solutions, ideal solutions) Raoult's law, real solutions

Objective: To study Raoult's law.

Topic Outcomes: At the end of topic you should be

1. Able to know ideal and real solution
2. Know the Raoults law.

Raoult who proposed a relationship between partial pressure and mole fraction of volatile liquids. According to the law, 'the mole fraction of the solute component is directly proportional to its partial pressure'.

On the basis of Raoult's Law, liquid-liquid solutions can be of two types. They are: Ideal Solutions, Non-ideal Solutions

The solutions which obey Raoult's Law at every range of concentration and at all temperatures are Ideal Solutions, which can be obtained from ideal solutions by mixing two ideal components that are, solute and a solvent having similar molecular size and structure.

The solutions which don't obey Raoult's law at every range of concentration and at all temperatures are Non-Ideal Solutions. Non-ideal solutions deviate from ideal solutions and are also known as Non-Ideal Solutions.

References

1. https://chem.libretexts.org/Bookshelves
2. *chen.chemistry.ucsc.edu/Chapter-9.*

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 8

Name of topic/lesson – Solubility

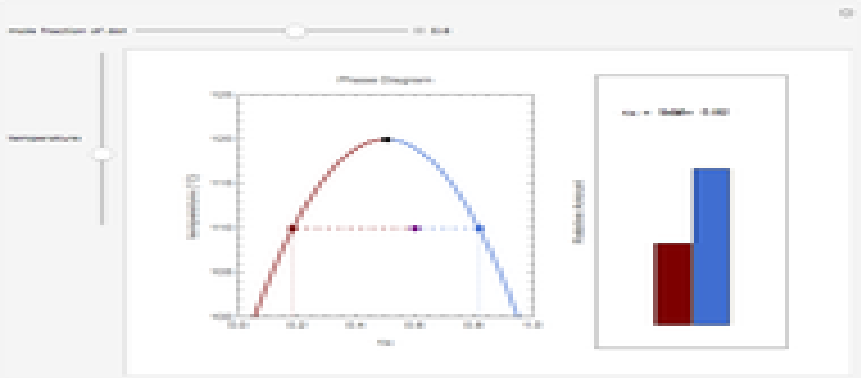
Subtopic: Partially miscible liquids

Objective: To study the partially miscible liquids with respect to miscibility.

Topic Outcomes: At the end of topic you should be

1. Able to know what is Partially miscible liquids.

2. Know the miscibility concept.



The miscibility of a pair of liquids refers to the degree to which they mix spontaneously. The phase diagram for a pair of partially miscible liquids A and B illustrates their behavior as a function of temperature and overall composition. For conditions corresponding to a point inside the curve, two phases are present (i.e., two layers are observed in the container). One phase is mostly substance A with some B dissolved in it. The other phase is mostly substance B with some A dissolved in it. Inside the two phase regions, the compositions of the two phases are determined by drawing horizontal lines (here shown dashed) to the red line (for the composition of the "B-rich" phase) and the blue line (for the "A-rich" phase). These are called "tie lines" or "levers". The lever rule is used to calculate the relative amounts of the two phases, which are represented on the bar graph on the right. The compositions of the two phases are indicated by dotted lines on the phase diagram and numerically at the top of the bar graph. Outside the curve, A and B mix spontaneously to form one layer. The highest temperature at which two phases form is called the upper consolute temperature and is indicated by a black dot on the phase diagram.

References

1.http://demonstrations.wolfram.com/LeverRuleAppliedToPhaseDiagramForPartiallyMiscibleLiquids/

2.https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Book%3A_Physical_Chemistry_(Fleming)/8%3A_Phase_Equilibrium/8.5%3A_Phase_Diagrams_for_Binary_Mixtures

Lecture No: 9, 10, 11

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Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

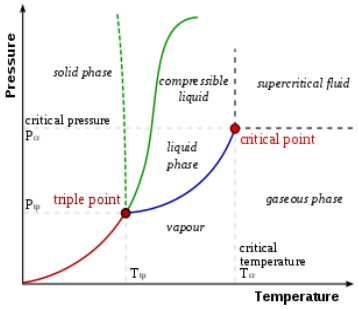
Name of topic/lesson – Solubility

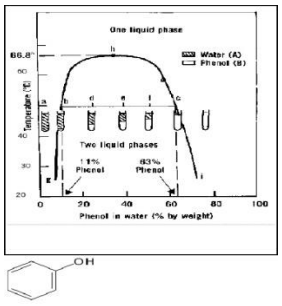
Subtopic: One component and three component diagram

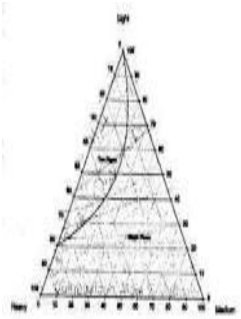
Objective: To study one component, two and three component diagram.

Topic Outcomes: At the end of topic you should be

1. Able to know what is one and two component system.
2. Know the rules for triangular diagram, and ternary phase system.







Three vertices are named after the three components A, B & C. These three points represent 100% A, B and C respectively. The three sides of the triangle represent the compositions of the 3 binary alloys. At every point on the line BC (the side opposite the vertex A) has 0% A. The each side of the triangle has been subdivided into 10 parts by a set of points. Join these as shown in slide 1. The entire space is now divided into a set of small equilateral triangles.

In the first part of the experiment, solubility of 1-butanol in water and solubility of water in 1-butanol will be determined. The switch to the two-phase region can be observed as appearance of the turbidity in the stirred solution. This gives the first two points in the phase diagram that lie along the horizontal axis. In the second part, the points defining the arc will be determined by starting from the two-phase region and adding 17.5 M acetic acid (molecular weight 60.05 g mol−1) until the system switches into one phase.

References

1. Papon, P.; Leblond, J.; Meijer, P. H. E. (2002). *The Physics of Phase Transition : Concepts and Applications*. Berlin: Springer. ISBN 978-3-540-43236-4..

2. https://www.csun.edu/~jeloranta/CHEM355L/experiment5.pdf

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 12

Name of topic/lesson – Distribution phenomenon

Subtopic: Definition and applications

Objective: To study distribution phenomenon.

Topic Outcomes: At the end of topic you should be

1. Able to define partition coefficient.

2. And applications

Extraction –

To determine the efficiency with which one solvent can extract a compound from a second solvent.

$$w_n = w\left(\frac{KV_1}{KV_1+V_2}\right)^n$$

1. Solubility and partition coefficient –

To determine the aqueous solubility of liquid or crystalline organic compound.

$$\log S = -\log K - 1.11\frac{\Delta S_f(mp-25)}{1364} + 0.54$$

2. Preservative action of weak acids in oil-water system –

Solution of foods, drugs and cosmetics are subject to deterioration by enzyme of microorganism that act as a catalyst in decomposition reactions. Sterilization and addition of chemical preservatives are common method used in pharmacy to preserve drug solution against attack by various microorganisms.

3. Drug action and partition coefficient –

Mayer and Overton propose the hypothesis that narcotic action of a non specific drug is a function of distribution coefficient of compound between a lipoidal medium and water.

References

1. Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins
2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 13, 14, 15

Name of topic/lesson – States of matter and properties of matter.

Subtopic: Latent heats, vapour pressure, changes in state of matter, sublimation, eutectic points.

Objective: To study latent heat and vapour pressure, sublimation and eutectic point.

Topic Outcomes: At the end of topic you should be

1. Able to know what is latent heat, vapour pressure.
2. You should know sublimation and eutectic point.

The heat which results in the change of matter without increasing the temperature is known as the **latent heat**. When this heat results in the change of state from solid to a liquid, it is known as latent heat of fusion. **Sublimation** is the transition of a substance directly from the solid to the gas phase, without passing through the intermediate liquid phase. **triple point** of a substance is the temperature and pressure at which the three phases and solid of that substance coexist in thermodynamic equilibrium.

Vapor pressure , also known as equilibrium vapor pressure , is the pressure of a vapor at equilibrium with its non-vapor phases. All liquids have a tendency to evaporate to a gaseous form and all gases to condense back into their original form(solid or liquid). At any given temperature, for a particular substance, there is a pressure at which the gas of that substance is in dynamic equilibrium with its liquid or solid forms. This is the vapor pressure of that substance at that temperature.

References

1. https://zehnderamerica.com/absolute-relative-humidity whats the difference

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 16

Name of topic/lesson – States of matter and properties of matter.

Subtopic: Liquification of Gases, aerosols – inhalers, relative humidity

Objective: To study aerosols and its applications.

Topic Outcomes: At the end of topic you should be

1. Able to know what is an aerosol.
2. And the terms aerosols and liquification

Liquefaction of gases is the process by which substances in their **gaseous** state are converted to the liquid state. When pressure on a **gas** is increased, its molecules closer together, and its temperature is reduced, which removes enough energy to make it change from the **gaseous** to the liquid state.

A metered dose **inhaler** (MDI) is a handheld **aerosol** device that uses a propellant to deliver the therapeutic agent. MDIs include a pressurized metal canister that contains the following: Pharmacological agent in suspension or solution.

The amount of water vapour present in air expressed as a percentage of the amount needed for saturation at the same temperature.

References

1.https://zehnderamerica.com/absolute-relative-humidity whats the difference

2. https://graphical.weather.gov/definitions/defineRH.html

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 17

Name of topic/lesson – States of matter and properties of matter.

Subtopic: Solid-crystalline, amorphous

Objective: To study crystalline, amorphous form of solid.

Topic Outcomes: At the end of topic you should be

1. Able to know what is crystalline form.
2. And what is amorphous form.

Crystalline and Amorphous Solids

(i) **Characteristic Geometry:** In *crystalline* solids the particles (atoms, ions, or molecules) are definitely and orderly arranged thus these have characteristic geometry while amorphous solids do not have characteristic geometry.
(ii) **Melting Point:** A crystalline solid has a sharp melting point, i.e., it changes into liquid state at a definite temperature. On the contrary an amorphous solid does not have a sharp melting point.
(iii) **Cooling curve:** Amorphous solids show smooth cooling curve while crystalline solids show two breaks in cooling curve. During crystallization process energy is liberated which compensates for the loss of heat, thus the temperature remains constant.
(iv) **Isotropy and Anisotropy:** Amorphous solids differ from crystalline solids and resemble liquids in many respects. The properties of amorphous solids, such as, electrical conductivity, thermal conductivity, mechanical strength, refractive index, coefficient of thermal expansion etc. are same in all directions. crystalline solids show these physical properties different in different directions. Therefore crystalline solids are called anisotropic. The anisotropy itself is a strong evidence for the existence of orderly molecular arrangement in crystals. For example, the velocity of light passing through a crystal is different in different directions. A ray of light entering in a crystal may split up into two components each following a different path and "aveling with a different velocity. This phenomenon is called **double refraction**.
(v) **Cutting:** Crystalline solids give clean cleavage while amorphous solids give irregular cut, due to conchoidal fracture on cutting with a sharp edged tool.

References

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1. https://www.sciencehq.com/chemistry/crystalline-and-amorphous-solids.html.
2.https://chem.libretexts.org

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 18

Name of topic/lesson – States of matter and properties of matter.

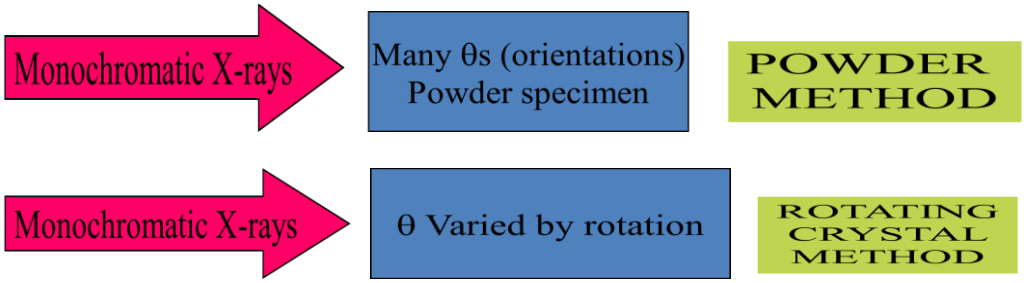
Subtopic: Method of crystal analysis: X Ray Diffraction and Braggs equation.

Objective: To study crystal analysis and diffraction pattern.

Topic Outcomes: At the end of topic you should be

1. Able to know X Ray Diffraction and Braggs equation.
2. Method of crystal analysis.

- X-ray powder diffraction (XRD) is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. The analyzed material is finely ground, homogenized, and average bulk composition is determined.
- For electromagnetic radiation to be diffracted the spacing in the grating should be of the same order as the wavelength
- In crystals the typical interatomic spacing ~ 2-3 Å so the suitable radiation is X-rays
- Hence, X-rays can be used for the study of crystal structures
- A beam of X-rays directed at a crystal interacts with the electrons of the atoms in the crystal
- The electrons oscillate under the influence of the incoming X-Rays and become secondary sources of EM radiation
- The secondary radiation is in all directions
- The waves emitted by the electrons have the same frequency as the incoming X-rays ⇒ *coherent*
- The emission will undergo constructive or destructive interference with waves scattered from other *atoms*



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2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed. S. Chand and Company

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 19, 20

Name of topic/lesson – Physicochemical properties of drug molecules.

Subtopic: Refractive index, Dielectric constant, optical rotation determination and application.

Objective: To study physicochemical properties.

Topic Outcomes: At the end of topic you should be

1. Able to know what is dielectric constant.
2. Know the mechanism of optical rotation and application.

In optics, the refractive index or index of refraction of a material is a dimensionless number that describes how fast light propagates through the material. It is defined as where *c* is the speed of light in vacuum and *v* is the phase velocity of light in the medium

Dielectric constant, property of an electrical insulating material (a dielectric) equal to the ratio of the capacitance of a capacitor filled with the given material to the capacitance of an identical capacitor in a vacuum without the dielectric material.

Optical rotation or optical activity (sometimes referred to as rotary polarization) is the rotation of the orientation of the plane of polarization about the optical axis of linearly polarized light as it travels through certain materials.

References

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2. Text book of Physical Chemistry by Bahl and Tuli

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 21

Name of topic/lesson – States of matter and properties of matter.

Subtopic: Dissociation constant determination and applications

Objective: To study physicochemical properties.

Topic Outcomes: At the end of topic you should be

1. Able to know what is dissociation and its constant.
2. Know the applications.

An acid dissociation constant, K_a, (also known as acidity constant, or acid-ionization constant) is a quantitative measure of the strengthof an acid in solution. It is the equilibrium constant for a chemical reaction known as dissociation. A knowledge of pK_a values is important for the quantitative treatment of systems involving acid–base equilibria in solution. Many applications exist in biochemistry; for example, the pK_a values of proteins and amino acid side chains are of major importance for the activity of enzymes and the stability of proteins. Buffer solutions also play a key role in analytical chemistry. They are used whenever there is a need to fix the pH of a solution at a particular value. In pharmacology, ionization of a compound alters its physical behaviour and macro properties such as solubility and lipophilicity, log *p*). For example, ionization of any compound will increase the solubility in water, but decrease the lipophilicity. Assessing the hazard associated with an acid or base may require a knowledge of pK_a values. For example, hydrogen cyanide is a very toxic gas, because the cyanide ion inhibits the iron-containing enzyme cytochrome c oxidase.

References

1. Text book of physical Chemistry by Bahl and Tuli

2. https://en.wikipedia.org/wiki/Acid_dissociation_constant

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 22

Name of topic/lesson – States of matter and properties of matter.

Subtopic: Dipole moment determinations and applications

Objective: To study physicochemical properties of matter.

Topic Outcomes: At the end of topic you should be

1. Able to know what is dipole moment.
2. Know the applications.

Molecules having two equal and opposite charges separated by certain distance are said to possess an electric dipole. Dipole moment can be defined as the product of the magnitude of the charge and the distance of separation between the charges.

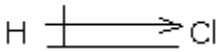
It is represented by the Greek letter 'm'. Mathematically it is equal to

dipole moment (m) = charge (e) x distance of separation (d).

It is expressed in the units of Debye and written as D

(1 Debye = 1 x 10^{-18}e.s.u cm)

For example, the dipole moment of HCl molecule is 1.03 D and that of H_2O is 1.84 D. The dipole of HCl may be represented as:



Importance of dipole moment

Dipole moment plays very important role in understanding the nature of chemical bonds.Importance of dipole moment and problems

- The measurement of dipole moment helps in distinguishing between polar and non-polar molecules. Non-polar molecules have zero dipole moment while polar molecules have some value of dipole moment.

For example:Non-polar molecules: O_2, Cl_2, BF_3, CH_4

Polar Molecules: HF (1.91 D), HCl (1.03 D), H_2S (0.90 D)

- Dipole moment measurement gives an idea about the degree of polarity in a diatomic molecule. The greater the dipole moment the greater is the polarity in such a molecule.
- Dipole moment is used to find the shapes of molecules. This is because the dipole moment not only depends upon the individual dipole moment of the bonds but also on the arrangement of bonds.
- It is possible to predict the nature of chemical bond formed depending upon the electronegativities of atoms involved in a molecule. The bond will be highly polar if the electronegativities of two atoms is large.

References

1. https://chem-guide.blogspot.com/2010/04/dipole-moments-and-its-application.html
2. *chemistry-desk.blogspot.com/2011/05/applications-of-dipole-moment.html*

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 23

Name of topic/lesson – Surface and interfacial phenomenon: Liquid interface

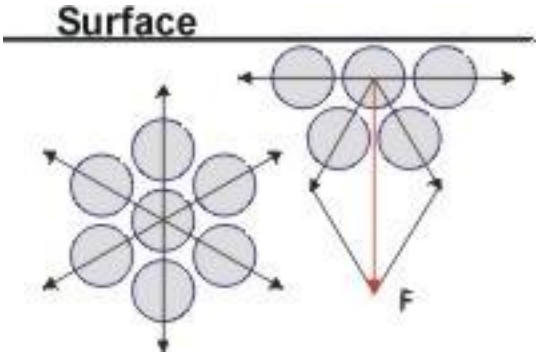
Subtopic: Liquid interface, Surface and Interfacial tension

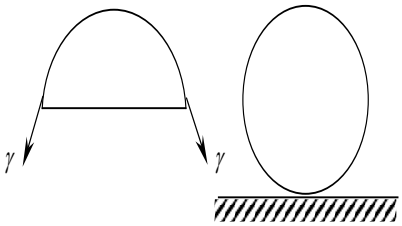
Objective: To study Liquid interface, Surface and Interfacial tension

Topic Outcomes: At the end of topic you should be

1. Able to know what is liquid interface.

It is well known that short-range forces of attraction exist between molecules, and are responsible for the existence of the
liquid state. The phenomena of surface and interfacial tension are readily explained in terms of these forces. The molecules which are located within the bulk of a liquid are, on average, subjected to equal forces of attraction in all directions, whereas those located at, for example, a liquid-air interface experience unbalanced attractive forces resulting in a net inward pull.
As many molecules as possible will leave the liquid surface for the interior of the liquid; the surface will therefore tend to contract spontaneously. For this reason, droplets of liquid and bubbles of gas tend to attain a ***spherical shape***.





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1. **Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins**

2. **Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company**

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Lecture No: 24

Name of topic/lesson – ST and IT

Subtopic: Surface free energy.

Objective: To study surface free energy.

Topic Outcomes: At the end of topic you should be

1. Able to know what is surface free energy

Surface energy quantifies the disruption of intermolecular bonds that occur when a surface is created. In the physics of solids, surfaces must be intrinsically less energetically favorable than the bulk of a material (the molecules on the surface have more energy compared with the molecules in the bulk of the material), otherwise there would be a driving force for surfaces to be created, removing the bulk of the material (see sublimation). The surface energy may therefore be defined as the excess energy at the surface of a material compared to the bulk.

The surface energy of a liquid may be measured by stretching a liquid membrane (which increases the surface area and hence the surface energy density). In that case, in order to increase the surface area of a mass of liquid by an amount, δA, a quantity of work, γδA, is needed (where γ is the surface energy density of the liquid). However, such a method cannot be used to measure the surface energy of a solid because stretching of a solid membrane induces elastic energy in the bulk in addition to increasing the surface energy.

The surface energy of a solid is usually measured at high temperatures. At such temperatures the solid creeps and even though the surface area changes, the volume remains approximately constant. If γ is the surface energy density of a cylindrical rod of radius r and length l at high temperature and a constant uniaxial tension P, then at equilibrium, the variation of the total Gibbs free energy vanishes and we have

$$\delta G = -P\ \delta l + \gamma\ \delta A = 0 \qquad \Longrightarrow \qquad \gamma = P\frac{\delta l}{\delta A}$$

Therefore, the surface energy density can be expressed as

$$\gamma = \frac{Pl}{\pi r(l-2r)}\ .$$

The surface energy density of the solid can be computed by measuring P, r, and l at equilibrium.

References

1. **Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins**

2. **Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company**

Lecture No: 25

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Name of topic/lesson – ST and IT

Subtopic: Measurement of ST and IT

Objective: To measure ST.

Topic Outcomes: At the end of topic you should be

1. Able to know what is ST.
2. Also know the methods for measuring ST

There are several methods of surface tension measurements: 1. Capillary rise method 2. Stallagmometer method – drop weight method 3. Wilhelmy plate or ring method 4. Maximum bulk pressure method. 5. Methods analyzing shape of the hanging liquid drop or gas bubble. 6. Dynamic methods.

This is the oldest method used for surface tension determination. A consequence of the surface tension appearance at the liquid/gas interface is moving up of the liquid into a thin tube, that is capillary, which is usually made of glass. This phenomenon was applied for determination of the liquid surface tension. For this purpose, a thin circular capillary is dipped into the tested liquid. If the interaction forces of the liquid with the capillary walls (adhesion) are stronger than those between the liquid molecules (cohesion), the liquid wets the walls and rises in the capillary to a defined level and the meniscus is hemispherically concave.

1. Essentials of Physical Chemistry by Bahl and Tuli
2. Physical Pharmacy by Martin

Lecture No: 26

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Name of topic/lesson – ST and IT

Subtopic: Spreading Coefficient

Objective: To study spreading coefficient.

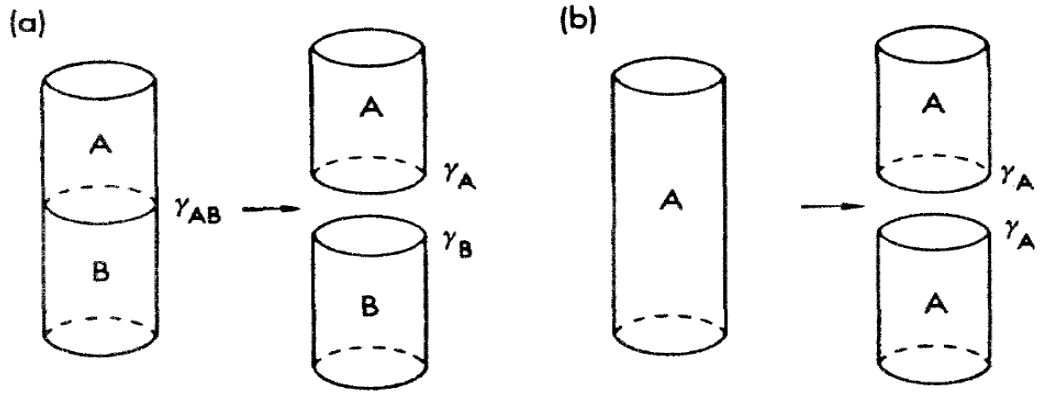
Topic Outcomes: At the end of topic you should be

1. Able to know what is spreading coefficient.

SPREADING COEFFICIENT

The *work of adhesion* between two immiscible liquids is equal to the work required to separate unit area of the liquid-liquid interface and form two separate liquid-air interfaces (Figure: Work of adhesion (a) and of cohesion (b), and is given by ***the Dupre equation***

$$W_a = \gamma_A + \gamma_B - \gamma_{AB}$$



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1. **Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins**

2. **Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company**

Lecture No: 27

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Name of topic/lesson – ST and IT

Subtopic: Adsorption at liquid interface

Objective: To study Adsorption process at liquid interface.

Topic Outcomes: At the end of topic you should be

1. Able to know adsorption.
2. Know the liquid interface.

Adsorption – the phenomenon of higher concentration of molecular species on the surface of a solid than in the bulk

Absorption is the process of arbitrary absorption of the substance by volume

Chemisorption - chemical interaction adsorbent with adsorbate

Adsorbent – an adsorptive material, such as activated charcoal

Adsorbate – an adsorbed substance

The solid substance on the surface of which adsorption occurs is known as ***adsorbent.***

The substances that get adsorbed on the solid surface due to intermolecular attraction are called ***adsorbate***.

The adsorbent may be a solid or a liquid and the adsorbate may be a gas or a solute in some solution.

References

1. Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins

2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company

Lecture No: 28

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Name of topic/lesson – ST and IT

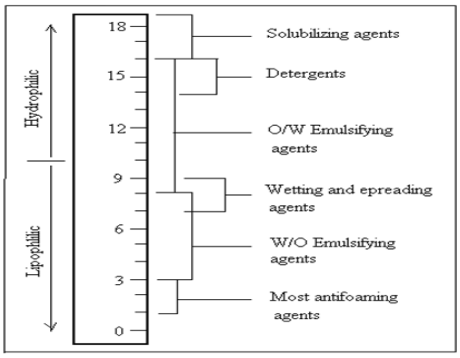
Subtopic: Surface active agents and HLB scale

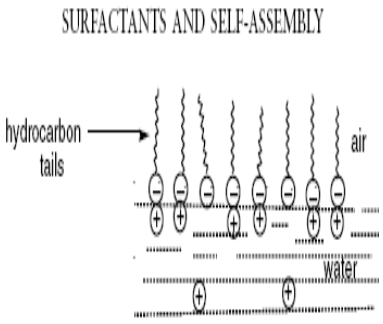
Objective: To study surface active agents and HLB scale.

Outcomes: At the end of topic you should be

1. Able to know what is HLB scale.
2. Know the surface active agents.

HLB is proposed by Griffin. HLB is an arbitrary scale indicates the extent of hydrophilic-lipophilic balance (HLB). Surfactants such as spans (sorbitan ester) are lipophilic and have low HLB value (1.8-8.6) and Tweens (polyoxyethylene derivatives of spans) are hydrophilic and have high HLB values (9.6-16.7).In general, the higher the HLB of an agent, the more hydrophilicity. A HLB value of 1 indicates that the surfactant is soluble in oil, a HLB value of 20 implies that it is soluble in water. The HLB scale is used to identify the optimum efficiency of a variety of surfactants.





The higher is the HLB number, the more hydrophilic is the surfactant, the lower the HLB number, the more lipophilic is the surfactant.

The name ‘surfactant’ refers to molecules that are ‘surface-active’, usually in aqueous solutions. Surface-active molecules adsorb strongly at the water–air interface and, because of this, they substantially ***reduce its surface energy*** (Gibbs theorem).

This is the opposite behaviour from that observed for most ***inorganic electrolytes***, which are desorbed at the air interface and hence ***raise the surface energy*** of water (slightly).

Surfactant molecules are **amphiphilic**, that is, they have both ***hydrophilic and hydrophobic moieties***, and it is for this reason that they adsorb so effectively at interfaces (note that ‘amphi’ means ‘of both kinds’ in Greek)

References

1. **Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins**

2. **Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company**

Lecture No: 29

Name of topic/lesson – ST and IT

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Subtopic: solubilisation and detergency

Objective: To study solubilisation and detergency.

Topic Outcomes: At the end of topic you should be

1. Able to know what is solubilisation.
2. Know the detergency process.

Solubilization is the increase in **solubility** of a poorly water–soluble substance with surface-active agents. The mechanism involves entrapment (adsorbed or dissolved) of molecules in micelles and the tendency of surfactants to form colloidal aggregations at critical micelle concentration levels.

Detergency is the process of cleaning without solvents. A detergent removes contaminants from a surface by solubilizing, suspending, or emulsifing them. The **detergency** process is surprisingly complex.

Ability of a detergent to lift soil (dirt and grease) from a surface by displacing it with chemicals (called surfactants) which adhere more readily to the surface being cleaned than to the soil.

References

1. http://www.businessdictionary.com/definition/detergency.html
2. Principles of Physical Chemistry by Bahl and Tuli

Lecture No: 30

Name of topic/lesson – ST and IT

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Subtopic: To determine adsorption at solid interface.

Objective: To determine adsorption at solid interface.

Topic Outcomes: At the end of topic you should be

1. know adsorption at solid interface.

Adsorption of material at solid interfaces may take place from either an adjacent liquid or gas phase. Adsorption of this type may be considered as an attempt to reduce the surface free energy of the solid. The material used to adsorb gases or liquids is termed as adsorbent. The substance that is attached to the surface of the solid is called adsorbate.

Adsorption is related to surface tension: $W=\Delta G=\gamma\Delta A$

1) **Adsorption at solid/gas interface**

-A solid surface in contact with gas usually attracts an adsorbed layer of gas molecules.

$\Delta G=\Delta H-T\Delta S \quad <0$

- **Freundlich isotherm –**

The relationship between pressure of the gas & amount adsorbed at constant temperature has been expressed by equation-

$$Y=(\frac{x}{m})=kP^{l/n}$$

- **Langmuir adsorption-**

Assumptions are-

1) The surface of solid possesses fixed number of active sites for the adsorption of gases.
2) At maximum adsorption the gas layer that is found around the solid is of only one molecule thick.
3) The rate of adsorption is proportional to number of sites unoccupied.
4) The rate of evaporation is proportional to the number of occupied sites.

Equation of Langmuir isotherm is represented as

$$\frac{p}{y} = \frac{1}{y_m b} + \frac{p}{y_m}$$

References

3. Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins

2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company

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Lecture No: 31

Name of topic/lesson – Complexation and Protien Binding

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Subtopic: Introduction

Objective: To study porosity and packing arrangement of given sample.

Topic Outcomes: At the end of topic you should be

1. Able to know what is complexation.

Complexation, a term with a broad definition, is used in the context of this chapter to characterize the covalent or noncovalent interactions between two or more compounds that are capable of independent existence. The ligand is a molecule that interacts with another molecule, the substrate, to form a complex. Drug molecules can form complexes with other small molecules or with macromolecules such as proteins. Once complexation occurs, the physical and chemical properties of the complexing species are altered. These properties include solubility, stability, partitioning, energy absorption and emission, and conductance of the drug. Drug complexation, therefore, can lead to beneficial properties such as enhanced aqueous solubility (e.g., theophylline complexation with ethylenediamine to form aminophylline) and stability (e.g., inclusion complexes of labile drugs with cyclodextrins). Complexation also can aid in the optimization of delivery systems (e.g., ion-exchange resins) and affect the distribution in the body after systemic administration as a result of protein binding. The topic of drug-protein binding is covered in depth in the later part of the chapter. In some instances, complexation also can lead to poor solubility or decreased absorption of drugs in the body. For example, the aqueous solubility of tetracycline decreases substantially when it complexes with calcium ions, and coadministration of some drugs with antacids decreases absorption from the gastrointestinal tract. For some drugs, complexation with certain hydrophilic compounds can enhance excretion. Finally, complexes can alter the pharmacologic activity

References

4. Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patric J. Sinka, Lippincott Williams and Wilkins

2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company

Lecture No: 32

Name of topic/lesson – Complexation and protein binding

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Subtopic: Classification of complexation

Objective: To study complexation and protein binding.

Topic Outcomes: At the end of topic you should be

1. Able to know what is complexation and mechanism of protein binding.

Complexes or coordination compounds, according to the classic definition, result from a donor–acceptor mechanism or Lewis acid–base reaction between two or more different chemical constituents. Any nonmetallic atom or ion, whether free or contained in a neutral molecule or in an ionic compound, that can donate an electron pair can serve as the donor. The acceptor, or constituent that accepts a pair of electrons, is frequently a metallic ion, although it can be a neutral atom. Complexes can be divided broadly into two classes depending on whether the acceptor component is a metal ion or an organic molecule; these are classified according to one possible arrangement in Table below

Classification of Complexes

I - Metal ion complexes
1- Inorganic type, 2- Chelates, 3- Olefin type,
4 - Aromatic type, 1- Pi (π) complexes, 2- Sigma (σ) complexes, 3- "Sandwich" compounds
II- Organic molecular complexes
1- Quinhydrone type, 2- Picric acid type, 3- Caffeine and other drug complexes
4- Polymer type
III- Inclusion/occlusion compounds
1- Channel lattice type, 2- Layer type, 3- Clathrates, 4- Monomolecular type

References

1. Physical Pharmaceutics by CVS subramanayam.

2. Physical Pharmacy by Martin

Lecture No: 33

Name of topic/lesson – Complexation and protein binding

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Subtopic: Applications

Objective: To study applications of compexation and protein binding.

Topic Outcomes: At the end of topic you should be

1. Able to know applications of complexation.

Complex formation in treatment of poisoning

Dialysis and complexation in t/t of poisoning

Influence of complex formation on drug distribution & drug bioavailability

Decreased drug absorption due to complexation

Enhanced drug absorption through complex formation

Complexation & p'ceutical formulation

Complex with iron(Haematinic)

Complexation as a therapeutic tool

Treatment of poisoning

References

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1. Physical Pharmacy by Martin
2. Google.com

Lecture No: 34

Name of topic/lesson – Complexation and protein binding

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Subtopic: Method of analysis.

Objective: To study method of analysis.

Topic Outcomes: At the end of topic you should be

1. Able to know method of analysis of complexation.

It include Nuclear magnetic resonance, infra red spectroscopy, polarography x-ray diffraction , kinetics etc & many more. Caffeine interacts with L-tryptophan at a molar ratio of 1:1

Eg. complexation of caffeine with tryptophan in aq. solution was done by using H1 NMR and NMR SPECTROSCOPY.

Spectrophotometric approach

Extrapolate the intersect point on x axis gives the concentration and mole fraction required to form stable complex.

Take the absorbance difference of this solution and plot graph absorbance Vs mole fractions. Measure the absorbance of another same mole fraction of solution in which the complex is not form. In this method measure the absorbance of the solutions of various mole fraction in which the complex is form.

pH titration methods : Eg. chelation of cupric ion by glycine: This is a method used in which the complexation is achieve by change in pH.

References

1. Physical Pharmacy by Martin.

2. Physical Chemistry by Bahl and Tuli.

Lecture No: 35

Name of topic/lesson – Complexation and drug action

Subtopic: Complexation and drug action

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Objective: To study complexation and drug action.

Topic Outcomes: At the end of topic you should be

1. Able to know what is complexation and drug action.

Drug Action • Protein binding inactivates the drug, because sufficient concentration of drug cannot be built up in the receptor site for action. Example is naphthoquinones. • Certain drugs though bind to proteins, still retain the drug activity. Examples are penicillins and sulfadiazine.

Metal Complex • In this type, metal ion constitutes the central atom (substrate) and interacts with a base (electron-pair donor, ligand). • This type of interaction leads to the formation of coordination bonds between the species.

In inorganic metal complexes, the ligand provides only one site for binding with metal

Chelates are a group of metal ion complexes in which a substance (ligand) provides two or more donor groups to combine with a metal ion

Olefin types • These types of complexes are used as catalysts in the manufacture of bulk drugs, intermediates and in the analysis of drugs

Organic Molecular Complex • In this type of coordination complexes, components are organic molecules and these are held together by weaker forces or hydrogen bonding.

Drug and caffeine complexes • Drugs such as benzocaine, procaine and tetracaine form complexes with caffeine. • A number of acidic drugs are known to form complexes with caffeine.

Many pharmaceutical additives such as polyethylene glycols (PEGs), carboxymethyl cellulose (CMC) contain nucleophilic oxygen. These can form complexes with various drugs. E.g. Polymers: carbowaxes, pluronics etc. Drugs: tannic acid, salicylic acid, phenols etc. Carboxyl methylcellulose (CMC) + Amphetamine = poorly absorbed complex (tablet additive – drug interaction)

References

1. Physical Pharmacy by Martin.

2. www.google.com

Lecture No: 36

Name of topic/lesson – Complexation of protein binding

Subtopic: Protein binding

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Objective: To study complexation and protein binding.

Topic Outcomes: At the end of topic you should be

1. Able to know what is complexation.

2. Know what is protein binding.

A complex in chemistry usually is used to describe molecules or ensembles formed by the combination of ligands and metal ions. •Originally, a complex implied a reversible association of molecules, atoms, or ions through weak chemical bonds. •As applied to coordination chemistry, this meaning has evolved. Some metal complexes are formed virtually irreversibly and many are bound together by bonds that are quite strong.

A drug's efficacy may be affected by the degree to which it binds to the proteins within blood plasma. •The less bound a drug is, the more efficiently it can traverse cell membranes or diffuse. Common blood proteins that drugs bind to are human serum albumin, lipoprotein, glycoprotein, α, β, and γ globulins.

A drug in blood exists in two forms: bound and unbound. •Depending on a specific drug's affinity for plasma protein, a proportion of the drug may become bound to plasma proteins, with the remainder being unbound.
If the protein binding is reversible, then a chemical equilibrium will exist between the bound and unbound states, such that: Protein + drug ⇌ Protein-drug complex.
It is the unbound fraction which exhibits pharmacologic effects. It is also the fraction that may be metabolized and/or excreted. For example, the "fraction bound" of the anticoagulant warfarin is 97%. •This means that of the amount of warfarin in the blood, 97% is bound to plasma proteins. The remaining 3% (the fraction unbound) is the fraction that is actually active and may be excreted. Protein binding can influence the drug's biological half-life in the body. •The bound portion may act as a reservoir or depot from which the drug is slowly released as the unbound form. Since the unbound form is being metabolized and/or excreted from the body, the bound fraction will be released in order to maintain equilibrium.

Since albumin is basic, acidic and neutral drugs will primarily bind to albumin. • If albumin becomes saturated, then these drugs will bind to lipoprotein. •Basic drugs will bind to the acidic alpha-1 acid glycoprotein. •This is significant because various medical conditions may affect the levels of albumin, alpha-1 acid glycoprotein, and lipoprotein

References

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1. Physical Pharmacy by Martin

2. www.google.com

Lecture No: 37

Name of topic/lesson – Complexation and protein binding.

Subtopic: Crystalline structure of complexes

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Objective: To study crystalline structure of complex.

Topic Outcomes: At the end of topic you should be

1. Able to know what is crystalline structure.
2. Know its relation with complexes.

The 1:1 reactions of psd with HgX2 (X = Cl, Br), gave only polymeric complexes i.e. [(psd)HgX2]n.

Examination of the crystal structure of the complex between the hormone and the extracellular domain of its receptor (hGHbp) showed that the complex consists of one molecule of growth hormone per two molecules of receptor. The hormone is a four-helix bundle with an unusual topology. The binding protein contains two distinct domains, similar in some respects to immunoglobulin domains. The relative orientation of these domains differs from that found between constant and variable domains in immunoglobulin. Both hGHbp domains contribute residues that participate in hGH binding. In the complex both receptors donate essentially the same residues to interact with the hormone, even though the two binding sites on hGH have no structural similarity. Generally, the hormone-receptor interfaces match those identified by previous mutational analyses. In addition to the hormone-receptor interfaces, there is also a substantial contact surface between the carboxyl-terminal domains of the receptors.

References

1. Physical Pharmacy by Martin .
2. Physical Chemistry by Bahl and Tuli

Lecture No: 38

Name of topic/lesson – Complexation and protein binding

Subtopic: Thermodynamic treatments of stability constants.

Objective: To study thermodynamic treatments.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Topic Outcomes: At the end of topic you should be

1. Able to know stability constants.
2. Know its relation with complexation.

A **stability constant** (formation constant, binding constant) is an equilibrium constant for the formation of a **complex** in solution. It is a measure of the strength of the interaction between the reagents that come together to form the complex. There are two main kinds of complex: compounds formed by the interaction of a metal ion with a ligand and supramolecular complexes, such as host–guest complexes and complexes of anions. The stability constant(s) provide the information required to calculate the concentration(s) of the complex(es) in solution. There are many areas of application in chemistry, biology and medicine.

The thermodynamics of metal ion complex formation provides much significant information.[13] In particular it is useful in distinguishing between enthalpic and entropic effects. Enthalpic effects depend on bond strengths and entropic effects have to do with changes in the order/disorder of the solution as a whole. The chelate effect, below, is best explained in terms of thermodynamics.

References

1. Physical Pharmacy by Martin
2. www.google.com

Lecture No: 39

Name of topic/lesson – pH, buffers and Isotonic solutions

Subtopic: Sorensen's pH scale

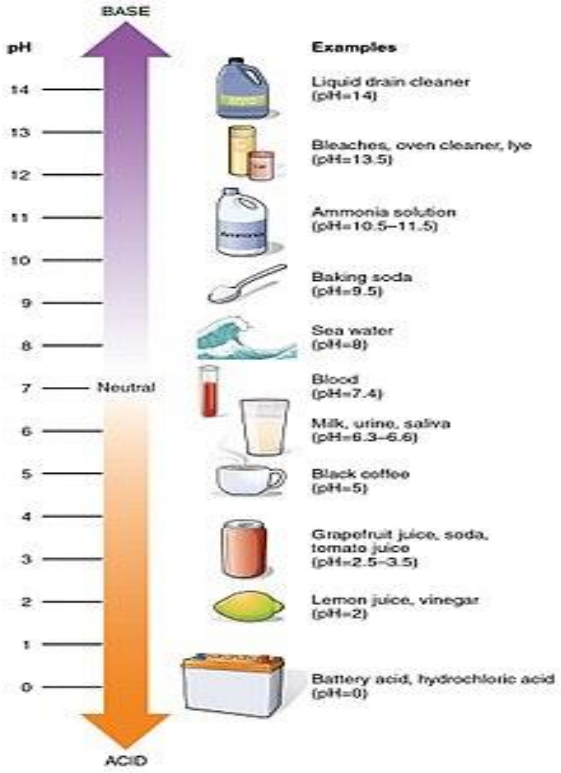
Objective: To study Sorensen's pH scale.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Topic Outcomes: At the end of topic you should be

1. Able to know what is Sorensen's pH scale.



pH is a scale used to specify how acidic or basic a water-based solution is. Acidic solutions have a lower pH, while basic solutions have a higher pH. At room temperature (25 °C), pure water is neither acidic nor basic and has a pH of 7.

The pH scale is logarithmic and approximates the negative of the base 10 logarithm of the molar concentration(measured in units of moles per litre) of hydrogen ions in a solution. More precisely it is the negative of the base 10 logarithm of the activity of the hydrogen ion. At 25 °C, solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. The neutral value of the pH depends on the temperature, being lower than 7 if the temperature increases. The pH value can be less than 0 for very strong acids, or greater than 14 for very strong bases.

References

1. Physical Pharmaceutics by Martin.

2. Physical Chemistry by Bahl and Tuli.

Lecture No: 40

Name of topic/lesson – pH, buffers and Isotonic solutions

Subtopic: pH determination (electrometric)

Objective: To study pH determination by electrometric method.

Topic Outcomes: At the end of topic you should be

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

1. Able to know what is pH

2. Know the methods for determining the same.

One of the most widely accepted **method** for the hydrogen ion **determination** (**pH**) is the **electrometric method**. This **method** is highly accurate and used in laboratory work and by researchers. The accuracy of the **pH** value is 0.1 to 0.0001.

Principle:

The basic principle of the electrometric pH measurement is determination of the activity of the hydrogen ion by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

Procedure:

Before use, remove electrode from storage solution, rinse, and blot, dry with a soft tissue paper. Calibrate the instrument with standard buffer solution. [Ex: KCl solution of pH 7.0] Once the instrument is calibrated remove the electrode from standard solution; rinse, blot and dry. Dip the electrode in the sample whose pH has to be measured. Stir the sample to ensure homogeneity and to minimize CO_2 entrainment. Note down the reading (pH) from the pH meter.

References

1. Physical Pharmacy by Martin
2. www.google.com

Lecture No: 41

Name of topic/lesson – pH, buffers and Isotonic solutions

Subtopic: pH determination by calorimetric method

Objective: To study pH determination by calorimetric method.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Topic Outcomes: At the end of topic you should be

1. Able to know what is calorimetric method.
2. Know the application process.

1. Use of test (T), standard (S) and blank (B) In colorimetric estimation, it is necessary to prepare a blank (B), a standard (S) & test (T). Test: this solution is prepared by treating a specific volume of specimen (blood, urine, CSF…etc) with reagents.
2. Primary standard: the same substance is used as standard one which is to be estimated. For ex: pure glucose is taken as standard in estimation of blood glucose. Standard: prepared by treating a solution of the pure substance of unknown conc. With reagents.
3. Secondary standard: Here the substance taken as standard is different from the substance to be estimated. This substance taken as standard should match the color of final product. For ex: methyl red is taken as standard in estimation of serum bilirubin.
4. Blank : prepared for rule out color produced by reagents alone. • Two types of blank : A) Distilled water as blank B) reagent blank (reagent used in the estimation is taken as blank)
5. OD of test- OD of blank conc. of standard 100 OD of standard – vol. of test sample OD of blank conc. Of substance in mg /100mg or gm/100ml of sample.

Used in determination of amount of many substances in blood, urine, saliva, CSF & other specimens. Ex for common colorimetric assay are : determination of blood glucose, blood urea, serum creatinine, serum proteins, serum cholesterol, serum inorganic phosphate, urine creatinine & glucose in CSF.

References

1. Physical Pharmacy by Martin.
2. www.google.com

Lecture No: 42

Name of topic/lesson – Solubility

Subtopic: Photolytic degradation and its prevention

Objective: To study photolytic degradation and prevention method.

Topic Outcomes: At the end of topic you should be

1. Able to know what is degradation due to photolysis
2. Know the mechanism of its prevention

Photodegradation is the alteration of materials by light. Typically, the term refers to the combined action of sunlight and air. Photodegradation is usually oxidation and hydrolysis. Often photodegradation is avoided, since it destroys paintings and other artifacts. It is however partly responsible for remineralization of biomass and is used intentionally in some disinfection technologies. Photodegradation does not apply to how materials may be aged or degraded via infrared light or heat, but does include degradation in all of the ultraviolet light wavebands.

Photodegradation of plastics and other materials can be inhibited with additives, which are widely used. These additives include antioxidants, which interrupt degradation processes. Typical antioxidants are derivatives of aniline. Another type of additive are UV-absorbers. These agents capture the photon and convert it to heat. Typical UV-absorbers are hydroxy-substituted benzophenones, related to the chemicals used in sunscreen.

References

1. Text book of Physical Chemistry by Bahl and Tuli.
2. Physical Pharmacy by Martin

Lecture No: 43

Name of topic/lesson – pH, buffers and Isotonic solutions

Subtopic: Applications of buffers

Objective: To study applications of buffers.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Topic Outcomes: At the end of topic you should be

1. Able to know applications of buffer.

The **buffer** is used to maintain a specific pH of the solution; it is used in the analysis and manufacture of various manufacturing processes.

Applications of Buffer Solution in Pharmacy

The buffer is a combination of an acid-base aqueous solution adjusted to an accurate pH value. The buffer is used to maintain a specific pH of the solution; it is used in the analysis and manufacture of various manufacturing processes such as food processing, electroplating, manufacture of medicines especially injection, ear drops, eye droplets, suspension, dissolution of tablets etc.

Here are mentioned some applications of buffer solution are as follows.

Improving Purity:

Proteins are purified depends on the fact that amphoteric compounds are slightly soluble at their isoelectric point. For example, insulin precipitates from the aqueous solution in the pH range of 5 to 6. This technique is used for insulin purification.

Increased Stability:

Because of hydrolysis, many compounds are unstable in aqueous solutions. These solutions can be stabilized by regulating the pH. For example, the stability of vitamins is within a narrow range of pH only.

Enhanced solubility:

If the pH of the solution is not properly maintained, then the drug dissolution can precipitate. This principle applies in the dosage forms manufacturing, and some pharmaceutical ingredients and drugs dissolve only at specific pH, hence, it is necessary to maintain the right pH of the solution.

Optimizing Biological Activity:

Enzymes contain most activity only on certain pH values. For example, at pH 1.5, there is a maximum activity of pepsin.

References

1. Essentials of Physical Chemistry by Bahl and Tuli
2. Physical Pharmacy by Martin

Lecture No: 44

Name of topic/lesson – pH, buffers and Isotonic solutions

Subtopic: Buffer equation, buffer capacity

Objective: To study buffer equation, buffer capacity.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Topic Outcomes: At the end of topic you should be

1. Able to know what is buffer.
2. Know the uses of buffer and its equation.

Conventionally, the **buffer capacity** is expressed as the amount of strong acid or base, in gram-equivalents, that must be added to 1 liter of the solution to change its pH by one unit. ... The **buffer capacity** is optimal when the ratio is 1:1; that is, when pH = pKa. Total **buffer** concentration

The Henderson-Hasselbalch equation describes the behaviour of such a buffer and for the mixture of a weak acid and its salt with a strong base (conjugated base) it has the form:

pH = pKa+log Cs/Cac

pKa negative logarithm of the dissociation constant for the weak acid, cs substance concentration of the salt (conjugated base), cac substance concentration of the weak acid (conjugated acid).

The equation for a weak base and its salt with a strong acid (conjugated acid) has the form:

pH = pKw-Pkb/Cac+log Cb/Cs

pKb negative logarithm of the dissociation constant for the weak base, cb substance concentration of the base, cs substance concentration of the salt (conjugated acid), pKw = 14 = − log 10-14 (ionic product of water).

References

1. Essentials of Physical Chemistry by Bahl and Tuli
2. Physical Pharmacy by Martin

Lecture No: 45

Name of topic/lesson – pH, buffers and Isotonic solutions

Subtopic: Buffers in pharmaceutical and biological systems

Objective: To study buffers in pharmaceutical and biological systems.

Lecture synopsis Sub: Physical Pharmaceutics I

Subject I/C: Dr. More S.D

Topic Outcomes: At the end of topic you should be

1. Able to know what is applications of buffers in pharmacy.

In Vivo Biologic Buffer Systems Blood is maintained at a pH of about 7.4. The plasma contains carbonic acid/bicarbonate and acid/alkali sodium salts of phosphoric acid as buffers. Plasma proteins, which behave as acids in blood, can combine with bases and so act as buffers. In the erythrocytes, the two buffer systems consist of hemoglobin/oxyhemoglobin and acid/alkali potassium salts of phosphoric acid.

Lacrimal fluid, or tears, have been found to have a great degree of buffer capacity, allowing a dilution of 1:15 with neutral distilled water. The pH of tears is about 7.4, with a range of 7 to 8 or slightly higher. It is generally thought that eye drops within a pH range of 4 to 10 will not harm the cornea. However, discomfort and a flow of tears will occur below pH 6.6 and above pH 9.0.

Urine The 24-hr urine collection of a normal adult has a pH averaging about 6.0 units; it may be as low as 4.5 or as high as 7.8. When the pH of the urine is below normal values, hydrogen ions are excreted by the kidneys. Conversely, when the urine is above pH 7.4, hydrogen ions are retained by action of the kidneys in order to return the pH to its normal range of values.

Pharmaceutical Buffers Buffer solutions are used frequently in pharmaceutical practice, particularly in the formulation of ophthalmic solutions.

References

1. Essentials of Physical Chemistry by Bahl and Tuli
2. Physical Pharmacy by Martin