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Pharmaceutical Microbiology - Covers all topics with images and clear explanation. Study Pharmaceut... Pharmacy Cosmetic Formulation - Covers all topics with images and clear explanation. Study Pharmace... Forensic Pharmacy - Covers all topics with images and clear explanation. Study Pharmaceutical Micro... Pharmacovigilance - Covers all topics with images and clear explanation. Study Pharmaceutical Micro... At low concentrations in solutions, amphiphiles exist as monomers and predominantly occupy the surface or interface.Micelles At low concentrations in solutions, amphiphiles exist as monomers and predominantly occupy the surface or interface. As the concentration is increased above the level required to completely occupy the surface (known as the critical micelle concentration or the critical micellization concen-tration and abbreviated as CMC), subvisible self-association structures form in solution. These soluble aggregates, which may contain up to 50 or more monomers, are called micelles. Therefore, micelles are small, gener-ally spherical structures composed of both hydrophilic and hydrophobic regions of surfactant molecules. In an aqueous bulk solution environment, the hydrophobic region is embedded on the inside (Figure 10.3). Conversely, in a hydrophobic, lipid, or lipophilic bulk solution, the hydrophilic region is embedded on the inside. The surfactant monomers in micelles are in dynamic equilibrium with free molecules (monomers) in solution, resulting in a continuous flux of monomers between the solution and the micellar phase. Figure 10.3 Types of micelles. Spherical micelles are formed when the concentration of monomers in the aqueous solution reaches the critical micelle concentration (CMC). Elongation of spherical micelles at high concentration leads to the for-mation of a cylindrical micelle. Reverse micelles are formed in a nonpolar solvent. Types of micelles The shape of micelles formed by a particular surfactant is greatly influ-enced by the geometry of the surfactant molecules. At higher surfactant concentrations, micelles may become asymmetric and eventually assume cylindrical or lamellar structures (Figure 10.3). Thus, spherical micelles exist at concentrations relatively close to the CMC. Oil-soluble surfactants have a tendency to self-associate into reverse micelles in nonpolar solvents, with their polar groups oriented away from the solvent and toward the cen-ter, which may also enclose some water (Figure 10.3). Micelles versus liposomes Micelles are unilayer structures of surfactants, whereas liposomes have a lipid bilayer structure that encloses the solvent medium (water) (Figure 10.3). Although both micelles and liposomes are formed from amphiphilic mono-mers, the structure and properties of the monomers play a role in determin-ing which of these structures forms. In addition, liposomes are not formed spontaneously—they require an input of energy and are typically formed by the application of one or more of agitation, ultrasonication, heating, and extrusion. Colloidal properties of micellar solutions Micellar solutions are different from other types of colloidal solutions (such as colloidal suspensions of particles), since micelles are association colloids; that is, the associated surfactant molecules are colloidal in size in solution. The micelles are formed by reversible self-association of monomers. The minimum concentration of a monomer at which micelles are formed is called the critical micelle concentration or the critical micellization concentration (CMC). The number of monomers that aggregate to form a micelle is known as the aggregation number of the micelle. The size of micelles depends on the number of monomers per micelle and the size and molecular shape of the individual monomers. For example, the longer the hydrophobic chain or the lower the polarity of the polar group, the greater the tendency for mono-mers to escape from water to form micelles and, hence, lower the CMC. The CMC and number of monomers per micelle differ for different types of surfactants. Some examples are listed in Table 10.4. As the surfactant concentration in a solution is progressively increased, the properties of the solution change gradually. Not all surfactants form micelles. In the case of surfactants that form micelles, a sharp inflection point in the physical properties of the solution is observed at the CMC. The properties that are affected include the following: Surface tension: As illustrated in Figure 10.4, surface tension of a surfac-tant solution decreases steadily up to the CMC but remains constant above the CMC. Table 10.4 Critical micellization concentration and number of surfactant molecules per micelle Figure 10.4 Micellization of an ionic surfactant (a) and its effect on conductivity and surface tension (b). This is attributed to the saturation of surface occupation of a surfactant above the CMC. Below the CMC, as the surfactant concentration in the solution is increased, more and more surfactant molecules partition into the surface or interface, leading to a steady reduction in surface ten-sion. Above the CMC, the surface or interface is already completely full or saturated with the surfactant. Thus, further addition of the surfactant leads to minimal changes in surface tension. The excess surfactant added to the solution forms micelles in the bulk of the liquid. Conductivity: The conductivity of a solution due to the presence of mon-ovalent inorganic ions is affected by the surfactant's concentration, since the polar head group of the surfactant can bind the ions, leading to reduced number of free ions available for conductance. As a surfactant is added to the solution, some of the surfactant occupies surface and some is available in the bulk of the solution, binding the counterions. Thus, solution con-ductivity reduces steadily as a function of the surfactant's concentration. As shown in Figure 10.4, this change is much more rapid above the CMC, following a sharp inflection point at the CMC. This is attributed to most of the added surfactant (above the CMC) being available in solution for bind-ing with the ions. Solubility: Solubility of a hydrophobic molecule in an aqueous solution increases slightly with the surfactant concentration below the CMC but shows significant and sharp increase above the CMC. Below the CMC, an increase in the solubility of a hydrophobic drug results from changes in the characteristics of the solvent medium (such as dielectric constant) and drug–surfactant interaction. Above the CMC, additional drug solubi-lization results from the hydrophobic drug getting incorporated into the micelles. Osmotic pressure: Micelles, formed above the CMC, act as association col-loids, leading to an increase in the osmotic pressure of the colloidal solution. Light-scattering intensity: Light scattering shows a sharp increase above the CMC due to the formation of colloidal micelles that scatter light. Factors affecting critical micelle concentration and micellar size ·   Size and structure of hydrophobic group: An increase in the hydro-carbon chain length causes a logarithmic decrease in the CMC. This is because an increase in hydrophobicity reduces aqueous solubility of the surfactant and increases its partitioning into the micelles. Micellar size increases with an increase in the hydrocarbon chain length, owing to an increase in the volume occupied per surfactant in the micelle. ·   Nature of hydrophilic group: An increase in hydrophilicity increases the CMC due to increased surfactant solubility in the aqueous medium and reduced partitioning into the interface. As the propor-tion of surface/interface to bulk surfactant concentration reduces, more of added surfactant is required to achieve saturation of the sur-face before micelles can form. Thus, nonionic surfactants have very lower hydrophilicity and CMC values compared with ionic surfac-tants with similar hydrocarbon chains. ·   Nature of counterions: About 70%–80% of the counterions of an ionic surfactant (e.g., Na+ is a counterion for carboxylate and sulfonate groups, and Cl- is a counterion for quaternary amine groups) are bound to the micelles. The nature of the counterion influences the properties of these micelles. For example, size of micelles formed with a cationic surfactant increases according to the series Cl– < Br– < I– and with an anionic surfactant according to the series Na+ < K+ < Cs+. This is a function of not only the size and electronegativity of the counterion but also the size of the hydration layer around the counterion. The weakly hydrated (smaller, highly electronegative) ions are adsorbed more closely to the micellar surface and neutralize the charge on the surfactant more effectively, leading to the formation of smaller micelles. ·   Addition of electrolytes: Addition of electrolytes, such as salt, to solu-tions of ionic surfactants decreases the CMC and increases the size of the micelles. This is due to a reduction in the effective charge on the hydrophilic headgroups of the surfactants. This tips the hydrophilic lipophilic balance toward greater lipophilicity, increases the propor-tion of surface/interface to bulk surfactant concentration below the CMC, and promotes the formation of micelles in the bulk liquid. In contrast, micellar properties of nonionic surfactants are only mini-mally affected by the addition of electrolytes. ·   Effect of temperature: Size of micelles increases and CMC decreases with increasing temperature up to the cloud point for many nonionic surfactants due to increased Brownian motion of the monomers. Temperature has little effect on ionic surfactants. This is due to stron-ger hydrogen bonding and electrical forces governing the hydrophilic interactions of ionic surfactants than nonionic surfactants. ·   Alcohol: Addition of alcohol to an aqueous solution reduces the dielectric constant and increases the capacity of the solution to sol-ubilize amphiphilic (surfactant) and hydrophobic molecules. Thus, greater surfactant solubility in the hydroalcoholic solutions decreases the surface/interface to bulk solution concentration of the surfactant, thus increasing the CMC. Krafft point Krafft point (Kt), also known as the critical micelle temperature or Krafft temperature, is the minimum temperature at which surfactants form micelles, irrespective of the surfactant concentration. Below the Krafft point, surfactants maintain their crystalline molecular orientation form even in an aqueous solution and are not distributed as freely tumbling random monomers that are able to self-associate to form micelles. The International Union of Pure and Applied Chemistry's Gold Book (. org) defines Krafft point as the temperature at which the solubility of a surfactant rises sharply to that at the CMC, the highest concentration of free monomers in solution. The Krafft point is determined by locating the abrupt change in slope of a graph of the logarithm of the solubility against temperature (T), or 1/T. Below Kt, the surfactant has a limited solubility, which is insufficient for micellization. As the temperature increases, solu-bility increases slowly. At the Krafft point, surfactant crystals melt and the surfactant molecules are released in solution as monomers, which can also get incorporated into micelles. Above the Krafft point, micelles form and, due to their high solubility, contribute to a dramatic increase in the surfac-tant solubility. Cloud point Cloud point is the temperature at which some surfactants begin to pre-cipitate and the solution becomes cloudy. The appearance of turbidity at the cloud point is due to separation of the solution into two phases. For nonionic surfactants, aqueous solubility is at least partially attributed to the hydration of their hydrophilic regions by water molecules. Increasing solution temperatures up to the cloud point leads to an increase in micellar size. Increasing temperature above the cloud point imparts sufficient kinetic energy to the hydrating water molecules to effectively dissociate from the surfactant and bond exclusively with the bulk water. This produces a suf-ficient overall drop in the solubility of the surfactant to cause surfactant precipitation and cloudiness of solution. At elevated temperatures, the sur-factant separates as a precipitate. When in high concentration, it separates as a gel. This phenomenon is commonly seen with many nonionic polyoxy-ethylate surfactants in solution. Organic solubilized molecules or solution additives, such as ethanol, generally decrease the cloud point of nonionic surfactants. Addition of aliphatic hydrocarbons increases the cloud point. Aromatic hydrocarbons or alkanols may increase or decrease the cloud point, depending on the concentration. Micellar solubilization Micelles can be used to increase the solubility of materials that are normally insoluble or poorly soluble in the dispersion medium used. This phenom-enon is known as solubilization, and the incorporated substance is referred to as the solubilizate. For example, surfactants are often used to increase the solubility of poorly soluble steroids. The location, distribution, and orienta-tion of solubilized drugs in the micelles influence the kinetics and extent of drug solubilization. These parameters are determined by the molecular loca-tion of the interaction of drugs with the structural elements or functional groups of the surfactant in the micelles. 1. Factors affecting the extent of solubilization Factors affecting the rate and extent of micellar solubilization include the nature of surfactants, the nature of solubilizates, temperature, and pH. 1. Nature of surfactants: Structural characteristics of a surfactant affect its solubilizing capacity because of its effect on the solubiliza-tion site within the micelle. In cases where the solubilizate is located within the core or deep within the micelle structure, the solubili-zation capacity increases with increase in alkyl chain length. For example, there was an increase in the solubilizing capacity of a series of polysorbates for selected barbiturates as the alkyl chain length was increased from C12 (polysorbate 20) to C18 (polysorbate 80). An increase in the alkyl chain length increases the hydrophobicity of the core and the micellar radius, reduces pressure inside the micelle, and increases the diffusive entry of the hydrophobic drug into the micelle. In addition, the solubilization of the poorly soluble drug tropicamide increased with an increase in the oxyethylene content of poloxamer. On the other hand, an increase in the ethylene oxide chain length of a polyoxyethylated nonionic surfactant led to an increase in the total amount solubilized per mole of surfactant because of the increasing number of micelles. Thus, the effect of increase in the number of micelles of the same (smaller) size can be very different than increase in the size of micelles. 2. Nature of solubilizate (drug being solubilized): The location of solu-bilizates in the micelles is closely related to the chemical nature of the solubilizate. In general, nonpolar, hydrophobic solubilizates are local-ized in the micellar core. Compounds that have both hydrophobic and hydrophilic regions are oriented with the hydrophobic group facing or in the core and the hydrophilic or polar groups facing toward the sur-face. For a hydrophobic drug solubilized in a micelle core, an increase in the lipophilicity or the lipophilic region or surface area of the drug leads to an increase in the solubilization in the core. Polyunsaturated compounds are generally more soluble than their satu-rated counterparts. Solubilizates that are located within micellar core tend to increase the size of the micelles. Micelles become larger not only because their core is enlarged by the solubilizate but also because the number of surfactant molecules per micelle increases in an attempt to cover the swollen core. 3. Effect of temperature: In general, the amount of the drug solubilized increases with an increase in temperature (Figure 10.5). The effect is particularly pronounced with some nonionic surfactants, where it is a consequence of an increase in the micellar size with increasing temperature. 4. Effect of pH: The main effect of pH on solubilizing ability of non-ionic surfactants is to alter the equilibrium between ionized and unionized drugs. The overall effect of pH on drug solubilization is a function of proportion of ionized and unionized forms of the drug in solution and in micelles, which is determined by (1) the pKa value of the ionizable functional group(s), (2) the solubility of the ionized and unionized forms in the solution, and (3) the solubilization capacity of the micelles for the ionized and union-ized forms. Generally, the unionized form is the more hydrophobic form and is solubilized to a greater extent in the micelles than the ionized form. Figure 10.5 Effect of temperature and surfactant type on the micellar solubilization of griseofulvin and hexocresol. (Modified from Bates, T.R, Gilbaldi, M. and Kanig, J.I. J. Pharm. Sci., 55, 191, 1966. With Permission.) 2. Pharmaceutical applications Several insoluble drugs have been formulated by using micellar solubiliza-tion. For example: ·   Phenolic compounds, such as cresol, chlorocresol, and chloroxylenol, are solubilized with soap to form clear solutions for use as disinfectants. ·   Polysorbates have been used to solubilize steroids in ophthalmic formulations. ·   Polysorbate are used to prepare aqueous injections of the water-insoluble vitamins A, D, E, and K. ·   Nonionic surfactants are efficient solubilizers of iodine. 3. Thermodynamics/spontaneity Micellar solubilization involves partitioning of the drug between the micel-lar phase and the aqueous solvent. Thus, the standard free energy of solubi-lization, ΔGs, can be computed from the partition coefficient, K, of the drug between the micelle and the aqueous medium: ΔGs = −RT In K   (10.1) where: R is the gas constant T is the absolute temperature Change in free energy with micellization can be expressed in terms of the change in enthalpy (ΔHs) and entropy (ΔSs) as: ΔGs = ΔHs − T ΔSs   (10.2) Thus, ΔH s − TΔ Ss = −RT In K Or, In K = − − ΔHs/R · 1/T + constant where the constant is ΔSs/R, assuming that the change in entropy from micellization is constant. Thus, experimental determination of enthalpy of micellization can be a useful tool to predict ΔGs, which, in turn, indicates whether micellar incorporation of a drug would be spontaneous. When ΔGs is negative, solubilization process is spontaneous. When ΔGs is positive, solubilization does not occur. Example 1: Given ΔHs = 2830 cal/mol and ΔSs = −26.3 cal/K mol, does ammonium chloride spontaneously transfer from water to micelles? ΔGs = ΔHs − TΔ Ss = 2830 cal/mol − (298K)(−26.3 cal/kmol) which is positive, indicating that micellar solubilization (transfer) would not occur. Example 2: Given ΔHs = −1700 cal/mol and ΔSs = 2.1 cal/K mol, does amobarbital spontaneously transfer from water to a micellar solution (sodium lauryl sulfate, 0.06 mol/L)? ΔGs = ΔHs − TΔ Ss = 1700 cal/mol − (298K)(− 2 .1 cal/kmol) = −2326 cal/mol which is negative, indicating that micellar solubilization (transfer) would indeed spontaneously occur. By Brijesh Sharma|Updated on 23 Apr 2025, 12:56 ISTMicelles are tiny but powerful structures that play a major role in chemistry, cleaning, and even skincare and medicine. If you've ever used soap, shampoo, or micellar water, you've already seen micelles at work—without even knowing it! In this guide, we'll explain what micelles are, how they form, and why they are important. We'll also cover essential concepts like micelle structure, critical micelle concentration, and micelle function in simple, easy-to-understand language.A micelle (pronounced "my-sell") is a small, ball-like structure formed when surfactant molecules mix with water. Surfactants are special compounds that have two parts:Fill out the form for expert academic guidanceHydrophobic tail – water-hating, but loves oil and greaseHydrophilic head – water-lovingWhen enough surfactants are added to water, they automatically arrange themselves into spheres. In these spheres, the hydrophobic tails hide inside (away from water), and the hydrophilic heads face outward (towards the water). This special structure is what we call a micelle.Unlock the full solution & master the conceptGet a detailed solution and exclusive access to our masterclass to ensure you never miss a conceptIn chemistry, a micelle is an example of self-assembly and colloidal chemistry. Surfactants—used in soaps, detergents, and emulsifiers—create micelles once a certain concentration is reached. This self-organization is driven by the balance between water-attracting and water-repelling forces.Micelles are not chemical compounds by themselves but physical assemblies of molecules held together by weak intermolecular forces. Micelles - Structure, Formation, Meaning, and Uses in Chemistry and Daily Life Micelle formation begins when surfactant concentration exceeds a particular limit known as the Critical Micelle Concentration (CMC). Below this limit, surfactants remain free in solution. Once CMC is reached, the surfactants cluster to minimize exposure of their hydrophobic tails to water.FactorRole in Micelle FormationConcentrationMust exceed Critical Micelle ConcentrationTemperatureHigher temperatures can affect micelle shapeType of SurfactantIonic or nonionic surfactants behave differentlySolventWater is most common, but micelles can form in oils (reverse micelles)A typical micelle has:Ready to Test Your Skills?Check Your Performance Today with our Free Mock Tests used by Toppers!A core made of hydrophobic tailsAn outer shell made of hydrophilic headsThis structure helps micelles trap and carry oily substances, dirt, or even drugs inside the core, making them very useful in various industries.Do Check - Latent Heat of Fusion Start Your JEE/NEET Prep at Just ₹1999 / month - Limited Offer! Check Now!In oily or non-polar environments, micelles flip their structure—hydrophilic heads are inside, and hydrophobic tails are outside. These are called reverse micelles.Micelles are the reason soap and shampoo clean so effectively. The micelle function in soap involves:create your own testYOUR TOPIC, YOUR DIFFICULTY, YOUR PACEThe hydrophobic tail grabs onto grease, oil, and dirtThe hydrophilic head stays in the waterWhen you rinse, the whole micelle washes away, taking the dirt with itThis process makes micelles the active cleaning agents in many products, including:Dishwashing liquidsLaundry detergentsFace cleansers (micellar water)Do Check - PropaneMicelles are also found in micellar water, a gentle skin cleanser. They remove dirt and makeup without harsh scrubbing or rinsing. This makes micellar products ideal for people with sensitive skin.In the field of drug delivery, scientists use micelles to transport fat-soluble and water-soluble drugs to specific areas of the body. Their structure allows them to carry medication through watery environments in the body and release them at the target site.TopicDescriptionMicelle PronunciationPronounced as "my-sell"Micelle MeaningFrom Latin mica = crumb or grainMicelle SizeTypically between 2 to 20 nanometersCritical Micelle Concentration (CMC)Minimum surfactant level needed to form micellesTypes of MicellesNormal, reverse, cylindrical, disc-likeCan You See Micelles?Not with a regular microscope; electron microscopes are usedMicelles may be tiny, but their impact is huge. From helping your soap clean better to improving how medicines work in your body, these smart little molecular assemblies are all around us. Whether in your kitchen, bathroom, or even hospital, micelles make modern life cleaner, safer, and smarter. Micelles help the body absorb lipid and fat soluble vitamins. They help the small intestine to absorb essential lipids and vitamins from the liver and gall bladder. They also carry complex lipids such as lecithin and lipid soluble vitamins (A, D, E and K) to the small intestine. What are micelles in organic chemistry? A micelle (/maɪˈsɛl/) or micella (/maɪˈsɛlə/) (plural micelles or micellae, respectively) is an aggregate (or supramolecular assembly) of surfactant phospholipid molecules dispersed in a liquid, forming a colloidal suspension (also known as associated colloidal system). Micelles are formed by a cumulative formation of amphipathic molecules in an aqueous solution. In simple terms, it is formed when an array of solutions is added to water. The molecules can either be phospholipid or fatty acids. See also How do you determine the solubility of an organic compound?What is a micelle in simple words? Definition of micelle : a unit of structure built up from polymeric molecules or ions: such as. a : an ordered region in a fiber (as of cellulose or rayon) b : a molecular aggregate that constitutes a colloidal particle. What is a micelle made of? Micelles are mostly composed of amphiphilic molecules in aqueous solution that self-assemble into a structure containing both hydrophobic and a hydrophilic segments (Scheme 2) [13,14,15]. When greasy dirt or oil is mixed with soapy water, the soap molecules arrange themselves into tiny clusters called micelles. The water-loving (hydrophilic) part of the soap molecules sticks to the water and points outwards, forming the outer surface of the micelle. What are micelles give an example of micelles? Micelles are the clusters or aggregated particles formed by association of colloids in solution. Soaps and detergents form micelles when temperatureis above Kraft temperature and concentration is above critical micelle concentration (CMC). For soaps, CMC is about 10−4 to 10−3 M. What is the function of micelles quizlet? What is the function of micelles? They are like taxis. They are intended to facilitate the movement of lipids across the unstirred water layer so that they can diffuse across the epithelial lining of the intestines. The process of forming micelles is known as micellisation and forms part of the phase behaviour of many lipids according to their polymorphism. How many molecules are in a micelle? Structure of a Micelle: The theoretical model shows 54 molecules of dodecylphosphocholine (DPC) and about 1200 H2O molecules. Each lipid has a polar head group (phosphocholine) and a hydrophobic tail (dodecyl = C12). See also What is the importance of chemistry in cosmetic industry?Why do surfactants form micelles? The intermolecular forces between surfactant and water molecule are much lower than between two water molecules and thus surface tension will decrease. When the surfactant concentration is high, they form micelles. The point at which micelles are formed is called critical micelle concentration. Micelle: Bile coated lipid droplets in lumen of small intestine. Chylomicron: Protein coated lipid found in the absorptive cell of small intestine. What is the size of a micelle? Micelles are vesicles composed of amphiphilic copolymers. The size of micelle is 10–100 nm. They self-assemble under aqueous conditions and form a spherical core-shell structure [78]. How are micelles broken down? The micelles move into the brush border of the small intestine absorptive cells where the long-chain fatty acids and monoglycerides diffuse out of the micelles into the absorptive cells, leaving the micelles behind in the chyme. The varying polarity in the micelles facilitates the incorporation of poorly water-soluble drug molecules, which results in solubilization, viz. in an increase in the apparent aqueous solubility of the drug. Why do micelles form in water? The formation of micelles is driven by the decrease of free energy in the system because of the removal of the hydrophobic segments from the aqueous environment and reestablishing of hydrogen bond network in water. Are micelles bubbles? These molecules, when suspended in water, alternately float about as solitary units, interact with other molecules in the solution and assemble themselves into little bubbles called micelles, with heads pointing outward and tails tucked inside. See also How do you calculate percent recovery in distillation? Soap is effective as a cleaning agent because it is amphiphilic; it is partly polar and partly nonpolar. Soap molecules contain an intensely polar "head" (the ionic part) and a non-polar "tail" (the long hydrocarbon chain, usually 10-18 carbons, depending on which fatty acid is used). What are types of micelles? Specific micelle structures include spherical micelles, cylindrical micelles, bilayer vesicles, lamellar phases, and inverse micelles [17,18,19]. What are micelles How do micelles differ from colloid? The key difference between micelles and colloidal particles is that micelles form at a certain concentration whereas colloidal particles form as soon as the solutes are added to the solvent. The terms micelles and colloidal particles come in analytical chemistry where colloids are discussed. Answer : Micelles are associated colloid, they have low colligative property than normal colloidal solution. Step by step solution by experts to help you in doubt clearance & scoring excellent marks in exams. What is a micelle in chemistry quizlet? It is an anionic surfactant. What is the structure of micelles quizlet? Micelles are structures composed of a monolayer of amphipathic molecules. In a biological system, the molecules tend to arrange themselves in such a manner that the inner core of these structures are hydrophobic and the outer layers are hydrophilic in nature. Micelles are produced in the liver, whereas chylomicrons are produced in the intestinal lumen. Micelles are lipid-bile salt complexes, whereas chylomicrons are lipoproteins. Micelles are found only in adipocytes, whereas chylomicrons are found in the bloodstream. See also How do you measure density of a powder?What are the 4 types of surfactants? Anionic Surfactants. Anionic surfactants have a negative charge on their hydrophilic end. Nonionic Surfactants. Nonionic surfactants are neutral, they do not have any charge on their hydrophilic end. Cationic Surfactants. Amphoteric Surfactants. Page 2Micelles help the body absorb lipid and fat soluble vitamins. They help the small intestine to absorb essential lipids and vitamins from the liver and gall bladder. 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Chylomicron: Protein coated lipid found in the absorptive cell of small intestine. What is the size of a micelle? Micelles are vesicles composed of amphiphilic copolymers. The size of micelle is 10–100 nm. They self-assemble under aqueous conditions and form a spherical core-shell structure [78]. How are micelles broken down? The micelles move into the brush border of the small intestine absorptive cells where the long-chain fatty acids and monoglycerides diffuse out of the micelles into the absorptive cells, leaving the micelles behind in the chyme. The varying polarity in the micelles facilitates the incorporation of poorly water-soluble drug molecules, which results in solubilization, viz. in an increase in the apparent aqueous solubility of the drug. Why do micelles form in water? The formation of micelles is driven by the decrease of free energy in the system because of the removal of the hydrophobic segments from the aqueous environment and reestablishing of hydrogen bond network in water. Are micelles bubbles? These molecules, when suspended in water, alternately float about as solitary units, interact with other molecules in the solution and assemble themselves into little bubbles called micelles, with heads pointing outward and tails tucked inside. See also How do you calculate extraction yield? Soap is effective as a cleaning agent because it is amphiphilic; it is partly polar and partly nonpolar. Soap molecules contain an intensely polar "head" (the ionic part) and a non-polar "tail" (the long hydrocarbon chain, usually 10-18 carbons, depending on which fatty acid is used). What are types of micelles? Specific micelle structures include spherical micelles, cylindrical micelles, bilayer vesicles, lamellar phases, and inverse micelles [17,18,19]. What are micelles How do micelles differ from colloid? The key difference between micelles and colloidal particles is that micelles form at a certain concentration whereas colloidal particles form as soon as the solutes are added to the solvent. The terms micelles and colloidal particles come in analytical chemistry where colloids are discussed. Answer : Micelles are associated colloid, they have low colligative property than normal colloidal solution. Step by step solution by experts to help you in doubt clearance & scoring excellent marks in exams. What is a micelle in chemistry quizlet? It is an anionic surfactant. What is the structure of micelles quizlet? Micelles are structures composed of a monolayer of amphipathic molecules. In a biological system, the molecules tend to arrange themselves in such a manner that the inner core of these structures are hydrophobic and the outer layers are hydrophilic in nature. Micelles are produced in the liver, whereas chylomicrons are produced in the intestinal lumen. Micelles are lipid-bile salt complexes, whereas chylomicrons are lipoproteins. Micelles are found only in adipocytes, whereas chylomicrons are found in the bloodstream. See also How do I calculate my teacher's salary over 10 months?What are the 4 types of surfactants? Anionic Surfactants. Anionic surfactants have a negative charge on their hydrophilic end. Nonionic Surfactants. Nonionic surfactants are neutral, they do not have any charge on their hydrophilic end. Cationic Surfactants. Amphoteric Surfactants. Page 3Micelles help the body absorb lipid and fat soluble vitamins. They help the small intestine to absorb essential lipids and vitamins from the liver and gall bladder. They also carry complex lipids such as lecithin and lipid soluble vitamins (A, D, E and K) to the small intestine. What are micelles in organic chemistry? A micelle (/maɪˈsɛl/) or micella (/maɪˈsɛlə/) (plural micelles or micellae, respectively) is an aggregate (or supramolecular assembly) of surfactant phospholipid molecules dispersed in a liquid, forming a colloidal suspension (also known as associated colloidal system). Micelles are formed by a cumulative formation of amphipathic molecules in an aqueous solution. In simple terms, it is formed when an array of solutions is added to water. The molecules can either be phospholipid or fatty acids. See also What is the relation between physics and chemistry class 11?What is a micelle in simple words? Definition of micelle : a unit of structure built up from polymeric molecules or ions: such as. a : an ordered region in a fiber (as of cellulose or rayon) b : a molecular aggregate that constitutes a colloidal particle. What is a micelle made of? Micelles are mostly composed of amphiphilic molecules in aqueous solution that self-assemble into a structure containing both hydrophobic and a hydrophilic segments (Scheme 2) [13,14,15]. When greasy dirt or oil is mixed with soapy water, the soap molecules arrange themselves into tiny clusters called micelles. The water-loving (hydrophilic) part of the soap molecules sticks to the water and points outwards, forming the outer surface of the micelle. What are micelles give an example of micelles? Micelles are the clusters or aggregated particles formed by association of colloids in solution. Soaps and detergents form micelles when temperatureis above Kraft temperature and concentration is above critical micelle concentration (CMC). For soaps, CMC is about 10−4 to 10−3 M. What is the function of micelles quizlet? What is the function of micelles? They are like taxis. They are intended to facilitate the movement of lipids across the unstirred water layer so that they can diffuse across the epithelial lining of the intestines. The process of forming micelles is known as micellisation and forms part of the phase behaviour of many lipids according to their polymorphism. How many molecules are in a micelle? Structure of a Micelle: The theoretical model shows 54 molecules of dodecylphosphocholine (DPC) and about 1200 H2O molecules. Each lipid has a polar head group (phosphocholine) and a hydrophobic tail (dodecyl = C12). See also What is the best amulet for Magic Osrs?Why do surfactants form micelles? The intermolecular forces between surfactant and water molecule are much lower than between two water molecules and thus surface tension will decrease. When the surfactant concentration is high, they form micelles. The point at which micelles are formed is called critical micelle concentration. Micelle: Bile coated lipid droplets in lumen of small intestine. Chylomicron: Protein coated lipid found in the absorptive cell of small intestine. What is the size of a micelle? Micelles are vesicles composed of amphiphilic copolymers. The size of micelle is 10–100 nm. They self-assemble under aqueous conditions and form a spherical core-shell structure [78]. How are micelles broken down? The micelles move into the brush border of the small intestine absorptive cells where the long-chain fatty acids and monoglycerides diffuse out of the micelles into the absorptive cells, leaving the micelles behind in the chyme. The varying polarity in the micelles facilitates the incorporation of poorly water-soluble drug molecules, which results in solubilization, viz. in an increase in the apparent aqueous solubility of the drug. Why do micelles form in water? 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What are micelles How do micelles differ from colloid? The key difference between micelles and colloidal particles is that micelles form at a certain concentration whereas colloidal particles form as soon as the solutes are added to the solvent. The terms micelles and colloidal particles come in analytical chemistry where colloids are discussed. Answer : Micelles are associated colloid, they have low colligative property than normal colloidal solution. Step by step solution by experts to help you in doubt clearance & scoring excellent marks in exams. What is a micelle in chemistry quizlet? It is an anionic surfactant. What is the structure of micelles quizlet? Micelles are structures composed of a monolayer of amphipathic molecules. In a biological system, the molecules tend to arrange themselves in such a manner that the inner core of these structures are hydrophobic and the outer layers are hydrophilic in nature. Micelles are produced in the liver, whereas chylomicrons are produced in the intestinal lumen. Micelles are lipid-bile salt complexes, whereas chylomicrons are lipoproteins. Micelles are found only in adipocytes, whereas chylomicrons are found in the bloodstream. See also Do you need math for environmental science?What are the 4 types of surfactants? Anionic Surfactants. Anionic surfactants have a negative charge on their hydrophilic end. Nonionic Surfactants. Nonionic surfactants are neutral, they do not have any charge on their hydrophilic end. Cationic Surfactants. Amphoteric Surfactants. At low concentrations in solutions, amphiphiles exist as monomers and predominantly occupy the surface or interface.Micelles At low concentrations in solutions, amphiphiles exist as monomers and predominantly occupy the surface or interface. As the concentration is increased above the level required to completely occupy the surface (known as the critical micelle concentration or the critical micellization concen-tration and abbreviated as CMC), subvisible self-association structures form in solution. These soluble aggregates, which may contain up to 50 or more monomers, are called micelles. Therefore, micelles are small, gener-ally spherical structures composed of both hydrophilic and hydrophobic regions of surfactant molecules. In an aqueous bulk solution environment, the hydrophobic region is embedded on the inside (Figure 10.3). Conversely, in a hydrophobic, lipid, or lipophilic bulk solution, the hydrophilic region is embedded on the inside. The surfactant monomers in micelles are in dynamic equilibrium with free molecules (monomers) in solution, resulting in a continuous flux of monomers between the solution and the micellar phase. Figure 10.3 Types of micelles. Spherical micelles are formed when the concentration of monomers in the aqueous solution reaches the critical micelle concentration (CMC). Elongation of spherical micelles at high concentration leads to the for-mation of a cylindrical micelle. Reverse micelles are formed in a nonpolar solvent. Types of micelles The shape of micelles formed by a particular surfactant is greatly influ-enced by the geometry of the surfactant molecules. At higher surfactant concentrations, micelles may become asymmetric and eventually assume cylindrical or lamellar structures (Figure 10.3). Thus, spherical micelles exist at concentrations relatively close to the CMC. Oil-soluble surfactants have a tendency to self-associate into reverse micelles in nonpolar solvents, with their polar groups oriented away from the solvent and toward the cen-ter, which may also enclose some water (Figure 10.3). Micelles versus liposomes Micelles are unilayer structures of surfactants, whereas liposomes have a lipid bilayer structure that encloses the solvent medium (water) (Figure 10.3). Although both micelles and liposomes are formed from amphiphilic mono-mers, the structure and properties of the monomers play a role in determin-ing which of these structures forms. In addition, liposomes are not formed spontaneously—they require an input of energy and are typically formed by the application of one or more of agitation, ultrasonication, heating, and extrusion. Colloidal properties of micellar solutions Micellar solutions are different from other types of colloidal solutions (such as colloidal suspensions of particles), since micelles are association colloids; that is, the associated surfactant molecules are colloidal in size in solution. The micelles are formed by reversible self-association of monomers. The minimum concentration of a monomer at which micelles are formed is called the critical micelle concentration or the critical micellization concentration (CMC). The number of monomers that aggregate to form a micelle is known as the aggregation number of the micelle. The size of micelles depends on the number of monomers per micelle and the size and molecular shape of the individual monomers. For example, the longer the hydrophobic chain or the lower the polarity of the polar group, the greater the tendency for mono-mers to escape from water to form micelles and, hence, lower the CMC. The CMC and number of monomers per micelle differ for different types of surfactants. Some examples are listed in Table 10.4. As the surfactant concentration in a solution is progressively increased, the properties of the solution change gradually. Not all surfactants form micelles. In the case of surfactants that form micelles, a sharp inflection point in the physical properties of the solution is observed at the CMC. The properties that are affected include the following: Surface tension: As illustrated in Figure 10.4, surface tension of a surfac-tant solution decreases steadily up to the CMC but remains constant above the CMC. Table 10.4 Critical micellization concentration and number of surfactant molecules per micelle Figure 10.4 Micellization of an ionic surfactant (a) and its effect on conductivity and surface tension (b). This is attributed to the saturation of surface occupation of a surfactant above the CMC. Below the CMC, as the surfactant concentration in the solution is increased, more and more surfactant molecules partition into the surface or interface, leading to a steady reduction in surface ten-sion. Above the CMC, the surface or interface is already completely full or saturated with the surfactant. Thus, further addition of the surfactant leads to minimal changes in surface tension. The excess surfactant added to the solution forms micelles in the bulk of the liquid. Conductivity: The conductivity of a solution due to the presence of mon-ovalent inorganic ions is affected by the surfactant's concentration, since the polar head group of the surfactant can bind the ions, leading to reduced number of free ions available for conductance. As a surfactant is added to the solution, some of the surfactant occupies surface and some is available in the bulk of the solution, binding the counterions. Thus, solution con-ductivity reduces steadily as a function of the surfactant's concentration. As shown in Figure 10.4, this change is much more rapid above the CMC, following a sharp inflection point at the CMC. This is attributed to most of the added surfactant (above the CMC) being available in solution for bind-ing with the ions. Solubility: Solubility of a hydrophobic molecule in an aqueous solution increases slightly with the surfactant concentration below the CMC but shows significant and sharp increase above the CMC. Below the CMC, an increase in the solubility of a hydrophobic drug results from changes in the characteristics of the solvent medium (such as dielectric constant) and drug–surfactant interaction. Above the CMC, additional drug solubi-lization results from the hydrophobic drug getting incorporated into the micelles. Osmotic pressure: Micelles, formed above the CMC, act as association col-loids, leading to an increase in the osmotic pressure of the colloidal solution. Light-scattering intensity: Light scattering shows a sharp increase above the CMC due to the formation of colloidal micelles that scatter light. Factors affecting critical micelle concentration and micellar size ·   Size and structure of hydrophobic group: An increase in the hydro-carbon chain length causes a logarithmic decrease in the CMC. This is because an increase in hydrophobicity reduces aqueous solubility of the surfactant and increases its partitioning into the micelles. Micellar size increases with an increase in the hydrocarbon chain length, owing to an increase in the volume occupied per surfactant in the micelle. ·   Nature of hydrophilic group: An increase in hydrophilicity increases the CMC due to increased surfactant solubility in the aqueous medium and reduced partitioning into the interface. As the propor-tion of surface/interface to bulk surfactant concentration reduces, more of added surfactant is required to achieve saturation of the sur-face before micelles can form. Thus, nonionic surfactants have very lower hydrophilicity and CMC values compared with ionic surfac-tants with similar hydrocarbon chains. ·   Nature of counterions: About 70%–80% of the counterions of an ionic surfactant (e.g., Na+ is a counterion for carboxylate and sulfonate groups, and Cl- is a counterion for quaternary amine groups) are bound to the micelles. The nature of the counterion influences the properties of these micelles. For example, size of micelles formed with a cationic surfactant increases according to the series Cl– < Br– < I– and with an anionic surfactant according to the series Na+ < K+ < Cs+. This is a function of not only the size and electronegativity of the counterion but also the size of the hydration layer around the counterion. The weakly hydrated (smaller, highly electronegative) ions are adsorbed more closely to the micellar surface and neutralize the charge on the surfactant more effectively, leading to the formation of smaller micelles. ·   Addition of electrolytes: Addition of electrolytes, such as salt, to solu-tions of ionic surfactants decreases the CMC and increases the size of the micelles. This is due to a reduction in the effective charge on the hydrophilic headgroups of the surfactants. This tips the hydrophilic lipophilic balance toward greater lipophilicity, increases the propor-tion of surface/interface to bulk surfactant concentration below the CMC, and promotes the formation of micelles in the bulk liquid. In contrast, micellar properties of nonionic surfactants are only mini-mally affected by the addition of electrolytes. ·   Effect of temperature: Size of micelles increases and CMC decreases with increasing temperature up to the cloud point for many nonionic surfactants due to increased Brownian motion of the monomers. Temperature has little effect on ionic surfactants. This is due to stron-ger hydrogen bonding and electrical forces governing the hydrophilic interactions of ionic surfactants than nonionic surfactants. ·   Alcohol: Addition of alcohol to an aqueous solution reduces the dielectric constant and increases the capacity of the solution to sol-ubilize amphiphilic (surfactant) and hydrophobic molecules. Thus, greater surfactant solubility in the hydroalcoholic solutions decreases the surface/interface to bulk solution concentration of the surfactant, thus increasing the CMC. Krafft point Krafft point (Kt), also known as the critical micelle temperature or Krafft temperature, is the minimum temperature at which surfactants form micelles, irrespective of the surfactant concentration. Below the Krafft point, surfactants maintain their crystalline molecular orientation form even in an aqueous solution and are not distributed as freely tumbling random monomers that are able to self-associate to form micelles. The International Union of Pure and Applied Chemistry's Gold Book (. org) defines Krafft point as the temperature at which the solubility of a surfactant rises sharply to that at the CMC, the highest concentration of free monomers in solution. The Krafft point is determined by locating the abrupt change in slope of a graph of the logarithm of the solubility against temperature (T), or 1/T. Below Kt, the surfactant has a limited solubility, which is insufficient for micellization. As the temperature increases, solu-bility increases slowly. At the Krafft point, surfactant crystals melt and the surfactant molecules are released in solution as monomers, which can also get incorporated into micelles. Above the Krafft point, micelles form and, due to their high solubility, contribute to a dramatic increase in the surfac-tant solubility. Cloud point Cloud point is the temperature at which some surfactants begin to pre-cipitate and the solution becomes cloudy. The appearance of turbidity at the cloud point is due to separation of the solution into two phases. For nonionic surfactants, aqueous solubility is at least partially attributed to the hydration of their hydrophilic regions by water molecules. Increasing solution temperatures up to the cloud point leads to an increase in micellar size. Increasing temperature above the cloud point imparts sufficient kinetic energy to the hydrating water molecules to effectively dissociate from the surfactant and bond exclusively with the bulk water. This produces a suf-ficient overall drop in the solubility of the surfactant to cause surfactant precipitation and cloudiness of solution. At elevated temperatures, the sur-factant separates as a precipitate. When in high concentration, it separates as a gel. This phenomenon is commonly seen with many nonionic polyoxy-ethylate surfactants in solution. Organic solubilized molecules or solution additives, such as ethanol, generally decrease the cloud point of nonionic surfactants. Addition of aliphatic hydrocarbons increases the cloud point. Aromatic hydrocarbons or alkanols may increase or decrease the cloud point, depending on the concentration. Micellar solubilization Micelles can be used to increase the solubility of materials that are normally insoluble or poorly soluble in the dispersion medium used. This phenom-enon is known as solubilization, and the incorporated substance is referred to as the solubilizate. For example, surfactants are often used to increase the solubility of poorly soluble steroids. The location, distribution, and orienta-tion of solubilized drugs in the micelles influence the kinetics and extent of drug solubilization. These parameters are determined by the molecular loca-tion of the interaction of drugs with the structural elements or functional groups of the surfactant in the micelles. 1. Factors affecting the extent of solubilization Factors affecting the rate and extent of micellar solubilization include the nature of surfactants, the nature of solubilizates, temperature, and pH. 1. Nature of surfactants: Structural characteristics of a surfactant affect its solubilizing capacity because of its effect on the solubiliza-tion site within the micelle. In cases where the solubilizate is located within the core or deep within the micelle structure, the solubili-zation capacity increases with increase in alkyl chain length. For example, there was an increase in the solubilizing capacity of a series of polysorbates for selected barbiturates as the alkyl chain length was increased from C12 (polysorbate 20) to C18 (polysorbate 80). An increase in the alkyl chain length increases the hydrophobicity of the core and micellar radius, reduces pressure inside the micelle, and increases the diffusive entry of the hydrophobic drug into the micelle. In addition, the solubilization of the poorly soluble drug tropicamide increased with increase in the oxyethylene content of poloxamer. On the other hand, an increase in the ethylene oxide chain length of a polyoxyethylated nonionic surfactant led to an increase in the total amount solubilized per mole of surfactant because of the increasing number of micelles. Thus, the effect of increase in the number of micelles of the same (smaller) size can be very different than increase in the size of micelles. 2. Nature of solubilizate (drug being solubilized): The location of solu-bilizates in the micelles is closely related to the chemical nature of the solubilizate. In general, nonpolar, hydrophobic solubilizates are local-ized in the micellar core. Compounds that have both hydrophobic and hydrophilic regions are oriented with the hydrophobic group facing or in the core and the hydrophilic or polar groups facing toward the sur-face. For a hydrophobic drug solubilized in a micelle core, an increase in the lipophilicity or the lipophilic region or surface area of the drug leads to solubilization near the core of the micelle and enhances drug solubility. Unsaturated compounds are generally more soluble than their satu-rated counterparts. Solubilizates that are located within micellar core tend to increase the size of the micelles. Micelles become larger not only because their core is enlarged by the solubilizate but also because the number of surfactant molecules per micelle increases in an attempt to cover the swollen core. 3. Effect of temperature: In general, the amount of the drug solubilized increases with an increase in temperature (Figure 10.5). The effect is particularly pronounced with some nonionic surfactants, where it is a consequence of an increase in the micellar size with increasing temperature. 4. Effect of pH: The main effect of pH on solubilizing ability of non-ionic surfactants is to alter the equilibrium between ionized and unionized drugs. The overall effect of pH on drug solubilization is a function of proportion of ionized and unionized forms of the drug in solution and in micelles, which is determined by (1) the pKa value of the ionizable functional group(s), (2) the solubility of the ionized and unionized forms in the solution, and (3) the solubilization capacity of the micelles for the ionized and union-ized forms. Generally, the unionized form is the more hydrophobic form and is solubilized to a greater extent in the micelles than the ionized form. Figure 10.5 Effect of temperature and surfactant type on the micellar solubilization of griseofulvin and hexocresol. (Modified from Bates, T.R, Gilbaldi, M. and Kanig, J.I. J. Pharm. Sci., 55, 191, 1966. With Permission.) 2. Pharmaceutical applications Several insoluble drugs have been formulated by using micellar solubiliza-tion. For example: · Phenolic compounds, such as cresol, chlorocresol, and chloroxylenol, are solubilized with soap to form clear solutions for use as disinfectants. · Polysorbates have been used to solubilize steroids in ophthalmic formulations. · Polysorbate are used to prepare aqueous injections of the water-insoluble vitamins A, D, E, and K. · Nonionic surfactants are efficient solubilizers of iodine. 3. Thermodynamics/spontaneity Micellar solubilization involves partitioning of the drug between the micel-lar phase and the aqueous solvent. Thus, the standard free energy of solubi-lization, ΔGs, can be computed from the partition coefficient, K, of the drug between the micelle and the aqueous medium: $\Delta G_s = -RT \ln K$ (10.1) where: R is the gas constant T is the absolute temperature Change in free energy with micellization can be expressed in terms of the change in enthalpy (ΔHs) and entropy (ΔSs) as: $\Delta G_s = \Delta H_s - T\Delta S_s$ (10.2) Thus, $\Delta H_s - T\Delta S_s = -RT \ln K$ Or, $\ln K = - - \Delta H_s/R \cdot 1/T$ + constant where the constant is $\Delta S_s/R$, assuming that the change in entropy from micellization is constant. Thus, experimental determination of enthalpy of micellization can be a useful tool to predict ΔGs, which, in turn, indicates whether micellar incorporation of a drug would be spontaneous. When ΔGs is negative, solubilization process is spontaneous. When ΔGs is positive, solubilization does not occur. Example 1: Given ΔHs = 2830 cal/mol and ΔSs = −26.3 cal/K mol, does ammonium chloride spontaneously transfer from water to micelles? $\Delta G_s = \Delta H_s - T\Delta S_s$ = 2830 cal/mol − (298K)(− 26.3 cal/kmol) which is positive, indicating that micellar solubilization (transfer) would not occur. Example 2: Given ΔHs = −1700 cal/mol and ΔSs = 2.1 cal/K mol, does amobarbital spontaneously transfer from water to a micellar solution (sodium lauryl sulfate, 0.06 mol/L)? $\Delta G_s = \Delta H_s - T\Delta S_s$ = 1700 cal/mol − (298K)(− 2 .1 cal/kmol) = −2326 cal/mol which is negative, indicating that micellar solubilization (transfer) would indeed spontaneously occur.