
Surfactants

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Definition

- **A surfactant is defined as a species that is active at the interface between 2 phases and accumulates at the interface.**
- **This alters the free energy of the system by changing the work required to expand the surface. This work per unit area is called the surface tension.**

- **Molecules at the surface have higher free energies than those in the interior due to the unbalanced forces on the surface molecules.**
- **A surfactant has dual nature (amphipathic) with a solvent loving end (lyophilic) and a solvent hating end (lyophobic). For the solvent water these terms are hydrophobic and hydrophilic.**
- **The solvent hating end increases the free energy of the solution and causes the molecules to be “squeezed out” of the water and to congregate at the surface. This movement to the surface lowers the surface tension because less work is needed to expand the surface than with pure solvent.**

Types of surfactants

Anionic – having a negatively charged polar head

Cationic – having a positively charged polar head

Nonionic – having a non-charged polar head

Zwitterionic/Amphoteric – having polar heads which can be either + or – (usually 2 polar heads are present) depending on pH

Micelles

- **Total expulsion of the surfactant is prevented by the solvent loving portion. At a specific concentration (known as the critical micelle concentration - cmc) aggregates in solution form in an attempt to deal with this energy problem. These aggregates are called micelles. (See handout for details and practical applications.)**
- **In water solutions the micelle is spherical at the beginning of aggregate formation. The polar heads orient themselves towards the water and the nonpolar tails orient themselves into a nonpolar cavity.**

- **At higher concentrations the micelles tend to form cylinders and lamellar sheets. These lamellar sheets are often used as models for biological membranes.**
- **Many properties of solutions change at the cmc – surface tension, light scattering, and conductance (for ionic surfactants)**
- **Thermodynamics**

Micelles form stepwise and have a small positive enthalpy change. This means that the micellization process is entropy driven.