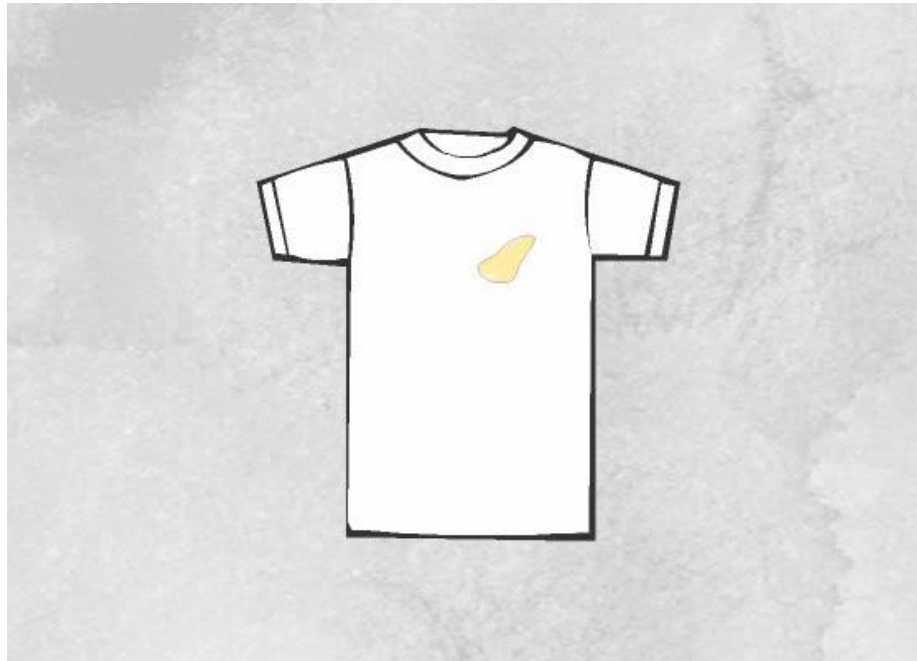


# Surfactants

Assoc. Prof. Kozet YAPSAKLI

A surfactant or surface active agent is a substance that, when dissolved in water, gives a product the ability to remove dirt from surfaces such as the human skin, textiles, and other solids.



# Definition



## SURFACE TENSION DIAGRAM



Water's Surface Tension is Stronger than the Fabric's Surface Tension, Water Beads Up and Rolls Off

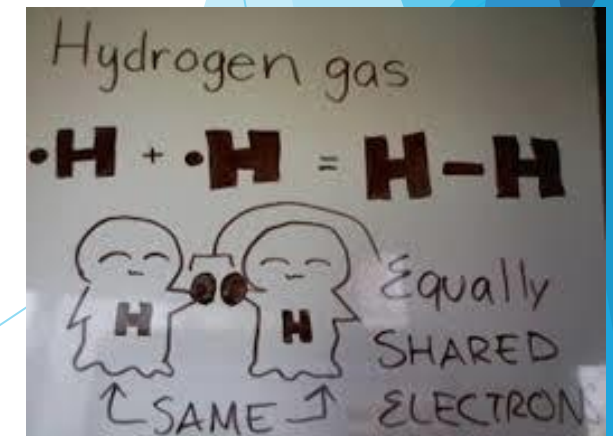
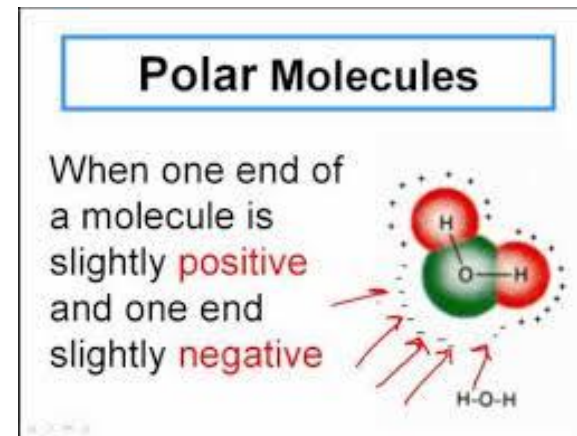
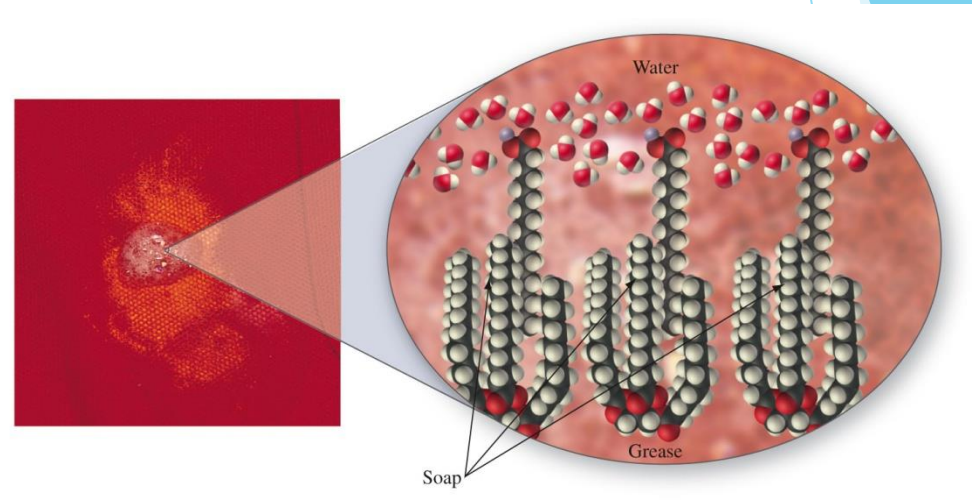
Water's Surface Tension is Less than the Fabric's Surface Tension, Water Soaks into the Fabric

wetting agents that lower the surface tension of a liquid, allowing easier spreading, and lower the interfacial tension between two liquids.

## Interfacial Tension: Salad dressing example



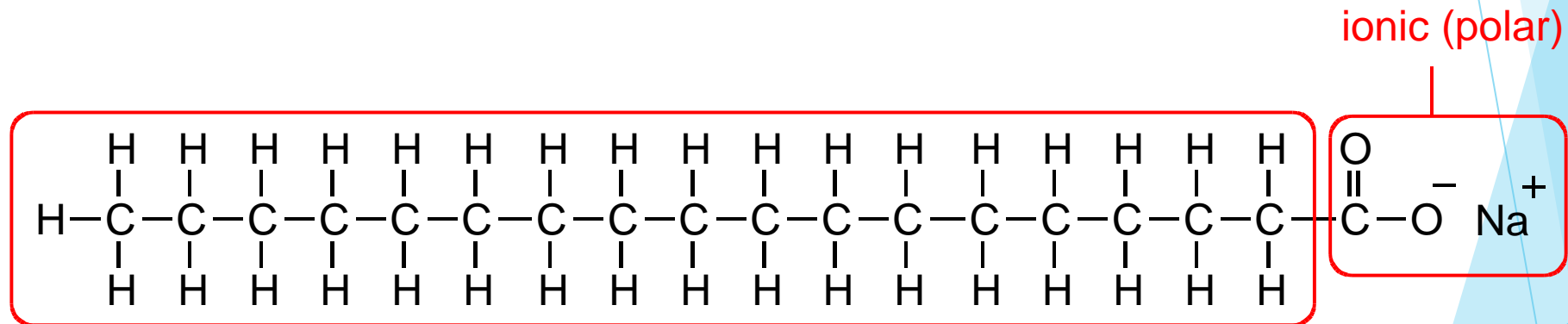
- ▶ Polar molecules have an uneven electron distribution.
- ▶ Nonpolar molecules have an even electron distribution.
  - ▶ Polar and nonpolar molecules do not interact.
- ▶ Soap molecules are relatively lengthy and have both an ionic (polar) end and a nonpolar end.





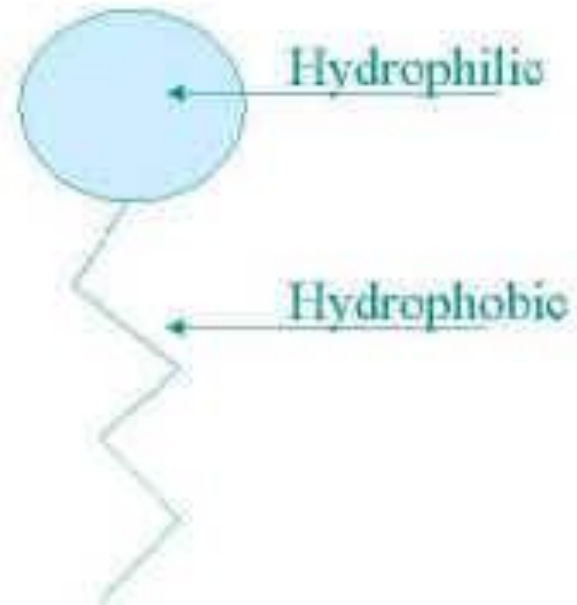
# Concept Check Solution

- ▶ Sodium stearate has both polar and nonpolar components in its structure. The nonpolar tail is hydrophobic and the ionic polar head of the molecule is hydrophilic.



nonpolar C-C and C-H bonds make this part of the molecule nonpolar

Each surfactant molecule has a hydrophilic (water-loving) head that is attracted to water molecules AND a hydrophobic (water-hating) tail that repels water and simultaneously attaches itself to oil and grease in dirt



# Surfactants

- ▶ Surfactants are so named because they act at surfaces.
- ▶ These colloidal suspensions are a type of *emulsion* and soap functions in them as an *emulsifier* or *emulsifying agent*.
- ▶ The particles in a colloidal suspension are too small to see with the naked eye, but they make a solution cloudy because they scatter light.





# Are surfactants of natural or synthetic origin ?

They can be either. Surfactants from natural origin (vegetable or animal) are known as oleo-chemicals and are derived from sources such as palm oil or tallow. Surfactants from synthetic origin are known as petro-chemicals and are derived from petroleum.

# Synthetic Detergents

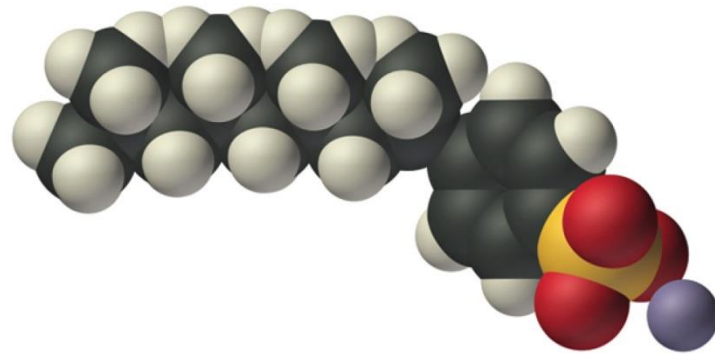
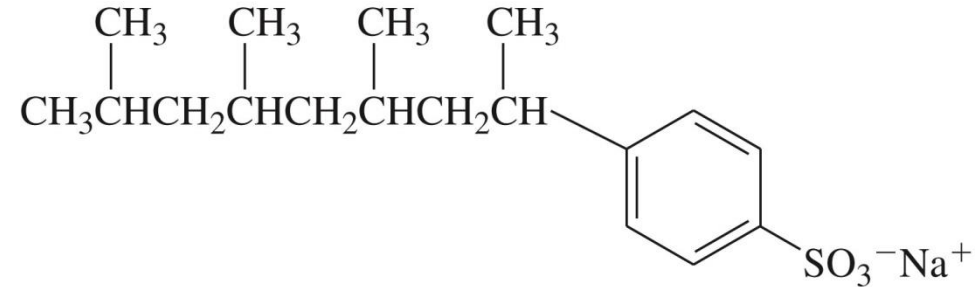
## ABS Detergents: Nonbiodegradable

- ▶ The first synthetic detergents were alkylbenzenesulfonates (ABS) detergents.
- ▶ nonbiodegradable and produced a foam that appeared on natural lakes and rivers as well as in wells and sewage treatment plants.
- ▶ were banned and replaced by biodegradable detergents.



# ABS Detergents

- ▶ Due to their highly branched alkyl chains, ABS detergents do not biodegrade.



- ▶ Soapy coastlines and inland bodies of water made a modification of ABS detergents necessary.

# Synthetic Detergents

## ABS Detergents: Nonbiodegradable



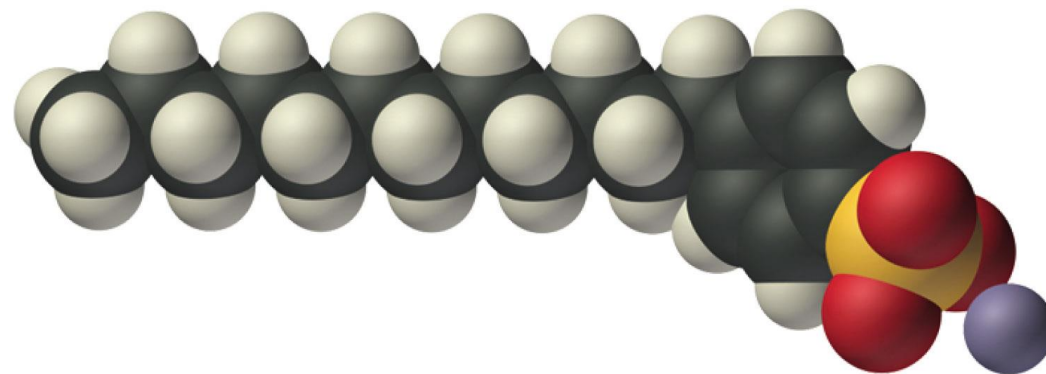
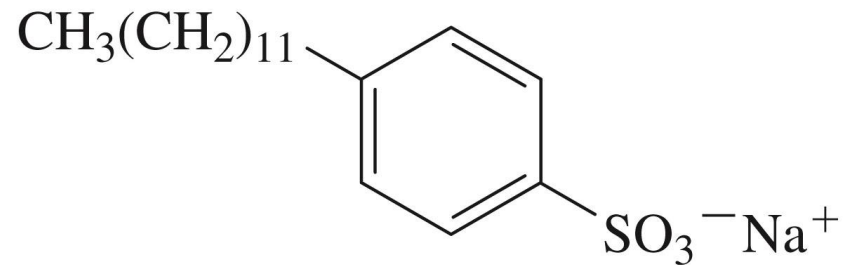
(a)



(b)

# LAS Detergents

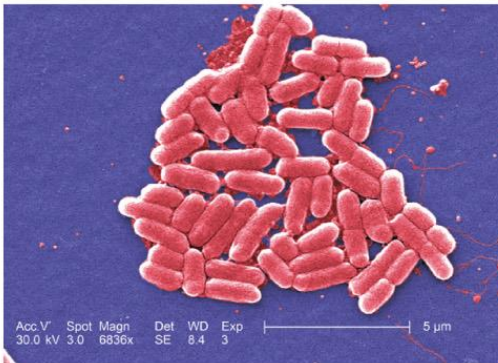
- ▶ Subsequent detergent designs had alkyl chains more like the linear alkyl chains found in soap.
- ▶ They did biodegrade into  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ , and  $\text{SO}_4^{2-}$ , all common substances in the environment.



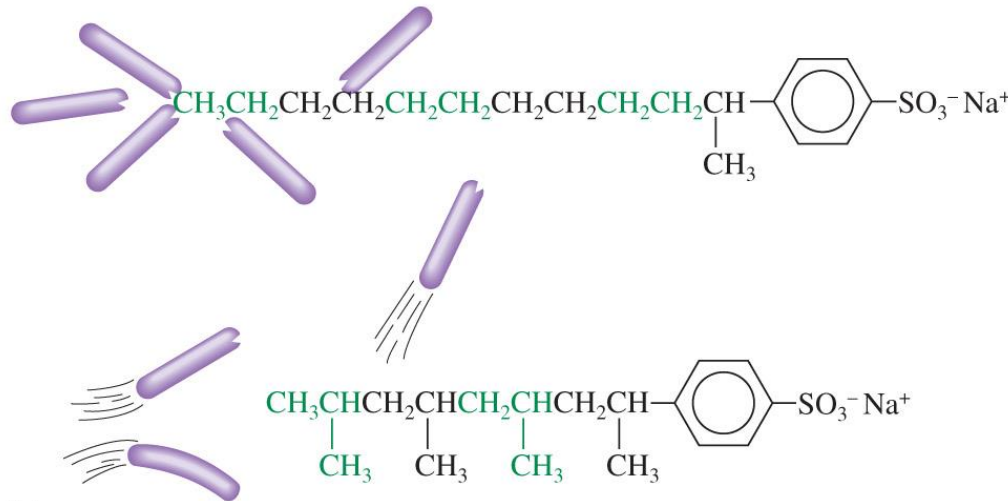
# Synthetic Detergents

## LAS Detergents: Biodegradable

*Linear alkylsulfonates (LAS) detergents* have linear chains of carbon atoms that can be broken down by microorganisms.



(a)



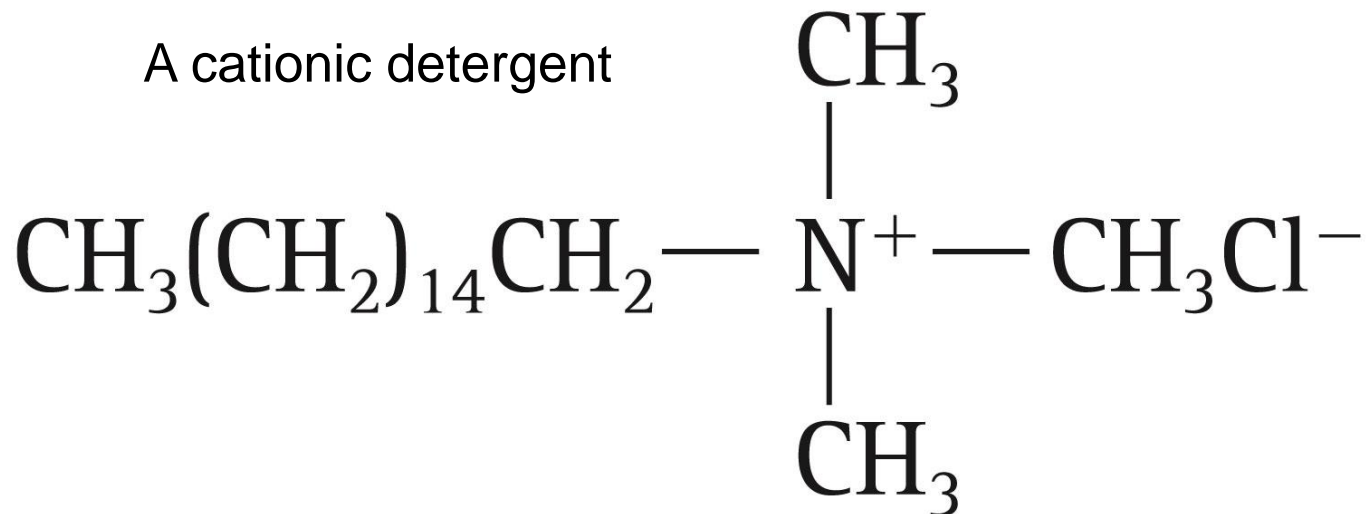
(b)

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# Types of Detergents

- ▶ Anionic-alkyl chain has a negatively charged group
  - ▶ ABS, LAS
- ▶ Cationic-alkyl chain has a positively charged group
- ▶ Nonionic-alkyl chain maintains polarity with OH or similar groups

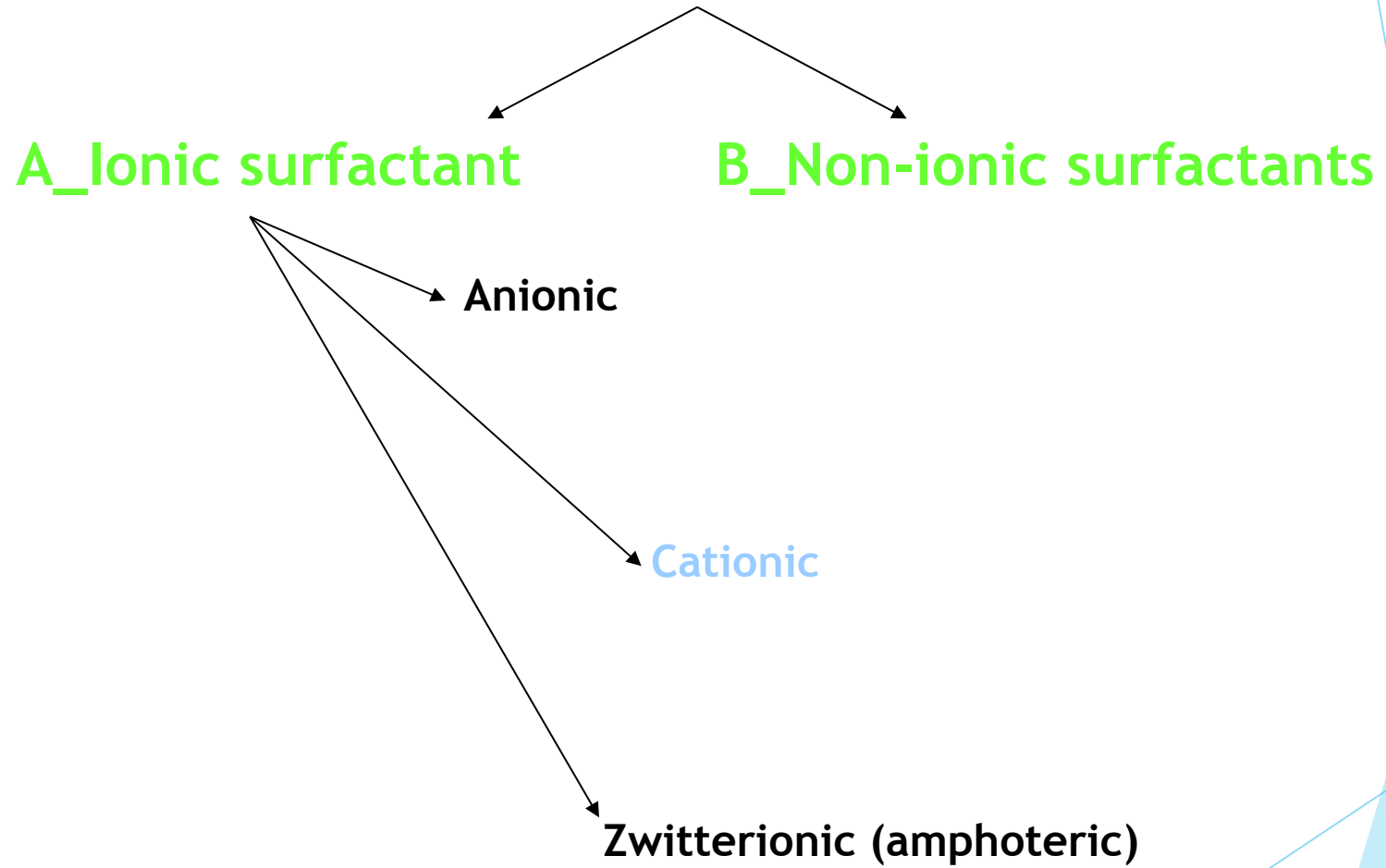
A cationic detergent



Conditioners are cationic



# Classification of surfactants?



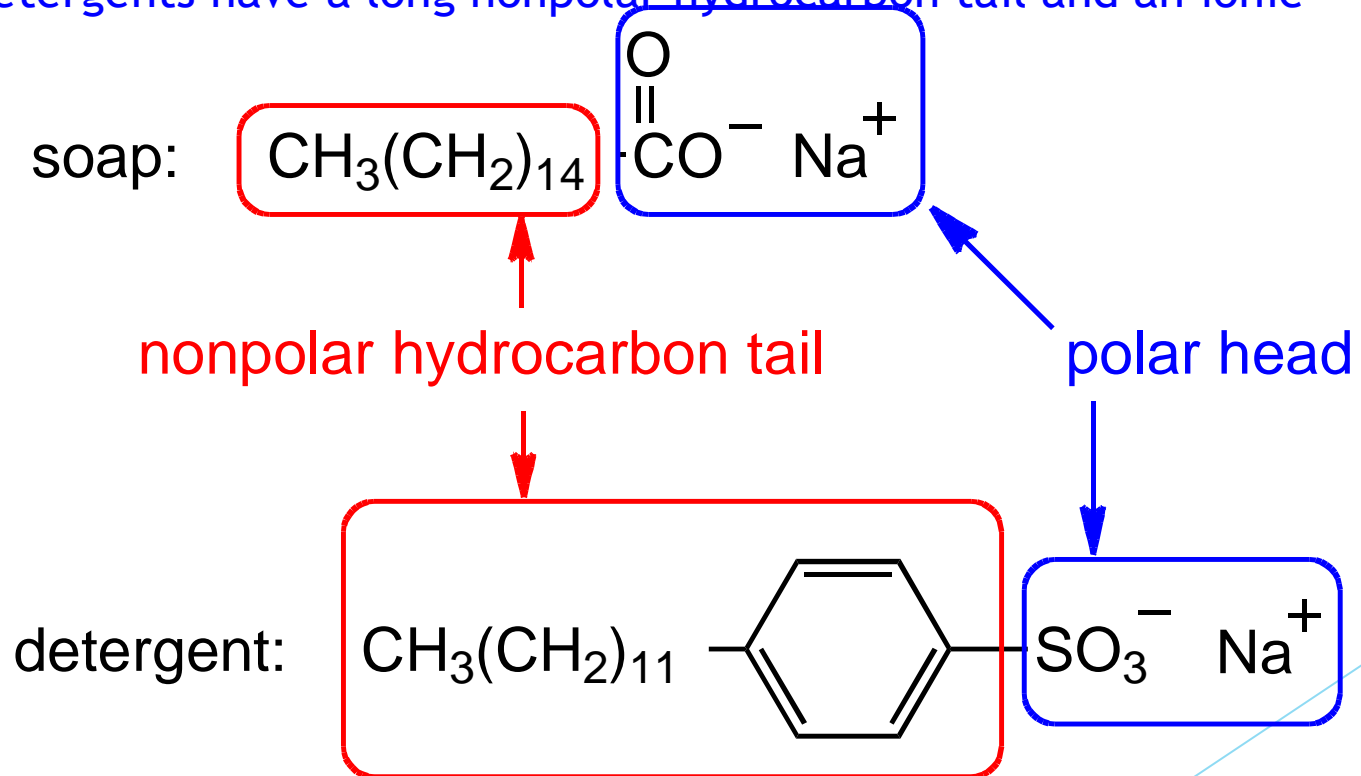


# Concept Check

- ▶ What structural features do soaps and detergents have in common?

# Concept Check Solution

- ▶ Both soaps and detergents have a long nonpolar hydrocarbon tail and an ionic (polar) head.



# How do surfactants work in detail?

Surfactants can work in three different ways:

a\_ roll-up,

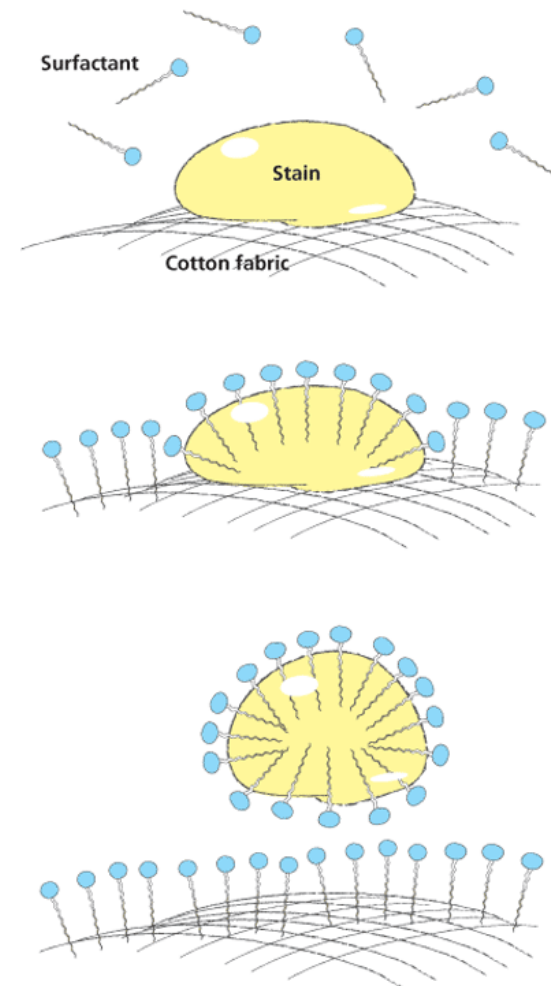
b\_ emulsification, and

c\_ solubilization.

## A\_ Roll-up mechanism

The surfactant lowers the oil/solution and fabric/solution interfacial tensions and in this way lifts the stain of the fabric.

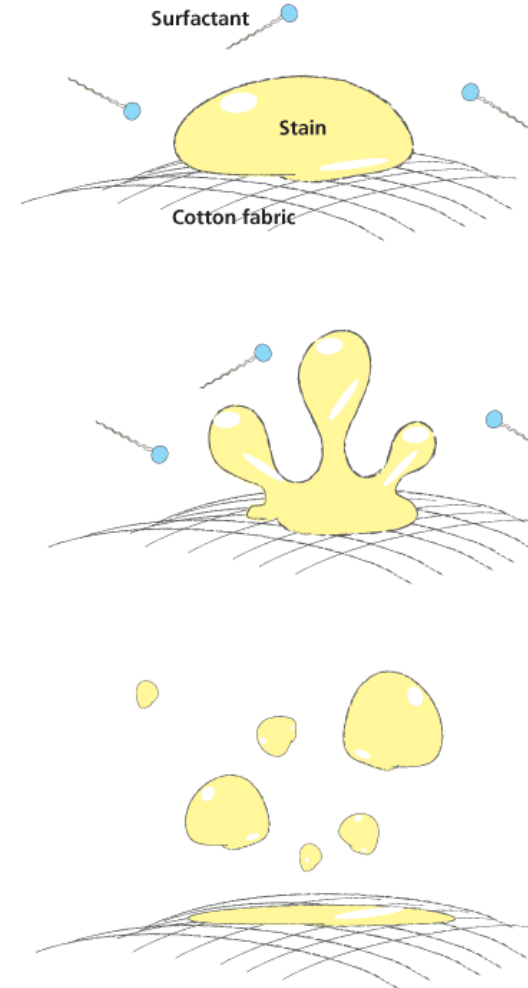
### Roll-up



## B\_ Emulsification

The surfactant lowers the oil-solution interfacial tension and makes easy **emulsification** of the oily soils possible.

### Emulsification



## C\_ Solubilization

Through interaction with the micelles of a surfactant in a solvent (water), a substance spontaneously dissolves to form a stable and clear solution.

# Measurement Method

- ▶ Anionic Surfactant → Methylene Blue Active Substances Assay (MBAS)
- ▶ If an anionic *surfactant* is present, then the cationic *methylene blue* and the anionic *surfactant* forms an ion pair, which is extracted into the water-insoluble organic phase such as dichloromethane
- ▶ The blue complex is measured at 650 nm