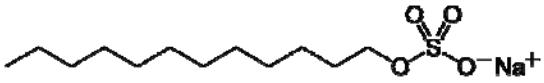
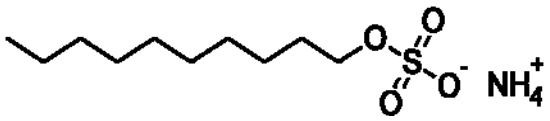
4.11 Detergents as surfactants

Dish and laundry detergents, shampoos, toothpaste and some laxatives also form micelles which act to emulsify grease and fats in an aqueous solution as well as provide foaming action! The structures of some detergents are shown:

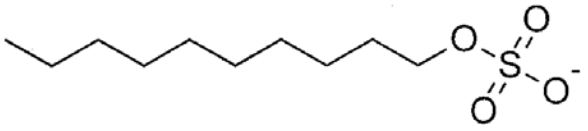
sodium dodecyl (lauryl) sulfate

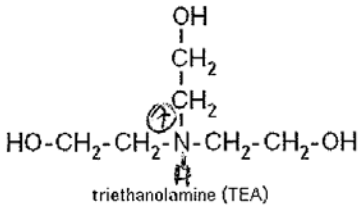


Ammonium lauryl sulfate



TEA(triethanolamine) lauryl sulfate





Sodium lauryl sulfate is commonly used as a "foaming agent" in toothpaste. There have been concerns that its presence in toothpaste may increase the incidence of oral canker sores. Several small studies indicated an increased incidence of canker sores in those using toothpaste with sodium lauryl sulfate, but another large study found no increase from use of toothpaste with sodium lauryl sulfate, so the jury is still out.

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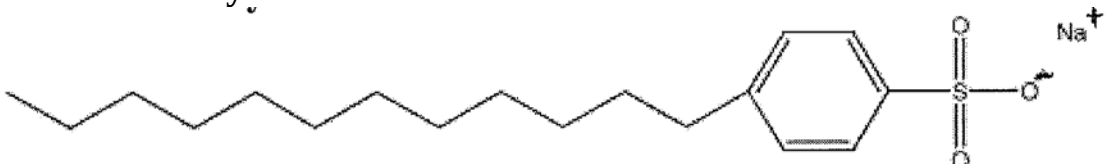
Sodium lauryl sulfate and closely related compounds like ammonium lauryl sulfate are also very commonly used in shampoos. On a molecule per molecule basis, they work more effectively under alkaline conditions, but that can cause stinging of the eyes and damage to the protein hair. The pH is often adjusted to be near neutrality which minimizes damage to the hair protein keratin. Baby's shampoo in particular may be adjusted to the pH of tears (7.0 +/-0.5) to minimize stinging of the eyes.

All three of the above surfactants have the same lauryl sulfate ion, only differing in what positive ion balances the negative charge.

Sodium dodecyl benzene sulfonate



(Notice that **sulfates** have an O atom between the S and the C atoms, while **sulfonates** have the S atom bonded directly to the C atom. The removal of one O atom does not significantly change the surfactant action of the molecule however.)

Label the hydrophilic and hydrophobic portions in the above molecules.

Detergents have replaced soaps in many uses because soap molecules tend to form precipitates when dissolved in water containing +2 ions like Ca^{+2}, Mg^{+2}, and Fe^{+2} (hard water). This precipitate produces the scum that forms bathtub ring. It also accumulates on clothes if soap is used instead of detergent when doing laundry in hard water.

Detergents are made from petroleum and only came into common use after World War II. Although detergents do lose some cleansing action in the presence of +2 metal ions, they do not form insoluble precipitates nearly as

readily as soaps do, so they have replaced soaps in many cleaning applications.

Before detergents were available, the pioneer women often preferred to do their laundry in rain water, if it was available. Rain water does not contain as many metal ions as well or stream water and hence does not have as igh a tendency to precipitate soap.

Pioneer women made soap by saving up the fat from slaughtered animals and from the frying pan. They then made lye (a mixture of NaOH and KOH) by filtering water through the ashes from the fireplace. They then added the lye to a kettle of fat and cooked it, thus saponifying the fat into soap. Frequently this soap contained an excess of lye. It was very hard on the skin!