Soaps and Detergents

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Soaps

- Soaps are the salts of fatty acids. Potassium and sodium soaps are the most commonly used.
- Magnesium and calcium soaps are found as bathtub ring.
- Lead and zinc are used to make medicinal soaps
- Lithium soaps are used to make lubricants.
- Aluminum soaps are used for waterproofing.

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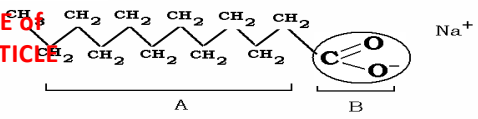
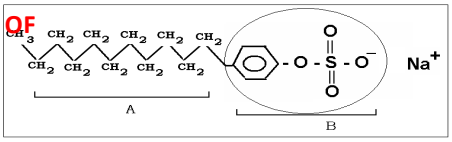
STRUCTURE OF SOAP PARTICLE



STRUCTURE OF DETERGENT PARTICLE



- the tail part
- the organic part
- the hydrophobic part
- the head part
- the ionic part
- the hydrophilic part

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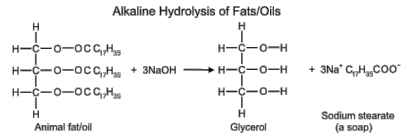
MAKING SOAPS

Soaps are formed by the alkaline *hydrolysis* (breaking up) of fats and oils by sodium or potassium hydroxide by boiling under reflux conditions:



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- Hydrolysis of esters such as fats/oil produces glycerol and *fatty acids*. Fats and oils are triglycerides meaning they are esters which contain 3 molecules of fatty acid condensed to 1 molecule of the *trihydric alcohol*, glycerol. So during hydrolysis, three molecules of soap are made per molecule of glycerol. (3:1 ratio of fatty acid:glycerol)
- The hydrolysis is carried out using alkalis (NaOH or KOH) as catalyst and the fatty acids formed are

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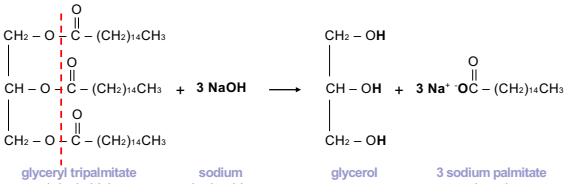
Saponification

Process of making soap from animal fat or vegetable oil using a base.



glyceryl tripalmitate (tripalmitin) | sodium hydroxide | glycerol | 3 sodium palmitate (soap)

6

The long covalent hydrocarbon chain that makes up the tail section of a soap structure can be represented in a number of ways, either in the shorthand notation shown below or as a bond-stick representation, shown at the bottom of the page. The charged carboxylate group represents the head section of the soap structure.

7

THE STRUCTURE OF SOAP

- The long covalent hydrocarbon chain gives rise to the *hydrophobic* (water hating) and oil-soluble (non-polar) properties of the soap molecule (represented in yellow). The charged carboxylate group (represented in blue) is attracted to water molecules (*hydrophilic*). In this way, soaps are composed of a hydrophilic head and a hydrophobic tail:

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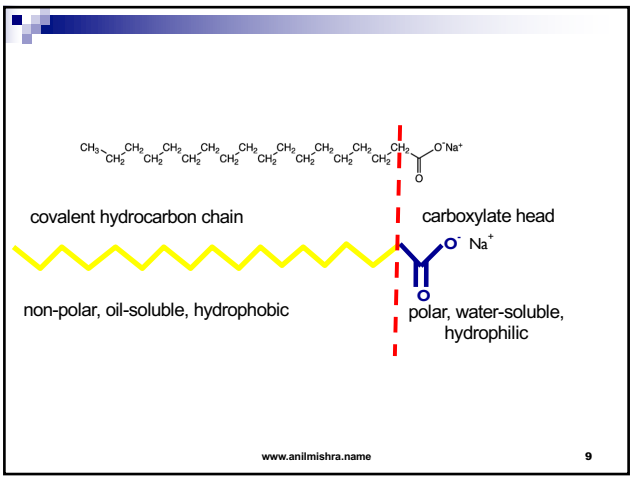

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- Oils and fats are treated with lye (sodium hydroxide or potassium hydroxide) to yield salt of the fatty acids. Formerly, extracts of wood ashes were used. Potassium gives soft soaps and sodium gives hard soaps.
- Detergents often made by sulfonation of other types of organic molecules.
- Saponins from plants used in some societies as soap or detergent substitutes.
- Coconut oil is still the most commonly used oil for soap.

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CLEANSING ACTION OF SOAP OR DETER

a) State three abilities of both soap and detergent that enable them to act as cleansing agents

i. Ability to lower the surface tension of water

This helps to wet the cloth better

ii. To emulsify oil or grease,

(break the oil or grease into smaller droplets)

iii. Suspend oil or grease in water,

Prevent the oil or grease from redeposit on the surface of the cloth

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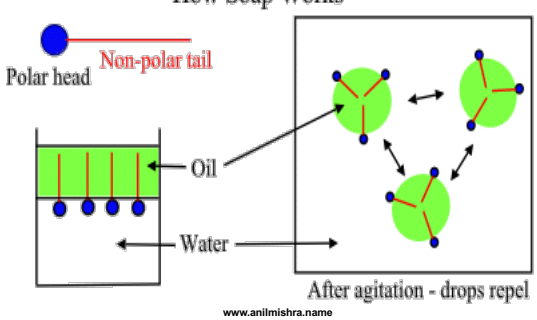
HOW A SOAP WORKS



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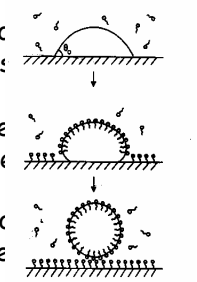
MECHANISM OF STAIN/DIRT REMOVAL

Roll-up mechanism

- The hydrophobic tails 'burro the droplet of oil or greas
- The hydrophilic heads are le face the surrounding wate
- This results in the formatic ball-like structure (a mice
- The non-polar substances, such as oil or grease, are held inside the ball



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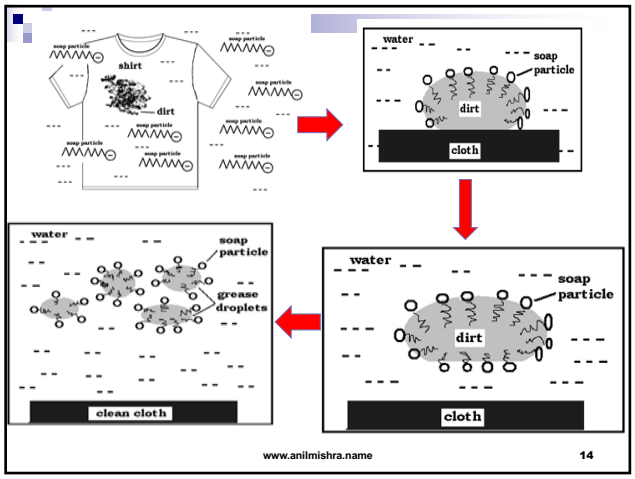

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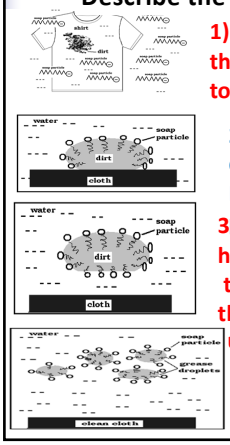
Describe the cleansing action of soap and deter



1) Soap dissolves in water and lowers the surface tension of water. This helps to wet the cloth better

2) The hydrophobic part (tail part) dissolves
In grease , the hydrophilic part (head part) dissolves in water

3) Movement of water during scrubbing helps
to loosen the grease and lift the grease the
surface

4) Repulsion of negative charges break the grease into small droplets.

Rinsing washes away these droplets

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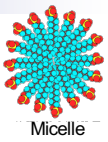
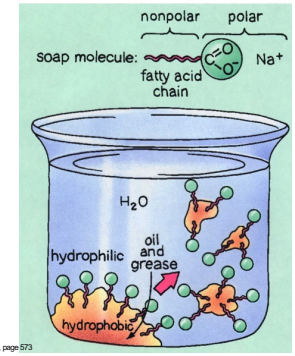
Cleaning Action of Soap





Timberlake, Chemistry 7th Edition, page 573

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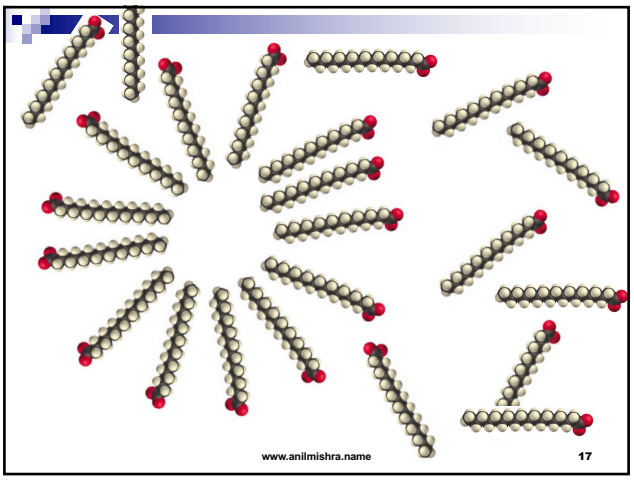
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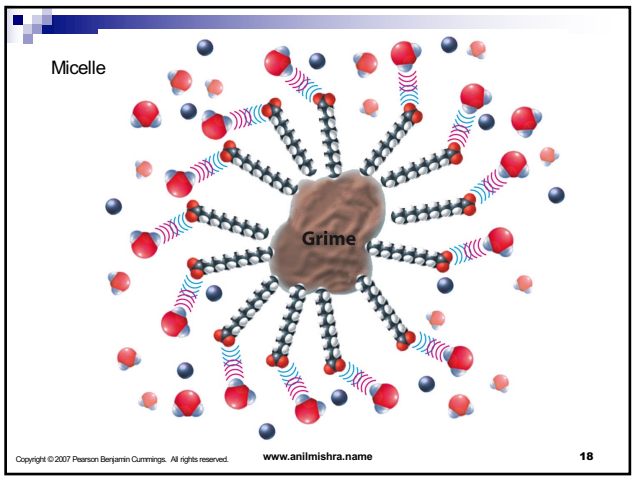
Micelle
Grime
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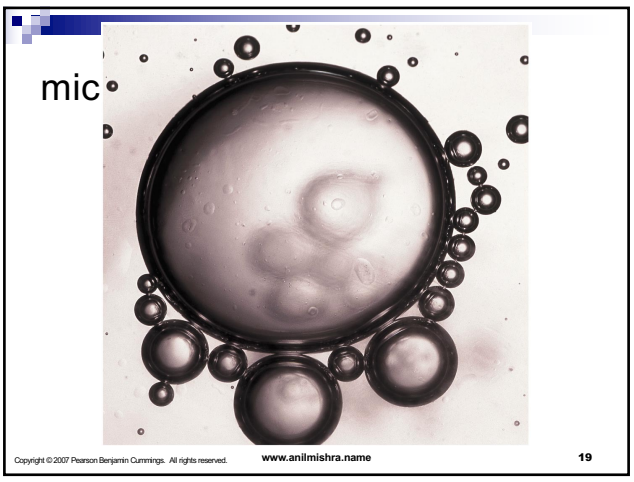
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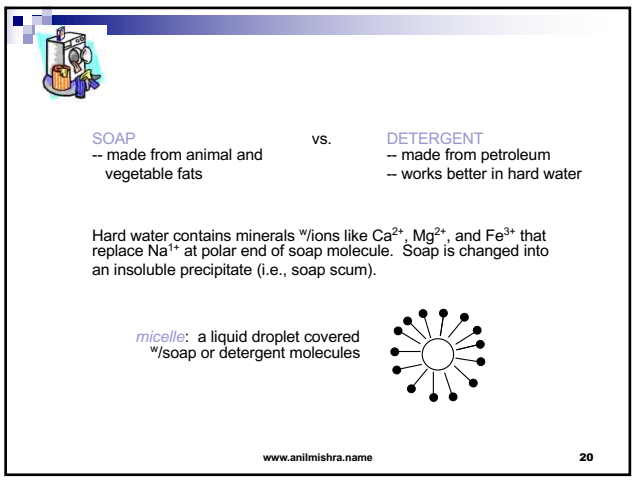
SOAP
-- made from animal and vegetable fats
vs.
DETERGENT
-- made from petroleum
-- works better in hard water
Hard water contains minerals w/ions like Ca^{2+}, Mg^{2+}, and Fe^{3+} that replace Na^{1+} at polar end of soap molecule. Soap is changed into an insoluble precipitate (i.e., soap scum).
micelle: a liquid droplet covered w/soap or detergent molecules
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"Like Dissolves Like"

NONPOLAR

NONPOLAR

POLAR

POLAR

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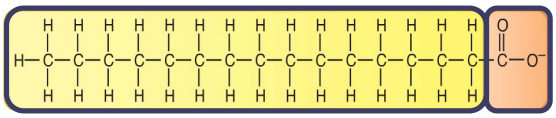
SOAP

As with any detergent, the hydrocarbon tail is…

HYDROPHOBIC (water hating / grease loving)



the ionic head is…

HYDROPHILIC (water loving / grease hating)

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- Soap / Detergent
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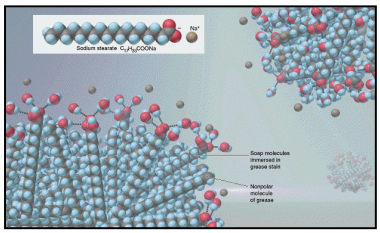

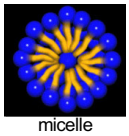

micelle

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On refluxing with alkali, triacylglycerols (fatty acid esters) are hydrolyzed to give glycerol and potassium salts of fatty acids (soap).

Such process is known as, *Saponification.*

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Saponification Number

- **The saponification value**

is the number of milligrams of KOH required to neutralize the fatty acids resulting from the complete hydrolysis of 1g of fat.

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- The saponification value gives an indication of the nature of the fatty acids constituent of fat and thus, depends on the average molecular weight of the fatty acids constituent of fat.
- The greater the molecular weight (the longer the carbon chain), the smaller the number of fatty acids is liberated per gram of fat hydrolyzed and therefore, the smaller the saponification number and vice versa.

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- Introduction and principle:
- The major constituents of fats and oil are TAG.
- Although some free f.as are also usually present and contribute to the acidity of the fat or oil.
- These free f.as and any other acids which may be present, may be neutralized with KOH in the determination of the acid value,

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Acid value is defined as the no. of mg of KOH required to neutralize the free f.as in one gm of fats or oil.

The saudi STD for edible fats and oils indicate that the acid value must not exceed 0.6 mg KOH/1gm.

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