







Acids, Esters and Fats

Alkanoic Acids (Carboxylic Acids),
Esters, Fats, Oils and Soaps

Index

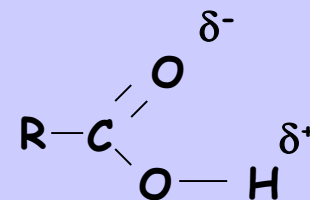
-  Alkanoic Acids $C_nH_{2n+1}COOH$
-  Uses and naming Carboxylic Acids
-  Esters
-  Fats and Oils
-  Fatty acids and Soap
-  Percentage yield



Alkanoic Acids $C_nH_{2n+1}COOH$

Properties

Because of the ability of **lower** molecular sized alkanoic acids to form **hydrogen bonds**, they are soluble in water. They have high b.p.'s for the same reason. They also have a sharp smell. Human sweat contains a mixture of these compounds.



Alkanoic acids are **weak acids**, so can react with some metals and alkalis.



Magnesium ethanoate



Sodium ethanoate



Potassium ethanoate

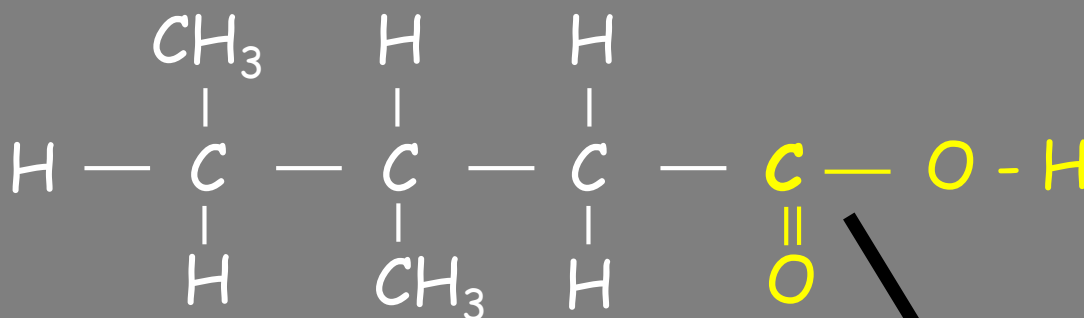


Uses for Carboxylic acids

- Carboxylic acids are used in some food items. Vinegar is dilute ethanoic acid. This is used in preparations for pickles, salads, sauces, etc.
- Carboxylic acids are used in the manufacture of soaps. Sodium salts of fatty acids are used in soap and detergent industries.
- Carboxylic acids find use in medicines. Ethanoic acid is used in aspirin.
- Carboxylic acids are used as industrial solvents.
- Carboxylic acids are used in preparing perfumes and artificial essences used in food manufacturing.
- Carboxylic acids (e.g. butanoic acid) are produced in your sweat glands. Dogs can track humans by detecting the characteristic blend of these acids in your sweat.



Naming Carboxylic acids



1. Decide on the type of compound (ie. consider functional group)

Carboxylic acid
(alkanoic acid)

2. Select the longest chain

5 C's ∴ pentanoic acid

3. Name the compound with the side branches in ascending order.

3-methylpentanoic acid



ESTERS

Esterification, Alkanoic acids reacting with Alkanols.



Esters have sweet smells and are more volatile than carboxylic acids.

They are responsible for sweet fruit smells.

280 aromas make up a strawberry smell!!

- 3-methylbutyl ethanoate in bananas.

- 2-aminobenzoate is found in grapes.

We imitate these smells by manufacturing **flavourings**.

- Esters are also used in **perfumes**.

- Esters can also be used as solvents in **glues**.

- Polyesters are used to make **plasticisers**.

- Methyl ester is a **biodiesel**.



Naming Esters

R-yl



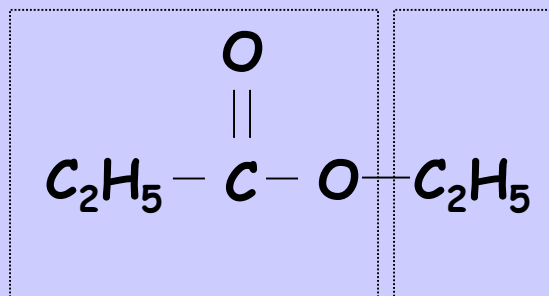
R'-oate

First, the 1st word comes from the alcohol. The name ends in **-yl**.

Second, find the C=O in the carboxylate group, this gives the 2nd word with the ending **-oate**. This comes from the acid.

Second

First

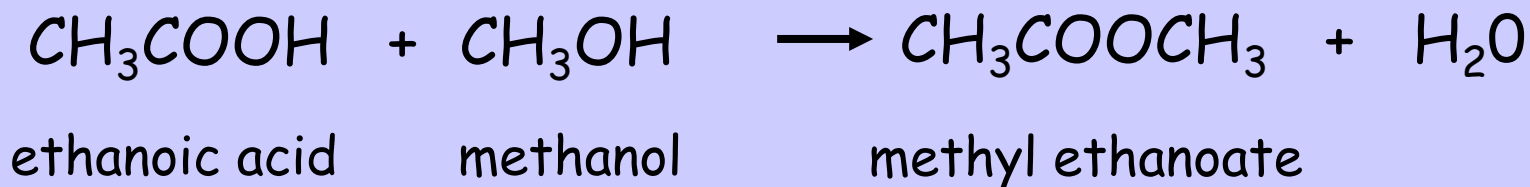
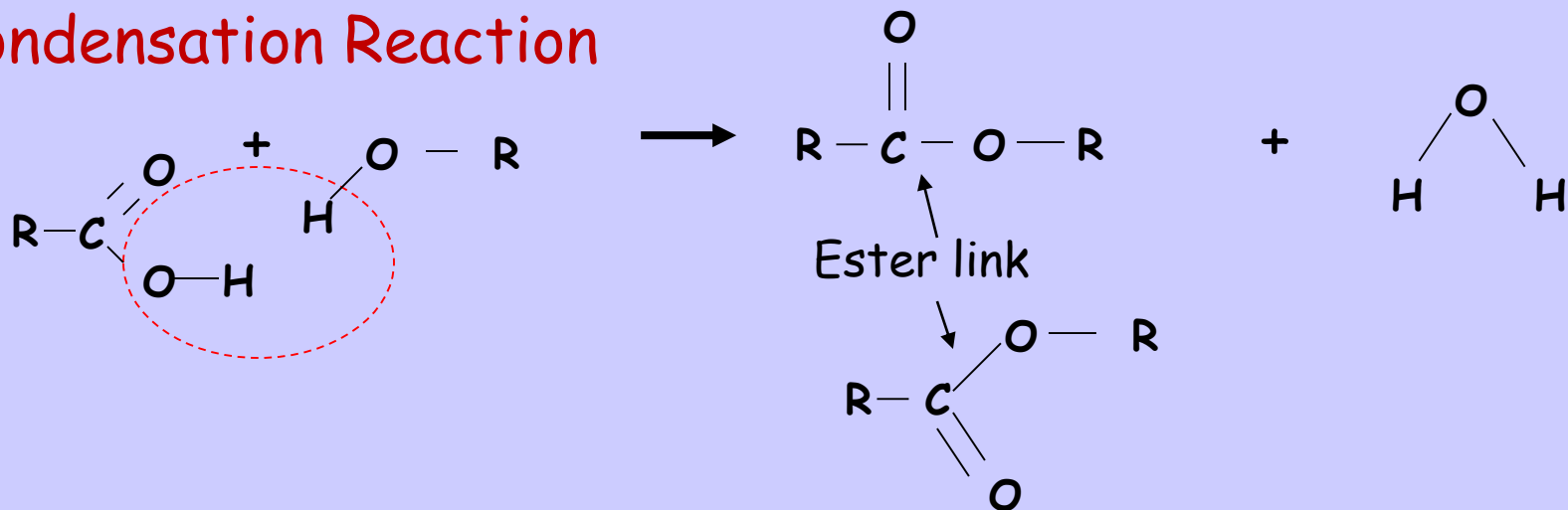


ethyl propanoate



Ester formation

Condensation Reaction



The reaction is brought about by heating a mixture of a carboxylic acid and an alcohol with a little **concentrated sulphuric acid**. (which acts as a Catalyst and absorbs the water produced).



Hydrolysing Esters

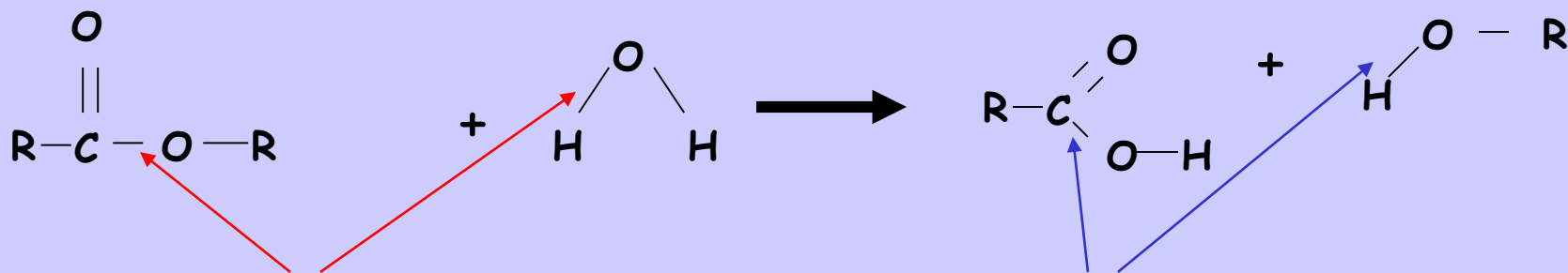
Condensation



Hydrolysis



The ester is split up by the chemical action of water, **hydrolysis**.
The hydrolysis and formation of an ester is a reversible reaction.



Bonds broken

Bonds formed

Ester + Water

Carboxylic Acid + Alcohol



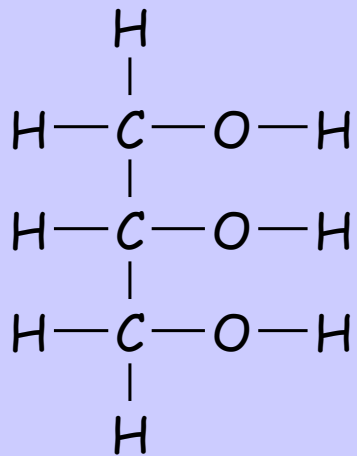
Fats and Oils

50% of your brain is fat.

All living things need **fats** (solids) and **oils** (liquids). They tend to be insoluble in water. They are **classified** according to their origin, animal, vegetable or marine,

Fats and oils are a range of substances all based on **glycerol**, propane-1,2,3-triol.

Natural fats and oils are a mixture of triglyceride compounds.



Each OH group can combine chemically with one carboxylic acid Molecule. The resulting molecules are fats and oils.

They are described as **triglycerides**.

The hydrocarbon chain in each can be from 4 to 24 C's long. The C's can be single bonded (**saturated**) or double bonded (**unsaturated**).

The latter (oils) causes the hydrocarbon chains to kink and so making it harder for the molecules to pack as close together, making their m.p.'s lower. (weakens the inter-molecular forces, Van der Waals' forces)

Glycerol

propane-1,2,3-triol
a trihydric acid



Fats and Oils

The degree of saturation in a fat or oil can be determined by the Iodine Number. (bromine can also be used).

The iodine reacts with the $C=C$ bonds, so the greater the iodine number, the greater the number of double bonds.

Fat	Av Iodine No
Butter	40
Beef Fat	45
Lard	50
Olive Oil	80
Peanut Oil	100
Soya Bean Oil	180

Solid fats - butter, beef fat & lard have low iodine numbers because they are more saturated than the unsaturated oils.

Margarine is made from vegetable oils, butter from animal fats. One reason why margarine spreads better!

Omega 3 fatty acids make up a large % of your brain's fat.



Fats in the Diet

Fats provide **more energy per gram** than carbohydrates.

Fat molecules are insoluble, and tend to group together and form a large droplet. This is how fat is stored in the adipose tissue. We store our extra energy as fat.

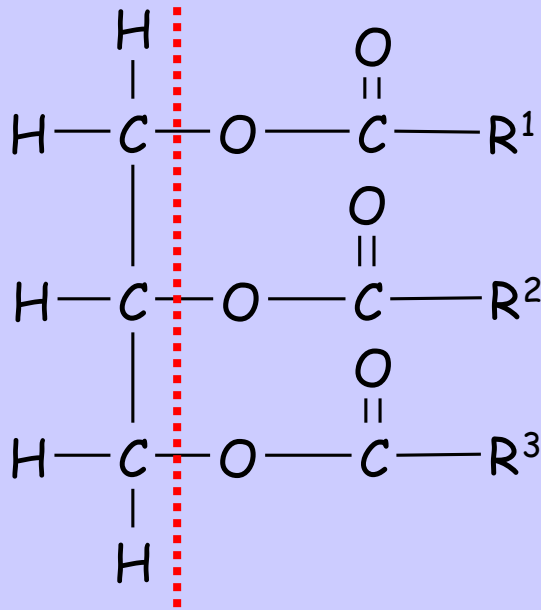
The type of fat we eat is important. Animal fats contain important fat soluble vitamins. Oils, are thought to be healthier than solid fats, as they are less likely to be deposited inside our arteries.

However, there is an ongoing debate about which fats are better for us. Polyunsaturated fats are considered to be less potentially harmful to the heart.



Structures of Fats and Oils

Hydrolysis of a fat or oil produces a molecule of glycerol (alcohol) for every 3 carboxylic acid molecules. The carboxylic acids are usually called **long chain fatty acids**. Most fats and oils are, in fact, esters of propane-1,2,3-triol, sometimes called, **triesters**.



$\text{R}^1, \text{R}^2, \text{R}^3$ are long carbon chains, which can be the same or different



Glycerol + Fatty Acids

Glycerol
part

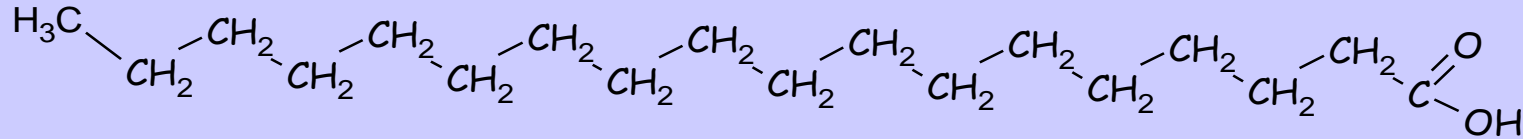
Fatty acid part

Triesters.

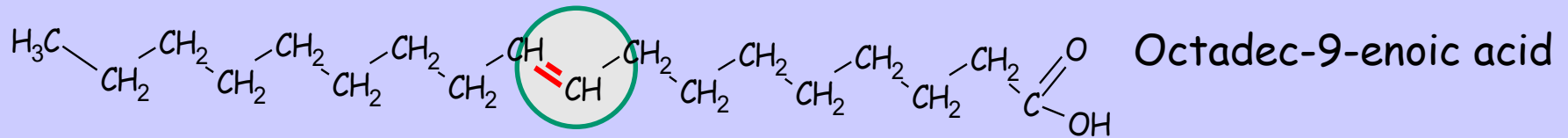


Fatty Acids

$C_{17}H_{35}COOH$ $CH_3(CH_2)_{16}COOH$ Stearic Acid (suet, animal fat) **Saturated**



$C_{17}H_{33}COOH$ $CH_3(CH_2)_7CH=CH(CH_2)_7COOH$ Oleic Acid (olive oil) **Unsaturated**



Humans fatty acids

Oleic acid	47%
Palmitic acid	24%
Linoleic acid	10%
Stearic acid	8%

Hydrogenation

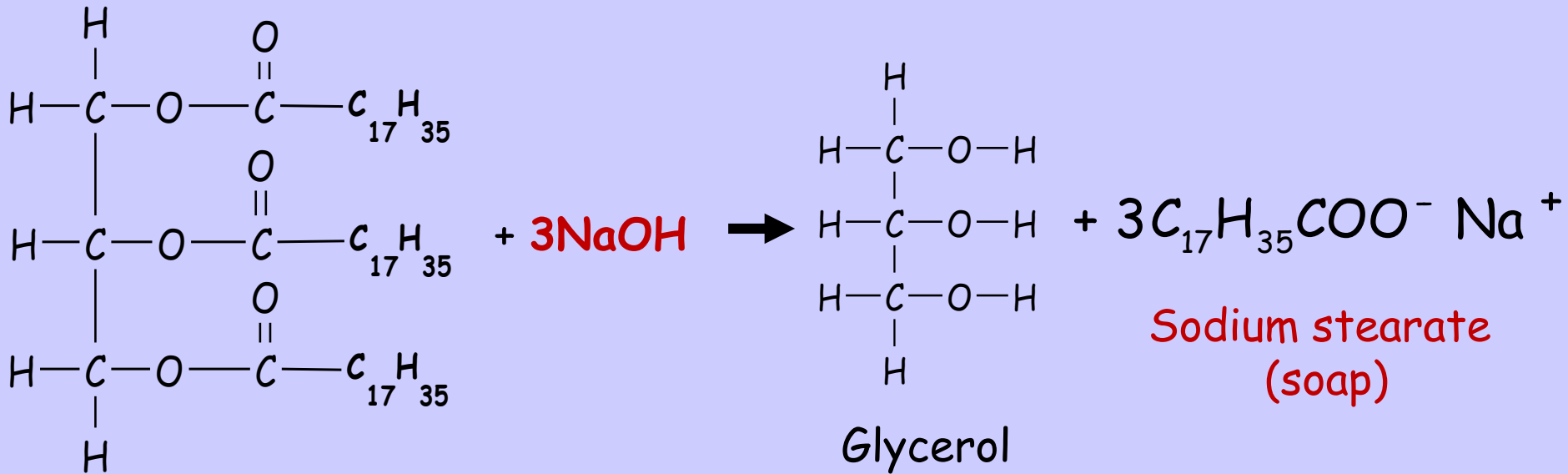
The addition of hydrogen to an unsaturated oil will 'harden' the oil. Increase it's m.p.
 The hydrogen is added across the double bond.
 Used with margarine, otherwise margarine would be a liquid when taken out of the fridge.



Soaps

Soaps are salts of fatty acids.

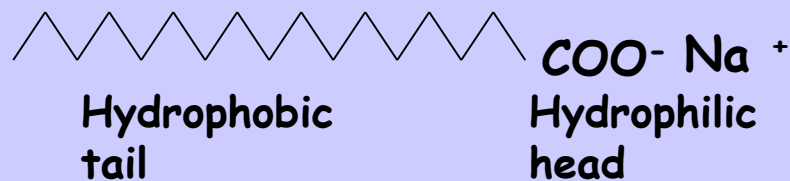
Alkaline hydrolysis is used to make sodium salts of fatty acids.



Glyceryl tristearate

Glycerol

Sodium stearate
(soap)



Percentage yields



4.3 g of propyl ethanoate was produced when 6 g of ethanoic acid was reacted with propan-1-ol.

What is the percentage yield of the ester?

6g of ethanoic acid is $6/60$ mol (gfm $\text{CH}_3\text{COOH} = 60$)

So, in theory, $6/60$ mol of the ester is also formed.

gfm $\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_3 = 102$

So, in theory, $6/60 \times 102$ mol formed = 10.2 g

Percentage yield = actual yield/theoretical yield $\times 100\%$

Answer: $(4.3/10.2) \times 100 = 42.5\%$

