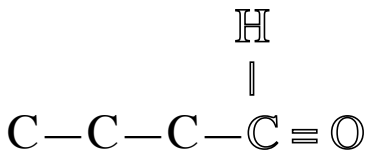
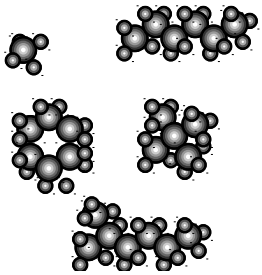
Higher Chemistry





Unit 2:

Nature's Chemistry

Student:

Pupil Notes Part 1

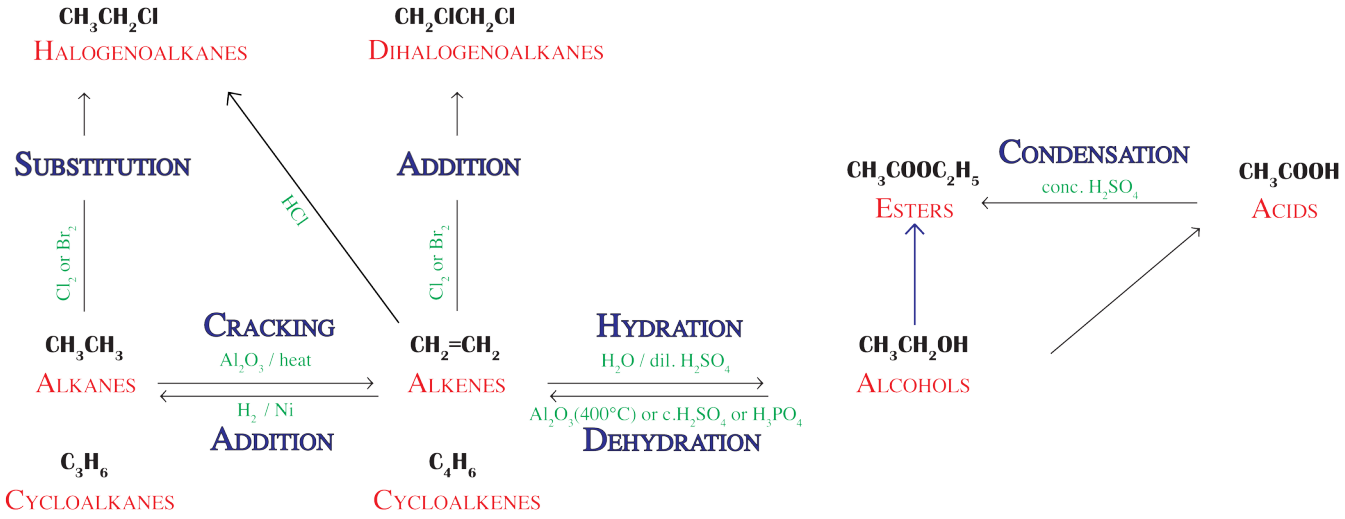
Systematic Organic in Context

5.1 Systematic Organic in Context

This first lesson topic takes an overview of the Organic reactions met in this and previous courses and some of the contexts in which these reactions are met.

Previous Chemistry

This activity examines the systematic approach to the reactions met in previous courses.



Learn:

- ***Names - RULES for naming !***
- ***Structures*** of both reactant molecule and product molecule
- ***Title*** of the reaction
- ***Reagents*** used to carry out the reaction

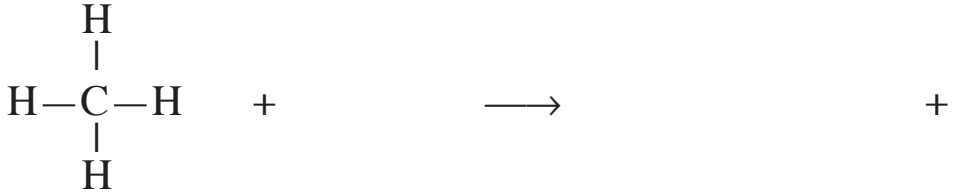
Substitution - an *atom* or *group* will be ***rem*** from a normally ***sat*** molecule to allow a ***diff*** *atom* or *group* to take its place.

Normally, the product formed is also ***sat*** and ***reac*** molecules react to form ***pro*** molecules

Equation using systematic names:

methane + ⟶ *chloromethane* +

Equation using full structural formulae:



Equation using shortened structural formulae:

$CH_{4(g)}$ + ⟶ +

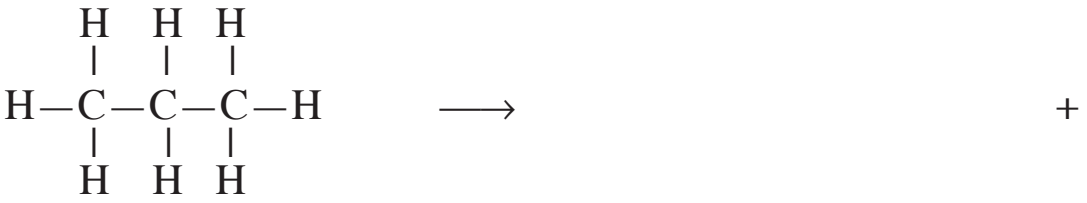
Cracking - a *larger* ***sat*** molecule is *broken apart* to produce *smaller* molecules, at least one of which will be ***uns*** .

Normally, a ***cat*** will be used. Sometimes only a couple of *neighbouring* ***hyd*** atoms will be '*cracked*' off to produce a single ***uns*** product. This reaction can also be called ***elimination***.

Equation using systematic names:

propane ⟶ *propene* +

Equation using full structural formulae:



Equation using shortened structural formulae:

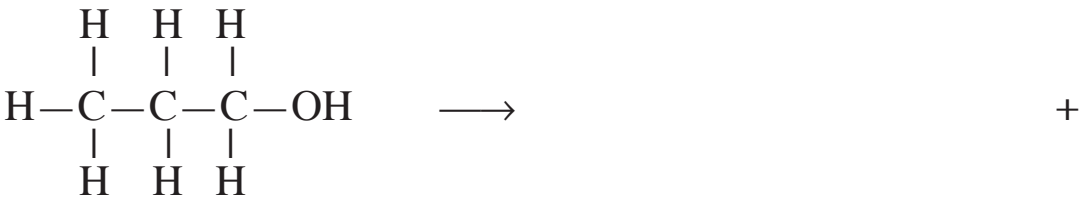
$CH_3CH_2CH_{3(g)}$ ⟶ +

Dehydration - a specific ***elim*** reaction in which *neighbouring* ***hyd*** atom and ***hydroxyl*** group (—OH) will be '*cracked*' off to produce an ***uns*** product. The eliminated atoms form a stable ***wa*** molecule.

Equation using systematic names:

propan-1-ol ⟶ *propene* +

Equation using full structural formulae:



Equation using shortened structural formulae:

$CH_3CH_2CH_2OH_{(l)}$ ⟶ +

Elim is the reverse reaction to ***add*** .

Addition - a small molecule reacts with an ***uns*** molecule and adds *across* the ***dou*** bond to make a ***sat*** product.

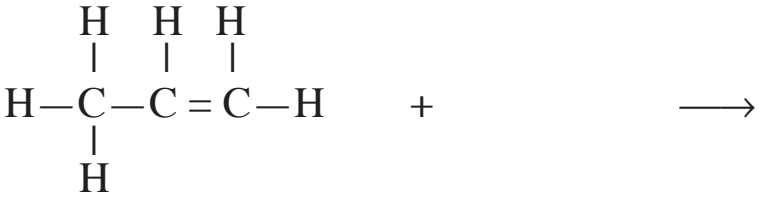
Many different molecules can be added and many of these reactions have their own names.

Hydrogenation - add of ***hyd***

Equation using systematic names:

propene + *hydrogen* $\xrightarrow{\text{Ni } catalyst}$

Equation using full structural formulae:



Equation using shortened structural formulae:

$$CH_3CHCH_{2(g)} + \longrightarrow$$

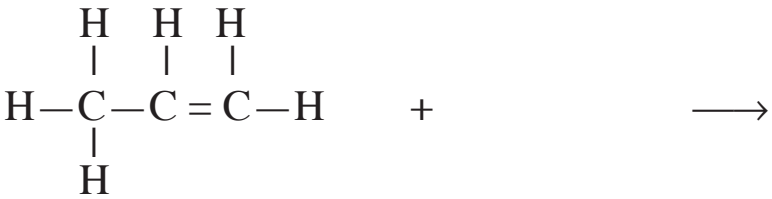
Hydr is mainly used to convert *highly* ***unsat*** ***oils*** into *more* ***sat*** ***fats***. E.g. *vegetable oil* can be thickened and solidified to make *margarine* by ***hydro*** .

Halogenogenation - add of ***hal***

Equation using systematic names:

propene + $\longrightarrow$ ***1,2-dibromopropane***

Equation using full structural formulae:



Equation using shortened structural formulae:

$$CH_3CHCH_{2(g)} + \longrightarrow$$

The ***add*** reaction with a ***hal*** , usually ***bro*** , remains the accepted test for ***unsat*** - the presence of a C = C ***dou*** or C ≡ C ***tri*** bond.

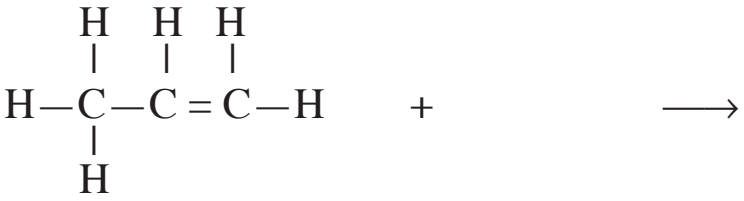
The ***hal*** is decol ***bro*** , ***or*** $\longrightarrow$ *colourless*
chlo , ***gr*** $\longrightarrow$ *colourless*
io , ***br*** $\longrightarrow$ *colourless*

Hydrohalogenation - add of ***hyd*** ***hal***

Equation using systematic names:

propene + *hydrogen iodide* ⟶ ***1-iodo***

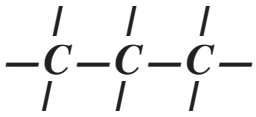
Equation using full structural formulae:



Equation using shortened structural formulae:

$$CH_3CHCH_{2(g)} + \longrightarrow$$

Hydr is an alternative when only ***one halo*** atom is wanted on the product molecule. Depending on the position of the ***dou*** ***bond***, however, more than one ***iso*** is possible. In the above example, *2-iodopropane* is another possible product.

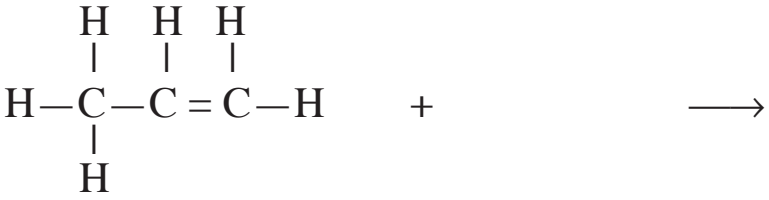


Hydration - add of ***wa***

Equation using systematic names:

propene + ⟶ ***propan-1-ol***

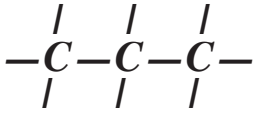
Equation using full structural formulae:



Equation using shortened structural formulae:

$$CH_3CHCH_{2(g)} + \longrightarrow$$

Hydr of an ***alk*** is an important method for making *alcohols* but, like the previous example, more than one product can be formed.



In this case, the second ***iso*** would be *propan-2-ol*.

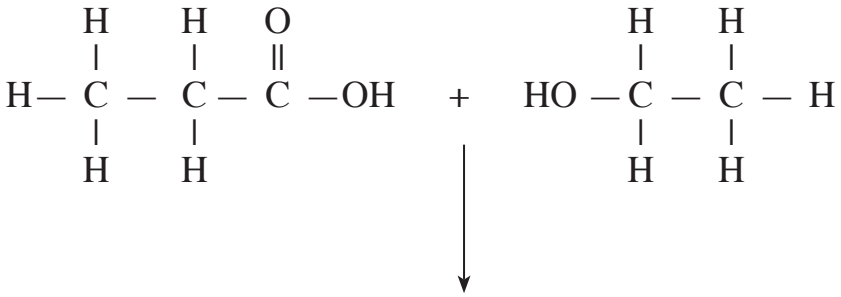
Propan-1-ol is a ***primary alcohol*** while *propan-2-ol* is a ***secondary alcoho***l. The significance of these labels will become clearer in later lessons.

Condensation - two smaller molecule react to ***join together*** and form a larger molecule, ***eliminating*** a *small stable molecule*, usually ***water*** through one molecule losing ***an —H atom*** whilst the other molecule loses ***an —OH*** (*hydroxyl*) group.

Equation using systematic names:

propanoic acid + *ethanol* ⟶

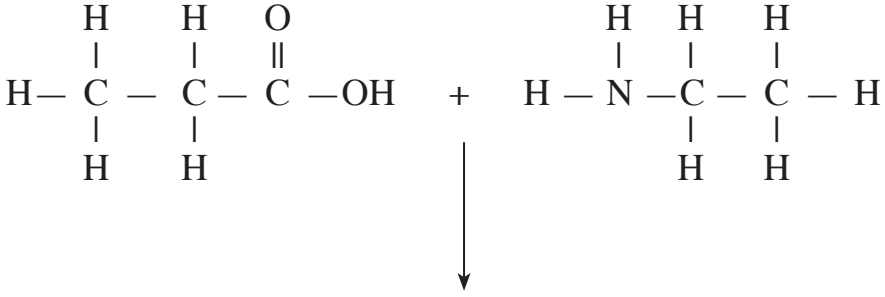
Equation using full structural formulae:

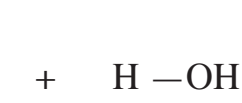


Equation using shortened structural formulae:

$CH_3CH_2COOH_{(l)}$ + ⟶

The other main ***cond*** reaction that you will meet will involve an *acid* reacting with an *amine* to form an *amide*. This is very similar to the *ester* forming reaction above.

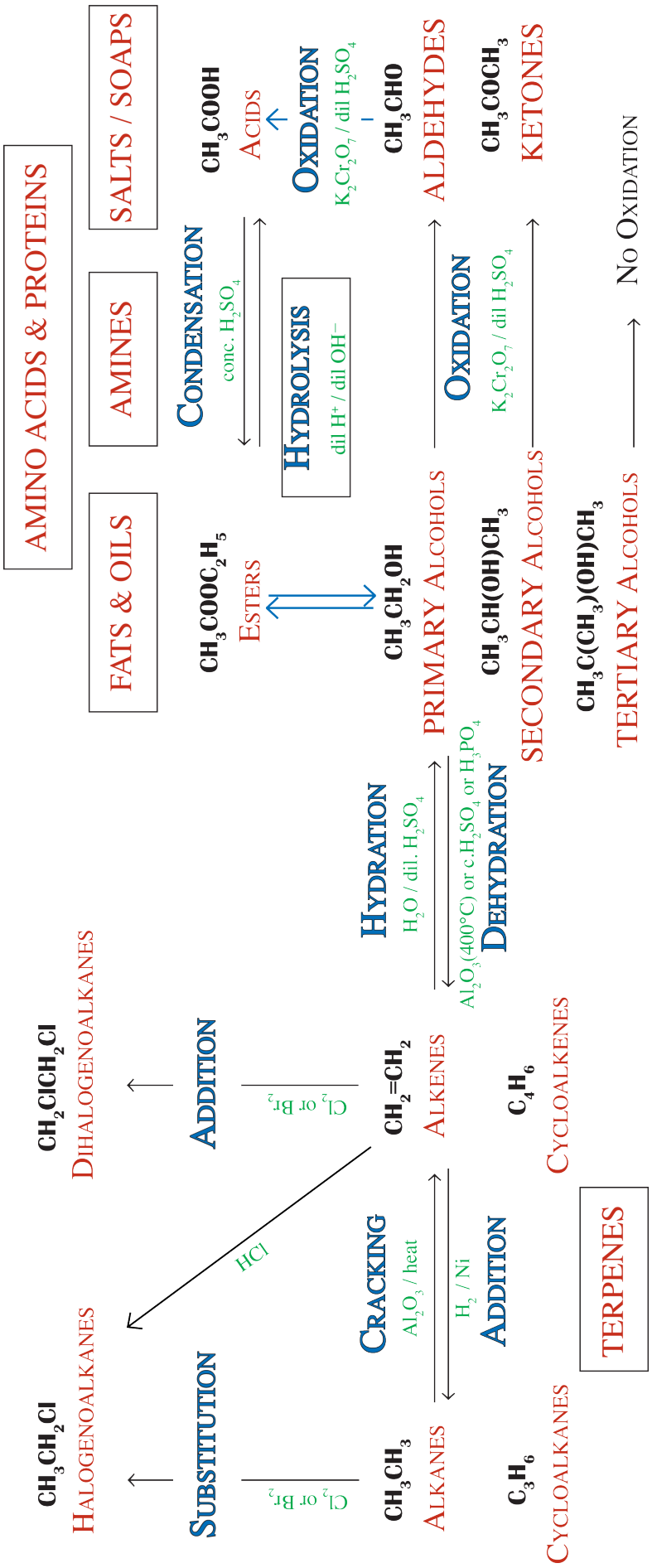




This is the reaction used to ***join*** many *amino acids* together to form *proteins*.

New Chemistry

This activity looks at some of the new reactions / families that you will meet in this Unit.



Much of the new Chemistry revolves round learning ***Oxi*** in more detail.

As can be seen, there are 3 types of ***Alc*** to be learnt and they have different products - ***Ald*** or ***Ket***, or none - when oxidised.

Ald are the intermediates formed when a ***Prim*** ***Alc*** is oxidised to eventually form an ***Ac***.

Cond becomes even more important - along with the reverse reaction, ***Hyd***.

Not just ***Est*** are formed by a ***Cond*** reaction - ***Prot*** and ***Fa*** ***& Oi*** are also formed by ***Cond*** and broken down by the ***Hyd*** reaction.

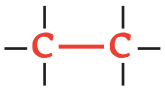
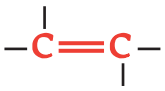
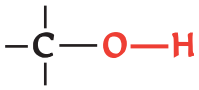
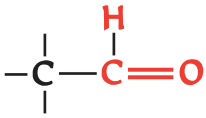
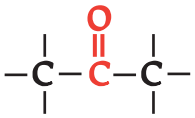
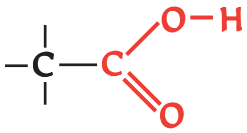
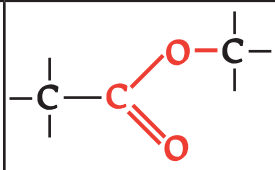
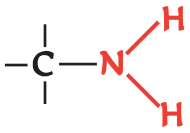
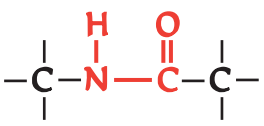
So are the ***Sa*** of *Fatty Acids* formed when ***Alk*** ***Hyd*** is done to a ***Fat*** or ***Oil***.

Ter are natural *hydrocarbons*, found mainly in plants, formed by joining together smaller molecules called ***isoprene***,
2-methylbuta-1,3-diene.

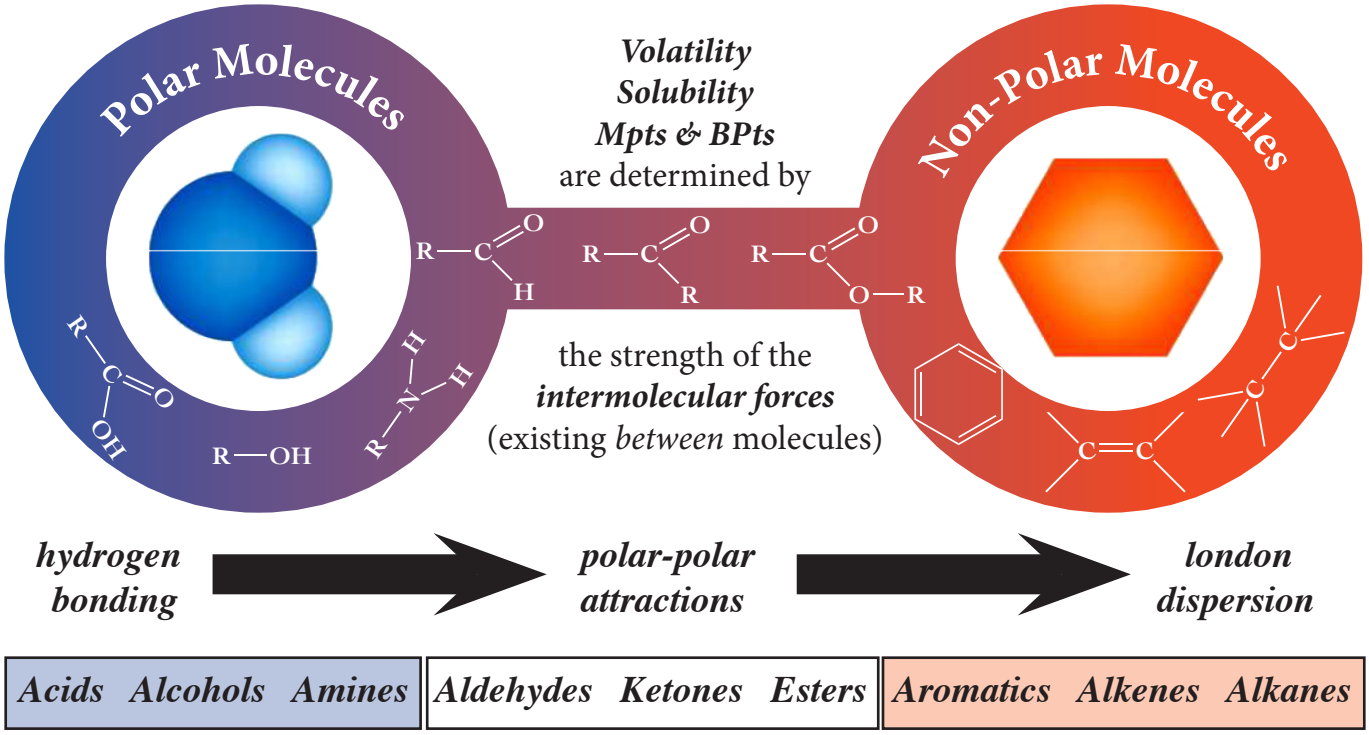
Terp belong to a group of chemicals usually referred to as *essential oils* which should not be mixed up with *edible oils* (***Fats & Oils***) and *mineral oils* derived from *Crude Oil* and made by the *Petrochemical* industry.

Functional Groups & Properties

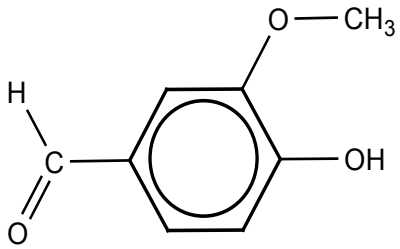
This activity explains the functional groups found in these molecules and their possible effect on the chemical and physical properties of the molecule.

Family Name	Functional Group	Name of Group	Chemical Reactions	Intermolecular Forces	Solubility in Water
		carbon to carbon single		london dispersion forces	
		carbon to carbon double			
			oxidation condensation		very soluble
aldehyde					limited solubility
			none	polar-polar	
					
		carboxylate group			insoluble
amine					
		amide link		hydrogen bonding	only small amides soluble

As well as determining their ***Chem*** ***Reactions***, ***Func*** ***Groups*** can also effect the ***Phy*** ***Properties***. Properties such as



For example, the *vanilla bean* produces a compound called *vanillin*, which is used as a flavouring additive in sweet foods such as ice cream.



Vanillin

This molecule has effectively, 4 ***func*** ***groups***:-

The ***ben*** ***ring*** and the *ether* group (—O—CH_3) are dealt with in *Advanced Higher*.

The ***hydr*** group (—OH) and the ***carb*** group (—CH=O) will be expected to be learnt well this year.

Within the same molecule there can be ***non-po*** ***groups*** such as the ***aro*** ***ben*** ring, whilst the *ether* and ***ald*** (***carb*** are ***sli*** ***polar***.

Probably the most influential group will be the ***very po*** ***hydr*** group which is capable of ***hydr*** ***bonding*** and may make this molecule ***water sol*** .

Context - Kitchen Chemistry

This activity demonstrates how much of the Organic Chemistry met in this Unit will be taught within the context of Kitchen Chemistry

Flavour Most of our 'tasting' is done through our noses, so most flavour molecules are*volatile* (*weak intermolecular forces*) such as

esters - many have sweet fruity smells - e.g. '*pear drops*' - *pentyl ethanoate*
aldehydes - can however be ***oxidised*** over time resulting in (sometimes unpleasant) changes in flavour
terpenes - '*essential oils*' are responsible for many distinctive flavours such as *cinnamon* and *ginger* as well as *oranges* and *lemons*.
acids - such as *vinegar*, *ethanoic acid* are used to introduce 'sour' flavours

Cooking Cooking can *dissolve* out the flavour molecules so whilst many foods can be safely *cooked in water,* others are better *cooked in oil*.

Cooking also effects the structure of, in particular, ***proteins*** which can result in significant change in the *texture* of certain foods during cooking.

Texture ***Protein*** *structure* has an important impact on the *texture* of food and can be effected by *changes in temperature* (*cooking*) and *changes in pH* (*marinading* in ***acids*** such as *vinegar*, *ethanoic acid*).

Foods, such as curries, often '*separate*' into '*water layer*' and '*oil layer*' as a result of *differences in solubility* (*different intermolecular forces*).

Colour Colour can arise in many ways but larger ***terpenes*** are often responsible for the *yellow*, *orange* or *red* colour of so many foods - e.g. *carotene* in carrots.

Energy Whilst ***carbohydrates,*** our main '*energy food*', are not covered in this course, ***proteins*** also contribute energy whilst *fats & oils* are our most concentrated source of energy.

Additives ***antioxidants*** - can be added to food, though many foods already contain *Vitamin C* - a natural *antioxidant*

emulsifying agents - are used to prevent '*water layers*' and '*oily layers*' from separating. These molecules are often made from ***fats & oils*** and behave in exactly the same way as *soap molecules*. *Milk* contains natural ***emulsifiers***.

In addition, many reactions triggered by *UV light*, such as the ***substitution*** reaction between *alkanes* and *bromine*, involve the production of ***free radicals***. ***Free radicals*** start ***chain reactions*** which are responsible for the ageing of your skin. *Sun cream* contains chemicals designed to absorb UV before it reaches your skin.

Vitamin E and *melatonin* are natural ***free radical scavengers*** that can help counter the effect of free radicals. Many ***cosmetic*** products contain *free radical scavengers* which react with ***free radicals*** to form stable molecules and prevent ***chain-reactions*** starting.