

# Unit 2

# Nature's Chemistry

# Key Areas

<b>Key Area 1 : Esters, Fats &amp; Oils</b>	
<i>Esters – naming, structural formulae and uses</i>	An ester can be identified from the ester group and by the name containing the –‘yl-oate’ endings.
	An ester can be named given the names of the parent carboxylic acid and alcohol or from structural formulae.
	Structural formulae for esters can be drawn given the names of the parent alcohol and carboxylic acid or the names of esters.
	Esters have characteristic smells and are used as flavourings and fragrances. Esters are also used as industrial solvents.
<i>Condensation and hydrolysis reactions</i>	Esters are formed by the condensation reaction between carboxylic acid and an alcohol.
	The ester link is formed by the reaction of a hydroxyl group and the carboxyl group.
	In condensation reactions, the molecules join together with the elimination of a small molecule, in this case water.
	Esters can be hydrolysed to produce a carboxylic acid and alcohol.
	Given the name of an ester or its structural formula, the hydrolysis products can be named and their structural formulae drawn.
	The parent carboxylic acid and the parent alcohol can be obtained by hydrolysis of an ester.
<i>Saturated and unsaturated fats and oils</i>  <i>Melting points of oils and fats, through intermolecular bonding</i>	Fats and oils are a concentrated source of energy.
	They are essential for the transport and storage of fat-soluble vitamins in the body.
	Fats and oils are esters formed from the condensation of glycerol (propane-1,2,3-triol) and three carboxylic acid molecules.
	The carboxylic acids are known as ‘fatty acids’ and are saturated or unsaturated straight-chain carboxylic acids, usually with long chains of carbon atoms.
	The lower melting points of oils compared to those of fats is related to the higher degree of unsaturation of oil molecules.
	The low melting points of oils are a result of the effect that the shapes of the molecules have on close packing, hence on the strength of van der Waals’ forces of attraction.

<b>Key Area 2 : Proteins</b>	
<i>Enzymes as biological catalysts</i>	Proteins are the major structural materials of animal tissue.
	Proteins are also involved in the maintenance and regulation of life processes.
	Enzymes are proteins.
<i>Amino acids, dietary proteins, condensation reactions to make proteins and amide link, peptide link.</i>	Amino acids, the building blocks from which proteins are formed, are relatively small molecules which all contain an amino group ( $\text{NH}_2$ ), and a carboxyl group ( $\text{COOH}$ ).
	The body cannot make all the amino acids required for body proteins and is dependent on dietary protein for supply of certain amino acids known as essential amino acids.
	Proteins are made of many amino acid molecules linked together by condensation reactions.
	In these condensation reactions, the amino group on one amino acid and the carboxyl group on a neighbouring amino acid join together, with the elimination of water.
	The link which forms between the two amino acids can be recognised as an amide link ( $\text{CONH}$ ) also known as the peptide link.
	Proteins which fulfil different roles in the body are formed by linking differing sequences of amino acids together.
<i>Digestion, enzyme hydrolysis of dietary proteins.</i>	During digestion, enzyme hydrolysis of dietary proteins can produce amino acids.
	The structural formulae of amino acids obtained from the hydrolysis of proteins can be identified from the structure of a section of the protein.
<b>Key Area 3 : Chemistry of Cooking</b>	
<i>Flavours in foods. Influence of functional groups on solubility, boiling points and volatility.</i>	Many flavour and aroma molecules are aldehydes.
	Flavour molecules with more polar functional groups are likely to have higher boiling points, be less volatile and may be soluble in water so flavour may be lost into cooking water so may be better to cook in oil.
	Flavour molecules with less polar functional groups are likely to have lower boiling points, be more volatile and are likely to be insoluble so flavour unlikely to be lost if cooked in water.
<i>For straight and branch chained aldehydes and ketones systematic names, structural formulae and isomers.</i>	Aldehydes and ketones can be identified from the '-al' and '-one' name endings respectively.
	Straight-chain and branched-chain aldehydes and ketones, with no more than eight carbon atoms in their longest chain, can be named from structural formulae.
	Given the names of straight-chain or branched-chain aldehydes and ketones, structural formulae can be drawn and molecular formulae written.

**Key Area 3 : Chemistry of Cooking (continued)**

<i>Oxidation reactions of aldehydes and ketones.</i>	Aldehydes, but not ketones, can be oxidised to carboxylic acids.
	Fehling's solution, Tollens' reagent and acidified dichromate solution can be used to differentiate between an aldehyde and a ketone.
<i>Effect of heat on proteins, denaturing of proteins.</i>	Within proteins, the long-chain molecules may be twisted to form spirals, folded into sheets, or wound around to form other complex shapes.
	The chains are held in these forms by intermolecular bonding between the side chains of the constituent amino acids.
	When proteins are heated, during cooking, these intermolecular bonds are broken allowing the proteins to change shape (denature).
	These changes alter the texture of foods.

**Key Area 4 : Oxidation of Food**

<i>For branch chained alcohols systematic names, structural formulae and isomers.</i>	For compounds with no more than eight carbon atoms in their longest chain. Branched-chain alcohols, can be named from structural formulae.
	Given the names of branched-chain alcohols, structural formulae can be drawn and molecular formulae written.
	Properties of alcohols are determined by the presence of hydrogen bonding and diols and triols exhibit even more hydrogen bonding.
<i>Primary, secondary and tertiary alcohols oxidation reactions and products, oxidising agents.</i>	Primary alcohols are oxidised, first to aldehydes and then to carboxylic acids.
	Secondary alcohols are oxidised to ketones.
	When applied to carbon compounds, oxidation results in an increase in the oxygen to hydrogen ratio.
	In the laboratory, hot copper(II) oxide or acidified dichromate(VI) solutions can be used to oxidise primary and secondary alcohols.
	Tertiary alcohols cannot be oxidised
<i>For branch chained carboxylic acids systematic names, structural formulae and isomers.</i>	Branched-chain carboxylic acids, with no more than eight carbon atoms in their longest chain, can be named from structural formulae.
	Given the names of branched-chain carboxylic acids, structural formulae can be drawn and molecular formulae written
<i>Reactions of carboxylic acids to include reduction and reactions with bases to form salts.</i>	Carboxylic acids react with reactive metals to produce hydrogen gas and carbonates to produce carbon dioxide gas
	Carboxylic acids react with bases to form salts
	Carboxylic acids undergo condensation reactions to form esters and amides and can be reduced to form aldehydes and then primary alcohols.

### Key Area 4 : Oxidation of Food (continued)

<p><i>Reaction of oxygen with edible oils.</i></p> <p><i>Antioxidants.</i></p> <p><i>Ion-electron equations for the oxidation of antioxidants.</i></p>	Oxygen reacts with edible oils giving the food a rancid flavour.
	Antioxidants are molecules which will prevent these oxidation reactions taking place.
	Ion-electron equations can be written for the oxidation of many antioxidants.

### Key Area 5 : Soaps, Detergents and Emulsions

<p><i>Hydrolysis of esters.</i></p> <p><i>Structure of soap ions including covalent tail, (hydrophobic), and an ionic head (hydrophilic)</i></p> <p><i>Cleansing action of soaps.</i></p>	Production of soaps by the alkaline hydrolysis of fats and oils to form water-soluble ionic salts called soaps.
	Soap ions have a long covalent tail, readily soluble in covalent compounds (hydrophobic), and an ionic carboxylate head which is negatively charged and water soluble (hydrophilic).
	During cleaning using soaps and detergents, the hydrophobic tails dissolve in a droplet of oil or grease, whilst the hydrophilic heads face out into the surrounding water.
	Agitation of the mixture results in ball-like structure forming with the hydrophobic tails on the inside and the negative hydrophilic head on the outside.
	Repulsion between these negative charges results in an emulsion being formed and the dirt released.
<p><i>Production, action and use of detergents.</i></p> <p><i>Emulsion and emulsifiers and their formation and use in food</i></p>	Detergents are particularly useful in hard water areas.
	An emulsion contains small droplets of one liquid dispersed in another liquid. Emulsions in food are mixtures of oil and water.
	To prevent oil and water components separating into layers, a soap-like molecule known as an emulsifier is added.
	Emulsifiers for use in food are commonly made by reacting edible oils with glycerol to form molecules in which either one or two fatty acid groups are linked to a glycerol backbone rather than the three normally found in edible oils.
	The one or two hydroxyl groups present in these molecules are hydrophilic whilst the fatty acid chains are hydrophobic.

### Key Area 6 : Fragrances

<p><i>Essential oils from plants: properties, uses and products.</i></p>	Essential oils are concentrated extracts of the volatile, non-water soluble aroma compounds from plants.
	They are widely used in perfumes, cosmetic products, cleaning products and as flavourings in foods.
	Essential oils are mixtures of organic compounds.

**Key Area 6 : Fragrances (continued)**

<i>Terpenes: functional group, structure and use.</i>	Terpenes are key components in most essential oils.
	Terpenes are unsaturated compounds formed by joining together isoprene (2-methylbuta-1,3-diene) units.
	They are components in a wide variety of fruit and floral flavours and aromas.
	Terpenes can be oxidised within plants to produce some of the compounds responsible for the distinctive aroma of spices.
<i>Oxidation of terpenes within plants.</i>	

**Key Area 7 : Skin Care**

<i>The damaging effect of ultraviolet radiation (UV) in sunlight on skin and the action of sun-block.</i>	Ultraviolet radiation (UV) is a high-energy form of light, present in sunlight.
	Exposure to UV light can result in molecules gaining sufficient energy for bonds to be broken.
	This is the process responsible for sunburn and also contributes to aging of the skin.
	Sun-block products prevent UV light reaching the skin.
<i>Formation of free radicals in UV light.</i>	When UV light breaks bonds, free radicals are formed.
<i>Structure, reactivity and reactions of free radicals.</i>	Free radicals have unpaired electrons and, as a result, are highly reactive.
	Free radical chain reactions include the following steps: initiation, propagation and termination.
<i>Free radical scavengers in cosmetic products, food products and plastics.</i>	Many cosmetic products contain free radical scavengers
	Free radical scavengers are molecules which can react with free radicals to form stable molecules and prevent chain reactions.
	Free radical scavengers are also added to food products and to plastics.
<i>Reaction of free radical scavengers with free radicals to prevent chain reactions.</i>	