

Subsection (a) Oxidation of alcohols

1. I can name and draw straight and branched-chain alcohols up to 8 carbon atoms in the longest chain.
2. I can describe the effect of hydrogen bonding on the properties of diols and triols.
3. I can classify alcohols as primary, secondary or tertiary.
In a primary (1°) alcohol, the carbon which carries the -OH group is only attached to one alkyl group (chain of carbon atoms). Methanol, CH₃OH, is counted as a primary alcohol even though there are *no* alkyl groups attached to the carbon with the -OH group on it.

In a secondary (2°) alcohol, the carbon with the -OH group attached is joined directly to *two* alkyl groups, which may be the same or different.

In a tertiary (3°) alcohol, the carbon atom holding the -OH group is attached directly to *three* alkyl groups, which may be any combination of same or different.
4. I can state what is produced on oxidation of a primary alcohol.
Primary alcohols can be oxidised to either aldehydes or carboxylic acids depending on the reaction conditions. In the case of the formation of carboxylic acids, the alcohol is first oxidised to an aldehyde which is then oxidised further to the acid.
5. I can state what is produced on oxidation of a secondary alcohol
Secondary alcohols are oxidised to ketones.
6. I can state what is produced on oxidation of a secondary alcohol
Secondary alcohols are oxidised to ketones.
7. I can state what happens on attempting to oxidise a tertiary alcohol.
Tertiary alcohols aren't oxidised. There is no reaction.
8. I can define oxidation in terms of a change in the oxygen to hydrogen ratio.
Oxidation results in an increase in the oxidation:hydrogen ratio.
9. I can correctly describe the colour changes associated with using mild oxidising agents like CuO and acidified dichromate solutions in the lab to oxidise primary and secondary alcohols and write ion equations to represent these changes.
Primary and secondary alcohols can be oxidised by a number of oxidising agents such as copper(II) oxide and acidified potassium dichromate solution.

At the same time, the black copper(II) oxide is reduced to red-brown copper metal.



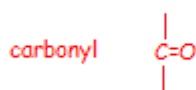
If a primary or secondary alcohol is warmed with acidified potassium dichromate

solution, the orange colour of the dichromate ions in this solution changes to a green colour caused by Cr^{3+} ions in a reduction reaction, while the alcohol is oxidised to an aldehyde or ketone.



Subsection (b) Aldehydes and ketones

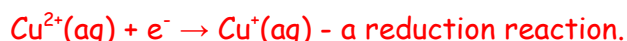
10. I can identify an aldehyde from the name ending '-al'
11. I can identify a ketone from the name ending '-one'
12. I can identify and name the functional group present in both aldehydes and ketones



13. I can name straight and branched-chain aldehydes and ketones.
14. I can draw structural formula and write molecular formulae when given the name of a straight-chain or branched-chain aldehydes and ketones.
15. I can use Fehling's (or benedict's) solution, acidified dichromate solution and Tollens' reagent to differentiate between an aldehyde and a ketone.

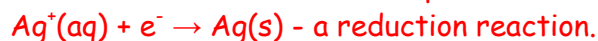
Oxidising agents such as Fehling's (or Benedict's) solution, acidified potassium dichromate or Tollen's reagents will convert aldehydes to carboxylic acids. Ketones do not undergo oxidation and this fact can be used to distinguish aldehydes from ketones.

If Fehling's (or Benedict's) solution is used as the oxidising agent, the blue colour of Cu^{2+} changes to the brown coloured Cu^+ ion.



If acidified potassium dichromate solution is used as the oxidising agent, the orange colour of $\text{Cr}_2\text{O}_7^{2-}$ changes to the green Cr^{3+} ions.

If Tollen's reagent is used, the colourless silver(I) ion dissolved in ammonia is converted to silver and a silver mirror is produced inside the glassware.



Subsection (c) Carboxylic Acids

16. I can name branched chain carboxylic acids with up to 8 carbon atoms in the longest chain.
17. I can write molecular formulae and draw structures from the names of branched chain carboxylic acids.
18. I can identify isomers of carboxylic acids.

SECTION 2: ESTERS, FATS AND OILS

Subsection (a) Esters

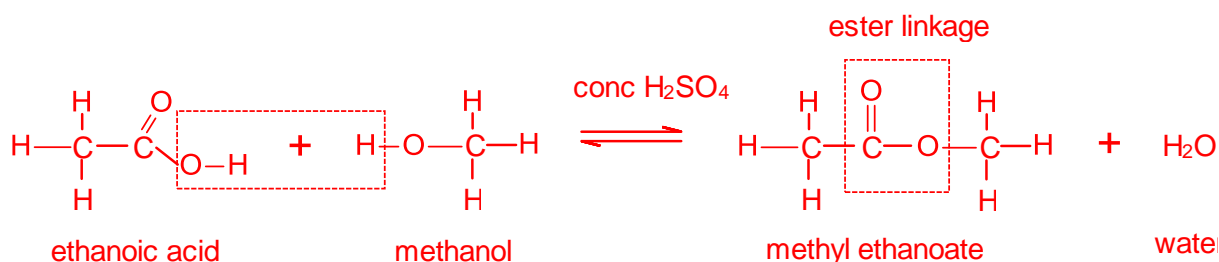
19. I can identify an ester from the name ending '-yl -oate'
20. I can name an ester from the names of the parent alcohol and carboxylic acid.
21. I can draw structural formula for an ester when given the name of the parent alcohol and carboxylic acid or the names of esters and I can identify the functional group present in an ester:



22. I can describe the characteristic smell of ester. **sweet/fruity smell**
23. I can name 3 major uses of esters:
- Flavourings** Esters are responsible for the smell and flavour of many fruits and flowers. They are used as artificial flavourings.
 - Fragrances** They are used in perfumes as fragrance which includes apple, bananas, strawberries, etc
 - Non-polar industrial solvents** Ethyl ethanoate can be used to extract caffeine from coffee and tea. Esters are used as solvents for dyes, drugs, antibiotics, glues, inks paints and varnishes.

Subsection (b) Making esters

24. I can explain how an ester is formed in a condensation reaction.
Esters are formed by a condensation reaction between a carboxylic acid and an alcohol in the presence of strong acid catalysts (such as concentrated sulphuric acid). In condensation reactions, the molecules join together with the elimination of a small molecule like water.
25. I can explain, using full structural formulae, how an ester linkage can be formed by reaction between a hydroxyl group and a carboxyl group with the elimination of a small molecule.

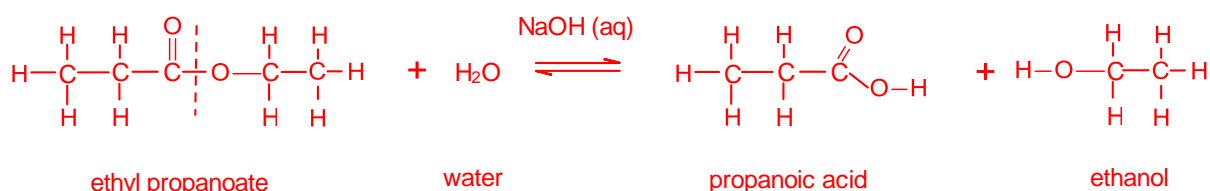


Subsection (c) Hydrolysis of esters

26. I can explain, using full structural formulae, how an ester can be hydrolysed.

Esters can be hydrolysed to produce a carboxylic acid and an alcohol in the presence of alkali catalysts (such as sodium hydroxide solution). In hydrolysis reactions, a molecule reacts with water breaking down into smaller molecules.

27. I can name the products of ester hydrolysis.



Subsection (d) Fats and Oils

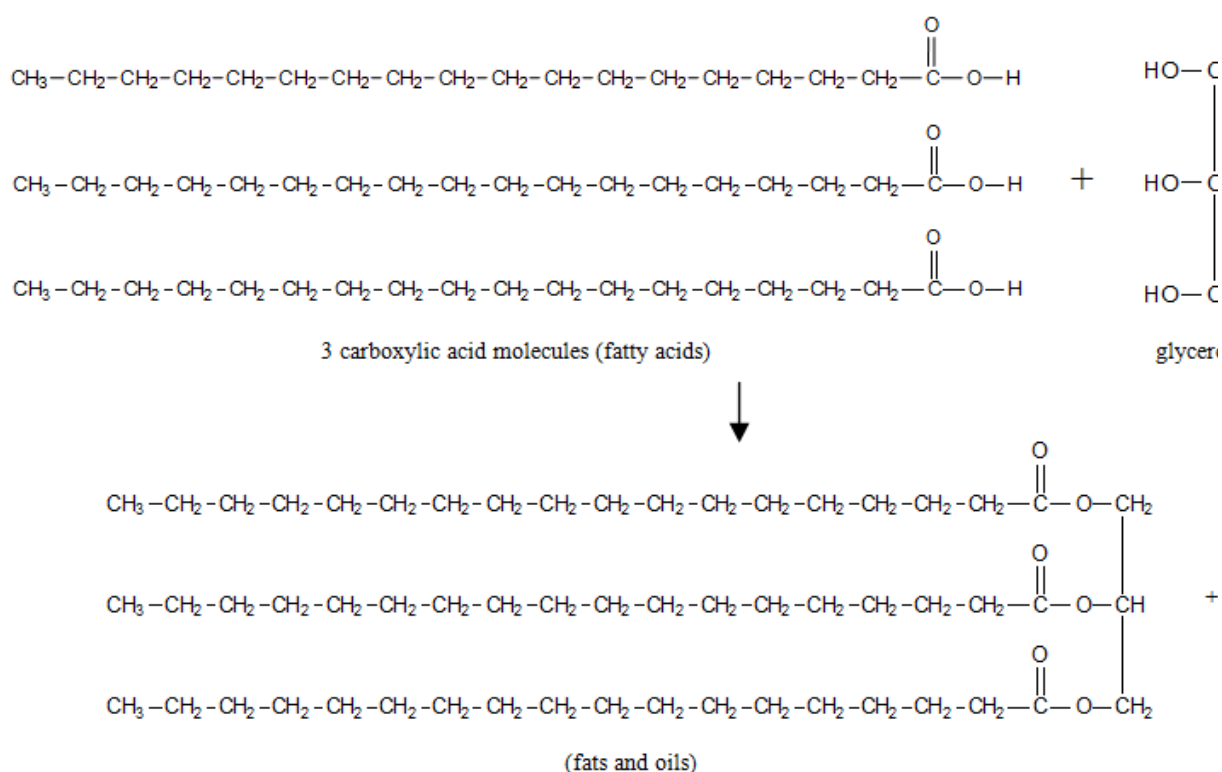
28. I can describe why fats and oils are an essential part of a healthy diet.

Fats and oils in the diet supply the body with energy and are a more concentrated source of energy than carbohydrates. They are essential for the transport and storage of fat soluble vitamins in the body

29. I can describe the formation and structure of fats and oils

Fats and oils are esters made when an alcohol, glycerol (propane-1,2,3-triol) condenses with three carboxylic acid molecules known as "fatty acids".

30. I can explain using full structural formula how fats and oils are formed.



31. I can describe the difference between saturated and unsaturated "fatty acids" and the impact on the state.

Unsaturated "fatty acids" contain carbon to carbon double bonds (C=C).

Saturated "fatty acids" contain carbon to carbon single bonds (C-C).

32. I can explain the difference in melting points of fats and oils in terms of their

- structure
- packing of molecules
- strength of intermolecular bonds.

The lower melting points of oils compared to those of fats is related to the higher unsaturation of oil molecules. The presence of double bonds in oil molecules causes the long chains of atoms to become distorted. This stops the oil molecules packing as closely together as the more saturated fat molecules can. The poorer packing makes Van der Waal's forces weaker between oil molecules than between fat molecules. Less heat energy is needed to separate oil molecules and oils have lower melting points than fats

Subsection (c) Antioxidants

33. I can explain how food containing edible oils turns rancid.

Oxygen molecules interact with the structure of the oil and damage its natural structure in a way that can change its odour, its taste, and its safety for consumption.

34. I can explain how to prevent foods turning rancid

Antioxidants are often added to fat-containing foods in order to retard the development of rancidity due to oxidation.

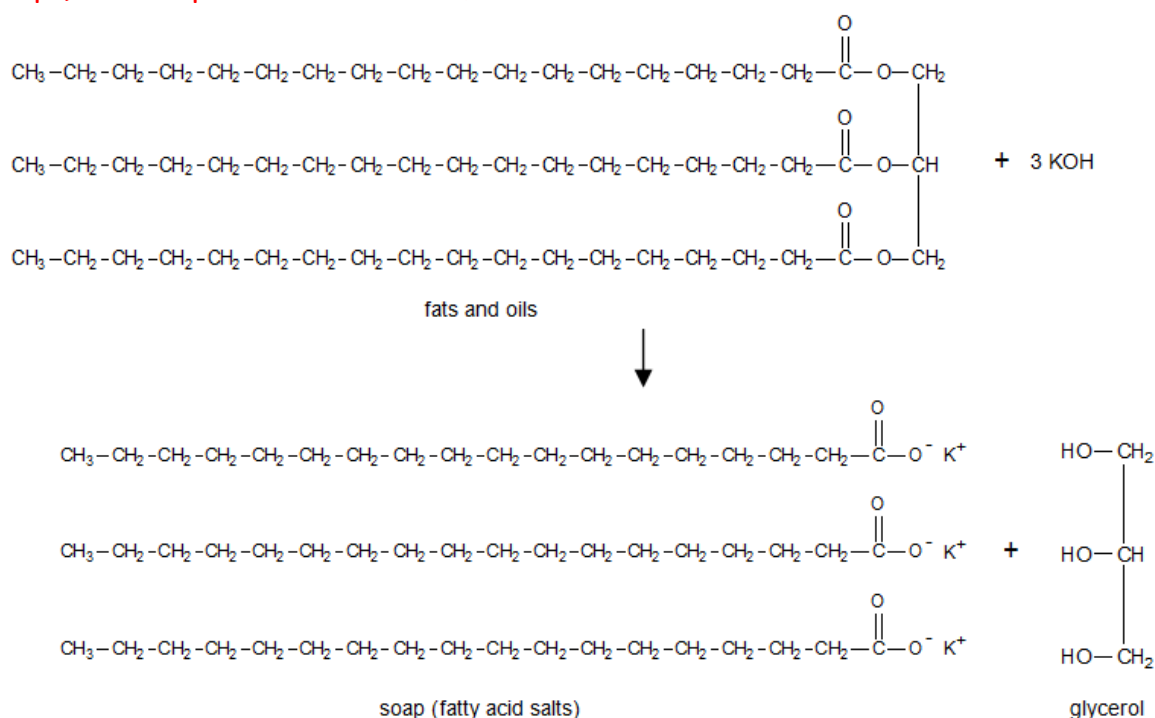
35. I can write ion-electron equations for the oxidation of many antioxidants

SECTION 3: SOAPS AND EMULSIONS

Subsection (a) Making soap

36. I can explain how soaps are produced by alkaline hydrolysis of fats and oils.

Fats and oils are esters. Soaps are produced by the hydrolysis of fats and oils and are the sodium or potassium salts of fatty acids. Hydrolysis of esters such as fats/oil produce glycerol and fatty acids. The hydrolysis is carried out using alkalis (NaOH or KOH) as catalyst and the fatty acids formed are changed into sodium or potassium salts (soaps) such as potassium stearate, $C_{17}H_{35}COO^-K^+$ a water soluble ionic salt.



Subsection (b) Cleansing Action of Soaps

37. I can relate the cleansing action of soaps and detergents to the hydrophobic and hydrophilic nature of soap molecules.

In solution a soap molecule consists of a long non-polar (hydrophobic) hydrocarbon tail (e.g. $C_{17}H_{35}$) readily soluble in non-polar compounds (hydrophobic) and an ionic carboxylate head ($-COO^-$) which is water soluble (hydrophilic). During cleaning the hydrophobic tails dissolve in the droplets of oil or grease, whilst the polar head hydrophilic heads face out into the surrounding water resulting in a ball-like structure. The non-polar substance, such as oil and grease are held inside the ball and suspended in the water. Repulsion prevents the oil droplets re-joining and helps disperse the oil.

38. I can describe the production of detergents and their importance in hard water areas.

Soaps are the sodium or potassium salts of **natural** fatty acids produced by the hydrolysis of esters. Detergents are synthetic versions of soaps produced from the petrochemical industry. Detergents are useful in hard water areas since they do not produce a scum on the surface of water but soaps do.

Subsection (c) Emulsions in food

39. I can define an emulsion.

An emulsion is a mixture of two or more immiscible liquids. In an emulsion the small droplets of one liquid are dispersed in another liquid.

40. I can explain why emulsifiers are added to food.

Emulsions in food are mixtures of oil and water. These normally do not mix and will separate if left without an emulsifier. The emulsifier, or emulsifying agent, keeps the mixture stable and prevents the oil and water from separating into two layers. Emulsifiers can help to make a food appealing. They are used to aid in the processing of foods and also to help maintain quality and freshness.

41. I can describe how emulsifiers are made and how they work.

Natural sources like vegetable oils and animal fats are often used to make emulsifiers. Emulsifiers are made by reacting fatty acids with glycerol to form molecules with either one fatty acid group (mono-glycerides) or two fatty acid groups (di-glycerides) linked to the glycerol backbone. Emulsifiers are molecules that have two distinct ends. One end likes to be in water (hydrophilic) and the other end likes to be in oil (hydrophobic). This means that they will coat the surface of oil droplets in an oil-in-water emulsion and effectively 'insulate' the oil droplets from the water. It keeps them evenly dispersed throughout the emulsion and stops them from clumping together to form their own, separate layer.

Section 4 : FRAGRANCES

Subsection (a) Essential Oils

42. I can define what essential oils are.

Essential oils are concentrated extracts of volatile, non-water soluble aroma compounds from plants. Essential oils do not as a group have any specific chemical properties or functional groups in common. Instead they are defined by the fact that they convey characteristic fragrances.

43. I can list examples of the uses, properties and products of essential oils.

Perfumes, cosmetic products, cleaning products, aromatherapy and food flavourings.

44. I can describe how many essential oils can be extracted from plant material.

Essential oils are generally extracted by distillation or solvent extraction.

45. I can state the key component in many essential oils. Terpenes

Subsection (b) Terpenes

46. I can explain the importance of Terpenes in terms of the flavour and aroma of food.

Terpenes are components in a wide variety of fruit and floral flavours and aromas. Terpenes can be oxidised in plants producing some of the compounds responsible for the aroma of spices.

47. I can explain how Terpenes are formed.

Terpenes are unsaturated compounds formed from units of isoprene (2-methylbuta-1,3-diene), which has the molecular formula C_5H_8 . The basic molecular formulae of terpenes are multiples of that, $(C_5H_8)_n$ where n is the number of linked isoprene units. The isoprene units may be linked together "head to tail" to form linear chains or they may be arranged to form rings. One can consider the isoprene unit as one of nature's common building blocks.

SECTION 5: PROTEINS

Subsection (a) Function of proteins

48. I can describe the role of proteins in the body.

Proteins are the major structural materials of animal tissue.

Proteins are also involved in the maintenance and regulation of life processes.

Enzymes are proteins.

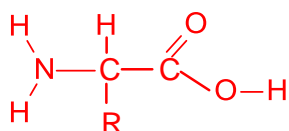
Subsection (b) Amino Acids

49. I can name the building blocks from which protein molecules are formed.

Proteins are formed from amino acid molecules.

50. I can identify and describe the structure of amino acid molecules and how they differ to produce the 20 common naturally occurring amino acids.

Amino acid molecules are relatively small molecules contain the carboxyl group ($-COOH$) and the amino group ($-NH_2$) the structures of amino acids differ in the atoms which make the R group.



51. I can explain why some amino acids are known as essential amino acids.

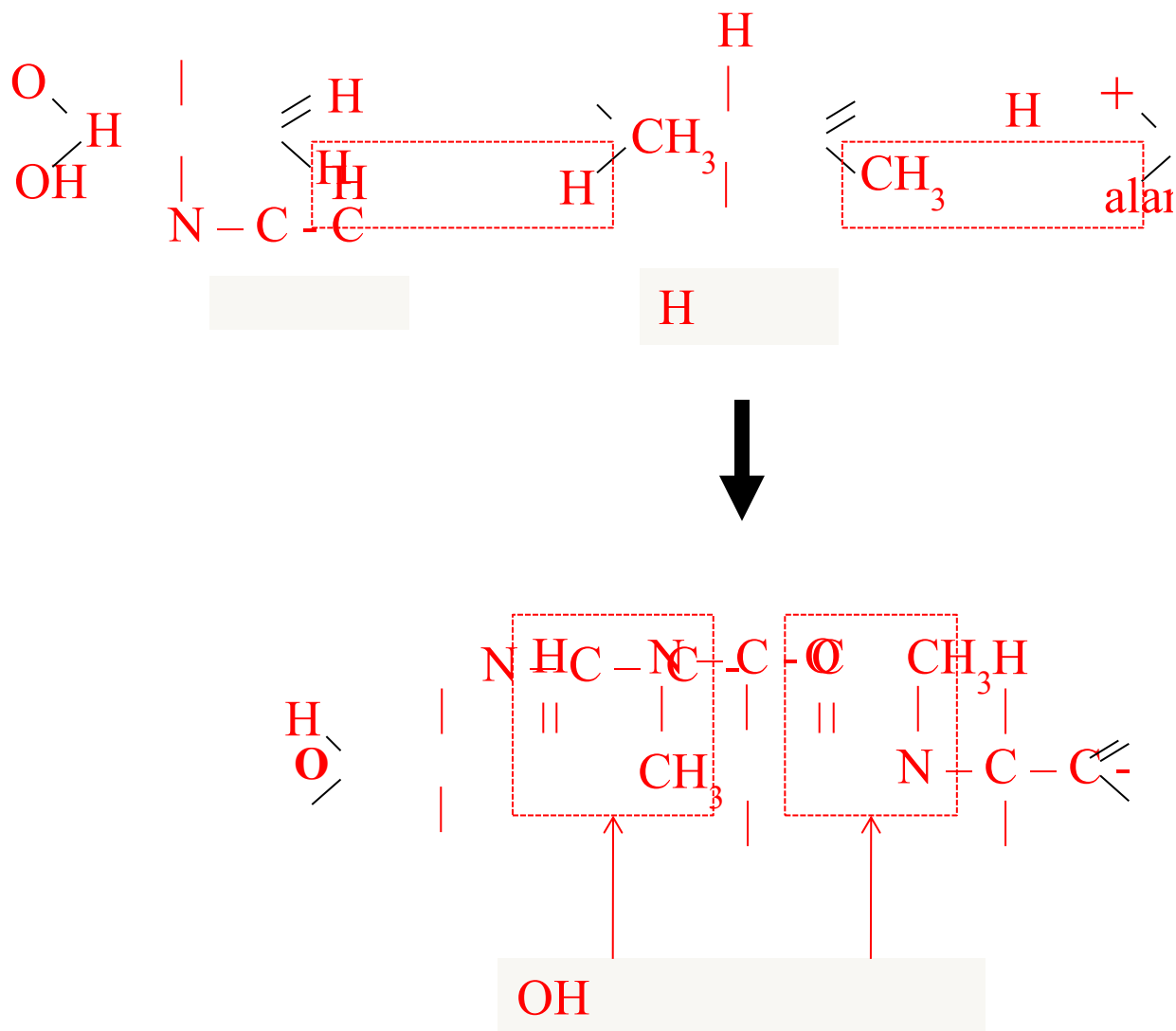
The body cannot make all the amino acids required for body proteins and is dependent on dietary protein for the supply of certain essential amino acids.

Subsection (c) Amide/Peptide Links

52. I can explain how many amino acids can link together to form a protein molecule in a condensation reaction.

Condensation of amino acids produces an amide (peptide) link. The amide link is formed by the reaction of an amino group on one amino acid and a carboxyl group on a neighbouring amino acid, a water molecule is eliminated.

53. I can explain, using full structural formulae, how an amide (peptide) link can be formed by the condensation reaction between amino acids.



54. I can describe how the diverse range of proteins needed to fulfil different roles in the body is produced from just 20 amino acids.

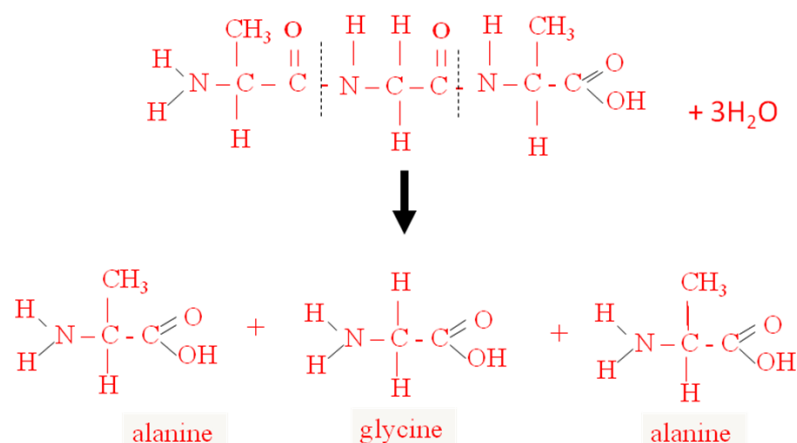
Proteins specific to the body's needs are built up within the body by many condensation reactions. The sequence by which the amino acids are joined together differs in different protein molecules.

Subsection (d) Hydrolysis

55. I can explain how proteins can be hydrolysed (digested) to produce amino acids.

Protein digestion occurs in the stomach mainly by the action of hydrochloric acid and an enzyme called pepsin. Water molecules break down the amide linkages in the protein molecule (hydrolysis) to give a mixture of amino acids.

56. I can draw, using full structural formulae, the amino acids obtained from the hydrolysis of a given section of the structure of a protein.



57. I can explain how the amino acids present in a sample of hydrolysed protein can be analysed and identified.

The amino acids present in a protein can be identified by first hydrolysing the protein using acid or alkali and then using chromatography. The application of known amino acids to the chromatogram alongside the hydrolysed protein allows identification of the amino acids in the protein.

SECTION 6: CHEMISTRY OF COOKING

Subsection (a) Changes in protein structure upon heating

58. I can explain the importance of intermolecular bonding in protein structure.

Amino acid molecules vary little in length because they each contain N-C-C atoms with a branch on the middle carbon atom. This means that the peptide links are regular distances apart along the chain and so there can be regular hydrogen bonding between peptide links. This hydrogen bonding allows chains to form sheets, spirals and other complex shapes.

59. I can describe the changes that take place on heating proteins and can relate this to the texture of foods (cooking eggs, meat).

When a protein is heated, intermolecular bonds are broken and the protein structure is irreversibly changed. These permanent changes are called denaturation of the protein. Egg white is a globular protein; on heating the protein chains unwind and can form intermolecular bonds with neighbouring proteins causing the egg white to solidify.

Different temperatures should be used to cook meat containing different levels of connective tissue. Slow cooking at 60°C results in tough collagen denaturing. Too high a temperature and the protein molecules bunch together making the meat tough.

Subsection (b) Flavour in food

60. I can explain why volatile molecules are important in flavour

The majority of what we described as "flavour" comes from odour identified by nasal cells. That requires the flavour molecules to be wafted up from the mouth. The flavours of foods are due to the presence of volatile organic molecules.

61. I can identify the functional groups present in flavour molecules and suggest whether

they are likely to be water soluble or oil soluble and give examples.

Asparagus for example should be cooked in oil or butter in which the flavour molecules are less soluble. In broccoli or green beans, the flavour molecules are more soluble in oil than in water and should be cooked in water.

62. I can make predictions about the relative boiling points and hence volatility of flavour molecules based on size of the molecule and the functional groups present.

SECTION 7: SKIN CARE PRODUCTS

Subsection (a) Effect of Ultraviolet light

63. I can describe Ultraviolet radiation (UV) and its effect on molecules.
Ultraviolet radiation 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.
64. I can explain the effects of UV light on the human body.
UV light is responsible for causing sunburn and contributes to aging of skin.
65. I can explain how sun-block works
Sun-block stops UV light reaching the skin

Subsection (b) Free Radical Reactions

66. I can explain what a free radical is and describe their reactivity
When UV light breaks bonds free radicals are formed. Free radicals are atoms or groups of atoms which have a single unpaired electron. Free radicals are highly reactive.
67. I can describe how free radicals are formed.
Free radicals are formed if a bond splits evenly - each atom getting one of the two electrons, this is called **homolytic fission**. Homolytic fission takes place when UV light breaks bonds.
68. I can describe and identify the steps involved in a free radical reaction
- a) Initiation: UV light generates radicals.
 - b) Propagation: A propagation reaction involves the loss of a radical, but also the formation of another radical. The reaction now has to keep going, or propagate itself.
 - c) Termination: Termination involves radicals coming together to form covalent bonds.

Subsection (c) Free-radical Scavengers

69. I can describe the effects of free-radicals on the body and how free-radical scavengers work.
Free radicals, particularly oxygen radicals, are thought to cause cell damage. Untreated, the damage from free radicals accumulates with age and the damage is thought to be the cause of many degenerative diseases, and is associated with many of the signs of

the aging process. Free radical scavengers are molecules that will trap free radicals by reacting with free radicals to form stable molecules and prevent chain reactions.

70. I can give examples of natural free radical scavengers.
Melatonin, Vitamin E and beta carotene are examples of natural free radical scavengers.
71. I can explain the scientific evidence for adding free radical scavengers to cosmetics, food and plastics.