Higher Chemistry: Unit 2 – Nature's Chemistry

End Unit Summary

WELL DONE!

By now you have completed the following topics in Nature's Chemistry:

D. **Proteins**

E. **Soaps, Detergents and Emulsions**

F. **Fragrances and Skin Care**

Now it's time for a summary of what you have learned in the second half of Nature's Chemistry and to check your understanding.

Success Criteria

You will have been successful in this lesson if you:

1. Read the summaries below (there is no need to copy/print these)
2. Watch the links provided
3. Complete the revision questions below (answers will be given on Wednesday)

MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge

You may wish to revise the following to help you understand this summary:

Nature's Chemistry lessons: Proteins, Soaps, Detergents and Emulsions and Fragrances and Skin Care

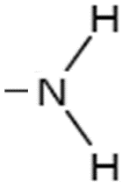
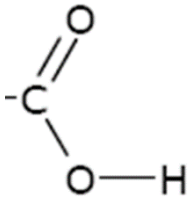
You may wish to have a data booklet for this lesson. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or from the SQA website
- https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Read through the following summary notes – you do not need to copy these, as you already have notes on these topics.

Part D – Proteins

1. Amino acids

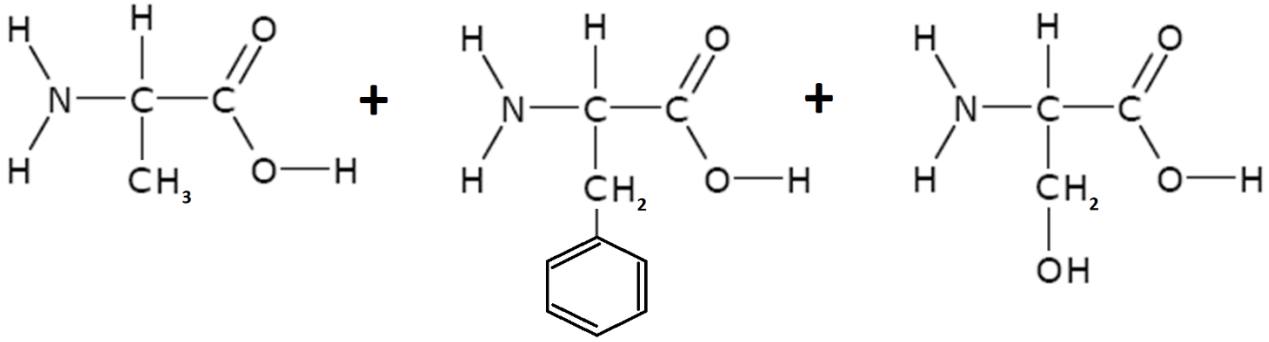
Proteins are **polymers** made up of a chain of small monomers known as **amino acids** that each contain:

The amino group, $-NH_2$  and the carboxyl group, -COOH 

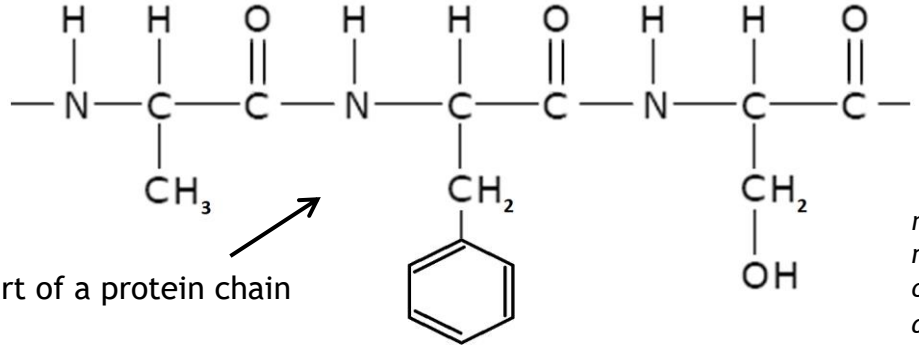
Essential amino acids are amino acids which we cannot make in our bodies, so must consume in our diet

2. Formation of Proteins

The reaction below shows three amino acids joining together to form part of a protein chain. The type of reaction is **condensation polymerisation.**



condensation polymerisation



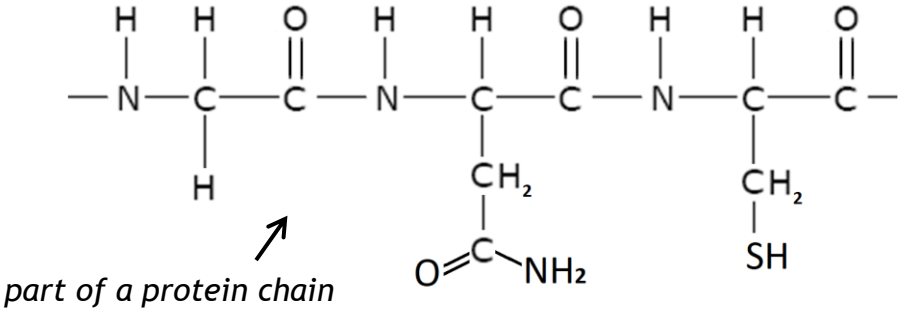
+ nH_2O

part of a protein chain

n = number of water molecules made (depends on the number of amino acids being added together)

3. Protein Digestion

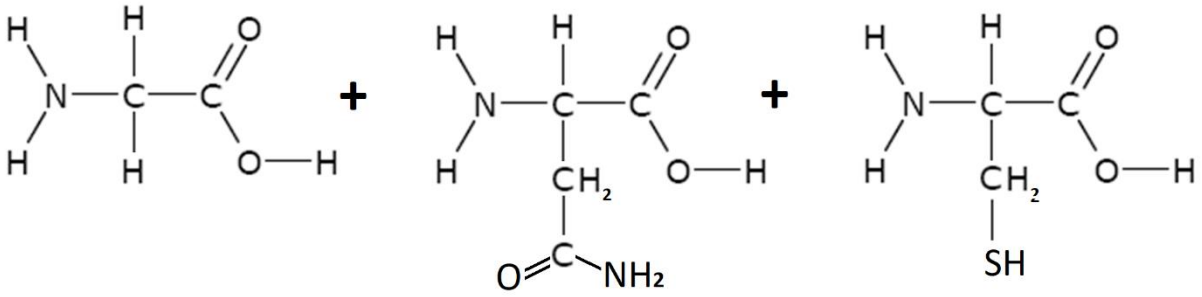
The reaction below shows part of a protein chain breaking up to form three amino acids. The type of reaction is **hydrolysis.**



part of a protein chain

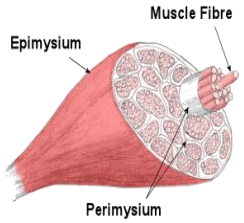
+ nH_2O

hydrolysis reaction



amino acids formed on hydrolysis of the protein

4. Protein Function



1. **Structural Proteins -** The major structural materials of animal tissue, eg muscle, skin, hair.

2. **Regulatory proteins -** involved in **the maintenance and regulation of life processes**. These include hormones, antibodies and enzymes.

5. Enzymes

Enzymes are proteins which act as **biological catalysts**.

Denaturing Proteins - When proteins are heated, during cooking, **intermolecular bonds are broken** allowing the proteins to **change shape**. Enzyme therefore don't work above certain temperatures.

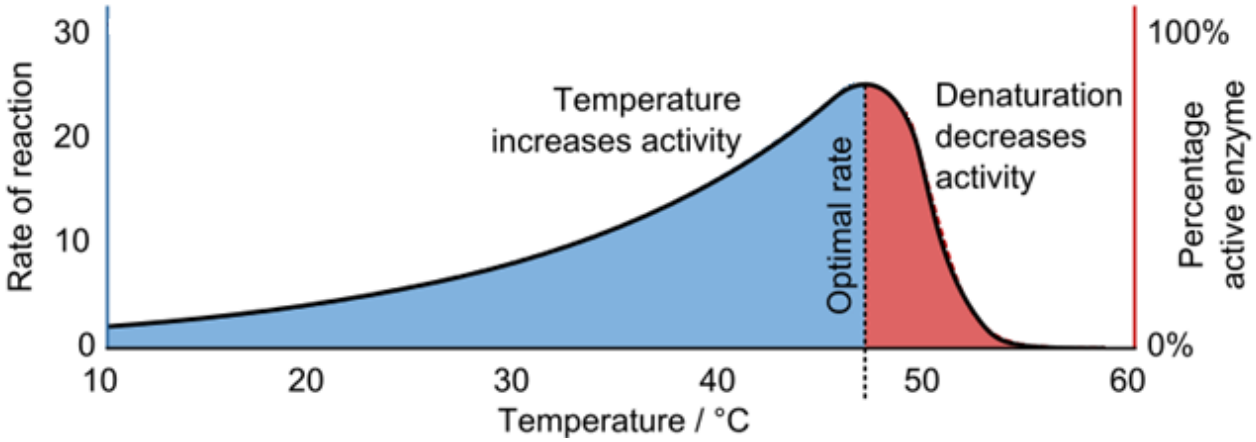


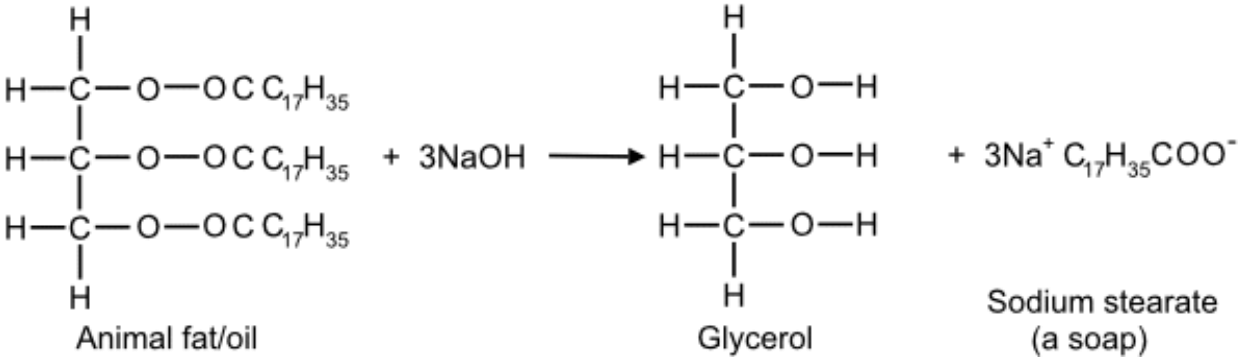
image from https://commons.wikimedia.org/w/index.php?curid=47436421

Part E – Soaps, Detergents and Emulsions

1. Making Soaps

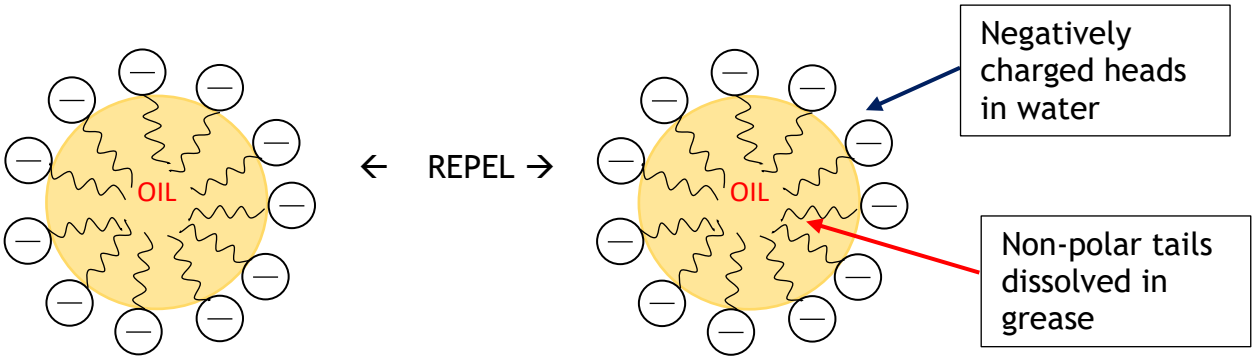
Soaps are **salts of fatty acids and alkalis**, such as sodium hydroxide or potassium hydroxide made by alkaline hydrolysis of fats or oils.

Example of alkaline hydrolysis:



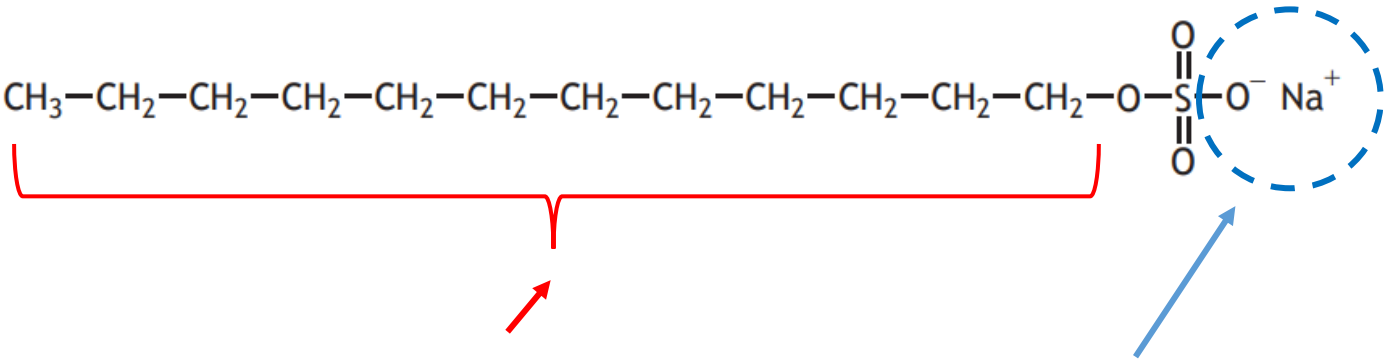
2. How Soaps Clean (3 points = 3 marks in a test)

1. Non-polar covalent **hydrophobic tail** dissolves in the oil or grease; ionic **hydrophilic head** dissolves in the water.
2. **Agitation causes ball-like structures to form**, (called micelles).
3. **The negatively-charged ball-like structures repel each** other and the oil or grease is kept suspended in the water. Then washed away with water.



3. Detergents

When soap is used hard water (containing dissolved metal ions) a scum is formed instead of a lather. Detergents are used instead of soap as they do not form a scum with hard water. Detergents remove grease and oil in the same way as soaps and have similar structures



Non-polar covalent TAIL = Hydrophobic

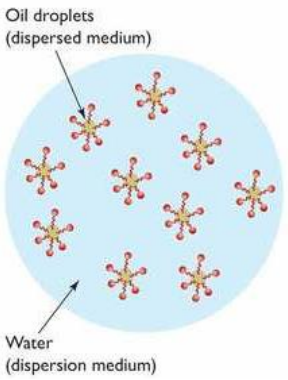
oil soluble

Ionic HEAD = Hydrophilic

water soluble

4. Emulsions & Emulsifiers

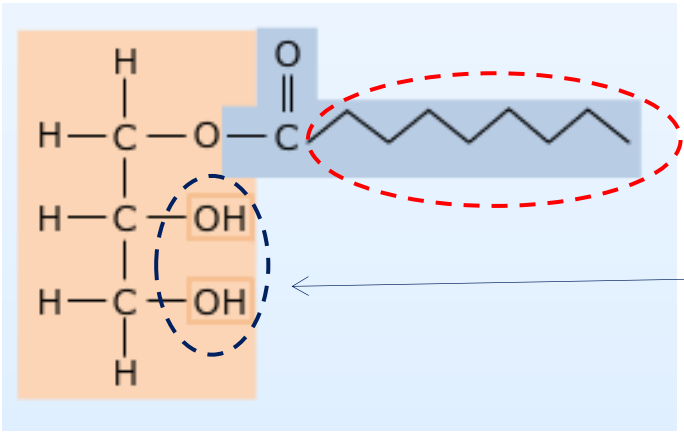
An **emulsion** contains small droplets of one liquid dispersed in another liquid.



An **emulsifier** is used to prevent non-polar and polar liquids separating into layers.

Emulsifiers for use in food can be made **by reacting edible oils with glycerol.**

In the molecules formed, only **one or two fatty acid groups** are linked to each glycerol backbone. (Instead of the



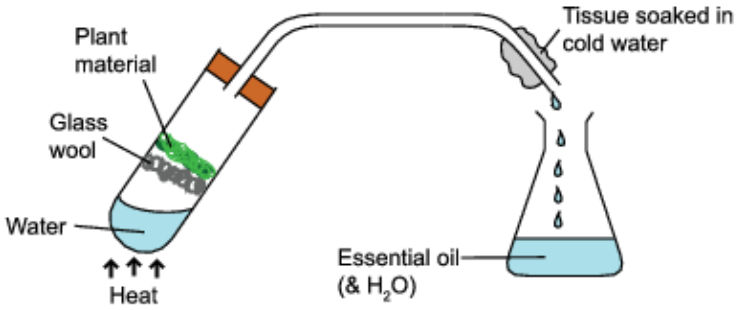
The long fatty acid chains are non-polar, **HYDROPHOBIC** and dissolve in the non-polar liquid. Eg oil

The hydroxyl groups are polar, **HYDROPHILIC** and dissolved in the polar liquid. eg water.

Part F - Fragrances and Skin Care

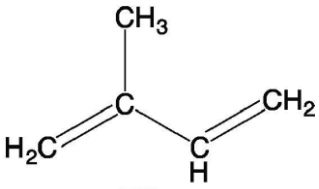
1. Essential oils

Essential oils are mixture of **volatile, non-water soluble** aroma compounds that can be extracted from plants. They can be extracted from plants through steam distillation.



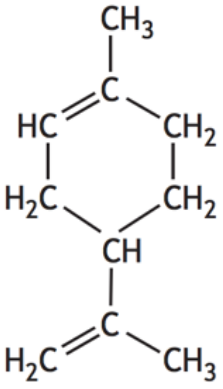
2. Isoprene & Terpenes

Isoprene (2-methylbuta-1,3-diene) is the starting compounds that make a huge variety of compounds in essential oils, called terpenes.



Isoprene, C_5H_8

Terpenes are unsaturated compounds formed by joining together isoprene units. Eg limonene, made from two isoprene units.

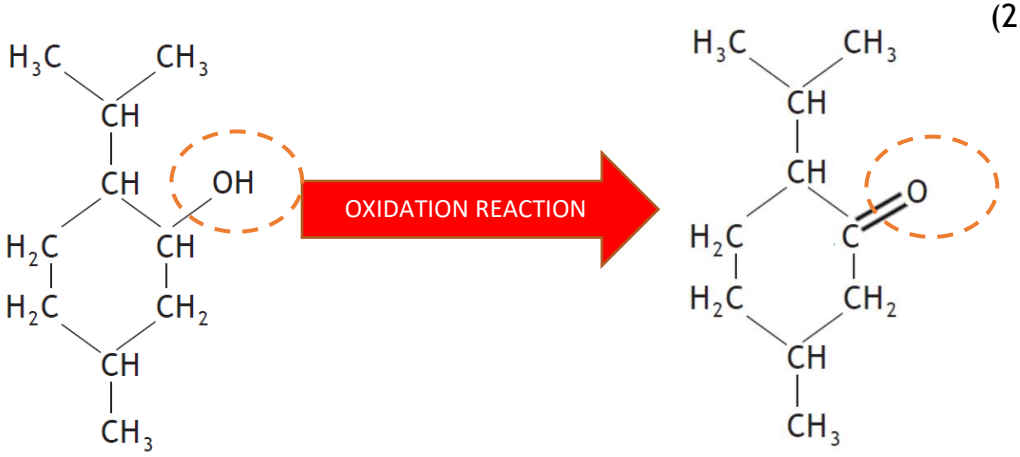


limonene, $C_{10}H_{16}$

(2 isoprene units)

3. Oxidation of Terpenes

Terpenes can be **oxidised** within plants to produce some of the compounds responsible for the distinctive aromas of **spices**.



menthol (secondary alcohol) menthone (ketone)

4. UV Radiation

UV light can provide enough energy to break covalent bonds within molecules producing **FREE RADICALS:**

Covalent bond: shown as a line between two atoms.

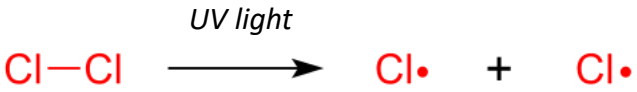
FREE RADICALS are shown as the atom symbol with a single dot beside, representing the **unpaired electron.**

Free Radicals are atoms or molecules that are **highly reactive** due to the presence of **unpaired electrons.**

5. Free Radicals Chain Reactions

1. Initiation Step:

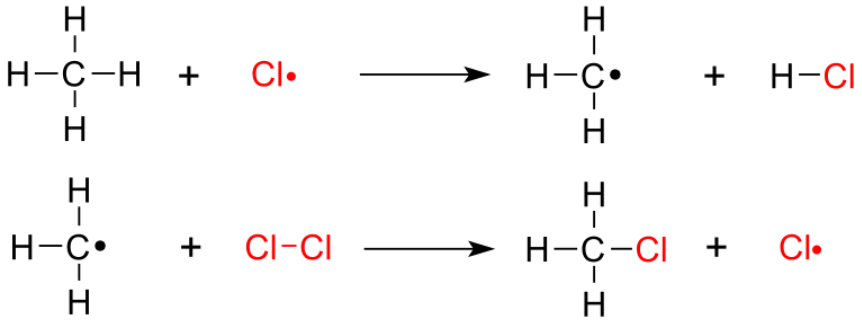
Splitting of a covalent bond, initiated by **UV radiation or sunlight**. This produces **two free radicals** each with an unpaired electron.



INITIATION: Free radicals on **RIGHT HAND SIDE** **of** equation

2. Propagation Step:

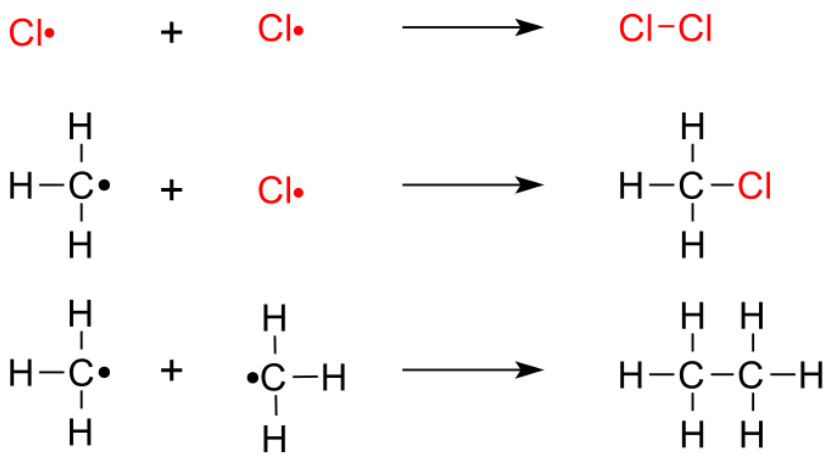
In each propagation step, one free radical enters the reaction and another free radical is generated.



PROPAGATION: Free radicals on **BOTH SIDES** **of** equation

3. Termination Step:

The chain reaction ends when two free radicals react with each other and form stable molecules. Multiple products are possible.



TERMINATION: Free radicals on **LEFT HAND SIDE** **of** equation

6. Protection from UV Radiation / Stabilising Free Radicals

UV light can cause damage to our skin and DNA. Sun-block products prevent UV light reaching the skin, by **reflecting or absorbing UV radiation**. It therefore decreases the formation of free radicals.

Free radical scavengers are molecules that **react with free radicals to form stable molecules** and prevent chain reactions from occurring.

Antioxidants are excellent free radical scavengers as they give away electrons while they are being oxidised.

WATCH - YOUTUBE: Miss Adam's Chemistry:
https://www.youtube.com/playlist?list=PLpeedPxQgHa3F1wG3qloJtW8s61w6PtDO

Any of the videos here will help you recap what you now know about Nature's Chemistry. Select the videos for any topic you are still not sure of.

Further Reading

To learn more about this part of Nature's Chemistry, try the following online resources:

BBC Bitesize: https://www.bbc.co.uk/bitesize/topics/zybg87h

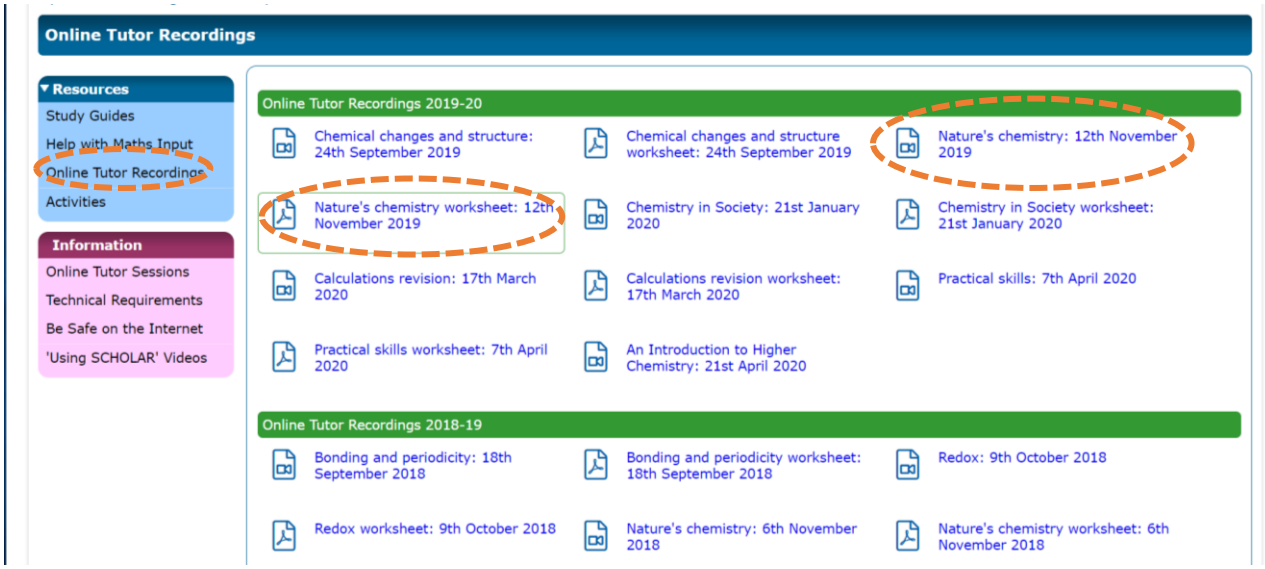
Go to any of the last 5 topics **and try the end of topic tests**

Scholar: Log in through GLOW

Higher Chemistry → Nature's chemistry → Topics 6-12

Try any of the activities and try the end of end of section test

Scholar online tutorial recordings: Each year, Scholar hosts an online tutorial about each unit of higher chemistry. If you want to test you understanding of this topic. Download the Nature's Chemistry Worksheet, complete this and watch the associated recording. There are two years of this now – both excellent ways to strengthen your knowledge of chemistry.



Evans^2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

Username: snhs password: giffnock

Select any teacher → revision material → CfE Higher → Unit 2: Nature's Chemistry

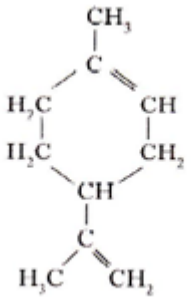
Revision Questions and Summary Quiz

2.20 Multiple Choice Revision

1. Which of the following types of compound always contain nitrogen?

A oils
B enzymes
C esters
D fatty acids

2. The terpene molecule below is responsible for the flavour in lemons.



How many isoprene units have been used to produce this molecule?

A 2
B 3
C 1
D 4

3. Soap ions have a

A hydrophilic tail and a covalent head
B hydrophobic tail and a covalent head
C hydrophilic tail and an ionic head
D hydrophobic tail and an ionic head

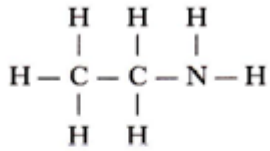
4. Which statement is **not** true about free radical scavengers?

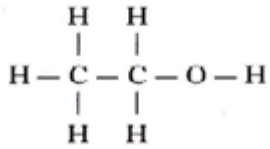
A they remove grease from clothes
B they are present in many cosmetic products
C they are added to food products and plastics
D they react with free radicals to form stable molecules

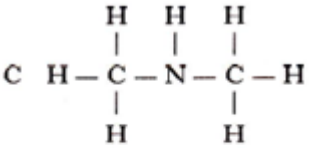
5. The monomer units used to construct protein molecules are

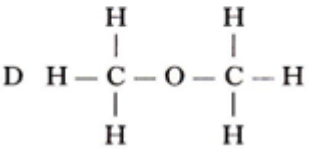
A amino acids
B fatty acids
C esters
D isoprenes

6. In which of the following compounds would hydrogen bonding **not** occur?

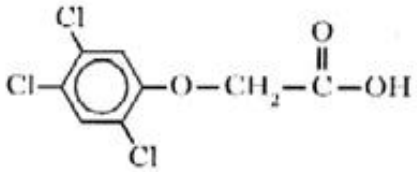
A 

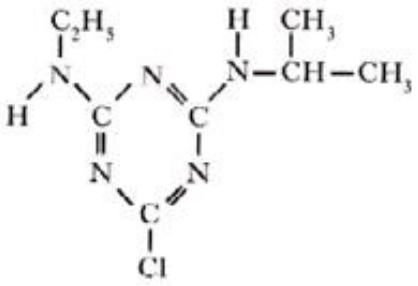
B 

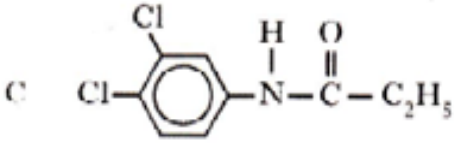
C 

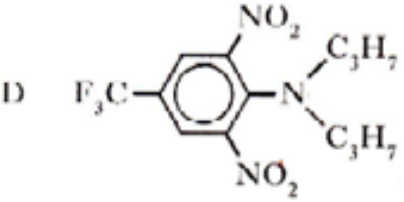
D 

7. The following molecules are found in herbicides. Which of the following contains a peptide link?

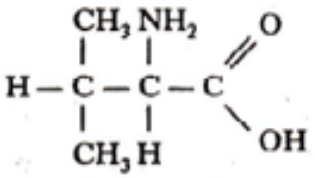
A 

B 

C 

D 

8.



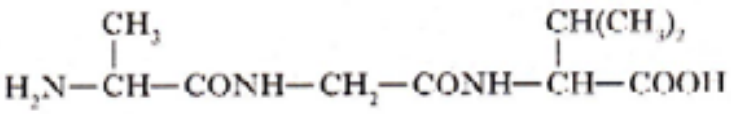
The above molecule can be classified as

A an emulsifier
B a peptide
C a protein
D an amino acid

9. Which of the following is a termination step in a free radical chain reaction?

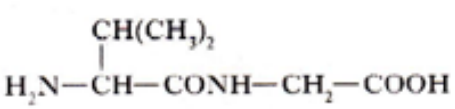
A $Cl_2 \rightarrow Cl\bullet + Cl\bullet$
B $CH_3\bullet + Cl\bullet \rightarrow CH_3Cl$
C $CH3\bullet + Cl_2 \rightarrow CH3Cl + Cl\bullet$
D $CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$

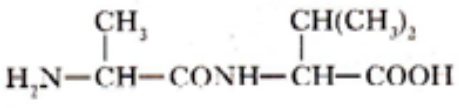
10. A tripeptide **X** has the structure



Partial hydrolysis of X yields a mixture of dipeptides. Which of the following dipeptides could be produced on hydrolysing X?

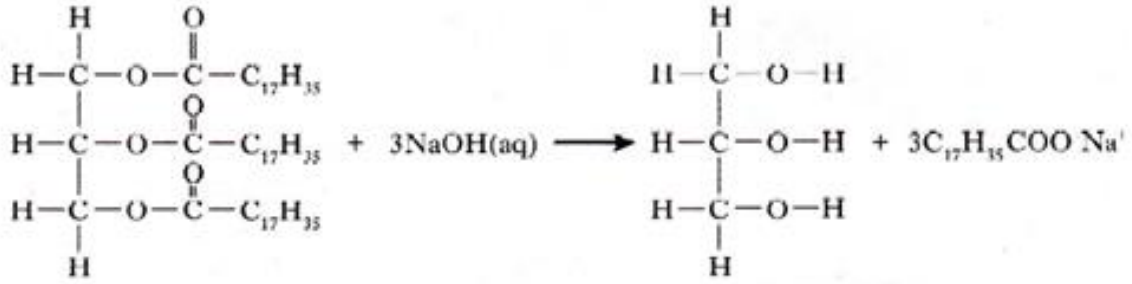
A 

C 

B 

D 

11. Soaps are produced by the following reaction



This reaction is an example of

A hydrolysis
B esterification
C condensation
D oxidation

12. Which of the following molecules could link together to form a protein?

A $HOOC-CH_2-COOH$

B $HOCH_2-CHOH-CH_2OH$

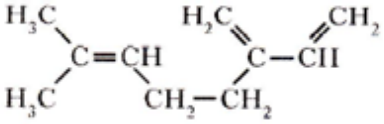
C $CH_3-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$

D $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-COOH$

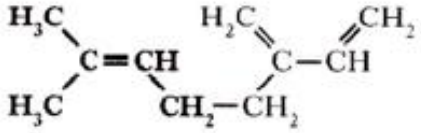
13. Substances added to foodstuffs to prevent separation of oil and water components are known as

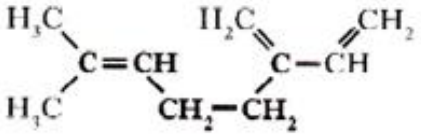
A fatty acids
B emulsifiers
C free radicals
D antioxidant

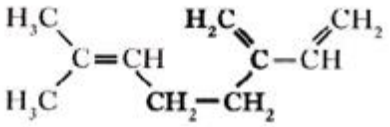
14. The molecule below is a terpene

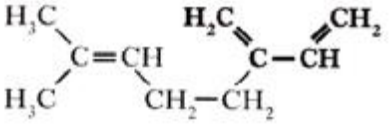


Terpenes are produced by joining 2 or more isoprene molecules together.
Which of the following shows an isoprene unit in bold?

A 

B 

C 

D 

15. The arrangement of amino acids in a peptide is

Z-X-W-V-Y

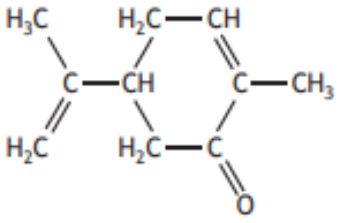
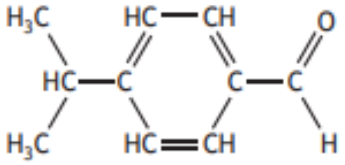
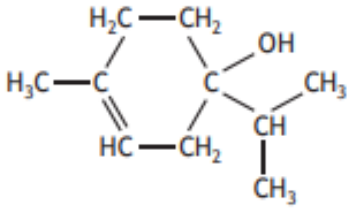
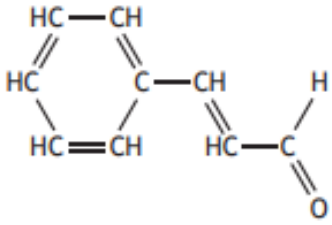
Where the letters represent amino acids.
On partial hydrolysis of the peptide which of the following sets of dipeptides is possible?

A V-Y, Z-X, W-Y, X-W
B Z-X, V-Y, W-V, X-W
C Z-X, X-V, W-V, V-Y
D X-W, X-Z, Z-W, Y-V

16. Which of the following compounds can be classified as proteins?

A fats
B amino acids
C Enzymes
D oils

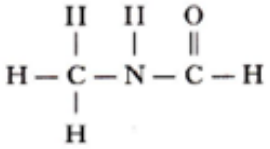
17. The table shows four compounds that contribute to the aroma of spices.
What compound is not derived from a terpene?

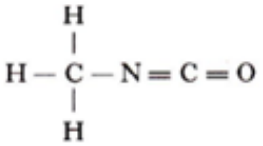
	Structural formula	Molecular formula
A		$C_{10}H_{14}O$
B		$C_{10}H_{12}O$
C		$C_{10}H_{18}O$
D		C_9H_8O

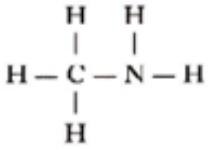
8. Amino acids are converted into proteins by

A hydration
B hydrolysis
C hydrogenation
D condensation

19. Which of the following is an amine?

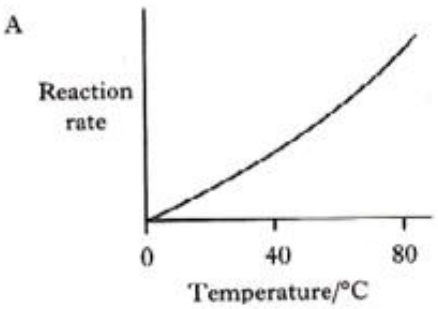
A 

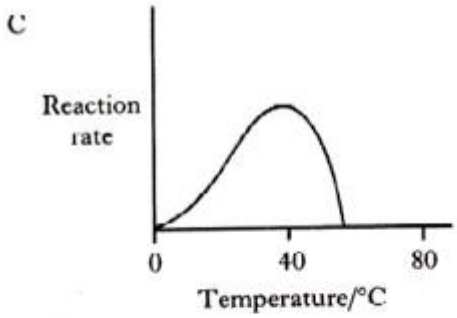
C 

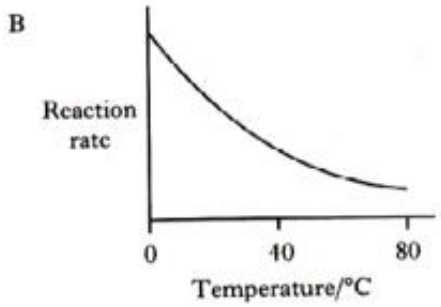
B 

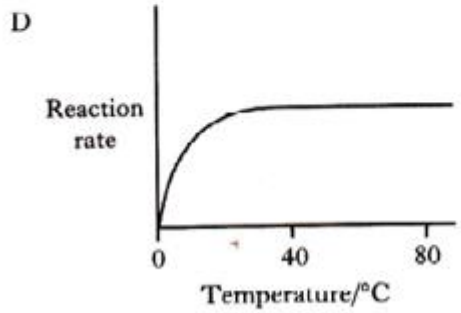
D 

20. The rate of a reaction using an enzyme was studied at different temperatures. Which of the following graphs would be obtained

A 

C 

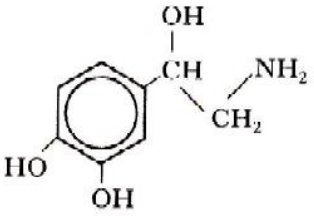
B 

D 

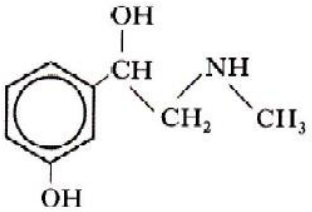
21. Diterpenes contain 4 isoprene units. Which of the following represents a diterpene?

A C_5H_8
B $C_{10}H_{16}$
C $C_{15}H_{24}$
D $C_{20}H_{32}$

22. The two molecules below can cause an increase in blood pressure, because the parts of their structure that they have in common, can attach to certain human protein.



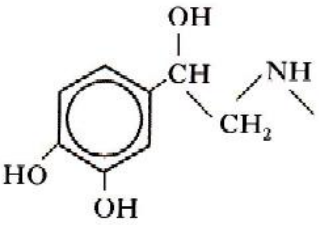
noradrenaline



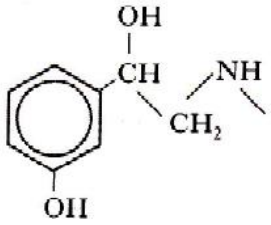
phenylephrine

The part of these molecules which is the correct shape to attach to the protein is

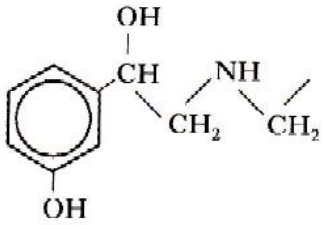
A



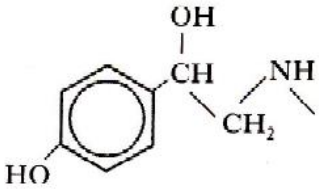
B



C



D



23. Ammonia solution may be used to distinguish between Fe^{2+} and Fe^{3+} ions as follows:

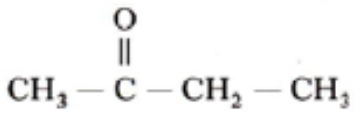
Green precipitate produced with Fe^{2+}

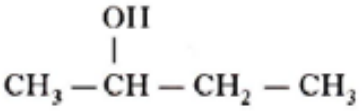
Brown precipitate produced with Fe^{3+}

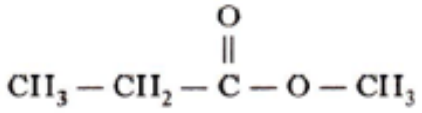
Which of the following is most likely to give similar results if used instead of ammonia?

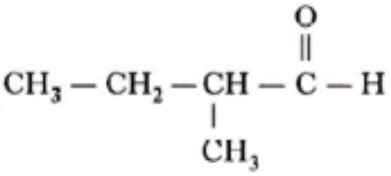
A a soap ion
B an emulsifier
C an amino acid
D a terpene

24. Which of the following compounds is hydrolysed when warmed with sodium hydroxide solution?

A 

C 

B 

D 

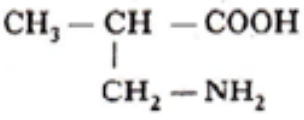
25. Which of the following is an initiation step in a free radical chain reaction?

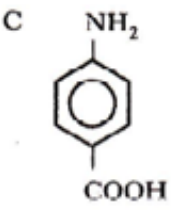
A $CH_3\bullet + Cl\bullet \rightarrow CH_3Cl$
B $Cl_2 \rightarrow Cl\bullet + Cl\bullet$
C $CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$
D $CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$

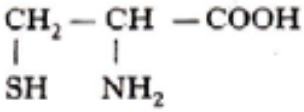
26. Emulsifiers for use in food are commonly made by reacting edible oils with

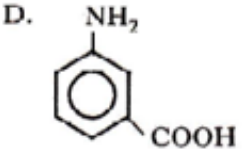
A esters
B amino acids
C fatty acids
D glycerol

27. In α-amino acids, the amino group is on the carbon atom adjacent to the acid group. Which of the following is an a-amino acid?

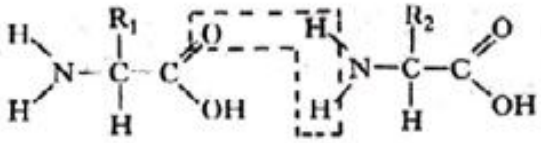
A 

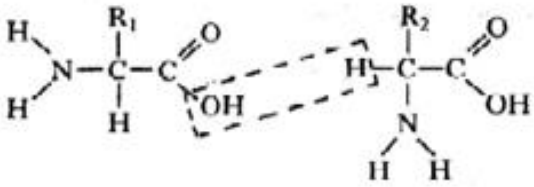
C 

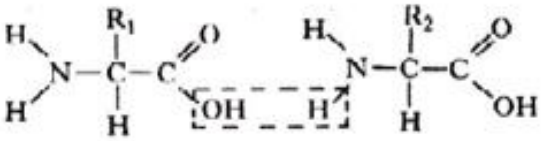
B 

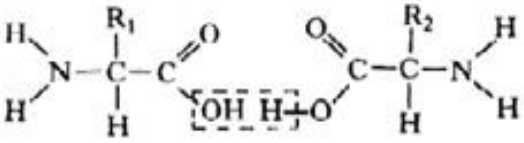
D. 

28. When two amino acids condense together, water is always eliminated and a peptide link is formed. Which of the following represents this process?

A 

B 

C 

D 

29. When a protein is denatured

A its overall shape is distorted
B its peptide links are hydrolysed
C it is broken into separate peptide fragments
D it decomposes into amino acids

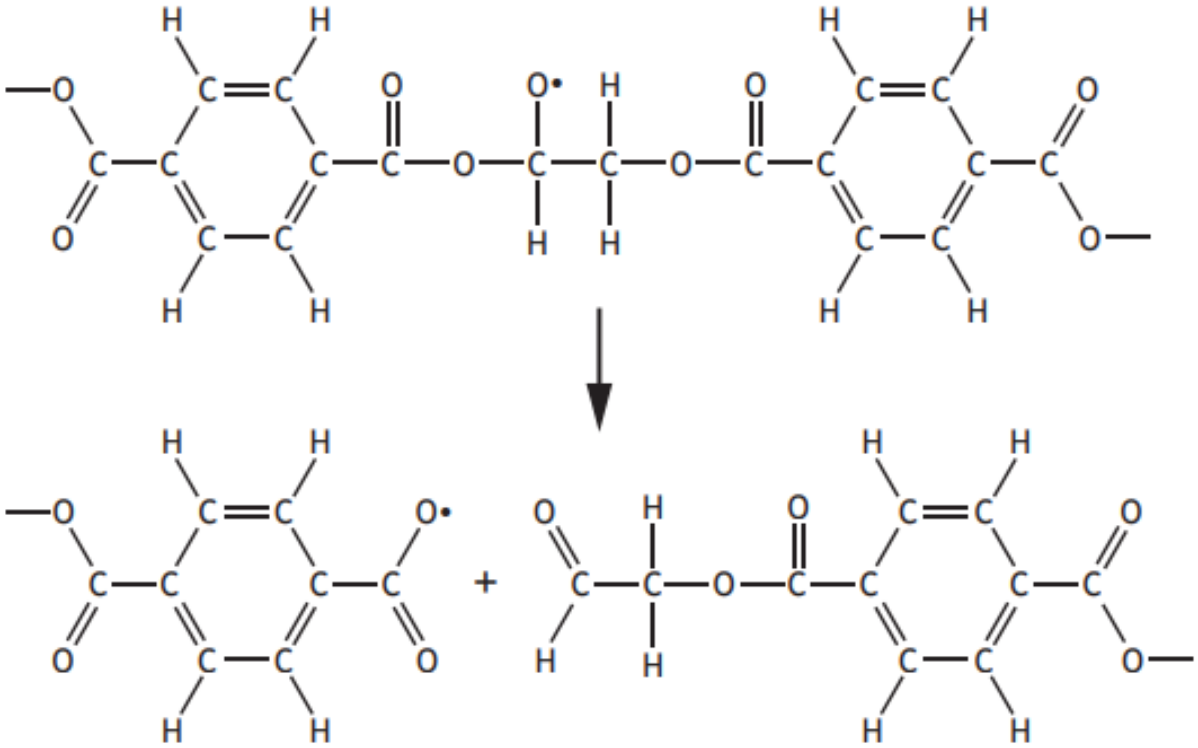
30. Emulsifiers for use in food are commonly made by reacting edible oils with

A esters
B amino acids
C fatty acids
D glycerol

31. A yellow pigment in plants is classified as a tetraterpene and has the molecular formula $C_{40}H_{64}$. How many isoprene units joined to form this substance?

A 4
B 6
C 8
D 10

32. Poly ethylene terephthalate (PET) is the plastic used to produce bottles. One of the steps involved in breaking down PET is shown below:



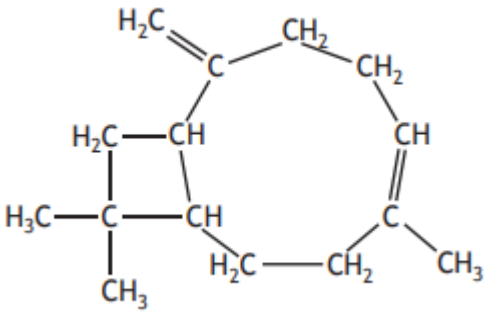
State the name for this step

A hydrolysis
B termination
C hydration
D propagation

33. There are different types of terpenes depending on the number of carbons they contain. A monoterpene is formed when two isoprene units join together. What could be the formula of a triterpene?

A $C_{10}H_{16}$
B $C_{15}H_{24}$
C $C_{20}H_{32}$
D $C_{30}H_{48}$

34. The structure of caryophyllene, which can be extracted from clove oil is



Which of the following would be the best solvent for extracting caryophyllene?

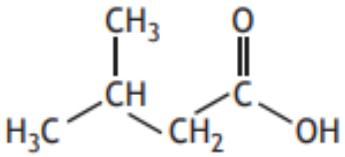
A $CH_3—CH_2—CH_2—CH_2—CH_2—CH_3$

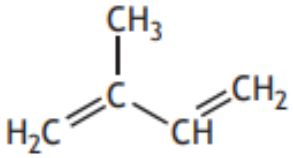
B $CH_3—CH_2—CH_2—CH_2—CH_2—CHO$

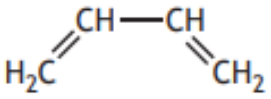
C $CH_3—CH_2—CH_2—CO—CH_2—CH_3$

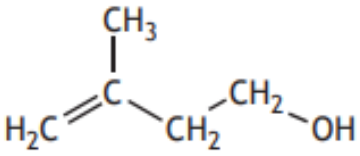
D $HO—CH_2—CH_2—CH_2—CH_2—CH_2—CH_3$

35. The structure of isoprene is

A 

B 

C 

D 

Answers will be given on Wednesday