

DARRELL ER (COPYRIGHTED) ©



TOPIC 11.4: ALCOHOLS

random | pt.asia.id

Chemically, DNA consists of repeating units of a sugar-phosphate backbone, with nitrogenous bases attached to the sugar. The backbone is made of alternating phosphate and deoxyribose groups. The phosphate groups are negatively charged, and the deoxyribose groups are neutral. The nitrogenous bases are attached to the deoxyribose groups via glycosidic bonds. There are four types of nitrogenous bases: adenine, guanine, cytosine, and thymine. Adenine and guanine are purines, and cytosine and thymine are pyrimidines. The bases are paired with each other via hydrogen bonds: adenine pairs with thymine (two hydrogen bonds), and guanine pairs with cytosine (three hydrogen bonds). The sequence of bases in a DNA molecule determines the genetic information it carries.



Through the B-DNA form, the DNA molecule is able to store and transmit genetic information. The B-DNA form is the most common form of DNA in cells. It is a right-handed helix with a diameter of approximately 2 nm. The distance between two adjacent base pairs is approximately 0.34 nm. The major groove and minor groove are formed by the helical structure. The major groove is wider and deeper than the minor groove. The major groove is the site where proteins and other molecules bind to regulate gene expression. The minor groove is the site where water molecules and other small molecules bind. The B-DNA form is stable under physiological conditions.

Other forms of DNA include A-DNA, Z-DNA, and C-DNA. A-DNA is a compact, wide, and shallow helix. It is found in dehydrated DNA and in the DNA of some viruses. Z-DNA is a narrow, zig-zag helix. It is found in regions of DNA that are rich in cytosine-guanine base pairs. C-DNA is a compact, wide, and shallow helix. It is found in DNA that is bound to certain proteins. The B-DNA form is the most common form of DNA in cells, but other forms can be found in specific regions of the genome.

THE ABOUT

CHAPTER ANALYSIS



MASTERY

- Important topic
- Take note of alcohol's chemical reactions



EXAM

- Alcohols are **commonly tested**
- Understand how **fermentation** works and the conditions needed



WEIGHTAGE

- **Heavy** overall weightage
- Entire Organic Chemistry portion accounts for **15-20%** of each year's Chemistry paper

KEY CONCEPT

ALCOHOLS

HOMOLOGOUS SERIES

FUNCTIONAL GROUP

GENERAL FORMULA



Name	Carbon atoms	Molecular Formula	Full Structural Formula	Condensed structural formula
Methanol	1	CH ₃ OH	$ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array} $	CH ₃ -OH
Ethanol	2	C ₂ H ₅ OH	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} $	CH ₃ CH ₂ -OH
Propanol	3	C ₃ H ₇ OH	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $	CH ₃ CH ₂ CH ₂ -OH
Butanol	4	C ₄ H ₉ OH	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $	CH ₃ CH ₂ CH ₂ CH ₂ -OH

Alcohols

Alcohols have the **general formula C_nH_{2n+1}OH** and can be identified by the **hydroxyl -OH functional group**.

Functional group

Alcohols have the **hydroxyl -OH functional group**.

Isomers

Isomerism can occur in alcohols that contain **at least three carbon atoms**.

Isomers have the same molecular formula and similar chemical properties.

However, isomers have **different physical** properties such as **different melting and boiling points** and **densities**.

KEY CONCEPT

ALCOHOLS

PHYSICAL PROPERTIES

PRODUCTION OF ALCOHOL

CHEMICAL REACTIONS



PHYSICAL PROPERTIES

Physical property	Reasoning
Melting and boiling points	<p>As the number of carbon atoms in the alcohols increases, the melting and boiling points of alcohols increases as well.</p> <p>As the number of carbon atoms in an alcohol increases, the size of the molecules are bigger and have stronger intermolecular forces of attraction between each other. As such, more heat energy is needed to overcome the intermolecular forces of attraction between the alcohol molecules. Hence, larger alcohol containing more carbon atoms will have higher melting and boiling points.</p>
Volatility	<p>As the number of carbon atoms in the alcohol increases, the volatility of alcohol decreases. (similar to m.p. & b.p.)</p> <p>With a higher relative molecular mass, there would be stronger intermolecular forces of attraction between the alcohol molecules. As such, more energy is needed to overcome the intermolecular forces of attraction between the alcohol molecules.</p> <p>Hence, larger alcohol molecules are less likely to evaporate in room temperature.</p>
Density	As the number of carbon atoms in the alcohols increases, the density of alcohols increases.
Viscosity	<p>As the number of carbon atoms in the alcohols increases, the viscosity of alcohols decreases. (more difficult to flow)</p> <p>Alcohols with longer hydrocarbon chains flow less easily as they tend to get stuck together.</p>
Flammability	As the number of carbon atoms in the alcohols increases, the flammability of alcohols decreases. (more difficult to burn)
Solubility	Alcohols are soluble in water , but as the number of carbon atoms increases, solubility in water decreases.

MAKING ALCOHOL

PRODUCTION OF ALCOHOLS

1) Fermentation

1) Manufacture of ethanol from ethene

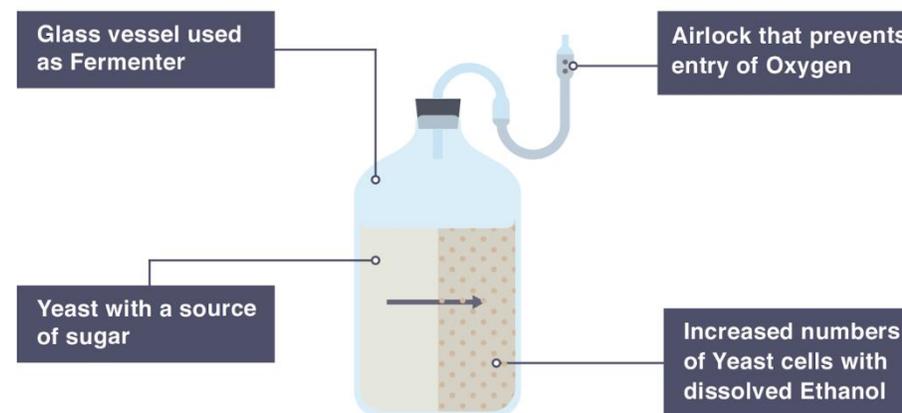
PRODUCTION OF ALCOHOL

1) Fermentation

Fermentation is a chemical reaction where glucose/sugar are broken down by micro-organisms into smaller molecules such as alcohol and carbon dioxide.

For instance, yeast contains enzymes that are used as catalyst for the breakdown **of glucose $C_6H_{12}O_6$ into ethanol C_2H_5OH and carbon dioxide.**

glucose \rightarrow ethanol + carbon dioxide
(in the presence of yeast)



MAKING ALCOHOL

PRODUCTION OF ALCOHOLS

1) Fermentation

1) Manufacture of ethanol from ethene

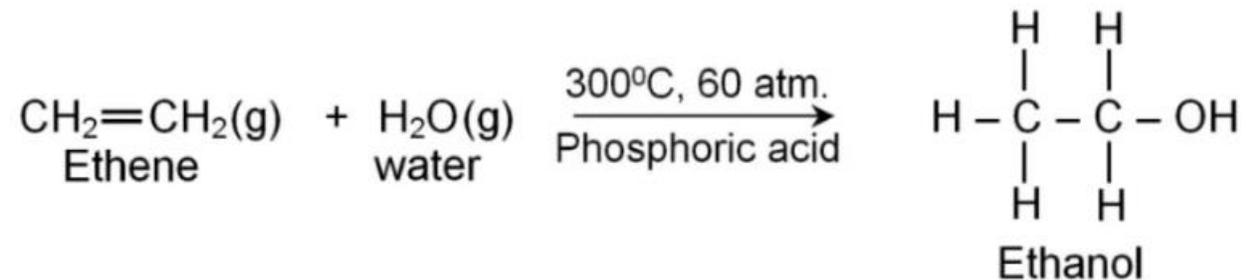
PRODUCTION OF ALCOHOL

2) Manufacture of ethanol from ethene (Hydration)

To produce alcohol, alkene and steam are reacted together at a temperature of **300°C** and at **60 atm**.

Phosphoric(V) acid is used as a catalyst for the reaction.

The following equation below shows the reaction between ethene and steam.



Uses of ethanol

Ethanol is used in **alcoholic drinks** such as beer and wine.

Ethanol is used as a organic **solvent for many organic compounds**.

Ethanol has high volatility and it is an **ideal solvent for perfume and deodorants**.

As it can undergo complete combustion to form carbon dioxide and water, ethanol is used as a **clean fuel**.

CHEMICAL REACTIONS

CHEMICAL REACTIONS OF ALCOHOLS

1) Combustion

1) Oxidation

1) Esterification

1) Combustion

In the presence of excess oxygen, an alcohol would undergo **complete combustion**, producing carbon dioxide and water.

If there is insufficient oxygen present for complete combustion, the alkene undergoes **incomplete combustion** to produce water and carbon monoxide instead.

Soot (carbon) could also be produced as a by-product during incomplete combustion.

2) Oxidation

Alcohols will be oxidised to form carboxylic acids in the presence of a strong oxidising agent.

Oxidising agents:

KMnO₄ (purple to colourless)

K₂Cr₂O₇ (orange to green)

For example, ethanol can be oxidised to ethanoic acid:



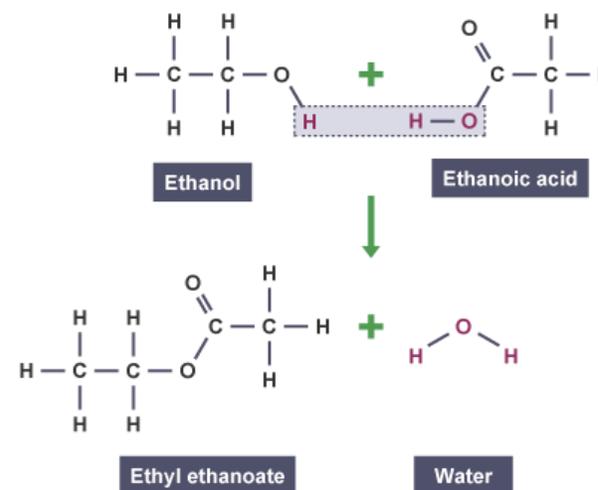
CHEMICAL REACTIONS

CHEMICAL REACTIONS OF ALCOHOLS

- 1) Combustion
- 1) Oxidation
- 1) Esterification

3) Esterification

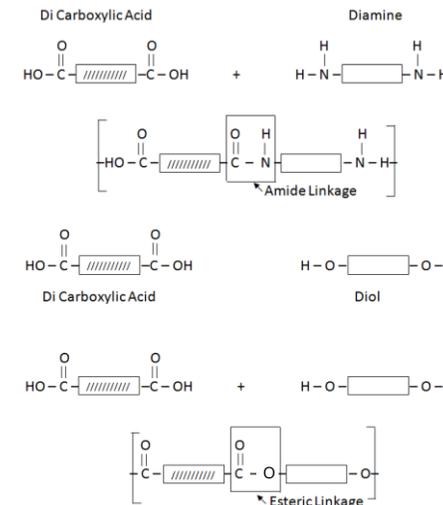
In the presence of a catalyst, **alcohols will react with carboxylic acids** to form **esters**.



Conditions: Concentrated H₂SO₄, heating under reflux

POLYMER

**Condensation
Polymerisation**
(elimination of water)



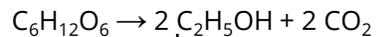
LONG CHAIN ALKANE

SUGAR

H₂ gas
(For Haber process)

Catalytic Cracking
(Al₂O₃ & SiO₂, 600 °C)

**Addition
Polymerisation**
(High temp &
pressure)



Fermentation
(37°C, yeast & no O₂)

Hydration
(300 °C & 60 atm, Phosphoric(V) acid)

Oxidation
(acidified aqueous potassium
manganate(VII) / exposed to air)

ALKANE

C - C

Hydrogenation
(200 °C & nickel)

ALKENE

C = C

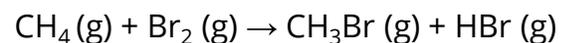
ALCOHOL

-OH

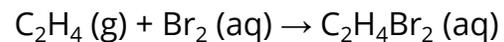
CARBOXYLIC ACID

-COOH

Substitution
(UV light)



Bromination
(Test for C=C bonds)



Esterification
(warm, sulfuric acid)

ESTER + H₂O
-COO-

ALL ORGANIC COMPOUNDS
Complete Combustion

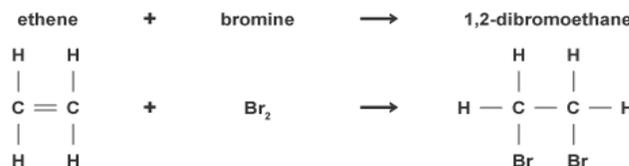


Incomplete Combustion



Prefix

Meth- 1
Eth- 2
Prop- 3
But- 4
Pent- 5
Hex- 6
Hep- 7
Oct- 8
Non- 9
Dec- 10



Try it yourself! (TYS Question)

46. Which statements about ethanol are correct?

Ethanol can be used:

(N2019/P1/Q37)

- 1 as the source of energy in car engines
- 2 to dissolve the active ingredients in perfumes
- 3 to manufacture polyesters.

A 1 only

B 1 and 2

C 2 only

D 2 and 3

()

Answer:

46. **B**
Ethanol can be used as a source of energy in cars and as a solvent. In the manufacture of polyesters, it is a diol that is used.

Try it yourself! (TYS Question)

48. Which alcohol and acid can be reacted together to make the ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_3$?
(N2019/P1/Q39)

- A $\text{C}_4\text{H}_9\text{OH}$ and HCO_2H
- B $\text{C}_3\text{H}_7\text{OH}$ and $\text{CH}_3\text{CO}_2\text{H}$
- C $\text{C}_2\text{H}_5\text{OH}$ and $\text{C}_2\text{H}_5\text{CO}_2\text{H}$
- D CH_3OH and $\text{C}_3\text{H}_7\text{CO}_2\text{H}$

()

Answer:

48. **D**
The ester is made from $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ and CH_3OH .

About Us

OVERMUGGED is a learning platform created by tutors, for students.

Our team of specialist tutors offer 1-to-1 private tuition, group tuitions and crash courses.

Follow us on [IG](#) and join our [Telegram channel](#) to get the latest updates on our free online revision sessions, webinars and giveaways!

If you would want to join Darrell's group tuition, contact him at:

Whatsapp: [8777 0921](#)

Telegram: [@DarrellEr](#)

Website: <https://www.overmugged.com/darrell>

For more free notes & learning materials, visit: www.overmugged.com

Notes prepared by:



Darrell Er
'O' Levels Chemistry & Physics



OVERMUGGED's Curated Notes

Found the free notes useful? We got something better!

OVERMUGGED's curated notes is a **highly condensed booklet** that **covers all content within the MOE syllabus**.

This booklet consist of **key concept breakdowns**, **worked examples** and **exam tips/ techniques** to required to ace your exams.

Get an **upgraded version** of the free notes and supercharge your revision!

Purchase [here](#).



Crash courses

Check out our upcoming crash courses at:
<https://www.overmugged.com/crashcourses>

'O' levels subject available:

- Pure Chemistry
- Pure Physics
- Pure Biology
- Combined Science
- E-Math
- A-Math
- English
- History
- Geography
- Combined Humanities
- Principles of Accounts (POA)