ALCOHOLS

Alcohols are organic compounds that contain one or more **hydroxyl groups** (**– OH functional groups***) in each molecule. The alcohols shown below in the chart are all members of a **homologous series*** of alcohols which are **aliphatic compounds*** with the **general formula*** $\mathbf{C_nH_{2n+1}OH}$. As the molecules in the series increase in size, their physical properties change steadily. Some of the trends are shown in the chart below. As a result of their **hydroxyl groups**, alcohol molecules are **polar***, and have **hydrogen bonds***. Short-chain alcohols mix completely with water, but long-chain alcohols do not as their molecules have more $-CH_2-$ groups, making them less polar. Alcohols do not **ionize*** in water and are **neutral***. They burn, giving off carbon dioxide and water.

Some properties of alcohols

Name of compound	Structural formula*	Physical state at 25°C	Boiling point (°C)
Methanol	CH_3OH	Liquid	65.6
Ethanol	CH_3CH_2OH	Liquid	78.5
Propan-1-ol	$CH_3CH_2CH_2OH$	Liquid	97.2
Butan-1-ol	$CH_3CH_2CH_2CH_2OH$	Liquid	117.5

*Alcohols are named in the same way as **alkanes***, but end in -ol. The number in the name tells you which carbon atom the **hydroxyl group** is attached to (see opposite and page 214-215).*

The next member of the series (going down) is always a $-CH_2-$ group longer than the last.

The members gradually change to solids as the molecules get longer.

*Boiling points of alcohols increase as the molecules get longer. They have high boiling points in relation to their **relative molecular mass***, due to **hydrogen bonding***.

Alcohols react with sodium:

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$$

Ethanol — *Sodium* — *Sodium ethoxide* — *Hydrogen*

Alcohols react with phosphorus halides to give **halogenoalkanes** (see page 195), and with **carboxylic acids*** to give **esters** (see **condensation reaction** and page 195).

Primary alcohols are **oxidized*** first to **aldehydes*** and then to **carboxylic acids***.

Acidified potassium permanganate ***catalyst****

$$CH_3CH_2CH_2OH \rightarrow CH_3CH_2CHO \rightarrow CH_3CH_2COOH$$

Propan-1-ol — *Propanal* — *Propanoic acid*

Secondary alcohols are **oxidized*** to **ketones** (see page 194).

Acidified potassium permanganate ***catalyst****

$$CH_3CHOHCH_3 \rightarrow CH_3COCH_3$$

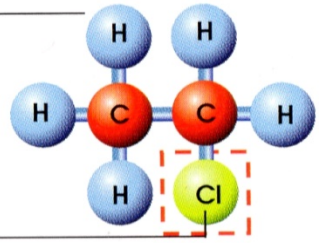
Propan-2-ol — *Propanone*

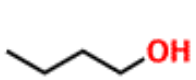
Halogenoalkanes or **alkyl halides**

A **homologous series*** whose members contain one or more **halogen*** atoms (see also page 215). Most halogenoalkanes are colourless, **volatile*** liquids which do not mix with water. They will undergo **substitution reactions***. The most reactive contain iodine, and the least reactive contain fluorine.

Molecule of ***chloroethane*** *(**CH_3CH_2Cl**), a* ***halogenoalkane****. Used to keep fridges cold (see* ***refrigerant****, page 345).*

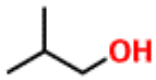
The chlorine atom is the ***halogen**** *functional group**. It is called a* ***chloro group*** *(**–Cl**) (see page 215).*





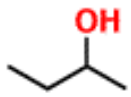
1-butanol
(*n*-butanol)
BP 117°C

(primary)



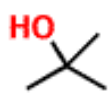
2-methyl 1-propanol
(isobutyl alcohol)
BP 107°C

(primary)



2-butanol
(*s*-butanol)
BP 98°C

(secondary)



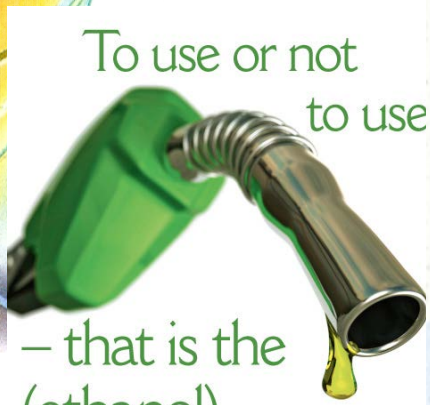
2-methyl-2-propanol
(*t*-butanol)
BP 82°C

(tertiary)

Ethanol (CH_3CH_2OH, often written C_2H_5OH)

Also called **ethyl alcohol**, or **alcohol**. An alcohol which is a slightly sweet-smelling water-soluble liquid with a relatively high boiling point. It burns with an almost colourless flame and is made by ethene reacting with steam. It is also produced by **alcoholic fermentation**.

Ethanol *is used as a solvent and in methylated spirits. It has many more uses including perfumes, paints, dyes, varnishes and alcoholic drinks.*



To use or not to use – that is the (ethanol) question

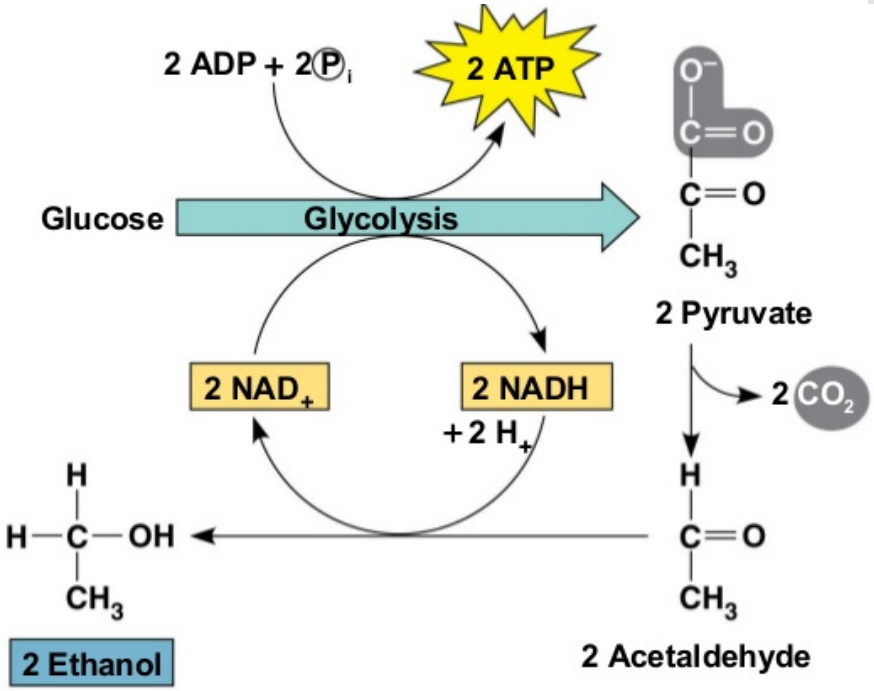
As Australia ramps up its productio of ethanol blended fuels, boaties need to weigh up the potential hazards associated with its use.

By Jeff Megahan

Alcoholic fermentation

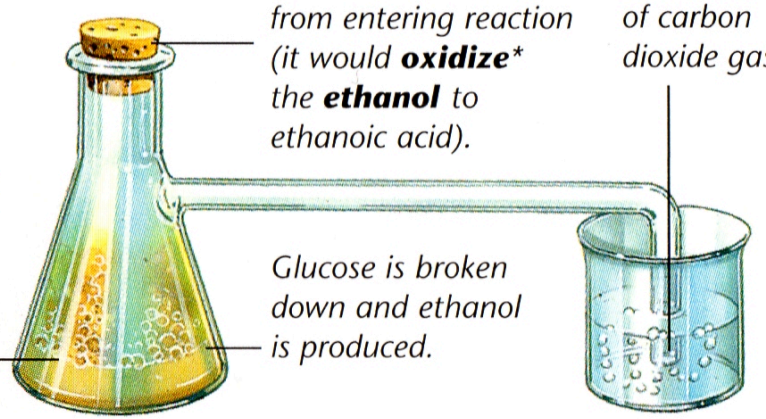
The name of the process used to produce **ethanol** (the potent chemical in alcoholic drinks) from fruits or grain. **Glucose*** from fruit or grain is converted into ethanol by **enzymes*** (**catalysts*** of the reactions in living cells). Yeast is used in alcoholic fermentation because it has the enzyme **zymase** which catalyses the change of glucose to ethanol.

Glucose* *in grapes is* ***fermented*** *to make wine.*



Laboratory fermentation

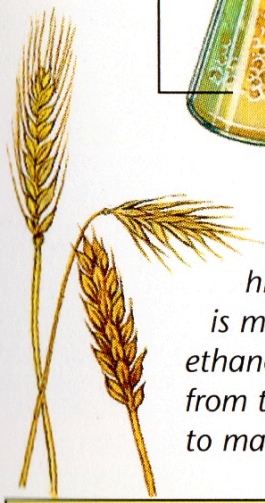
Fermentation *mixture:* ***glucose****, water and yeast (ideal temperature is 37°C).*



Bung stops oxygen from entering reaction (it would ***oxidize**** *the* ***ethanol*** *to ethanoic acid).*

Bubbles of carbon dioxide gas

Glucose is broken down and ethanol is produced.



Yeast dies if ***ethanol*** *concentration gets too high. Stronger alcoholic drinks, e.g. whisky, which is made from cereals, are made by* ***distilling**** *the ethanol solution. This process separates the ethanol from the water, and the concentrated alcohol is used to make the drinks more potent.*

Enzyme*

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$$

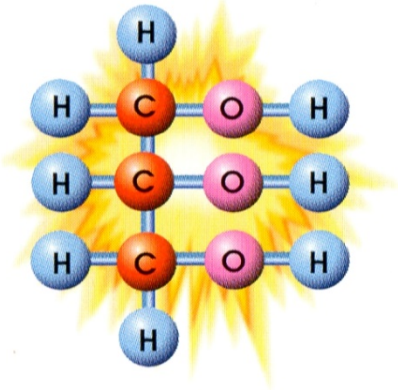
Glucose solution from fruit or barley — *Ethanol* — *Carbon dioxide*

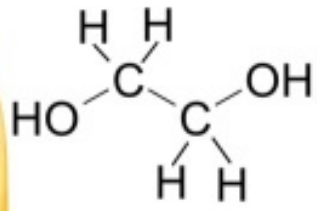
Polyhydric alcohols

Alcohols whose molecules contain more than one **hydroxyl group** (see introduction).

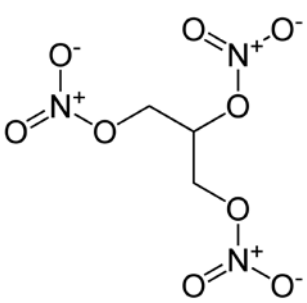
Ethane-1,2-diol, *or* ***ethylene glycol*** *is a* ***diol*** *(contains two* ***hydroxyl groups****). Used as antifreeze.*

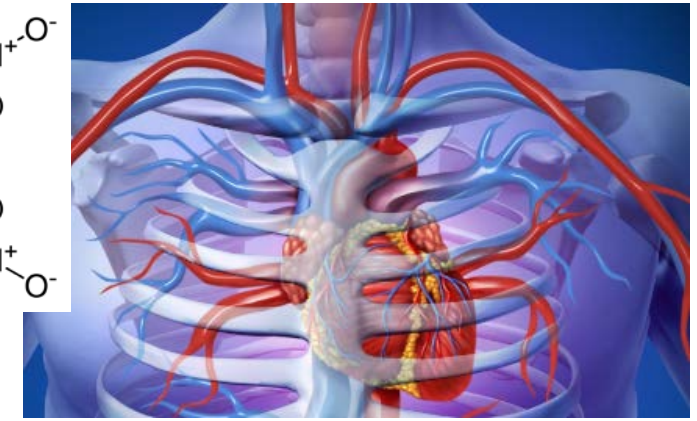
Propane-1,2,3-triol, ***glycerine***, *or* ***glycerol***, *is a* ***triol*** *(contains three* ***hydroxyl groups****). Used to make explosives.*





Ethylene glycol





Nitroglycerin for Acute Coronary Syndrome

Condensation reaction

A type of reaction in which two molecules react together to form one, with the loss of a small molecule, e.g. water. (See also **condensation polymerization**, page 200.)

Example of a ***condensation reaction****:*

$$CH_3CH_2OH + CH_3COOH \rightarrow CH_3COOCH_2CH_3 + H_2O$$

Ethanol	*Ethanoic acid*	*Ethyl ethanoate*	*Water molecule is lost*

This reaction is also an **esterification reaction** as the product ethyl ethanoate is an **ester***. An alcohol and an organic acid always react to form an ester.

Protein Structures

一次構造

Primary Structure = sequence of amino acids

3-letter code

Lys-Thr-Tyr-Phe-Pro-His-Phe-Asp-Leu-Ser-His-**Gly** ...

1-letter code

KTYFPHFDLSH**G**

二次構造

Secondary Structure = alpha helices, beta strands

三次構造

Tertiary Structure = fold helices and strands into domains

四次構造

Quaternary Structure (Biological Units) = functional assemblies of chains (subunits)