Alcohol in the body

Have you ever taken a *xenobiotic*? No? Well, if you hadn't you wouldn't be alive. Xenobiotics are substances which the body doesn't contain but which can affect it. They can be divided into three types:

- **foods** provide the molecules which give us energy and keep our bodies well maintained
- **drugs** alter the biochemical processes in our bodies, for example changing the way we feel and behave – drugs which lead to an improvement in health are called **medicines**
- ***poisons*** *severely damage our biochemical processes* and cause a deterioration in health or even death.

You must have eaten foods, and you would be very unusual if you had not taken at least one medicine. You would have been unwise if you had taken non-medicinal drugs or poisons.

But some substances can behave in more than one way. Their effect depends on the quantity you take and on your state of health. Ethanol is an example; it is a source of energy, but it also affects behaviour, and, in excess, can cause liver damage and even death.

In this unit you will find out how chemists design medicines to perform specific tasks in the body. This involves making new compounds and modifying existing ones. To do this they need to have a 'tool-kit' of reactions which can be used to convert one compound into another. You can read about using organic reactions in this way in **Chemical Ideas 14.1** and **14.2**.

Aldehydes and ketones are important intermediate compounds in many synthetic routes. You can read about their chemistry in **Chemical Ideas 13.7**.

Alcohol as a food

Some people celebrate Christmas with a Christmas pudding ablaze with burning brandy. This is a reminder that energy is released when ethanol reacts with oxygen to produce carbon dioxide and water. Oxidation of ethanol in the body is more controlled and less complete, but it is still highly exothermic.

At the present time, alcoholic drinks contribute about 6% of the total dietary energy intake of people in the UK. In the 17th century they accounted for almost 25% – for children as well as adults. The common drink at that time was beer.

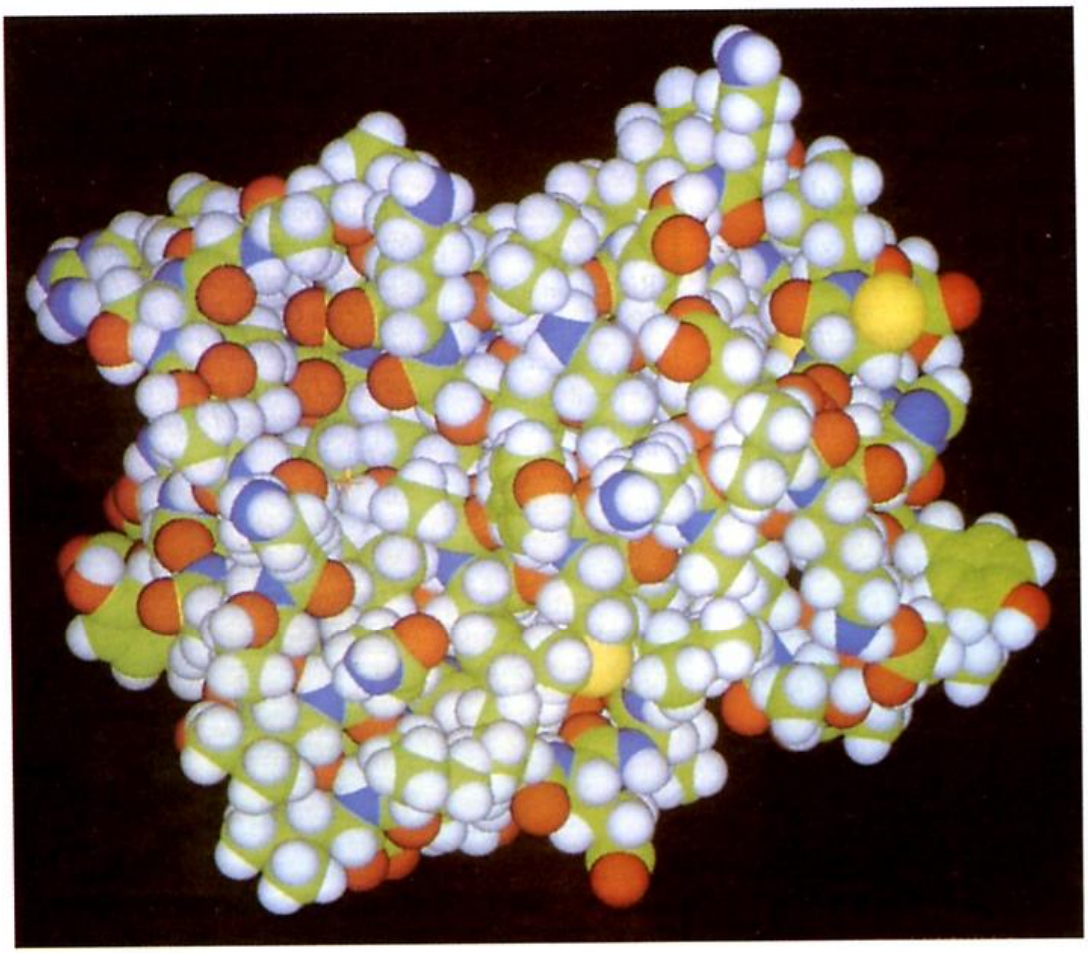

Figure 1 Molecular graphics systems are vital in the design of modern medicines. This shows a computer-generated graphic of interleukin–2, used in the treatment of some cancers.

ASSIGNMENT I

(You will need to refer to the Data Sheets to answer parts of this assignment.)

When ethanol burns, carbon dioxide and water are produced. Under more controlled conditions such as in bacterial metabolism, ethanol can be converted into ethanoic acid.

a Write a balanced equation for the complete combustion of ethanol. Look up the standard enthalpy change for this process.

b i Write a balanced equation for the oxidation of ethanol by oxygen to produce ethanoic acid and water.

ii Using Hess's law and appropriate enthalpy changes of formation, calculate the standard enthalpy change for this reaction.

c Metabolism of ethanol in the human body releases about 770 kJ per mole of ethanol. Suggest what might be likely products of ethanol oxidation in human metabolism.

d Some ethanol is not metabolised. Suggest two ways in which ethanol can be lost from the human body.

Alcohol as a drug

Alcoholic drinks make many people feel better for a short time. They help them to relax or cope with stress. Alcohol can make them feel happier and relieve tension, anxiety or boredom. These effects are all outcomes of a single aspect of the behaviour of ethanol molecules in the body – they depress the activity of the central nervous system. This is explained in more detail in Section **MD2**.

Figure 2 Many road accidents involve either drivers or pedestrians who have drunk too much alcohol.

This depression of nervous activity has important short-term effects. Drinking alcohol reduces vigilance, slows reaction times and impairs our judgement. It is largely because of these effects that so many laws have been introduced to control the use of alcohol. This is particularly important in relation to driving motor vehicles.

Blood alcohol concentration (BAC) is closely related to the extent of the effects of alcoholic drinks. It is usually defined as

BAC = mg of ethanol per 100 cm^3 of blood

The quantity of alcohol needed to produce a particular BAC varies with age, sex, body weight, how quickly you drink and several other factors. The concentration of ethanol in the blood rises for some time after taking a drink, as the alcohol is absorbed. Then it slowly decreases as the ethanol is excreted or metabolised.

A 'unit' of alcohol is a convenient measure of how much ethanol is contained in a drink. It is an approximate measure, roughly equivalent to

- a half-pint of beer or lager
- a glass of wine
- a single measure of spirits.

Figure 3 Some wine bottles now show how many units of alcohol are present in one glass of wine.

Paul's story

Dr Paul Williams, who worked on the development of the 'Alcolmeter' and is now International Marketing Director for Lion Laboratories Ltd, Barry, South Glamorgan, describes his career.

Figure 5 Paul Williams and the 'Lion Alcolmeter'.

"After A-levels, and a degree in Applied Chemistry, I realised I was interested in forensic chemistry. Luckily for me, a research post was advertised on a project to develop an electrochemically based instrument for the breath alcohol testing of drink-driving suspects.

"I got the job, gained an MSc and PhD while doing it, and at the end of 4 years had developed the 'Alcolmeter' instruments. During this time, I decided that the business life was for me – particularly marketing, where I could use my scientific training to talk to potential customers on their own level.

"So, having developed the 'Alcolmeter', I went out and sold it! There is no better way to learn the trade than to hawk your wares from a company car for a year or so. That set me up to be made Marketing Director for Lion Laboratories.

"Instead of selling, I was now formulating company marketing policy, and getting to talk to 'high fliers' in the alcohol field around the world. The Vauxhall gave way to a Boeing, and home became very often a room in the local Sheraton, Hilton or Intercon. The opportunity to travel to South America, Africa and the Middle East annually, the US at least three times a year and – of course – Europe, meeting police officers and forensic scientists, being able to talk with them and, in many cases, to educate and inform them, are features of the job which I enjoy and find intellectually satisfying.

"Providing expert testimony in court is also a regular part of the job – daunting at first, but easier as it goes along.

"And it was with great pleasure that I became a Fellow of the Royal Society of Chemistry in 1996, based on all this work.

"I think my training did more to help me in my career than simply to provide the chemistry I needed. It improved my memory, and taught me to analyse and evaluate situations logically – which is very useful in the modern commercial world. If you are thinking of 'going commercial' it is probably best not to become too specialised. Keep a broad subject base and make sure your knowledge is practical – that way it is capable of being applied to the job in hand."

Back at the station .....

The techniques used for roadside breath tests give a quick, reliable result but are not used for evidence in court cases as the instrument does not give a print-out at the time of testing. If the roadside test indicates a high level of alcohol, the driver will be taken to a police station for a more accurate determination of BAC.

At the police station, most suspects undergo a second type of breath test, where the ethanol concentration is measured using **infrared spectroscopy** (Figure 6). The driver is asked to breathe continuously into the cell of an i.r. spectrometer and the intensity of radiation absorbed at 2950 cm^{-1} is measured. If the driver is incapable or suffers from a breathing problem such as asthma, blood or urine samples are taken by a doctor. Two samples are taken, one for the forensic service and one for the driver, who can use it to have the analysis checked independently. The sample is analysed in the forensic laboratory using **gas–liquid chromatography** (**g.l.c.**).

Figure 6 The Lion Intoxilyzer analyses the ethanol in a suspect's breath by absorption of infrared radiation. An immediate print-out of the result is obtained. This is shown to the driver and can be used as evidence in court cases.

Gas–liquid chromatography is described in **Chemical Ideas 7.6.**

You can read about infrared absorption spectroscopy in **Chemical Ideas 6.4.**