Alcohol in your body

All over the world, people drink alcoholic drinks. They drink them to have a good time, to celebrate, to forget their worries and their cares. Alcohol is a drug, and so its use is usually controlled. Children may not be allowed to buy alcohol, or to drink it. In some countries, alcoholic drinks are banned all together. Governments put tax on alcohol to make it more expensive and so reduce consumption.

The effects of alcohol

When you drink an alcoholic drink, the alcohol gets into your blood stream. The table shows the effect of different concentrations of alcohol. (The concentration is shown as the number of milligrams of alcohol in every 100 millilitres of blood.)

<table>
<thead>
<tr>
<th>concentration of alcohol (mg/100 ml)</th>
<th>approximate effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>sense of relaxation and well-being</td>
</tr>
<tr>
<td>40</td>
<td>less inhibited, talkative, increased sense of well-being, greater likelihood of accidents</td>
</tr>
<tr>
<td>60</td>
<td>ability to make decisions impaired</td>
</tr>
<tr>
<td>80</td>
<td>physical co-ordination diminishes</td>
</tr>
<tr>
<td>100</td>
<td>deterioration in physical and social control; obviously drunk</td>
</tr>
<tr>
<td>140</td>
<td>staggering, double vision, vomiting</td>
</tr>
<tr>
<td>400 - 500</td>
<td>death</td>
</tr>
</tbody>
</table>

Activity 1: Questions for discussion

- At what age are you allowed to drink alcohol in your country?
- At what age can you buy alcoholic drinks?
- Should parents impose stricter rules on their children, as far as drinking alcohol is concerned? Should parents introduce their children to alcohol gradually?
- Do you know of any other countries or societies where the rules are stricter, or more lax?
How much alcohol?

The container of an alcoholic drink is usually labelled to show how much alcohol there is in it. Beer is much weaker than whisky: beer might contain only 4% alcohol, but whisky might contain 40%. The table shows some typical values, as well as the volume of alcohol in a standard drink. These are the standard sizes of drink served in Scotland and Ireland.

<table>
<thead>
<tr>
<th>beverage</th>
<th>volume of standard drink</th>
<th>concentration of alcohol</th>
<th>volume of alcohol in standard drink</th>
</tr>
</thead>
<tbody>
<tr>
<td>beer</td>
<td>1 pint (= 550 ml)</td>
<td>4%</td>
<td>22 ml</td>
</tr>
<tr>
<td>wine</td>
<td>1 glass (= 125 ml)</td>
<td>12%</td>
<td>15 ml</td>
</tr>
<tr>
<td>sherry</td>
<td>1 glass (= 125 ml)</td>
<td>20%</td>
<td>25 ml</td>
</tr>
<tr>
<td>whisky</td>
<td>1 single (= 35 ml)</td>
<td>40%</td>
<td>14 ml</td>
</tr>
</tbody>
</table>

The volume of alcohol in a pint of beer is worked out like this:

\[
\text{Volume of alcohol} = \text{volume of standard drink} \times \text{concentration of alcohol} \\
= 550 \text{ ml} \times 4 \\
= 22 \text{ ml} \frac{4 \times 550}{100}
\]

Some olde units

In most parts of Europe, the volume of a drink is given in millilitres (ml), but the table shows some older measurements, such as the pint, that are still used today.

An old-fashioned way of describing the strength of an alcoholic drink was known as ‘proof’. A 70% proof spirit such as whisky contains 40% alcohol. In Scotland, some beers are labelled as ‘40 shilling ale’ (40/- ale). This was the amount of tax paid on a barrel of the beer; the stronger the beer, the more the tax.

Activity 2: How much alcohol? – Some calculations

1. If one pint of beer contains 22 ml of alcohol, how much alcohol is there in a half pint?
2. A can of Scottish beer is labelled ‘80/- Scotch ale’, volume of 440 ml, alcohol 6% by volume. How much alcohol does it contain?
3. In France, it is recommended that you should not drive after consuming more than about 30 ml of alcohol. How many glasses of wine contain this much alcohol?
Burning up alcohol

Alcohol is absorbed into the bloodstream from the stomach. Eventually it is broken down in the liver. Scientists have measured how long the alcohol stays in someone's blood, after they have been drinking. The graph shows their results.

Activity 3: Data analysis

Look at the graph:

- Which line is for the person who has consumed most beer?
- The alcohol in a drink doesn't take full effect until some time after it has been drunk. How can you tell this from the graph?
- The liver breaks down alcohol at a steady rate. How can you tell this from the graph?
- What is the drink-driving limit, in mg of alcohol per 100 ml of blood, as shown on the graph?
- If you drink two litres of beer, how long should you wait before you are likely to be below the drink-driving limit?

Activity 4: Devising a publicity campaign

- In some countries, the drink-driving limit is 50 mg/100 ml; in others it is 80. What is it where you live?
- Do you think people stick to the limit? Are younger drivers more or less careful than older ones?
- Look back to the table on page 1. What do you think would be a safe limit?
- How much beer could someone drink and still drive safely?
- How could you use the graph on this page to help people understand the dangers of driving under the influence of alcohol?
- Devise a poster, a talk or a TV commercial to show your ideas in a convincing way.
Enzymes at work

The chemical name for the alcohol in alcoholic drinks is ethanol. It is a compound of carbon, hydrogen and oxygen; its chemical formula is C₂H₅OH. In the liver, ethanol is oxidised – it combines with oxygen, like burning. In the end, it becomes ethanoic acid, the same acid that is found in vinegar.

\[
\text{C}_2\text{H}_5\text{OH} + \text{O}_2 \rightarrow \text{CH}_3\text{COOH}
\]

ethanol + oxygen \rightarrow ethanoic acid + water

To make the oxidation happen, an enzyme called LAD has to be present. LAD is ‘liver alcohol dehydrogenase’, and it is found in the liver. People who drink too much may damage their liver; then they don’t have enough LAD to burn up the alcohol quickly, so it stays around in their blood stream for much longer.

A genetic effect

In the Far East, people tend to avoid alcohol. If they do drink some, their faces go bright red and they feel very ill. This is because they do not have the LAD in their liver which is needed to burn up the alcohol. The alcohol is simply turned into ethanal, which is a poisonous substance that makes you feel very ill.

ethanol/ethanal

To make LAD, liver cells must contain a gene to make the enzyme. It’s not just most Far Eastern people who don’t have this gene. A few European people don’t have it, as well as many people in eastern countries including India and China. Geneticists don’t understand why this gene is missing, but perhaps it helps to explain why drinking alcohol is frowned on in so many of these countries.

A cure for alcoholism

Some people become addicted to alcohol. This addiction is known as alcoholism. Some alcoholics are helped by taking a drug called antabuse. Originally, antabuse was designed as a drug to kill parasitic worms which sometimes get into people’s guts. Then it was noticed that, if the patient had been drinking alcohol, the antabuse made them feel very sick. Antabuse stops LAD doing its work so the patient’s body fills up with ethanal. This makes them feel so ill that they soon learn to avoid drinking alcohol.

Activity 5: Discussion

- Young people tend to drink different alcoholic drinks than those chosen by older people.
- What alcoholic drinks are advertised to young people in magazines and in cinemas? What techniques are used to sell these drinks?
- Do you know of any alcoholic drinks which are specifically designed to appeal to young people? Is it fair to try to sell these drinks to young people, given the dangers of alcohol?
Alcohol in your body – Teacher’s Notes

Acknowledgement

This module is based on ideas and information from *Organic Chemicals in Everyday Life*, published by the Irish Science Teachers’ Association.

Introduction

In this module, students are asked to:

- consider the social context of alcohol consumption;
- calculate the alcohol content of a variety of drinks;
- analyse data relating to the metabolism of alcohol in the body;
- apply their knowledge to devise publicity in favour of responsible alcohol use.

Scientific concepts

- concentration of substances;
- metabolism;
- oxidation;
- enzymes;
- genetic characteristics.

Teaching approaches

The consumption of alcohol is a sensitive topic. Some students may already be users of alcohol; others may come from backgrounds where alcohol is not used; some may have cases of abuse in their families. Some caution will be needed in opening up this topic.

The module shows how some basic ideas from chemistry can be applied in a Health Education topic. You might start by having a brief discussion of the effects of alcohol on the body, as shown in the table on page 1. It is likely that students will take the opportunity to tell of their own experiences (first or second-hand). This can cause amusement; however, it is advisable to let this run its course before making the point that alcohol use and abuse is a serious topic. All societies where adults use alcohol as a social drug have rules about alcohol consumption, and ways of inducting children into sensible use. This is the focus of the discussion on page 1. Thereafter, the unit deals with various aspects in a fairly straightforward way.

Notes on the activities, answers to questions

*Page 1:* As mentioned above, this page introduces the idea of alcohol as a social drug in many societies. The discussion questions deal with some factual points; the answers to these will depend on the country where you live. Students may well know of the situations in other countries, and this is an opportunity to consider whether the rules in your own country might be changed. You might wish to point out that the descriptions of the effects of alcohol on the body are only approximate. Different people react differently; this is discussed further on page 4. Everyone needs to discover their own level of alcohol tolerance.
Page 2: This page shows students how to calculate the quantity of alcohol in a standard drink. It also takes the opportunity to point out some unusual units in which the strength and volume of drinks may be measured; you may be able to provide other examples of such units. Students could discuss the merits or otherwise of 'rationalising' weights and measures.

1  11 ml of alcohol
2  26.4 ml of alcohol
3  2 glasses of wine

Page 3: The graph on this page shows the results of an experiment in which people were given various amounts of beer to drink; their blood was sampled at intervals. Students could be asked how they thought this graphical information was obtained. Then they could devise a protocol for this experiment.

1  The top line.
2  The graph takes a while to reach its peak.
3  The graph slopes down in a straight line.
4  50 mg/100ml
5  Approximately 6 hours.

All three lines slope downwards with the same gradient. It is interesting to note the reason for this. The liver has to oxidise the alcohol using the enzyme LAD (see page 4). At these concentrations of alcohol, the liver is working at top speed; all the available LAD reaction sites are in use. It is comparable to a petrol station with a long queue of customers. All the pumps are working continuously, and the queue decreases at a fixed, maximum rate.

In the activity to devise a publicity campaign, students should bring together all of the ideas which they have looked at so far in this unit. This could simply be a homework project, or you could allow more time for students to gather additional information. You will need to decide how much time to allow for this, whether they should work as groups, and so on. For students who are going on to look at page 4, you could delay this activity until the unit is completed.

Page 4: This page considers aspects of the metabolism of ethanol. You may need to explain that an enzyme is a biological catalyst. Students could be asked to write balanced equations for the two reactions shown at the top of the page. Only one major problem associated with alcohol consumption is mentioned: that of poisoning by ethanal (acetaldehyde), arising from LAD deficiency. This may have a genetic basis, or it may result from a damaged liver caused by alcohol abuse. Liver damage also results in defective protein production in the body, and many other problems. Alcohol affects the brain in a variety of ways, too: it causes dehydration (by osmosis), and can flush out vitamins, particularly vitamin B.

The final discussion provides an opportunity to consider the commercial pressures which young people are exposed to, to encourage them to drink alcohol.