Unit 3

Chemistry and Life

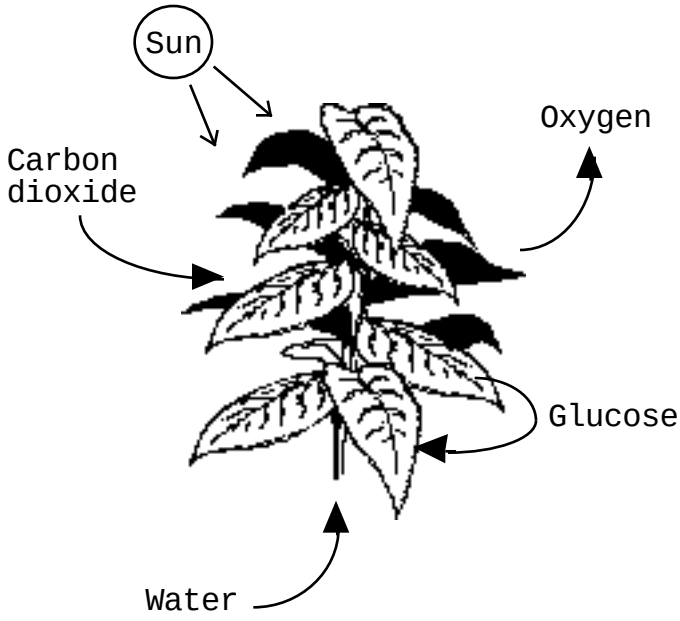
Photosynthesis

Plants make their own food by a chemical reaction called photosynthesis:

1. Carbon dioxide from the air is absorbed through the leaves.

2. Water is drawn up through the roots.

3. Light energy from the sun is absorbed by Chlorophyll - the green substance in the leaves.

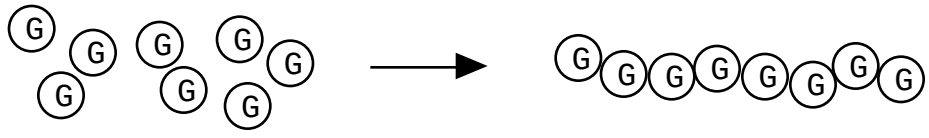


4. The plants use this light energy to make the Carbon dioxide and Water react to form Glucose (a sugar) and Oxygen gas:

Carbon dioxide + Water + Energy -> Glucose + Oxygen

5. The Oxygen gas is released into the air through the leaves.

6. The Glucose remains in the leaves and some is used as a food for the plant.
The plant links the rest of the Glucose molecules together to make Starch molecules:



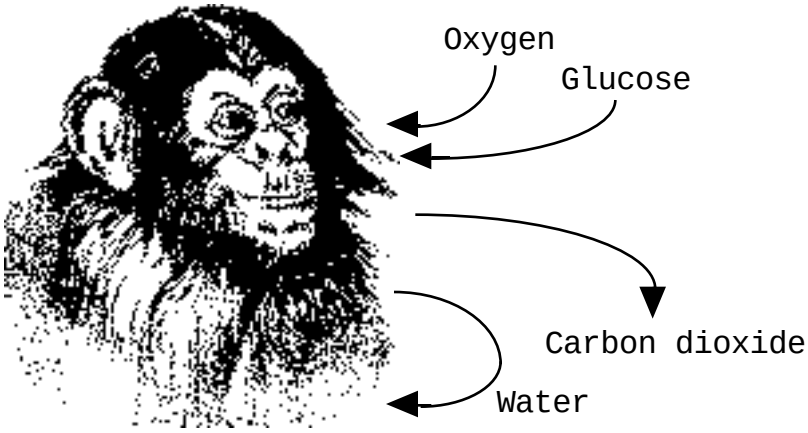
Glucose molecules Starch molecule

Thus the Glucose is stored, in Starch, as an energy supply for the plant's future use.

Respiration

Animals need energy for warmth and movement. They obtain this energy from a chemical reaction called respiration:

1. The animal eats the plant.



2. The Glucose from the plant reacts with the Oxygen breathed in by the animal forming Carbon dioxide, Water and energy.

Glucose + Oxygen -> Carbon dioxide + Water + Energy

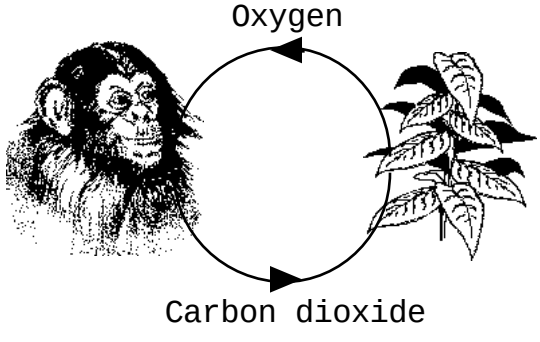
This is just the reverse of Photosynthesis (Sisehtnysotohp !)

3. The Carbon dioxide is breathed out.
4. The Water remains within the animal.
5. The Energy is used by the animal.

The combined effects of phtosynthesis and respiration maintain constant amounts of Carbon dioxide and Oxygen in the air:

Carbon dioxide is breathed out by animals but taken in by plants.

Oxygen is given off by plants but breathed in by animals.



Unfortunately man is upsetting the balance of Carbon dioxide in the atmosphere .... read on !

The Greenhouse Effect and Global Warming

Extensive clearing of forests reduces the amount of Carbon dioxide removed from the air by photosynthesis. This is causing an increase in the amount of Carbon dioxide in the air.

Increased burning of fossil fuels also contributes to the increasing amount of Carbon dioxide in the air.

Carbon dioxide in the air traps the sun's heat - a process known as the 'Greenhouse Effect'. The increasing amount of Carbon dioxide in the atmosphere is causing the Earth to gradually get warmer - a process known as 'Global Warming'.

'Global Warming' could result in changes in the Earth's climate and melting of the polar ice-caps resulting in an increase in sea-levels. How many feet above the sea do ***you*** live .... at the moment?!

Chemicals and Plants

We can use the following chemicals to help plants to survive:

Fungicides
These are chemicals which kill fungi which cause disease in plants.

Herbicides
These are chemicals which kill weeds which use up essential plant foods in the soil.

Pesticides
These are chemicals which kill pests like insects and slugs which eat the plants. Pesticides are toxic, however, and must be used with care. Natural predators can be used instead e.g. greenfly larvae are eaten by ladybirds.

Fertilisers

These are chemicals which provide plants with the three essential elements needed for normal, healthy growth: Potassium, Nitrogen and Phosphorus.

Compounds containing these elements are naturally found in the soil. Solutions of these compounds are taken in through the roots of plants.

In areas of natural vegetation (woodlands, bogs, moorlands etc) the decay of dead plants and animals returns all these essential elements to the soil. Harvesting plants for food, however, prevents this natural decay - plant foods are not returned to the soil. In this case, ***we*** must add fertilisers to the soil to restore the essential elements.
Fertilisers can be

- Natural materials recycled by man e.g. compost, manure etc

- Artificial (Synthetic) compounds, made by the chemical industry e.g. Potassium nitrate

Though it seems sensible to use natural fertilisers as much as possible, the increased demand for food has resulted in an increasing use of artificial fertilisers which are easier to produce in bulk.

To be taken in through the roots of plants, these artificial fertilisers must be soluble in Water.

Your teacher will provide you with three compounds. Test their solubilities in water.

Since artificial fertilisers are soluble in water, however, they get washed out of the soil and into rivers, lochs and end up in the public water supply! Nitrate fertilisers are particularly toxic and can kill all life in a river or stream.

Food and Diet

Unlike plants we cannot make our own food. We get all the essential elements and compounds we need from the food we eat.

The elements we need are present in the body and in our foods as compounds and not as the free elements.

The food we eat usually contains the following substances:

1. Carbohydrates

Carbohydrates are obtained from plants.
Carbohydrates are required for energy.
There are two types of carbohydrates in foods:

- sugars e.g. Glucose and Sucrose (table sugar)

  Sugars are carbohydrates with small molecules.

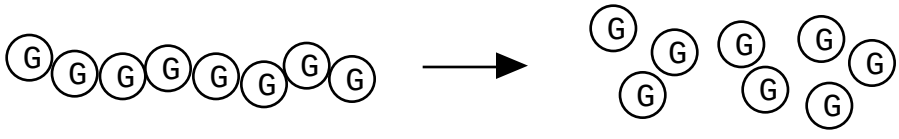
- Starch

Test for Starch in some foods by adding Iodine solution - the Iodine turns blue/black if Starch is present.

The Starch molecule consists of lots of Glucose molecules linked together to make a big long chain:

Starch molecule

During digestion, Starch is broken down into Glucose:



Starch molecule Glucose molecules

The Glucose is then carried by the blood stream to body cells where respiration occurs:

Glucose + Oxygen -> Carbon dioxide + Water + Energy

2. Fats and Oils

Fats and oils are obtained by eating butter, cheese, vegetable oils etc.

Test some foods for fats and oils by rubbing them on filter paper and warming gently. A greasy mark will appear if fats and oils are present.

Fats and oils are required to provide an energy store in the body. They provide us with much more energy than Carbohydrates.

Solid fats, otherwise known as saturated fats, are believed to increase the level of Cholesterol in the bloodstream. Cholesterol blocks arteries and causes heart disease. We should not eat saturated fats.

Liquid fats, otherwise known as unsaturated fats or oils, do not produce as much Cholesterol and are less harmful to the heart. If we need to eat fats, we should eat unsaturated fats.

3. Proteins

Proteins are obtained by eating meat, cheese, beans etc. Proteins are required for body growth and repair. Different proteins are used to make particular parts of the body e.g. the protein in our hair is different from the protein in our skin.

4. Minerals

These supply the body with small amounts of Calcium for making bone, Iron for making blood and trace elements e.g. Sodium, present in Sodium chloride (salt).

5. Vitamins

These are complicated Carbon compounds which are required to keep the body healthy.

e.g. a lack of Vitamin A leads to loss in weight, eye disease and more infections

6. Water

More than 60% of body weight is made up of Water. If you weigh 50 kg then you contain about 30 kg of Water!

7. Fibre

Fibre is the part of the plant we cannot digest. It is, however, very useful. It absorbs water and swells in the gut. This provides bulk for the gut muscles to work on as food is squeezed along. Fibre therefore keeps the gut working well and prevents constipation.

8. Food additives

Food additives are chemicals added by the food manufacturer for the following reasons:

- To improve the nutritional value
- To improve the flavour
- To improve the colour
- To prevent decay

They can only be used once they have been tested and approved.

All of the above substances, with the exception of the food additives, are essential for a **balanced diet**.

Drugs

A drug is a substance which alters the way the body works.

e.g. **Caffeine**, present in coffee and tea, is a stimulant.

Some drugs like medicines are beneficial.

In our body, chemical reactions are going on all the time to keep the body working properly. Medicines are usually made up of many chemicals; the active ingredient is a drug which helps the body when it is not working correctly.

e.g. **antibiotics** fight the micro-organisms (germs) which can cause infections

Some drugs can damage our health because of the way they affect our bodies and our lifestyle.

e.g. **Nicotine**, present in cigarette smoke, speeds up the heart rate and raises blood pressure.

Alcohol gives a feeling of well-being but slows us down. It damages the liver and brain if we take too much.

LSD causes hallucinations e.g. users think they can safely fly out of windows ten stories high!

Cannabis heightens the sense of colour, taste and music. It makes most users relaxed and talkative.

Ecstasy gives a feeling of well-being and increased alertness. Users push their bodies to the limit and heart failure can be the result.

Some drugs are addictive: we are unable to manage without them. Though we may know they are harmful, we cannot give them up.

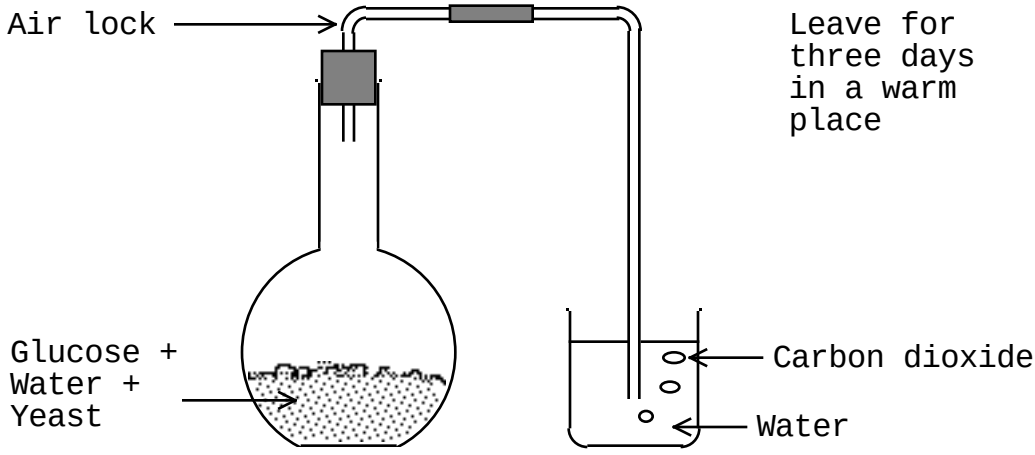
Some drugs are legal e.g. medicines, alcohol, Nicotine and Caffeine.

Others are illegal e.g. Cannabis, LSD and Ecstacy.

Alcohol

Alcohol is made by the reaction between Glucose and yeast, a reaction known as **fermentation**.

Your teacher will show you how to make alcohol from Glucose:



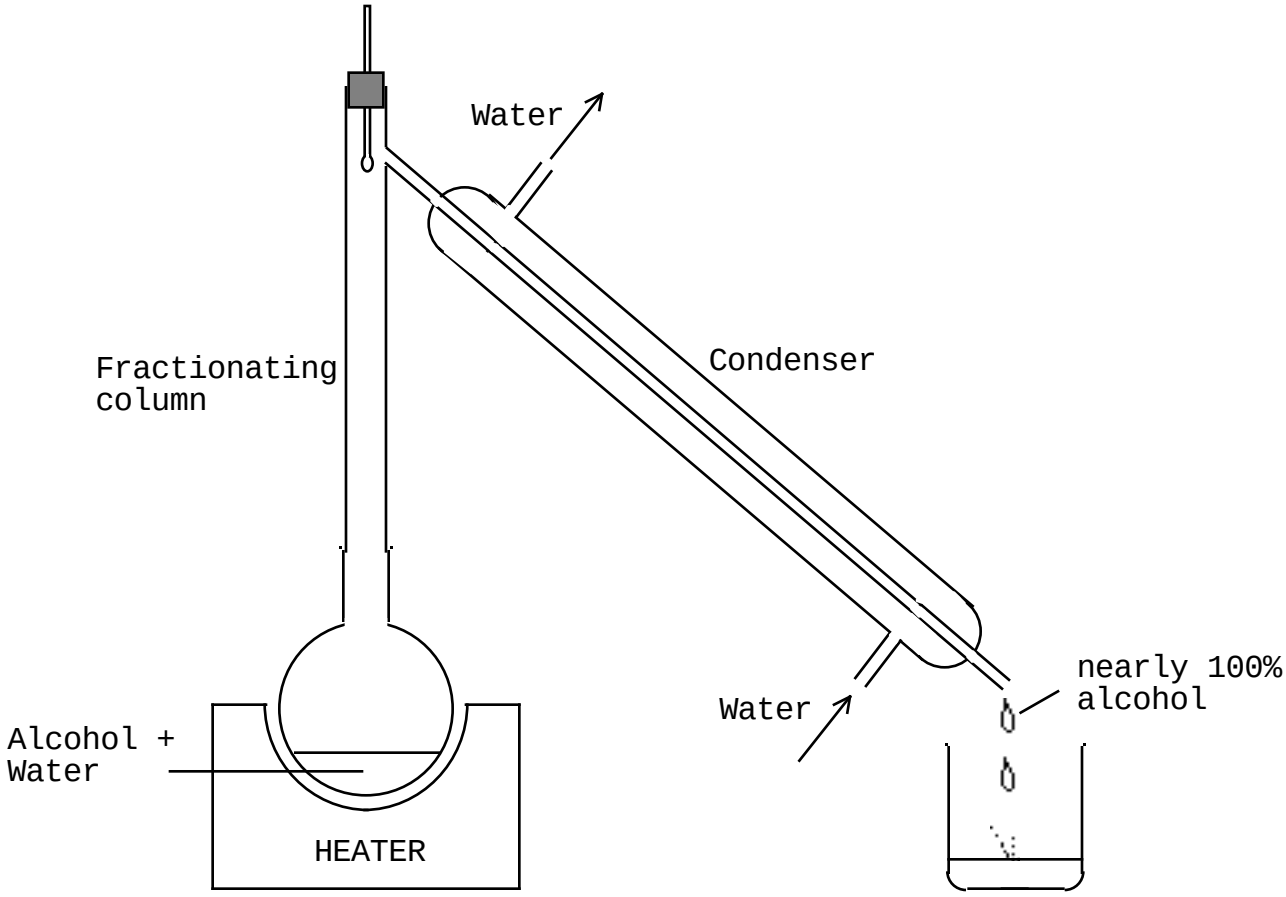
After a few hours bubbles of Carbon dioxide come out of the mixture. After a few days the froth dies down and the liquid smells of alcohol.

The Glucose required to make alcohol is obtained from plants. Alcoholic drinks are made by fermenting the actual plant material containing the Glucose. Different plants give different flavours and therefore different drinks e.g.

- Wine is made from grapes.
- Cider is made from apples.
- Beer is made from barley.

Fermentation produces very dilute alcohol (5-12%). Most of the mixture is water!

Your teacher will show you how to increase the concentration of the alcohol by a process called distillation:



Alcohol boils at 78 ^{0}C; Water boils at 100 ^{0}C. When we heat the mixture the alcohol boils out of the mixture first, condenses in the condenser and drips into the beaker as nearly 100% alcohol!

Spirits (whisky, gin, vodka etc) are made from this more concentrated alcohol.

Alcohol is usually measured in Units.

One unit = 10 cm^3 of 100% alcohol

A bottle of alcopop or a pint of beer contain about 2 units of alcohol.

A pub measure of spirit or a glass of wine contain about 1 unit of alcohol.

Alcohol is broken down in the body at about 1 unit per hour.