WJEC GCSE SCIENCE

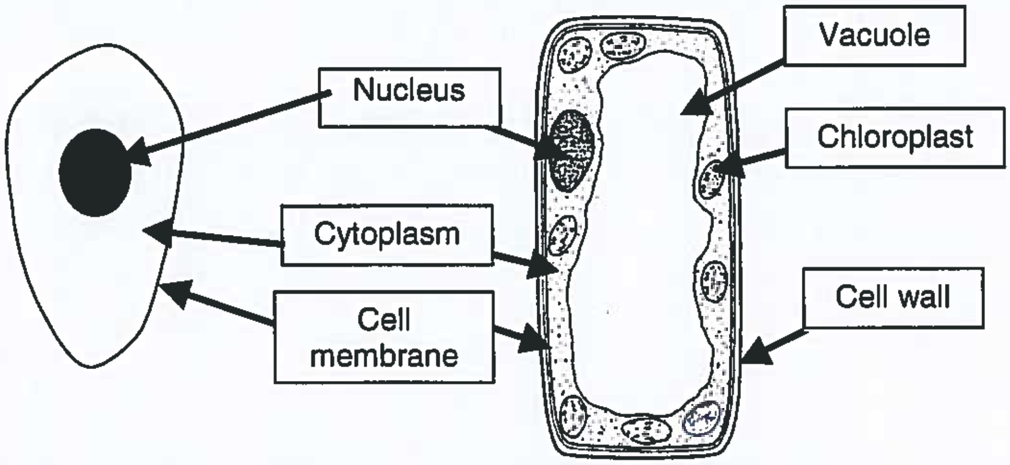
Triple Award
Biology Topics
Year 10

Revision Guide

Cells and Cell Processes

Plant and Animal Cells

Every organism, except viruses, contains one or more cells.
The size of the organism depends on the number of cells and not the size of the cells.



Examiners also like to compare animal and plant cells:

Plant Cells	Animal Cells
Cell wall present	No cell wall present
Chloroplast present	No chloroplasts present
Large permanent vacuole present	No permanent vacuole present

Function of cell parts

Part of cell	Function
Cell membrane	Controls substances entering and leaving the cell
Cytoplasm	Where most chemical reactions take place
Nucleus	Controls the activities of the cell/codes for making proteins
Cell wall	Supports the cell
Chloroplast	Absorb light for photosynthesis
Vacuole	Space filled with cell sap (a dilute solution of sugars and mineral salts)

Cell Theory

Cells were first described by Robert Hooke in 1665.
In the 1830s two German scientists, Theodor Schwann and Matthias Schleiden, using light microscopes, suggested the **cell theory:**

1. All organisms are composed of cells.
   They may be **unicellular** (one celled) or **multicellular** (many celled).
2. The cell is the basic 'unit' of life.

Scientists have modified the cell theory over time as new technology leads to new discoveries. Additions to the original cell theory are:

3. Cells are formed from pre-existing cells during cell division.
4. Energy flow (the chemical reactions that create life) occurs within cells.
5. Hereditary information (DNA) is passed on from cell to cell when cell division occurs.
6. All cells have the same basic chemical composition.

Microscopy

Light Microscopes
Light microscopes allow you to see the image because light passes through it.
The properties of light mean that it is impossible to magnify an image by more than *x1500*

Electron Microscopes
The electron microscope was developed in the 1930s.
It uses a beam of electrons instead of light.
It is possible to get much larger magnifications, up to *x50,000,000*.
Because you can't see electrons, the image is displayed on a monitor.
The disadvantage of electron microscopes is that you cannot see colour, and can only study dead cells.
Electron microscopes allowed scientists to discover the internal structures of cells.

Confocal Laser Scanning Microscopy
Lasers build up an image via a computer by scanning an object in the microscope.
Highly detailed images can be built up using this technique.
The technique does not produce as high a magnification as electron microscopy, but it produces clearer images than light microscopy.

1.1(c) Cell Form and Function, Specialised Cells

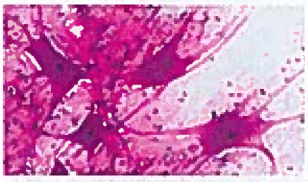
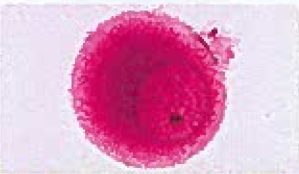
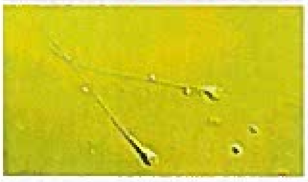
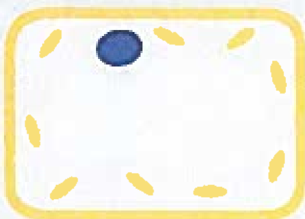
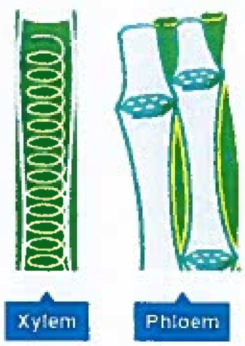
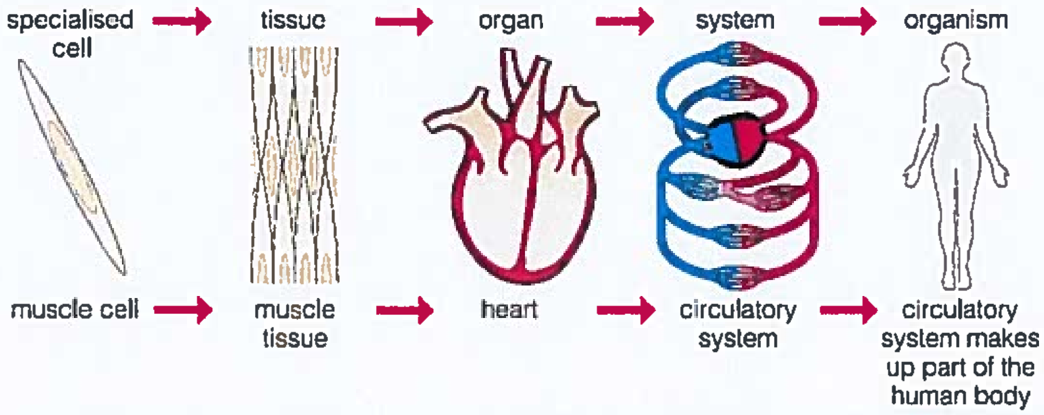
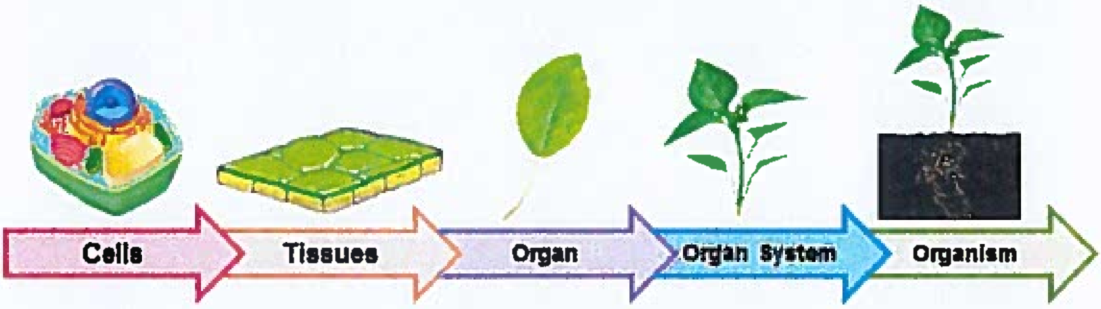
Image	Type of animal cell	Function	Special features
	**Red blood cells**	To carry oxygen	• Large surface area, for oxygen to pass through • Contains haemoglobin, which joins with oxygen • Contains no nucleus
	**Nerve cells**	To carry nerve impulses to different parts of the body	• Long • Connections at each end • Can carry electrical signals
	**Female reproductive cell (egg cell)**	To join with male cell, and then to provide food for the new cell that's been formed	• Large • Contains lots of cytoplasm
	**Male reproductive cell (sperm cell)**	To reach female cell, and join with it	• Long tail for swimming • Head for getting into the female cell • **Streamlined**

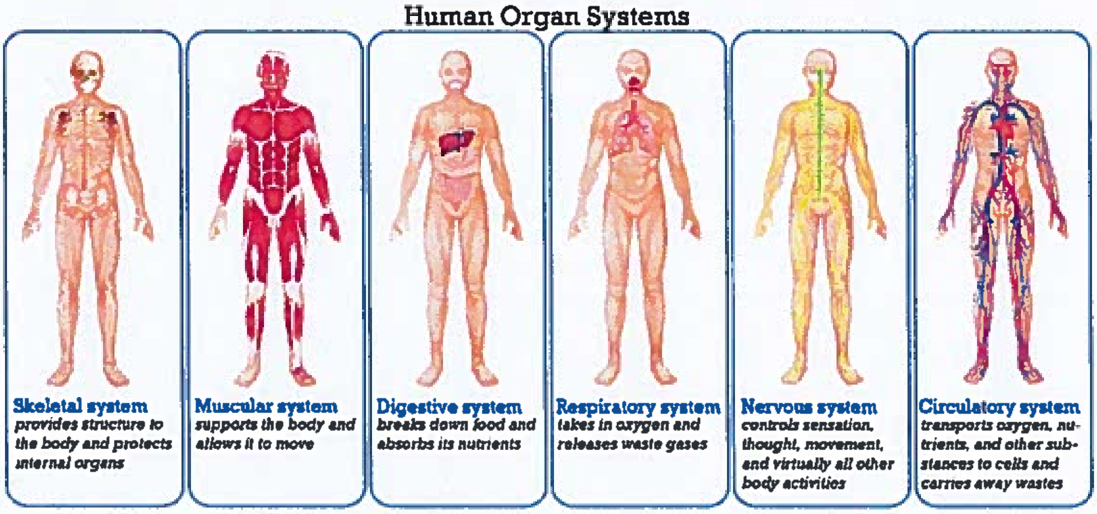
Image	Type of plant cell	Function	Special features
	**Root hair cell**	To absorb water and minerals	• Large surface area
	**Leaf cell** **Palisade Mesophyll**	To absorb sunlight for photosynthesis	• Large surface area • Lots of chloroplasts
		Xylem Carries water and minerals from the roots to the leaves. Phloem carries sugars made in the leaves to the rest of the plant.	Xylem have a primary and secondary cell wall. They have no cell contents and vessel elements at each end allowing the flow of water. Phloem have companion cells next to them which help load the sugars into them.

1.1(d) Levels of Organisation in Organisms

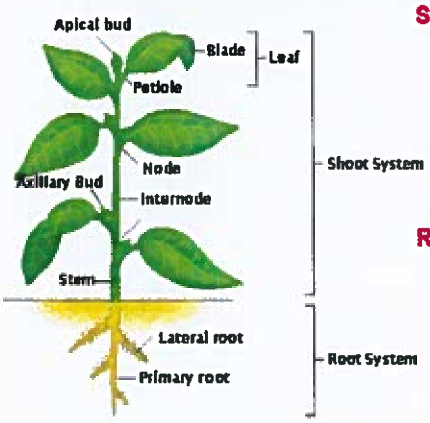




Human Organ Systems



The Plant Body Consists of the Shoot System and the Root System



Shoot System - Functions

- Photosynthesis
- Reproduction
- Storage
- Transport
- Hormones

Root System - Function

- Anchorage
- Absorption
- Storage
- Transport
- Hormones

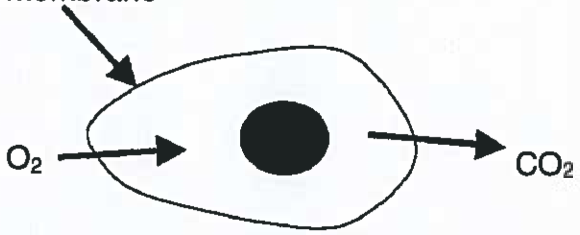
Substances Enter and Leave Cells Through the Cell Membrane

Diffusion

Molecules are constantly moving.

Molecules of liquids and gases collide against each other all the time.

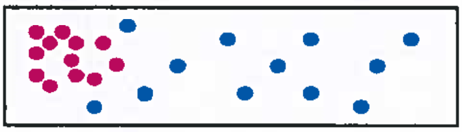
We see this process of **mixing** and **moving** in **diffusion**.

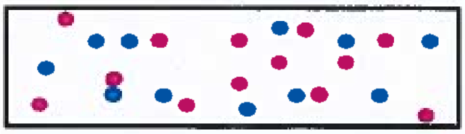


Oxygen and carbon dioxide pass through the cell membrane by diffusion.

Molecules diffuse from an area of high concentration to an area of low concentration.
This process does not require energy.

Fig. 1
Diffusion.
All liquid and gas molecules have kinetic energy;
they are constantly moving and mixing.





The rate of diffusion can be affected by the following factors:

1. Concentration

The greater the difference in concentration between two areas (the concentration gradient), the faster the rate diffusion happens.

2. Temperature

As the temperature increases, the rate of diffusion increases to (molecules have more kinetic energy).

3. Pressure

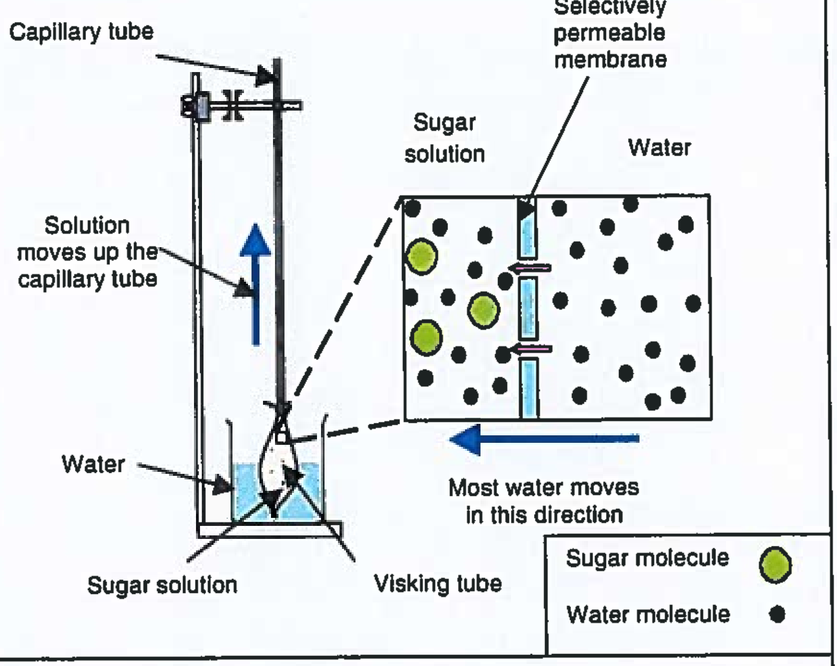
If there is high pressure, the molecules will quickly move from the area of high pressure to low pressure.

Osmosis Investigations 1 – Modelling Living Material

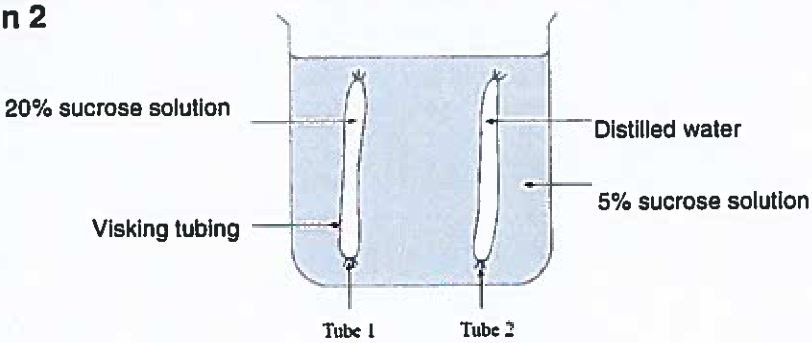
Visking tubing is very similar to the cell membrane.
It is also a selectively permeable membrane.
It has tiny holes (pores), which allow small molecules through, but stop molecules that are too large to fit through them.
You will also come across visking tubing in experiments to do with the digestive system).

Investigation 1

The concentration of water outside the visking tubing is higher than the concentration of water inside the visking tubing.
Water moves in through the pores in the selectively permeable membrane by osmosis.
This increases the pressure inside the visking tubing causing the solution to move up the capillary tube.



Investigation 2



Tube 1
Gets bigger (becomes turgid).
The **concentration of water outside** the visking tubing is **higher** than the **concentration of water inside.**
Water has moved in through the selectively permeable membrane by osmosis.

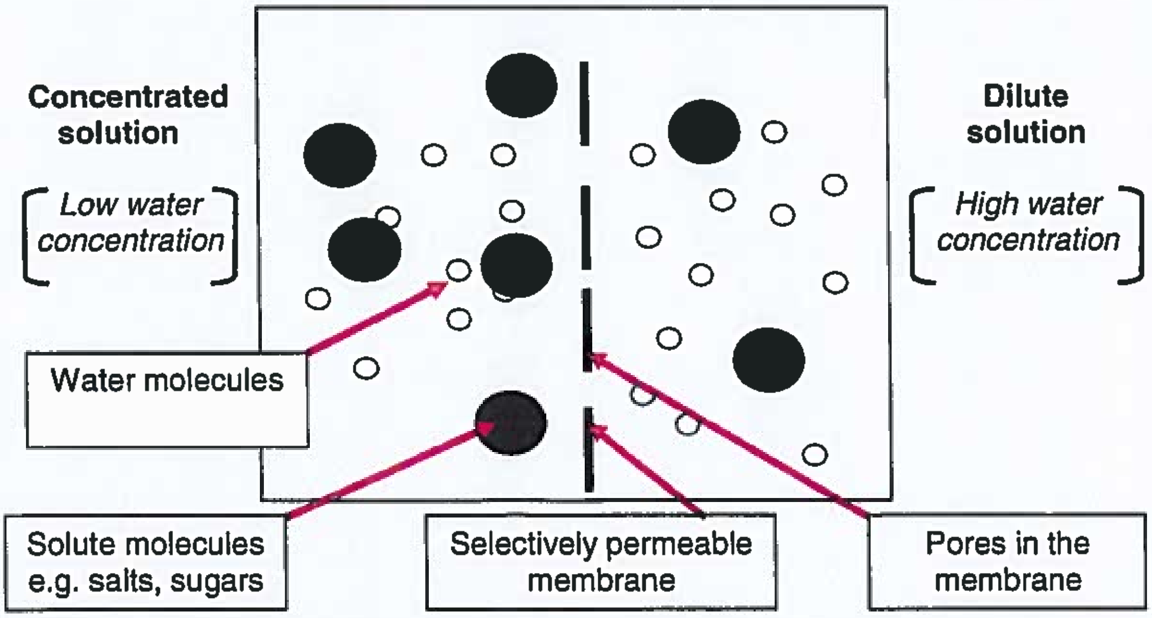
Tube 2
Gets smaller (becomes flaccid).
The **concentration of water inside** the visking tubing is **higher** than the **concentration of water outside.**
Water has moved out through the selectively permeable membrane by osmosis.

Substances Enter and Leave Cells Through the Cell Membrane

Osmosis

Osmosis is the **diffusion of water molecules** from an area of high water concentration to an area of low water **concentration through a selectively permeable membrane.**

The cell membrane is a **selectively permeable membrane;**
it lets some molecules through but not others.



The pores in the membrane allow small water molecules to pass through.
The solutes are too large to pass through the pores in the membrane.

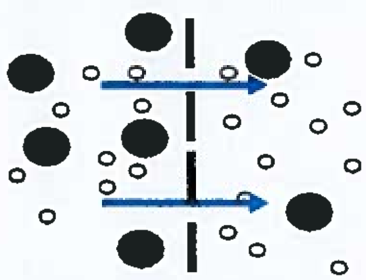


Fig.1
The movement of water is from an area of high water concentration to an area of low water concentration through a selectively permeable membrane.

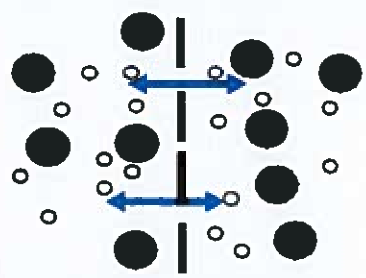


Fig. 2
No net movement of water.
The concentration of water on both sides of the membrane is equal. The same numbers of water molecules move in both directions.

Active Transport

When the concentration of a material is lower outside the cell it must be **actively transported** into the cell (sometimes referred to as **active uptake**).

During active transport, salts or ions are pumped from an area of low concentration to an area of higher concentration.
This process requires energy released by the cell.

Example – Uptake of nitrate ions by root hair cells

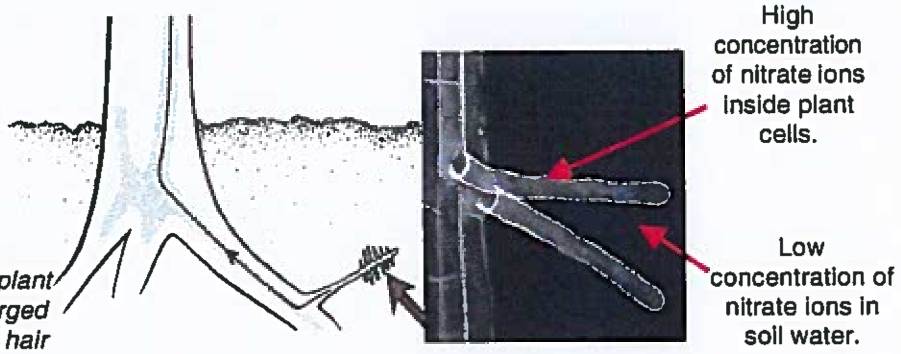


Fig. 1
Diagram of a plant root with enlarged view of a root hair cells.

- Nitrate ions cannot move in by diffusion.
- Nitrate ions must be actively transported from the soil water (an area of low nitrate concentration) to the inside of the plant cells (an area of high nitrate concentration).

Other examples of active transport include:

- Glucose actively transported from the small intestine into the blood.
- Marine algae can use active transport to concentrate iodine in their cells to concentrations a million times greater than surrounding sea water.

Factors affecting active transport

- Active transport needs **energy**.
- Energy is released during **respiration**.

Any factor that affects the rate of respiration will affect the rate of active transport:

- **Glucose concentration** – respiration needs glucose.
- **Oxygen** – aerobic respiration needs oxygen.
- **Temperature** – affects the enzymes controlling respiration.
- **Toxic substances** – e.g. cyanide stops respiration.

Enzymes

An enzyme is a biological catalyst; it speeds up a reaction, but it does not take part in the reaction.

At any one point in time, there are over 500 different chemical reactions taking place in every cell.

These reactions are controlled by a special type of molecule called an enzyme.

How do enzymes work?

The way enzymes work is described by the **lock and key** model.

A substrate is held in an active site, this increases the probability that a reaction will take place.

The Lock and Key Model

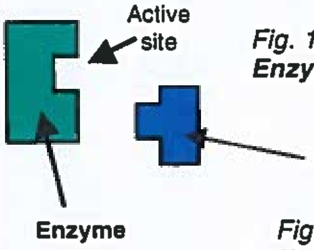


Fig. 1
Enzyme and substrate

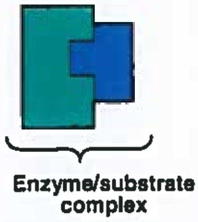


Fig. 2
Enzyme/substrate complex.
Only a substrate with a specific shape can 'fit' into the active site.
*The enzyme is **specific** to a certain substrate.*

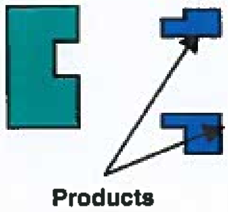


Fig. 3
Enzyme and products
Enzyme unchanged at the end of the reaction.

Properties of enzymes

1. Enzymes are **proteins**
2. Enzymes speed up/catalyse the rate of a chemical reaction.
3. All enzymes are **specific** and can only catalyse **one type** of molecule. *(See lock and key model above).*
4. Enzymes work best at a particular temperature – the **optimum temperature**.
   - If the temperature is higher or lower than this temperature the enzymes will catalyse the molecule at a much slower rate.
   - If the temperature gets too high the enzyme's active site will change shape and stop working – this is called **denaturation**.
5. Enzyme work best at a particular pH – the **optimum pH**.

How are the activities of a cell controlled?

All the activities of a cell depend on chemical reactions, which are controlled by special molecules called **enzymes**.

Enzymes are **proteins**.
Proteins have a number of important functions:

- enzymes,
- hormones (e.g. insulin)
- muscle tissue

The structure of proteins
Proteins are made of different **amino acids** linked together to form a **chain**:

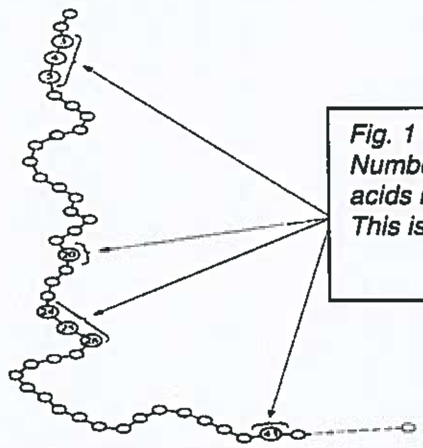


Fig. 1 – amino acid chain.
Numbers refer to the sequence of the amino acids in the protein chain.
This is determined by the 'triplet code' of DNA.

The chain is then **folded** to form a **specific shape**:
The specific shape of an enzyme enables it to function.

Active site of enzyme.
A cleft in the protein where a specific substrate 'fits'

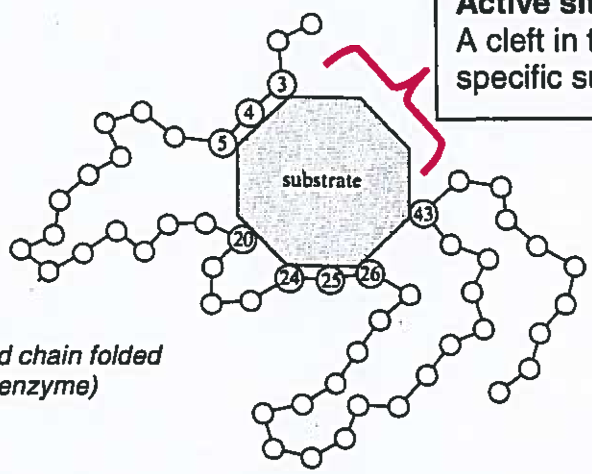


Fig. 2 – amino acid chain folded to form a protein (enzyme)

The active site of an enzyme depends on the shape (of the protein), which is held by the chemical bonds.

The Effect of Temperature on Enzyme Action

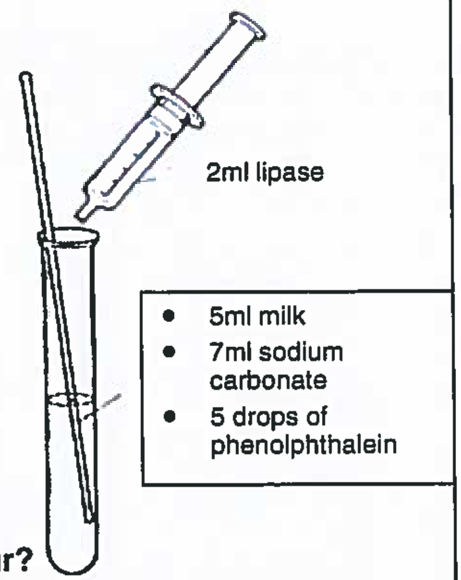
The effect of temperature on enzymes can be demonstrated using the following investigation.

Investigating effect of temperature on the activity of lipase

This investigation shows:

- how lipase activity changes with temperature
- how indicators can help us to follow chemical reactions.

1. Place test tubes containing milk, sodium carbonate and phenolphthalein in different water baths until the contents reach the same temperature as the water bath.
2. Add 2 ml of lipase and start timing.
3. The time taken for the solution to lose its pink colour is recorded.



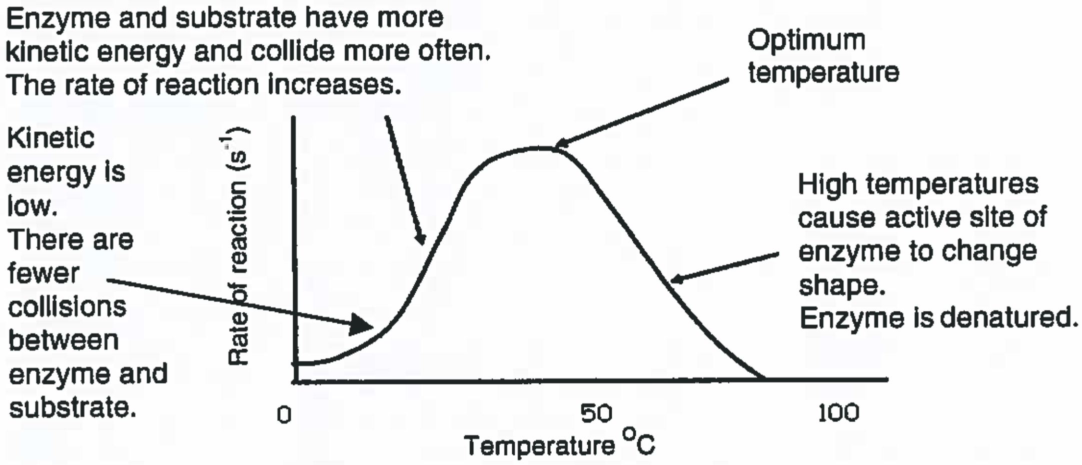
How is *rate of reaction calculated*(s^{-1})?

$$= \frac{1}{\text{time taken for solution to lose colour.}}$$

Why does the phenolphthalein change colour?

- When the fat in milk breaks down, fatty acids and glycerol are produced.
- The fatty acids lower the pH of the mixture, which changes the colour of the phenolphthalein from pink to colourless.

Interpreting effect of temperature on enzymes



Aerobic Respiration

Releasing energy from food (glucose) using oxygen

Through aerobic respiration, a cell gets its energy to do work or grow. Respiration occurs all the time (day and night) in all plant and animal cells.

You need to learn the formula for respiration:

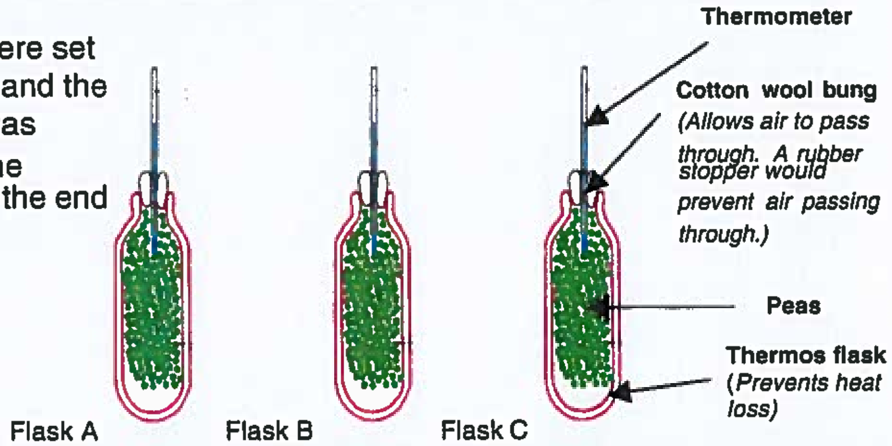
Glucose + Oxygen → Carbon Dioxide + Water + ENERGY

Water and carbon dioxide are the **waste products** that are removed from the body.

In animals, muscle cells use the energy to contract, and move their bodies. **Some energy is released as heat**, and this keeps the body temperature constant.

Investigating the energy released as heat during respiration.

Three flasks were set up (as shown) and the temperature was measured at the beginning and the end of a week.



Flask	Contents of flask	Flask temperature (°C)	
		At start	At the end
A	Pea seeds	20	32
B	Boiled pea seeds	20	28
C	Boiled pea seeds in disinfectant	20	20

Flask A – Temperature has increased because heat is released during respiration from the living cells of the peas.
Flask B – Temperature has increased because microbes such as bacteria are present. These release heat during respiration in their cells.
Flask C – A **control** flask. It shows the difference between living and dead peas. (The disinfectant has killed any bacteria).

Anaerobic Respiration

Releasing energy from food without using oxygen

This is what happens when there is not enough oxygen available.
It releases much less energy from each molecule of glucose than aerobic respiration because the glucose molecule is not completely broken down.

You also need to learn this equation:

Glucose → Lactic acid

Disadvantage of anaerobic respiration

- Lactic acid is released in the muscles, which can cause pain (cramp).

Advantage of anaerobic respiration

- Muscles can release energy for a short period when not enough oxygen is available, e.g. 100m sprints.

What is an 'oxygen debt'?

After using anaerobic respiration to release energy, an **'oxygen debt'** is created.
Breathing deeply after finishing exercise, to get oxygen to the muscle, breaks down lactic acid to water and carbon dioxide.

It is a good measure of fitness to see how quickly you can recover from an 'oxygen debt'.
A fit person can:

- Breathe in a greater volume of air.
- Produce less lactic acid,
- Break down lactic acid faster.

Anaerobic Respiration in Yeast (Fermentation)

Anaerobic respiration in yeast results in different products compared to animals:

Another equation you also need to learn:

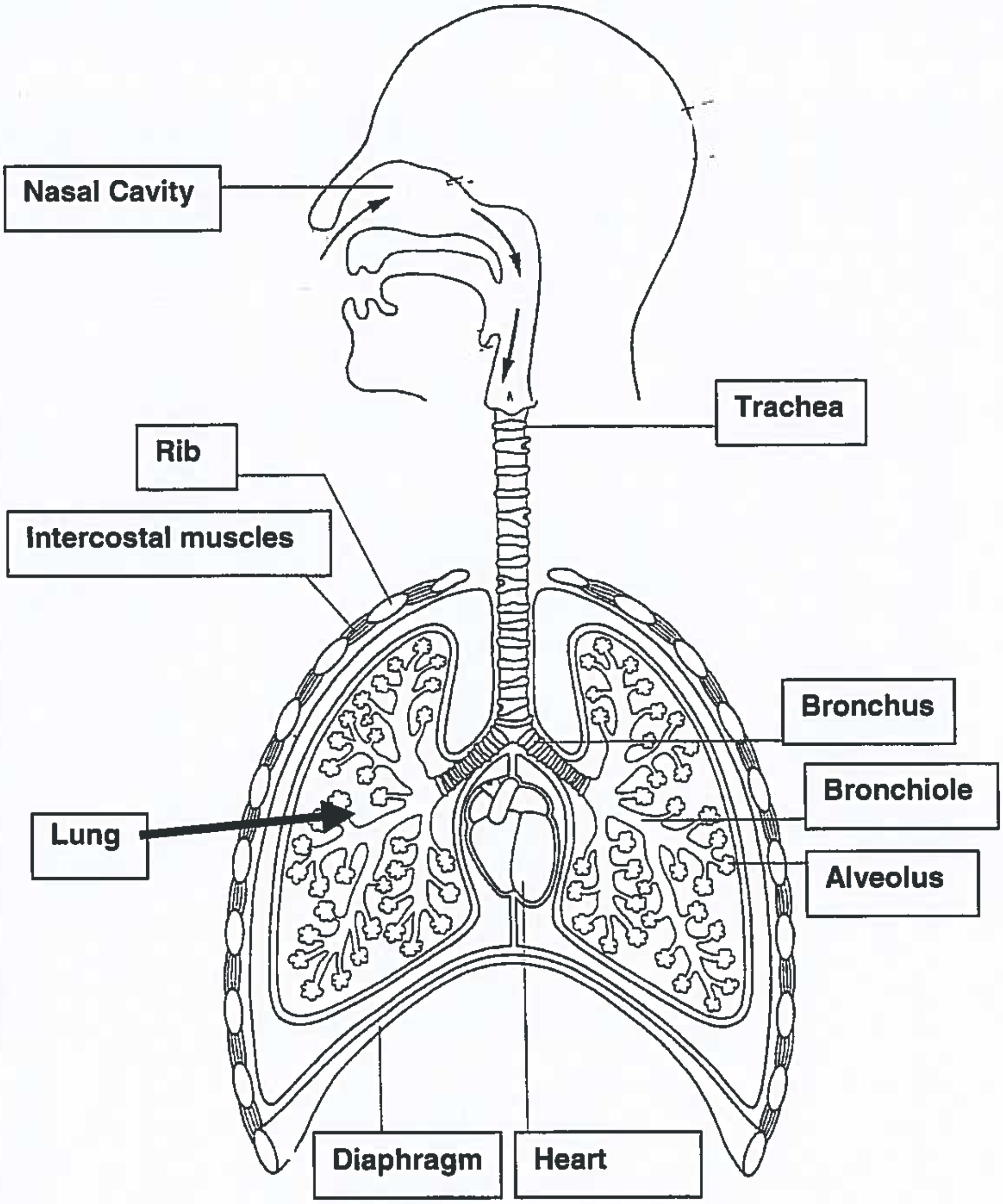
Glucose → Ethanol + Carbon dioxide

Humans, who brew alcoholic drinks by growing yeast in anaerobic conditions, use the reaction.

The Respiratory System

The function of the respiratory system is to:

- get oxygen into the blood
- remove carbon dioxide from the blood.



Gaseous Exchange in the Alveoli

The alveoli are the **respiratory surface** of the lungs.
The alveoli are full of air and are covered on the outside by blood capillaries.

Oxygen **diffuses** across the walls of the alveoli from the air into the blood.
Carbon dioxide **diffuses** across the walls of the alveoli from the blood into the air in the alveoli.

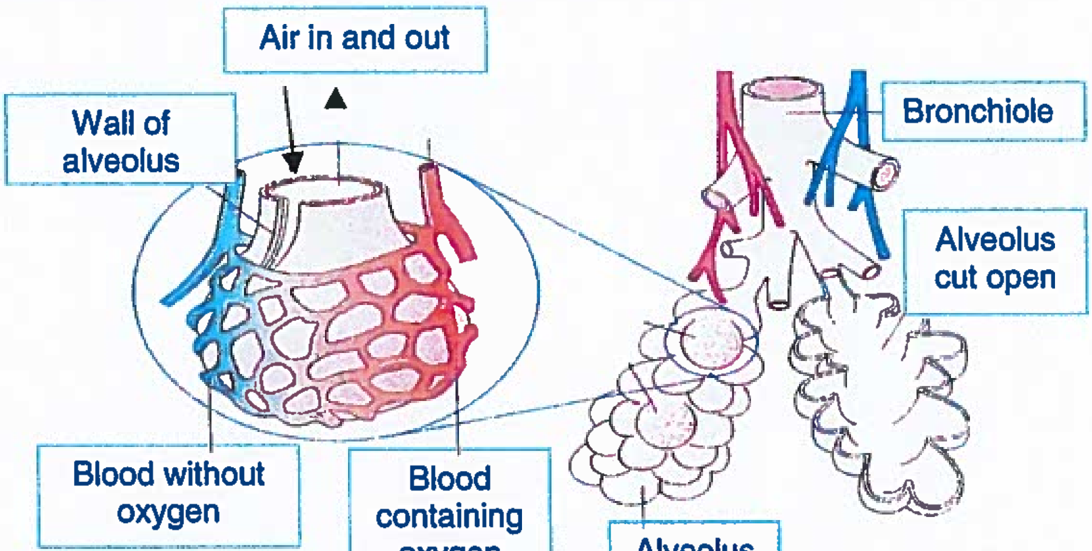


Fig.1 Outside view of alveolus.

How are alveoli adapted for gaseous exchange?

1. Good blood supply
So that more gases can be exchanged.

2. Large surface area
Increases gaseous exchange. (Provided by a large number of alveoli.)

3. Thin walls
Gases can pass through by diffusion much easier.

4. Moist lining
To dissolve oxygen so that it can diffuse through the alveolus wall.

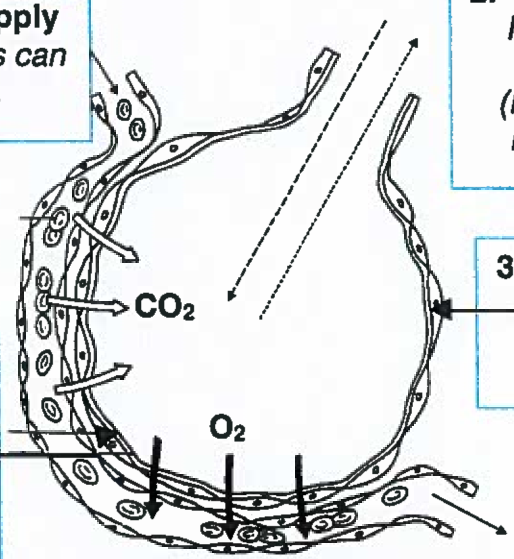
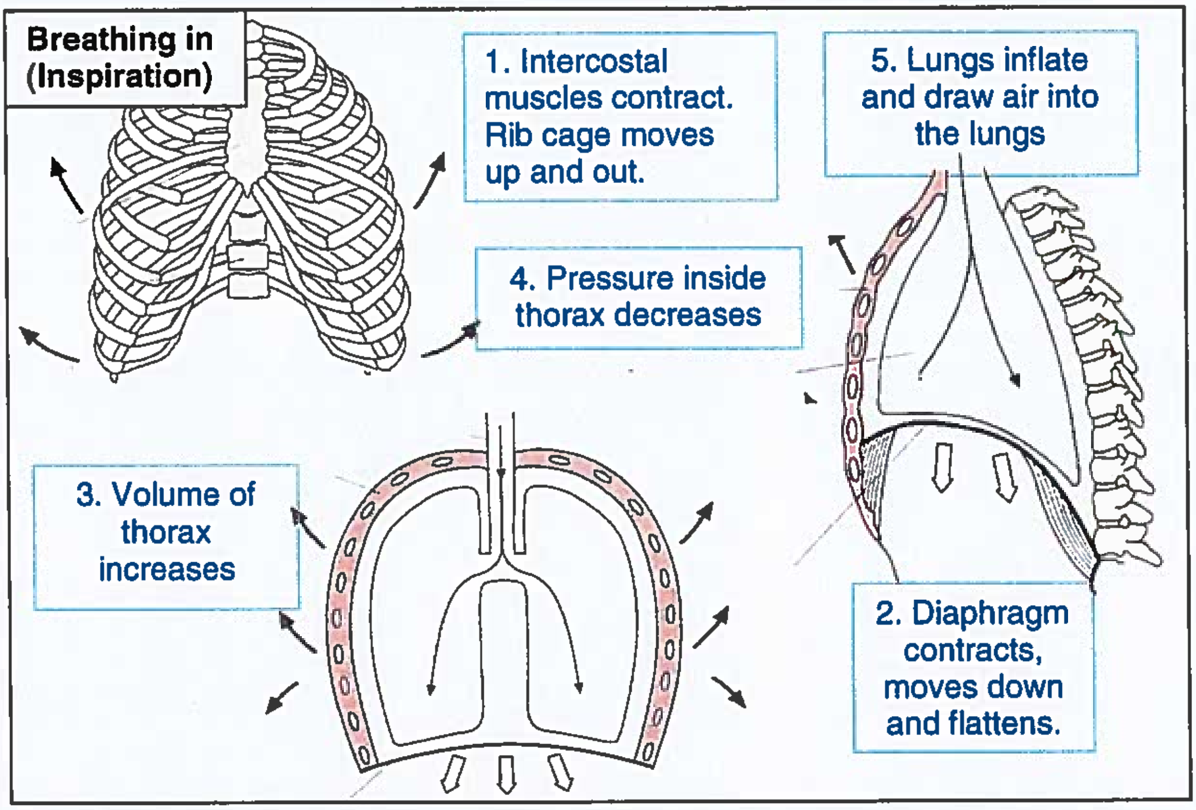
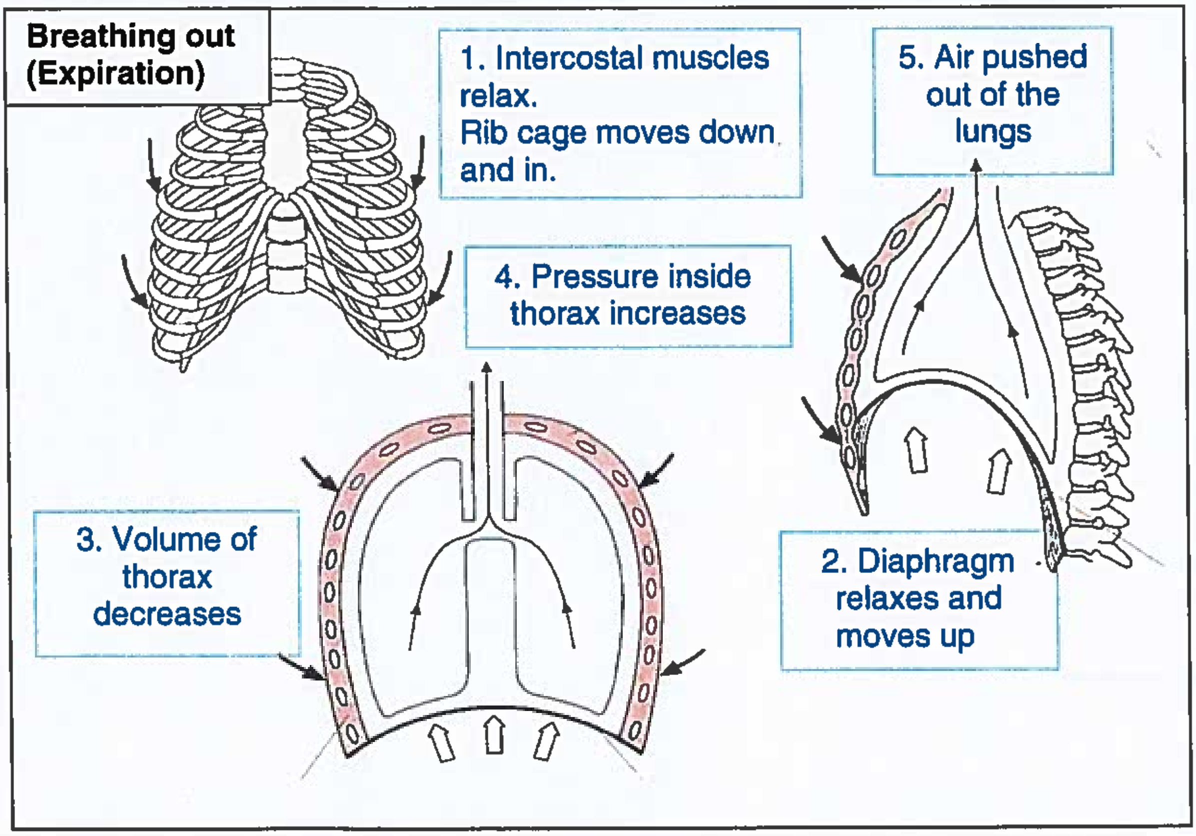


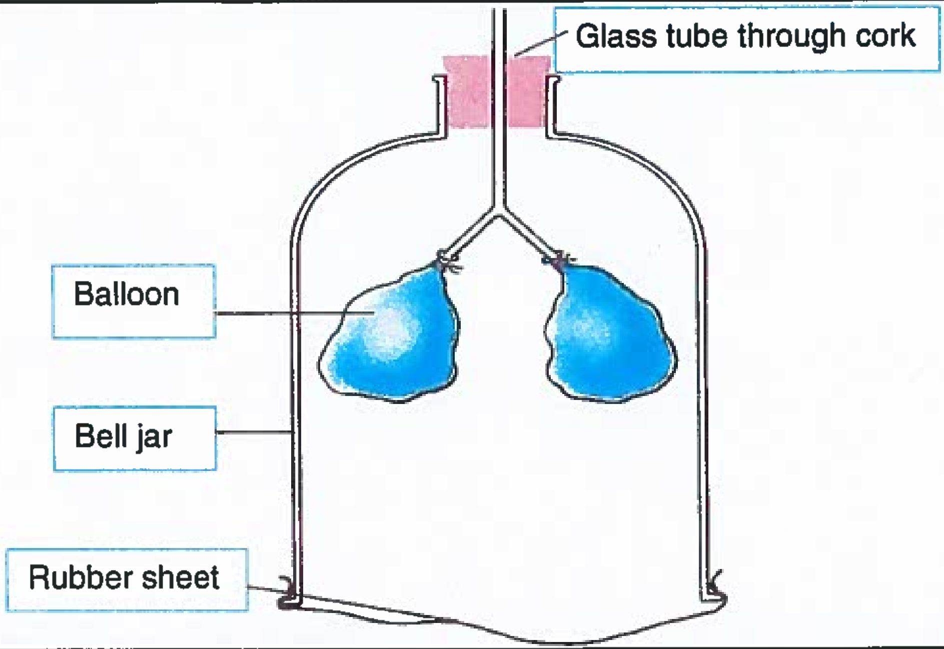
Fig.2 View of alveolus cut open.

Breathing


Breathing in
(Inspiration)
1. Intercostal muscles contract. Rib cage moves up and out.
5. Lungs inflate and draw air into the lungs
4. Pressure inside thorax decreases
3. Volume of thorax increases
2. Diaphragm contracts, moves down and flattens.


Breathing out
(Expiration)
1. Intercostal muscles relax.
Rib cage moves down and in.
5. Air pushed out of the lungs
4. Pressure inside thorax increases
3. Volume of thorax decreases
2. Diaphragm relaxes and moves up

Model of the Respiratory System



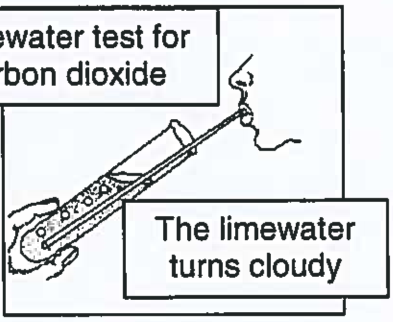
Part of model	Part of real body	How model is the same as the body	How the model is different from the body
Bell jar	Ribcage	Approximately the same shape.	Has no muscles attached to 'ribs' and so is rigid and cannot move up and down/ in and out.
Balloon	Lung	Inflates and deflates.	• Single bag, not a series of tubes with terminal alveoli; • balloon does not fill the space, or stick to the inside of the ribcage.
Rubber sheet	Diaphragm	Domed up position matches position when air is exhaled.	• pulls down further than flat; • has to be pushed in and out by us;
Tube into balloon	Trachea	The windpipe is a relatively wide tube conducting air into the lungs.	Is not held open by horseshoe shaped stiffening rings.

Differences between inspired air and expired air

Inspired air is breathed in and expired air is breathed out.
The body absorbs oxygen from inspired air and adds carbon dioxide and water vapour to expired air.

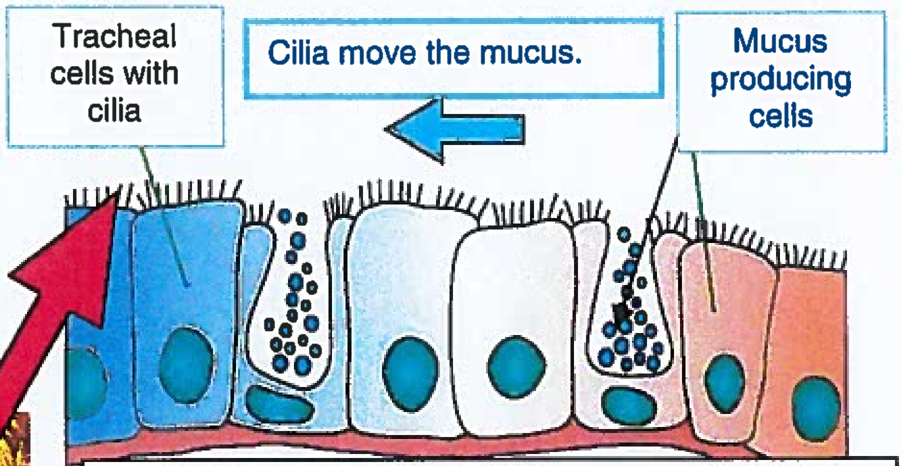
- Expired air has less oxygen than inspired air.
- Expired air has more carbon dioxide than inspired air.
- Expired air has more water vapour than inspired air.

	Inspired air	Expired air
Oxygen	21%	16%
Carbon dioxide	0.04%	4%
Water vapour	Varies	Saturated
Nitrogen	79%	79%



Keeping the Lungs Clean

The air you breathe contains dust, bacteria and viruses.
The alveoli are very delicate, so the air has to be 'cleaned' before it reaches them



Electron micrograph showing tracheal cells with cilia.

The **mucus traps** any **dust** and **bacteria** in the air.

- The **cilia move the mucus** out of the lungs into the back of your throat in a wave like motion (like a Mexican wave).
- You swallow the mucus and acid in the stomach destroys any bacteria.

Effects of tobacco smoke on the body

Effects of smoking on cilia and mucus

Smoke from tobacco paralyses cilia in the trachea and bronchi for about an hour after a cigarette has been smoked.

Dry dust and chemicals in the smoke irritate the lungs, and clog up the mucus. Cilia normally sweep this mucus away, but smoke has paralysed them. Mucus builds up and if this becomes infected it can cause bronchitis.

Coughing causes damage to the alveolar walls, this reduces their surface area for gas exchange and results in the sufferer being short of oxygen.

Tobacco smoke contains many chemicals

Tar is a dark brown, sticky substance, which collects in the lungs as the smoke cools. It contains **carcinogens** – chemical substances known to cause cancer.

Carbon monoxide is a gas that combines with haemoglobin, and reduces the oxygen-carrying capacity of the blood by as much as 15% in heavy smokers.

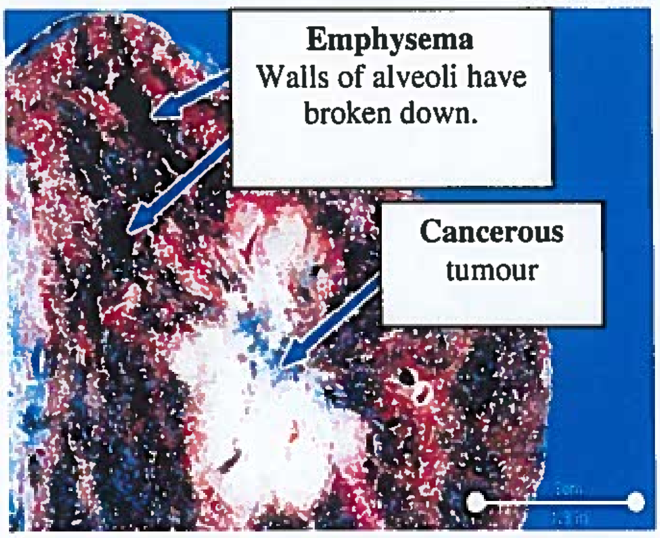
Nicotine is the addictive drug that makes smoking such a hard habit to give up. Nicotine makes the heart beat faster and the blood pressure rise.

Nicotine narrows blood vessels – vaso constriction.

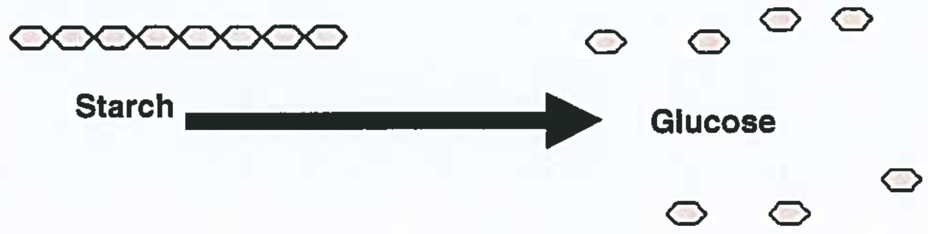
Smoking related diseases

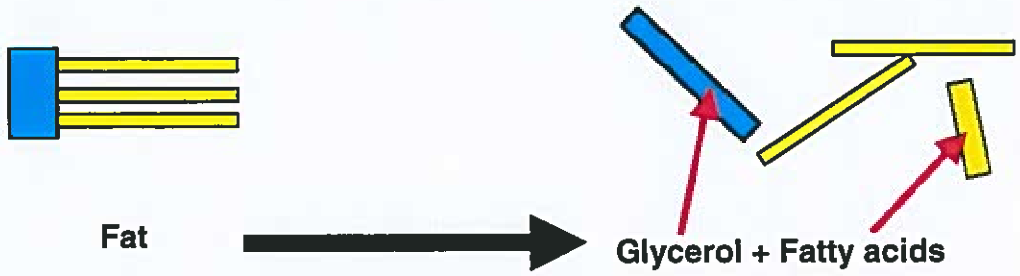
Lung cancer
90% of lung cancers are thought to be caused by smoking.
One in ten moderate smokers, and one in five heavy smokers die from the disease.

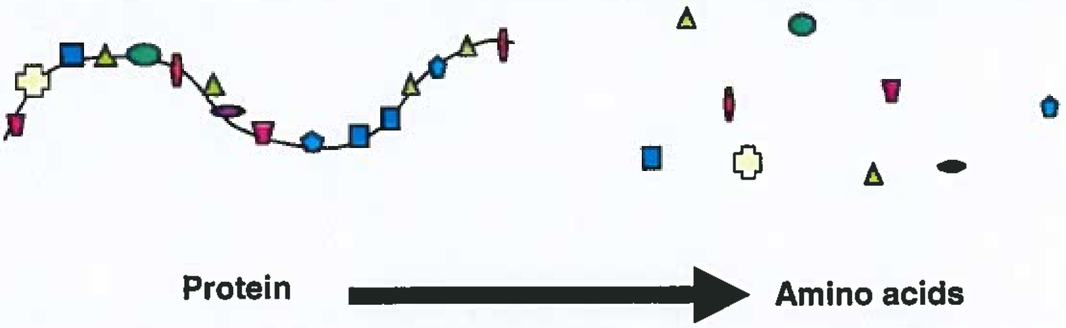
Emphysema
The chemicals in tobacco smoke damage the walls of the alveoli, and they eventually break down. This reduces their surface area for gas exchange and results in the sufferer being short of oxygen.



Digestion of Fats, Proteins and Carbohydrates



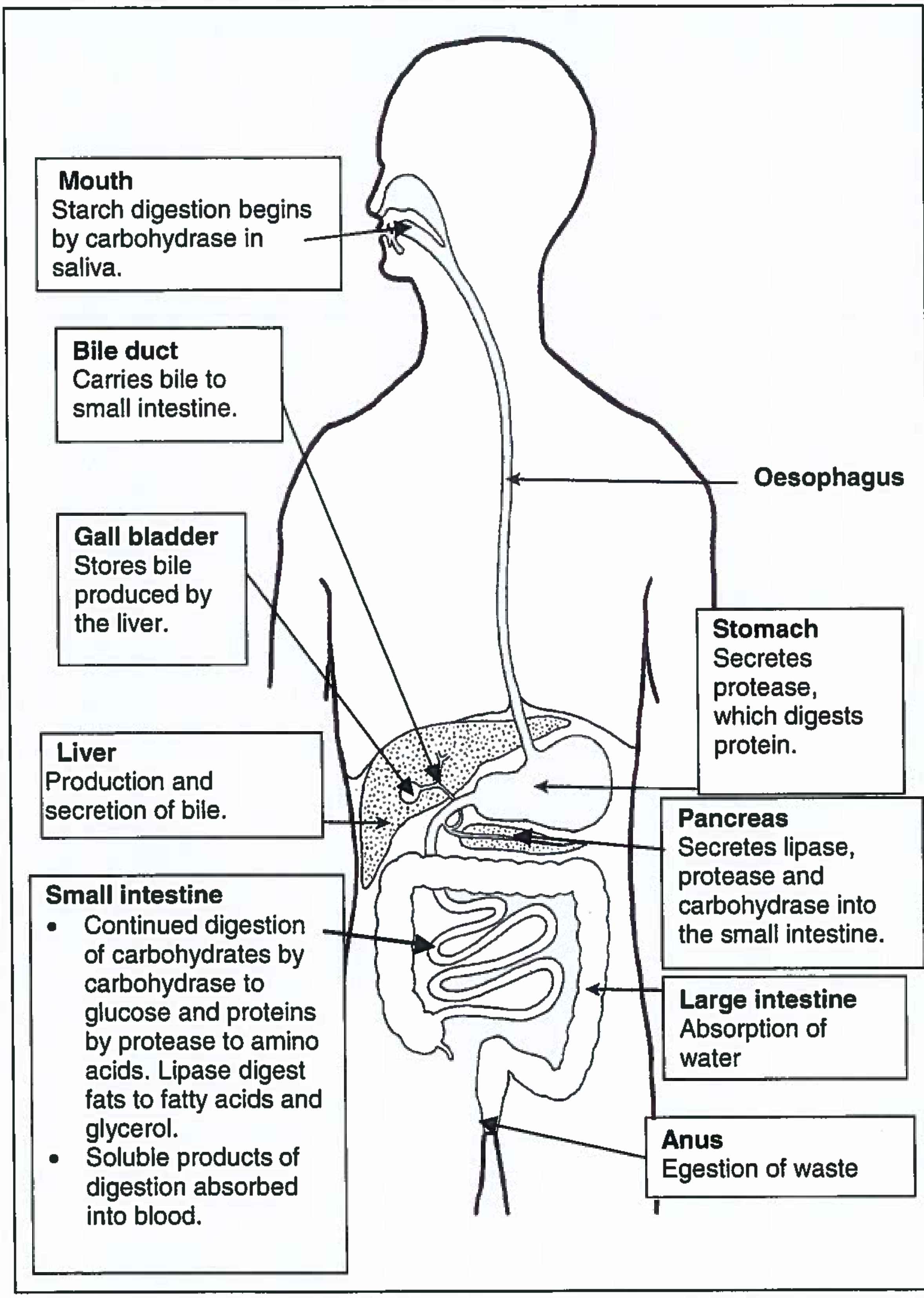




Testing for Products of Digestion

Food	Reagent	Method	Positive Result
Protein	Biuret	• Add **blue** Biuret to some food in a test tube.	**Lilac** colour
Glucose	Benedict's	• Add **blue** Benedict's to some food in a test tube. • Place the test tube in boiling water bath for 5 minutes.	Turns **green**, **orange** then **brick red**. (Colour change depends on concentration of glucose)
Starch	Iodine	• Add **brown** iodine to some food.	**Blue-black** colour.

Organs of the Digestive System and their Functions



How is food moved along the digestive system?

Food is moved along the digestive system by the contraction of muscles in the gut wall. This movement is called **peristalsis.**

The gut walls contain two layers of muscles running in different directions:

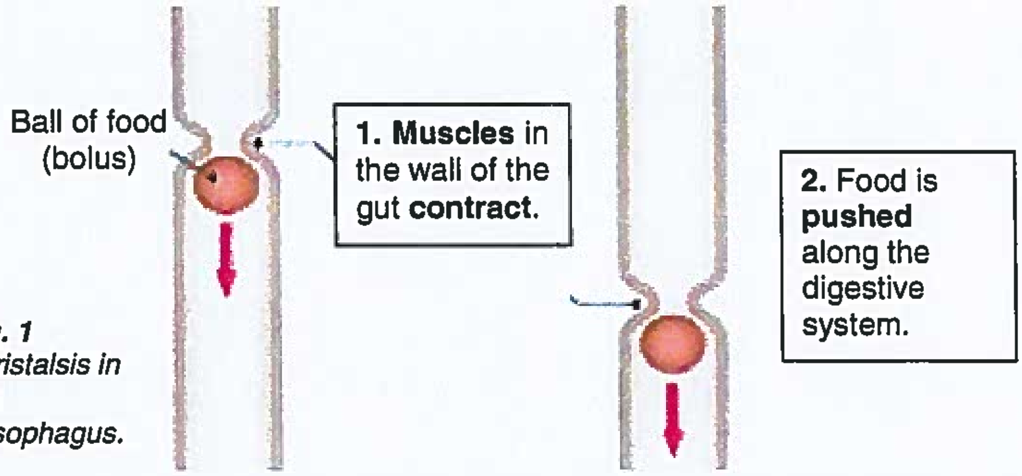
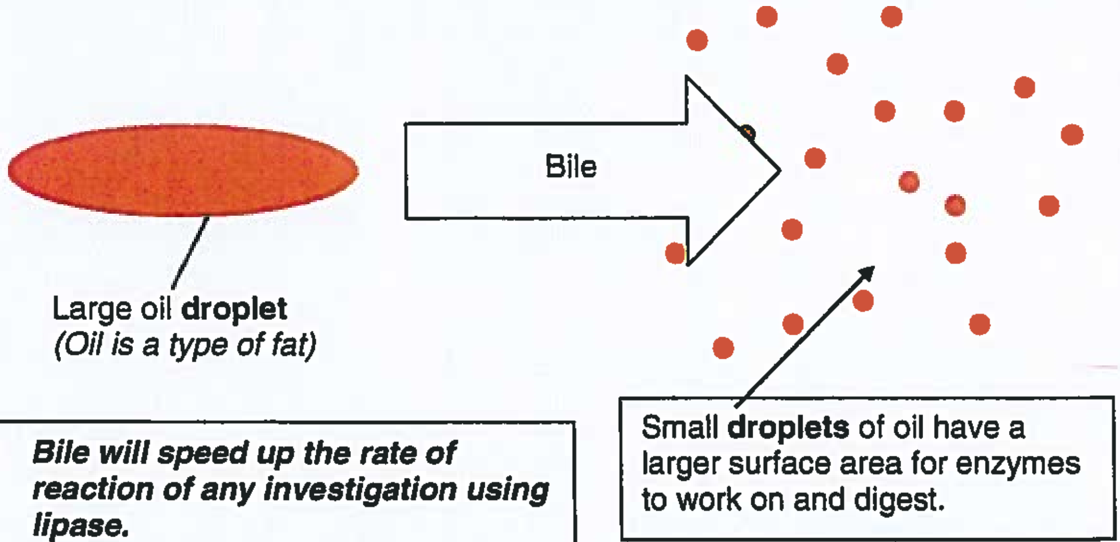


Fig. 1 Peristalsis in the oesophagus.

What does bile do?

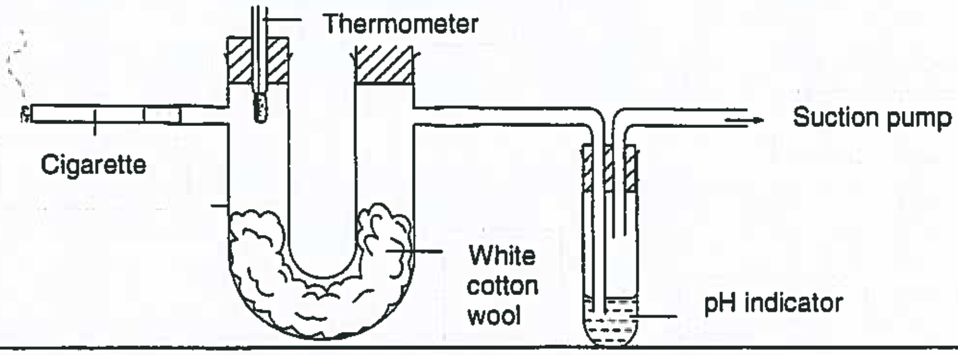
Bile is produced in the liver and stored in the gall bladder.
Bile is not an enzyme.
Bile **emulsifies** fats, which means breaking down large droplets of fat to smaller droplets (a physical change not a chemical change).
This increases the surface area of the fats for the enzyme lipase to work on.



- ***Bile will speed up the rate of reaction of any investigation using lipase.***

What's in cigarette smoke?

The following apparatus can be used to analyse the smoke from cigarettes:



The air is drawn through the apparatus before the cigarette is lit.
This is the **control experiment.**
This is to show that it is the smoke from burning tobacco that causes any changes and not drawing air through unlit tobacco.

Result

- The white cotton wool will turn brown as it filters tar from the tobacco smoke.
- The pH indicator will turn red; this shows tobacco smoke is acidic.

Smoking – Ethical Issues

How have attitudes to smoking changed?

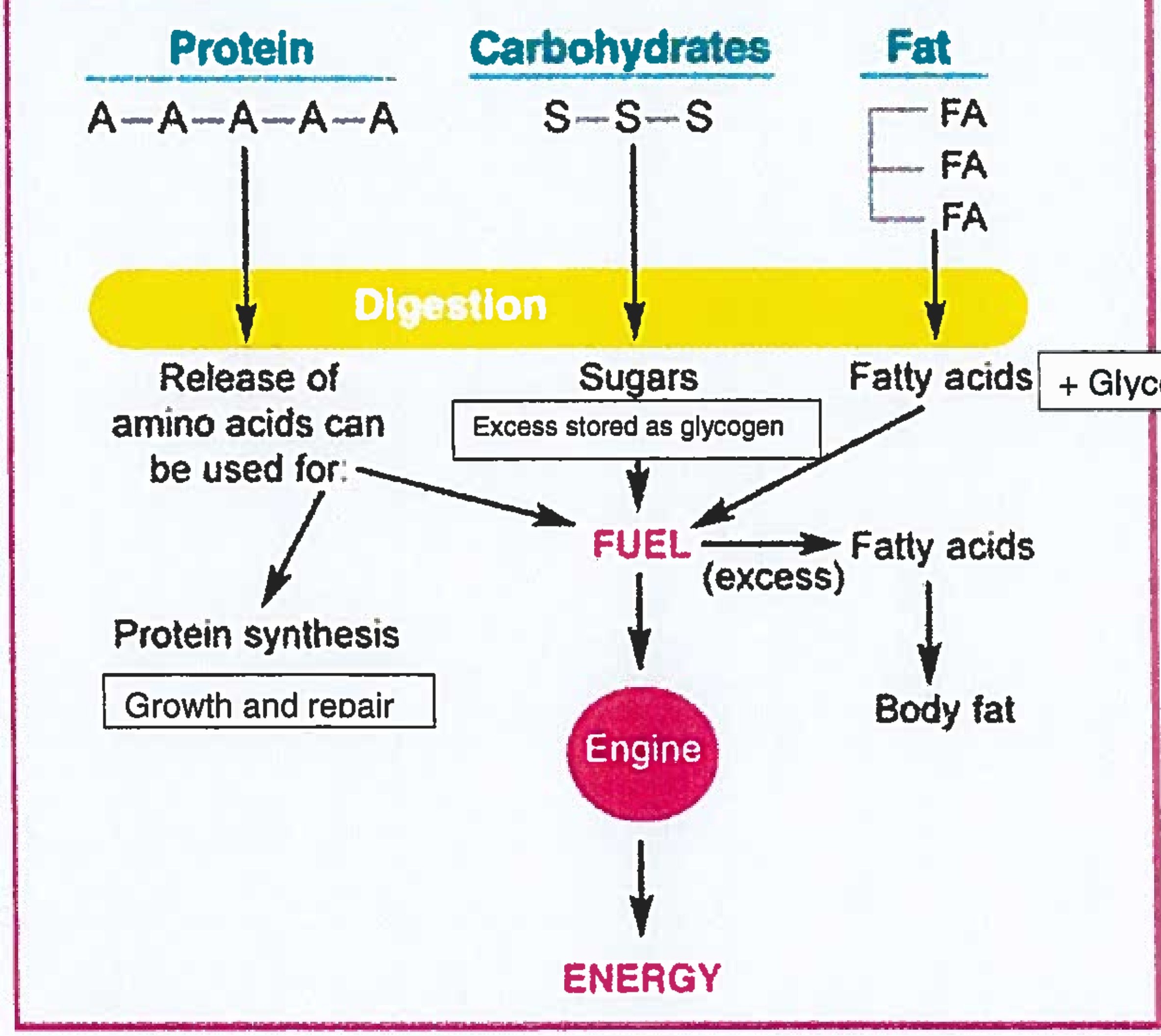
- Less people smoke now;
- More smokers are trying to give up;
- There are more help lines and advertising to encourage people not to or to stop smoking;
- Smoking is socially unacceptable;
- There are no cigarette advertisements;
- Sponsorship of sports by tobacco companies has been banned;
- Cigarette packets carry health warnings;
- Cigarettes for sale are no longer displayed in large shops;
- Smoking has been banned in public places.

Why have attitudes to smoking changed?

- People know that nicotine is an addictive drug;
- People know that smoking can cause lung cancer and emphysema;
- The dangers of smoking are now recognised, **e.g. passive smoking.**

1.3(j) How the digested products are used within the body

Figure 4



CARBS

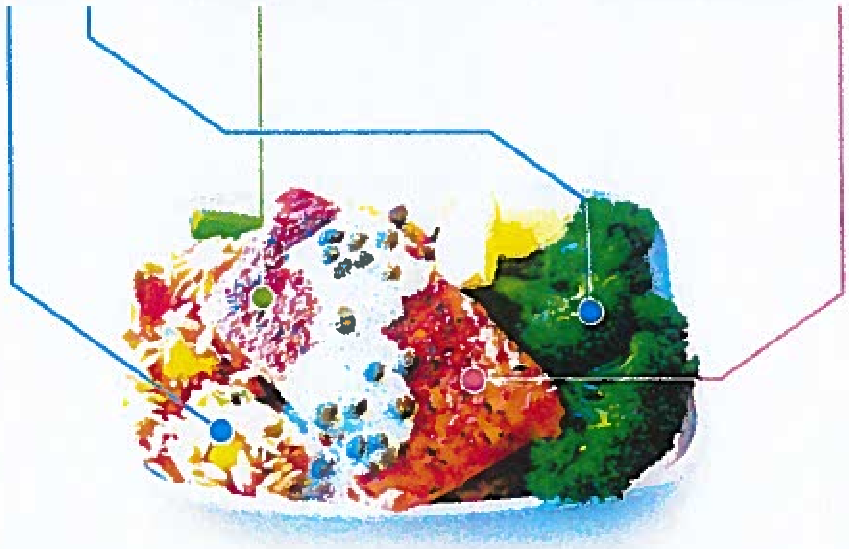
ENERGY: 4 CALORIES PER GRAM
FUNCTIONS: PROVIDE ENERGY, FACILITATE FAT METABOLISM, PREVENT PROTEIN BREAKDOWN
RECOMMENDED INTAKE: 45% - 65%

PROTEIN

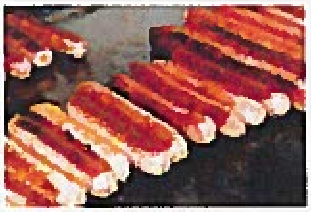
ENERGY: 4 CALORIES PER GRAM
FUNCTIONS: PROVIDE ENERGY, BUILD AND REPAIR TISSUE, USED AS ENZYMES TO FACILITATE BODY REACTIONS
RECOMMENDED INTAKE: 20% - 45%

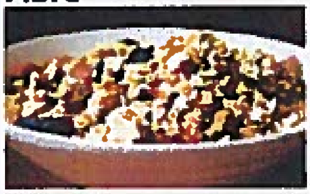
FAT

ENERGY: 9 CALORIES PER GRAM
FUNCTIONS: PROVIDE ENERGY, ABSORB VITAMINS, REGULATE BODY TEMPERATURE, PROVIDE ESSENTIAL FATTY ACIDS
RECOMMENDED INTAKE: 15% - 35%



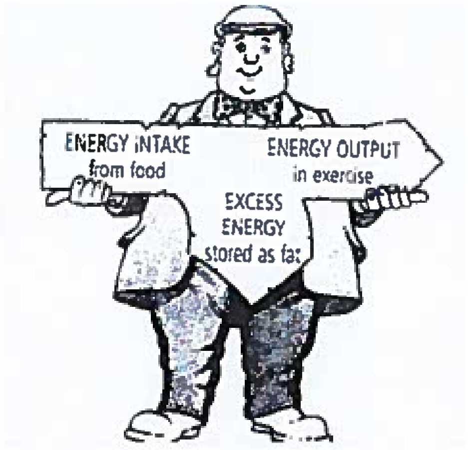
1.3(k) The Need for a Balanced Diet

Food type	How does it help?	When do we need it in sport?	Where do we get it?
Carbohydrates 	Provides quick energy. 60% of our diet should comprise 'carbs'. Glucose is used during cellular respiration to produce energy (ATP)	Running. Athletes in training will eat more 'carbs'. Marathon runners will '*load*' before the event.	Plant origin from photosynthesis, stored as the insoluble polysaccharide starch (repeating units of glucose): pasta, cereals and potatoes
Fats NB Unsaturated fats are healthy. Too much saturated fat from animal products can lead to heart disease. 	Used in making cell membranes, hormones, storage of energy and insulation	Walking and low impact exercise - it produces energy too slowly to be used when working hard.	Oils, dairy products, nuts and fish
Protein 	Builds and repairs all cells. We need 15% of our diet to be protein.	When training hard and recovering from injury. 'Power' athletes such as weight lifters will eat more protein.	Meat, pulses and fish
Vitamins  **eg** **A** - for vision **B** - for energy production and stress reduction **C** - to keep skin healthy **D** - to help bones and teeth	Helps the body work. Helps concentration.	Staying calm, making quick decisions	Fresh fruit and vegetables Vitamin A- Carrots, sweet potatoes Vitamin B – Meat, fish Vitamin C – Citrus Fruits Vitamin D - Cod liver oil,

Food type	How does it help?	When do we need it in sport?	Where do we get it?
Minerals 	**Calcium** - to strengthen bones **Iodine** – making thyroxine that controls activity **Iron** – making red blood cells	When training hard and competing	Calcium- milk and diary Iodine- Sea fish, table salt Iron- Red meat, spinach
Fibre 	Can't be digested. Fills you up and keeps you 'regular'. Absorbs water and binds the food into a bolus. This is then easier to pass through the intestines by peristalsis.	Healthy digestion, (no constipation) helps in sport. Also helps with weight control.	Fresh fruit, vegetables and wholegrain cereals
Water 	Maintains fluid levels. Needed for chemical reactions in cells. Used to maintain body temperature.	Whenever you sweat. It prevents dehydration	The tap! It's all you need most of the time.

Balanced Diet

A balanced diet involves eating the right amounts of the essential food groups.
Overeating can lead to serious dietary diseases.



We can think of a person as taking in energy (**energy intake**) and giving out energy (**energy output**).

The energy content in food eaten must be balanced with the energy used,
Obesity is caused by a person's energy intake being greater than the energy output.

Excess (too much) energy is stored as fat.
The most fattening foods are therefore those that provide most energy.

Carbohydrate foods contain a lot of energy.
Foods that contain **fat** contain a lot of energy because 1g of fat has twice as much energy than 1 g of carbohydrate.

Eating too much
You are eating too much if the energy value of the food you eat each day is more than the amount of energy you use in that time.
Eating too much can lead to **weight increase** and **obesity.**

Obesity can contribute to **heart disease, high blood pressure, diabetes** (type 2), **gall bladder disease, cancer of the bowel** and also **breast** and **womb cancer.**

Food Labelling

Nutrition information on labels is provided 'per 100g' (or 'per 100ml' for liquids) and usually per serving too.
Looking at the nutrients 'per 100g' helps you compare the levels of nutrients in different products.

Too much sugar can lead to an **increased chance** of developing **type 2 diabetes**

Saturated fat tends to be from animal fat.
It is high in cholesterol and **increases the chances** of developing **heart disease.**

A **high salt diet** can **increase blood pressure.**

High blood pressure is linked to an **increased chance** of a **heart attack, stroke** or **kidney disease.**

NUTRITION			GDA	
Typical values	per 100g	per pack	adult	per pack
Energy kJ	450	1345		
Energy kcal	105	315	2000	16%
Protein	7.9g	23.7g	45g	53%
Carbohydrate	8.8g	26.4g	230g	11%
of which sugars	1.2g	3.6g	90g	4%
Fat	4.2g	12.6g	70g	18%
of which saturates	2.7g	8.1g	20g	41%
Fibre.	1.2g	3.6g	24g	15%
Sodium	0.24g	0.72g	2.4g	30%
Equivalent as salt	0.60g	1.80g	6g	30%

GDA = Guideline daily amount

- Knowing how much energy is in food helps people control their diet, especially if they want to lose weight.
- Information of food additives helps inform people with food allergies.

Blood

Red Blood Cells.
These cells **carry oxygen** around the body.

They are flattened, biconcave, disc shaped cells; they are red in colour because of a pigment called **haemoglobin.** This joins with oxygen to transport it around the body.
Red blood cells don't have a nucleus.

Fig. 1 – micrograph of red blood cells

Iron is needed to produce haemoglobin. If there is a shortage of iron a person won't have enough red blood cells, this is called **anaemia**, less oxygen will be carried around the body.

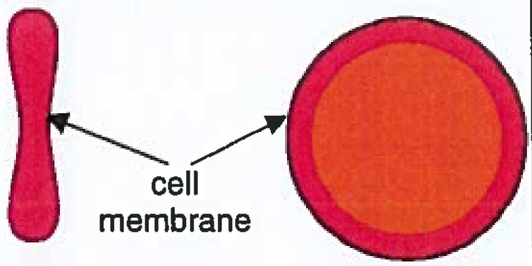
White blood cells
These cells **defend the body against pathogens** (microbes that cause disease).

They are bigger than red blood cells, and have a nucleus, but don't contain a pigment so are colourless.
If you have an infection the number of white blood cells in you body increases rapidly.
There are many types of white blood cells, but you only need to learn about two of them:

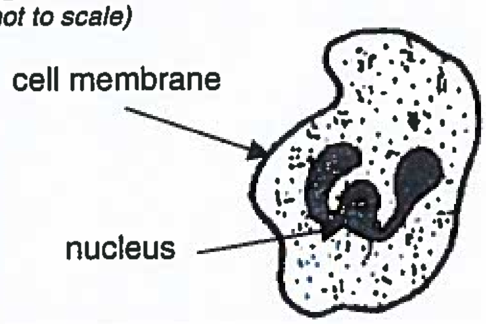
- **Phagocytes** – ingest and digest 'foreign' cells.
- **Lymphocytes** – produce antibodies and antitoxins.

Comparing red and white blood cells
(You should be able to draw, label and compare a red and white blood cell)

Red blood cells
***Fig. 2** – side view (left)and front view (right) of red blood cell (not to scale)*



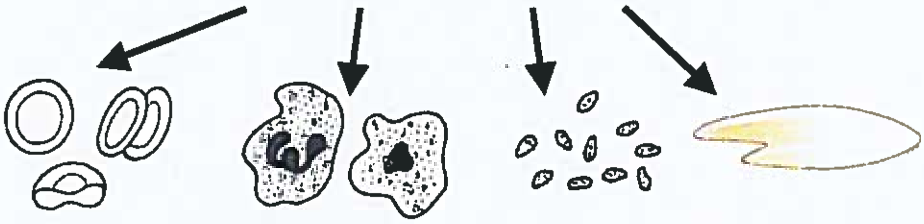
White blood cells
***Fig. 3** –white blood cell (phagocyte) (not to scale)*



Red blood cells	White blood cells
No nucleus present	Nucleus present
Regular disc shaped	Irregular shape
Smaller than white blood cells	Larger than red blood cells

Blood

Blood is made up of



Red blood cells carry oxygen	**White blood cells** defend the body against pathogens	**Platelets** clotting of blood	**Plasma** carries dissolved substances

Fig. 1 – Illustration of the components of blood.

Examining blood smears

(These are diagrams you should be able to label).

Fig 2. Micrograph of a blood smear.
The centre of red blood cells appear paler because they have no nucleus and therefore more light from the microscope passes through them.

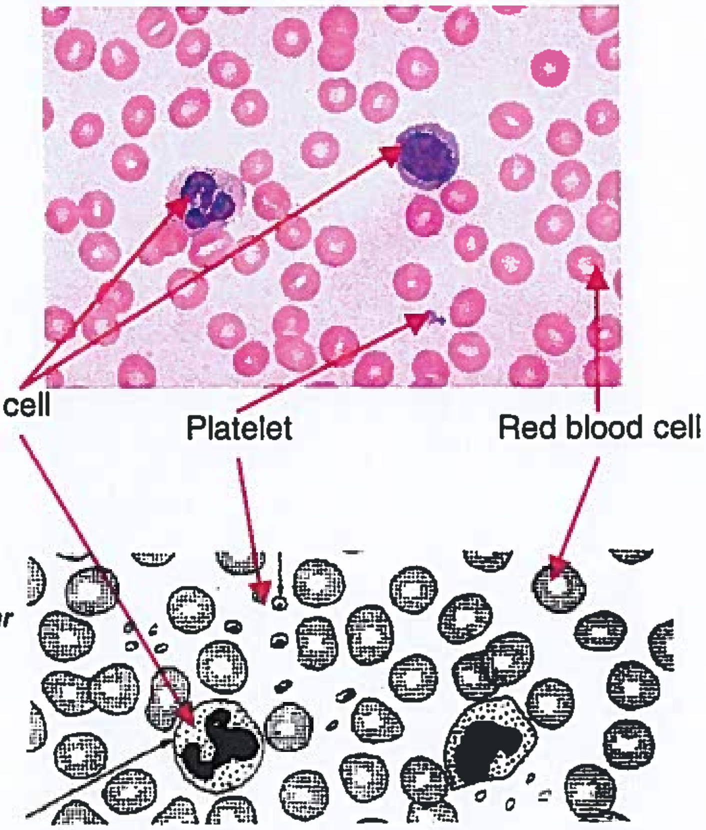


Fig.3 – Illustration of blood smear

Platelets
Platelets clot the blood.

When the skin is cut you bleed. Platelets make the blood clot, forming a thick jelly. This hardens to form a scab, **preventing bleeding and blood loss.** The scab keeps the wound clean as new skin grows underneath.

Fig. 1 – micrograph showing red blood cells clotting.

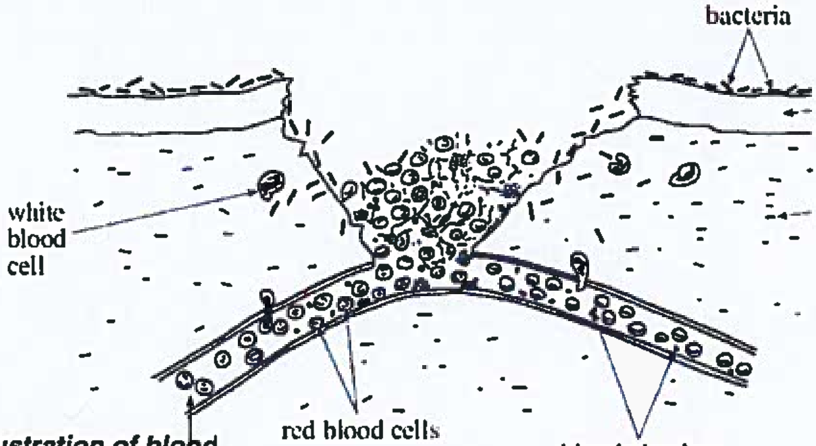


Fig 2. – Illustration of blood clotting in a wound

Plasma

Plasma **carries dissolved substances.**

This is the liquid part of blood. It is pale yellow in colour and is 90% water.

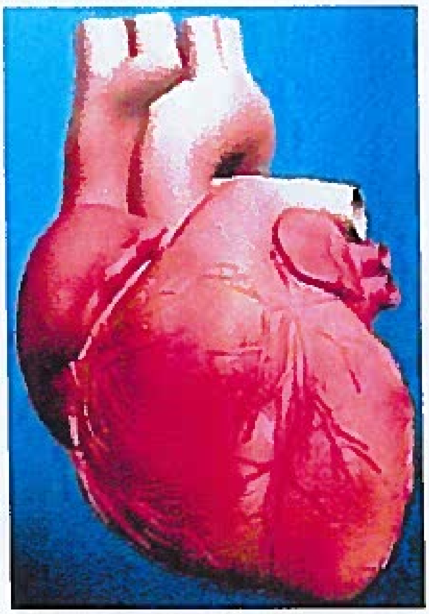
Plasma carries many dissolved substances around the body:

- Small soluble food molecules, e.g. **glucose, amino acids**, etc.
- Waste chemicals produced by the body, e.g. **carbon dioxide** from respiration and **urea** produced by the liver.
- **Hormones** carried from the endocrine glands to their target organs, e.g. insulin.
- **Antibodies** produced by lymphocytes (white blood cells).
- **Mineral salts**, e.g. sodium ions.

The Heart

Structure of the Heart

The function of the heart is to pump blood.
The heart is made of a special muscle called cardiac muscle.



There are blood vessels on the outside of the heart – the **coronary arteries.**
These supply oxygen and glucose to the heart muscle.
Without a steady supply of oxygenated blood the heart muscle couldn't keep contracting and pumping blood.

If a blood clot blocks a coronary artery, the heart muscles won't get enough oxygen and will stop working – this is a heart attack.

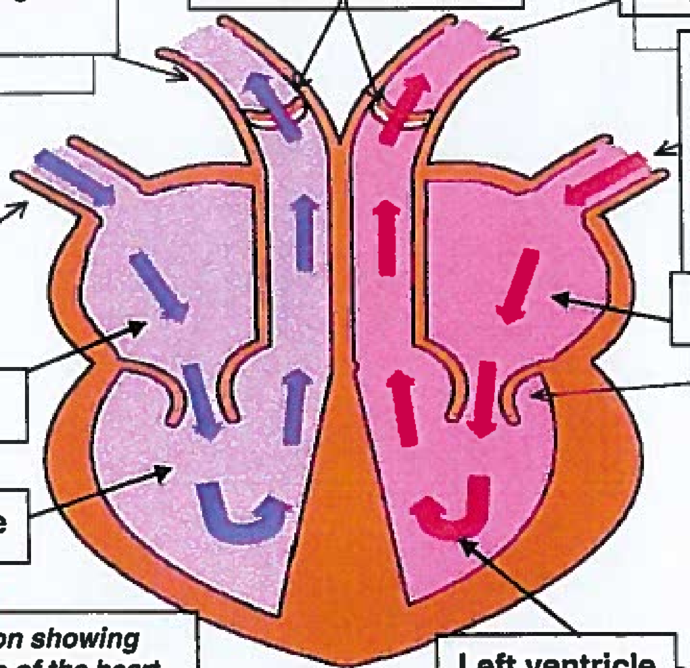


Fig. 2 – illustration showing internal structure of the heart.

Blood Vessels

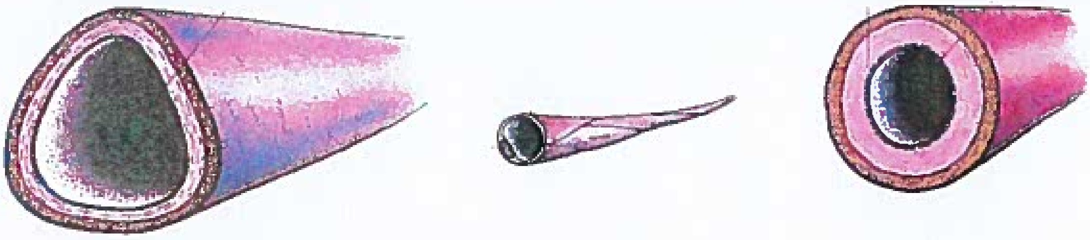


Fig.1 – (Left to right) Illustration of an artery, capillary and vein (not drawn to scale).

- **Arteries** have thick walls because they carry blood under pressure **away from the heart**.
- **Veins** have thins walls because they carry blood under low **pressure back to the heart.**

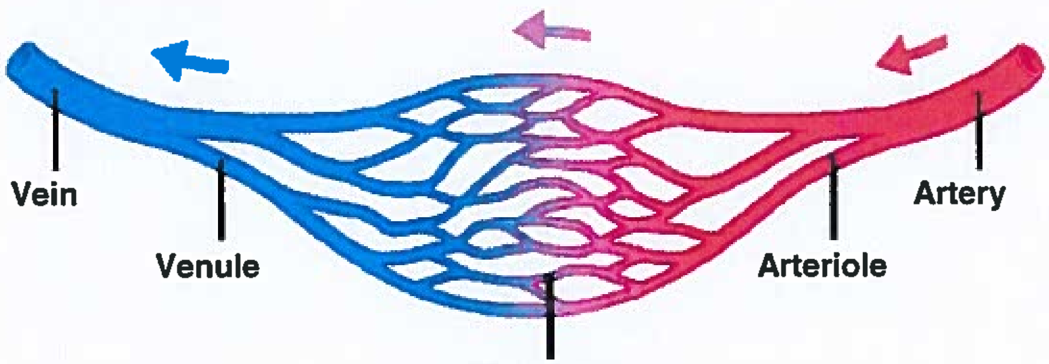


Fig. 2 Illustration showing structural relationship between blood vessels.

Capillaries are the smallest blood vessels that carry blood through the organs of the body.

- They form extensive networks so that no cell is far away from a capillary.
- Their walls are very thin to allow materials to diffuse easily between the blood and the body cells.

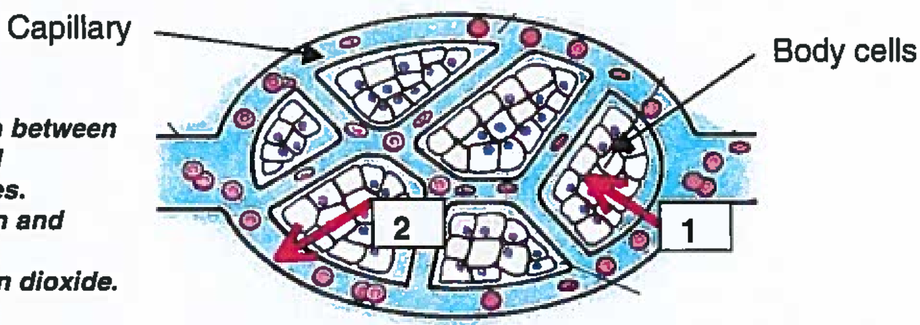


Fig. 3
Diffusion between cells and capillaries.
1 Oxygen and glucose.
2. Carbon dioxide.

Facts you must learn about the heart:

- The heart is divided into 2 halves.
- Blood flows in one direction through each half of the heart.
- There are valves between the atria and ventricles. These can close to stop backflow of blood when the ventricles contract.
- There are valves at the bottom of the bottom of the pulmonary artery and aorta to prevent backflow of blood to the ventricles when they relax.
- There are tendons attached to the valves so they don't get pushed inside out.
- The right side of the heart pumps blood to the lungs.
- The left side of the heart pumps blood to the body.
- The atria *(more than one atrium)* have thin walls because they only pump blood to the ventricles.
- The ventricles have thick muscular walls, because when they contract they have to pump blood out of the heart.
- The left ventricle has a thicker muscular wall than the right ventricle because it pumps blood to all parts of the body – the right ventricle only pumps blood to the lungs.

Flow of Blood Through the Heart

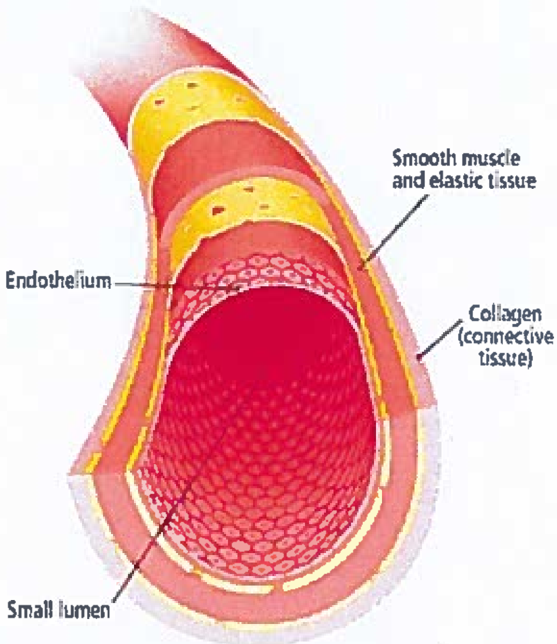
- The **vena cava** carries blood from the organs of the body to the **right atrium.**
- Blood passes through a **valve** to the **right ventricle.**
- The **right ventricle** contracts, pumping blood through the **valve** into the **pulmonary artery.**
- The **pulmonary artery** carries the blood to the **lungs** where it is oxygenated.
- The **pulmonary vein** carries blood back from the **lungs** to the **left atrium.**
- Blood passes through the **valve** into the **left ventricle.**
- The **left ventricle** contracts, pumping blood through the **valve** into the **aorta.**
- The **aorta** carries blood form the heart to the organs of the **body.**

2WC questions sometimes ask you to describe the flow of blood through the heart. Always check to see where you need to start and finish.

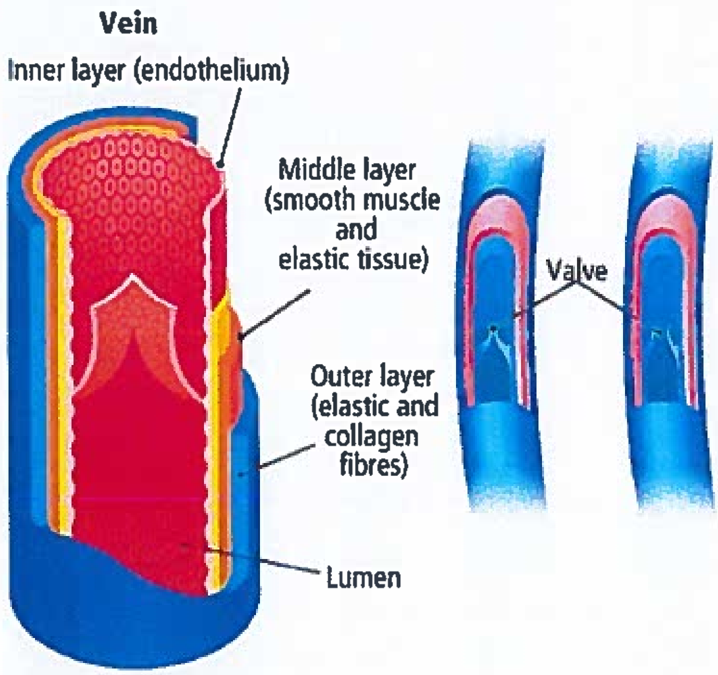
Remember, you will lose marks by including irrelevant information!

1.4(j)
Blood vessels:

Arteries: blood vessels that carry blood away from the heart in pulses. It has a thick muscular wall and a small lumen. This lumen narrows the further it is from the heart to maintain blood pressure. The thick wall of arteries contains a tough outer layer of **collagen** that gives strength to the artery that supports the pressure the blood is under from the heart. It also contains a layer of **smooth** (involuntary) **muscle** that contracts pushing blood along. The internal layer of the artery is composed of a layer of cells called the **endothelium**.

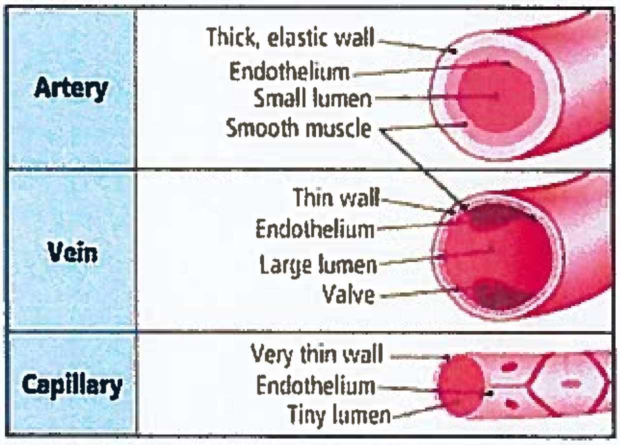


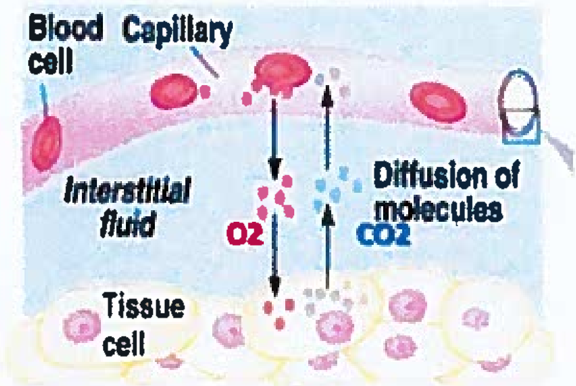
Veins: blood vessels that carry blood towards the heart in an even flow. They have thin walls, a large lumen and valves. Blood pressure in veins is much lower than in arteries, hence the thinner wall. They also have smooth muscle to push blood along in one direction and have valves to prevent back flow of blood. Many veins are found in the large muscle groups of the arms and legs. When the muscles contract during movement, blood is squeezed along the veins. Valves ensure the blood flows back towards the heart.



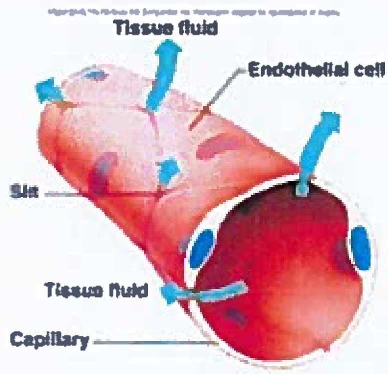
- **Capillaries:** blood vessels with walls one cell thick that carries blood from arterioles to venuoles through tissues releasing nutrients and taking away wastes. The thin single cell wall enables the efficient diffusion of substances into surrounding cells. It also enables the efficient transport of substances from the cell into the capillary.

  The diameter of each capillary is small, the smallest being no wider than a red blood cell. They have a very simple structure well suited to their function. Their walls are very thin containing no elastic fibres, smooth muscle or collagen. This helps them fit between cells and allows the rapid diffusion between the blood and cells.



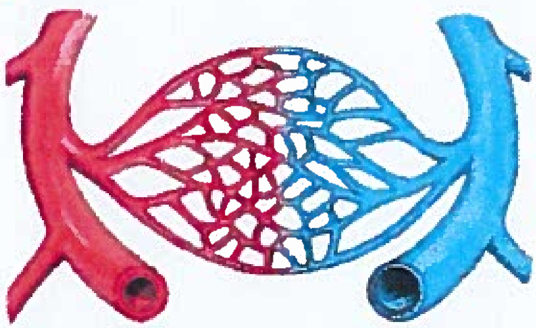


Thin- walled capillaries allow ***exchanges*** *of gas, nutrients and waste products with tissues*



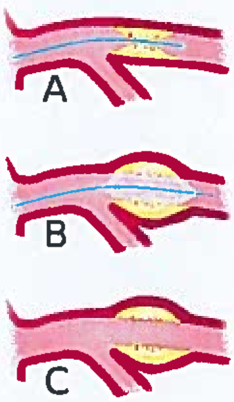
Oxygen passes by ***diffusion*** *through the capillary wall and into the tissues, carbon dioxide passes from the tissues into the blood*

(a)



Capillary bed, capillary network

1.4 (I) The advantages and disadvantages of the following treatments for cardiovascular diseases: Statins, angioplasty, changes to lifestyle/exercise.

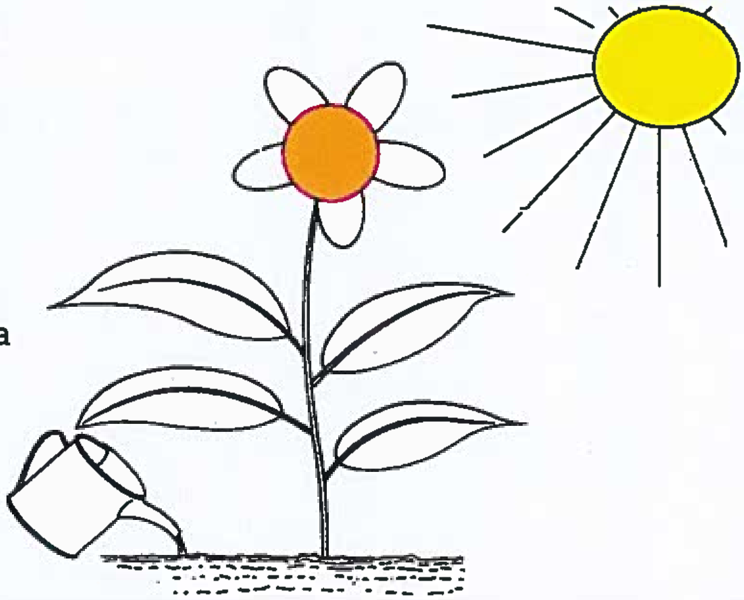
Treatment	Advantage	Disadvantage
Statins  A daily medication to control blood cholesterol levels preventing atherosclerosis (narrowing of the arteries, atheroma development)	Stains lower blood cholesterol (LDL) preventing hardening and narrowing of the arteries. They also help to prevent atherosclerosis, atheroma formation leading to heart attacks and strokes.	Statins can sometimes interact with other medicines, increasing the risk of unpleasant side effects, such as muscle damage. Some types of statin can also interact with grapefruit juice. Minor side effects are: upset stomach, headache or feeling sick.
Angioplasty  Surgery to place a small balloon in a blood vessel (A) which is inflated to remove the blockage (B).	Blood flow through the coronary arteries improves after an angioplasty (C). Many people find their symptoms get significantly better and they're able to do more than they could before the procedure. If you've had a heart attack, an angioplasty can increase your chances of surviving more than clot-busting medication (thrombolysis). The procedure can also reduce your chances of having another heart attack in the future.	The risk of serious complications from a coronary angioplasty is generally small, but this depends on factors such as: • your age • your general health • whether you've had a heart attack Serious problems that can occur as a result of the procedure include excessive bleeding, a heart attack and a stroke. Sometimes the procedure is temporary.
Changes to lifestyle, diet/exercise  Stop smoking, regular exercise, eating healthy foods	Improved changes to lifestyle can reduce the risk of cardiovascular diseases such as hardening and narrowing of the arteries, atherosclerosis, strokes and high blood pressure.	A high level of self-discipline is needed to maintain these long-term changes.

Photosynthesis

Photosynthesis is the process that 'produces food' in green plants and other photosynthetic organisms (e.g. algae)

Photosynthesis takes place in the green parts of plants – mostly in leaves.

- Chlorophyll (found in the chloroplasts) absorbs light energy.
- This energy is used to convert carbon dioxide and water into glucose.
- Oxygen is produced as a by-product.



The word equation for photosynthesis:

$$\text{Carbon dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Light}} \text{Glucose + Oxygen}$$

Enzymes control the chemical reactions of photosynthesis.

Some other factors we can investigate with this experiment:

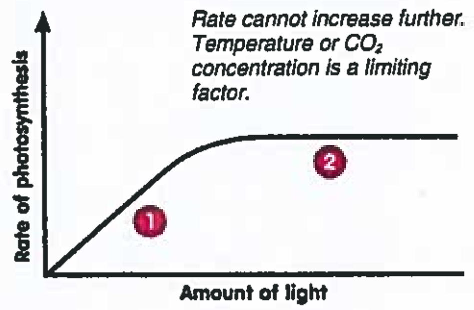
Independent variable	How to change independent variable	Dependent variable	Controlled variables
Carbon dioxide levels	Different concentrations of potassium hydrogen carbonate solutions.	Volume of oxygen produced every minute **OR** Number of bubbles of oxygen produced every minute	• Temperature. • Distance of light • Same species of plant.
Temperature	Carry out experiment in water baths at different temperatures.		• Distance of light. • Same species of plant. • Mass of potassium hydrogen carbonate in water.
Species of plant	Using different species, e.g. *Elodea* (pondweed), *Cabomba*, etc.		• Distance of light. • Mass of sodium hydrogen carbonate in water. • Temperature.

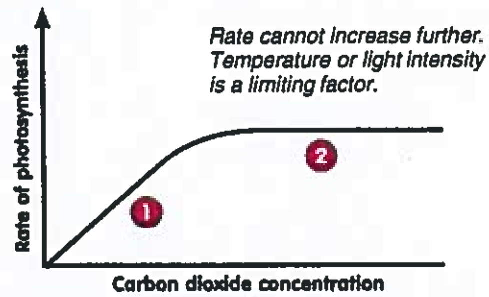
Environmental Factors Affecting the Rate of Photosynthesis

Temperature
This affects the enzymes controlling photosynthesis.

Light intensity
This provides energy for photosynthesis. Increasing light intensity will increase rate of photosynthesis (1) up to a point when another factor will be **limiting** (2).

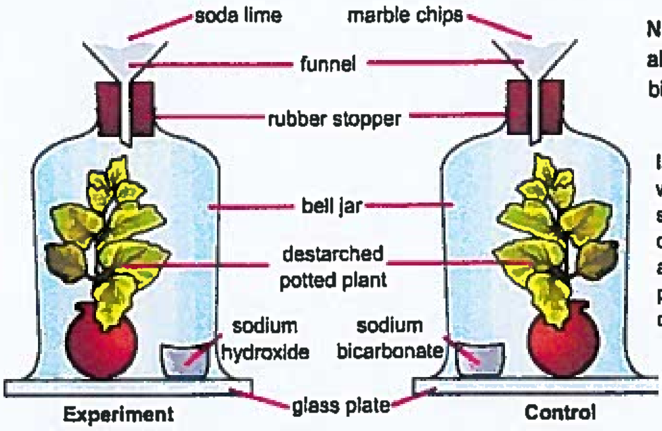
Carbon dioxide concentration
Increasing carbon dioxide concentration will increase rate of photosynthesis (1) up to a point when another factor will be **limiting** (2).





A **limiting factor** is the factor that is controlling the rate of photosynthesis at a given time. Increasing this factor will increase the rate of photosynthesis.

Experiment 3 – To show that carbon dioxide is needed for photosynthesis
We can deprive a plant of carbon dioxide and then test it for the presence of starch.



Note - Soda lime (sodium hydroxide) **absorbs** carbon dioxide, while sodium bicarbonate **releases** carbon dioxide.

Into the funnel of the experiment (the one with sodium hydroxide solution), place soda lime granules to absorb any carbon dioxide that passes into the funnel from the atmosphere. Into the other funnel, the control, place a few marble chips or keep open to the atmosphere.

Airtight seal using Vaseline

Result:
Leaves of plant from bell jar with sodium hydrogen carbonate (plenty of carbon dioxide) stained blue-black - starch is present.
Leaves of plant from bell jar with sodium hydroxide (no carbon dioxide) iodine remains orange – no starch present.
Conclusion:
Plants need carbon dioxide to be able to photosynthesise.

Does the presence or absence of water affect photosynthesis?
It is difficult to set up an experiment to prove that water is needed for photosynthesis because you cannot easily remove water from the system.
If you remove water from a plant it will die.
To follow how water is used in photosynthesis you need to use water containing radioactive isotopes of hydrogen or oxygen.

Uses of glucose produced in photosynthesis:

1. Glucose is used to **release energy** in respiration
   Respiration is taking place all the time in plant cells.

2. Glucose can be changed to **starch** and **stored**.

3. Glucose can be used to **make cellulose** which make up the body of plants (e.g. cell walls)

4. Glucose can be used to **make proteins**, which also make up the body of plants.

Testing a Leaf for the Presence of Starch

- Glucose produced during photosynthesis cannot be stored and is either used up or stored as insoluble starch.
- We can test a leaf to see if photosynthesis has happened by testing for the presence of starch.
- The plant must me kept in the dark for 24-48 before the experiment. This is so that the plant will use up its store of starch.
- Any starch found afterwards must have been formed by photosynthesis during the experiment.

You need to learn how this experiment works and explain the importance of each step.

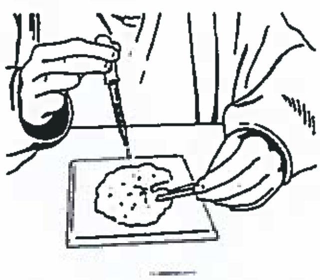
1. **The leaf is placed in a beaker of boiling water for 1 minute.**
   (This breaks down the cell membrane, making it easier for iodine to enter the cell and to remove the chlorophyll in step 3).

Turn off the Bunsen burner
Ethanol is highly flammable

2. **The leaf is removed from the water and put into a boiling tube half full of ethanol.**
3.

4. **The boiling tube containing the leaf and ethanol is placed in the hot water for 10 minutes.**
   (The boiling ethanol will dissolve the chlorophyll. This removes the green colour from the leaf.)

5. **The leaf is removed from the boiling tube and washed in the beaker of water.**
   (This softens the leaf)



6. **The leaf is placed on a white tile and covered in iodine.**
   (Any parts containing starch will be coloured dark blue-black).

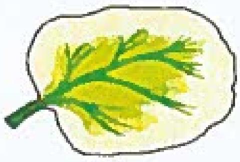
Identifying the Conditions Needed for Photosynthesis

Testing leaves for the presence of starch can be used to show how photosynthesis is affected by:

- the presence of chlorophyll in the cells of a leaf;
- light reaching a leaf;
- carbon dioxide in the atmosphere around a leaf.

Experiment 1 – To show that chlorophyll is needed for photosynthesis
We can test a plant to show it needs **chlorophyll** for photosynthesis by using a **variegated leaf** and testing it for the presence of starch.

Before



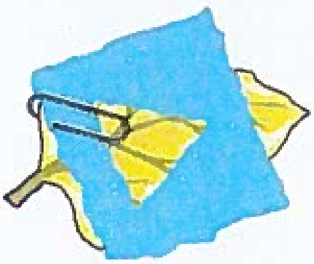
After

Result:
Green parts containing chlorophyll- stained blue-black - starch is present.
Light parts of plant with no chlorophyll the iodine remains orange – no starch present.
Conclusion:
Chlorophyll must be present in leaf cells for photosynthesis to occur.

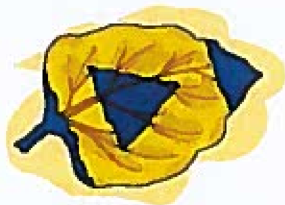
Experiment 2 – To show that light is needed for photosynthesis
We can deprive a part of a leaf of light and then test it for the presence of starch.

A tin foil stencil is cut out and put on one of the leaves of a plant.
This excludes all light, except at the edges and on the pattern.

Before



After



Result:
Parts exposed to light stained blue-black - starch is present.
Parts excluded from light iodine remains orange – no starch present.
Conclusion:
Leaves must be exposed to light for photosynthesis to occur.

Investigating the Conditions Needed for Photosynthesis

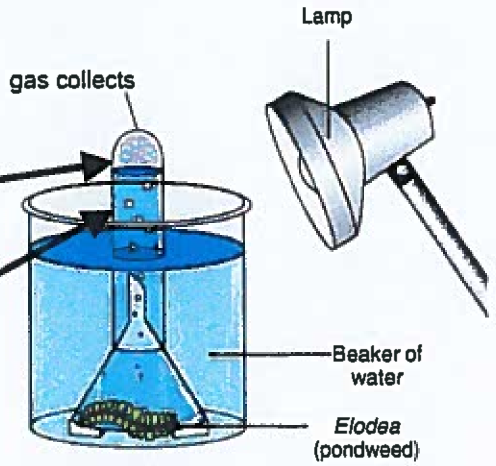
As oxygen is given off during photosynthesis, its rate of production can be used to measure the rate of photosynthetic activity.

This is made possible by using a plant that grows in water, e.g. *Elodea* (also called pondweed) and measuring:

- The **volume** of oxygen produced **per minute**

  OR

- The **number** of oxygen **bubbles** produced **per minute**



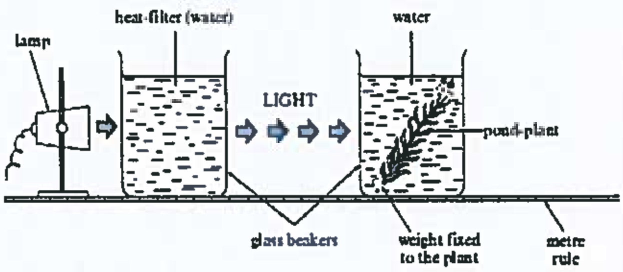
This allows us to compare results under different conditions.

Investigation – Effect of Light Intensity on the Rate of Photosynthesis

- Measure and record the distance of the lamp from the plant (e.g. 10cm);
- Count the number of bubbles given off every minute;

  OR

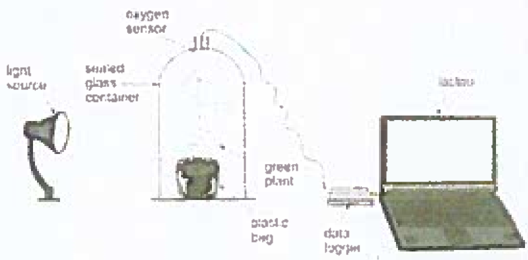
  Measure volume of gas produced every minute.



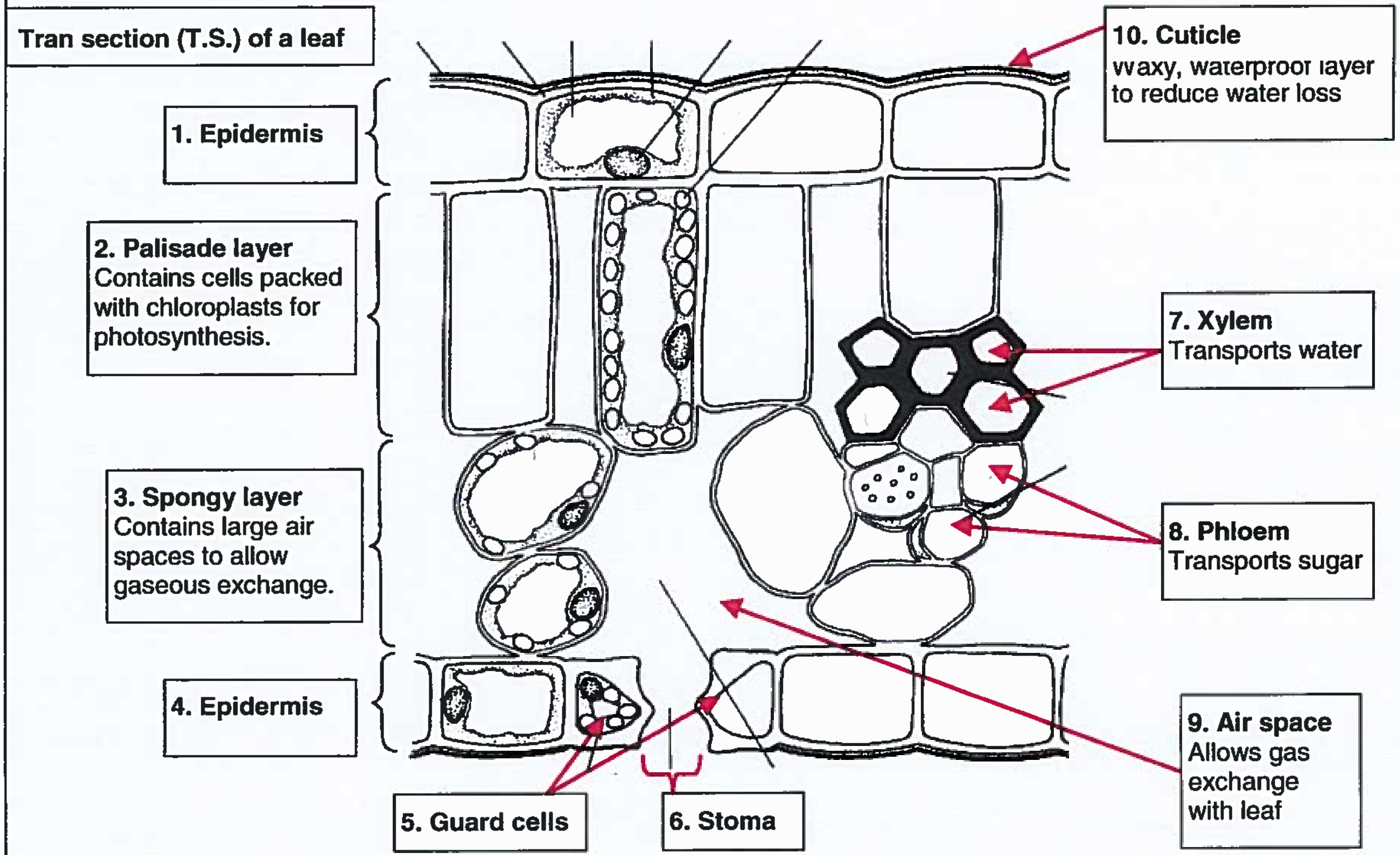
- Repeat experiment to check the repeatability of the results;
- Redo the experiment at different distances by moving the lamp a further 10cm from the plant each time.

The rate of photosynthesis can also be measured by using oxygen or carbon dioxide sensors and data loggers to measure:

- Oxygen produced per minute;
- Carbon dioxide used up per minute;



Structure of a Leaf



Plants, Water and Nutrients

Xylem Vessels
The function of xylem vessels are:
1. **Transport of water** – from the roots to the rest of the plant.
2. **Transport minerals** – minerals such as nitrates phosphates and potassium are transported by xylem around the plant dissolved in water.
3. **Support the plant** – the xylem vessels in the shoots and roots of mature plants are inflexible and strong and give support to the plant.

Investigation into the movement of a dye through a flowering plant
1. Take a white flower with a long stalk, e.g. a chrysanthemum and cut the stalk carefully lengthwise.
2. Put each half of the stalk into a measuring cylinder (or boiling tube) containing either plain water or water to which food dye has been added.
3. Tape the measuring cylinders to a plastic tray so that they don't fall over.
4. Leave the flower for a few hours.
5. Observe where the dye ends up in the flower head.

Fig. 1 Flower at beginning.

Fig. 2 Flower after a few hours.

Explanation
Water and dye are pulled up through xylem vessels.
When they reach the flower petals the water evaporates from pores in the petal surface but the dye remains in the cells of the petals.
The petals become coloured as dye accumulates in them.
This procedure could be useful for producing quantities of unusually coloured flowers.

The Importance of Water
Water is important to the plant for:
1. Use in photosynthesis;
2. Transport of minerals;
3. Support.

How does water support the structure of plant?
Water provides support due to the pressure of the vacuoles pushing against the cell walls and this keeps the cells turgid and prevents cells becoming flaccid and plants wilting.

Fig. 3 Turgid cell

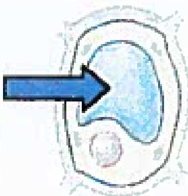
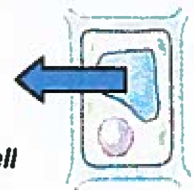


Fig. 4 Flaccid cell



The Transpiration Stream

There is a constant flow of water through a plant; this is called the **transpiration stream.**

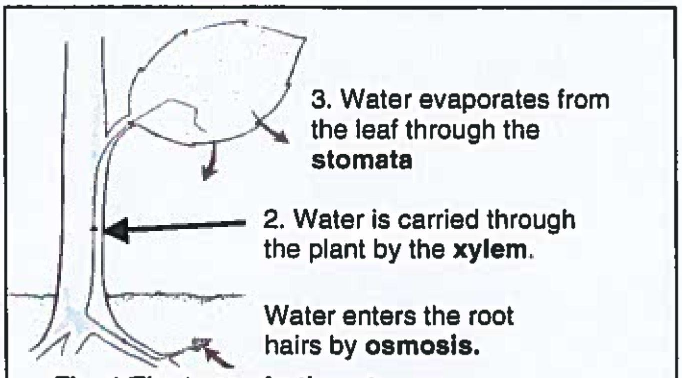


Fig. 1 The transpiration stream

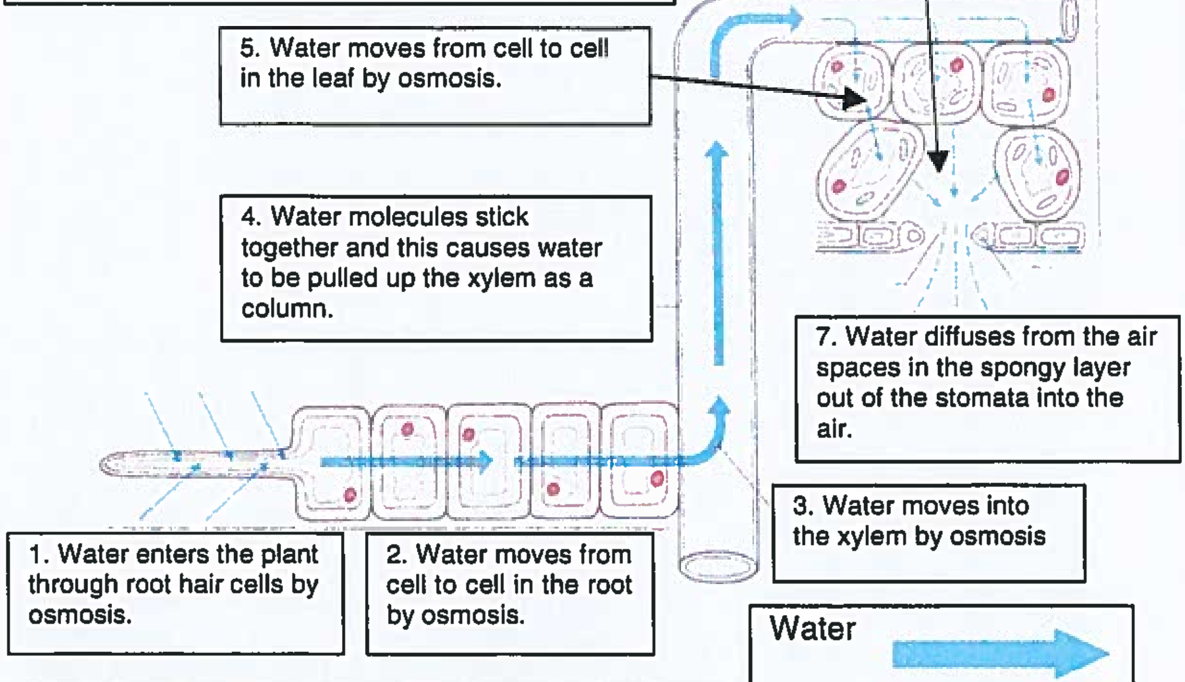


Fig. 2 Annotated illustration of the transpiration stream

Observation of root hair cells

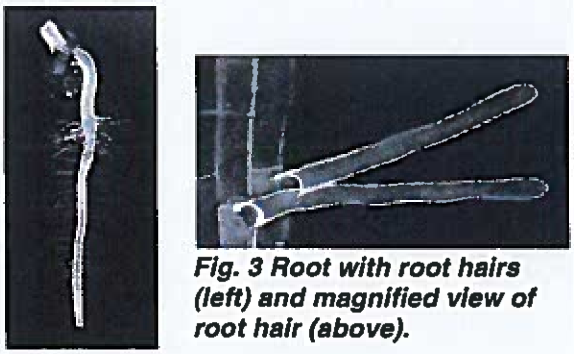


Fig. 3 Root with root hairs (left) and magnified view of root hair (above).

Water enters the plant from an area of high concentration of water in the soil to an area of lower water concentration inside the root hair cell, through it's partially permeable membrane, by osmosis.

The **increased surface area** of the root hair cell allows the plant to **take in more water faster** by osmosis.

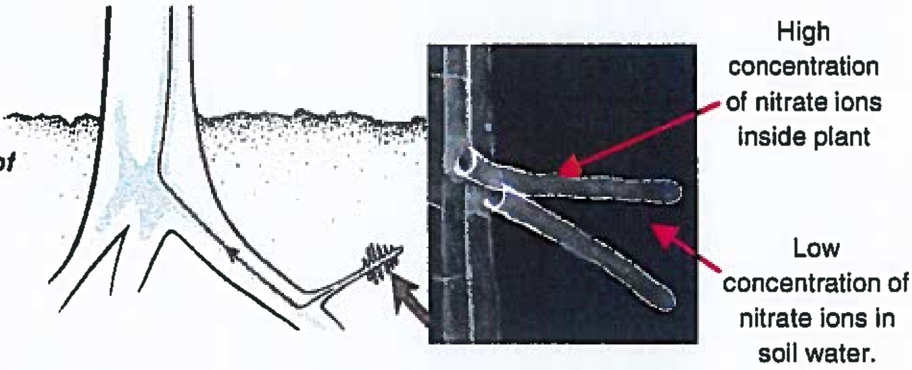
Active Uptake of Mineral Ions by Plant Roots

When the concentration of a material is lower outside the cell it must be **actively transported** into the cell (sometimes referred to as **active uptake**).

Example – Uptake of nitrate ions by root hair cells

Fig. 1

Diagram of a plant root with enlarged view of a root hair cells.



- Nitrate ions cannot move in by diffusion.
- Nitrate ions must be actively transported from the soil water (an area of low nitrate concentration) to the inside of the plant cells (an area of high nitrate concentration).

During active transport, salts or ions are pumped from an area of low concentration to an area of higher concentration.

This process requires energy released by the cell during respiration.

Factors that affect active transport:

- Active transport needs **energy**.
- Energy is released during **respiration**.

Any factor that affects the rate of respiration will affect the rate of active transport, e.g.:

- **Glucose concentration** – respiration needs glucose.
- **Oxygen** – aerobic respiration needs oxygen.
- **Temperature** – affects the enzymes controlling respiration.
- **Toxic substances** – e.g. cyanide stops respiration.

Factors that affect active transport will have an effect on the rate of uptake of ions from the soil into root hair cells.

Investigation 5 – Using a Simple Potometer to Measure Transpiration Rate.

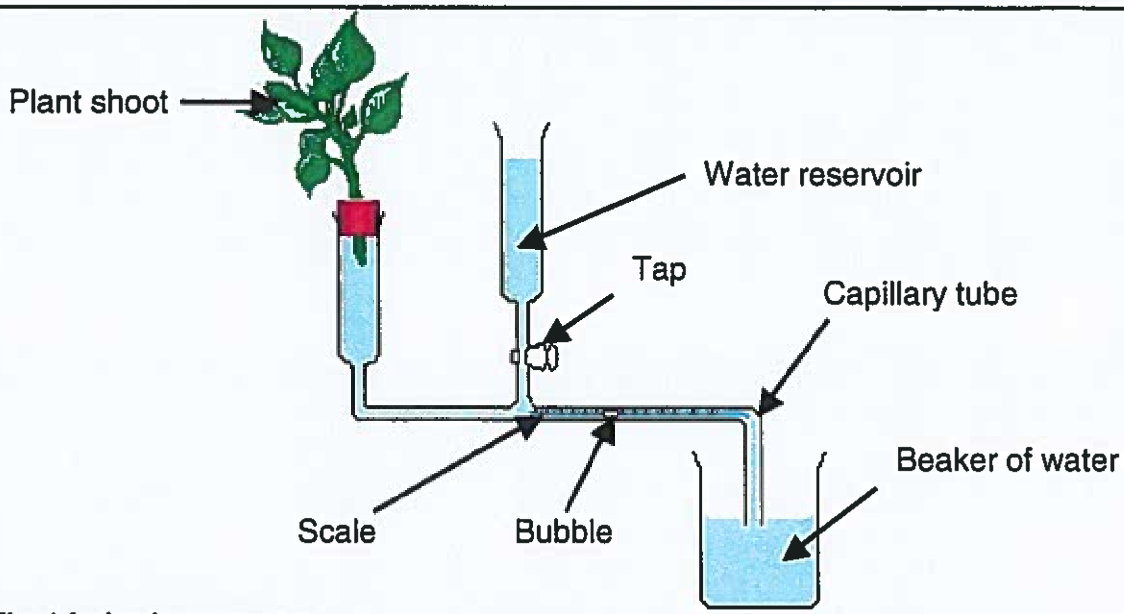


Fig. 1 **A simple potometer.**
An air bubble is introduced into the capillary tube at the start of the investigation. As water evaporates through the stomata of the leaves water is drawn up the capillary tube causing the bubble to move.
The investigation makes the assumption that water uptake is equal to the transpiration rate. However not all water is lost from the leaves, some is taken up by leaf tissue or used for photosynthesis.

Method

1. Set the bubble to it's starting position by using the tap to release water from the water reservoir.
2. Measure the time taken for the bubble to move a set distance

   OR

   Measure how far the bubble moves in a set period of time.
3. Record the results.
4. Repeat the experiment.

Environmental factors that affect water loss from a plant

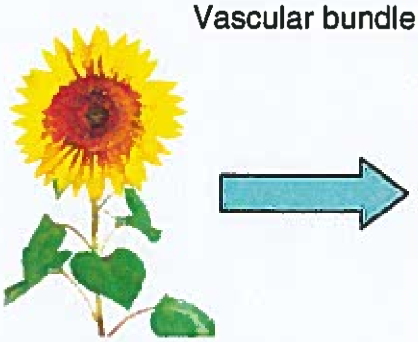
- **Temperature** – as temperature increases water molecules have more kinetic energy and therefore move faster. This increases transpiration.
- **Humidity** - increasing humidity reduces the concentration gradient of water between the air and the intercellular spaces in the spongy layer of the leaf – this decreases the diffusion of water out of the stomata.
- **Wind speed** – increasing wind speed carries away more water vapour from near the leaf surface and increases the rate of diffusion of water vapour out of the stomata.

Plant Transport Systems

Plants have two separate transport systems.

- **Phloem vessels** (tubes) – **transport sugar** and other substances that are produced by cells to all the other parts of the plant.
- **Xylem vessels** (tubes) – **transport water** and **mineral ions** from the roots to the rest of the plant.

Phloem and xylem vessels usually run together side by side.
Groupings of phloem and xylem vessels are called **vascular bundles**.



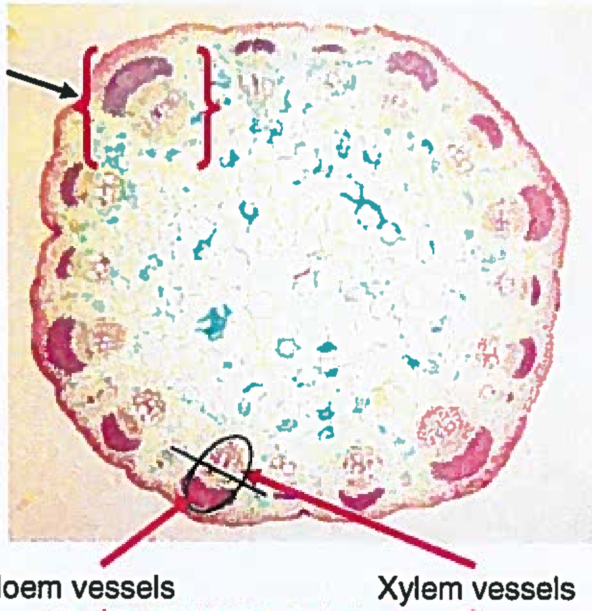


Fig. 1 – T.S. of a sunflower stem showing positions of vascular bundles.

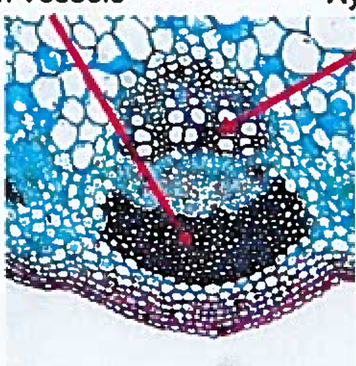


Fig. 2 – T.S. of a sunflower stem showing a single vascular bundle.

Phloem Vessels

Phloem carries sugar from the photosynthetic areas to other parts of the plant.
Sugar is moved to other parts of the plant for **use in respiration** and converted into **starch for storage.**
The transport of sugar is not fully understood so plant scientists are still investigating it.

Healthy Plant Growth

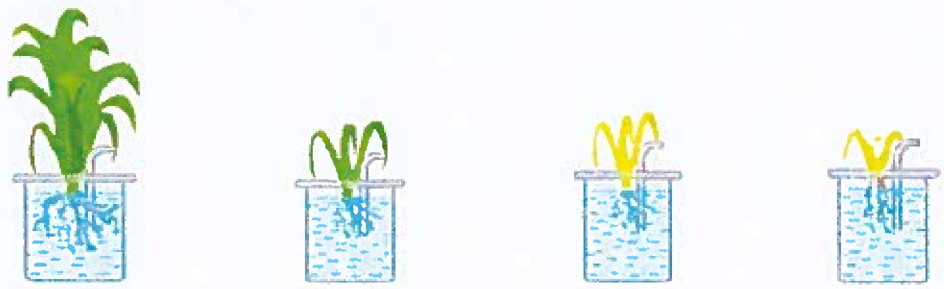
Plants can only grow well if they are in a soil rich in **mineral** nutrients.
Plant roots absorb the minerals from the soil and use them to produce materials that they need to grow.

Three main minerals are needed:

- **Nitrates**
- **Potassium**
- **Phosphates**

Investigating Plant Nutrient Requirements

1. Three healthy plants of the same species and age are grown in an equal volume of aerated mineral solutions.
2. After eight weeks the growth of the plants are observed.



Plant 1 Plant 2 Plant 3 Plant 4

Analysis

Plant	Description	Explanation
1	Healthy growth	Complete solution of minerals
2	Poor growth	Nitrogen deficiency
3	Yellowing of leaves	Potassium deficiency
4	Poor root growth	Phosphate deficiency

NPK fertilisers that contain nitrates, phosphates and potassium can be added to soil to increase the mineral content.

Energy and Nutrient Transfer

Light energy from the sun is the source of all energy for all living things on the planet.
Green plants absorb only a small percentage of this energy (about 1%), using the chlorophyll in their chloroplasts. The rest of the light is either reflected or is at the wrong wavelength.

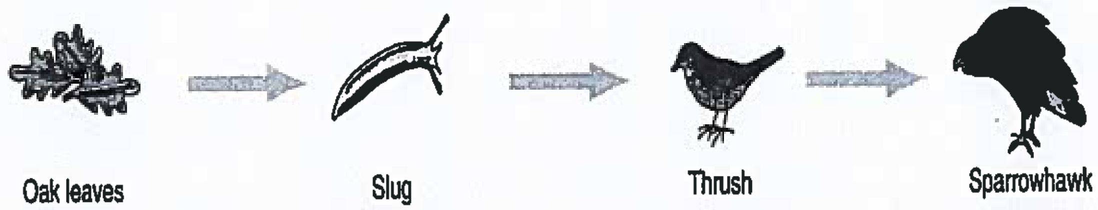
The **absorbed energy** is **used** for **photosynthesis** to produce substances that become part of the cells. These **increase the biomass** of the plant.

- Biomass is the mass of living material in plants and animals.

Food Chains – Glossary of terms

There are many terms to describe the organisms in a food chain. Some organisms can be described using more than one label.
E.g. an herbivore can also be described as a first stage consumer.

Producer	Herbivore	Carnivore	Carnivore



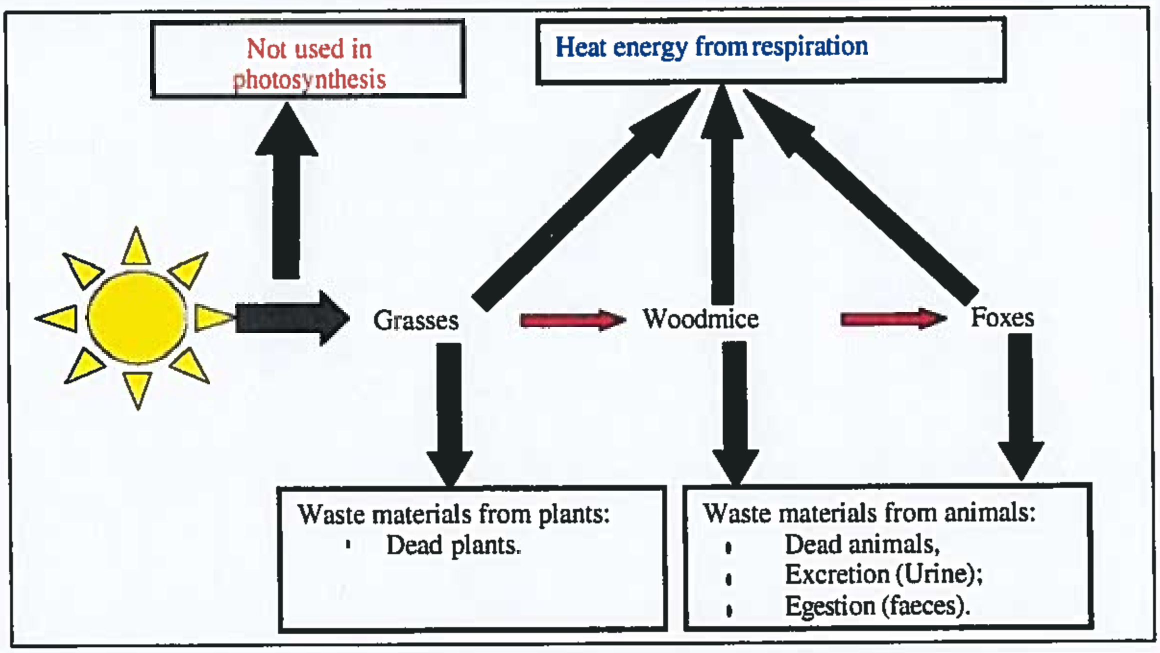
	PRIMARY First stage consumer	**SECONDARY** Second stage consumer	**TERTIARY** Third stage consumer

- The **arrows** in a food chain show **energy being passed** from one living thing to the next. (*This is sometimes described as a **flow of energy***).

Producer	Makes it's own food by photosynthesis.
Consumer	An organism that eats other organisms.
First stage consumer	The first organism that is 'eating' in a food chain.
Second stage consumer	The second organism that is 'eating' in a food chain.
Third stage consumer	The third organism that is 'eating' in a food chain.
Herbivore	An organism that only eats plants.
Carnivore	An organism that only eats animals.
Omnivore	An organism that eats both animals and plants.

Energy Flow Through a Food Chain

There is energy lost at each step of a food chain, so there's less available for the next animal. This is why the numbers of organisms in a food chain is limited. The more energy lost every step, the shorter the food chain.

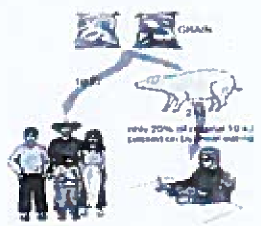


Energy is also **'lost'** from the food chain for the **repair** of animal or plant **cells.**

Some things to consider about energy lost as heat during respiration.

- Animals lose more heat than plants because their metabolism is higher (the amount of chemical activity in cells).
- Animals lose more heat than plants because they move around; plants don't.
- Warm-blooded animals (mammals and birds) lose more heat than cold-blooded animals (all the others) because they need to keep their body temperature constant. *(See homeostasis).*
- Land animals lose more energy than animals in water, because they have to support their bodies. E.g. we humans have to stand, a jellyfish just floats!

Efficient Food Production
More food can be produced from an area of land if it is used for growing crops rather than grazing animals.
Less energy is lost if people eat plants, because the food chain is shorter.
However, potatoes wouldn't grow on a mountain, but sheep can graze there, so no need to stop all animal production.



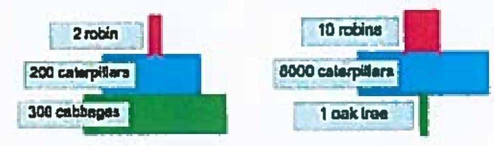
Food Pyramids

Pyramids of number show the **number of organisms in a given area** or volume for every feeding level.

Rules for pyramids of number:

1. The producer is always at the bottom.
2. The size of every block (area or volume) shows the **number** of plants or animals in the food chain.

Pyramids of numbers can be misleading. The pyramid on the left represents a cabbage field, and the one on the right woodland. Their shapes are different even though they show the number of individual organisms. A tree can support thousands of animals; therefore the base of the pyramid is smaller than the levels above.



Pyramids of biomass shows the **dry mass of organisms in a given area** or volume for every feeding level.

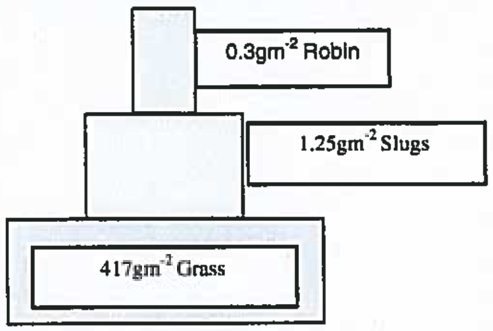
Rules for pyramids of biomass:

1. The producer is always at the bottom.
2. The size of every block (area or volume) shows the **dry mass of the** of **plants** or **animals** in the food chain

The shape of a pyramid of biomass can change during the year, depending on the time a survey is carried out.

The pyramid on the right has been drawn from grassland during May.

If a survey were carried out in December the mass of grass would be less.
During the winter it is colder and there is less sunlight, therefore the grass would be producing less biomass by photosynthesis.

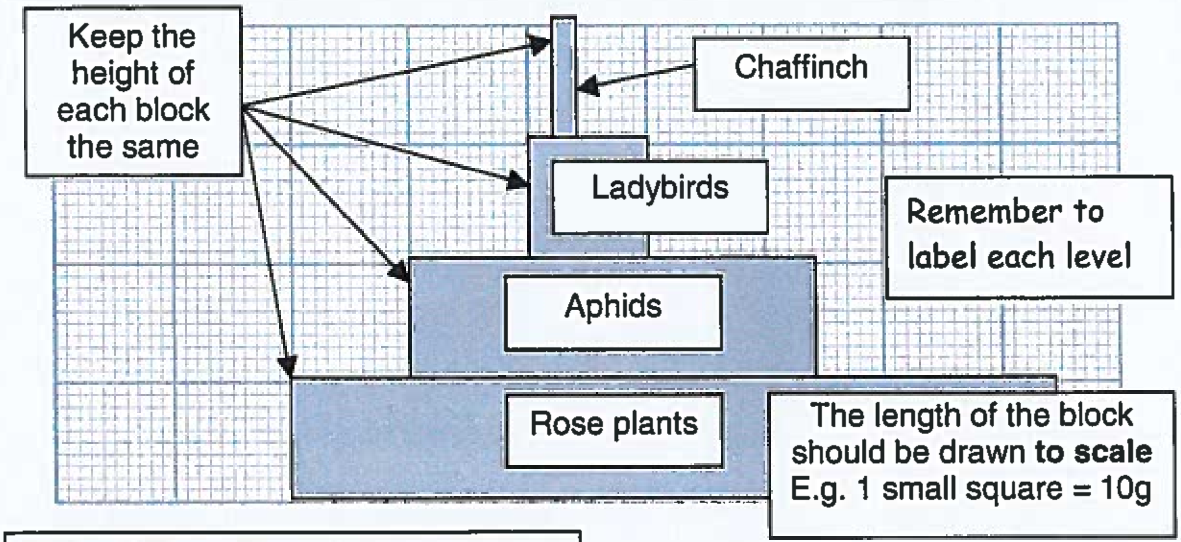


Remember
A pyramid of biomass will always be pyramid shaped.

Building Food Pyramids
Organisms are represented as small squares on graph paper. Drawing a line around all the small squares will give a box that represents the numbers or biomass of an organism.

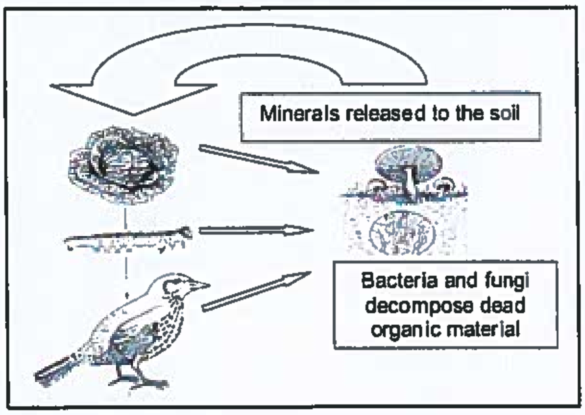
=Number x mass

Organism	**Number** in the food chain	**Mass** of each organism (g)	Total biomass of organisms (g)
Rose plants	1	640	640
Aphids	7000	0.05	350
Ladybirds	400	0.25	100
Chaffinch	1	25	25



Natural Recycling
Not every animal or plant gets eaten!

- **Decomposers** are **bacteria** and **fungi**.
- Decomposers digest and use animal and plant waste for growth and respiration.
- Minerals such as nitrates are released to the soil, and are then used by plants for growth.



Factors that affect the activity of decomposers (bacteria and fungi):

- Temperature
- Oxygen
- pH
- Heavy metals

1.6(d) How to calculate the efficiency of energy transfers between trophic levels

Nearly all organisms are dependent on energy from the Sun.

Plants harness light energy to drive food production. By the process of photosynthesis, organic compounds like glucose are made from carbon dioxide and water using this energy. Plants only absorb a small percentage of the Sun's energy **(1%)** for the process of photosynthesis. The energy is absorbed in chemicals that make up the plants' cells.

Energy transfer

Animals cannot make their own food so they have to eat. This is one way in which energy is transferred between organisms in an ecosystem. The energy is used for a number of life processes.

In a food chain only around **10%** of the energy is passed on to the next level. The rest of the energy, **90%**, passes out of the food chain in a number of ways (life processes Mrs Gren):

- via heat energy
- is used for life processes (Mrs Gren)
- uneaten parts that pass to decomposers
- is excreted and passes to decomposers.

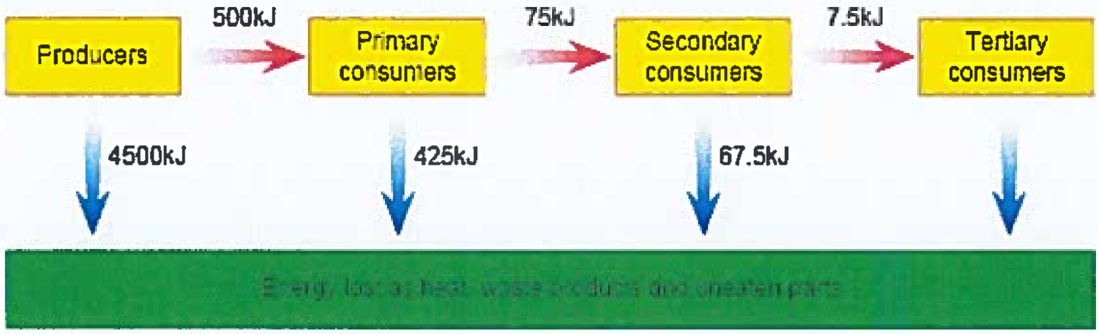
Movement
Respiration
Sensitivity

Growth
Reproduction
Excretion
Nutrition

As less energy is transferred at each level (trophic level) of the food chain, the number of organisms at each level gets smaller, due to the much reduced available energy.

Percentage efficiency of energy transfer

An example of energy flow through an ecosystem is shown below:



Energy flow through an ecosystem

If we want the percentage efficiency of energy transfer between producers and primary consumers.

1. Calculate the total energy that came into the level of the food chain:

4,500kJ + 500kJ = **5,000kJ**

2. Identify how much energy is transferred to the primary consumers:

500kJ

3. Calculate the efficiency of the transfer from the primary producer to the primary consumers using the equation:

(Energy transferred to next level ÷ Total energy in) X 100

(500kJ ÷ 5,000kJ) X 100 = 10%

This shows the percentage efficiency of energy transfer between producers and primary consumers in this ecosystem is **10 per cent.**

4. Calculate the efficiency of the transfer from the primary consumers to the secondary consumers using the equation:

(Energy transferred to next level ÷ Total energy in) X 100

(75kJ ÷ 500kJ) X 100 = 15%

5. Calculate the efficiency of the transfer from the secondary consumer to the tertiary consumers using the equation:

(Energy transferred to next level ÷ Total energy in) X 100

(7.5kJ ÷ 75kJ) X 100 = 10%

Biodiversity and Protecting Endangered Species

Biodiversity is the number of different species in a particular area.

Biodiversity leads to stable ecosystems that can resist possible harmful situations.
This is important because ecosystems help to:

- regulate the atmosphere,
- regulate water supply,
- regulate nutrient cycles, e.g. the nitrogen cycle,
- provide fertile soil.

Biodiversity is important for:

- food,
- potential foods,
- industrial materials,
- new medicines,
- human well being.

These days more and more species are becoming **extinct** because man is destroying their habitats.
This leads to a **decrease in biodiversity.**
Habitats are being destroyed because of increases in the use of land for:

- Building
- Quarrying
- Dumping rubbish
- Agriculture

The methods of protecting biodiversity and rare species are listed below:

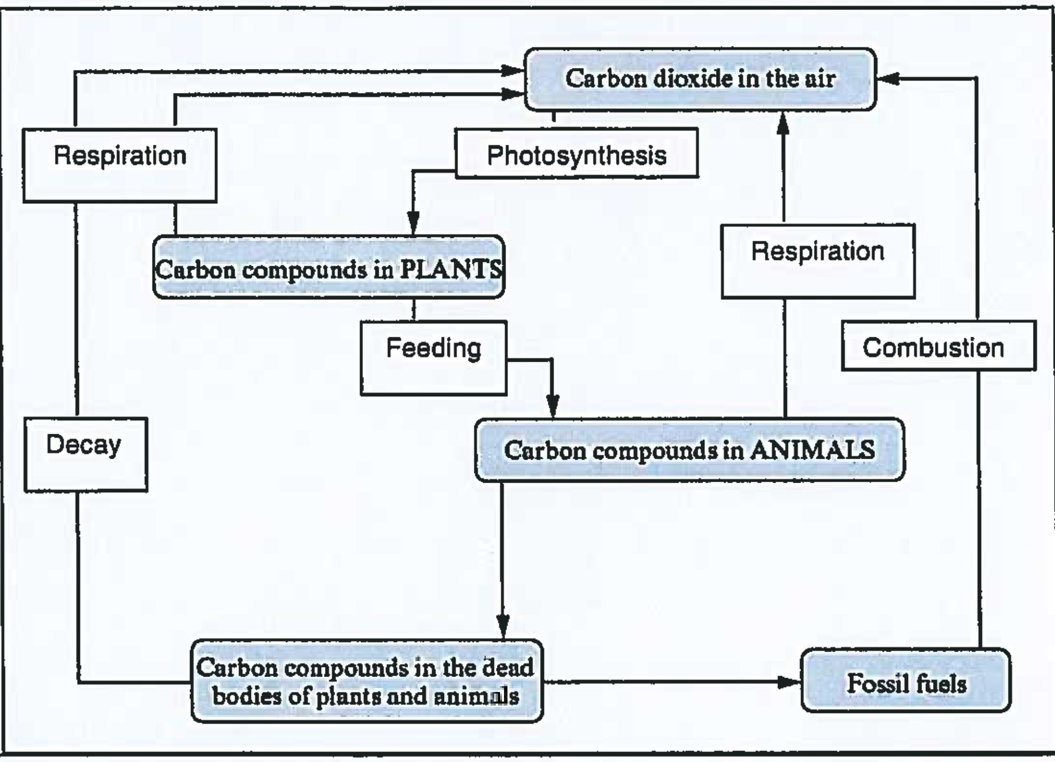
- **CITES** *(Convention on International Trade in Endangered Species) – Agreement in the international market to prevent trade in endangered species.*
- **SSSI** – Sites of Special Scientific Interest
- **Captive breeding programs** (e.g. Zoos)
- **National Parks**
- **Seed banks**
- **Local biodiversity conservation schemes**

Computer programs can be used as simulations of environmental interactions and to predict trends.
For example:

- modeling climate change,
- investigating the effect of pollutants on populations,
- predicting trends in populations of endangered species.

The Carbon Cycle

- Carbon enters the food chain via **photosynthesis.**
- Some of this carbon then becomes carbohydrates, fats and proteins in plants.
- The carbohydrates, fats and proteins are passed along the food chain when animals are **feeding** (consuming).
- Some carbon is converted to carbon dioxide during **respiration** by plants and animals.
- Carbon is returned to the environment when living things die or produce waste material, e.g. faeces.
- **Decomposers** (micro-organisms such as **bacteria** or **fungi**) feed on dead organisms and the waste material for growth and other life processes. This is called decomposition or decay.
- Carbon is released to the atmosphere as carbon dioxide when decomposers respire.
- When decay is prevented substances such as peat, coal, oil and gas are formed and these store energy in carbon compounds.
- Energy and carbon dioxide are released when these fossil fuels are burnt.



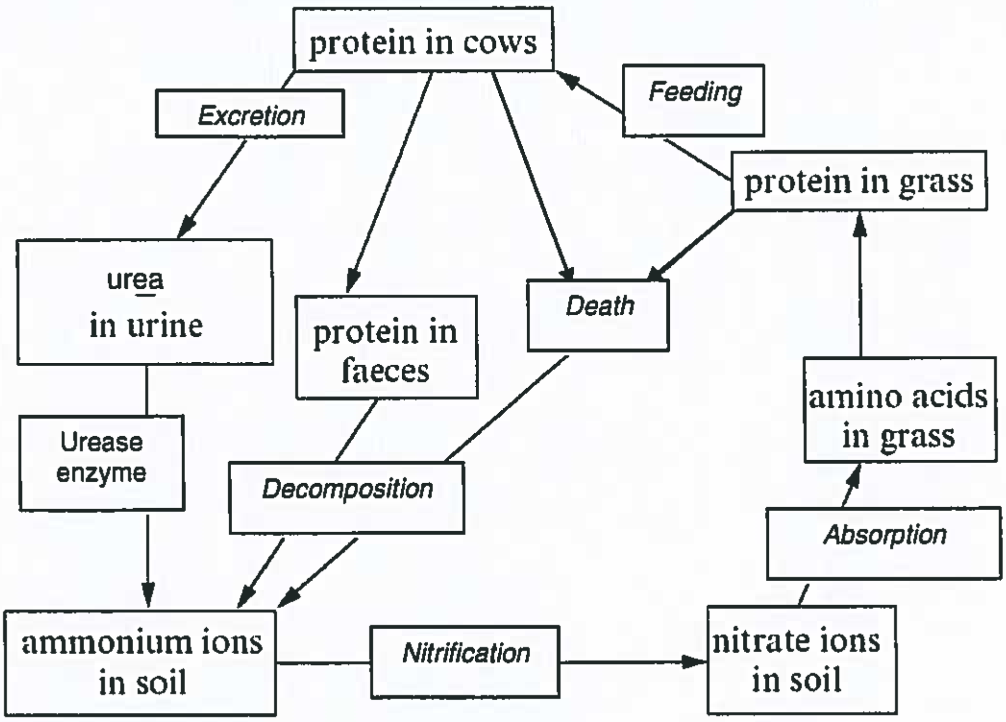
Human effects on the carbon cycle

- **Combustion** (burning) of fossil fuels has increased the concentration of carbon dioxide in the environment.
- **Combustion** of fossil fuels also releases sulphur dioxide that leads to acid rain.

The Nitrogen Cycle

- Living organisms need nitrogen to make **proteins.**
- 78% of the air is nitrogen, but plants and animals can't use nitrogen gas.
- Nitrogen must be changed into **nitrates** before plants can use it.

Nitrates can be absorbed by plant roots and used to make proteins. This protein then becomes food for animals as it is passed on along food chains.

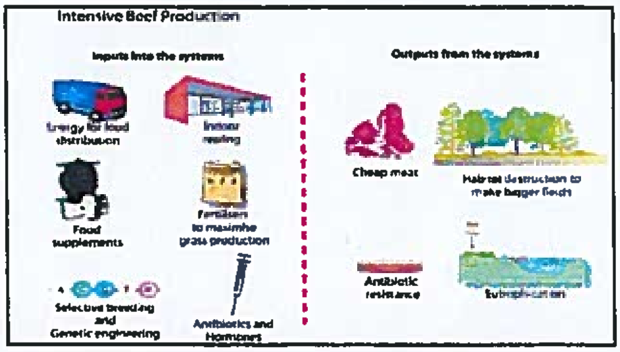


How does the nitrogen cycle work?

- When a plant or animal dies,
- Soil bacteria and fungi act as decomposers,
- They convert protein (and urea from urine) into ammonia,
- The ammonia is then converted to nitrates in a process called nitrification.
- Nitrifying bacteria carry out nitrification.
- The nitrates are then absorbed (taken up) by plant roots.
- The nitrates are used to make amino acids.
- The amino acids are then used to make new proteins.

Intensive Farming

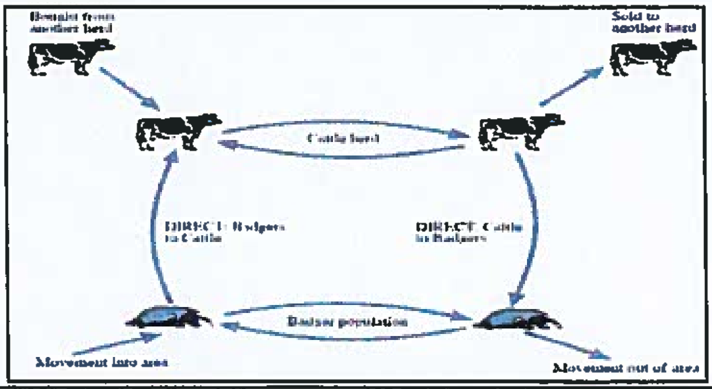
In order to feed the growing world population we need get as much **yield** (from plants or animals) from **less land.**
We can do this by using **intensive farming methods.**



You need to be able to name **methods** of intensive farming and describe their **advantages** and **disadvantages**:

Methods	Advantages	Disadvantages
Fertilisers	Increase plant yield.	Can wash out of soils and pollute rivers and streams.
Pesticides	Increases yield by stopping pests from eating or competing with crop plants.	Can destroy non-pest species. Can lead to bioaccumulation.
Disease control	Prevents losses of plants and animals.	Antibiotics given to animals may still be found in meat form treated animals.
Battery methods	Less room to move. Less energy wasted. Less food needed. Reduced costs.	Poor quality of life for animal.

TB infection in cattle and badgers
Bovine tuberculosis (bTB) is a very serious disease of cattle in Britain.
There is very strong evidence of a link between bTB in cattle and bTB in badgers.



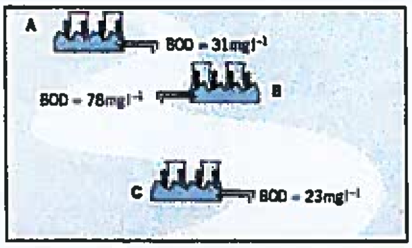
Farmers believe that badgers should be culled to prevent the spread of bTB.

Arguments supporting a cull	Arguments against a cull
Badgers carry bTB and pass it on to cattle.	Badger culls have not always been effective.
Many cattle die each year.	Badgers that survive can move to other areas spreading the disease.
	Vaccination may be more effective.

Measuring pollution in rivers and streams

Populations can be upset by the introduction of harmful materials into the environment, which results in pollution.

Pollution in rivers and streams can be measured using:
- Changes in pH levels
- Changes in oxygen levels
- Indicator species



- **Changes in pH**

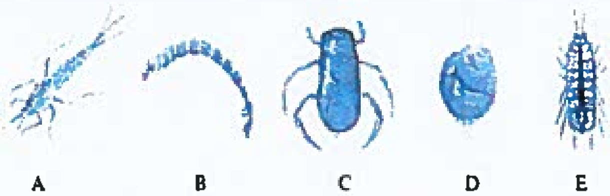
Acidification of rivers and streams is due to acid rain and run-off from surrounding land. Below pH 4.5-5 aluminium is released from rocks. This is toxic to fish.

- **Changes in oxygen levels**

The change in oxygen concentration shows how much bacteria there is in the water. The more bacteria there are, the more polluted the water is.

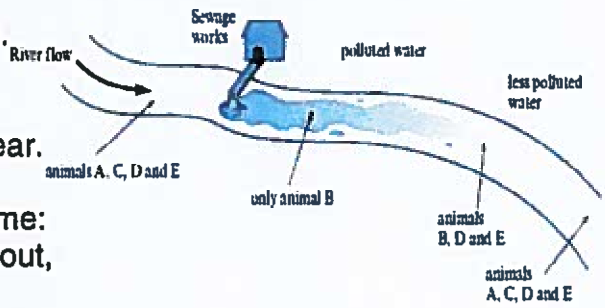
- **Indicator species**

You can estimate the amount of pollution by recording the presence or absence of certain indicator species.



- **Carrying out a survey**

A survey should be a **fair test**. Therefore only one factor should change (the independent variable).
Everything else should stay the same.



Example of an annual survey
- The independent variable is the year.

The variables that should stay the same:
- Time of year the survey is carried out,
- Same locations sampled,
- Time of day the survey is carried out,
- Volume of water sampled,
- Method of sampling,
- Same water conditions, e.g. temperature, flow rate, turbidity.

Measuring Air Pollution

Lichen can be used as indicator species for air pollution.
Lichens are sensitive to **sulphur dioxide** gas (produced form burning fossil fuels).
Some species are so sensitive that a very low concentration of the gas will kill them.
Lichen found growing on trees or rocks could be used to indicate the concentration of sulphur dioxide in the air.

Zone	Description	Sulphur dioxide content of the air (ug/m^3)
0	Heavy Pollution	High sulphur dioxide concentration
1	↓	↓
2		
3		
4		
5		Low sulphur dioxide concentration
6	Clean Air	

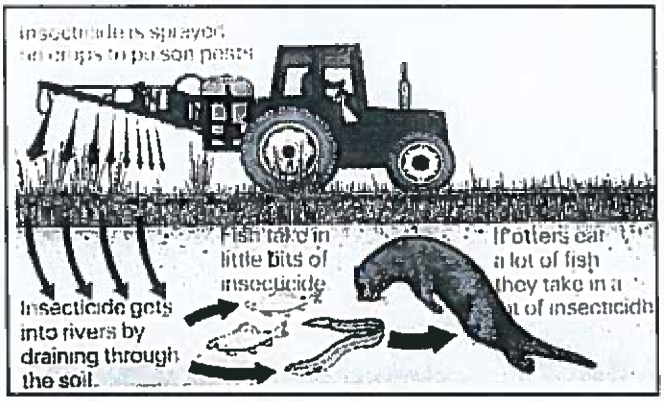
Note, some of the species found in more polluted air can also be found in purer air. Always look for the lichen giving the *highest* zone reading on the scale.

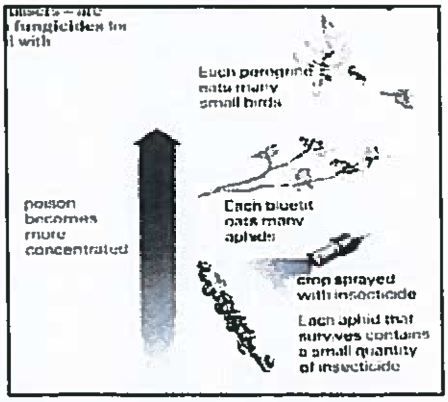
Pesticides in Food Chains

These are chemicals that farmers use to control pests and diseases on crop plants.

- **Insecticides** kill insect pests feeding on plants.
- **Herbicides** (weed killers) reduce competition for water and light between pest plants and crops.
- **Fungicides** kill fungi that cause plant diseases.

Environmental Effects of Pesticides - Bioaccumulation





Pesticides can be sprayed on crops.
Pesticides from crops may be washed into lakes, rivers and natural underground water stores and so contaminate drinking water.

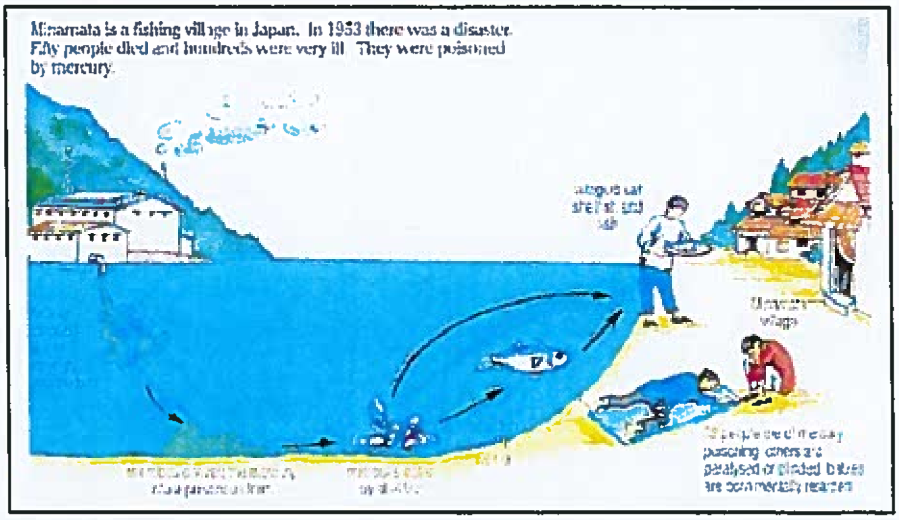
Some chemicals are not broken down by the cells of living organisms and therefore enter the food chain.
The **further along a food chain** an organism is, the more **chemicals accumulate in its tissues**. The scientific name for this is **bioaccumulation**.
The organism at the end of a food chain will receive a **toxic dose** that has harmful effects, e.g. **reducing fertility** or **death**.

DDT – A Case Study for Bioaccumulation
Between 1960 and 1970 seeds were often treated with pesticides, such as DDT to try and stop insects from eating them.
Before long, the numbers of birds of prey, such as the Sparrowhawk were decreasing. Many were found dead with high levels of pesticides in their bodies.
Scientific evidence has shown that DDT stays in the environment for a long time.
DDT has been banned in the USA since 1972 and in the UK since 1984.

Heavy Metals in Food Chains

In the year 2000 new laws were passed to reduce the level of pollution by industry.
Many industries (**oil refineries, chemical works, steel plants** and **paper mills**) used to release chemicals into rivers and the sea. These chemicals included **heavy metals** such as **lead, mercury, cadmium** and **tin.**

A well-known case of industrial pollution is the tragedy of Minamata, a fishing village in Japan.



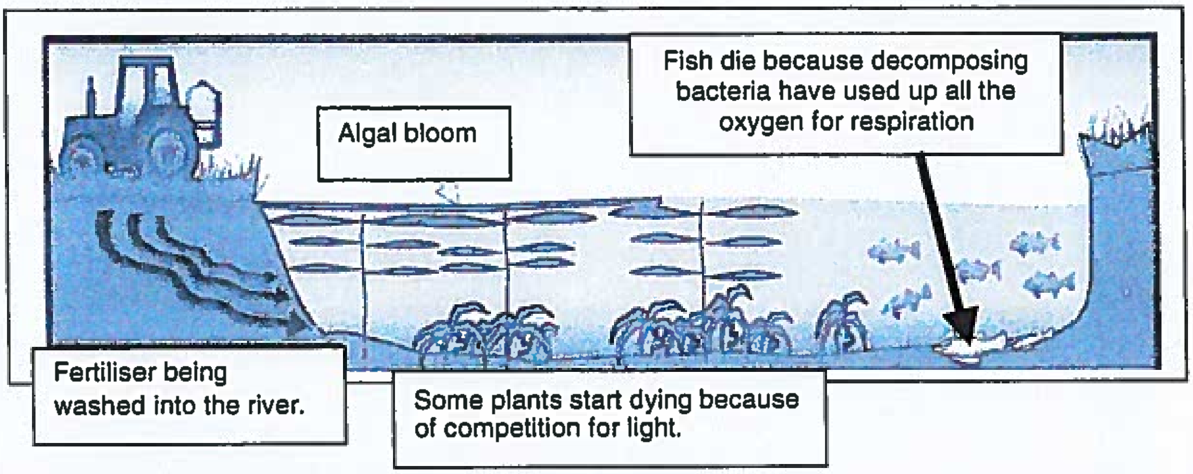
52 people died from mercury poisoning. Others were paralysed and babies were born with brain damage. Mercury affects the nervous system.

Explanation

- A plastics factory released mercury compounds into the sea.
- Plant plankton (microscopic plants) absorbed mercury.
- Animal plankton (microscopic animals) ate a lot of the plant plankton, and mercury built up inside them.
- Fish ate a lot of the animal plankton. Because they could not excrete the mercury (get rid of it from their bodies), the concentration increased inside them.
- When people ate a lot of the fish they received a very high concentration of mercury.
- This toxic or poisonous dose was enough to kill them or make them very ill.

Effect of Fertilisers and Sewage on the Environment

Fertilisers contain the minerals that crop plants need to grow, e.g. **nitrates** and **phosphates**. Chemical fertilisers are important in intensive farming, but they must be used carefully especially near streams, rivers and ponds.



Explanation – (QWC question model answer)

- Fertilisers containing nitrates and phosphates are washed into streams, rivers, ponds and the sea.
- Nitrates and phosphates cause an increase in the growth of water plants or algal blooms.
- Some plants start dying because there is increased competition for light.
- Decomposing bacteria decompose (rot) the dead plants.
- The number of decomposing bacteria increases.
- The decomposing bacteria use up the oxygen in the water for respiration.
- There is less oxygen in the water.
- Animals, such as fish, die because there is not enough oxygen in the water.

What about sewage?

- Untreated sewage causes an increase in the growth of water plants. (It has the same effect as fertilisers).
- Bacteria in the water also feed on untreated sewage, using up the oxygen in the water for respiration.