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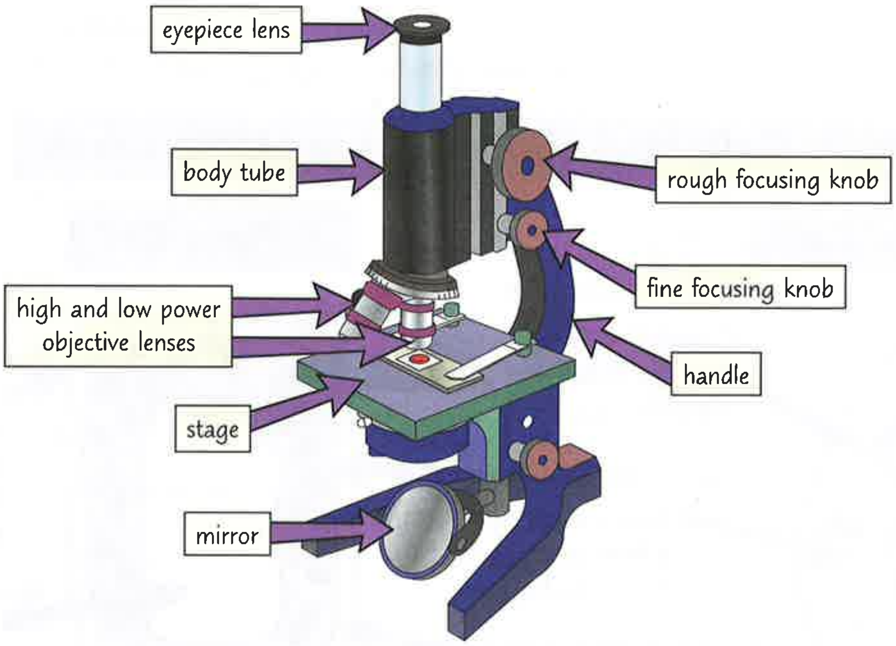
The Microscope

A microscope is used for looking at objects that are too small to see with the naked eye.
The lenses in the microscope magnify objects (make them look bigger) so that you can see them.

Learn the Different Parts of a Microscope

Here are some of the main parts of a light microscope — make sure you can identify them.



Follow These Easy Steps to Using a Light Microscope

1) Carry your microscope by the handle.
2) Place it near a lamp or a window, and angle the mirror so light shines up through the hole in the stage.
3) Clip a slide onto the stage. The slide should have the object(s) you want to look at stuck to it.
4) Select the lowest powered objective lens.

Don't reflect direct sunlight into the microscope — it could damage your eyes.

5) Turn the rough focusing knob to move the objective lens down to just above the slide.
6) Look down the eyepiece lens and adjust the focus using the fine focusing knob.
7) Keep adjusting until you get a clear image of whatever's on the slide.

DON'T BREAK THE SLIDE

Always turn the fine focusing knob so that the objective lens is moving away from the slide — so the lens and slide don't crash together.

8) If you need to see the slide with greater magnification, switch to a higher powered objective lens (a longer one).
9) Now refocus the microscope (repeat steps 5 to 7).

WORKING SCIENTIFICALLY

Microscopes are great for looking at cells

A microscope lets you see all the tiny building blocks (called cells) that make up living things. Choosing the correct equipment and using it properly and safely is a key part of being a scientist.

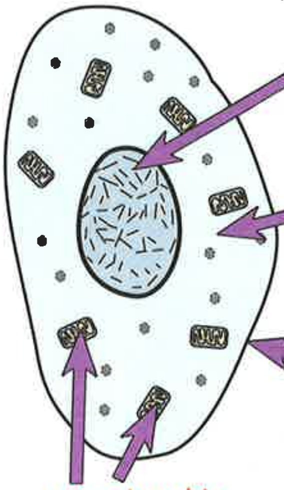
Cells

Living Things are Made of Cells

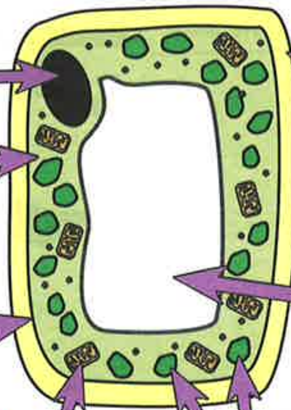
1) Another word for a living thing is an organism.
   All organisms are made up of tiny building blocks known as cells.
2) Cells can be seen through a microscope (see previous page) — but it helps if you stain them first (using a coloured dye).

Animal and Plant Cells Have Similarities and Differences

An Animal Cell



A Plant Cell



BOTH have:

1) A Nucleus:
   This controls what the cell does.
2) Cytoplasm:
   This is a jelly-like stuff where most chemical reactions happen.
3) A Cell Membrane:
   This is a thin skin around the cell — it holds the cell together and also controls what goes in and out.
4) Mitochondria:
   These are tiny structures inside the cell where most of the reactions for aerobic respiration (see page 4) take place. Respiration releases energy for the cell.

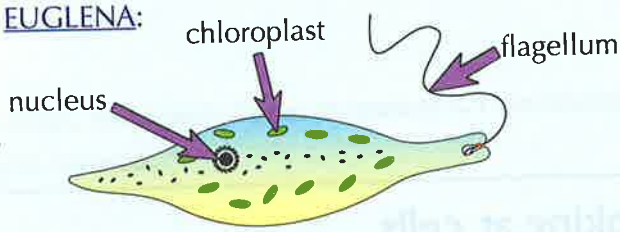
ONLY PLANTS have:

1) A Cell Wall:
   A rigid outer coating made of cellulose — it gives support to the cell.
2) A Vacuole:
   This is filled with cell sap — a weak solution of sugar and salts.
3) Chloroplasts:
   These contain chlorophyll used for photosynthesis (see p.30). Photosynthesis makes food for the plant.

Some Living Things are Unicellular

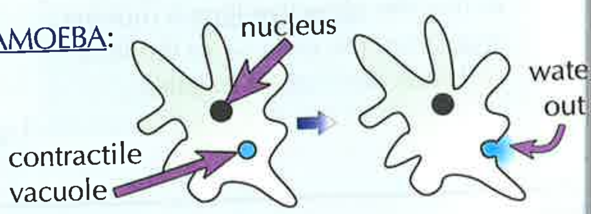
1) Animals and plants are made up of lots of cells. They're multicellular organisms.
2) But many living things are made up of only one cell — these are called unicellular organisms. Unicellular organisms have adaptations to help them survive in the environment they live in, e.g.

EUGLENA:



Euglena live in water. They have a tail-like structure called a flagellum to help them swim.

AMOEBA:



Some amoeba also live in water. They use a contractile vacuole to collect any excess water insi them and squeeze it out at the cell membrane.

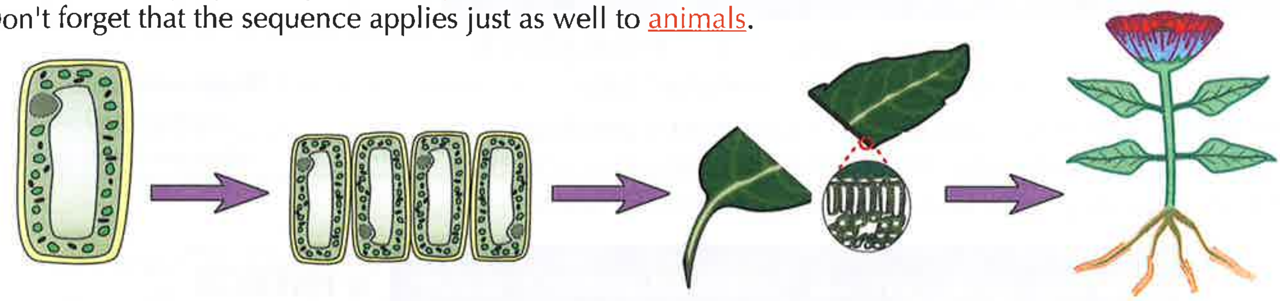
Cell Organisation

Learn How Cells are Organised

In organisms with lots of cells (like animals and plants), the cells are organised into groups. Here's how:

A group of similar cells come together to make a tissue.
A group of different tissues work together to make an organ.
A group of organs work together to make an organ system.
A multicellular organism is usually made up of several organ systems.

Here's a rather jolly example from a plant.
Don't forget that the sequence applies just as well to animals.

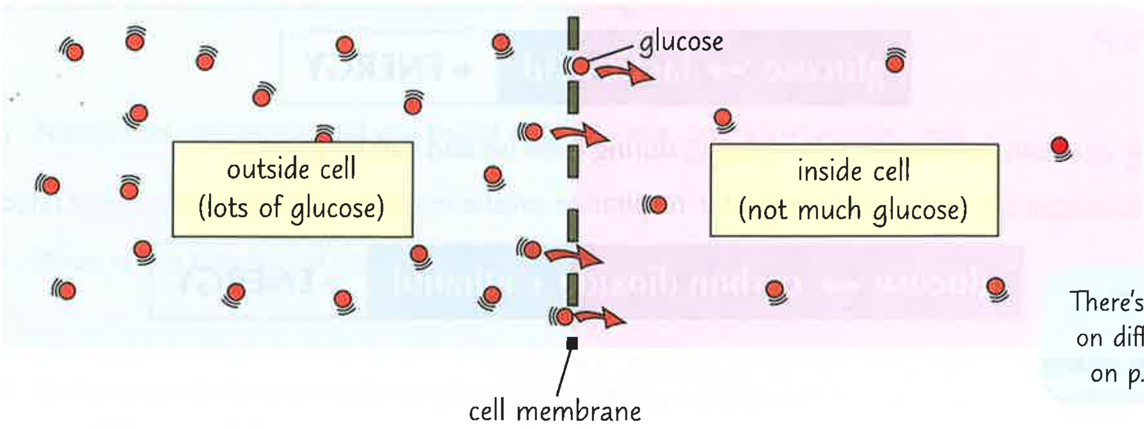


palisade CELLS... ...make up palisade TISSUE... ...which, with other tissues, makes up a leaf (an ORGAN)... ...which, with more leaves and other organs, makes up the shoot system (an ORGAN SYSTEM). Different organ systems make up a full plant (an ORGANISM).

A palisade cell is just the name for a particular type of plant cell.

Stuff Moves Into and Out of Cells by Diffusion

1) Cells need things like glucose (a sugar) and oxygen to survive. They also need to get rid of waste products, like carbon dioxide.
2) These materials all move into or out of cells by a process called diffusion.
3) Diffusion is where a substance moves from an area of high concentration (where there's lots of it) to an area of low concentration (where there's less of it) — just like glucose in this diagram...



There's more on diffusion on p.50.

Cells are the building blocks of organisms

Remember: cells → tissues → organs → organ systems → organisms. You need to get your head around diffusion too — it comes up all the time in KS3 science, so it's worth getting to grips with now.

Respiration

Respiration is one of the most important life processes there is. It's worth learning really well.

Respiration is a Chemical Reaction

1) Respiration happens in every cell of every living organism.
2) Respiration is the process of releasing energy from glucose (a sugar).
3) The energy released by respiration is used for all the other chemical reactions that keep you alive. For example, the reactions involved in building proteins, muscle contraction and keeping warm.

Aerobic Respiration Needs Plenty of Oxygen

1) Aerobic respiration is respiration using oxygen. It takes place in the mitochondria (see page 2) of animal and plant cells.
2) In aerobic respiration, glucose and oxygen react to produce carbon dioxide and water. This reaction releases lots of energy.
3) Here's a word equation to show what happens in the reaction — learn it:

There's more on chemica reactions and word equations on page 57.

glucose + oxygen → carbon dioxide + water + ENERGY

These are the reactants. These are the products.

Anaerobic Respiration Takes Place Without Oxygen

1) Anaerobic respiration is respiration without oxygen.
2) Anaerobic respiration is less efficient than aerobic respiration, so it releases less energy.
3) Because of this, anaerobic respiration usually only happens when cells can't get enough oxygen, e.g. if body can't get enough oxygen to your muscle cells when you exercise, they start to respire anaerobicall

Anaerobic Respiration is Different in Different Organisms

1) In humans, anaerobic respiration produces a substance called lactic acid:

glucose → lactic acid + ENERGY

Lactic acid can build up in your muscles during exercise and can be painful.

2) In microorganisms like yeast, anaerobic respiration produces carbon dioxide and ethanol (alcohol):

glucose → carbon dioxide + ethanol + ENERGY

When anaerobic respiration produces ethanol, it's called fermentation. Fermentation is the process used to make beer.

REVISION TASK

There are two types of respiration — learn the difference

It can be tricky to get your head around respiration, but it just means turning glucose into energy. Make sure you've learnt those equations — cover the book and write them down.

Warm-Up and Practice Questions

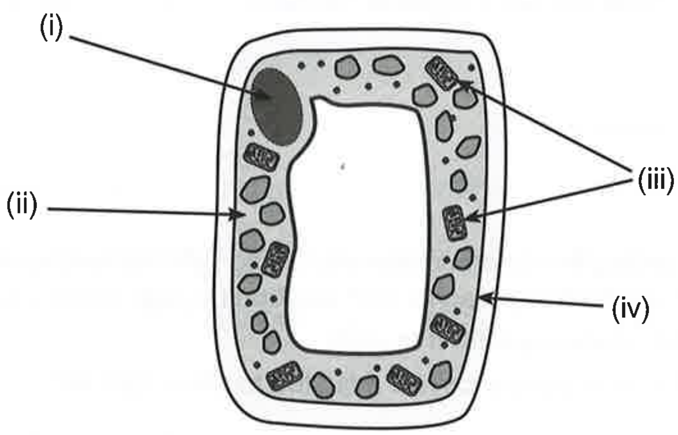
Take a deep breath then ease yourself in gently with these warm-up questions. Then attack the practice questions. All the answers are somewhere in this section, so there are no excuses.

Warm-Up Questions

1) Why would you stain a cell before looking at it under a microscope?
2) Name three structures that are found in both plant and animal cells. Describe what they all do.
3) What is the difference between a tissue and an organ?
4) Which process is responsible for the movement of glucose from an area of high concentration to an area of low concentration?
5) Which sort of respiration involves oxygen? Write the relevant word equation.
6) Which sort of respiration is the most efficient?

Practice Questions

1 The diagram below shows a plant cell.



(a) Name the cell parts labelled (i)-(iv) on the diagram.

(4 marks)

(b) Name **two** structures that are found in plant cells, but not in animal cells.

(2 marks)

(c) What is the function of the cell wall?

(1 mark)

(d) Some organisms are made up of only one cell.

(i) What word describes organisms that have only one cell?

(1 mark)

(ii) Give an example of an organism made up of only one cell and explain how it is adapted to its environment.

(3 marks)

Practice Questions

2 Respiration is a very important life process for all organisms.

(a) In which part of animal and plant cells does aerobic respiration take place?

(1 mark

(b) Sometimes respiration does not involve oxygen.

(i) Which sort of respiration does not involve oxygen?

(1 mark

(ii) Write the word equation for this process when it occurs in **humans**.

(1 mark

(iii) In what situation might a human start respiring in this way?

(1 mark

3 (a) Use the following words to complete the gaps in the sentences below.

a tissue **cells** **an organ**

.... are the simplest building blocks of organisms.

Several of these can come together to make up .... ,

and several of these can work together to make ....

(3 marks

(b) What is an **organ system**?

(1 mark

4 Alana's class are investigating the cells in onion skin using light microscopes. Alana collects a microscope from the teacher and positions it near a window.

(a) Light has to enter the microscope for it to work.

(i) Which part of the microscope can be adjusted to allow light in?

(1 mark

(ii) Which kind of light should not be allowed to enter the microscope? Explain your answer.

(2 marks

(b) Alana clips a slide with a piece of onion skin stuck to it onto the stage.

(i) Describe the steps she should take to get a clear image of the onion cells.

(4 marks

(ii) Alana would like to make the image of the onion cells bigger. Describe how she can do this.

(2 marks

Revision Summary for Section One

Welcome to your very first Section Summary. It's full of questions written especially for finding out what you actually know — and, more importantly, what you don't. Here's what you have to do...

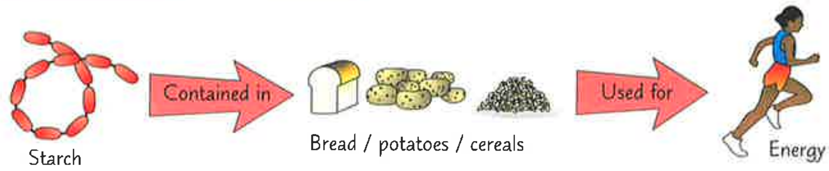
- Go through the whole lot of these Section Summary questions and try to answer them.
- Look up the answers to any you can't do and try to really learn them (hint: the answers are all somewhere in Section One).
- Try all the questions again to see if you can answer more than you could before.
- Keep going till you get them all right.

1) What part of a microscope do you clip your slide onto? ☐
2) What do the focusing knobs on a microscope do? ☐
3) Why should you always move the objective lens away from the slide when you're focusing a microscope? ☐
4) What is an organism? ☐
5) What instrument would you use to look at a cell? ☐
6) What do chloroplasts do? What sort of cell would you find them in? ☐
7) Explain the meaning of: a) tissue b) organ. Give an example of each. ☐
8) Give an example of an organ system. ☐
9) What is diffusion? ☐
10) Give two examples of substances that move into or out of cells by diffusion. ☐
11) What's the name of the process that goes on in every cell, releasing energy? ☐
12) What is the energy released by this process used for? Give three examples. ☐
13) What is aerobic respiration? ☐
14) Write down all the reactants of aerobic respiration. Now write down the products. ☐
15) Give two differences between aerobic respiration and anaerobic respiration in humans. ☐
16) Write down the word equation for anaerobic respiration in yeast. ☐
17) What is fermentation? What can fermentation be used to make? ☐

Nutrition

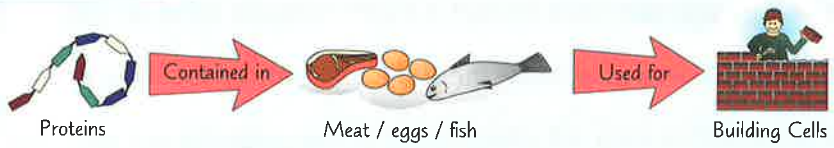
Nutrition is what you eat — and what you eat is really important for your health.
A balanced diet will have the right amount of the five nutrients listed below, as well as fibre and water.

1) Carbohydrates



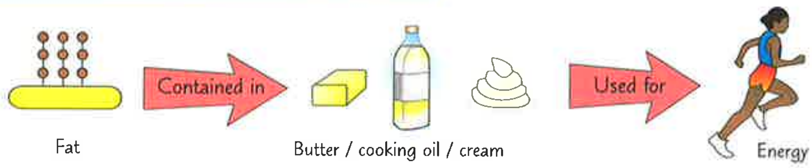
These are like fuel for your body. Active or growing folk need lots of carbohydrate.

2) Proteins



Proteins are vital for growth and to repair damaged areas.

3) Lipids (Fats and Oils)



Lipids act as a store of energy — which you use if your body runs out of carbohydrates.

4) Vitamins

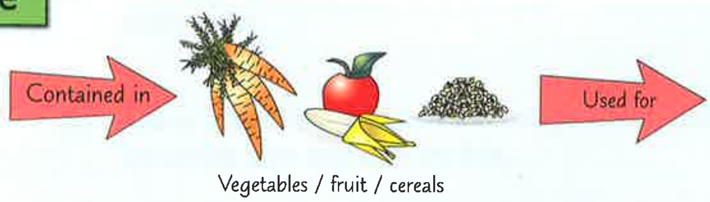
E.g. A B_1 B_2 C D E

Vitamins are only needed in very small amounts — they keep many vital processes happening.

5) Minerals

E.g. —	Iron	Calcium	Sodium
Found in —			
Needed for —	Blood	Teeth/Bones	Nerves

Fibre



Fibre helps food move through your digestive system.

Water

About 75% of your body is water and all chemical reactions (e.g. digestion), take place in water – it's really important.

Nutrition and Energy

Your body needs energy all the time. Even when you're asleep your body is using energy just to keep you alive. It's important that you get this energy from a balanced diet, or a few nasty things can happen...

An Unbalanced Diet Can Cause Health Problems

Obesity

1) If you take in more energy from your diet than you use up, your body will store the extra energy as fat — so you will put on weight.
2) If you weigh over 20% more than the recommended weight for your height, then you are classed as obese.
3) Obesity can lead to health problems such as high blood pressure and heart disease.

Starvation and Deficiency Diseases

1) Some people don't get enough food to eat — this is starvation.
2) The effects of starvation include slow growth (in children), being more likely to get infections, and irregular periods in women.
3) Some people don't get enough vitamins or minerals — this can cause deficiency diseases. For example, a lack of vitamin C can cause scurvy, a deficiency disease that causes problems with the skin, joints and gums.

Different People Have Different Energy Requirements

1) The amount of energy you need each day depends on your body mass ("weight") and level of activity.
2) Every cell (see page 2) in the body needs energy. So the bigger you are, the more cells you have, and the more energy you'll need.
3) For every kg of body mass, you need 5.4 kJ of energy every hour. This is the basic energy requirement (BER) needed to maintain essential bodily functions.

A kJ is a unit of energy.

You calculate it like this:

Daily BER (kJ/day) = 5.4 × 24 hours × body mass (kg)

E.g. a 60 kg person requires 5.4 × 24 × 60 = 7776 kJ/day

4) You also need energy to move, and it takes more energy to move a bigger mass.
5) So, the heavier and the more active you are, the more energy you will need.
6) To find out how much energy you need in a day you have to add together your daily BER and the extra energy you use in your activities.

For example, a 60 kg person will use about 400 kJ walking for half an hour, but 1500 kJ running for half an hour.

You need to eat a balanced diet to stay healthy

Too much or too little food (or not eating the right foods) can lead to some serious health problems. Make sure you understand the health problems on this page. You also need to know how to work out someone's daily energy requirement — it's important for avoiding the health problems above.

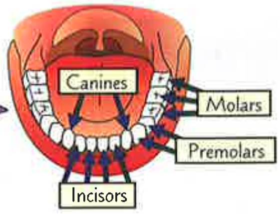
Digestion

Digestion's great. The body breaks down the food we eat, so we can use the nutrients it contains. But it's not easy — lots of different organs have to work together to get the job done.

Digestion is All About Breaking Down Food

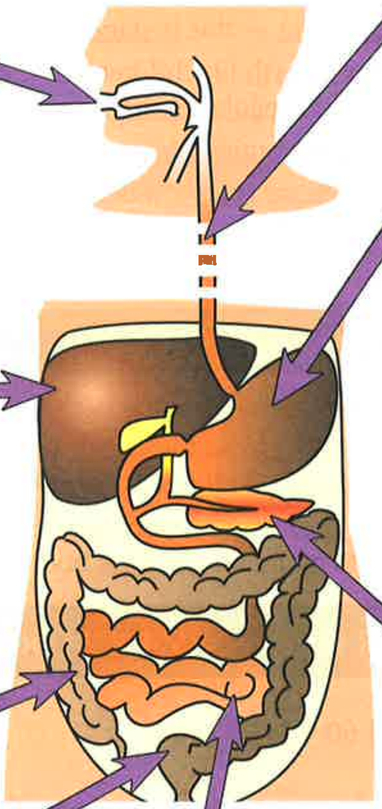
There are two steps to this. The first is quick, the second isn't:

1) Breaking down the food MECHANICALLY, e.g. chewing with teeth:



2) Breaking down the food CHEMICALLY — with the help of proteins called enzymes. Enzymes are biological catalysts — this means they speed up the rate of chemical reactions in the body.

Eight Bits of The Alimentary Canal



1) Mouth

Digestion starts here where the teeth have a good old chew and mix the food with saliva. Saliva contains an enzyme (called amylase) that breaks down carbohydrates.

2) Oesophagus

Food pipe — links the mouth to the stomach.

3) Stomach

1) Here the food mixes with protease enzymes which digest proteins. The stomach contains muscular tissue to move the stomach wall and churn up food.
2) Hydrochloric acid is present to kill harmful bacteria and give a low pH for the enzymes to work.

4) Liver

The liver makes bile, which breaks fats into tiny droplets (emulsification). It's also alkaline to give the right pH for the enzymes in the small intestine.

5) Pancreas

The pancreas contains glandular tissue, which makes three enzymes:

1) PROTease digests PROTein.
2) CARBOHYDRAse digests CARBOHYDRAtes.
3) LIPase digests LIPids — i.e. fats.

6) Small intestine

1) This produces more enzymes to further digest proteins, carbohydrates and fats.
2) Food is also absorbed through the gut wall into the blood, which then takes it around the body to wherever it's needed.

7) Large intestine

Here water is absorbed — so we don't all shrivel up.

8) Rectum

Food usually contains some materials that we can't digest. This undigested food is stored as faeces. Here the digestion story ends when it plops out of the anus — egestion.

More on Digestion

Well would you believe it? There's more to learn about digestion.

Absorption of Food Molecules

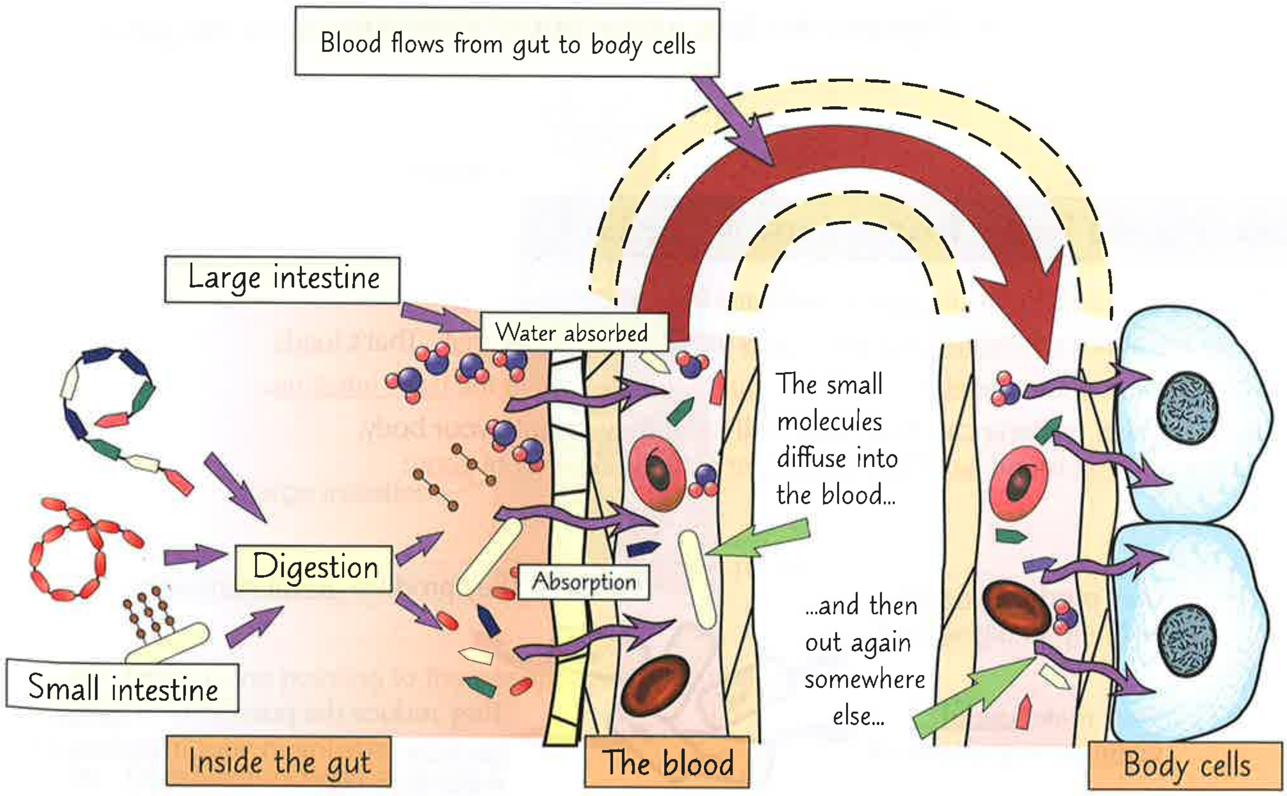
1) Big, insoluble food molecules can't pass through the gut wall.

2) So enzymes are used to break up the big molecules into smaller, soluble ones.

'Insoluble' means 'won't dissolve'. 'Soluble' means 'will dissolve'. See page 61 for more.

3) These small molecules can pass through the gut wall into the blood.

4) They are then carried round the body, before passing into cells where they are used.



You need to absorb all of these facts

REVISION TASK

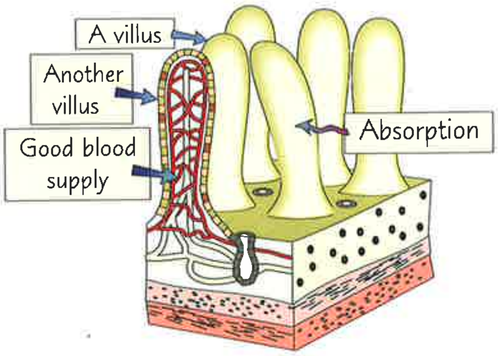
As well as looking pretty, the diagrams on digestion are really important for helping you understand how food is broken down and absorbed by the body — so look at them really thoroughly and absorb the information. Make sure you know the name and function of all eight bits of the alimentary canal. To test yourself, cover up these pages and draw the diagrams showing how food is digested. Include as much detail as you can remember.

More on Digestion

More on digestion — don't worry, it's the last page on it, I promise. (Apart from the questions anyway...)

The Small Intestine is Covered with Millions of Villi

1) Food molecules are absorbed into the blood in the small intestine.
2) The small intestine is lined with tiny finger-like projections called VILLI.



Villi is the plural of villus — i.e. it's one villus but two (or more) villi.

3) Villi are perfect for absorbing food because:

- They have a thin outer layer of cells.
- They have a good blood supply.
- They provide a large surface area for absorption.

Bacteria are Really Important in the Gut

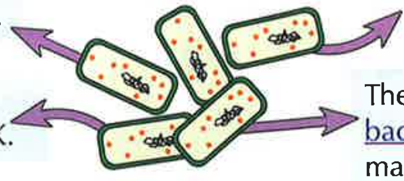
1) Bacteria are unicellular organisms (see page 2).
2) There are about 100 trillion bacterial cells in the alimentary canal. That's loads.
3) Most of these are in the end part of the small intestine and in the large intestine.
4) Some types of bacteria can make you really ill if they get into your body, but the bacteria found naturally in your gut actually do a lot of good:

They produce enzymes that help to digest food.

They produce useful hormones.

They make useful vitamins, e.g. vitamin K.

They reduce the possibility of harmful bacteria growing in your intestines and making you ill.



Who knew having bacteria inside you was such a good thing?

Villi are brilliant absorbers of food. Make sure you know the three things that make villi so awesome at doing this — their large surface area, their blood supply and their thin outer layer of cells.

Warm-Up and Practice Questions

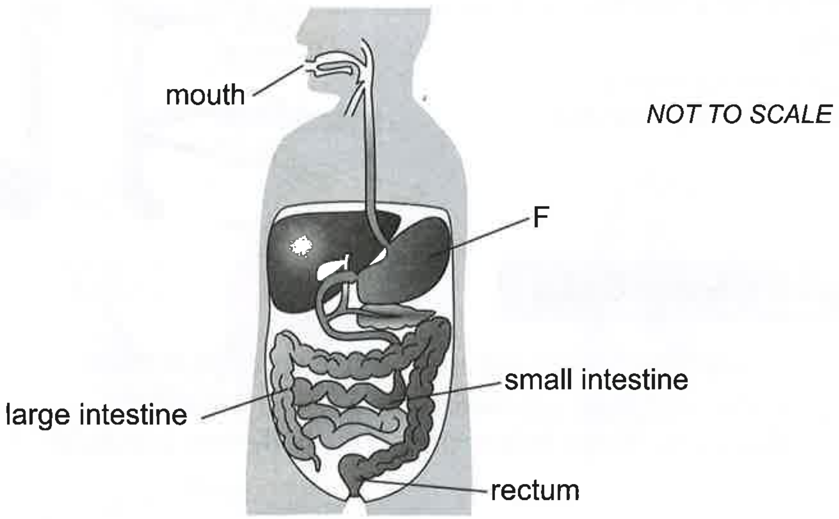
When you've digested all that information, have a crack at these questions to test what you know...

Warm-Up Questions

1) Which two nutrients does the body get energy from?
2) Name one type of food that contains fibre.
3) What health risk is caused by taking in more energy than you use up?
4) What is meant by your daily basic energy requirement?
5) Name the two ways that food is broken down by the body.
6) Enzymes are biological catalysts. What does this mean?
7) Which part of the body does digestion start in?
8) Why do we need to digest our food?
9) What type of organisms are present in the gut and produce enzymes that help digest food?

Practice Question

1 The diagram shows some of the organs of the human digestive system.



(a) Draw a line pointing to the oesophagus and label it **O**.

(1 mark)

(b) Give two functions of organ **F**.

(2 marks)

(c) The small intestine is responsible for the absorption of digested food. It has millions of villi to help with this process. State three ways in which villi are adapted to help with the absorption of digested food.

(3 marks)

(d) What is the name of the organ that produces bile?

(1 mark)

The Skeleton

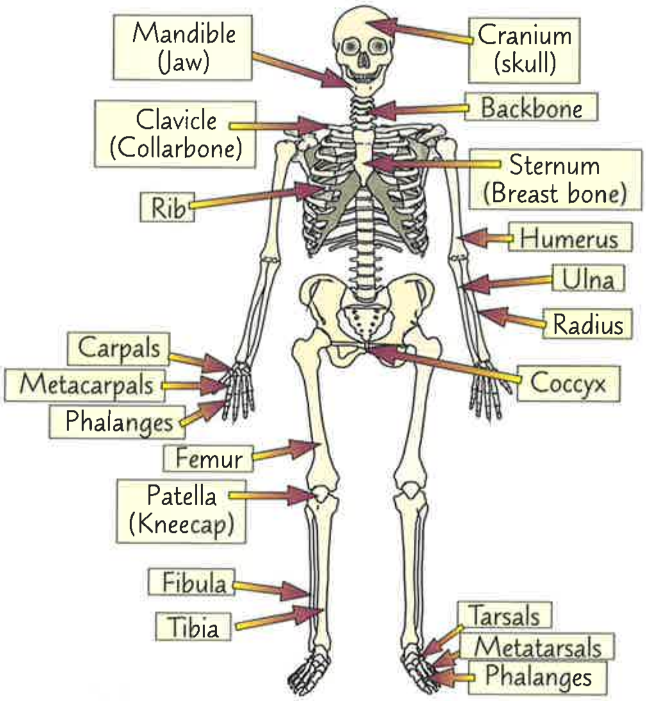
The adult human skeleton is made up of 206 bones. Thankfully you don't need to learn them all...

The Skeletal System

Bones are made from different types of tissue:

- The outer layer of bone is made from really strong and hard tissue — this makes bones rigid (they can't bend).
- The inner layer is made from more spongy tissue, but it's still strong.

The skeletal system has four main functions:



1) Protection

Bone is rigid and tough so it can protect delicate organs — in particular the brain.

2) Support

1) The skeleton provides a rigid frame for the rest of the body to kind of hang off — kind of like a custom made coat-hanger.
2) All the soft tissues are supported by the skeleton — this allows us to stand up.

3) Production of Blood Cells

1) Many bones have a soft tissue called bone marrow in the middle of them.
2) Bone marrow produces red blood cells (which carry oxygen around the body) and white blood cells (which help to protect the body from infection).

4) Movement

1) Muscles are attached to bones (see next page).
2) The action of muscles allows the skeleton to move.
3) Joints (e.g. the knees and elbows) also allow the skeleton to move.

REVISION TASK

A body without bones? Ever seen a tent without poles?

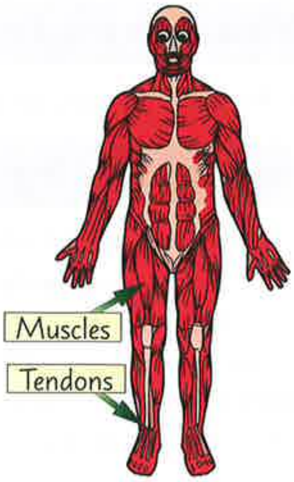
Lots of bone-tinglingly exciting facts to learn here. You don't need to learn the names of all those bones — the main thing here is to learn what it is that the skeleton actually does. The skeletal system has four main functions. Cover up the page and jot them all down.

The Muscular System

Another fun number for you — the muscular system is made up of around 640 muscles.
The muscular and skeletal systems work together so you can move around.

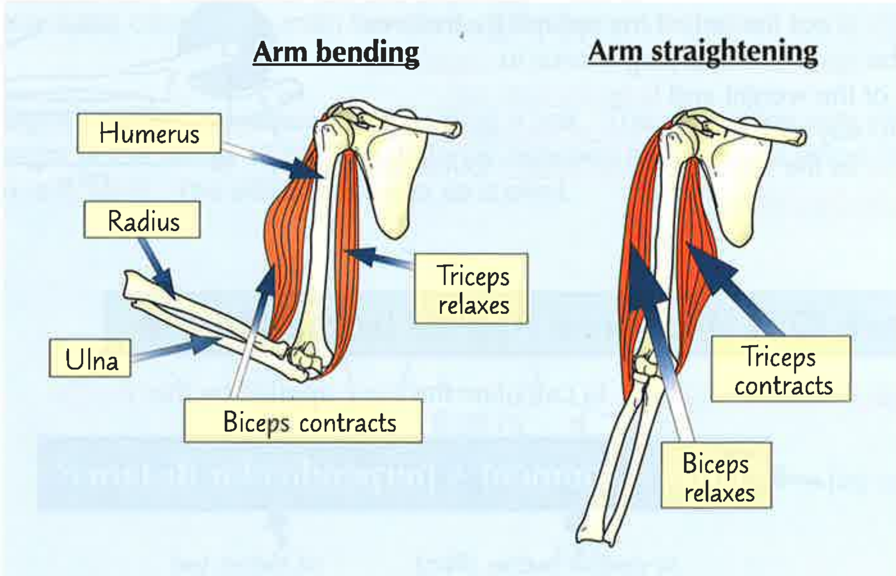
Tendons Attach Your Muscles to Your Bones

1) Muscles are attached to bones via tough bands called tendons.
2) When a muscle contracts it applies a force to the bone it's attached to, which makes the bone move.
3) Muscles are found in pairs round a joint (see below).



Antagonistic Muscles Work in Pairs

1) Antagonistic muscles are pairs of muscles that work against each other.
2) One muscle contracts (shortens) while the other one relaxes (lengthens) and vice versa.
3) They are attached to bones with tendons. This allows them to pull on the bone, which then acts like a lever (see next page).
4) One muscle pulls the bone in one direction and the other pulls it in the opposite direction — causing movement at the joint.
5) The biceps and triceps muscles in the arm are examples of antagonistic muscles:



6) The hamstrings and quadriceps in the legs are another example.

REVISION TIP

When you show off your muscles, you can claim it's revision

Remember that antagonistic muscles just can't get along — whatever one is doing, the other is doing the opposite. Just like me and my sister...

The Force Applied by Muscles

A lot of your bones act like levers that get pulled by muscles. There's a handy little formula you can use to work out how much force a muscle applies to a bone... enjoy.

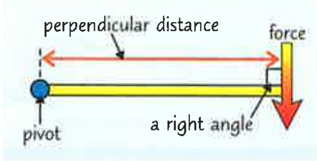
You Can Measure the Force Applied by a Muscle

Let's look at a muscle in the arm as an example:

The study of forces acting on the body is called biomechanics.

1) Start by Calculating the Moment

1) A pivot is the point around which a rotation happens. A lever is a bar attached to a pivot.
2) When a force acts on something that has a pivot, it creates a "turning effect" known as a moment (see page 129).
3) The arm works as a lever with the elbow as a pivot. This means when a force acts on the arm there's a moment.
4) To calculate the size of a moment, you can use this equation:

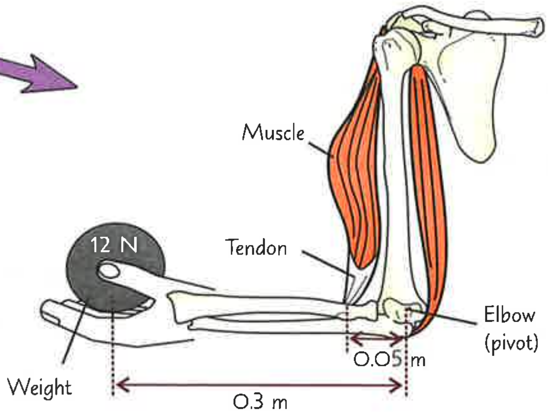


Moment = force × perpendicular distance

In newton metres (Nm) — In newtons (N) — In metres (m)

'Perpendicular distance' is the distance at a right angle from the pivot to the line of force.

5) In the diagram here, the weight (a force) in the hand is creating a moment.
6) The weight has a force of 12 N. It is 0.3 m away from the pivot (the elbow). So using the equation above, the moment of the weight is 12 × 0.3 = 3.6 Nm.
7) But the weight is not the only thing applying a force to the arm — the muscle is applying a force to counteract the moment of the weight and keep the arm still. For the arm to stay still, the moment of the muscle has to be the same as the moment of the weight (but acting in the opposite direction).



2) Now Work Out the Force Applied by the Muscle

You can rearrange the equation above to calculate the force applied by the muscle:

Force = moment ÷ perpendicular distance

In newtons (N) — In newton metres (Nm) — In metres (m)

In the example above, the weight has a moment of 3.6 Nm, so the muscle must also have a moment of 3.6 Nm.

The distance between the muscle and the pivot (elbow) is 0.05 m. So the force applied by the muscle is 3.6 ÷ 0.05 = 72 N.

Hang on a moment... what?

All this talk of forces and levers and moments can be tricky to get your head around. But stick with it — you'll really impress if you can explain how muscles work and can use that formula to calculate a moment.

Warm-Up and Practice Questions

That's it for bones and muscles. Make sure you know all the things your skeleton does and how your muscles put the whole thing in motion. Time to test how much of the last few pages has made it inside your skull by having a go at these questions...

Warm-Up Questions

1) Name one property of bone that makes it suitable for protecting delicate organs.
2) Describe how the skeleton supports the body.
3) Which part of a bone makes blood cells?
4) What attaches muscles to bones?
5) Describe what antagonistic muscles are and how they work.
6) Give one example of a pair of antagonistic muscles.
7) Write down the equation you would use to calculate the moment caused by a force.

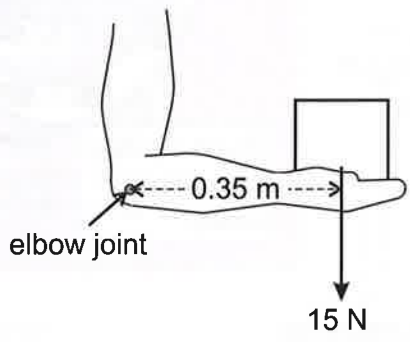
Practice Question

1 The human skeleton has joints with muscles attached to the bones around them, which allow us to move.

(a) Movement is one function of the skeleton.
Write down the other three main functions of the human skeleton.

(3 marks)

(b) The diagram below shows someone holding a box. They hold their arm still. The weight of the box is 15 N. The distance between the person's elbow joint and the box is 0.35 m. The elbow joint acts as a pivot.



(i) Calculate the moment of the box about the elbow joint.

(1 mark)

(ii) What is the moment of the muscle that is keeping the arm and the box in the position shown? Explain your answer.

(2 marks)

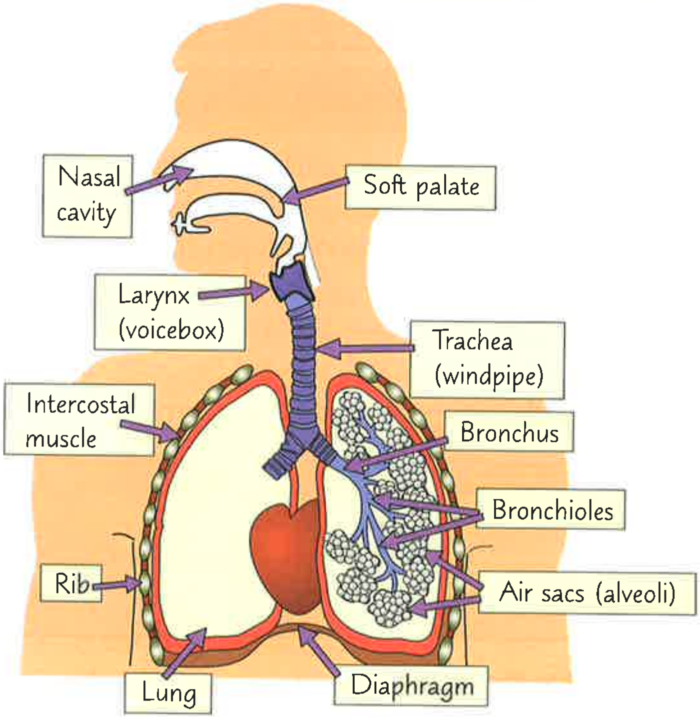
(iii) The distance between the muscle and the elbow joint is 0.05 m. Calculate the force applied by the muscle to keep the arm still in this position.

(1 mark)

Gas Exchange

You need to get oxygen from the air into your bloodstream and to get rid of the carbon dioxide that's in your bloodstream. This all happens in your gas exchange system.

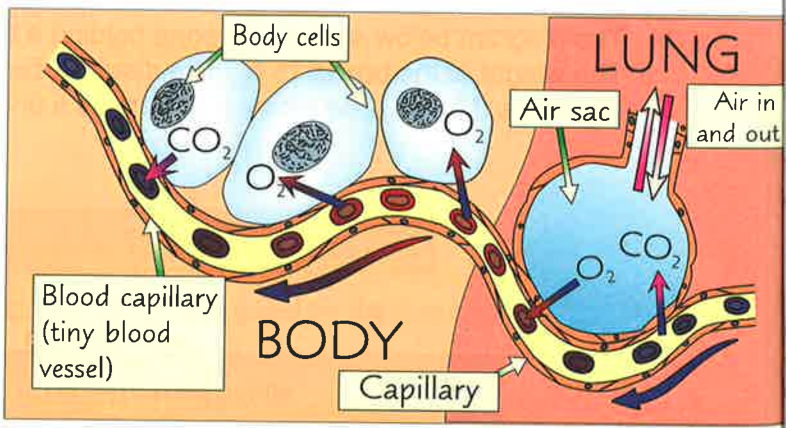
Learn These Structures in the Gas Exchange System



1) The lungs are like big pink sponges. They're protected by the ribcage.
2) The diaphragm is a muscle that sits underneath the ribcage. It moves up when it relaxes and down when it contracts. This movement helps to get air in and out of your lungs (see next page).
3) The air that you breathe in goes through the trachea. This splits into two tubes called 'bronchi' (each one is 'a bronchus'), one going to each lung.
4) The bronchi split into smaller tubes called bronchioles.
5) The bronchioles end at small air sacs in the lungs called alveoli. These are where gas exchange takes place.

Gas Exchange Happens in the Lungs

1) Air is inhaled into the lungs.
2) Some of the oxygen in the inhaled air passes into the bloodstream to be used in respiration (see page 4).
3) Carbon dioxide is a waste product of respiration. In the lungs it passes out of the blood and is then breathed out.
4) The gases pass into or out of the bloodstream by diffusion — where a substance moves from where there's lots of it to where there's less of it (see page 3).
5) The lungs are well adapted for gas exchange:



   1) They're moist.
   2) They have a good blood supply.
   3) The alveoli (air sacs) give the lungs a big inside surface area.

I love ribs — spare ones are my favourite though

There are a couple of detailed diagrams here which need learning. Sooner or later you're expected to learn all the structures in the gas exchange system and what they do, so you may as well start now.

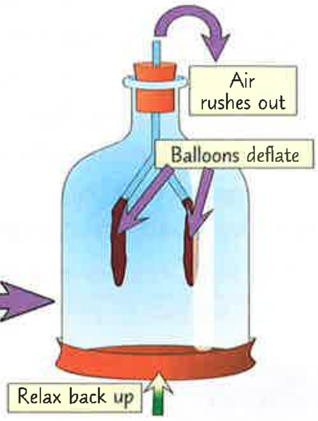
Breathing

Breathing is how the air gets in and out of your lungs. It's definitely a useful skill.

The Mechanism of Breathing

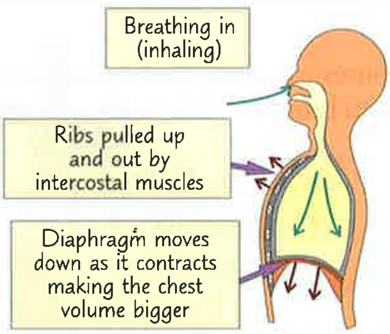
The bell jar demonstration shows us what's going on when you breathe:

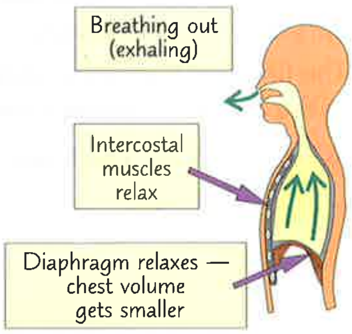
1) First you pull the rubber sheet down — like it's your diaphragm.
2) This increases the volume inside the bell jar, which decreases the pressure.
3) The drop in pressure causes air to rush into the balloons — this is like breathing in.
4) Let go of the rubber sheet — this is like relaxing your diaphragm.
5) The volume in the jar gets smaller. This increases the pressure, so air rushes out.



Inhaling and Exhaling is Breathing In and Out

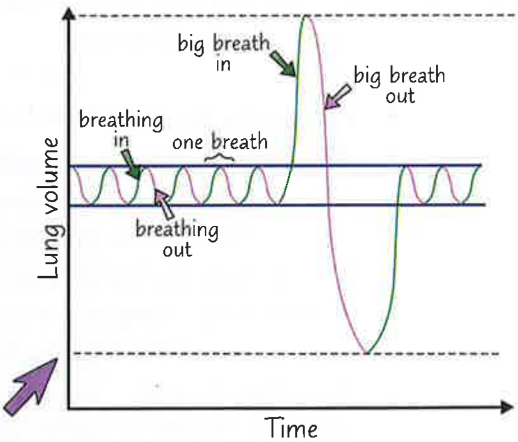
1) The chest cavity is like a bell jar.
2) When you breathe in, the diaphragm moves down and the ribs move up. This increases the volume of the chest cavity, which decreases the pressure. So air rushes in to fill the lungs.
3) When the diaphragm moves up and the ribs move down, air rushes out.





Lung Volume Can Be Measured

1) Lung volume is the amount of air you can breathe into your lungs in a single breath.
2) Lung volume is different for different people. For example, taller people tend to have a bigger lung volume than shorter people. And some diseases may reduce a person's lung volume.
3) Lung volume can be measured using a machine called a spirometer.
4) To use a spirometer, a person breathes into the machine (through a tube) for a few minutes.
5) The volume of air that is breathed in and out is measured and plotted on a graph (called a spirogram) like this one.



Now take a deep breath and learn these facts

Well, if ever you wanted to know how you breathe in and out, now you do. Learn how breathing works — use that bell jar demonstration to help you understand what goes on in your actual lungs. Make sure you know how lung volume can be measured too. You'll be an expert in breathing soon.

Exercise, Asthma and Smoking

Exercise, asthma and smoking can all affect your gas exchange system and the way that you breathe.

Exercise

1) When you exercise, your muscles need more oxygen and glucose so they can respire and release energy (see page 4) to keep you going.
2) During exercise, your breathing rate and depth of breathing increase so you can get more oxygen into your blood.
3) If you exercise regularly, the muscles that you use to breathe (the diaphragm and intercostal muscles) will get stronger.
4) This means that your chest cavity can open up more when you breathe in, so you can get more air into your lungs.
5) Over time, regular exercise can also cause an increase in the number and size of the small blood vessels in your lungs and in the number of alveoli. This makes gas exchange more efficient.

Asthma

1) People with asthma (asthmatics) have lungs that are too sensitive to certain things (e.g. pet hair, pollen, dust, smoke...).
2) If an asthmatic breathes these things in, the muscles around their bronchioles contract. This narrows the airways.
3) The lining of the airways becomes inflamed and fluid builds up in the airways, making it hard to breathe. This is an asthma attack.
4) Symptoms of an attack are:
   - difficulty breathing,
   - wheezing,
   - a tight chest.

5) When symptoms appear, sufferers can use an inhaler containing drugs that open up the airways.

Smoking

1) Cigarette smoke contains four main things: carbon monoxide, nicotine, tar and particulates.
2) Tar in particular is really bad for you:
   - Tar covers the cilia (little hairs) on the lining of the airways.
   - The damaged cilia can't get rid of mucus properly.
   - The mucus sticks to the airways, making you cough more — this is known as smoker's cough.
   - The damage builds up and can eventually lead to bronchitis (a disease that inflames the lining of the bronchi) and emphysema (a disease that destroys the air sacs in the lungs). Both these diseases make it difficult to breathe.
   - And there's more... tar contains carcinogens (substances that can cause cancer). Smoking causes cancer of the lung, throat and mouth.

REVISION TIP

This page is just breathtaking

So there you have it, three different things that have an impact on the gas exchange system. Make sure you get to grips with all of them — cover up the page and see how much you can write about each one.

Warm-Up and Practice Questions

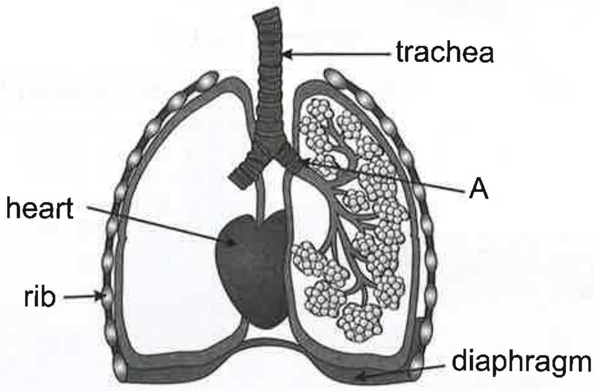
Take a deep breath, then have a bash at these questions...

Warm-Up Questions

1) Why is it important to have a good blood supply going to the lungs?
2) What is meant by lung volume?
3) What does a spirometer measure?
4) Give two changes that can happen to your gas exchange system if you exercise regularly over a long period of time.
5) Explain why a person's airways narrow during an asthma attack.

Practice Questions

1 The diagram below shows the chest cavity of a healthy person.
One of the lungs is drawn in cross-section to show the air sacs.



(a) Write down the name of the part of the chest cavity labelled **A**.

(1 mark)

(b) Which gas enters the blood from the alveoli (air sacs)?

(1 mark)

(c) Which gas leaves the blood to enter the lungs at the alveoli (air sacs)?

(1 mark)

(d) Describe what happens to the chest cavity as you breathe in.

(4 marks)

2 Cigarette smoke contains tar which can damage your airways.

(a) Name two other harmful substances present in cigarette smoke.

(2 marks)

(b) Explain why the tar in cigarette smoke causes smokers to cough more.

(3 marks)

(c) Name one disease that smoking can cause.

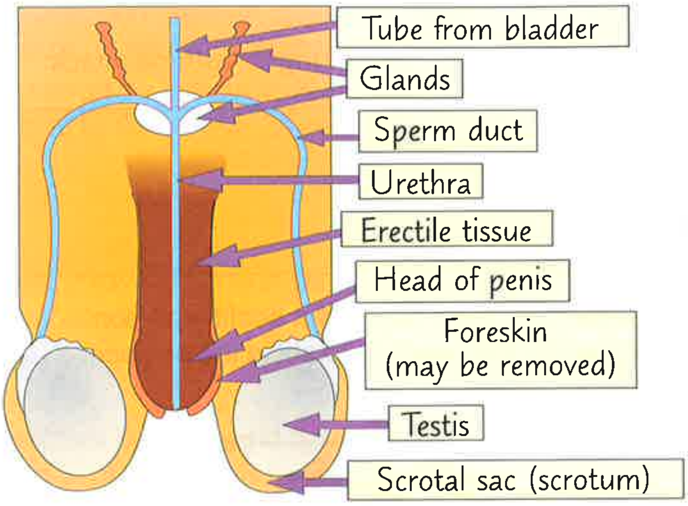
(1 mark)

Human Reproductive System

Like all mammals, we have different male parts and female parts that allow us to reproduce. No giggling...

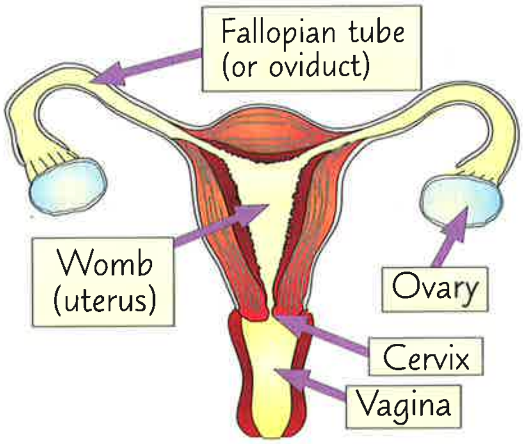
The Male Reproductive System

1) Sperm are the male sex cells or 'gametes'.
2) Sperm are made in the testes after puberty.
3) Sperm mix with a liquid to make semen, which is ejaculated from the penis during sexual intercourse.



The Female Reproductive System

1) An egg is a female sex cell or 'gamete'.
2) One of the two ovaries releases an egg every 28 days.
3) It passes into the fallopian tube (or oviduct) where it may meet sperm, which has entered the vagina during sexual intercourse (sometimes known as copulation).
4) If it isn't fertilised by sperm (see next page), the egg will die after about a day and pass out of the vagina.



The Menstrual Cycle

The menstrual cycle — not the most exciting of things, but you wouldn't be here without it.

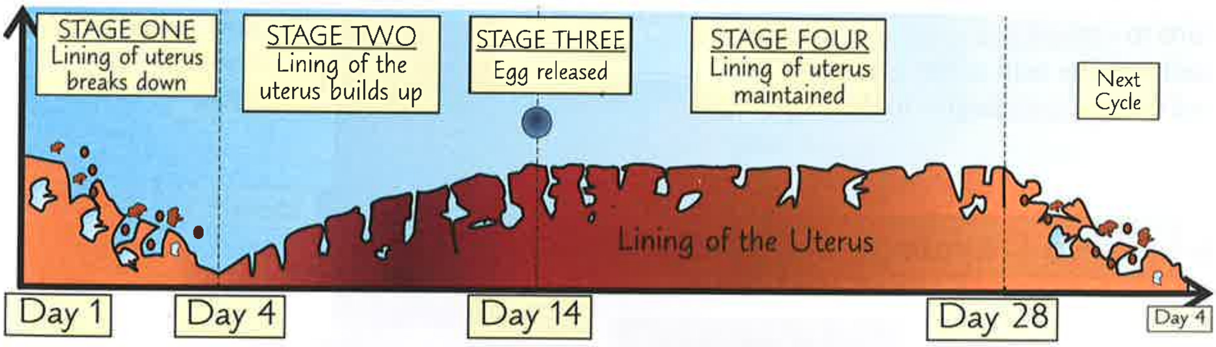
The Menstrual Cycle Takes 28 Days

1) From the age of puberty, females undergo a monthly sequence of events which are collectively known as the MENSTRUAL CYCLE.

2) This involves the body preparing the uterus (womb) in case it receives a fertilised egg.

3) If this doesn't happen, then the egg and uterus lining break down and are lost from the body through the vagina over a period of three to four days, usually.

4) The cycle has four main stages — they are summarised in the diagram and table below:



Day	What happens...
1	BLEEDING STARTS as the lining of the uterus (the womb) breaks down and passes out of the vagina — this is what's known as "having a PERIOD".
4	The lining of the uterus starts to build up again. It thickens into a spongy layer full of blood vessels ready for IMPLANTATION. (See next page.)
14	An egg is released from the ovaries of the female, so this is the MOST LIKELY time in which a female may become pregnant. (This day may vary from one woman to the next.)
28	The wall remains thick awaiting the arrival of a fertilised egg. If this doesn't happen then this lining breaks down, passing out of the vagina. Then the whole cycle starts again.

Menstruation — nothing to do with 'men' whatsoever

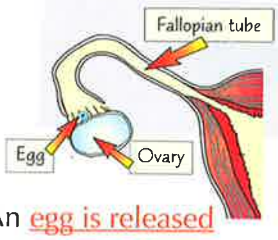
Phew, there are quite a few details to learn here. Make sure you know the names of all the bits and bobs in the male and female reproductive systems on page 22. You need to know exactly what happens at each of the four stages of the menstrual cycle and when they occur too.

Having a Baby

Once Dad's sperm has fertilised Mum's egg, an embryo forms, gestation happens, and a baby is born.

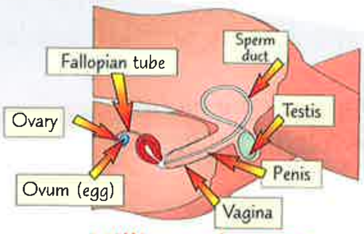
Fertilisation and Development

1) Ovulation



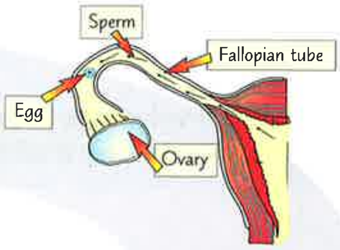
An egg is released from an ovary (around day 14).

2) Copulation



Millions of sperm are released from the penis into the vagina during intercourse.

3) Fertilisation



The egg is fertilised when the nuclei of the egg and sperm join — the fertilised egg is called a ZYGOTE.

4) Cell Division

24 HOURS after fertilisation the fertilised egg divides into two. After about 4 DAYS the egg has divided into 32 cells. It's now called an EMBRYO.

5) Implantation

About one week after fertilisation, the embryo starts to embed (implant) itself into the wall of the uterus and the placenta begins to develop.

The Embryo Develops During Gestation

Start here →

At 1 Month

The embryo is 6 mm long and has a brain, heart, eyes, ears and legs.

At 9 Weeks

The body is about 25 mm long and is completely formed — it's now called a FOETUS.

At 3 Months

The foetus is 54 mm long and looks much more like a baby.

At 5 Months

It's now about 160 mm long. It kicks and its fingernails can be felt.

At 7 Months

The foetus is 370 mm long and is 'VIABLE'. This means it would have a fair chance of surviving if it were born at this stage.

At 39 weeks

The baby is about 520 mm long. It's fully developed and ready to be BORN.

Health and Pregnancy

Good health is a situation where you're fine and dandy both physically and mentally. It's important to make sure you look after your health if you're pregnant, as your health affects the baby's health.

Health is More Than Just the Absence of Disease

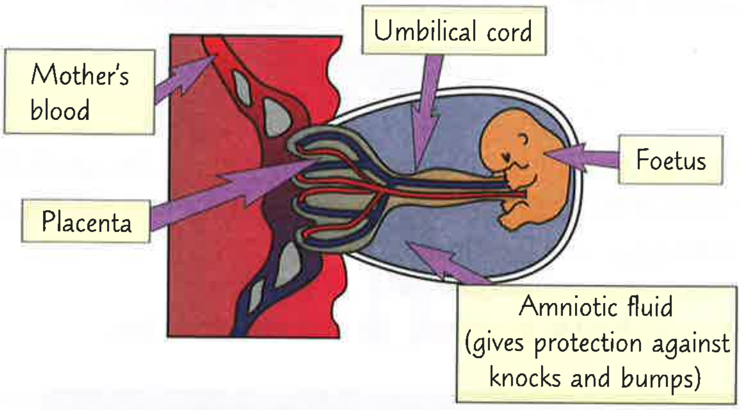
Good health means having BOTH of these:

1) A healthy body that's all working properly with no diseases.
2) A healthy mental state where you're able to cope with the ups and downs of life.

You should look after your body by eating a balanced diet, doing enough exercise and not abusing drugs.

The Mother's Lifestyle During Pregnancy is Important

1) The placenta lets the blood of the foetus and mother get very close to allow exchange of food, oxygen and wastes.



2) If the mother smokes, drinks alcohol or takes other drugs while she is pregnant, harmful chemicals in her blood can cross the placenta and affect the foetus.

3) For example, the foetus may not develop properly and could have health problems after it's born.

Well, that's all a bit different to the stork story I got told

There's a lot to learn on these pages. Make sure you know all the different stages it takes to make an embryo and how an embryo develops into a baby ready to pop out into the world. Remember, having good health and a good lifestyle is important for everyone, but especially when you're pregnant.

Drugs

Recreational drugs can have serious negative effects on your health.

Drugs

1) A drug is any substance that affects the way the body works. E.g. They may raise the heart rate or cause blurred vision.
2) There are LEGAL DRUGS and ILLEGAL DRUGS. Aspirin, caffeine and antibiotics are examples of legal drugs. Cannabis, speed and ecstasy are examples of illegal drugs.
3) RECREATIONAL DRUGS are drugs used for fun. They can be legal or illegal.
4) Drugs can affect life processes. For example, drugs that affect the brain are likely to affect movement and sensitivity. And drugs that affect the liver and kidneys will most likely affect excretion (as these are the organs that process waste).

The 7 Life Processes

Movement — moving parts of the body.
Reproduction — producing offspring.
Sensitivity — responding and reacting.
Nutrition — getting food to stay alive.
Excretion — getting rid of waste.
Respiration — turning food into energy.
Growth — getting to adult size.

Solvents

1) Solvents are found in most homes — in things like paints, aerosols and glues.
2) They're drugs because they cause hallucinations, which are illusions of the mind. Solvents usually have a severe effect on behaviour and character.
3) They also cause serious damage to the lungs, the brain, liver and kidneys.

Alcohol

1) Alcohol is found in beers, wines and spirits. It's illegal to buy it under the age of 18.
2) It's a depressant, which means it decreases the activity of the brain and slows down responses.
3) It's a poison which affects the brain and liver leading to various health problems, e.g. cirrhosis (liver disease).
4) It impairs judgement, which can lead to accidents. It's also very addictive.

Illegal Drugs — Dangerous, Addictive and Life-Wrecking

1) Ecstasy and LSD are hallucinogens. Ecstasy can give the feeling of boundless energy which can lead to overheating, dehydration and sometimes DEATH.
2) Heroin and morphine were developed as painkillers. However they turned out to be highly addictive. They can both cause severe degeneration of a person's life.
3) Amphetamine (speed) and methedrine are stimulants. They give a feeling of boundless energy. However, users quickly become psychologically dependent on the drug (i.e. they think they need them), so behaviour and character deteriorate.
4) Barbiturates are depressants. They slow down the nervous system and therefore slow down reaction time. They can help you to sleep but they're seriously habit-forming.

REVISION TIP

Drugs aren't harmless fun — they're a slippery slope

It's important that you know the different effects that drugs can have on your health. Make sure that you know how different types of recreational drugs can affect behaviour, health and life processes — use MRS NERG to remember the 7 life processes.

Warm-Up and Practice Questions

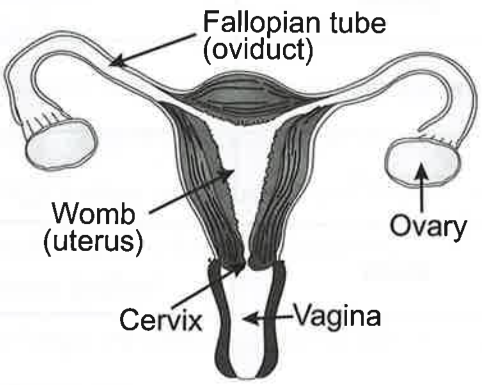
Well, that's almost it for this section. Just a few questions to go and you're done.

Warm-Up Questions

1) What are the male sex cells called? Where are they made?
2) On which day, approximately, will an egg be released from the ovary, during a 'normal' 28-day menstrual cycle?
3) State one function of the placenta, as the embryo develops inside the mother's uterus.
4) You need a healthy body to have good health. What else do you need?
5) Explain why it's not a good idea for a woman to smoke while she's pregnant.
6) What is meant by a 'recreational' drug?
7) Name two things containing solvents that you can find in the home.
8) Name two organs that you can damage by using solvents.
9) Name two drugs that are hallucinogens.

Practice Questions

1 The diagram below shows the human female reproductive system.



(a) A female will usually release an egg from an ovary roughly every 28 days. What is this process called?

(1 mark)

(b) (i) In what part of the female reproductive system does fertilisation usually take place?

(1 mark)

(ii) Underline the correct definition of **fertilisation** in the list below:

When an egg cell is released from the ovary

When the egg and sperm meet

When the nuclei of the egg and sperm join

When the egg and sperm attach to the uterus wall

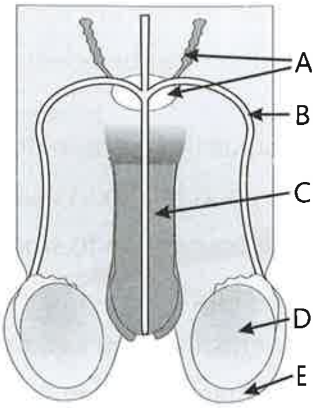
(1 mark)

(c) After how many weeks of pregnancy is a human baby considered to be 'fully developed'?

(1 mark)

Practice Questions

2 (a) Five parts of the human male reproductive system are named in the table below. Using the diagram, write the letter for each part next to its name.



name of organ	letter
sperm duct	
glands	
erectile tissue	
scrotum	
testis	

(5 marks)

(b) What is the name of the substance ejaculated from the penis during sexual intercourse?

(1 mark)

3 Alcohol is one type of legal drug.

(a) Name one other type of legal drug.

(1 mark)

(b) Why does drinking alcohol slow down a person's reactions?

(1 mark)

(c) Write down **two** organs in the body that can be damaged by drinking alcohol.

(2 marks)

(d) Alcohol is a depressant. Name **one** other type of drug that is a depressant.

(1 mark)

Revision Summary for Section Two

Well, that's the end of Section Two. Now what you've got to do is make sure you learn it all. And here again for your enjoyment are some more of those splendid questions. Remember, you have to keep coming back to these questions time and time again, to see how many of them you can do. All they do is test the basic simple facts. OK then — let's see how much you've learnt so far...

1) Name all five nutrients in a balanced diet. Say what each nutrient is important for in the body. ☐
2) For each of the five nutrients, give three examples of foods that contain them. ☐
3) Apart from the five nutrients, give two things that are needed in a balanced diet and explain why they're needed. ☐
4) What is obesity? How is it caused? ☐
5) What health problems can be caused by getting too little food? ☐
6) Give two things that affect how much energy a person needs each day. ☐
7)* Sonia has a body mass of 54 kg. What is her daily basic energy requirement? ☐
8) Name eight main bits of the alimentary canal. Say what goes on in each of the eight bits. ☐
9) Why can't big molecules pass through gut walls? What has to happen to them first? ☐
10) What are villi? What is their function (job) and how are they well-suited to do it? ☐
11) Give four reasons why the bacteria found naturally in your digestive system are good news. ☐
12) Explain how the skeleton protects parts of the body. ☐
13) What are antagonistic muscles? ☐
14) Explain in terms of "muscle contraction" how you can move your arm up and down. ☐
15) What is a moment? What two pieces of information do you need to be able to calculate one? ☐
16) Sketch the human gas exchange system and label all the important structures. ☐
17) What gases are exchanged in the lungs when air is breathed in? Where does each gas move from and to? ☐
18) Give three ways in which the lungs are well-adapted for gas exchange. ☐
19) Explain how we breathe air in and out. ☐
20) How can lung volume be measured? ☐
21) What happens in the gas exchange system when someone has an asthma attack? ☐
22) What are the symptoms of an asthma attack? ☐
23) Give two ways in which smoking affects the gas exchange system. ☐
24) What are the human female sex cells called? Where are they made? ☐
25) Outline the four main stages of the menstrual cycle and say when they happen. ☐
26) In human reproduction, what is meant by implantation? ☐
27) Describe what an embryo looks like at: 1 month, 9 weeks, 3 months, 5 months, 7 months, 39 weeks. ☐
28) What does being 'healthy' mean? ☐
29) What are drugs? Name three legal drugs and three illegal drugs. ☐
30) Name one recreational drug and explain how it affects life processes. ☐

*Answer on page 189.

Plant Nutrition

Think about this: plants make their own food — it's a nice trick if you can do it.

Photosynthesis Makes Food From Sunlight

1) Photosynthesis is a chemical process which takes place in every green plant.
2) Photosynthesis basically produces food — in the form of glucose (a carbohydrate).
3) The plant can then use the glucose to increase its biomass — i.e. to grow.
4) Photosynthesis happens in all the green bits of a plant but mainly in the leaves.

Four Things are Needed for Photosynthesis...

1) Sunlight
2) Chlorophyll — a green chemical found in the chloroplasts of plant cells.
3) Carbon dioxide — this diffuses into the leaves from the air.
4) Water — this is absorbed from the soil by the plant roots and is carried up to the leaves.

There's more on chloroplasts on p.2.

The chlorophyll absorbs sunlight and uses its energy to convert carbon dioxide and water into glucose. Oxygen is also produced. This word equation summarises what happens during photosynthesis. Learn it:

Carbon dioxide + Water —(Sunlight / Chlorophyll)→ Glucose + Oxygen

These are the reactants. These are the products.

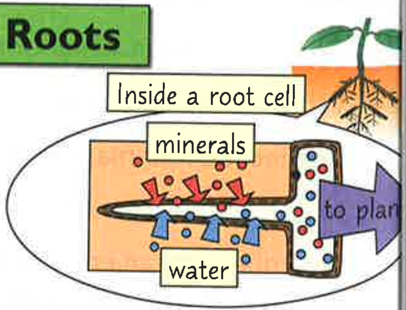
Leaves are Adapted for Efficient Photosynthesis

Leaves are really good at carrying out photosynthesis. Here's why...

1) Leaves are broad, so there's a big surface area for absorbing light.
2) Most of the chloroplasts are found in cells near the top of the leaf, where they can get the most light.
3) The underside of the leaf is covered in tiny holes called stomata. These holes allow carbon dioxide to diffuse (move) into the leaf from the air. They also allow oxygen to diffuse out. Air spaces inside the leaf allow carbon dioxide to move easily between the leaf cells.
4) Leaves also contain a network of veins, which deliver water to the leaf cells and take away glucose.

Plants Absorb Minerals from the Soil Through Their Roots

1) Plants grow using the food they make themselves in photosynthesis. But to keep healthy they also need mineral nutrients from the soil.
2) Plants absorb these minerals through their roots (along with water).



Hmm, it's all clever stuff — just make sure you learn it

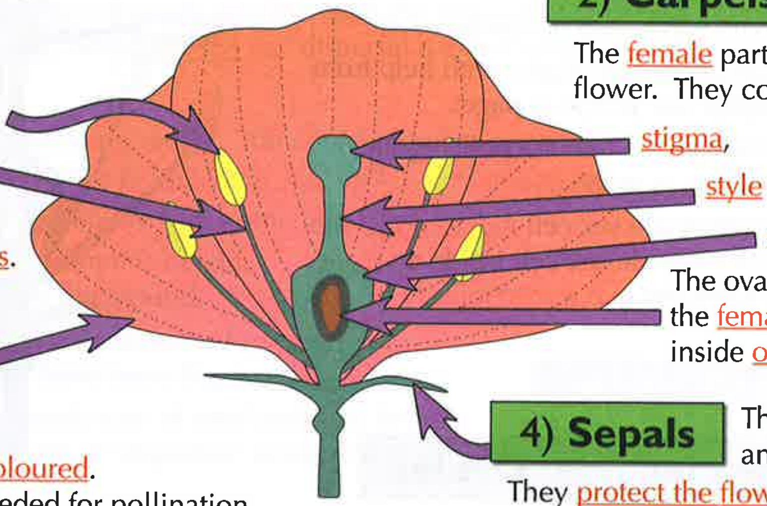
Remember, plants make their own food using photosynthesis. Chlorophyll absorbs sunlight and uses the energy to make glucose and oxygen from carbon dioxide and water. The roots suck up all the water needed for photosynthesis as well as nutrients needed from the soil. Got that? Sorted.

Plant Reproduction

The Flower Contains the Reproductive Organs

1) Stamens

The sta-men-s are the male parts of the flower. They consist of the anther and the filament. The anther contains pollen grains, which produce the male sex cells. The filament supports the anther.



2) Carpels

The female parts of the flower. They consist of the stigma, style and ovary. The ovary contains the female sex cells inside ovules.

3) Petals

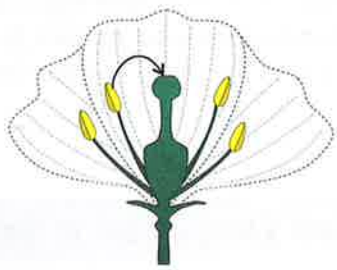
These are often brightly coloured. They attract the insects needed for pollination.

4) Sepals

These are green and leaf-like. They protect the flower in the bud. They're found below the main petals.

"Pollination" is Getting Pollen to the Stigma

1) To make a seed (which will eventually grow into a new plant) the male and female sex cells must "meet up".
2) To do this, the pollen grains must get from a stamen to a stigma. This can happen in two ways:



1) Self-pollination

— pollen is transferred from stamen to stigma on the SAME PLANT.

2) Cross-pollination

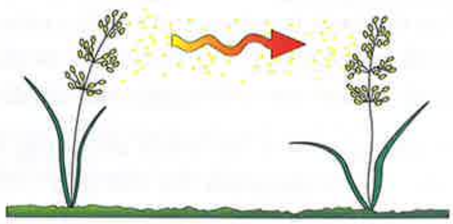
— pollen is transferred from the stamen of one plant to the stigma of a DIFFERENT PLANT. Cross-pollination can involve...

...Insect Pollination

Plant features that help insect pollination:

1) Bright coloured petals.
2) Scented flowers with nectaries (glands that produce a sugary liquid for insects to feed on).
3) Sticky stigma to take the pollen off the insect as it goes from plant to plant to feed in the nectaries.

...Wind Pollination



Features of plants that use wind pollination:

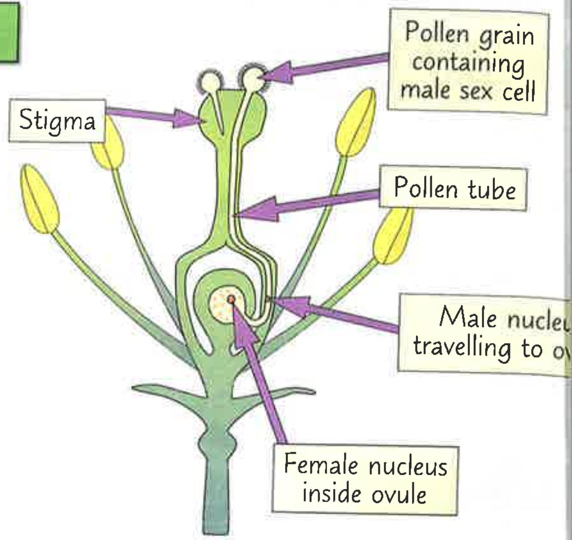
1) Usually small dull petals on the flower.
2) No scent or nectaries.
3) Long filaments hang the anthers outside the flower so a lot of pollen is blown away.
4) Stigmas are feathery to catch pollen as it's carried past in the wind.

Fertilisation, Seed Formation and Distribution

Here it is, the follow-up to Plant Reproduction — or what happens after a flower is pollinated.

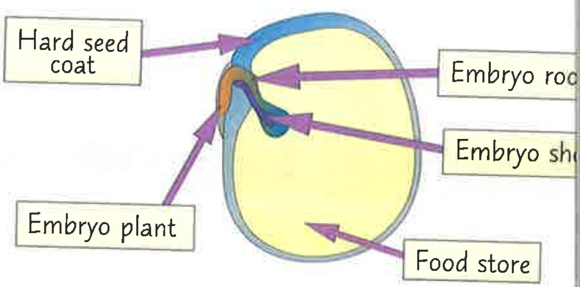
Fertilisation is the Joining of Sex Cells

1) Pollen is the plant equivalent of human sperm.
2) Pollen grains land on a ripe stigma with help from insects or the wind (see previous page).
3) A pollen tube then grows out of a pollen grain, down through the style to the ovary.
4) The nucleus from a male sex cell moves down the tube to join with a female sex cell inside an ovule. Fertilisation is when the two nuclei join.



Seeds are Formed from Ovules

1) After fertilisation, the ovule develops into a seed. Each seed contains a dormant (inactive) embryo plant.
2) The embryo plant has a food store which it uses when conditions are right — i.e. when it starts to grow or "germinate".
3) The ovary develops into a fruit around the seed. Fruits can tempt animals to eat them and so scatter the seeds in their faeces ("poo").

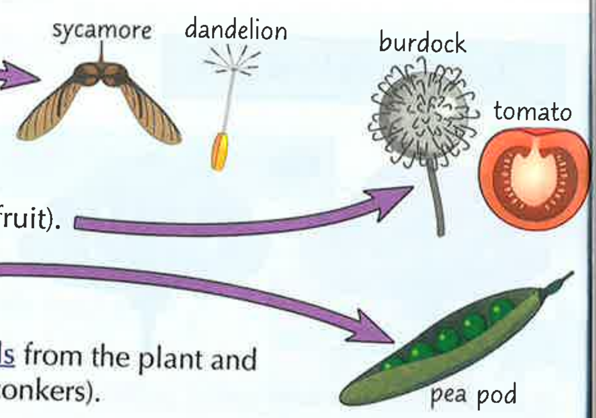


Seed Dispersal is Scattering Seeds

Seeds are dispersed or spread out so that they can grow without too much competition from each other. Here are some ways in which the seed can be dispersed:

Seeds that have been flung or have rolled away from the parent plant then tend to be further dispersed by animals.

1) Wind dispersal, where the seeds are carried away by the wind, like dandelion or sycamore fruit.
2) Animal dispersal, where animals spread the seeds. Either the fruit is eaten and seeds come out in the animal's droppings, e.g. tomatoes or the seeds get caught on the animal's coat and carried (e.g. burdock fruit).
3) Explosions, where the seeds are flung from the plant — like when pea pods dry out and flick out peas.
4) Drop and roll — just as the name suggests, the fruit falls from the plant and rolls away. An example of this is horse chestnut fruit (conkers).



Plants come up with all sorts of ways to disperse their seeds

After pollination and fertilisation, next comes seed development. Then you've got the business of dispersal. Eventually, the seeds will grow into new plants far away from their parents.

Investigating Seed Dispersal Mechanisms

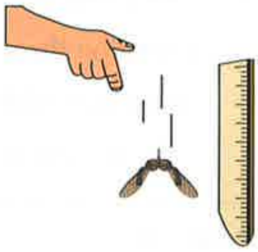
At last, a little bit of science in action. Roll up your sleeves and let's get started.

You Can Investigate Seed Dispersal by Dropping Fruit

You can investigate how well different seeds disperse from the comfort of your own classroom. It's easiest to investigate the wind and drop and roll dispersal mechanisms.

Here's what you have to do.

1) Get yourself some fruit (containing seeds). You could compare ones with different dispersal mechanisms, e.g. sycamore fruit and horse chestnut fruit.
2) Decide on a fixed height to drop the fruit from.
3) Drop the fruit one at a time from this height, directly above a set point on the ground.
4) Using a tape measure, measure and record how far along the ground the seeds have been dispersed.



Do this at least three times for each type of seed and then find the average distance each type travels or 'disperses' when dropped.

Seed Type	Distance Dispersed (cm)			
Sycamore	20	25		
Horse Chestnut				

Make Sure it's a Fair Test

So that you can make a fair comparison between the distances travelled by different seed types, you need to keep the following the same each time you do the experiment:

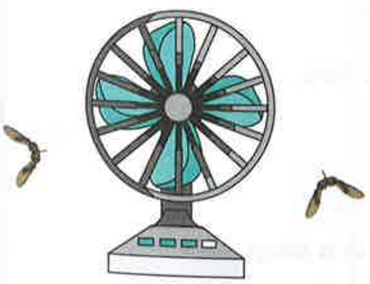
- the person dropping the fruit,
- the height the fruit are dropped from,
- the place you're doing the experiment (stay away from doors and windows that might cause draughts).

This is called "controlling the variables".

Use a Fan to Investigate the "Wind Factor"

Many seed dispersal mechanisms are affected by the wind. The special shape of sycamore fruit helps the wind to catch the fruit and carry the seeds far away from the parent sycamore tree.

You can investigate just how much the wind affects seed dispersal by introducing an electric fan into the experiment above.



Here's how:

1) Set up the fan a fixed distance from the person dropping the fruit.
2) Switch the fan on — it needs to be set to the same speed for every fruit you drop. This makes sure the experiment will be a fair test.
3) Drop the fruit as before and measure how far along the ground the seeds travel.

You should find that the sycamore seeds travel much further in windy conditions (i.e. when the fan is switched on). This might not be the case for every seed type though.

WORKING SCIENTIFICALLY

Come on now, fair's fair

Knowing how to control variables to make a test fair is an important part of being a scientist.

Warm-Up and Practice Questions

Photosynthesis and plant reproduction are really important. You're bound to get asked about them at one point or another, so make sure you can answer all these questions without peeking.

Warm-Up Questions

1) What four things are needed for photosynthesis?
2) Describe **three** ways in which leaves are adapted for photosynthesis.
3) What part of the flower develops into the seed after fertilisation?
4) Why do plants disperse their seeds?

Practice Questions

1 Jen found a packet of seeds in her garage. The packet wasn't labelled, so Jen decided to plant the seeds to see what kind of plants grew from them.

(a) Suggest **three** things that will be needed for the seeds to grow into healthy plants.

(3 marks)

(b) After two months some small plants that had flowers with bright yellow petals grew from the seeds.

Suggest a reason why the plants had bright yellow petals.

(1 mark)

(c) After the plants had flowered, Jen noticed some seed heads covered in little tiny hooks on the plants.

Describe how the hooks would help the plant to disperse its seeds.

(1 mark)

2 The leaves of plants absorb light for photosynthesis.

(a) Write the word equation for photosynthesis using the words below.

oxygen **carbon dioxide** **water** **glucose**

(2 marks)

(b) Rob planted some marigold plants in his garden. He planted some under a tree and some in full sunlight.

The plants in full sunlight grew much better than those under the tree. Suggest why the plants grew better in full sunlight.

(2 marks)

(c) Rob also planted some marigold plants in his greenhouse.

Half the marigolds were planted in mineral-rich compost bought in a shop. The other half were planted in ordinary soil from the garden.

Suggest which group of marigolds were healthier. Explain your answer.

(2 marks)

Practice Questions

3 Elspeth is investigating how well different seeds are dispersed by wind. She sets up a fan and drops a sycamore fruit and a horse chestnut fruit in front of it. She then measures how far along the ground each of them travels. She does this three times for each fruit.

(a) Give **two** things Elspeth needs to keep the same each time she repeats the experiment to make sure it is a fair test.

(2 marks)

(b) Which fruit would you expect to disperse its seed(s) further? Explain your answer.

(2 marks)

4 (a) Chris and Jim were talking about fertilisation in plants.

Chris said that "fertilisation in plants happens when the pollen grain lands on the stigma".

Jim said that "fertilisation is when the nuclei from the ovule (egg) and male sex cell actually join together".

Who is correct, Jim or Chris?

(1 mark)

(b) The sentences below can be rearranged to describe the stages that must occur if a plant is to reproduce successfully. Copy and complete the table, numbering the steps 1 to 5 to show the correct order of these events. The first one has been done for you.

stage	order
The nucleus of the male sex cell joins with the nucleus of the egg cell (ovule).	
Pollen grain lands on the stigma.	1
The ovary develops into a fruit with the seeds inside.	
The nucleus from a male sex cell moves down through the tube.	
A pollen tube grows down through the style to the ovary.	

(4 marks)

Dependence on Other Organisms

Organisms in an Ecosystem are Interdependent

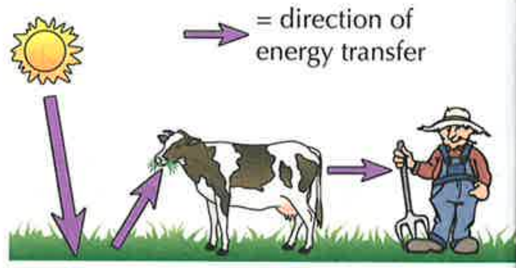
1) An ecosystem is all the living organisms in one area, plus their environment.
2) The organisms in an ecosystem are interdependent — they need each other to survive.

Almost All Living Things Depend on Plants

Almost all life on Earth depends on plants. Without them, we just wouldn't be here. Here's why...

Plants Capture the Sun's Energy

1) Almost all energy on Earth comes from the Sun.
2) Plants use some of the Sun's energy to make food during photosynthesis (see page 30). They then use this food to build "organic molecules" (things like carbohydrates and proteins), which become part of the plants' cells.
3) These organic molecules store the Sun's energy. The energy gets passed on from plants to animals when animals eat the plants. It gets passed on again when these animals are eaten by other animals.
4) Only plants, algae (seaweeds) and some bacteria are able to carry out photosynthesis. So nearly all living things rely on plants to capture and store the Sun's energy.



Plants Release Oxygen and Take in Carbon Dioxide

1) All living things respire (see page 4).
2) When plants and animals respire, they take in oxygen (O_2) from the atmosphere and release carbon dioxide (CO_2).
3) When plants photosynthesise, they do the opposite — they release oxygen and take in carbon dioxide.
4) So photosynthesis helps make sure there's always plenty of oxygen around for respiration. It also helps to stop the carbon dioxide level in the atmosphere from getting too high. This is an example of organisms affecting their environment.

Many Plants Depend on Insects in Order to Reproduce

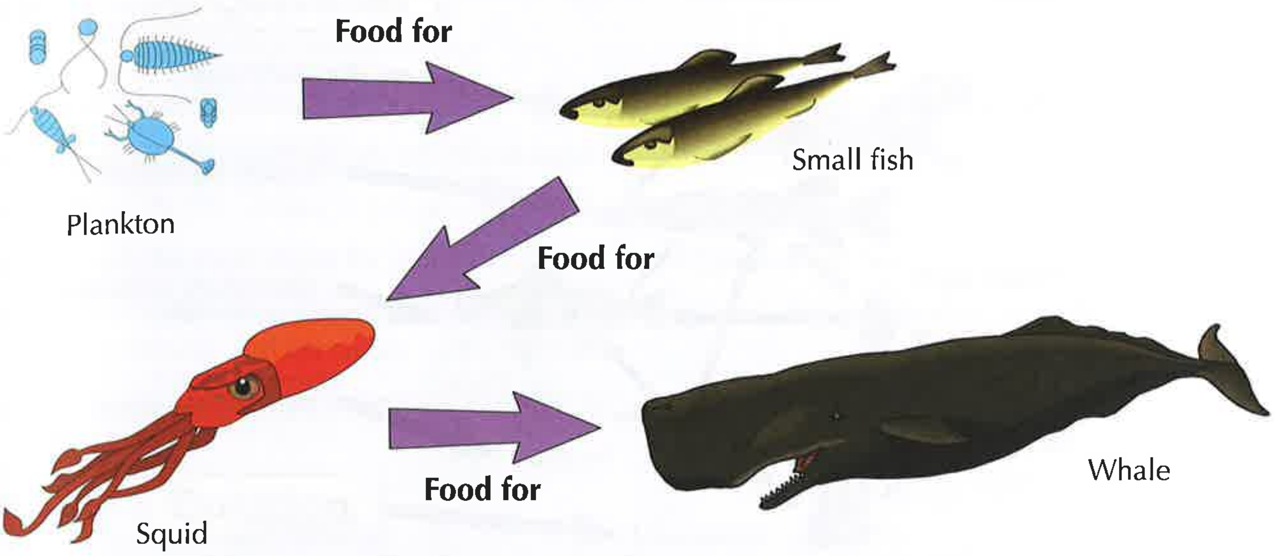
1) Many plants depend on insects to pollinate them (see page 31).
2) Without insects like bees, moths and butterflies, these plants would struggle to reproduce.
3) This would obviously be bad for the plants, but it would be bad for humans too. Many of our crop plants need to be pollinated by insects in order to produce the fruit, nuts and seeds that we eat.
4) So we depend on insects to pollinate our crops and ensure our food supply.

Food Chains

Organisms depend on each other to survive. Mainly this means that they depend on each other for food.

Food Chains Show What is Eaten by What

1) The organisms in a food chain are usually in the same ecosystem.

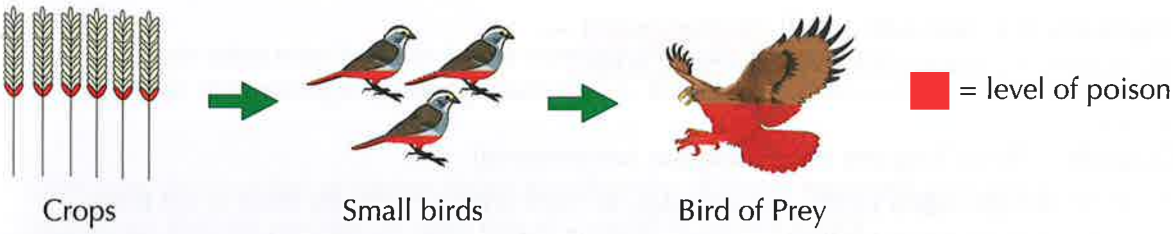


2) The arrows show what is eaten by what — i.e. "food for". (Plankton is food for small fish, etc.)
3) The arrows also show the direction of energy flow.

Poisons Build Up as They are Passed Along a Food Chain

Toxic materials (poisons) can sometimes get into food chains and harm the organisms involved. Organisms higher up the food chain (usually the top carnivores) are likely to be the worst affected as the toxins accumulate (build up) as they are passed along.

A top carnivore is an organism that isn't eaten by anything else.



EXAM TIP

Food chains show what's highest in the pecking order

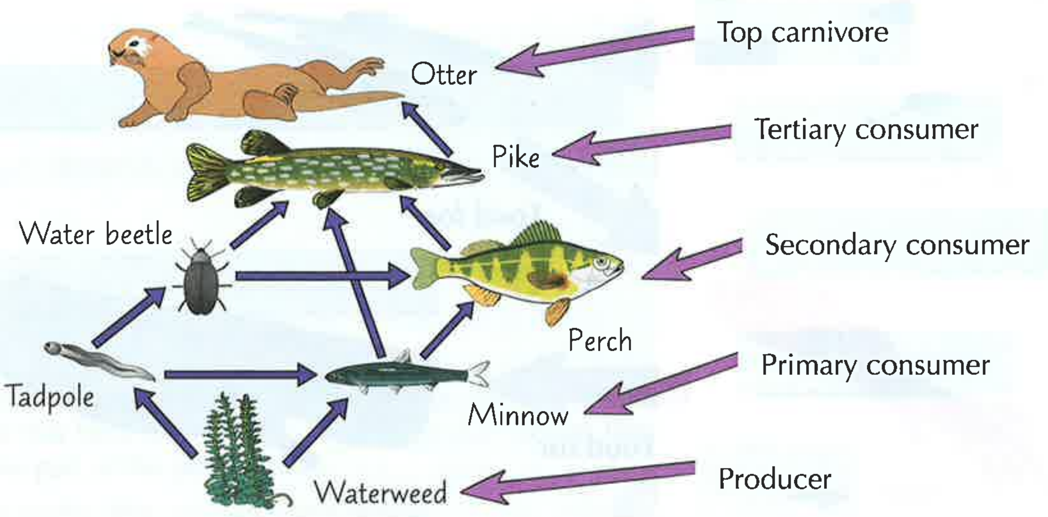
Food chains are simple, so you've no excuse not to learn them. They show you what eats what, right up to the top carnivore. In the exam, if you're asked to draw a food chain, make sure you have the arrows pointing the correct way — you don't want to say a leaf eats a snail.

Food Webs

You saw simple food chains on the last page — now it's time to delve into the more complicated food webs. In a food web, lots of the animals and plants are linked together in multiple ways.

Food Webs and Their Tremendous Terminology

Food webs contain many interlinked food chains, as shown here:



Learn these nine bits of terminology:

1) PRODUCER — all plants are producers. They use the Sun's energy to 'produce' food energy.
2) HERBIVORE — an animal that only eats plants, e.g. tadpoles, rabbits, caterpillars, aphids.
3) CONSUMER — all animals are consumers. (All plants are not, because they're producers.)
4) PRIMARY CONSUMER — an animal that eats producers (plants).
5) SECONDARY CONSUMER — an animal that eats primary consumers.
6) TERTIARY CONSUMER — an animal that eats secondary consumers.
7) CARNIVORE — eats only animals, never plants.
8) TOP CARNIVORE — is not eaten by anything else.
9) OMNIVORE — eats both plants and animals.

The organisms in a food web are all interdependent — so a change in one organism can easily affect others.

Example — What happens if the minnows are removed?

1) Who will get eaten LESS? The tadpoles, as there are no minnows there to eat them.
2) Who will get eaten MORE? a) Water beetles (by perch who'll get hungry without minnows).
b) Waterweeds (since the numbers of tadpoles will increase).

Learn about food webs — but don't get tangled up

REVISION TASK

Once you've got this page learnt, you can practise this typical food web question: "If the number of otters decreased, give one reason why the number of water beetles might a) decrease b) increase". You can find the answer to this question on page 190.

Warm-Up and Practice Questions

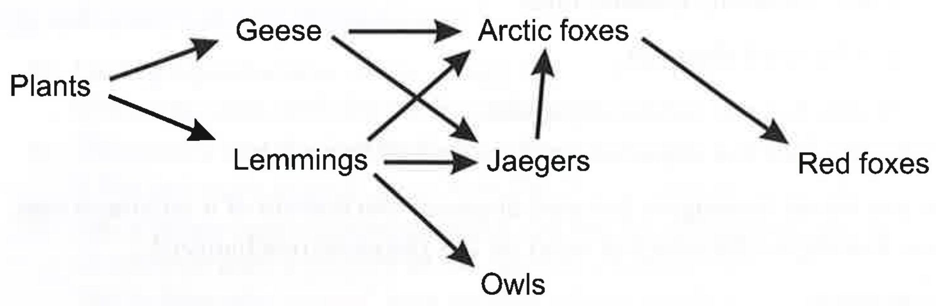
It's easy to think you've learnt everything in the section until you try to answer the Warm-Up Questions. If that happens to you, don't worry, just go back over the pages and write out the bits you got wrong until you can answer them standing on your head.
Then stand on your head and try to answer the Practice Question.

Warm-Up Questions

1) All the organisms in an ecosystem are interdependent. What does this mean?
2) Explain why animals rely on plants for energy.
3) What do the arrows in a food chain or web represent?
4) Draw the food chain for plankton, squid, small fish and whales.
5) Give a definition for each of the following food web terminologies:
a) producer b) carnivore c) omnivore

Practice Question

1 Below is part of the food web of plants and animals in the Arctic.



(a) The numbers of lemmings in the Arctic goes up and down a lot.

(i) Suggest **two** reasons why the number of lemmings may suddenly decrease.

(2 marks)

(ii) Suggest what may happen to the number of Arctic foxes if the number of lemmings suddenly decreased. Explain your answer.

(2 marks)

(b) One year, the number of geese drops significantly. Gideon suggests that this is due to the fact that the number of owls has increased in recent years.
Is Gideon likely to be correct? Explain your answer.

(3 marks)

(c) Suggest which organism would be the worst affected if a toxic material was taken up by the plants.

(1 mark)

(d) Fully explain your answer to part (c).

(2 marks)

Revision Summary for Section Three

Green plants are ace aren't they? What I really like about them is that they're all so clean and fresh — human and animal biology always seems to end up so gory with all sorts of gruesome diagrams and horrid diseases. But plants have such simple lives — they just seem to "go with the flow", with no apparent discomfort and no worries — and let's face it, it's a nice trick if you can do it.

Alas, nature conspired to give humans an altogether more "challenging" experience on this little blue-green planet of ours — and somehow that's ended up with you needing to know the answers to all these questions. Hmmm, it's a funny old world isn't it — when you think about it from that angle... Anyway, here they are. Off you go then...

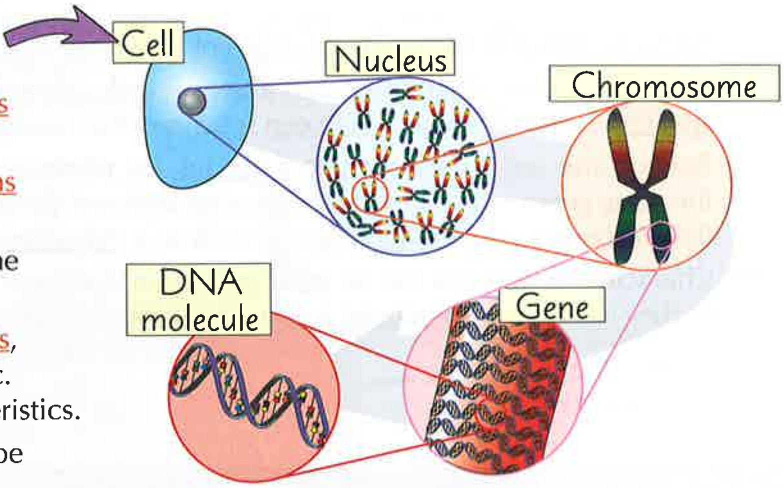
1) What is made during photosynthesis?
2) What do plants do with glucose?
3) What is the by-product made in photosynthesis, which is needed by animals?
4) Apart from water, what do plants need from the soil?
5) What are the four main parts of a flower? Say what each part actually does.
6) What is pollination? What are the two types of pollination?
7) What is the difference between insect pollination and wind pollination?
8) Give three features of: a) an insect pollinated plant, b) a wind pollinated plant.
9) What does an ovule develop into after fertilisation?
10) What does the ovary eventually develop into?
11) Give another name for seed dispersal.
12) Give four ways in which seeds can be dispersed.
    Give an example of a fruit that disperses seeds in each of these ways.
13) Describe how you could investigate the seed dispersal mechanism of a sycamore tree.
    How could you investigate the effect of wind on this dispersal mechanism?
14) What is an ecosystem?
15) Explain how plants store the Sun's energy.
16) Explain why living things rely on plants to control the level of some gases in the air.
17) What do many plants rely on insects for? How does this affect us humans?
18) What is a food chain?
19) What happens to poisons as they are passed along a food chain?
20) What is a food web?
21) Give good definitions for all of the following terms:
    a) herbivore b) consumer c) primary consumer
    d) secondary consumer e) tertiary consumer f) top carnivore.

DNA and Inheritance

DNA is a bit like your body's own instruction manual. When you're being made, you get bits of DNA from your mum and bits from your dad — this is how you inherit characteristics.

Chromosomes, DNA and Genes

1) Most cells in your body have a nucleus. The nucleus contains chromosomes.
2) Chromosomes are long, coiled up lengths of a molecule called DNA.
3) DNA is a long list of chemical instructions on how to build an organism.
4) A gene is a short section of a chromosome (and so a short section of DNA).
5) Genes control many of our characteristics, e.g. hair colour, eye colour, hairiness, etc. Different genes control different characteristics.
6) Genes work in pairs — one will usually be dominant over the other.



We Inherit Characteristics from Our Parents

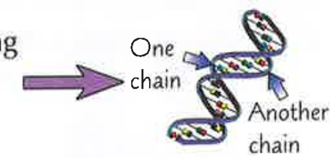
1) Human body cells have 46 chromosomes (23 pairs).
2) Sperm and egg cells carry only 23 chromosomes.

3) During reproduction, when an egg is fertilised, the nucleus of the egg fuses with the nucleus of the sperm.
4) This means that the fertilised egg contains 23 matched pairs of chromosomes. It has one copy of each gene from the mother and one from the father.
5) Since genes control characteristics, the fertilised egg develops into an embryo with a mixture of the parents' characteristics. This is how you 'inherit' your parents' characteristics.
6) The process by which genes are passed down from parents to their offspring is called heredity.

A characteristic passed on in this way is called a 'hereditary' characteristic.

The Structure of DNA Was Only Worked Out Recently

1) Scientists struggled for decades to work out the structure of DNA.
2) Crick and Watson were the first scientists to build a model of DNA — they did it in 1953.
3) They used data from other scientists, Wilkins and Franklin, to help them understand the structure of the molecule. This included X-ray data showing that DNA is a double helix — a spiral made of two chains wound together.
4) By putting all the information together, Crick and Watson were able to build a model showing what DNA looks like.



REVISION TASK

Some important details to learn on this page

There are three main headings, sixteen numbered points and two important diagrams — and they all need learning. Sit down and challenge yourself to repeat the main details. If you struggle with any bits, reread the page, then cover it back up and try again.

Variation

This page is all about differences between organisms — both big, obvious differences, like those between a tree and a cow, and less obvious differences, like people having different blood groups.

Different **Species** Have Different **Genes**

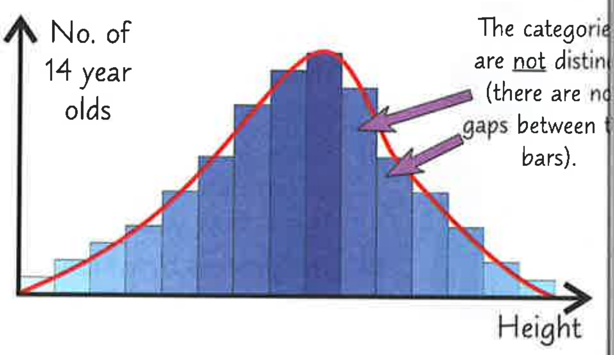
1) All living things in the world are different — we say that they show VARIATION.
2) A human, a cow, a dandelion and a tree all look different because they're different species. These differences between species occur because their genes are very different.
3) But you also see variation within a species, i.e. plants or animals that have basically the same genes will also show differences between them, e.g. skin colour, height, flower size, etc. Any difference is known as a characteristic feature.
4) Characteristic features can be inherited (come from your parents via genes) or they can be environmental (caused by your surroundings).

Continuous and **Discontinuous** Variation

Variation between individuals within a species can either be classed as continuous or discontinuous.

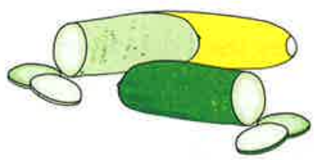
Continuous Variation — the feature can vary over a **range of values**

1) Examples of this are things like height, weight, skin colour, intelligence, leaf area, etc. where the feature can have any value at all — within a certain range.
2) If you did a survey of kids' heights you could plot the results on a chart like the one to the right (the heights would be collected into groups to give the bars).
3) The smooth distribution curve drawn on afterwards (the red line) shows much better the continuous way that values for height actually vary.



Discontinuous Variation — the feature can only take **certain values**

1) An example of this is a person's blood group, where there are just four distinct options, NOT a whole continuous range.
2) Another example is the colour of a courgette. A courgette is either yellow, light green or dark green — there's no range of values.



You need to be able to explain variation in terms of genes

Don't let the fancy word "variation" put you off. It's really not as complicated as it sounds. It just means "differences" (between any living things). You can have variation (differences) between different species, and you can also have variation (differences) within one species.

Natural Selection and Survival

In nature, being different can be really important. Having a different characteristic to other organisms can determine whether an organism (and its future generations) is likely to survive in the long run or not.

Variation Leads to Natural Selection

1) Organisms show variation because of differences in their genes (see previous page).
2) Organisms also have to compete for the resources they need in order to survive and reproduce, e.g. food, water and shelter. They have to compete with other members of their own species, as well as organisms from other species.

FOR EXAMPLE...

...this red squirrel...

...has to compete with other red squirrels (members of its own species)...

...as well as grey squirrels (a different species), in order to get food.

3) Organisms with characteristics that make them better at competing are more likely to survive and reproduce. This means they're more likely to pass on the genes for their useful characteristics to the next generation.
4) Organisms that are less successful competitors are usually the first to die — possibly before they've had a chance to reproduce. This means their genes and less useful characteristics won't be passed on to any offspring.
5) So, over time, the gene for a useful characteristic will become more common.
6) This process in which a characteristic gradually becomes more (or less) common in a population is known as natural selection.

A population is all the organisms of one species that live in the same ecosystem.

Giraffes Have Long Necks Due to Natural Selection

Are you sitting comfortably...

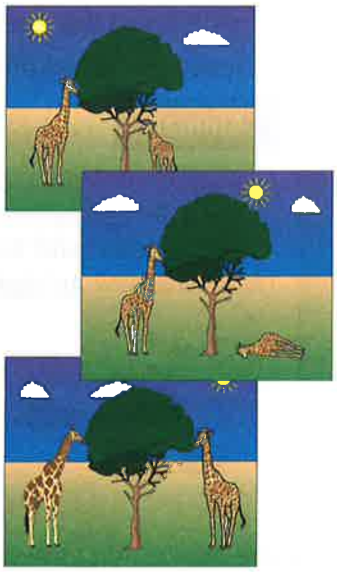
Once upon a time there was a group of animals munching leaves from a tree. Unfortunately the population was high and food was running short.

Soon all the leaves on the lower parts of the trees were gone and the animals started to get hungry — some even died. Except, that is, for a couple of animals which happened to have slightly longer necks than normal. This meant that they could compete better for food — they could reach just that bit higher, to the juicy and yummy leaves higher up the trees.

They survived that year, unlike a lot of animals, and had lots of babies.

The babies also had longer necks, and could eventually reach up the tree for the juicy yummy leaves.

It soon got to a situation where most of the animals in the population had long necks...



It's all about competition and being the best

Only those who are born with features that make them great at competing in the world they live in are likely to survive and produce offspring — the sick and the inept all die off very quickly.

Extinction and Preserving Species

Organisms that can't compete don't survive for long. If they suddenly become less competitive due to changes in the environment, they could die out in a certain area — or even become extinct.

Many Species Are at Risk of Becoming Extinct

1) Many organisms survive because they are well-adapted for competing in their environment.
2) But if the environment changes in some way, some organisms may struggle to compete successfully for the resources they need to survive and reproduce.
3) If this happens to a whole species, then that species is at risk of becoming extinct. Extinct means that there are none of them left at all (like the woolly mammoth).
4) Species at risk of becoming extinct are called endangered species.

Humans Can Suffer When Species Become Extinct

1) Humans rely on plants and animals for food.
2) We also use them to make clothing, medicines, fuel, etc.
3) We need to protect the organisms we already use in this way. We also need to make sure organisms we haven't discovered yet don't become extinct before we find them — or we might miss out on new sources of useful produ
4) Ecosystems are complex. If one species becomes extinct, this can have a knock-on effect for other organisms — including us.
5) That's why it's important for us to maintain the planet's biodiversity — the variety of species that live on Earth.

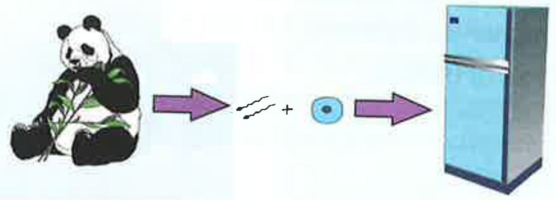
There are probably loads of spe
we don't know about, e.g. in unex
rainforests and deep in the oce

Gene Banks May Help to Prevent Extinction

1) A gene bank is basically a store of the genes of different species.
2) This means that if a species becomes endangered or even extinct, it may be possible to create new members of that species. So gene banks could be a way of maintaining biodiversity in the future.
3) Genes are stored differently for plants and animals. For example:

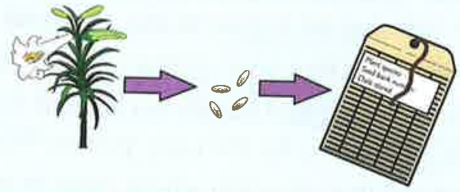
Animals

Sperm and egg cells (which contain genes) may be frozen and stored.
Scientists could then use these cells to create new animal embryos in the future.



Plants

Seeds (which contain genes) can be collecte from plants and stored in seed banks. If the plants become extinct in the wild, new plan can be grown from the seeds kept in storage



Gene banks aren't the only way to maintain biodiversity. It's much better to try to stop species becomin extinct in the first place, e.g. by preventing the destruction of habitats (the areas where organisms live).

EXAM TIP

It's not just animals that suffer when they go extinct

Underline key words in exam questions to make sure your answer covers exactly what the question asks — it's no good telling them all about gene banks if you won't get marks for it.

Warm-Up and Practice Questions

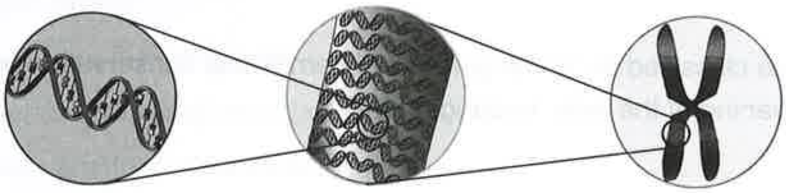
If you don't take time to warm up you're risking some serious brain-strain. So take a look at these quick questions and get your mind nice and supple on some of the basic facts. Then launch yourself slowly into the exam questions and enjoy.

Warm-Up Questions

1) What are chromosomes?
2) What did Watson and Crick build in 1953?
3) Can you get variation within a species?
4) What two things can cause characteristic features?
5) What are the two different classes of variation? How are they different?
6) How can scientists help to maintain biodiversity?
7) What's a habitat? Why is preserving habitats important to keeping species alive?

Practice Questions

1 (a) Copy and complete the labels in the diagram below



(i) .... (ii) .... (iii) ....

(3 marks)

(b) The double helix model describing the structure of DNA was first developed in 1953.

(i) What is DNA?

(1 mark)

(ii) What is a double helix?

(1 mark)

(c) A gene is a short section of DNA. Genes are found on chromosomes.

(i) Give three examples of characteristics controlled by genes.

(3 marks)

(ii) How many matched pairs of chromosomes does a fertilised human egg contain?

(1 mark)

(iii) What is the name of the process that describes how genes are passed on from parents to their offspring?

(1 mark)

Practice Questions

2 Kate wants to get a pet rabbit. She looks at several rabbits in the pet shop and notices that some have long, straight ears and some have large, floppy ears even though they all belong to the same species.

(a) (i) Explain why the rabbits can have different types of ear even though they belong to the same species.

(1 mark)

(ii) Is this variation in ear type continuous or discontinuous? Explain your answer.

(2 marks)

(b) The picture below shows a typical rabbit. Suggest why rabbits have evolved to have big ears.

(3 marks)

3 Some species are classified as 'endangered' by international conservation organisations.

(a) Give the meaning of the term 'endangered'.

(1 mark)

(b) Explain how a change in the environment could lead to a species becoming endangered.

(3 marks)

(c) Explain why it is important to preserve endangered plant and animal species.

(3 marks)

(d) One way to maintain diversity is to store the genes of endangered species in gene banks. Explain how genes can be stored in and retrieved from gene banks for:

(i) endangered plants

(2 marks)

(ii) endangered animals

(2 marks)

Revision Summary for Section Four

Section Four is fairly basic stuff really, but there are one or two fancy words which might cause you quite a bit of grief until you've made the effort to learn exactly what they mean: "DNA" is just a list of instructions for how any living creature is put together; "variation" just means "differences", etc., etc. These questions aren't the easiest you could find, but they test exactly what you know and find out exactly what you don't. You need to be able to answer them all, because all they do is test the basic facts. You must practise these questions over and over again until you can just sail through them.

1) Where do you find chromosomes?
2) What are chromosomes made of?
3) What is a gene? What do genes control?
4) How many chromosomes do humans have in each body cell?
5) How many chromosomes are there in human sperm cells? How about in human egg cells?
6) What happens at fertilisation?
7) What does heredity mean?
8) Name the two scientists who first built a model of DNA.
Name the other two scientists whose data helped them.
9) Describe the structure of a DNA molecule.
10) What does variation mean?
11) Why do different species look different?
12) What is a characteristic feature of an organism?
13) What is continuous variation? Give three examples.
14) What is discontinuous variation? Give two examples.
15) Give one way in which a graph showing continuous variation would differ from a graph showing discontinuous variation.
16) Why is it important that organisms are good at competing for the things they need?
17) Why are genes for useful characteristics likely to become more common in a population over time? What is this process called?
18) How did giraffes end up with very long necks?
19) Why could it be bad news for an organism if its environment changes?
20) What does extinct mean?
21) What does endangered mean?
22) What is biodiversity? Why is it important for us to maintain the planet's biodiversity?
23) What is a gene bank? What are they used for?
24) What part of a plant may be stored in a gene bank? What about an animal?

Solids, Liquids and Gases

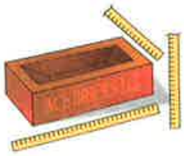
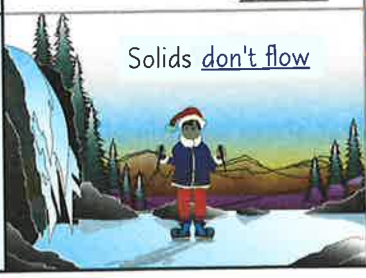
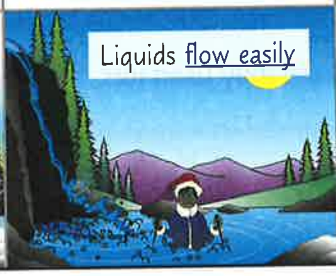
The first page in this section is all about <u>states of matter</u> and there are only <u>three</u> you need to know.

The **Three States of Matter** — Solid, Liquid and Gas

1) Materials come in <u>three</u> different forms — <u>solids</u>, <u>liquids</u> and <u>gases</u>.
2) These are called the <u>Three States of Matter</u>.
3) All <u>materials</u> are made up of <u>tiny particles</u>.
4) Which <u>state</u> you get (<u>solid</u>, <u>liquid</u> or <u>gas</u>) depends on how <u>strongly</u> the particles <u>stick together</u>. How well they stick together depends on <u>three things</u>:
   a) the <u>material</u> b) the <u>temperature</u> c) the <u>pressure</u>.

Solids, Liquids and Gases Have **Different Properties**

1) We can <u>recognise</u> solids, liquids and gases by their different <u>properties</u>.
2) A <u>property</u> of a substance is just a way of saying <u>how it behaves</u>.

Property	Solids	Liquids	Gases
Volume This is how much space something takes up.	<u>Solids</u> have a <u>definite volume</u> 	<u>Liquids</u> have a <u>definite volume</u> 	<u>Gases</u> have <u>no</u> definite volume — they always <u>fill the container</u> they're in 
Shape	<u>Solids</u> have a <u>definite shape</u> 	<u>Liquids</u> match the shape of the <u>container</u> 	<u>Gases</u> become the same shape as the <u>container</u> 
Density This is how heavy something is for its size.	<u>Solids</u> usually have a <u>high density</u> (heavy for their size) 	<u>Liquids</u> usually have <u>medium density</u> 	<u>Gases</u> have a very <u>low density</u> 
Compressibility This is how much you can squash something.	<u>Solids</u> are <u>not</u> easily squashed 	 Can't push <u>Liquids</u> are <u>not</u> easily squashed	<u>Gases</u> are <u>easily squashed</u> 
Ease of Flow	 Solids <u>don't flow</u>	 Liquids <u>flow easily</u>	Gases <u>flow easily</u> 

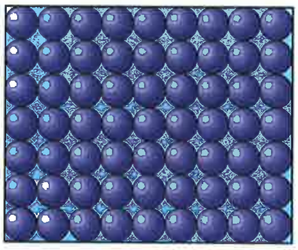
Particle Theory

Particle theory — sounds pretty fancy. But actually it's pretty straightforward.

It's all about the **Energy** and **Arrangement** of **Particles**

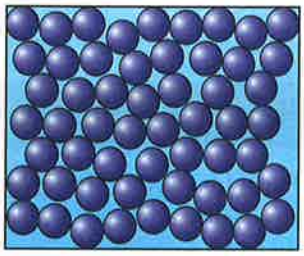
1) The particles in a substance stay the same whether it's a solid, a liquid or a gas.
2) What changes is the arrangement of the particles and their energy.

Solids — Particles are Held **Very Tightly Together**



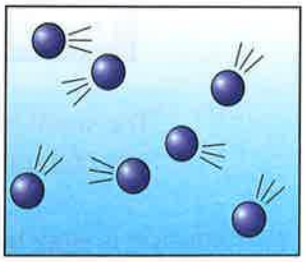
1) The particles in a solid have the least energy.
2) There are strong forces of attraction between particles.
3) The particles are held closely in fixed positions in a very regular arrangement. But they do vibrate to and fro.
4) The particles don't move from their positions, so all solids keep a definite shape and volume, and can't flow like liquids.
5) Solids can't easily be compressed because the particles are already packed very closely together.
6) Solids are usually dense, as there are lots of particles in a small volume.

Liquids — Particles are **Close Together** But They Can **Move**



1) The particles in a liquid have more energy.
2) There are some forces of attraction between the particles.
3) The particles are close, but free to move past each other — and they do stick together. The particles are constantly moving in all directions.
4) Liquids don't keep a definite shape and can form puddles. They flow and fill the bottom of a container. But they do keep the same volume.
5) Liquids won't compress easily because the particles are packed closely together.
6) Liquids are quite dense, as there are quite a lot of particles in a small volume.

Gases — Particles are **Far Apart** and **Whizz About a Lot**



1) The particles in a gas have the most energy.
2) There are very weak forces of attraction between the particles.
3) The particles are far apart and free to move quickly in all directions.
4) The particles move fast, and so collide with each other and the container.
5) Gases don't keep a definite shape or volume and will always expand to fill any container. Gases can be compressed easily because there's a lot of free space between the particles.
6) Gases all have very low densities, because there are not many particles in a large volume.

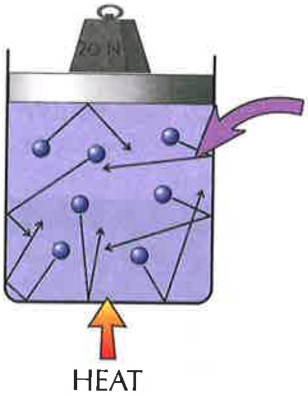
The particles in gases are far apart and have lots of energy

I think it's pretty clever the way you can explain all the differences between solids, liquids and gases with just a page full of blue snooker balls. Anyway, that's the easy bit. The not-so-easy bit is making sure you've learnt it all. Keep at it and you'll get to grips with what the particles are up to in no time.

More Particle Theory

Gas Pressure is Due to Particles Hitting a Surface

Increasing the Temperature Increases Pressure



1) When you increase the temperature, it makes the particles move faster.
2) This has two effects:

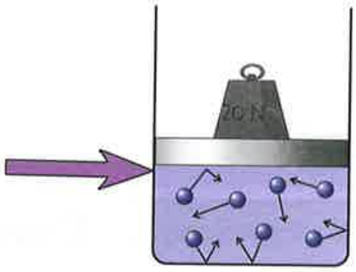
   a) They hit the walls harder.
   b) They hit more often.

Increasing the temperature will only increase the pressure if the volume stays the same (and vice versa).

3) Both these things increase the pressure.

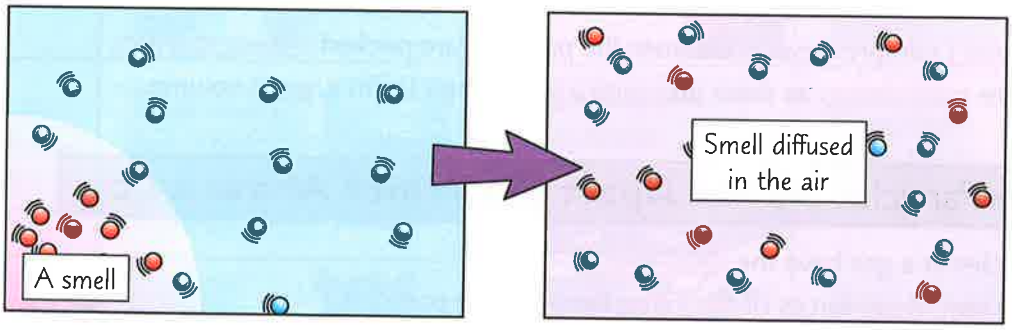
Reducing the Volume Increases Pressure

1) If you reduce the volume it makes the pressure increase.
2) This is because when the particles are squashed up into a smaller space they'll hit the walls more often.



Diffusion is Just Particles Spreading Out

1) Particles "want" to spread out — this is called diffusion. An example is when a smell spreads slowly through a room.



The smell particles move from an area of high concentration (i.e. where there are lots of them) to an area of low concentration (where there's only a few of them).

2) Diffusion is slow because the smell particles keep bumping into air particles, which stops them making forward progress and often sends them off in a completely different direction.

Think about gases squashed in an aerosol can

Aerosols hold gases under pressure, and when you spray an aerosol, you get to smell diffusion in action. Marvellous. Now cover the page and see how much you can write down.

Physical Changes

Physical changes don't change the particles — just their arrangement or their energy.

Physical Changes can be Changes of State

— i.e. changing from one state of matter to another.

1) When a solid is heated, its particles gain more energy.

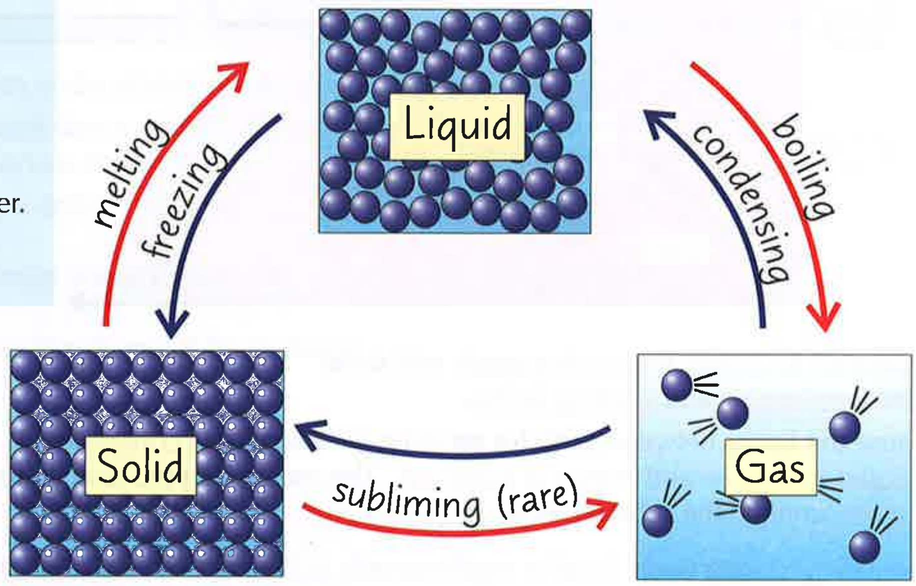
2) This makes the particles move more which weakens the forces that hold the solid together. This makes the solid expand.

3) At a certain temperature, the particles have enough energy to break free from their positions. This is called melting and the solid turns into a liquid.

4) When a liquid is heated, again the particles get even more energy.

5) This energy makes the particles move faster which weakens the forces holding the liquid together.

6) At a certain temperature, the particles have enough energy to break free of the forces. This is called boiling and the liquid turns into a gas.



A red arrow means energy is supplied

A blue arrow means energy is given out

A change of state doesn't involve a change in mass, only a change in energy.

From the sublime to the ridiculous

So matter can move from solid to liquid to gas and back again. Learn this, and learn what happens when it changes state. Write it all down bit by bit. Start with the diagram, then add the five labels — then try to learn all the details that go with each one. You'll know it all in no time — you'll see.

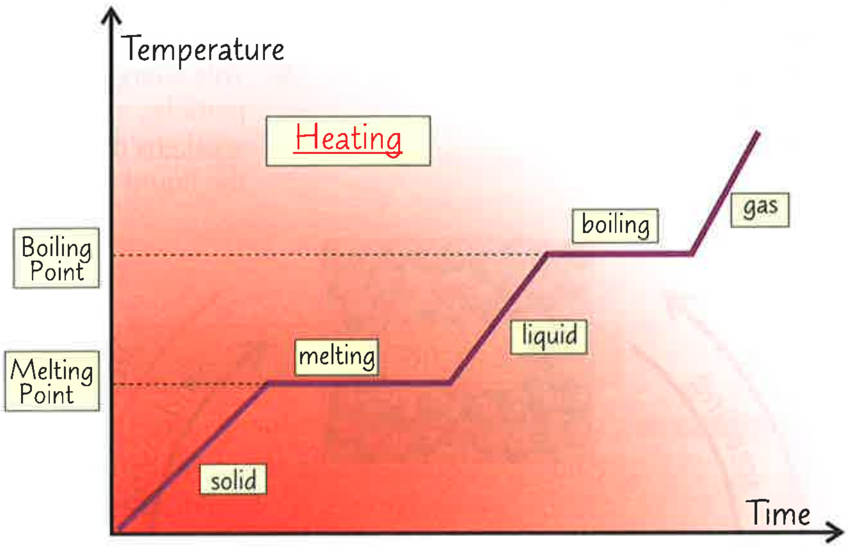
Heating and Cooling Curves

When a substance changes state, its temperature stops increasing or decreasing for a while.

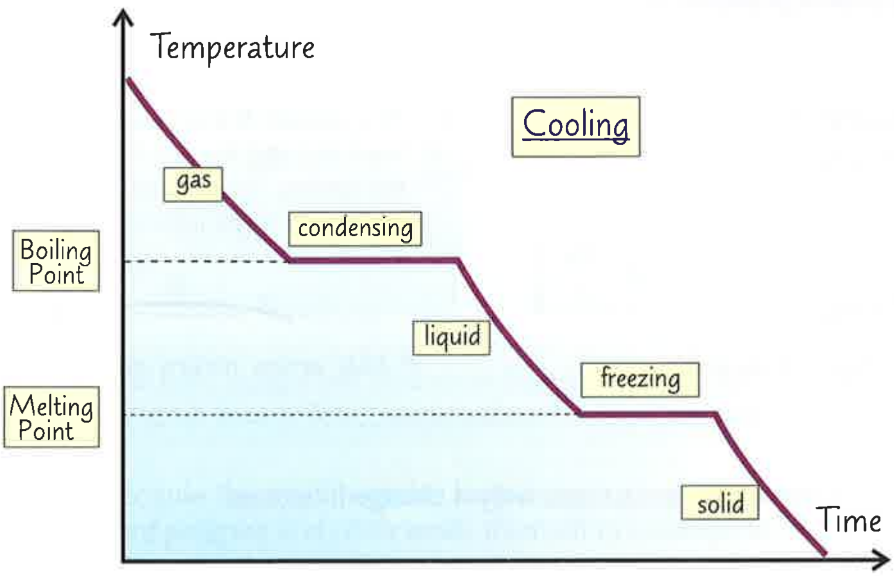
Heating and Cooling Curves have Flat Bits

Heating and cooling curves show the energy changes that happen when a substance changes state.

1) When a substance is melting or boiling, all the energy supplied from heating is used to weaken the forces between particles rather than raising the temperature — hence the flat bits on the heating graph.



2) When a substance is cooled, the cooling graph will show flat bits at the condensing and freezing points.
3) This is because the forces between particles get stronger when a gas condenses or when a liquid freezes — and energy is given out. This means that the temperature doesn't go down until all the substance has changed state.



During changes of state, heating and cooling curves go flat

Make sure you understand that when a substance is heated, its temperature increases until it starts melting or boiling. Then the temperature stays the same while the energy is used to weaken forces between particles, giving a flat bit on the curve. The opposite happens when a substance cools.

Warm-Up and Practice Questions

There's a bit too much gas in this section in my opinion. Just tackle the Warm-Up Questions first, then move on to the trickier Practice Questions.

Warm-Up Questions

1) Name the only state of matter that can be easily compressed.
2) In which state of matter are the particles fixed in a regular pattern?
3) What happens to the speed at which particles move when they are heated?
4) What is sublimation?
5) Why does gas pressure increase when the volume is decreased?

Practice Questions

1 An aerosol can of deodorant contains liquefied gas under pressure.

(a) The aerosol can is a solid. Which two of the following properties are properties of a solid?

Has a definite volume — Flows easily

Is easily compressed — Has a high density

Takes the shape of its container

(2 marks)

(b) When the deodorant is sprayed, it changes from a liquid into a gas.
Each deodorant particle can be represented by a circle.
Copy and complete the diagrams below to show the arrangement of particles in the deodorant, as a liquid and as a gas.

gas	liquid

(2 marks)

(c) A student uses the deodorant in the corner of a changing room.
After a while everyone in the room can smell the deodorant.

(i) Name the process that causes gas particles to spread through the room.

(1 mark)

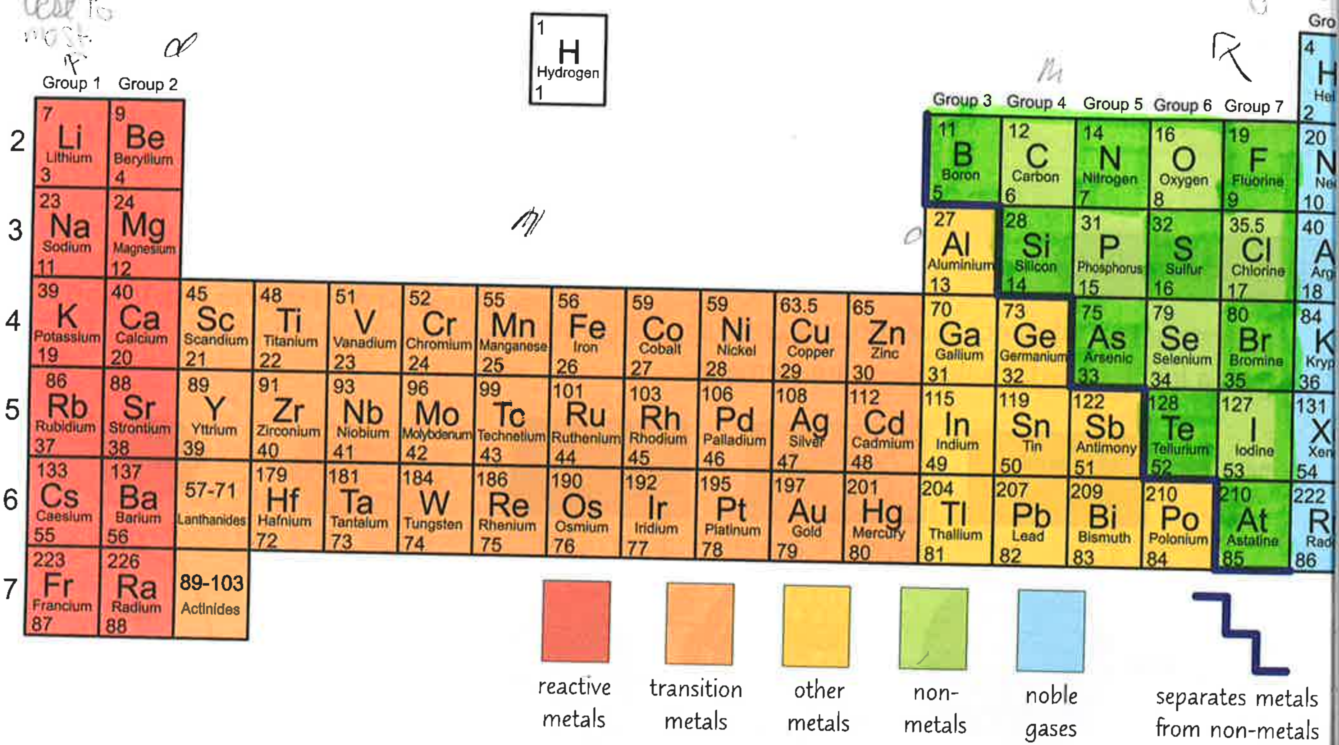
(ii) Describe how the process works.

(2 marks)

The Periodic Table

The Periodic Table Lists All the Elements

1) The periodic table shows all the elements we have discovered.
2) The first version of the table was put together by a scientist called Mendeleev. It's thanks to Mendeleev that elements with very similar properties are arranged into vertical columns in the table.
3) The vertical columns are called groups.
4) The horizontal rows are called periods.
5) If you know the properties of one element in a group, you can predict the properties of other elements in that group. E.g. Group 1 elements are all soft, shiny metals, which react in a similar way with water.



You Can Use the Periodic Table to Predict Patterns in Reactions

1) In a chemical reaction, elements combine to form new substances (see next page).
2) An element that's dead keen to combine with other elements is said to be very reactive. Group 1, 2 and 7 elements are all pretty reactive.
3) Group 0 elements (the "noble gases") are all extremely unreactive. They almost never take part in any chemical reactions.
4) You can use the periodic table to predict patterns in chemical reactions. For example...

The Group 1 metals get MORE reactive as you go down the group.

You can see this by the way the Group 1 metals react with water. When lithium (Li) reacts with water, it fizzes. When rubidium (Rb) reacts with water, it explodes. This is because rubidium is much more reactive than lithium.

The non-metals in Group 7 behave in the opposite way to the metals in Group 1.

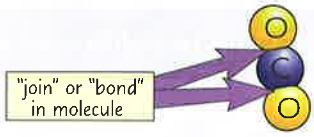
They get LESS reactive as you go down the group.

Compounds

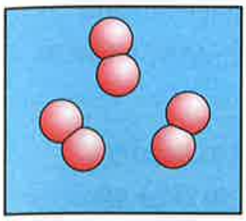
Compounds form when different atoms join together.

Compounds Contain Two or More Elements Joined Up

1) When two or more atoms join together, a molecule is made. The join is known as a chemical bond.
2) Compounds are formed when atoms from different elements join together. Like in CO_2.

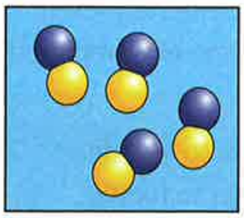


An element which is made up of molecules:



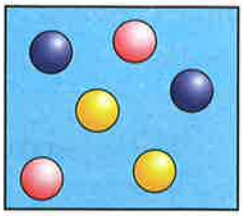
The atoms are joined, but they're all the same, so it's an element.

Molecules in a compound:



Here we have different atoms joined together — that's a compound alright.

A mixture of different elements:



This is not a compound because the elements aren't joined up — it's a mixture (p.60).

Compounds are Formed from Chemical Reactions

1) A chemical reaction involves chemicals (called the reactants) combining together or splitting apart to form one or more new substances (called the products).
2) When a new compound is synthesised (made), elements combine.
3) The new compounds produced by any chemical reaction are always totally different from the original elements (or reactants). The classic example of this is iron reacting with sulfur as shown below.

Iron's Properties Change when it Forms a Compound

Iron is magnetic. It reacts with sulfur to make iron sulfide, a totally new substance which is not magnetic. These equations show what happens in the reaction:

Word equation:	Iron + Sulfur	Heated →	Iron Sulfide
In symbols:	Fe + S	Heated →	FeS

Remember, every element has a name and a symbol. See p.55 for more.

1) When elements undergo a chemical reaction like the one above, the products will always have a chemical formula — e.g. H_2O for water or FeS for iron sulfide.
2) Compounds can be split up back into their original elements but it won't just happen by itself — you have to supply a lot of energy to make the reaction go in reverse.

REVISION TIP

Chemical reactions form brand new products

Don't get confused between elements, compounds and mixtures. If you're struggling to remember which is which, cover the page and practice writing out what each one means.

Mixtures

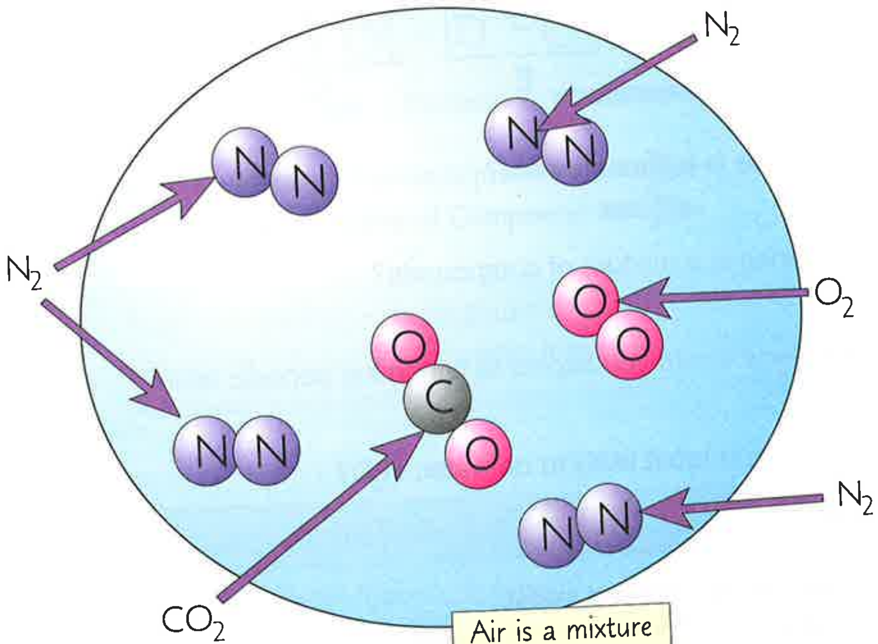
Mixtures in chemistry are like cake mix in the kitchen — all the components are mushed up together, but you can still pick out the raisins if you really want. You'll need to learn the technical terms too though...

Mixtures are Substances That are NOT Chemically Joined Up

1) A pure substance is made up of only one type of element OR only one type of compound. It can't be separated into anything simpler without a chemical reaction.

E.g. pure water is made up of H_2O molecules only. These molecules can't be separated into H and O atoms without a chemical reaction.

2) A mixture contains two or more different substances. These substances aren't chemically joined up — so, if you're clever, you can separate them very easily using physical methods (i.e. without a chemical reaction). See pages 62-64 for more.
3) Sea water and air are good examples of mixtures — they contain several different substances which aren't chemically combined.
4) A mixture has the properties of its constituent parts (i.e. the parts it's made from).



Air is a mixture of different gases

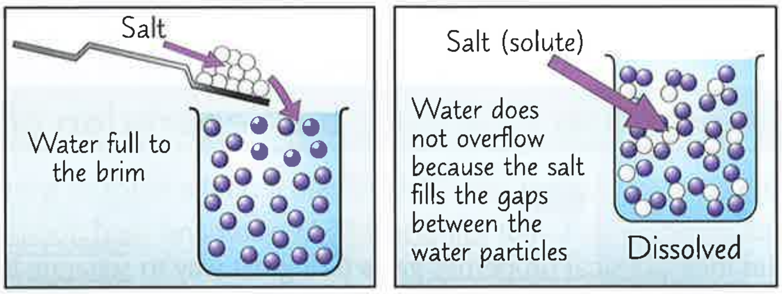
The components of a mixture are not chemically combined

I've said it already, but this is important — the parts of a mixture are not chemically joined up at all. You can separate the substances relatively easily using physical methods (more on them later). This makes them very different to compounds, which need a chemical reaction to separate them.

Mixtures

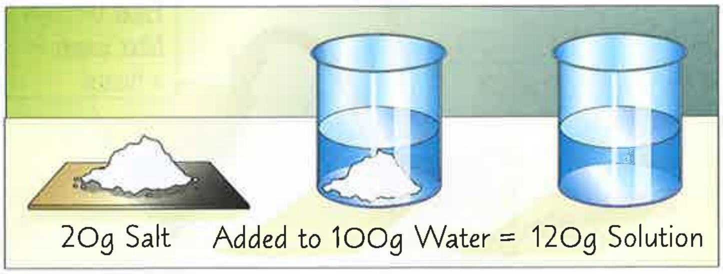
Dissolving isn't Disappearing

1) Dissolving is a common way mixtures are made.
2) When you add a solid (the solute) to a liquid (the solvent) the bonds holding the solute particles together sometimes break.
3) The solute particles then mix with the particles in the liquid, forming a solution.



Learn these seven definitions:

1) Solute – is the solid being dissolved.
2) Solvent – is the liquid it's dissolving into.
3) Solution – is a mixture of a solute and a solvent that does not separate out.
4) Soluble – means it WILL dissolve.
5) Insoluble – means it will NOT dissolve.
6) Saturated – a solution that won't dissolve any more solute at that temperature.
7) Solubility – a measure of how much solute will dissolve.



4) Remember, when salt dissolves it hasn't vanished — it's still there — no mass is lost.
5) If you evaporated off the solvent (the water), you'd see the solute (the salt) again.

Solubility Increases with Temperature

1) At higher temperatures more solute will dissolve in the solvent because particles move faster.
2) However some solutes won't dissolve in certain solvents. E.g. salt won't dissolve in petrol.

There is no change in mass when a solid dissolves

It might look like salt disappears in water, but it's still there and it still has a mass. A given amount of water can only dissolve a certain amount of salt — but you can increase this amount by heating the water. Make sure you remember that, and learn the seven terms in the box.

Separating Mixtures

There are all sorts of ways you can separate mixtures. You've got to know four of them.

Mixtures Can be Separated Using Physical Methods

There are four separation techniques you need to be familiar with.

1) FILTRATION 2) EVAPORATION 3) CHROMATOGRAPHY (page 63) 4) DISTILLATION (page 64)

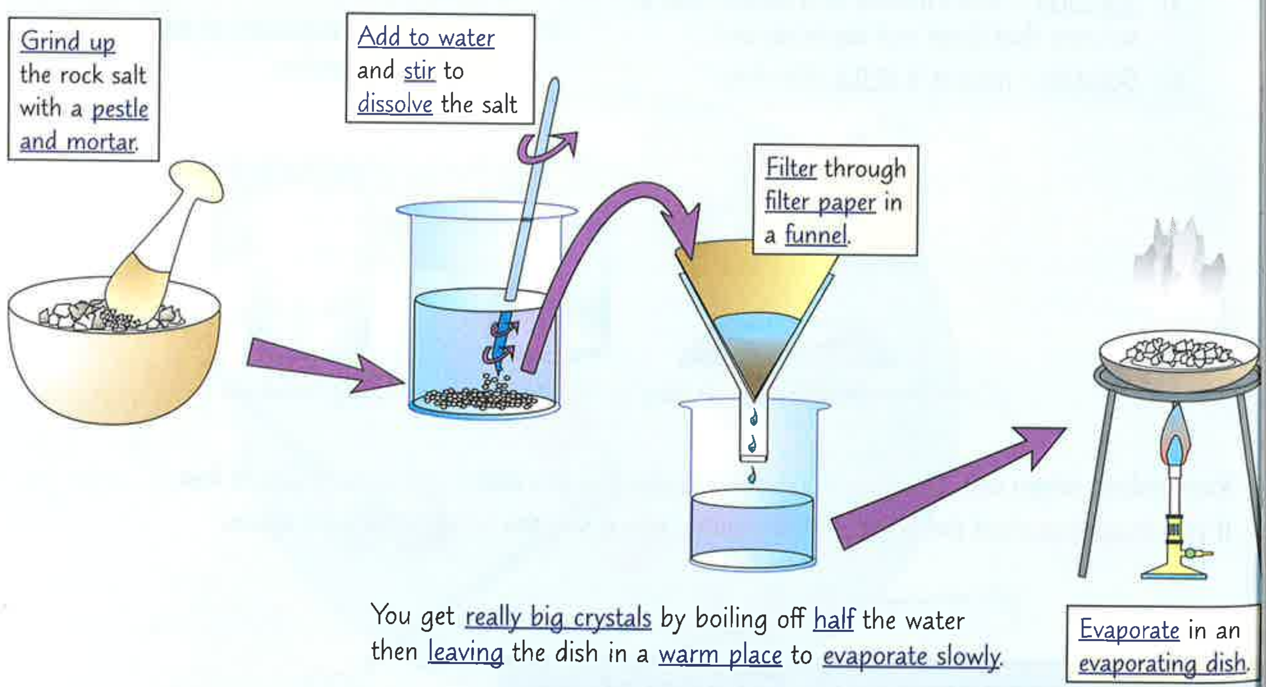
All four make use of the different properties of the constituent parts to separate them out.

Filtration and Evaporation — E.g. for the Separation of Rock Salt

1) Rock Salt is simply a mixture of salt and sand (they spread it on the roads in winter).
2) Salt and sand are both compounds — but salt dissolves in water and sand doesn't. This vital difference in their physical properties gives us a great way to separate them.

You Need to Learn the Four Steps of the Method:

1) Grinding 2) Dissolving 3) Filtering 4) Evaporating



- The sand doesn't dissolve (it's insoluble) so it stays as big grains and obviously these won't fit through the tiny holes in the filter paper — so it collects on the filter paper.
- The salt is dissolved in solution so it does go through — and when the water's evaporated, the salt forms as crystals in the evaporating dish. This is called crystallisation. (Surprise surprise.)

Grind, dissolve, filter, evaporate.

It's pretty easy to separate rock salt into rock (sand) and salt. Salt dissolves in water, but sand does not. So all you need to do is mash up the rock salt, dissolve the salt, fish out the sand with a filter and then get rid of the water by evaporating it off. Easy when you know how — make sure you do.

Separating Mixtures

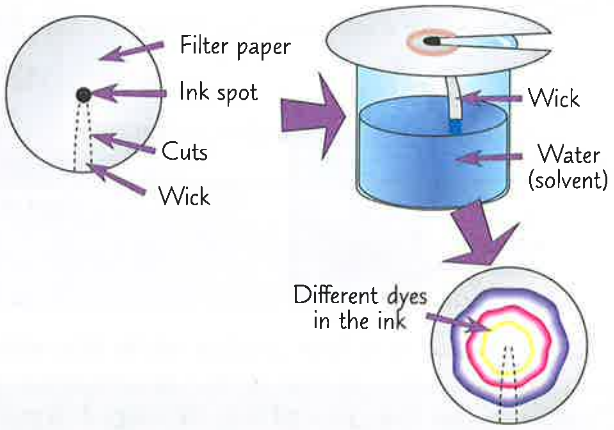
Chromatography is all about separating different liquids, like ink dyes.

Chromatography is Ideal for Separating **Dyes** in **Inks**

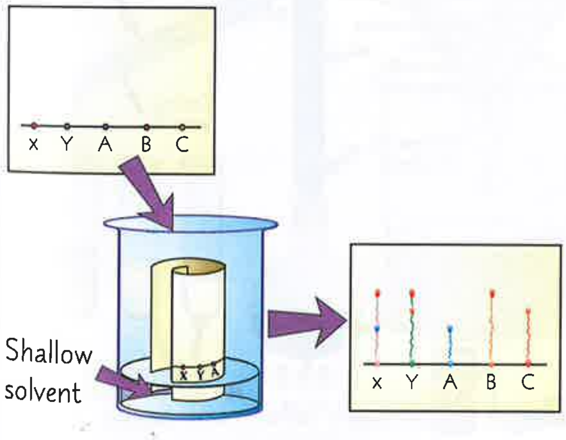
1) Different dyes in ink will wash through paper at different rates.
2) Some will stick to the paper and others will remain dissolved in the solvent (see below) and travel through it quickly.

Method 1

1) Dots of ink are put onto chromatography paper.
2) A wick is cut from part of the paper (as shown).
3) The solvent washes the dyes through the paper.



Method 2



1) Put spots of inks onto a pencil baseline on chromatography paper.
2) Roll the sheet up and put it in a beaker.
3) The solvent seeps up the paper, carrying the ink dyes with it.
4) Each different dye will form a spot in a different place.
5) You can compare a forged ink to a known ink to see which it is.

Two other exciting uses of chromatography are:
1) **Identifying blood samples.**
2) **Investigating chlorophyll.**

WORKING SCIENTIFICALLY

Remember — chromatography is for separating liquids

It's important to think about why you do each stage of an experimental method. For example, in method 2 the baseline is drawn in pencil. If it were drawn in pen it might be carried up the paper with the ink spots and make the separation of the spots hard to see.