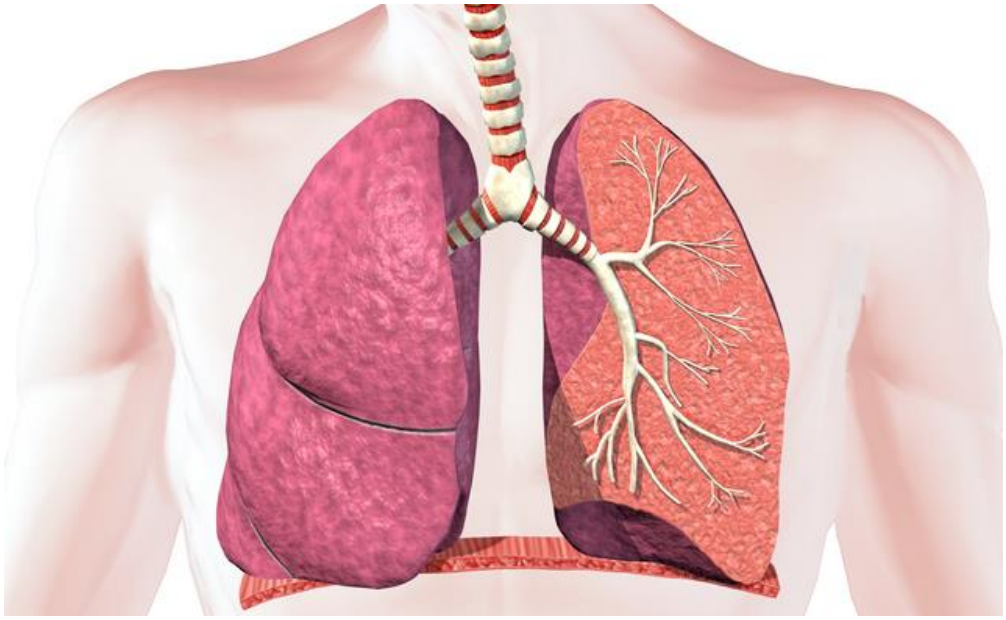
Name ……

Biology Unit 1

HT/FT Separates Revision Guide 2016 →



Contents:

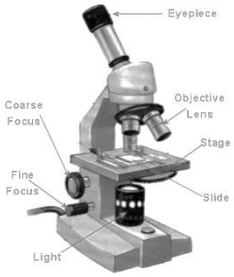
1. Cell Biology.

All living things are built out of cells. The cell is the basic unit of life. This was the cell theory put forward by Biologists in the 1830's. New cells are formed by cell division, and their DNA is passed from parent to daughter cells. Biologists still believe this even though they have discovered some organisms (like viruses) which don't have a cell structure.

The Microscope.

Microscopes are instruments used by Biologists to observe objects which are too small to be seen with the naked eye. All microscopes function by magnifying an object, which means to make it appear larger. The different types of microscope differ in the level of magnification, the type of image they produce and the degree of resolution (clarity of image) they provide.

The Light Microscope.



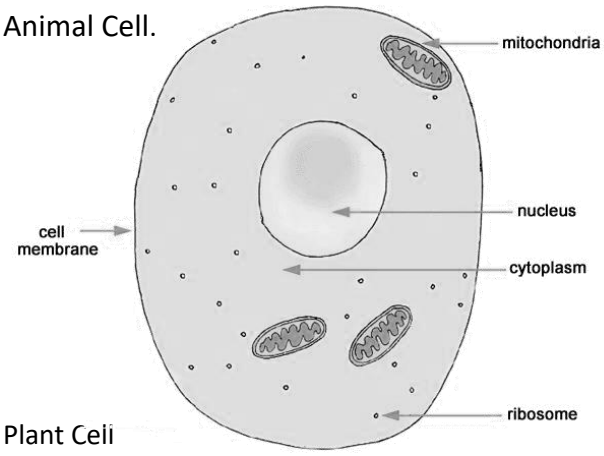
These use light rays to make the object visible. There are two lenses, the eyepiece and objective lens.
The total magnification can be calculated:
Total mag = Eyepiece x Objective
When slides are made A stain may be used to make detail more visible.
Adv. ~ can be used to see living specimens; and tissues do not need to be placed in harsh chemicals to be viewed.
Disadv. ~ level of magnification and resolution is limited.

The Electron Microscope.

First used in 1949. They use beams of high speed electrons, focused by electromagnets instead of light to produce an image on a fluorescent screen.
Advantages. ~ gives much greater magnification and resolution.
Disadvantages. ~ use very harsh chemical treatment, which can damage the specimen, causing distortions. Only dead material can be used. All images are in black and white. They are very expensive.

Typical Cells.

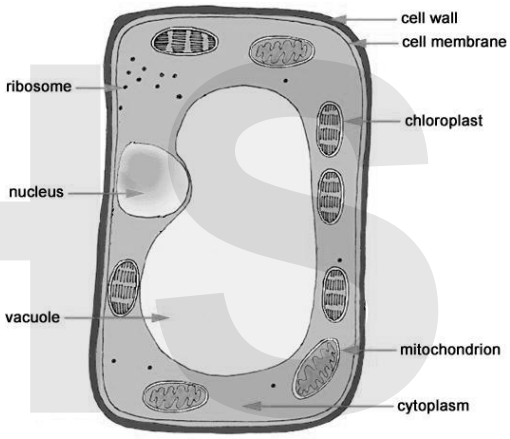
Animal Cell.



Name of cell part	Function
Cell membrane	This is a thin layer around the cell. It controls the movement of substances into and out of the cell.
Nucleus	This is a large structure inside the cell. It contains chromosomes which control the activities of the cell, and how it develops.
Cytoplasm	This is a jelly-like substance containing many chemicals. Most of the chemical reactions of the cell occur here.
Mitochondria	These are small rod shaped structures they release energy from sugar during aerobic respiration.
Ribosomes	These are small ball-shaped structures in the cytoplasm, where proteins are made.

Plant Cell

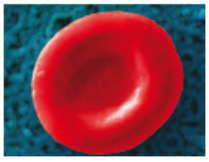
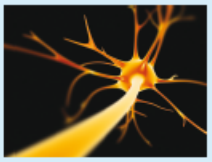
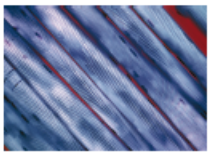
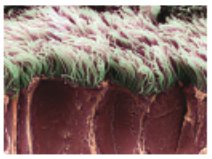
Part of cell	Function
Cell wall	This is outside the cell membrane. It is made of cellulose and supports plant cells.
Vacuole	Contains a watery sugar solution called sap. A swollen vacuole pushes the cell contents against the cell wall making the cell firm.
Chloroplasts	Small discs in the cytoplasm that contain chlorophyll. Chlorophyll traps light energy for photosynthesis.



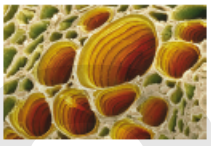
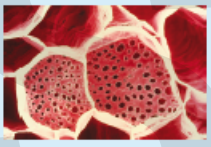
Differentiation.

Differentiation ~ where cells specialise into different types, each with a specific purpose; these specialised cells are more efficient at performing specific functions. There are many examples of both plant and animal specialised cells.

Specialised Animal Cells.

Cell type	Specialised structure	Function of cell
red blood cell 	Lacks a nucleus. Large surface area. Cell is small so fits into narrowest blood vessels. Contains haemoglobin which binds reversibly to oxygen.	Haemoglobin binds to oxygen and transports it around the body. The red blood cell gives up the oxygen to other body cells that need it.
nerve cell 	Many short extensions at the ends of the nerve. One long nerve fibre extension. Nerve fibre insulated with fatty sheath.	Receives impulses from other nerve cells via its many extensions. The impulses travel along the long nerve fibre. The insulation prevents loss of the impulse and makes it travel quickly.
muscle cell 	Cell is long and thin. Full of proteins that can make it contract.	The contractile proteins shorten the cell. This brings about movement.
sperm cell 	Cell has a head containing a nucleus, and a long tail.	The tail helps the cell to swim to the egg. The nucleus contains DNA which combines with the DNA of the egg cell.
ciliated epithelial cell 	Tall column-shaped cells. Cells can pack tightly together. Each cell covered at the top with fine hairs called cilia.	Tightly packed cells form a covering layer of cells. The cilia beat to create a current which can move particles such as bacteria up and out of the windpipe.

Specialised Plant Cells.

Cell type	Specialised structure	Function of cell
palisade mesophyll cell 	Found in the upper part of the leaf. Column-shaped cells with many chloroplasts.	The shape means that many cells can pack side by side. The chloroplasts contain chlorophyll for trapping light.
root hair cell 	Found in the young root. Long extension which protrudes out into the soil.	The extension increases the surface area of the cell, which improves its ability to absorb water and minerals from the soil.
xylem 	Found in roots, stems, and leaves. Hardened cell wall. Hollow inside with no living contents.	The hard cell wall gives strength, which helps support the plant. Being hollow allows the xylem to transport water.
phloem 	Found in roots, stems, and leaves. End walls of cells perforated. Cells largely hollow inside with small living cells next to them.	The hollow cavity and perforated end walls allow sugars to move through the plant. The living neighbouring cells supply energy for the transport of sugars.

Stem Cells.

In mature tissues, cells have generally lost the ability to differentiate into different types of cells. Some cells in both plants and animals do not lose this ability, and are called stem cells.

Levels of Organisation.

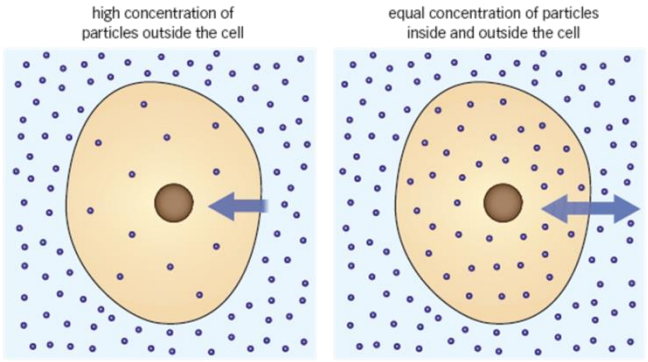
Animals and plants are multicellular, which means build of many cells. Cells do not work in isolation. The cells in our body are organised.

Cell	The basic building block, which can become specialised to do a particular function.
Tissue	A tissue is a group of similar cells with a similar function working together.
Organ	An organ is a group of different tissues working together at a specific function.
Organ system	An organ system is a group of different organs working together at a specific function.
Organism	An organism is a living thing.

2. Movement across membranes.

It is important for molecules to be able to move into and out of cells for them to work. There are three methods:

Diffusion.



Diffusion is the net movement of particles from an area of high concentration to an area of low concentration, (down a concentration gradient) until the concentration evens out. This happens in a liquid or gas where the particles can move. It is a passive process so does not need energy.

Examples of diffusion through cell membranes are:

- Oxygen diffuses into cells for use in respiration.
- Carbon dioxide diffuses out of cells as the waste of respiration.

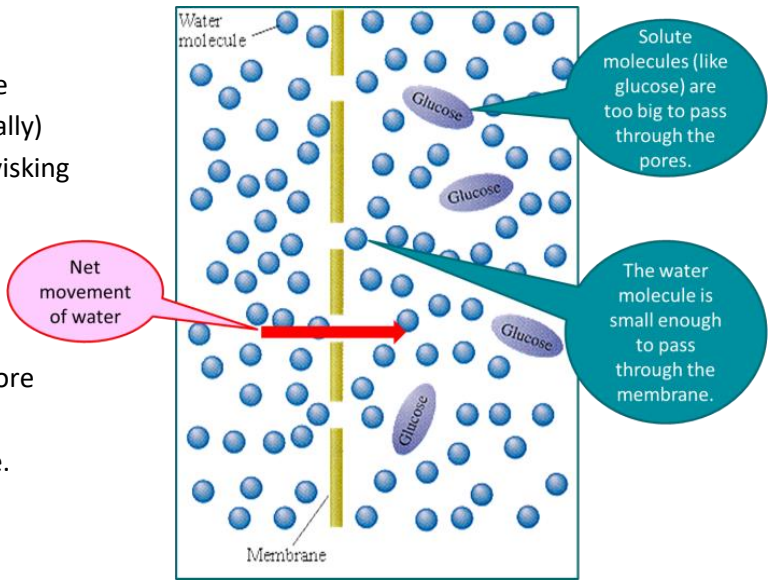
Factors affecting the rate of diffusion include:

- Distance – the shorter the distance the particles have to move, the quicker the rate of diffusion.
- Concentration gradient – particles move down a concentration gradient from high to low concentration. The greater the difference in concentration, the faster will be the rate of diffusion.
- Surface area – the greater the surface area over which the molecules move, so the rate is faster.
- Particles can only diffuse through a membrane if the pores in the membrane are big enough.

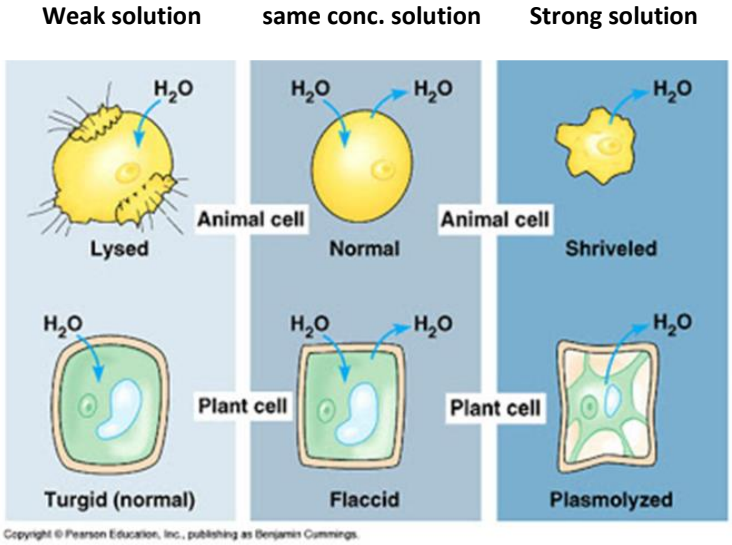
Osmosis.

This is a special case of diffusion. It only involves the movement of water. Through a selectively (or partially) permeable membrane. E.g. the cell membrane (or visking tubing like in the osmosis expt).

- Osmosis is the net movement of water
- from an area of high water concentration (a dilute solution)
- to an area of low water concentration (a more concentrated solution)
- through a selectively permeable membrane.



Osmosis In Cells.



When cells are placed in a weak solution, water moves from the high water concentration in the solution into the cell. This causes the cell to expand (gain mass and size) or burst in animals cells.

When cells are placed into a solution the same concentration as the cell, equal amounts of water move in or out. The cell remains the same.

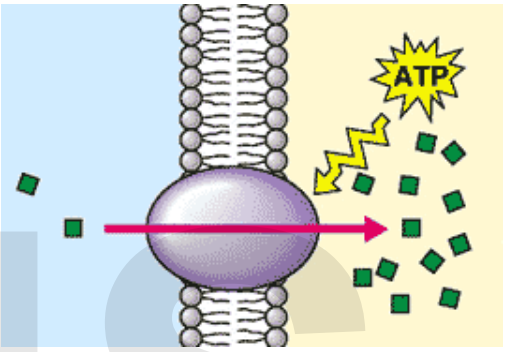
When cells are placed in a strong solution, water moves out from the high water concentration in the cell. This causes the cell to shrink (lose mass and size) or plasmolyse in plant cells.

Osmosis experiments

Experiments can be carried out using plant material such as potatoes. The potato cylinders are weighed then placed in different concentration solutions for a set time. The cylinders are then re-weighed and any change in mass is recorded.

Active Transport. (HT)

Sometimes cells need to move substances up a concentration gradient. The molecules move from a low concentration to an area of high concentration. To do this the cell uses energy in the form of ATP to pump molecules against the concentration gradient. E.g. the uptake of sugars by cells.

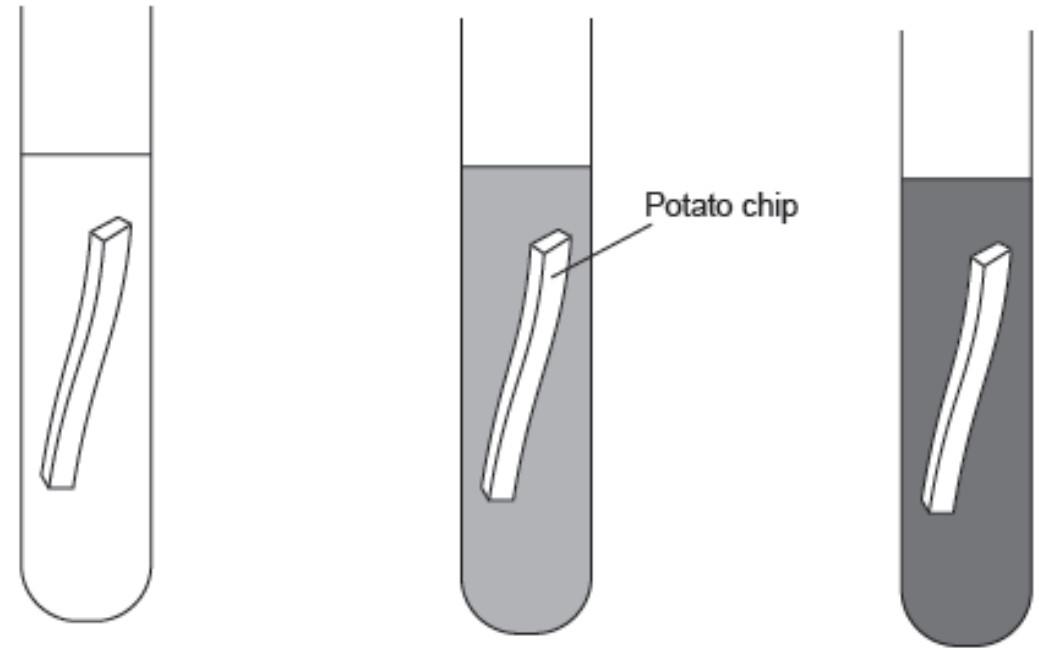


4. *(a)* Complete the sentence using some of the words below. [2]

low **fully permeable** **high** **semi-permeable**

During osmosis, water moves from a region where it is in a ..... concentration to a region where it is in a ..... concentration, through a ..... membrane.

(b) Ceri and Sajid investigated osmosis in potato chips.
They set up three test tubes containing blackcurrant squash and water as shown in the diagram below. Blackcurrant squash contains sugar.
A potato chip of exactly the same size and mass was added to each tube.

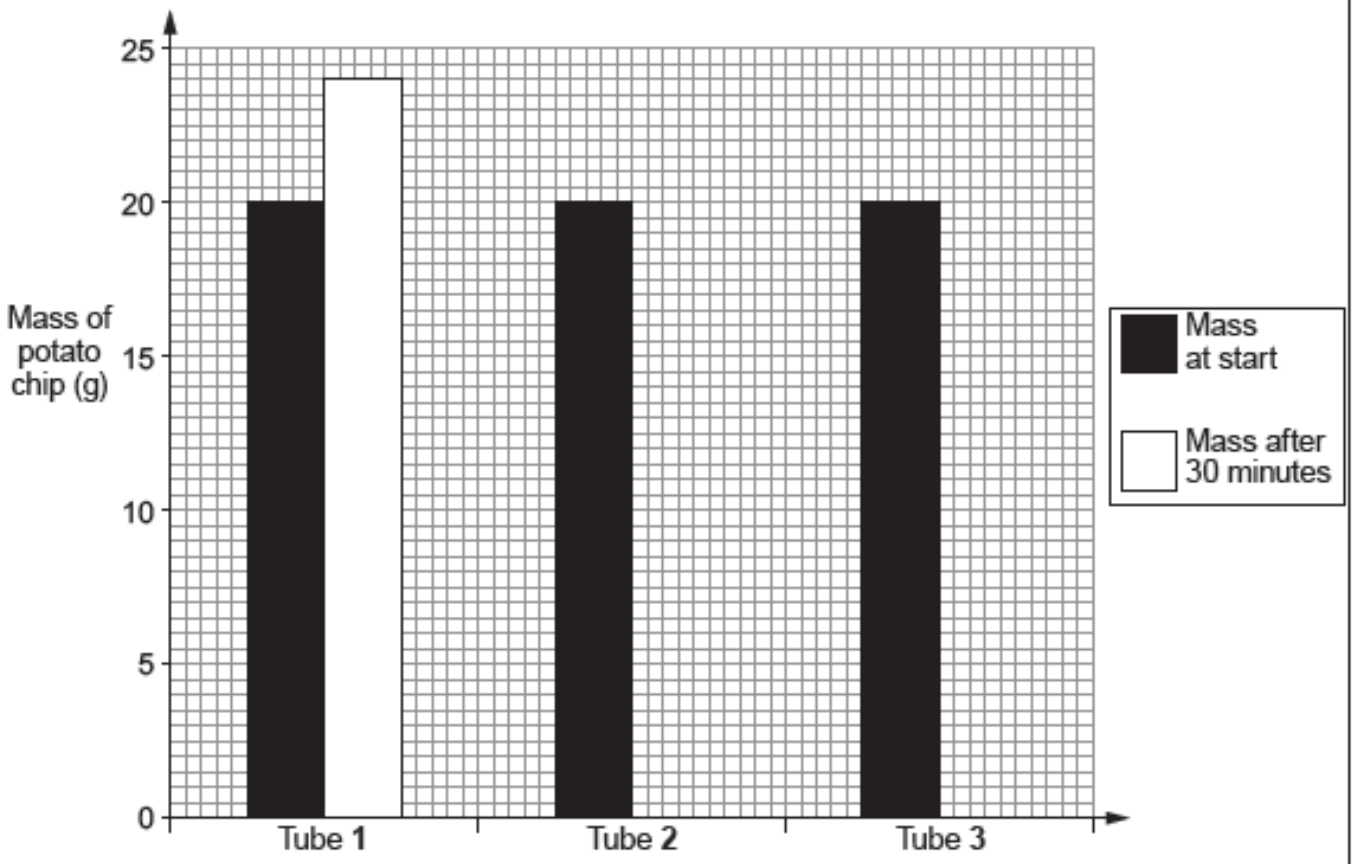


(i) State the number of the tube which contained the **lowest** concentration of **water**. [1]

.....

After 30 minutes they removed the potato chips and recorded the mass of each.

Tube	Mass of potato chips at start (g)	Mass of potato chips after 30 minutes (g)
1	.....	.....
2	.....	20
3	.....	15



(ii) Use the bar chart to **complete** the results table above. [1]

(iii) **Complete** the bar chart for tubes **2** and **3**. [1]

(iv) State the number of the tube in which the concentration of water in the chips was the **same** as that in the solution, giving a reason for your answer. [1]

Number of tube .....

Reason .....

.....

(v) Explain why the potato chip in tube **1** gained mass. [2]

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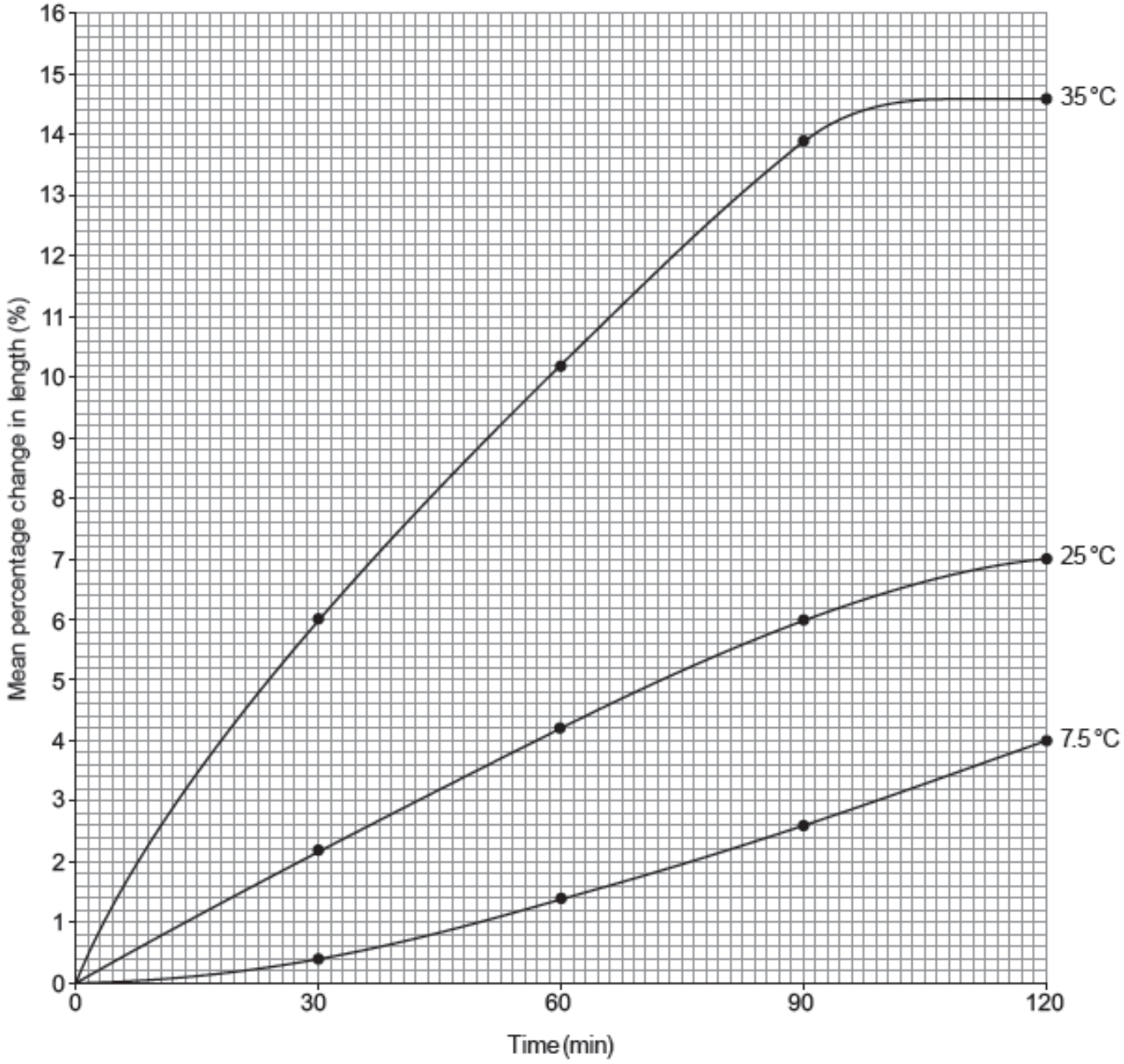
Jan 2015 Ht 2

10. Five identical cylinders of potato were placed in water at each of the following temperatures: 7.5 °C, 25 °C and 35 °C.
After 30 minutes, they were removed and the length of each cylinder measured. This was repeated every 30 minutes for 120 minutes.
The mean percentage change in length for the cylinders was plotted on the graph below.



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(a) Explain why the cylinders increased in length and name the process involved. [4]

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(b) Suggest why at 60 minutes the percentage increase in length of the cylinders at 35 °C is greater than the increase in length at 25 °C. [1]

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(c) The cylinders at 35 °C have reached their maximum length by 120 minutes. State how this length is maintained. [1]

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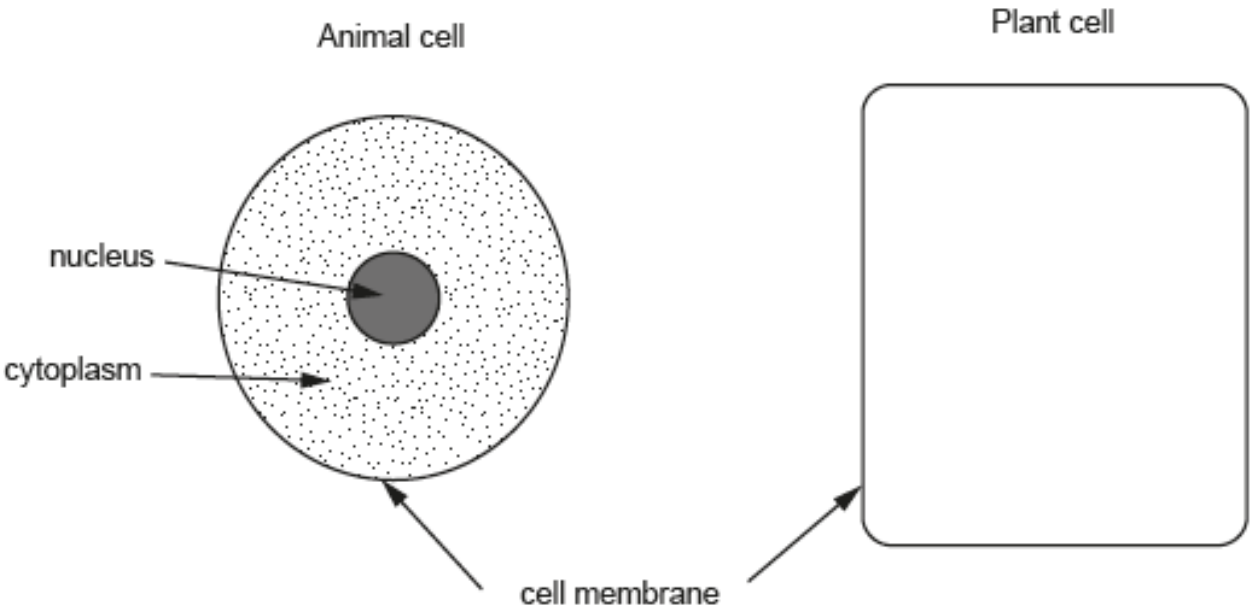
6

1. *(a)* (i) The diagrams below show an animal cell and the **cell membrane** of a plant cell. Complete the drawing of the plant cell. *No labels are required.* [2]



(ii) State the function of the cell membrane. [1]

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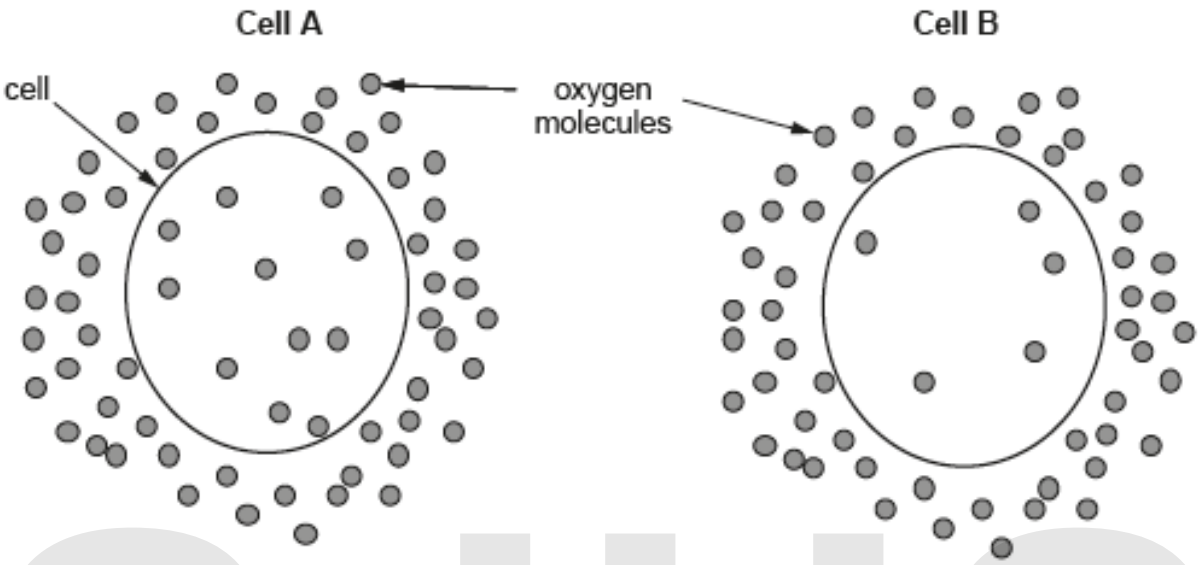
(b) The diagrams below show two cells which are carrying out respiration. Oxygen molecules are shown inside and outside both cells.



(i) Answer the following questions by placing a tick [✓] in the correct box. [3]

I. In cell **A** the oxygen molecules move:

into the cell ☐

out of the cell ☐

no net movement. ☐

II. In cell B the oxygen molecules move:

into the cell ☐

out of the cell ☐

no net movement. ☐

III. Into which cell could there be the greater net movement of oxygen:

cell **A** ☐

cell B? ☐

(ii) Name the process by which the oxygen molecules are moving. [1]

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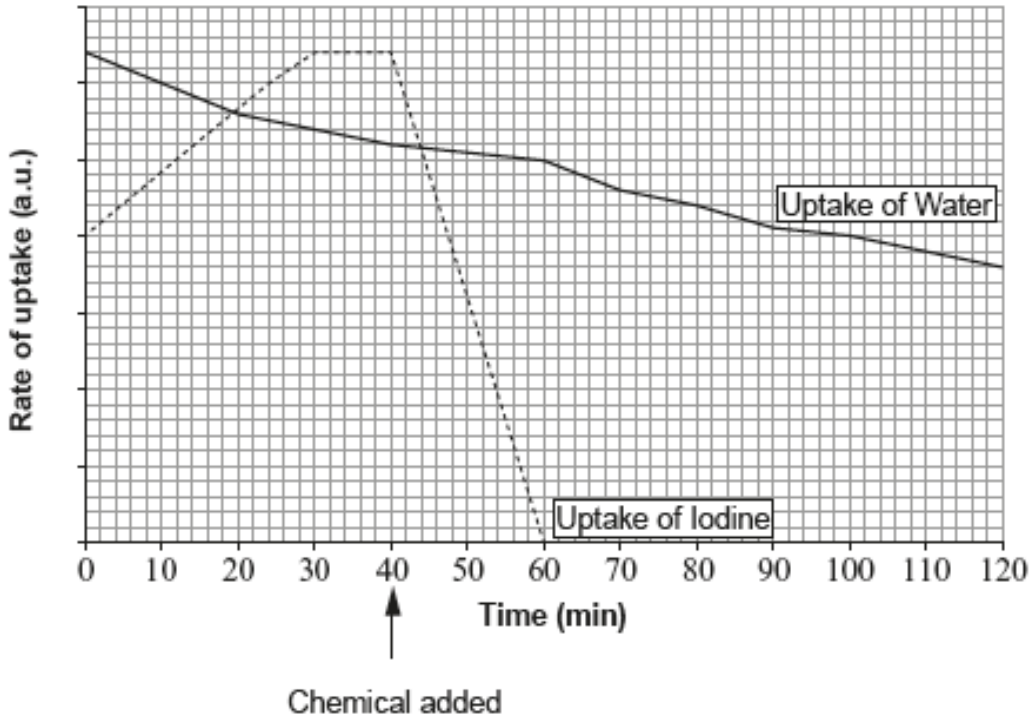
7. Kelp, *Laminaria digitata*, is an alga which lives in the sea.

The graph below shows the rate of uptake of water and iodine from sea water into kelp in a laboratory.



At forty minutes, a chemical was added to the sea water which stopped respiration taking place in the cells of the kelp.

(a) (i) Use the graph opposite to **describe** the effect of adding the chemical on the uptake of iodine **and** water. [3]

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(ii) **Explain** the effect of adding the chemical on the uptake of iodine. [3]

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(b) What process is responsible for the uptake of the water? [1]

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7

only

9. A student used red blood cells to carry out an investigation into cell membranes. Red blood cells were placed in salt solutions at three different concentrations. A sample of red blood cells was then removed from each concentration and placed on a microscope slide. The cells were viewed using a microscope for a period of time. The observations were recorded in a table:

concentration of salt solution (%)	observation of red blood cells
0.0	swell and burst
0.9	remain the same size
3.0	smaller and shrivelled

Explain the observations shown in the table. [6 QWC]

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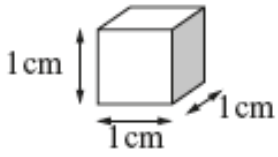
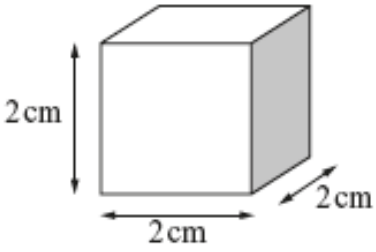
END OF PAPER

7. An investigation was carried out to find the effect of surface area: volume ratio on the rate of absorption in plants.
Cubes of potato were cut to the following sizes.



Surface area = $6\,cm^2$
Volume = $1\,cm^3$



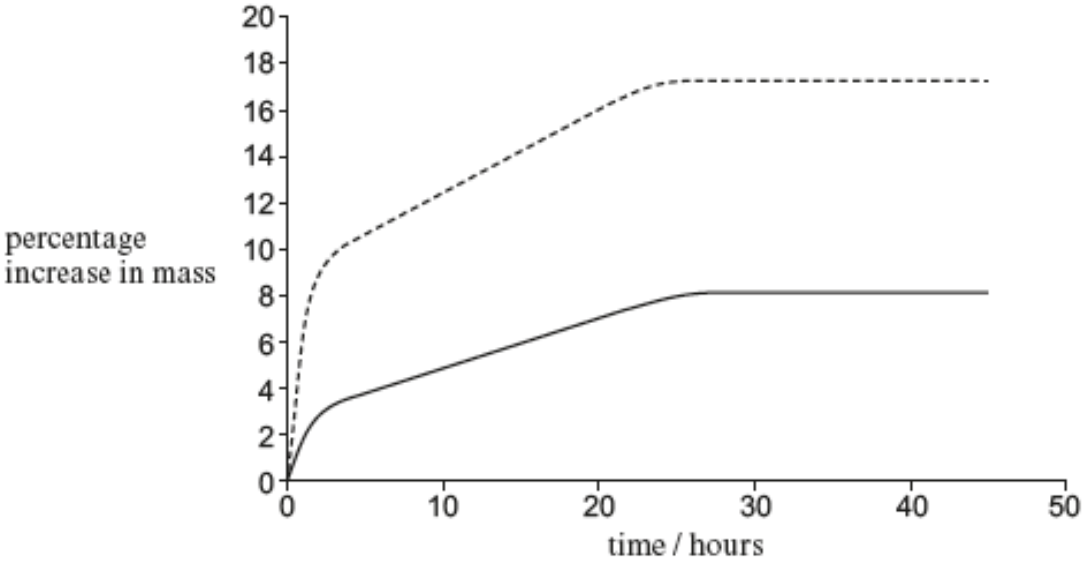
Surface area = $24\,cm^2$
Volume = $8\,cm^3$

The cubes were carefully blotted dry, weighed and their masses recorded.

One cube, 2 cm × 2 cm × 2 cm, was put into a beaker and completely covered with distilled water.

Eight cubes, each measuring 1 cm × 1 cm × 1 cm, were put into another beaker and completely covered with distilled water.

At regular intervals for a period of 45 hours, the cubes were removed from the beakers, blotted dry, reweighed and then replaced into fresh distilled water. The percentage increase in mass was measured for the eight cubes of side 1 cm and the one cube of side 2 cm. The results are shown in the graphs below.



key
---------- 8 cubes of side 1 cm × 1 cm × 1 cm
———— 1 cube of side 2 cm × 2 cm × 2 cm

only

(a) State why **eight** cubes of sides, 1 cm × 1 cm × 1 cm were used in this investigation. [1]

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(b) (i) Name the process which caused the cubes to gain mass. [1]

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(ii) Describe the process by which the cubes of potato gained mass. [3]

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(iii) Use the evidence gained by the investigation to describe the importance of root hairs in the absorption of water from the soil. [3]

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(c) Name the process by which mineral salts are absorbed into the roots of plants. [1]

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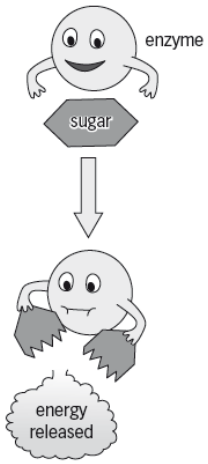
9

3. Respiration and the Respiratory System.



Respiration is the process where cells release energy from molecules like sugar. It occurs continuously in both plants and animals. It is controlled by enzymes. It can occur in two ways:

• aerobic – with oxygen

• anaerobic – without oxygen.

The energy is needed for all life processes. This enables organs and systems to function. E.g.

- It allows us to build new molecules like proteins.
- It allows muscle contraction.
- It maintains the body temperature.

Aerobic Respiration.

Aerobic respiration requires oxygen to release the energy from sugars like glucose.

• It is very efficient, releasing a lot of energy.

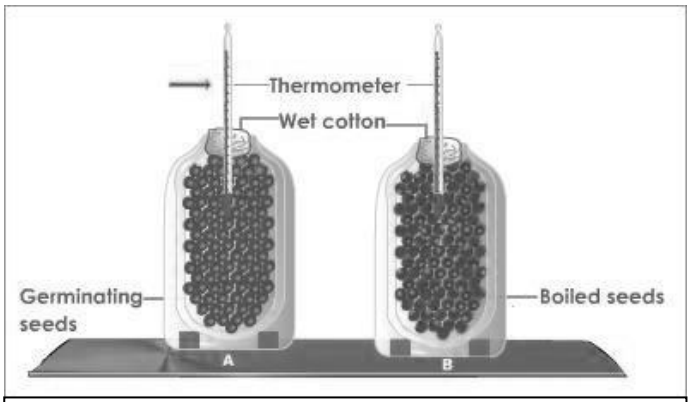
• It is a series of reactions of chemical reaction in the cell controlled by enzymes.

• The reactions of aerobic respiration occur mainly in tiny structures in the cell called mitochondria.

• During the reactions some of the energy is lost as heat to the surroundings.

The equation for aerobic respiration is:

glucose + oxygen → carbon dioxide + water (+ energy)



Respiring seeds release heat energy in a flask. The flask keeps the heat in and it can be measured. If the seeds are boiled then they will not respire and will not release heat. Seeds are washed in disinfectants to remove any microbes which might respire, and generate heat.

Anaerobic Respiration.

This type of respiration will only occur when there is not enough oxygen.

• It is less efficient at releasing energy than aerobic respiration, as less energy is released per molecule of glucose.

• This is because it is an incomplete breakdown of glucose.

• The reactions occur in the cytoplasm of cells.

• This will happen inhuman muscles during intense or sprinting activities.

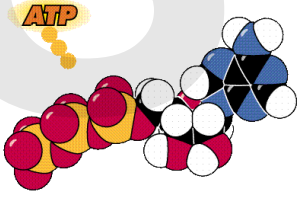
• The waste product is lactic acid.

Glucose → lactic acid (+ a little energy)

Lactic acid is toxic and it builds up in muscles during long periods of vigorous exercise, when the body cannot supply enough oxygen to the muscles. When it reaches high levels it causes the muscles to become fatigued. This means they will no longer contract efficiently. The blood flowing through the muscles will remove the lactic acid and takes it to the liver where it will be broken down. Oxygen is used to breakdown the lactic acid. The amount of oxygen used in this breakdown is called oxygen debt.

ATP (HT only)

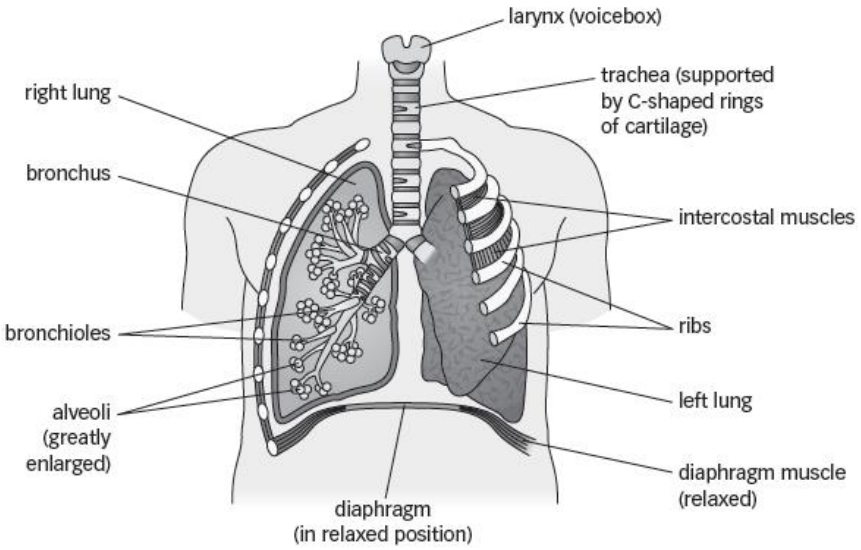
The energy released in both types of respiration is in the form of an energy rich chemical molecule called ATP. Anaerobic respiration is much less efficient than aerobic respiration because of the incomplete breakdown of glucose. Less ATP is produced per molecule of glucose in anaerobic respiration.



The Respiratory System in Humans.

The respiratory system allows oxygen into the blood for respiration and removes the waste gas carbon dioxide. Large animals need a respiratory system because their surface area to volume ratio is too small. This makes diffusion inefficient.

The lungs are located in the chest or thorax, surrounded by the rib cage. The ribs protect the lungs and are also used in the process of breathing. The thorax is separated from the abdomen by a muscular sheet called the diaphragm. This encloses the lungs in the thorax.



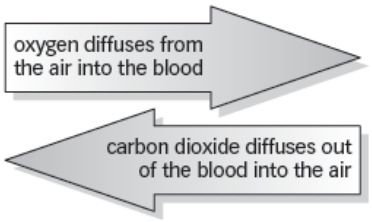
Into the lungs

Air gets into the lungs.

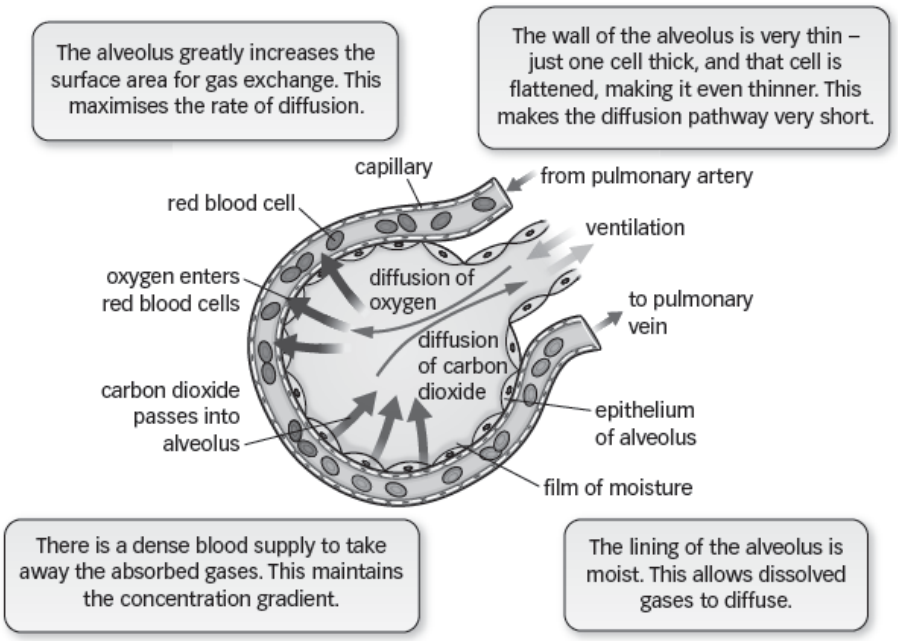
- Air moves in through the nasal cavity in the nose and mouth.
- It passes into a tube called the windpipe or trachea.
- The trachea branches into two tubes, each called a bronchus, one going to each lung.
- The bronchi divide into smaller and smaller tubes called bronchioles.
- Finally they end in small sacs called alveoli.

Gas Exchange

It is in the alveoli that gas exchange occurs. They are effective exchange surfaces. In the alveolus:



Air arrives in the alveolus from the bronchiole. Oxygen passes through the wall (epithelium) of the alveolus, and the wall (epithelium) of the capillary to pass into the red blood cell.



Ventilation.

Ventilation is the movement of air into (inhaling) and out of (exhaling) the lungs.

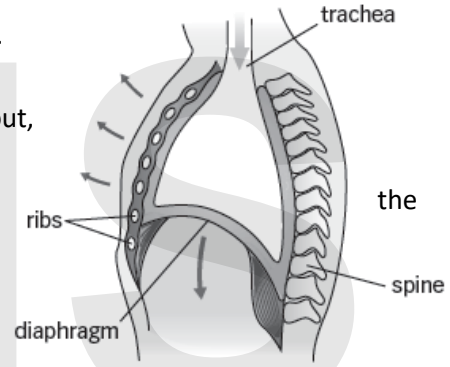
Breathing in – inhaling

1 The intercostal muscles between the ribs contract, lifting the rib cage up and out, expanding the thorax.

2 The diaphragm muscle contracts, flattening the diaphragm. This also expands the thorax.

3 The volume inside the lungs increases, and the pressure decreases.

4 Air rushes into the lungs due to the low pressure.



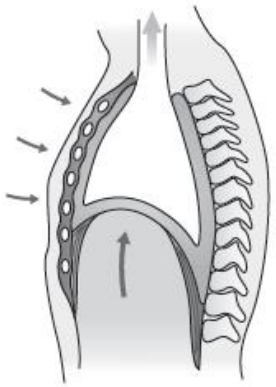
Breathing out – exhaling

1 The intercostal muscles relax, and the ribs move down and in, reducing the volume of the thorax.

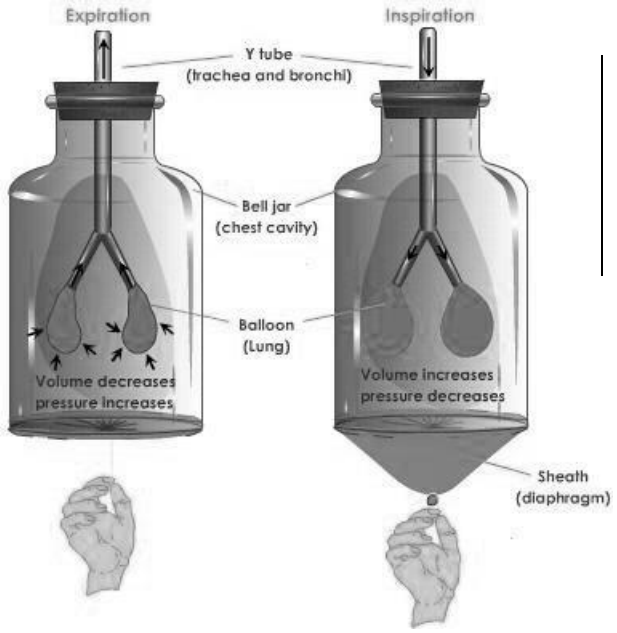
2 The diaphragm muscle relaxes, and arches up.

3 The volume inside the lungs decreases, which increases the pressure in the lungs.

4 The higher pressure forces air out of the lungs.



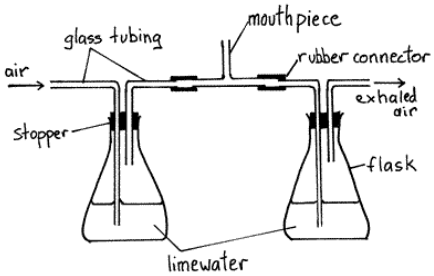
The Model Lung.



The Difference between Inhaled and Exhaled air.

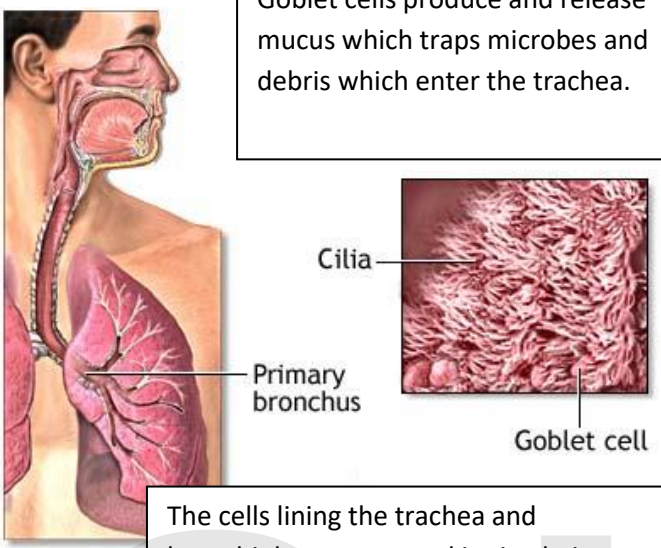
Gas	Inhaled air (%)	Exhaled air (%)
Nitrogen	**79**	**79**
Oxygen	**21**	**16**
Carbon dioxide	**0.04**	**4**
Water vapor	**Variable**	**Saturated**

Limewater is used to indicate the presence of carbon dioxide. If you bubble exhaled air through limewater it will turn milky.



Smoking and Health.

Goblet cells produce and release mucus which traps microbes and debris which enter the trachea.



The cells lining the trachea and bronchioles are covered in tiny hairs called cilia. These move in a wave like action and move microbes and debris to the throat where it can be swallowed.

The Effects of smoking.

Cigarette smoke causes paralysis of the cilia. Mucus and trapped particles stay in the lungs causing damage, irritation and disease. Cigarettes also contain nicotine which is addictive making it hard to give up smoking.

Emphysema.

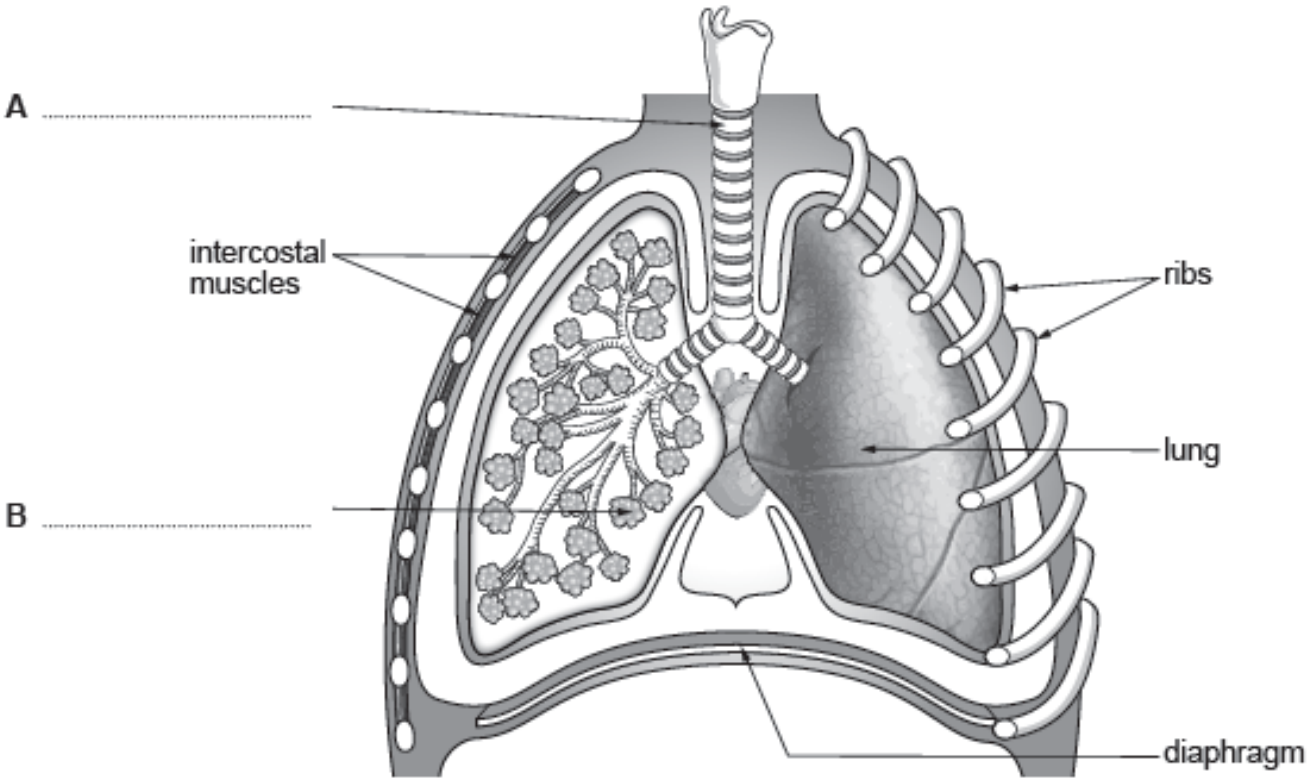
This is inflammation and damage to lung tissue, including the alveoli. It causes the alveoli to breakdown and then reduces the SA of the lungs making it difficult to breathe, causing a cough. It is caused by cigarette smoke destroying lung tissue

Lung Cancer.

This is caused by chemicals in smoke called carcinogens. This causes cells to divide forming tumours to grow in the lungs that can then spread to other parts of the body in the blood. Lung cancer is very difficult to treat and is often fatal.

only

2. The diagram shows a section through the chest of a human.



(a) Label **A** and **B** on the diagram above. [2]

(b) While a person is breathing in, the volume of the lungs increases.

(i) Describe the movements of the diaphragm and ribs as they bring about the increase in volume. [2]

Diaphragm .....

.....

Ribs .....

.....

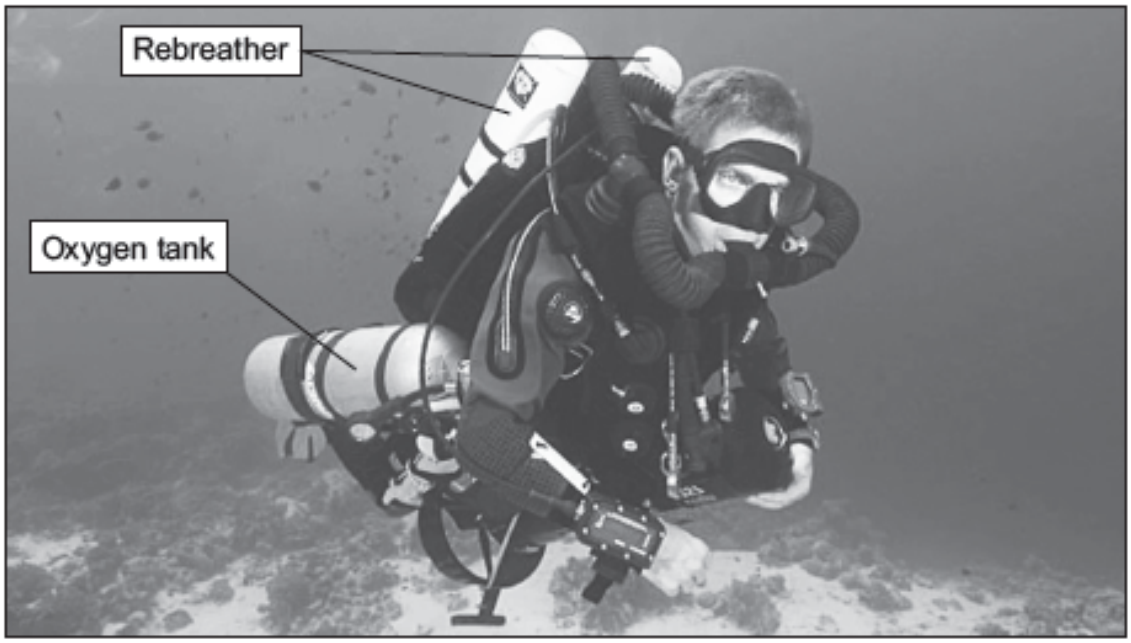
(ii) How does the *pressure* in the lungs change when the volume increases? [1]

.....

5

2. Look, no bubbles!

SCUBA diver wearing a rebreather



In standard SCUBA equipment when you breathe in through the mouthpiece you get a lungful of fresh air from the tank on your back. When you breathe out, the expired air goes out from the equipment into the water in the form of bubbles.

Modern SCUBA equipment contains a rebreather. This allows you to breathe the same air many times and produces no bubbles.

(a) (i) Complete the following table to show the composition of inspired and expired air. [2]

gas	inspired air (%)	expired air (%)
oxygen	.....	16
carbon dioxide	.....	4
nitrogen	79	.....
water vapour	varies	1

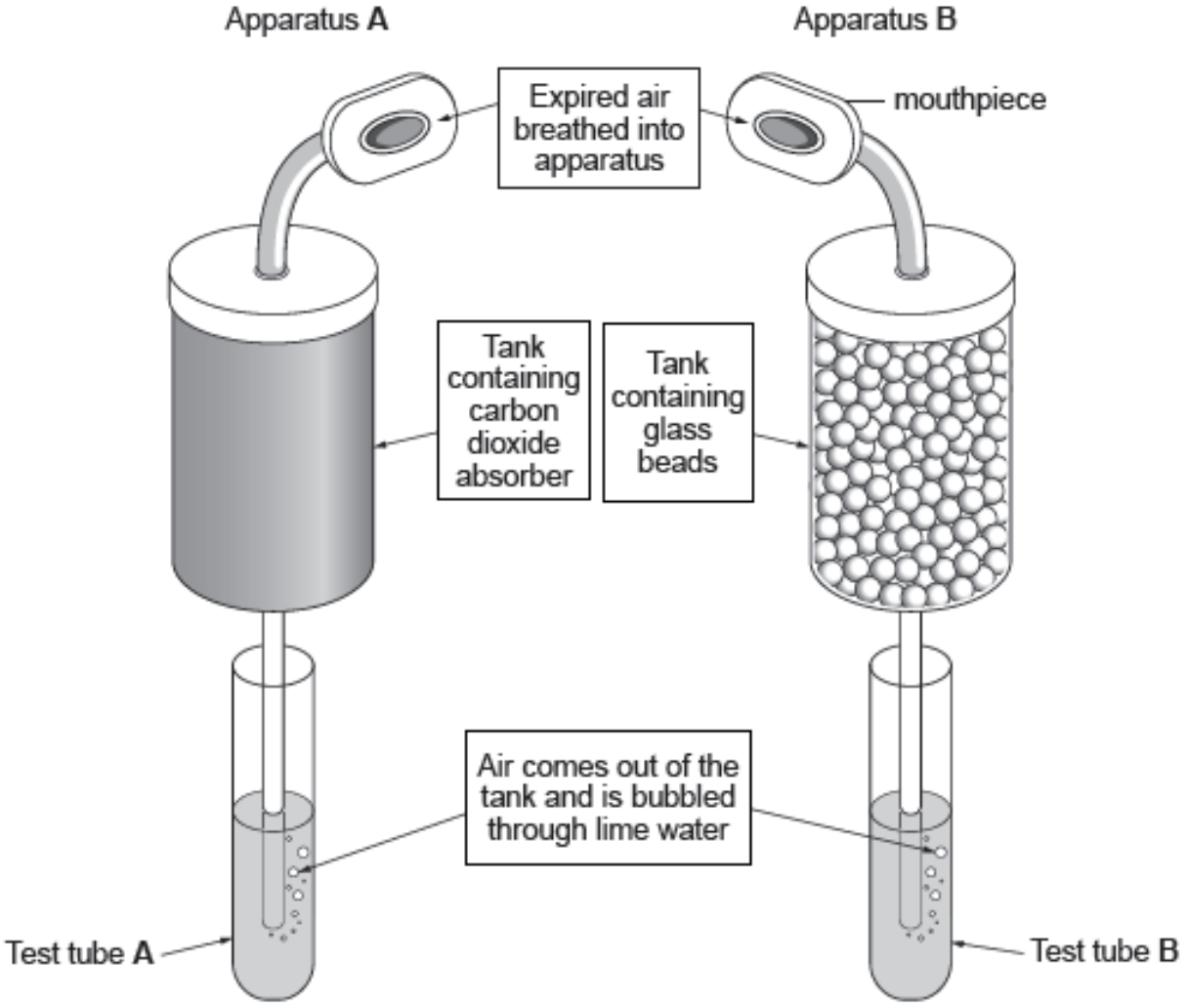
(ii) Use the table to state why it is possible for a diver to use a rebreather. [1]

.....

(iii) Expired air contains 4% carbon dioxide. This concentration of carbon dioxide in air is poisonous. Rebreathers also contain a tank which absorbs the carbon dioxide making the air rebreathable for the diver.
Suggest the name of the chemical compound which absorbs the carbon dioxide. [1]

.....

A scientist tested the air coming out of the tank using apparatus **A** and **B** as shown below.



(b) What result would you expect to see in test tubes **A** and **B** after bubbling the expired air through lime water for 2 minutes? [2]

Test tube **A**

.....

Test tube **B**

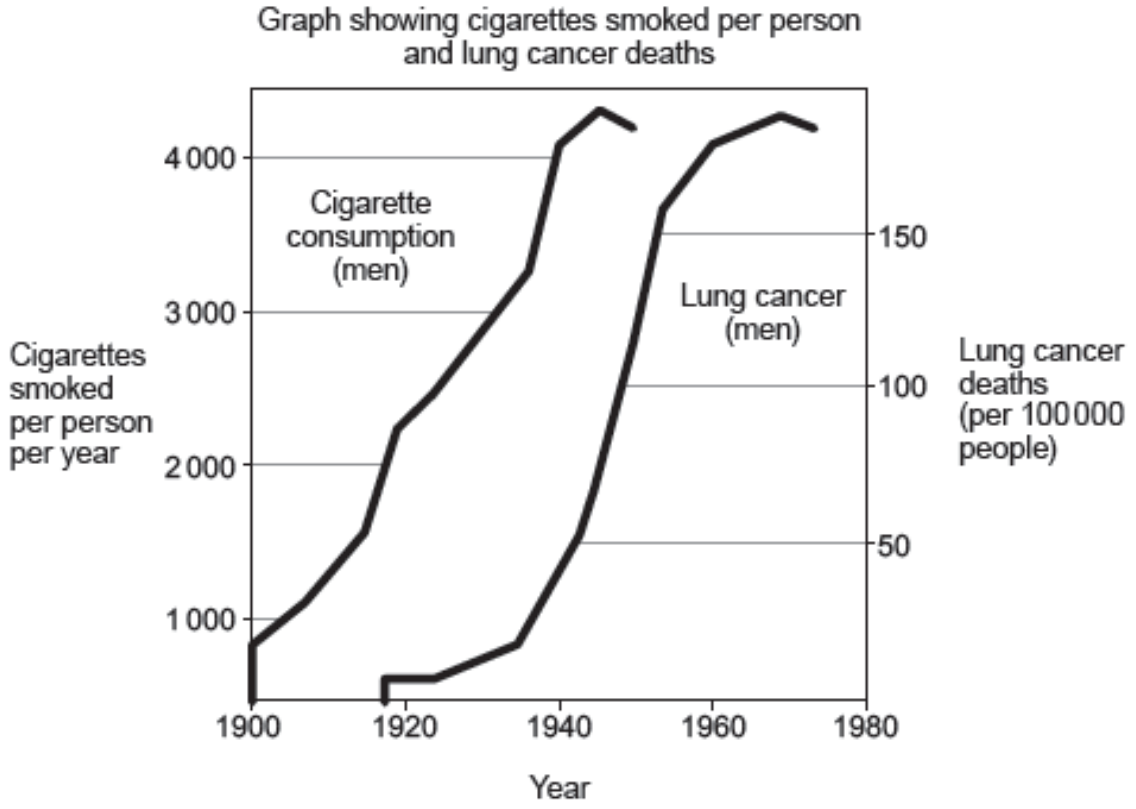
.....

(c) Apart from not producing any bubbles, suggest **one** *other* advantage to a diver using a rebreather. [1]

.....

only

3. The major rise in cigarette smoking amongst the UK population occurred at the start of the 20th century.



(a) From the graph, describe fully the relationship between cigarette smoking and lung cancer deaths in men. [2]

.....

.....

.....

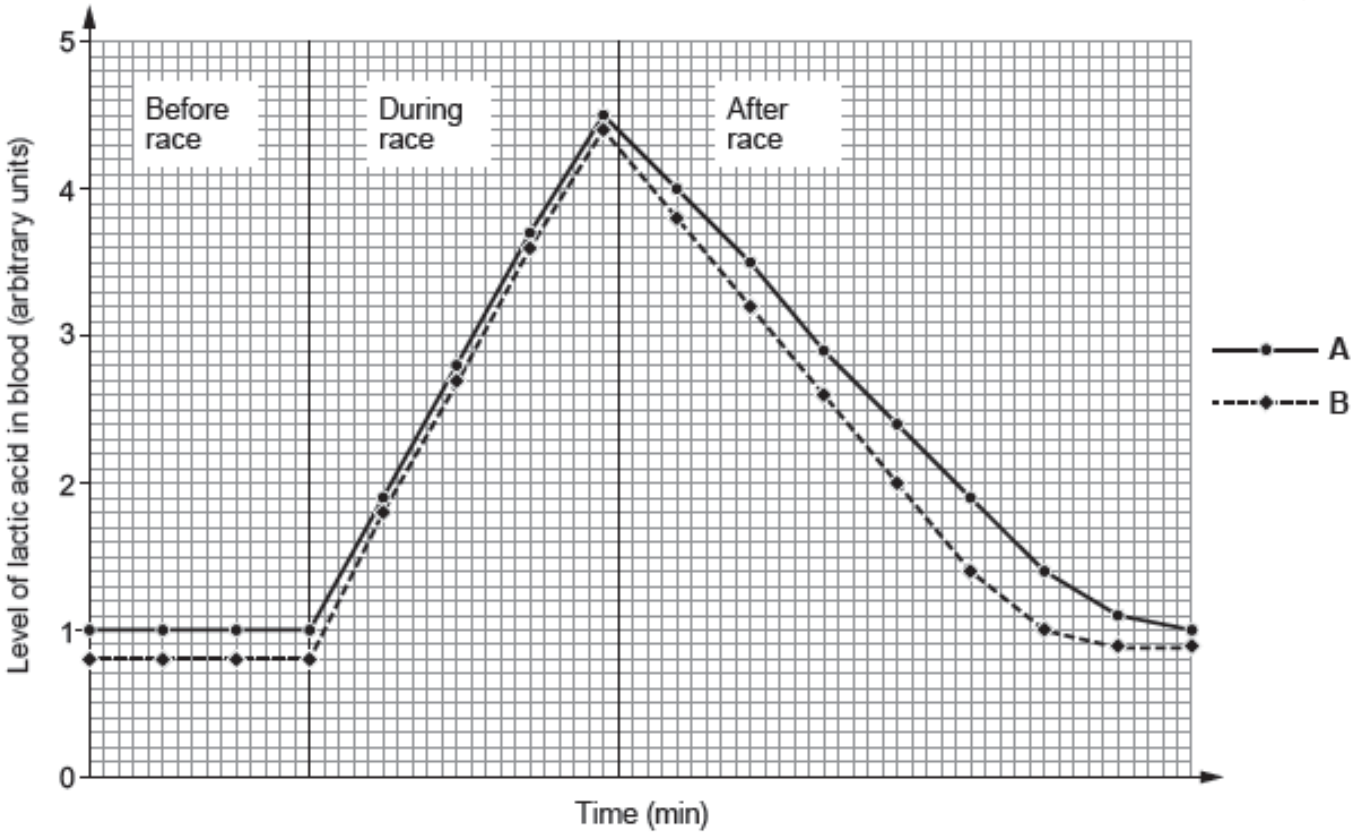
(b) The link between smoking and lung cancer was first made by Sir Richard Doll, Professor of Medicine at the University of Oxford. Use the information in the graph to suggest when he first made the public aware of the link between cigarette smoking and lung cancer. [1]

.....

3

Examiner only

9. The concentration of lactic acid in the blood of an athlete was measured before, during and after a race.
The athlete then followed a two week period of increased regular exercise to improve fitness.
The lactic acid measurements were then repeated, as before, for a race of the same distance.
The graph shows the results.



(a) Give reasons why line B shows evidence that it represents the results **after** the two week period of exercise. [2]

.....

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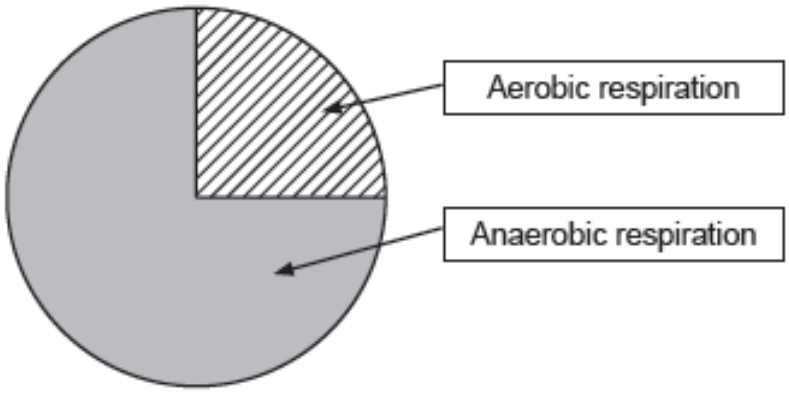
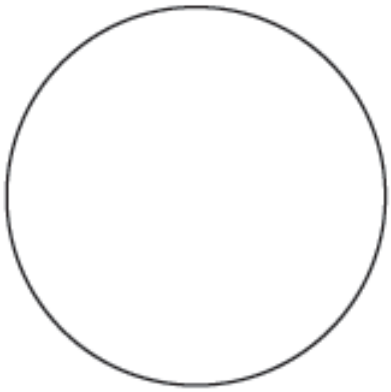
(b) The pie chart below shows the proportions of aerobic respiration and anaerobic respiration taking place in an athlete during a 100 m race.



(i) State the proportions as a ratio. [1]

..... anaerobic respiration : ..... aerobic respiration

(ii) Complete a pie chart, in the circle below, to suggest the expected proportions of aerobic and anaerobic respiration in an athlete during a **1500 m race**. Use the same key as above. [1]



(c) Why is aerobic respiration more efficient than anaerobic respiration? [2]

.....

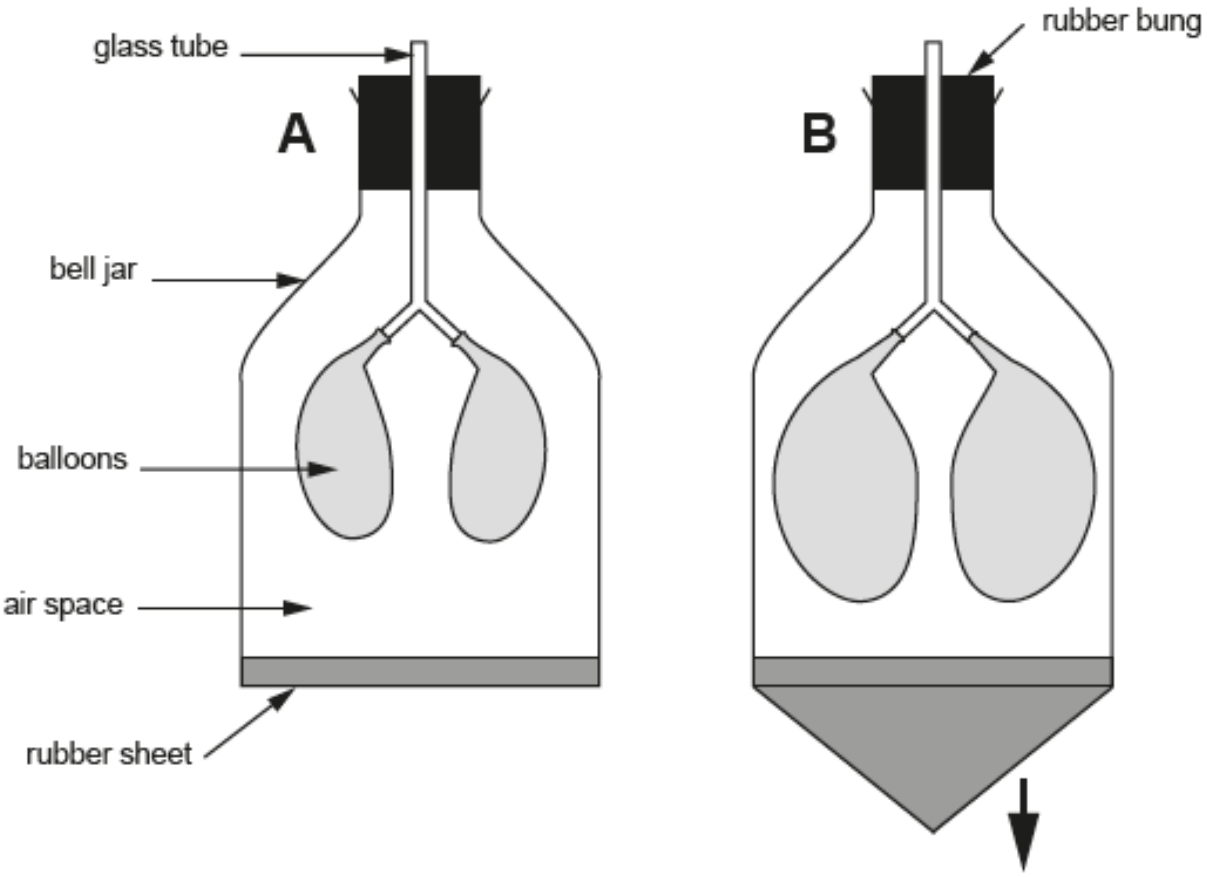
.....

.....

6

only

2. The model below represents the human thorax (chest) during expiration and inspiration.



(a) Complete the following sentences by using one of the following choices. [4]

the same **greater** **less**

(i) Compared to diagram **A**, the 'lung' volume in diagram B is ..... .

(ii) Compared to diagram **A**, the 'lung' pressure in diagram B is ..... .

(iii) Compared to diagram **A**, the 'thoracic' volume in diagram B is ..... .

(iv) Compared to diagram **A**, the 'thoracic' pressure in diagram B is ..... .

(b) Give reasons why the bell jar model above is not a true representation of the human thorax. [2]

.....

.....

.....

6

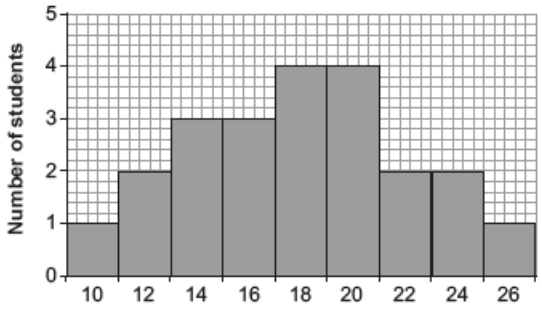
(b) An athlete ran a 100 m race. The table below shows events which occurred in her body from the start of the race to the end of the recovery period after the race.
The events below are given letters but are NOT in the correct order in which they occurred.

A She breathes oxygen rapidly and respires aerobically.
B Her oxygen debt is repaid.
C Her muscles ache.
D Lactic acid is produced.
E She begins anaerobic respiration in her muscles.
F She breathes slowly and respires aerobically.

Arrange the events above in the correct order in which they occurred by writing the correct letter in the appropriate box in the table below.
One has been done for you. [4]

order of events	letter
1st	F
2nd	
3rd	
4th	
5th	
6th	

(c) Some year 11 students had their rates of breathing measured before and after running on the spot for three minutes.
The following bar chart shows the increase in breathing rates of the students after they had finished running.



Number of extra breaths per min after running on the spot for 3 minutes

(i) How many students had their breathing rates measured? [1]

.....

(ii) The average breathing rate for a physically fit year 11 student is 18 breaths per minute at rest. This rises to 36 breaths per minute after running on the spot for three minutes.
Scientists consider that physically fit year 11 students take a maximum of 18 extra breaths per minute after running on the spot for three minutes.
Use the bar chart to calculate how many of the students may be physically **unfit**.[1]

..... students

9

4. Food

We need food for three reasons: for growth and repair; for energy; to remain healthy. Food contains different chemical groups, each needed for a reason. ***Balanced diets*** contain the correct amount of each chemical group.

Chemical group.	Source	Why needed	Concerns and health problems
Carbohydrates Simple sugars e.g. glucose Complex sugars e.g. starch	Sweets, rice, bread etc.	Main source of energy.	Overeating can lead to obesity, heart disease, type II diabetes. If left on teeth can cause tooth decay.
Fats Made from fatty acids and glycerol	Cheese, milk, fried food etc.	Energy, insulation and protection.	Overeating can lead to obesity. Cholesterol can be deposited in blood vessels leading to heart disease and strokes.
Proteins Made from amino acids	Meat, cheese nuts etc.	Growth of bone and muscle.	Lack of protein can lead to poor muscle development and growth.
Vitamins & Minerals e.g. Vit C and Iron	Fresh foods, e.g. fruit and veg.	To keep the body healthy, e.g. Vit. C stops scurvy.	Lack of these leads to deficiency diseases such as scurvy or anaemia (as iron is needed to make haemoglobin).
Fibre	Whole grains and vegetables	Provides bulk in the digestive system.	Alack of fibre means food is not pushed along the digestive system efficiently so this leads to constipation.
Water	From drinks and in food	Needed for many body functions and processes	A lack of water leads to dehydration.

Knowing what's in Food.

You need to be able to interpret tables of data and good examples of this could be found on food packaging. When you do this you need to:

- You need to identify the correct piece of data for the question.
- Remember to link your scientific knowledge about foods to the data.
- Look for relationships between the data and scientific theory.
- Look for unusual or stand out data, which might be very high or low.

Energy in food

You should know how to measure the energy in food by burning the food. The heat released is used to heat water. The temperature rise is measured and can be used to calculate the energy content. You may be asked to do this using a formula, but you will not be expected to remember it, just substitute in the figures.

$$\text{Energy in 1g of food} = \frac{\text{volume water heated } (cm^3) \times \text{rise in temperature } (^oC) \times 4.2}{\text{Mass of food (g)}}$$

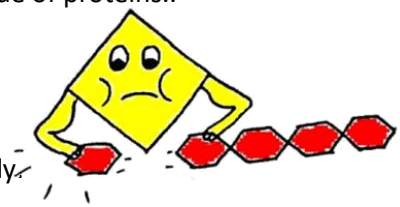
Obesity.

Obesity can result from excess energy intake which is stored in fat. It results from a combination of an unhealthy diet and a lack of exercise. It can cause heart disease, some cancers, high blood pressure and type II diabetes. (NOT TYPE I DIABETES). Excess salt in food can also lead to high blood pressure.

Digestion and the Digestive System.

During digestion large molecules need to be broken down into smaller molecules, so that they can be absorbed for use by the body's cells. Much of this breakdown is carried out by enzymes, which are made of proteins..

Enzymes.



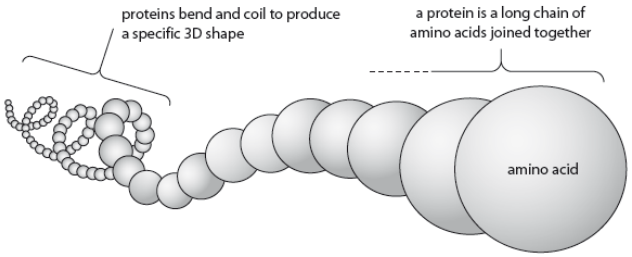
Enzymes are biological catalysts which speed up the rate of chemical reactions in the body.

- They are made of proteins.
- Without them the reactions of the body would be too slow for us to survive.
- The molecule that the enzyme works on is called the substrate.
- They can:
  - break down large molecules into small ones, for example in digestion
  - build large molecules from small one, for example in photosynthesis.

All enzymes names end in the letters –**ase**. Enzymes are named after the molecule on which they act (called the substrate). E.g. Carbohydrase ~ are enzymes which breakdown carbohydrates.

Different Enzymes are Different Proteins (HT only).

Proteins are one of the major molecule groups which make up living things.

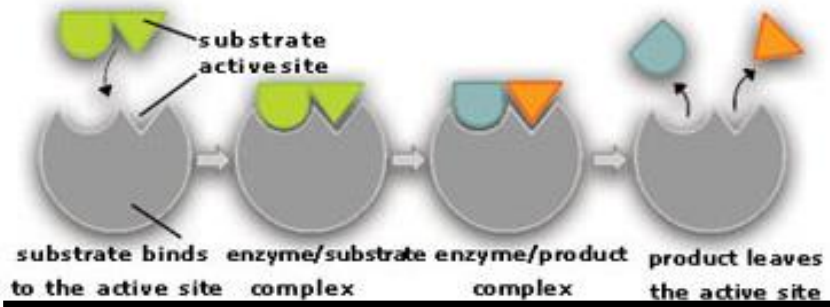


- **They are built of amino acids.**
- **The amino acids are linked together in long chains.**
- **The chains are folded to give a specific shape.**
- **The shape is important for their function.**
- **The shape allows other molecules to fit into them.**
- **If the sequence of amino acids is changed the shape of the protein will change.**

Proteins have many functions in living things, each protein does one job so there are many different proteins. Three important functions are, enzymes, hormones and muscle tissue.

How enzymes work

The shape of the enzyme is vital for its function. The shape has an area into which substrate molecules can fit. This area is called the ***active site***. The key to the function of the enzyme is that the active site shape is complementary to the substrate shape. This is not the same shape, but the two will fit together, like a key fits into a lock. This is called the ***lock and key hypothesis***. No other substrate molecule will fit, which makes them specific. The substrate collides with the enzyme and fits into the active site. The reaction occurs and the products are released.



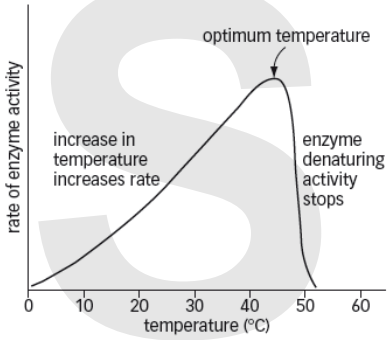
(HT only) When an enzyme binds to a substrate, an enzyme substrate complex is formed.

What makes enzymes work best?

The way enzymes work is affected by the temperature and the pH.

<u>Temperature</u>

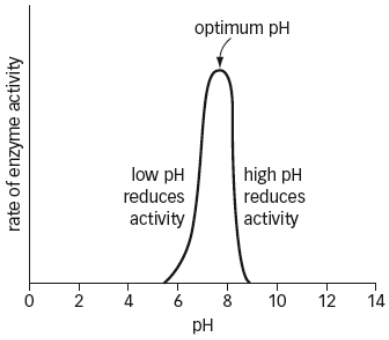
- As the temperature increases, the rate of reaction will increase.



- This is because the temperature causes the enzyme and substrate to move more and bump into each other more often.
- This will not continue forever.
- Eventually the rate reaches a peak called the optimum temperature.
- Above the optimum, the increase in temperature starts to damage the shape of the enzyme.
  - It cannot then work.
  - The enzyme is said to be denatured. (boiling will denature most enzymes)

pH

- Each enzyme has an optimum pH.
  - Here it works best.
- Above or below this level it does not work so well.
  - This is because the shape of the enzyme active site is damaged.
- It is denatured.



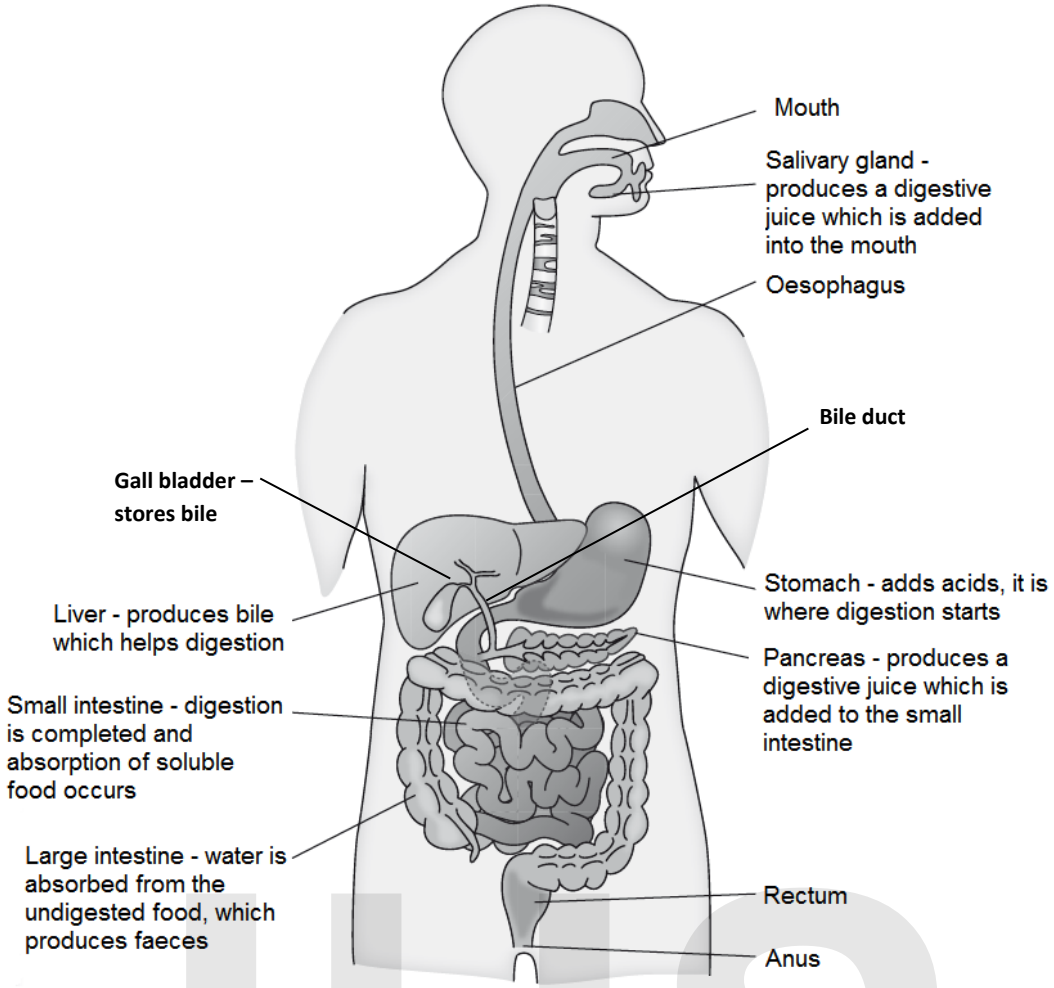
Uses of Enzymes.

Enzymes are used in biological washing powders to remove stains from textiles. Lipases, proteases and carbohydrases breakdown food stains at lower temperatures, requiring less energy.

Digestion.

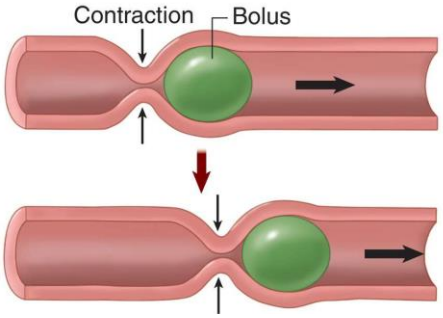
Digestion is the breakdown of large insoluble molecules into small soluble molecules, so that they can be absorbed. It occurs in a tube in the body called the alimentary canal.

Enzymes bring about digestion. Bile is produced in the liver is stored in the gall bladder and trickles into the small intestine. Bile breaks fats into droplets (emulsifies). This provides a larger surface area for enzymes to act on. It also increases the pH of the small intestine to the optimum pH for lipase activity.



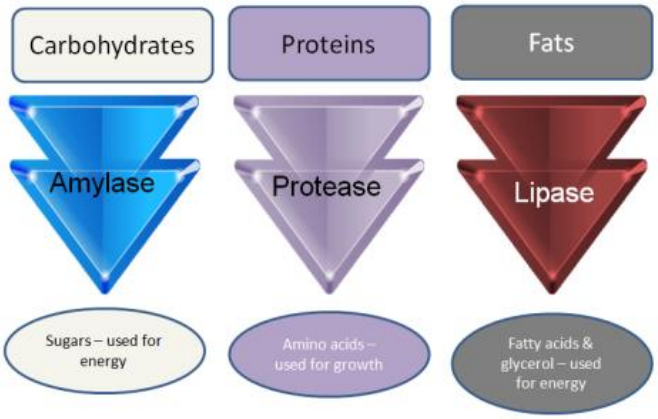
Peristalsis

Food is moved through the tube by a wave of muscle contractions in the wall of the tube, behind the food (bolus). This is called peristalsis.



Digestion and Enzymes

Gland where enzymes produced	Enzymes released	Reactions occurring
salivary gland	**amylase**	starch → sugars
wall of stomach	**protease**	proteins → amino acids
pancreas and small intestine	amylase	starch → sugars
	protease	proteins → amino acids
	lipase	lipids → fatty acids and glycerol (fats and oils)



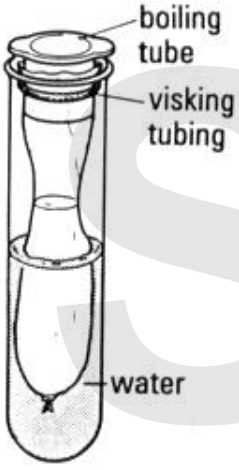
Food Tests.

Food Group	Test	Result
Starch (a carbohydrate)	Add iodine solution.	Turns from brown to **blue/black**.
Glucose	Add Benedict's solution and place in boiling water for 2 minutes.	Turns from blue depending on the amount glucose~ Green – small amount Yellow – medium amount Orange/red – lots of glucose
Protein	Add Biuret A and then Biuret B	Produces a lilac colour.

Absorption

Once the food molecules have been digested they are absorbed into the bloodstream. This happens by diffusion through the wall of the small intestine.

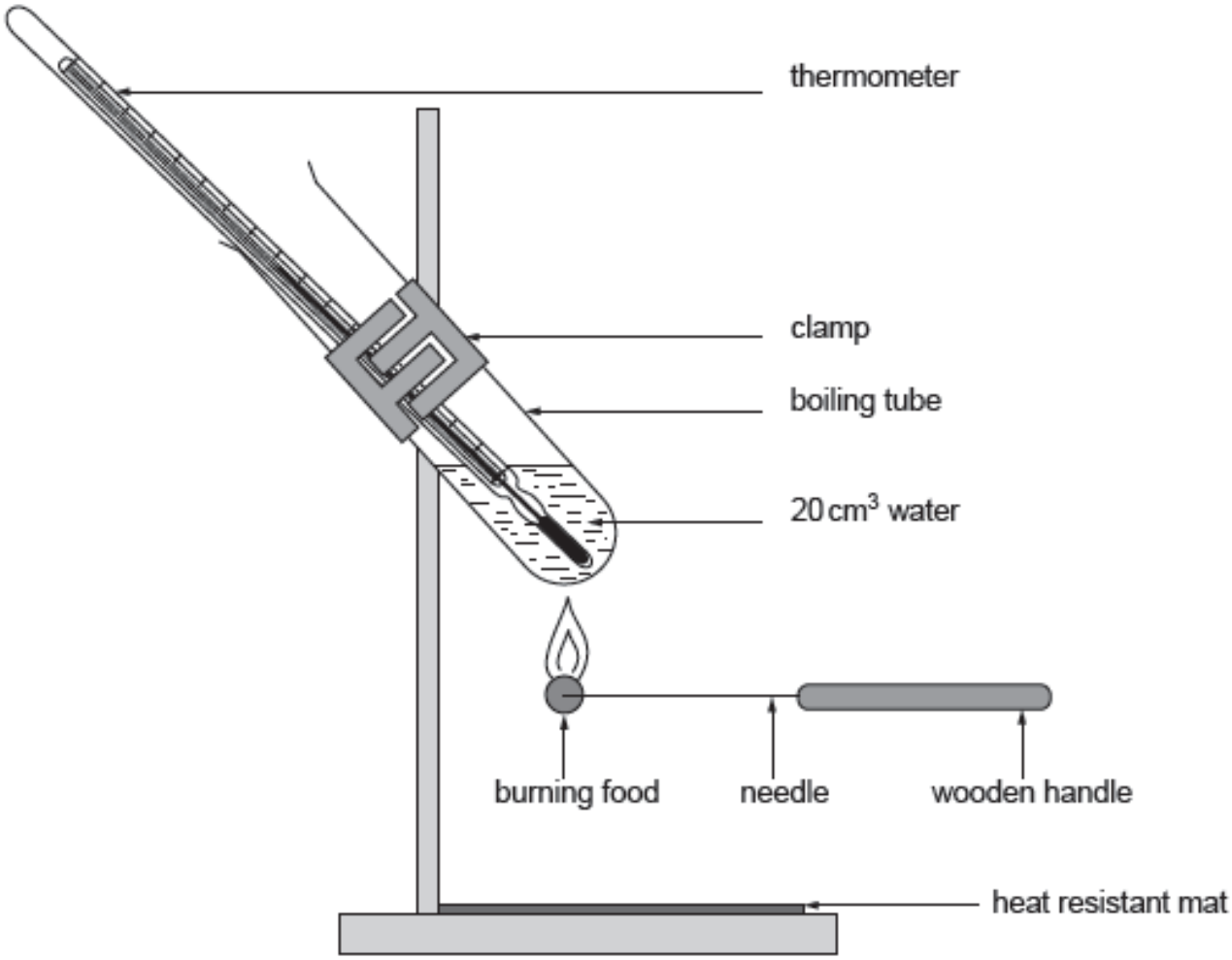
The Model Gut.



The visking tubing represents the gut. The visking tubing bag contains enzymes and substrate (e.g. starch and amylase). The starch will be digested into sugars. The sugars will pass through the visiking tubing. This mimics the process of absorption. The water represents the blood.

We can test either water or the contents of the tube using the tests above. Over time we should notice that the starch will reduce inside the tube, and the sugar increases. Also the sugar will start to appear in the water, because it is small enough to be absorbed.

2. Rhys used the apparatus shown below to find the energy in a piece of food.



(a) The first time Rhys carried out the experiment he obtained the following results.

initial temperature of water (°C)	final temperature of water (°C)
19	35

(i) Use the formula below to calculate the energy content of this piece of food. Show your working. [2]

Energy content (J)= rise in temperature (°C) x volume of water (cm^3) x 4.2

Energy content ..... J

(ii) The mass of this piece of food was 0.2 g. Calculate the energy content of 1 g of this food. [1]

Energy content ..... J

Rhys repeated the experiment and obtained the following results.

repeat	energy content of food (J/g)
1	5049
2	7260
3	6800
4	4896
5	5724

(b) Suggest **three** possible reasons why the measured energy content in J/g of the food differed each time Rhys carried out the experiment. [3]

(i) .....

.....

(ii) .....

.....

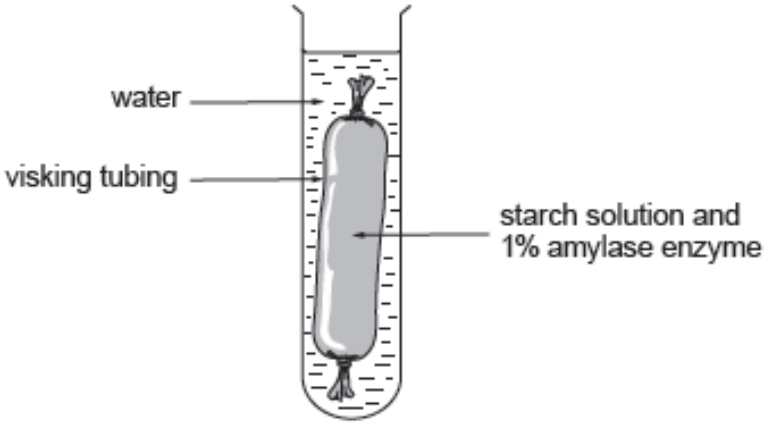
(iii) .....

.....

6

only

4. An experiment was set up using visking tubing as a model gut. This is shown in the following diagram. The visking tubing was filled with a starch solution and 1% amylase enzyme. After 30 minutes the water surrounding the visking tubing was tested and found to contain glucose but no starch.



Explain why glucose appeared in the water surrounding the visking tubing but no starch was found. Include in your account a description of how the water was tested for glucose using Benedict's solution and for starch using iodine solution giving the expected observations.

[6 QWC]

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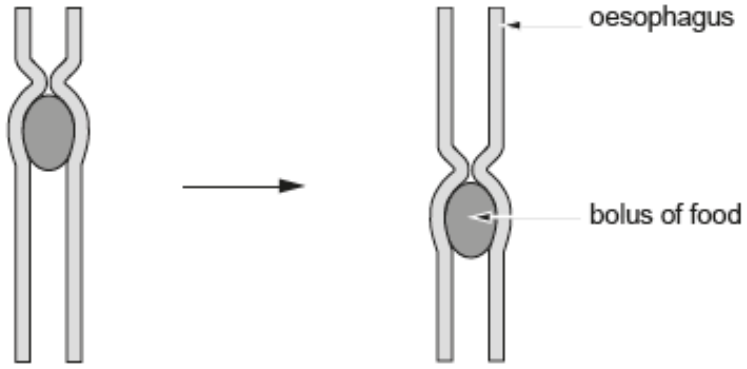
4. The diagram below shows some food passing through part of the human digestive system.



(a) (i) Name the process by which the food is moved. [1]

.....

(ii) Food passes through different parts of the digestive system.
Which letter, **A**, **B**, **C** or **D** shows the correct order? [1]

A stomach → oesophagus → large intestine → small intestine

B oesophagus → stomach → small intestine → large intestine

C stomach → small intestine → large intestine → oesophagus

D oesophagus → small intestine → stomach → large intestine

Answer .....

(b) Complete the table below about the digestion of food. [3]

food	enzyme	digested food
.....	carbohydrase	glucose
fat	.....	fatty acids and .....

(c) State a function of the *large* intestine. [1]

.....

6

5. *(a)* Complete the sentence below. [2]

Enzymes, which are made of ..... , control the rate of

..... reactions in living cells.

(b) Students investigated the activity of the enzyme amylase, at different pH values. They used the same volumes of solutions and the same time at each pH.

Results of investigation

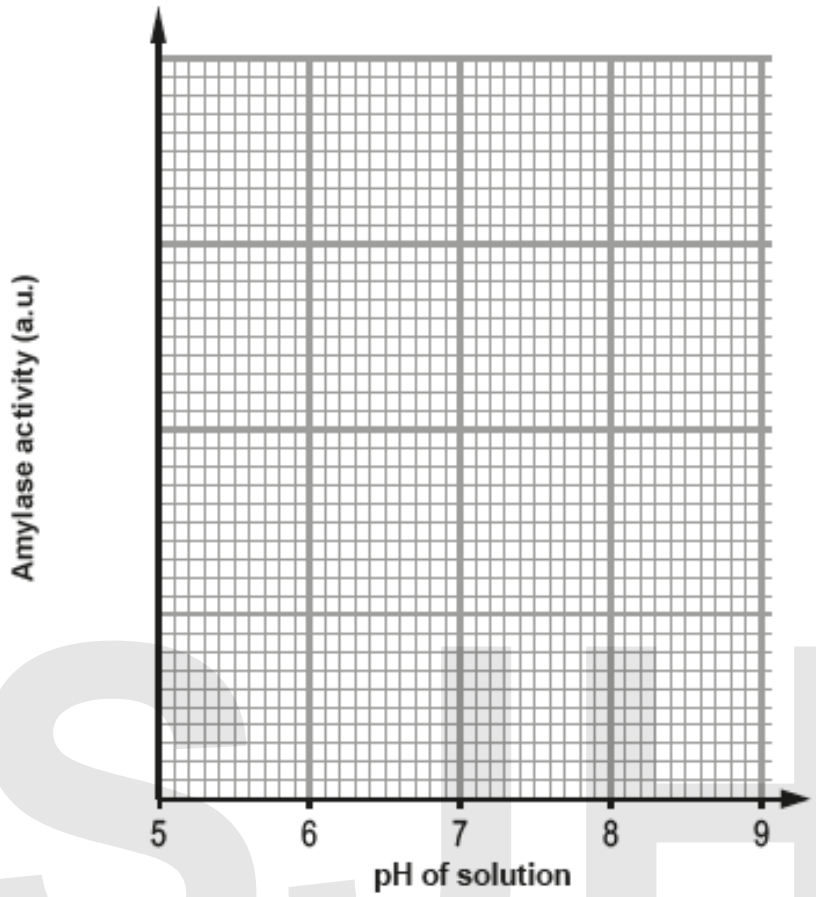
pH of solution	amylase activity (a.u.)
6.0	18
6.5	27
7.0	52
7.5	66
8.0	50
8.5	21

(i) Draw a line graph of the results of the investigation on the grid below by [4]

I. choosing a suitable scale for the amylase activity;

II. plotting the results onto the grid;

III. joining your plots with a ruler.



Examiner only

(ii) I. From the graph opposite, describe in detail the effect of pH on the activity of amylase. [2]

.....

.....

.....

II. Calculate the difference in activity of amylase between pH 6.2 and pH 7. Show your working. [2]

Answer ..... a.u.

(iii) The students did not keep the temperature constant during their investigation. Why did this prevent their investigation from being a fair test? [1]

.....

.....

(c) Biological washing powders contain enzymes and are often used in the home. Explain the advantage of these powders. [2]

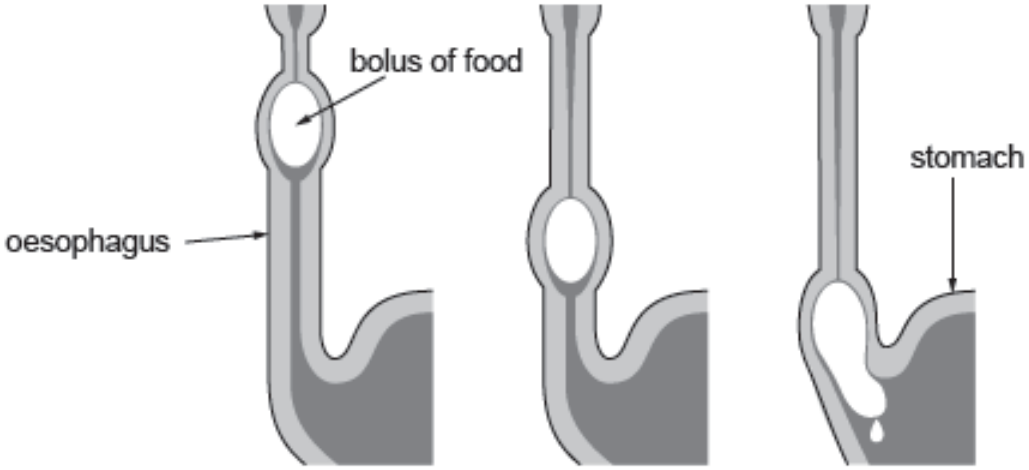
.....

.....

.....

13

5. The diagram shows a process occurring in the human digestive system.



(a) (i) Name the process shown in the diagram. [1]

.....

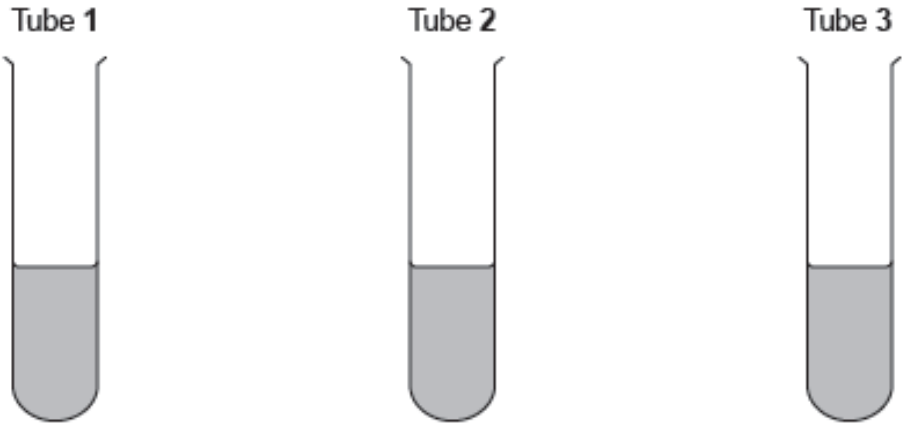
(ii) Explain how the bolus of food is moved along the oesophagus. [2]

.....

.....

.....

The apparatus shown below was used to investigate the effect of washing-up liquid (detergent) on the digestion of fat by lipase.



Contents Tube 1	Contents Tube 2	Contents Tube 3
full fat milk ($50\,cm^3$)	full fat milk ($50\,cm^3$)	full fat milk ($50\,cm^3$)
washing-up liquid ($5\,cm^3$)	water ($5\,cm^3$)	washing-up liquid ($5\,cm^3$)
water ($5\,cm^3$)	2% boiled lipase solution ($5\,cm^3$)	2% lipase solution ($5\,cm^3$)

The 3 tubes were left at 20 °C for 60 minutes and the pH of the contents of each tube was measured every 15 minutes. The results are shown in the table below.

	pH		
Time (minutes)	Tube 1	Tube 2	Tube 3
0 (start)	8.5	6.7	8.5
15	8.5	6.7	7.4
30	8.5	6.7	6.6
45	8.5	6.7	6.3
60	8.5	6.7	5.9

(b) Explain the results for Tube 3. [3]

.....

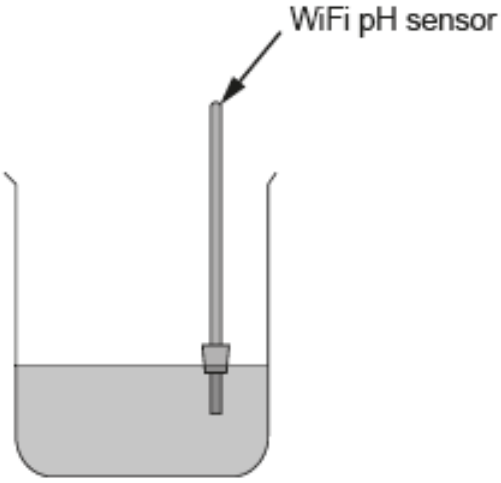
.....

.....

.....

6

5. An experiment was set up to investigate the digestion of fat in milk by lipase. The following apparatus was used.



Beaker containing milk and lipase

Laptop with pH readout from WiFi pH sensor

The beaker containing milk and lipase was kept at a constant temperature in a water bath.
The pH readout on the laptop was recorded every 5 minutes for 40 minutes.
The results are shown below.

time (minutes)	pH
0	9.1
5	8.9
10	8.8
15	8.7
20	8.6
25	7.5
30	7.0
35	6.4
40	5.9

(a) Explain why the pH changed during the experiment. [2]

.....

.....

.....

only

(b) (i) The average rate of fall in pH in the first 20 minutes is 0.025 pH units per minute. After 20 minutes bile was added to the beaker.
Calculate the average rate of fall in pH units per minute in the 20 minutes after the bile was added. [1]

..... pH units per minute

(ii) Explain why the rate of fall in pH **increased** when bile was added. [3]

.....

.....

.....

.....

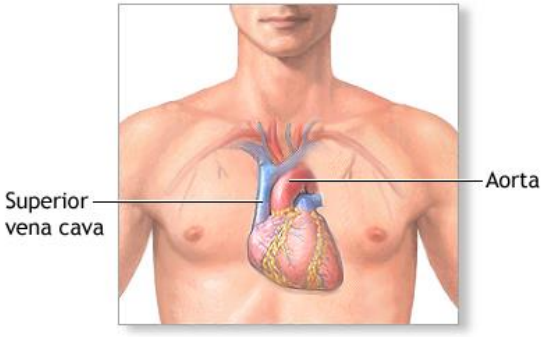
6

The need for a circulatory system

As animals get larger they need a circulatory system. This is because diffusion becomes too inefficient to move molecules
like

- oxygen – from the surface, deep into the cells of the body
- waste carbon dioxide – from the cells, to the outside of the body
- foods – from the small intestine, to the cells of the body.

Circulatory systems transport these substances around the body.



Parts of a circulatory system

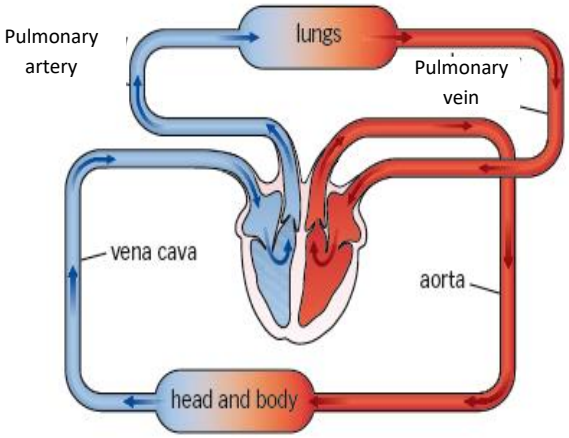
Human circulatory systems have three component parts:

- Blood – a fluid to carry the molecules.
- The **heart** – a pump to move the blood around the body.
- Vessels – tubes to contain the blood.

The human circulatory system

Humans have a double circulatory system. This mean that the blood passes through the heart twice as it makes its way around the body. The heart pumps deoxygenated blood to the lungs in the first circuit, called the pulmonary circuit and oxygenated blood to the body in the systemic second circuit. In a complete **circulation** blood passes

- from the heart to the lungs to remove carbon dioxide and collect oxygen
- back to the heart
- to the body organs and tissues
- back to the heart before going to the lungs again.

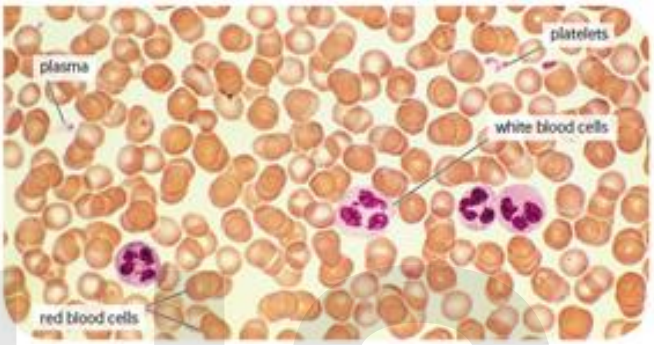


▲ The human double circulatory system

Blood

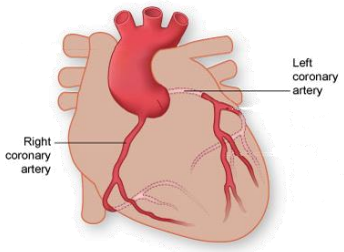
Blood is a tissue, because it is made of similar cells working together. It is a fluid which flows through the blood vessels, pumped by the heart. It has three main functions:

- Transport – carries substances and cells around the body.
- Protection – from infection and blood loss.
- Regulation – helps to maintain the body temperature and pH.

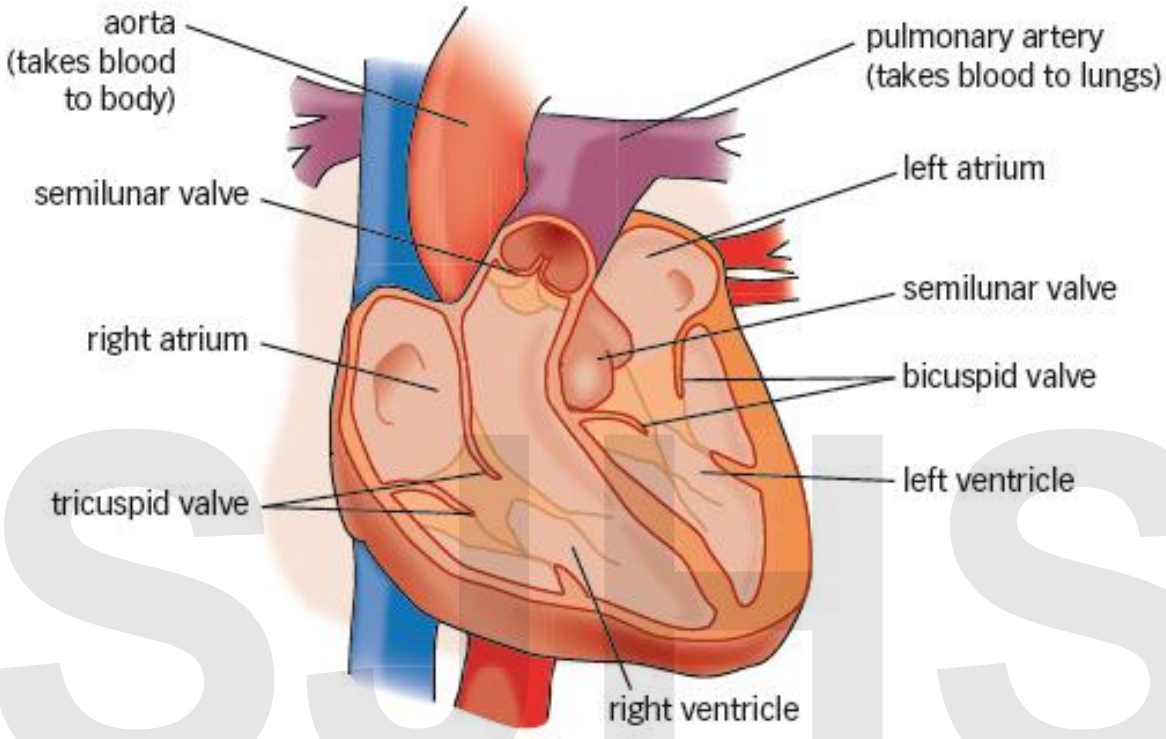


Component	Function
Plasma	Transports dissolved substances such as: • carbon dioxide from the cells to the lungs • soluble products of digested foods from the small intestine to the rest of the body • urea from the liver to the kidneys. • distribution of heat around the body.
Red Blood Cell 	• Contains the red pigment called **haemoglobin**. This combines with oxygen in the lungs to form oxyhaemoglobin. • Red blood cells transport the oxygen around the body; oxyhaemoglobin then breaks up to release the oxygen in other organs. • There is no nucleus, which provides more room for haemoglobin. • Made in the bone marrow, and destroyed in the liver.
White Blood Cell (Phagocyte) 	• There are several types. They all contain a nucleus. They all form part of the immune system, working to fight infection. • Some, like the phagocyte, engulf and digest microorganisms, others make antibodies to destroy microorganisms.
Platelets 	• Small fragments of cells with no nucleus. They help form blood clots at the site of wounds, to prevent blood loss and infection.

The heart



The heart is an organ which pumps blood around the body. Typically the heart beats 60–80 times a minute. Much of the wall of the heart is made of muscle tissue. The heart muscle has its own supply of blood in the coronary vessels; this provides oxygen and glucose to allow the muscle to contract.
The heart is divided into four chambers (left and right **atria** and left and right **ventricles**). The atria have thin walls as they only pump blood to the ventricles. The ventricles have thick walls as they pump blood all around the body.



Circulation through the heart

1 Deoxygenated blood arrives from the body through the **vena cava** to the right atrium.
2 The right atrium contracts and forces the blood into the right ventricle.
3 The right ventricle contracts and forces the blood up and out of the heart through the **pulmonary artery**.
4 There is a **valve** between the ventricles and atria which is forced shut when the ventricles contract, preventing backflow of blood, so the blood flows in the right direction.
5 A second valve prevents blood from the artery draining back into the heart.
6 Blood goes to the lungs and picks up oxygen and loses carbon dioxide.
7 Oxygenated blood returns to the left atrium of the heart through the **pulmonary vein**.
8 The atrium contracts and forces blood into the left ventricle.
9 The left ventricle contracts and forces the blood out of the heart through the **aorta**, to the body. The left ventricle has a thicker wall to pump the blood all around the body.
10 The two valves again prevent the backflow of blood in the heart.

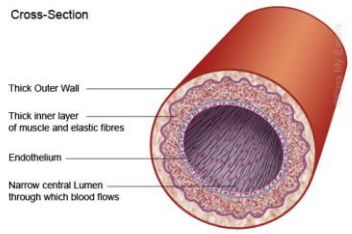
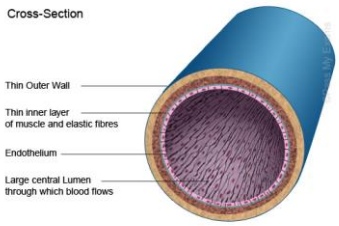
These two processes happen at the same time: the atria contract together, then the ventricles contract together, so the process of blood moving round your body and through your lungs is a continuous flow.
The heart has its own blood supply in the coronary artery.

The blood vessels

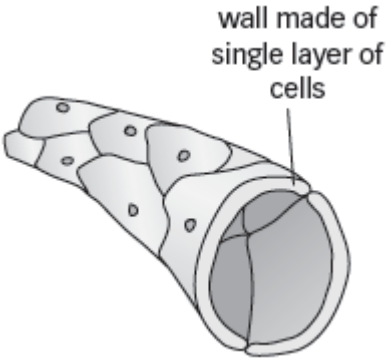
The blood vessels are the tubes through which the blood flows. There are three types of blood vessels.

- **Arteries** take blood away from the heart,
- **Capillaries** take blood through the organs,
- **Veins** return blood to the heart.

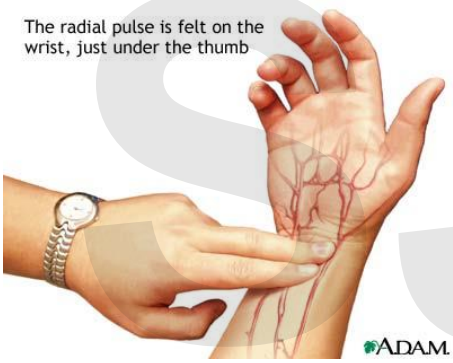
Their structure is related to their functions.

Arteries		Veins	
	Arteries have **thick muscular walls** which contain **elastic fibres** that allow the artery to stretch under pressure. In addition the **narrow lumen** maintains a high pressure and ensures the blood flows quickly to all parts of the body.		Blood pressure is low. To keep the blood flowing in the right direction veins have **valves** which prevents backflow. Veins are often surrounded by muscle when these contract they squeeze the veins helping push blood back to the heart.

Capillaries



• Walls are very thin, only one cell thick, so diffusion is quick.
• Large number of capillaries gives a large surface area for diffusion.
• Molecules needed by the cells (such as oxygen and glucose) pass out of the blood.
• Molecules produced by the cells (carbon dioxide and wastes) pass into the blood.
• Blood pressure has been lost, and the blood flows slowly by the time the blood reaches the capillaries.
• Very narrow, just wide enough to allow one red blood cell through.
• Capillaries form an extensive network, so that every cell in the body is near a capillary carrying blood.

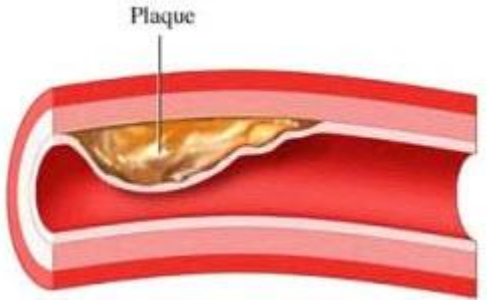


Taking Your Pulse.

When the heart contracts, it forces the blood out into an artery. This surge of blood is the pulse, which we can feel in an artery close to the skin. When we exercise our heart rate will increase. This is because it pumps blood to the tissues quicker. This brings oxygen and sugars to the tissues, and carries the wastes away.

Cardiovascular Disease.

There are a number of risk factors for cardiovascular disease. These include high levels of fat and salt in the diet, high blood pressure, high blood cholesterol, smoking, genetic factors and a lack of exercise.



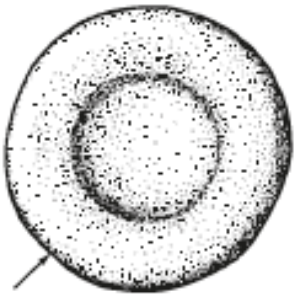
The effects of cardiovascular disease

Atheroma is a problem where a plaque of cholesterol forms in the artery wall. This means the artery cannot stretch as it should. It also restricts the flow of blood in the artery. If this occurs in the coronary artery the heart cannot get a good enough supply of oxygen and food. This causes pain called angina.

Treatments for Cardiovascular Disease.

Treatment		Advantages and Disadvantages
Statins		Statins, a daily medication to control blood cholesterol levels, but may cause side effects.
Angioplasty		Angioplasty, surgery to place a small balloon in a blood vessel, which is inflated to remove a blockage. A stent, which is a small metal cage is then put in place to hold the artery open. This results in improved blood flow e.g. in coronary vessels, but sometimes is only a temporary remedy.
Changes to lifestyle		Changes to diet/ lifestyle. These include stopping smoking, taking up regular exercise, eating more healthy food. These can reduce risk and lower blood pressure. However, a high level of self-discipline is needed to maintain these long-term changes.

1. *(a)* The table below has information on some of the parts of blood.

part of blood	structure	function
red blood cell	 cell membrane	.....
white blood cell		defence against disease
platelets		.....

Complete the table above by

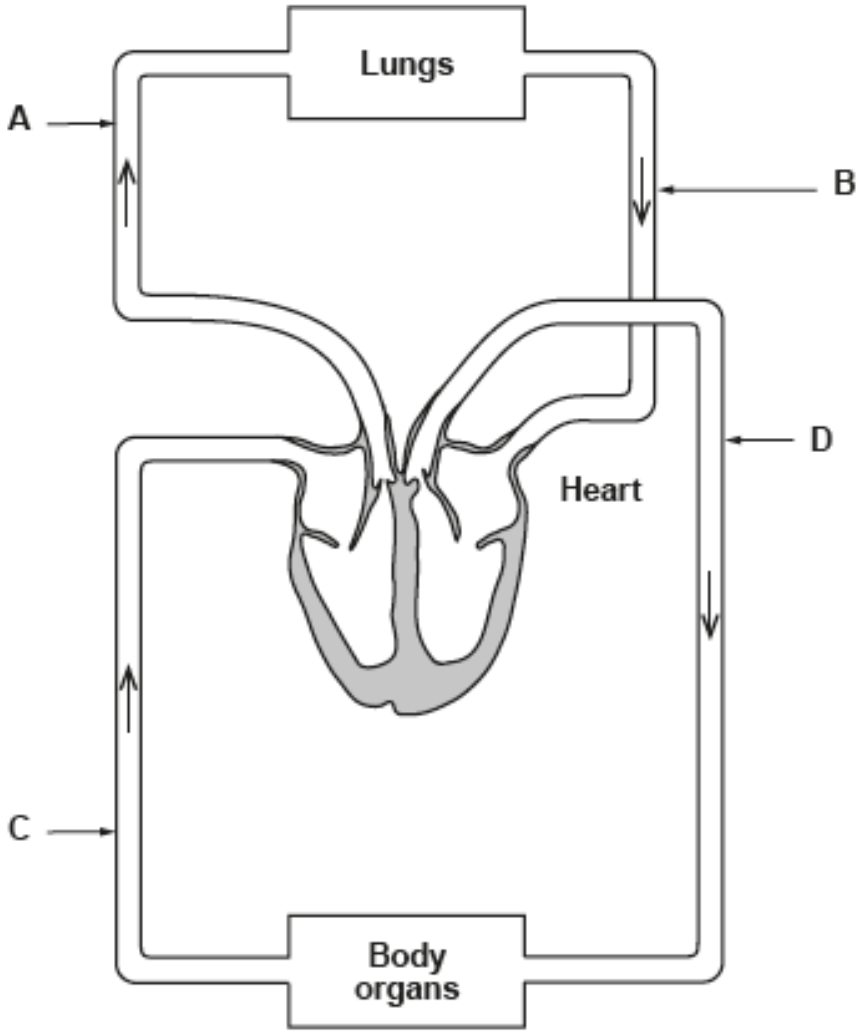
(i) drawing a diagram of a white blood cell and labelling the cell membrane and nucleus; [2]

(ii) giving the functions of a red blood cell and platelets. [2]

(b) The liquid part of the blood is called plasma. State **two** substances which are transported in blood plasma. [2]

....

(c) The diagram below shows the human circulatory system.

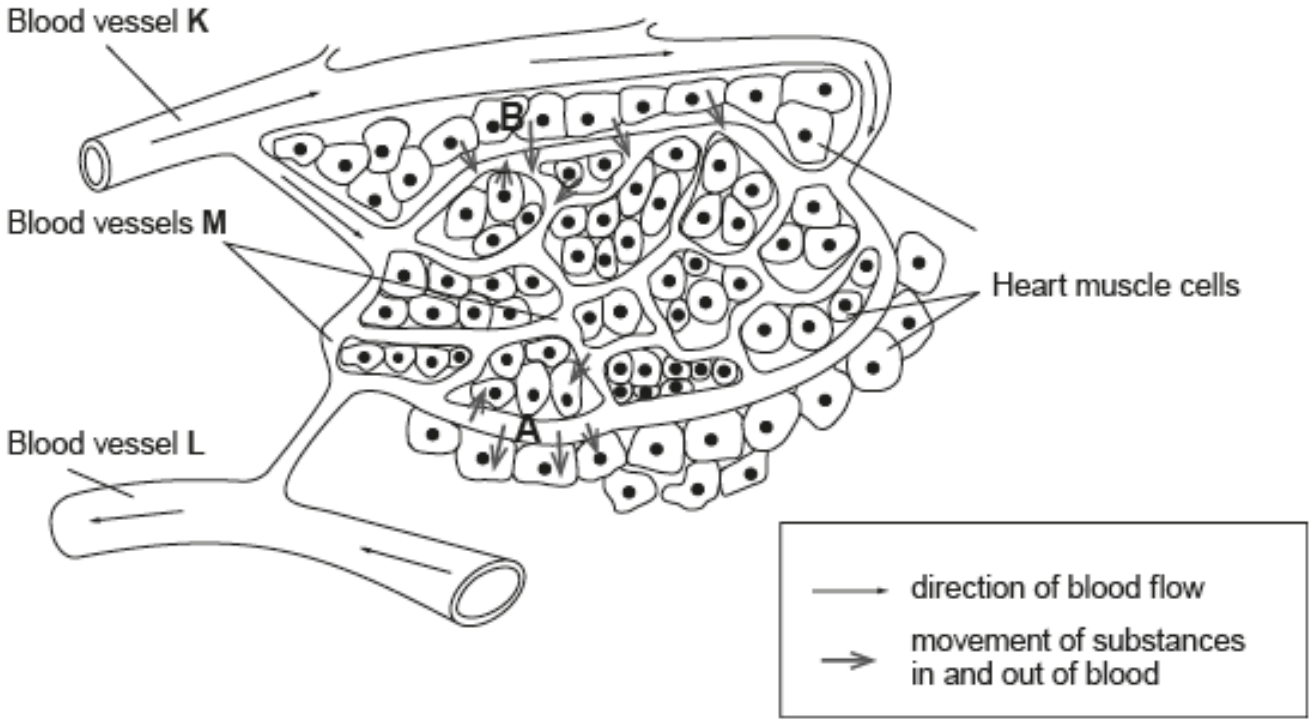


(i) From the diagram above, state the letter which shows [2]

I. the pulmonary artery .....

II. the aorta .....

7. *(a)* The diagram below shows a small part of the blood system supplying the muscle cells of the heart. The direction of blood flow is shown by the arrows on the blood vessels.



(i) Name the blood vessel which supplies the heart muscle with blood. [1]

.....

(ii) Explain why the action of platelets in this blood vessel could be a problem. [2]

.....

.....

.....

.....

(iii) Name the type of blood vessels labelled **M**. [1]

.....

only

(b) The table below compares the contents of the blood in blood vessels **K** and **L**.

contents	vessel **K** (a.u.)	vessel **L** (a.u.)
glucose	120	90
oxygen	100	40
carbon dioxide	30	44

(i) Use the data in the table to calculate how much carbon dioxide will pass from the muscle cells into the blood shown by the arrows **B**. [1]

..... a.u.

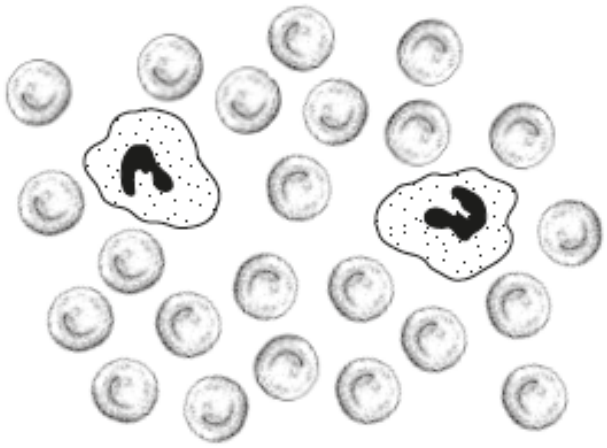
(ii) Choose **one** substance from the table above which will pass from blood vessel **M** to the muscle cells in the direction shown by the arrows **A**. [1]

.....

6

only

2. The diagram shows a blood smear as seen through a light microscope.



(a) Complete the table below about the different parts of the blood. [4]

name of part	function
red cell	.....
.....	produce antibodies
phagocyte	.....
platelets	.....

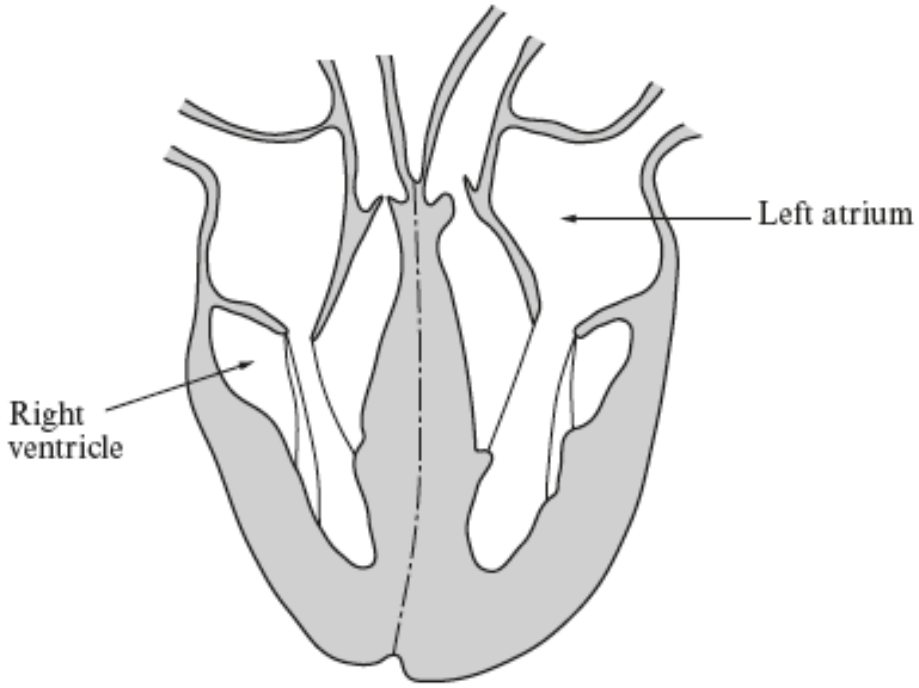
(b) Explain why the centre of a red blood cell appears paler than the surrounding cytoplasm when seen through a light microscope. [2]

.....

.....

6

4. The diagram shows the human heart in section.



Describe and explain how blood in the right ventricle travels to the left atrium. [6 QWC]

6

6. Plants and Photosynthesis.

Plants and Algae cannot eat like us. They have to make their own food by the process of photosynthesis. To do this plants take in:-

- Carbon Dioxide from the air, which enters the leaf through the stomata.
- Water from the soil, which enters through the root hairs.

Using the suns light energy which is trapped by ***chlorophyll***, they can build these substances into Glucose and Oxygen. Photosynthesis is an enzyme controlled series of reactions.

$$\text{Carbon Dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose + Oxygen}$$

The Products:

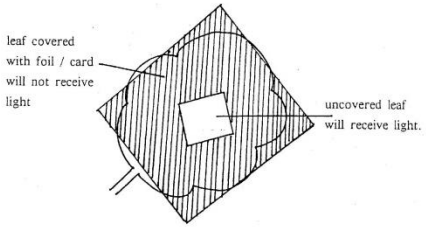
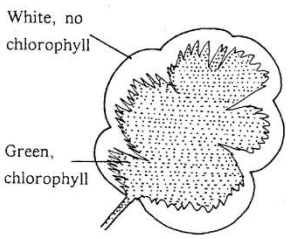
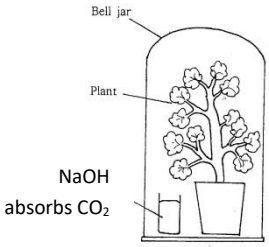
Food.~ This is a carbohydrate, usually the sugar glucose.

Oxygen. ~ This is a waste gas in photosynthesis. It is given off into the air or water.

Testing a Leaf for Starch.

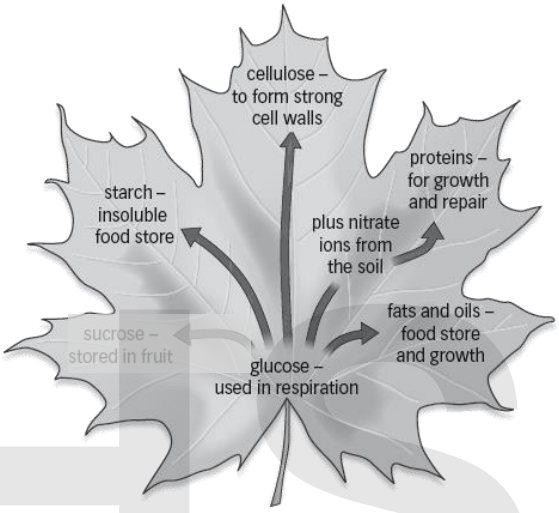
1. Boil the leaf in water for about a minute. ~ this kills the cells and stops photosynthesis.
2. Boil the leaf in ethanol/alcohol ~ this removes the chlorophyll. (safety ~ ethanol is flammable)
3. Wash the leaf in warm water ~ to soften the leaf.
4. Cover the leaf in iodine ~ stains starch black.

Before the experiment the plant is placed in darkness for 48 hours to stop photosynthesis, and remove any starch. This is called ***destarching***. This will allow us to test what conditions are needed for photosynthesis.

Is light needed for Photosynthesis?	Is Chlorophyll needed for Photosynthesis?	Is Carbon dioxide needed for Photosynthesis?
		
Covered areas turn orange – no starch Uncovered area turns black – starch present.	White areas turn orange – no starch Green area turns black – starch present.	Leaf turns orange – no starch

The Uses of the Product of Photosynthesis.

The glucose made in photosynthesis can be used in respiration to provide the plant with energy.



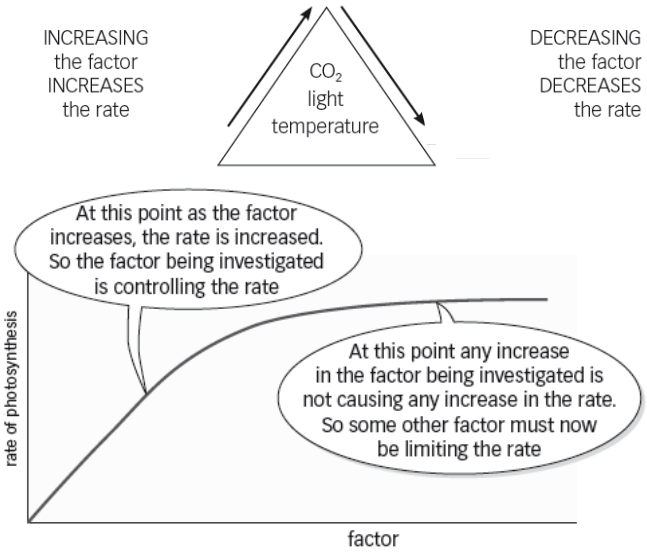
The Rate of Photosynthesis.

The rate of photosynthesis is the speed at which a plant photosynthesises. Biologists can measure this in one of two ways:

- the amount of raw materials used up in a period of time
- the amount of product made in a period of time.

Limiting factors (HT only)

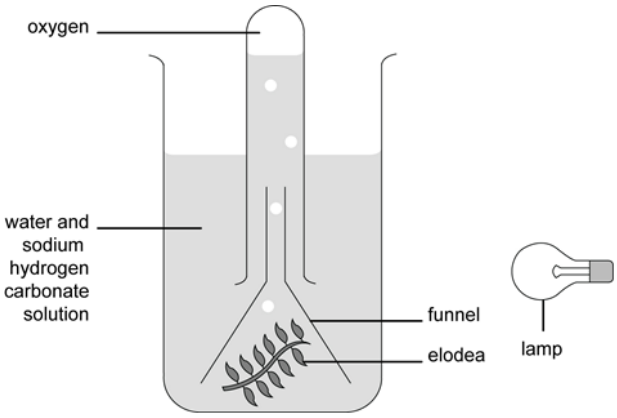
When a process is affected by several factors, the one that is at the lowest level will be the factor which limits the rate of reaction. This is called the limiting factor.
There are three factors which limit the rate of photosynthesis.
• Availability of light – the less light there is, the slower the rate of photosynthesis.
• A suitable temperature – temperature affects the enzyme reactions. As the temperature increases so does the rate, but if the temperature become too high it will damage the enzymes and stop photosynthesis.
• The amount of carbon dioxide – the less carbon dioxide, the slower the rate of photosynthesis.
If the limiting factor is increased, then the rate of photosynthesis will increase, until one of the other factors becomes limiting.



Investigating Rates of Photosynthesis.

This apparatus could be used to measure the rate of photosynthesis. Students would count the number of bubbles of oxygen produced in a set period of time e.g. one minute. The conditions could be changed like the distance from the lamp; the colour of light; temperature; species of plant. This will change the number of bubbles produced, and would show the effect on the rate.

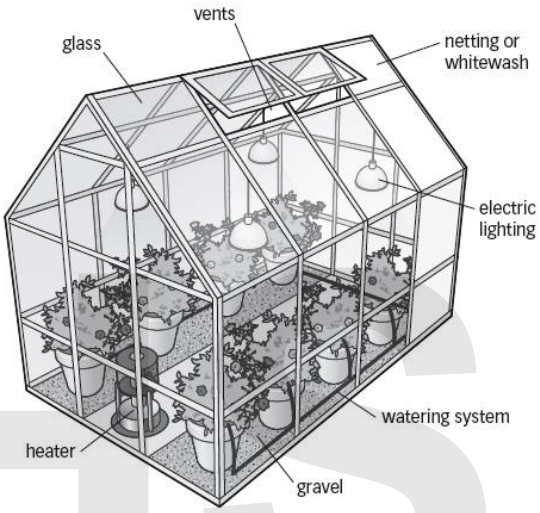
The sodium hydrogen carbonate dissolves to release carbon dioxide, so the amount needs to be controlled.



Other methods of investigating the rate of photosynthesis.

Plants could be placed in sealed containers, and sensors which detect oxygen or carbon dioxide levels can be used to record the composition of the air in the container. In conditions with more photosynthesis there will be more oxygen occurring and less carbon dioxide present. (Remember if any organisms like microbes in the soil, if photosynthesis stops like at night, then carbon dioxide levels will increase and oxygen will decrease, due to respiration by the organisms.)

Greenhouses are perfect examples of controlling conditions to maximise the rate of photosynthesis.

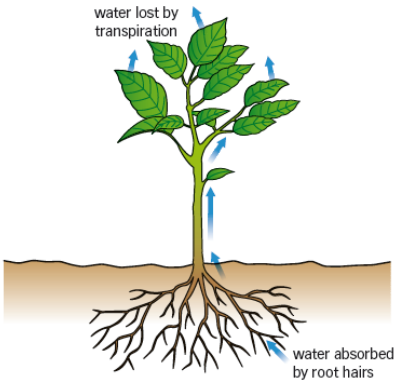


Transport in Plants.

Water is important for plants for a number of reasons:
1. Water is needed for the process of photosynthesis.
2. When water evaporates from the leaf it has a cooling effect.
3. Water enters the cells of the plant by osmosis, and makes the cells firm. This helps to support the plant.
4. As water moves through the plant, it transports dissolved minerals.

Transpiration

Plants take up water and minerals from the soil through their root hairs, which extend into the soil. The root hairs greatly increase the surface area of the root for the absorption of water and dissolved mineral ions. The water flows up the stem and into the leaves. Water exits the plant by evaporation through the leaves in a process called transpiration. The flow of water from the roots to the leaves is called the transpiration stream.



▲ The transpiration of water through a plant

Controlling water loss: stomata

Leaves are highly adapted to be efficient at photosynthesis. A consequence of these adaptations is that the leaves can lose a lot of water by transpiration. To help reduce this, the leaf can control water loss through pores in the leaf, called stomata.

• Most stomata are on the lower leaf surface.

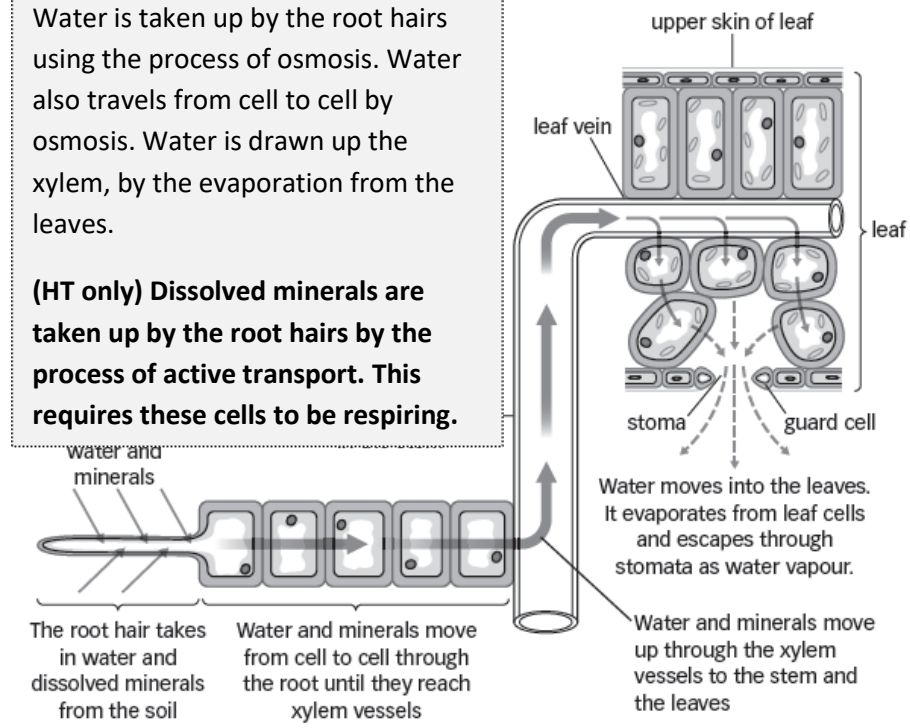
• Each stoma can be opened or closed. When the plant is photosynthesising the stomata are open. The stomata are closed at night. When the stomata are closed, this reduces water loss.

• If there is little water, a plant is in danger of losing water faster than it can be replaced. The stomata do not open when the plant is short of water, and this reduces water loss. This prevents the plant dehydrating and wilting.

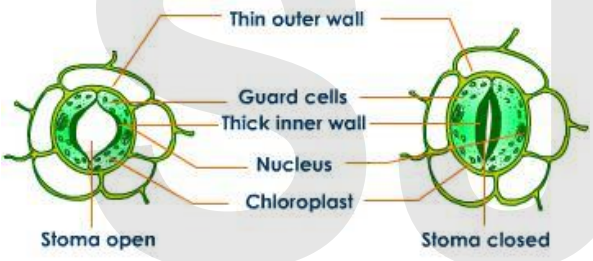
There are two special cells, called guard cells, on either side of the stoma. When there is plenty of light and water, the guard cells take up water by osmosis, swell, and become firm. This causes them to bend and open the stoma. If there is little water, then the guard cells cannot become fi rm. Then they do not open the stoma.

Water is taken up by the root hairs using the process of osmosis. Water also travels from cell to cell by osmosis. Water is drawn up the xylem, by the evaporation from the leaves.

(HT only) Dissolved minerals are taken up by the root hairs by the process of active transport. This requires these cells to be respiring.



▲ The process of transpiration

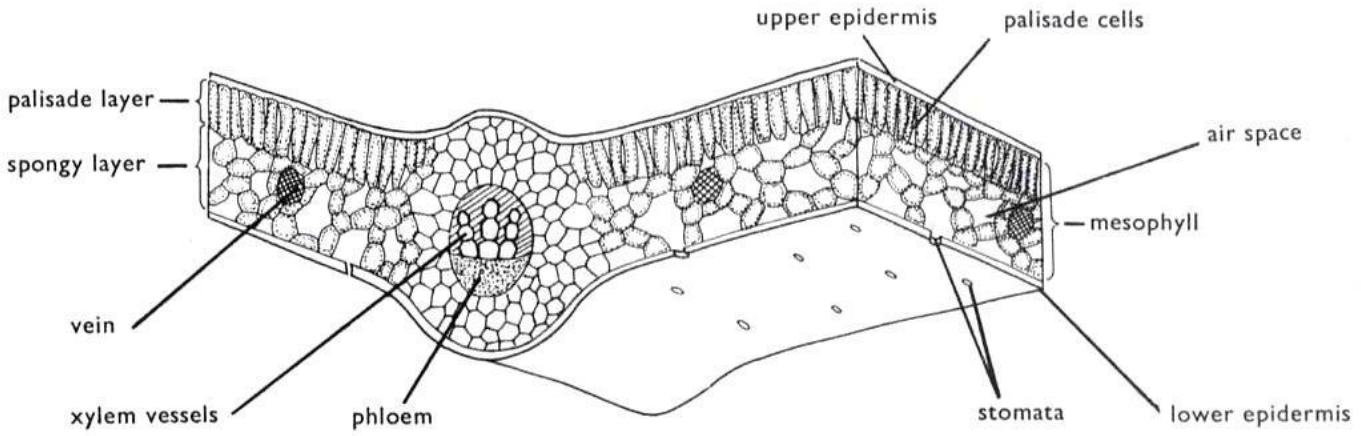


Experiments on this topic include:

1. Using dye to observe location of xylem.
2. Observing stoma using nail varnish.
3. Simple potometers.
4. Bell Jar containing transpiring plant.

Inside the leaf

The leaf is made up of many specialised cells. Each type of cell has its own function. They work together, making the leaf well-adapted to carry out photosynthesis.

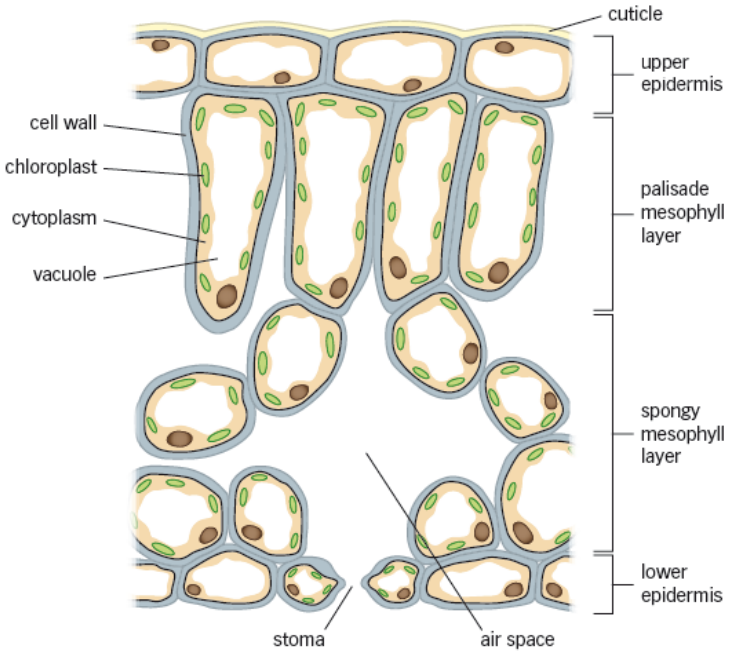


Factors affecting the rate of transpiration

There are four main factors in the environment that can affect the rate of evaporation of water. Anything that affects evaporation will affect how quickly water moves through the plant – the rate of transpiration. The following factors make the rate of transpiration faster:

- an increase in light intensity
- an increase in temperature
- an increase in air movement
- a decrease in humidity.

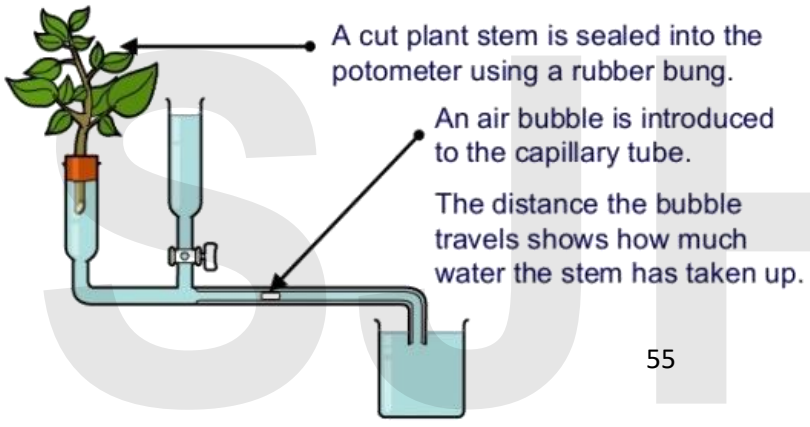
Biologists use a piece of apparatus called a bubble photometer to measure the rate of transpiration. You can change a factor such as the light level, or temperature, and note the change in the rate of transpiration using a bubble potometer, by measuring how fast a bubble moves along a glass tube. The bubble shows how quickly water is moving through the plant.



▲ The internal structure of a leaf

Transpiration

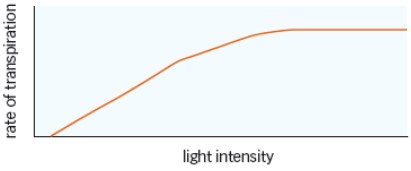
Transpiration can be measured using a **potometer**.



Factors affecting the rate of transpiraition include:

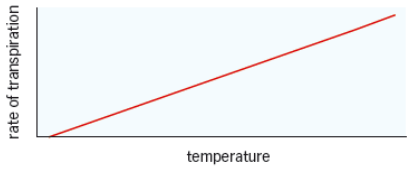
1. Higher light intensity

Stomata close in the dark and open in the light. When the light intensity is greater, more stomata will open. This allows more water to evaporate, so the rate of transpiration will be faster.



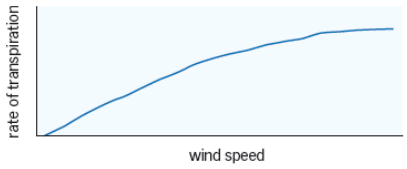
2. Increase in temperature

The higher the temperature, the faster the particles in the air will move. This means that water molecules move faster and evaporate from the leaf quicker. So the rate of transpiration will increase.



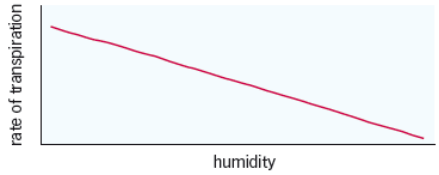
3. Increased air movement

When air moves over the leaf, it moves evaporated water molecules away from it. The faster the air movement, the quicker the water will be moved away. This increases the diffusion of water out of the leaf, because water molecules do not build up in the air outside the leaf. The concentration of water outside the leaf is kept lower, keeping a high concentration gradient between the inside of the leaf and the air outside. So the rate of transpiration increases.



4. Decreased humidity

The less humid the air, the less water there is in it (it is drier). This again makes for a greater concentration gradient between the inside and the outside of the leaf. Water molecules will diffuse out more quickly, increasing the rate of transpiration.



Plant Minerals.

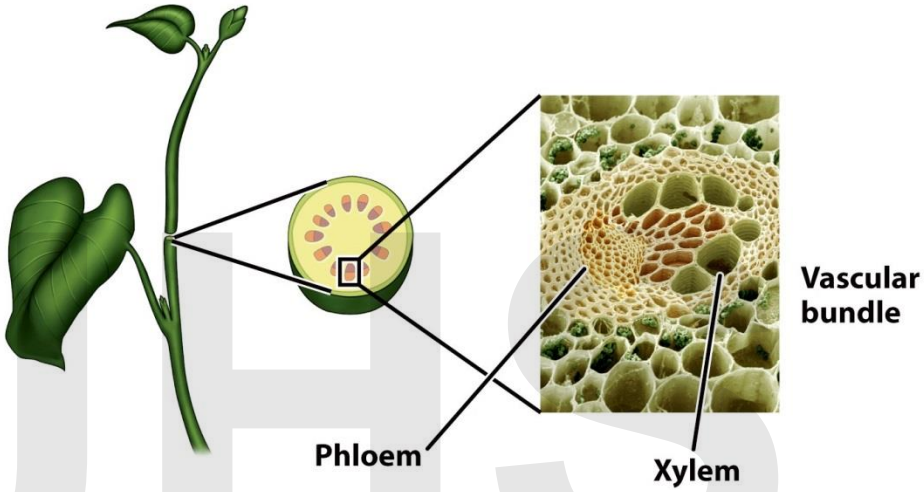
Plant roots absorb minerals dissolved in water in the soil. **The minerals are absorbed by the process of active transport, because there are more minerals inside the root hair cells than in the soil water.** Without minerals plants become unhealthy. They show deficiency symptoms. The lack of each mineral shows different symptoms.

Plant Mineral	Why Needed	Deficiency Symptoms
Nitrogen	Contributes to making proteins	Poor growth.
Phosphates	Used for energy carrying molecules	Poor root growth.
Potassium	Used in photosynthesis and respiration	Discoloured yellow leaves, poor flower growth.

Fertilisers are used by farmers and gardeners to add minerals to the soil. They usually contain a mixture of the minerals shown above and are often called NPK fertilisers.

Translocation.

The sugars made in photosynthesis are carried from the areas that they are made (the leaves) to the rest of the plant in the phloem. This process is called translocation. These sugars are used for respiration or converted to starch for storage. The transport of sugars is not fully understood, so is still being investigated by scientists.



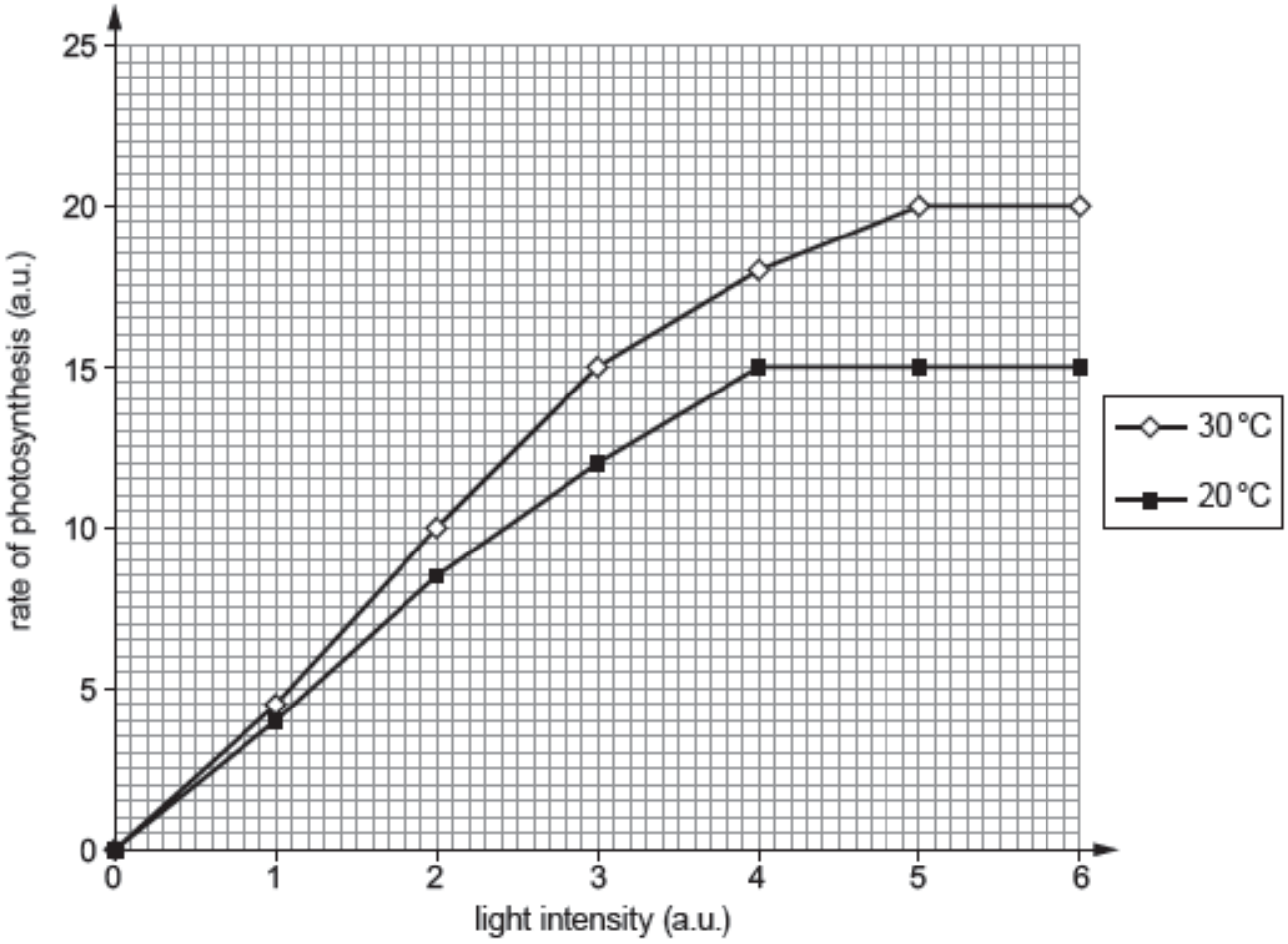
5. *(a)* (i) Complete the following equation for photosynthesis in green plants.

..... + water $\xrightarrow{\text{light}}$ glucose + ... [1]

(ii) Name the chemical substance which absorbs the light needed for photosynthesis. [1]

.....

(b) A scientist investigated the rate of photosynthesis at different light intensities and temperatures. The results are shown in the graph.



Use the graph to:

(i) Describe in detail how light intensity affected the rate of photosynthesis at **20** °C. [2]

.....

.....

(ii) Calculate the difference in the rate of photosynthesis between 20 °C and 30 °C at a light intensity of 3.5 a.u. [2]

difference in rate of photosynthesis ..... a.u.

(iii) Name **one** *other* environmental factor which can affect the rate of photosynthesis. [1]

.....

(c) Complete the table to show **two** ways in which plants use the glucose produced in photosynthesis. [2]

substance produced from glucose	how the substance is used in a green plant
.....	storage
cellulose	.....

9

only

11. Describe the process of photosynthesis with reference to the production of materials in plant cells. In your account, identify relevant limiting factors. [6 QWC]

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6

only

4. Describe the method involved in testing a leaf for the presence of starch.
Each of the stages involved in the method should be described in sequence and the reason for carrying out each stage should be included.
Your description must include reference to the colour changes shown by the leaf and what these changes indicate. [6 QWC]

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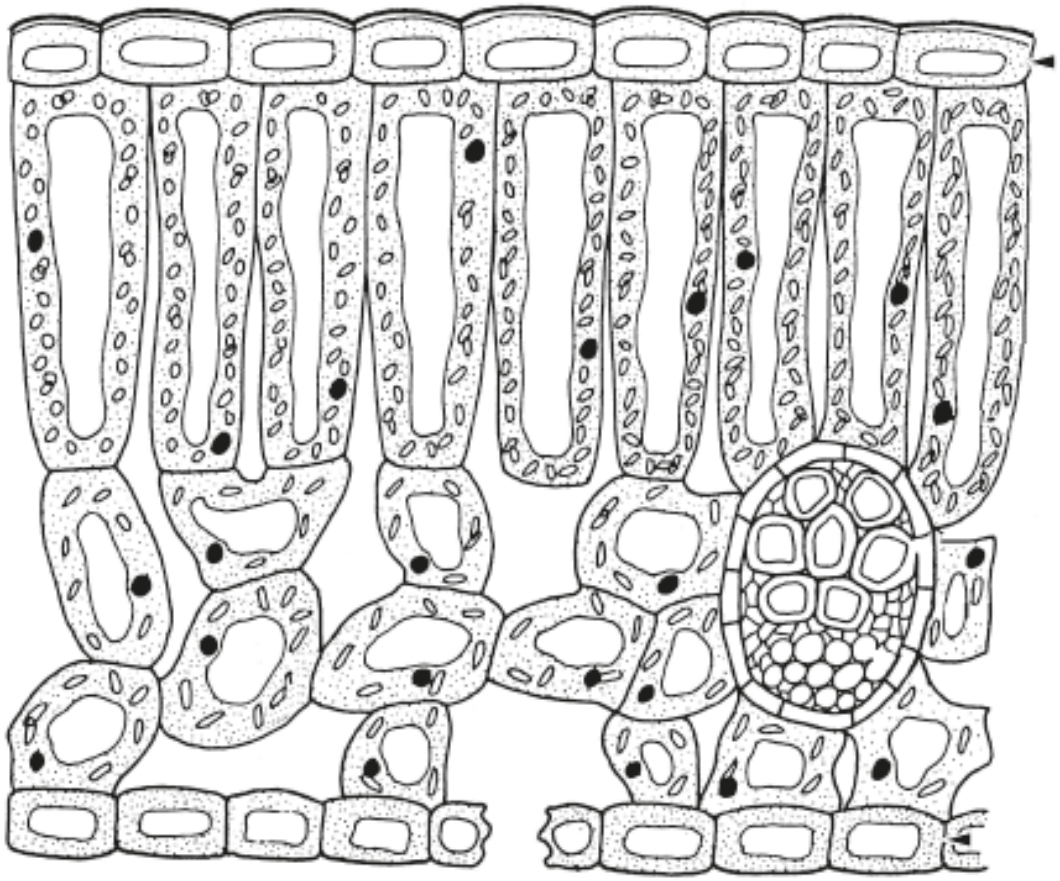
1. *(a)* The diagram below shows a leaf in section.



(i) State the name of the tissue in a leaf that transports sugar. [1]

.....

(ii) On the diagram above, label this tissue with the letter **A**. [1]

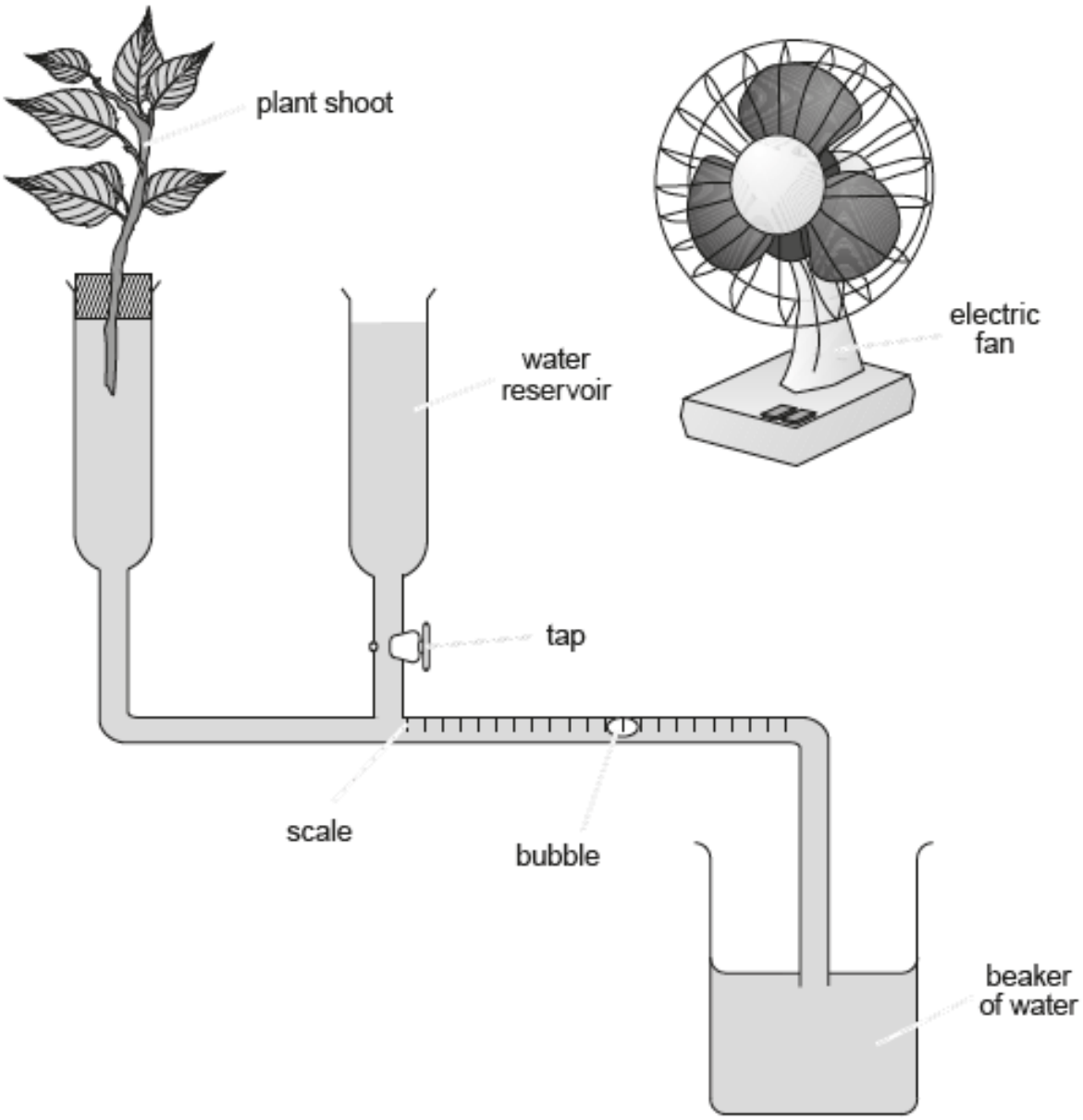
(b) Complete the following sentence. [1]

Sugar cannot be stored in a plant, it has to be converted into ..... for storage.

3. *(a)* What word is used to describe water loss from the leaves of a plant? [1]

.....

The diagram below shows a plant shoot in a simple potometer and an electric fan.



(b) Describe how you would investigate the effect of moving air on the rate of water loss from the shoot using the apparatus shown opposite. [6 QWC]

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(c) Apart from air movement, give **two** *other* environmental factors that affect the rate of water loss from a plant. [2]

1. .....

2. .....

9

1. The photograph below shows a tomato plant.

(a) Some of the sugar made in photosynthesis is transported to the tomato fruits.

State the name of the tissue in plants that transports sugar. [1]

.....

(b) (i) Siân grows tomato plants. She decides to use a fertiliser called Topgrow. The label from a bottle of Topgrow is shown below.

TOPGROW FERTILISER
CONCENTRATED NUTRIENT SOLUTION
Dilution: 1 part Topgrow: 200 parts water
Contents of bottle: 500 cm^3

Using the instructions for use shown on the label, calculate the volume of diluted Topgrow that can be made from the contents of one bottle.

..... [2]

(ii) Siân carried out a trial to find out the effect of using Topgrow on the tomato plants.
She used tap water only on half the plants and diluted Topgrow on the rest.

What else should Siân have done to make sure that the trial was a fair test? [2]
Give **two** suggestions.

I. .....

II. .....

(iii) The table shows some of the results of the trial.

treatment	**mean yield (mean mass of tomatoes per plant) (kg)**	**mean number of tomatoes per plant**	**mean mass per tomato (g)**
tap water	4.8	40	120
Topgrow	5.2	65	.....

I. Complete the table above by calculating the mean mass per tomato (in g) for Topgrow. [1]

II. Siân was pleased with the effect of Topgrow on yield. Suggest why Siân was still disappointed with the results. [1]

.....

(c) Apart from nitrates, give the names of **two** *other* nutrients required for healthy plant growth.

..... and ..... [2]

9

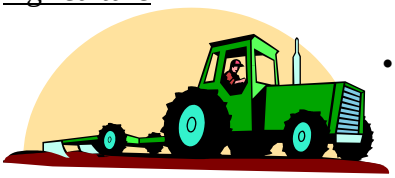
7. Ecosystem, Cycles and Human Impact.

Humans have an impact on the environment, by

- reducing the amount of land available for other animals and plants;
- producing pollution.

There are two main ways in which a growing human population influences the environment:

Agriculture



- Use of ***fertilizer***.
- Use of ***pesticides***.
- Loss of habitat.
- Deforestation.

Towns and Industry

- Loss of habitat.
- Quarrying and extraction of raw materials
- Dumping of wastes.
- Production of toxic chemicals & sewage

Farming.

Intensive farming uses methods to get as much yield from plants or animals in as small a space as possible. It can involves a number of methods.

Method	Advantage	Disadvantage
Fertilisers	Increases the yield of the crop	Cause eutrophication
Pesticides	Prevent pests from eating or competing with the crop, increasing yield.	Can destroy non pest organisms. Chemicals may stay on the crop and be eaten by humans, may cause bioaccumulation.
Disease control	Prevents loss of animals, or crops to disease.	Antibiotics given to animals may remain in meat.
Battery methods	More animals are kept in a given space. Animals use less energy so need less food. Costs are reduced so meat is cheap.	The animals' quality of life is very poor. Diseases can spread between animals.

Badgers and Tuberculosis (TB).

Badgers can catch bovine TB and pass it onto cattle. Many cattle die from TB. ***Culling badgers can sometimes be effective at reducing TB in an area.*** For this reason farmers are keen to cull badgers. ***Badgers can move from area to area***. Vaccinating badgers may also control the disease. ***The evidence is conflicting so valid experiments are needed***.

Eutrophication.

Fertilisers are washed from the fields into streams and lakes. ***The nitrates in the fertilisers increase the growth of plants and Algae***. The plants and Algae block the sunlight from entering the water. ***The lower plants and Algae die due to lack of sunlight***. Bacteria decay the dead plants and Algae. ***The bacteria use up the oxygen in the water***. Fish die due to lack of oxygen. ***Untreated sewage can have the same effect.***

Bioaccumulation

Chemicals like pesticides or heavy metals wash into water. ***These chemicals/pesticides are absorbed by plankton in the water***. Small animals eat lots of plankton. ***Each plankton contains some pesticide***. So the levels of pesticide accumulate (increase) in the small animals. ***The same happens at each step in the food chain***. The pesticide becomes more and more concentrated. ***Until it reaches toxic levels and kills the top carnivores.*** An example is DDT.

Pollution

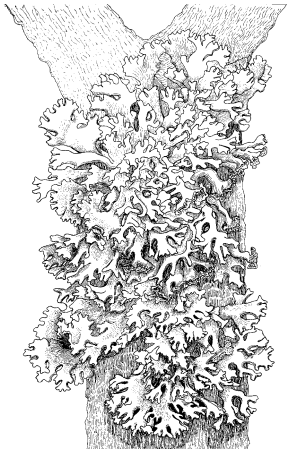
Water can be polluted by:

- Sewage and fertilisers – from farms and sewage works – causes eutrophication; high levels of bacteria will use up the oxygen in the water.
- Pesticides – from farms – causes bioaccumulation.
- Toxic chemicals – from industry – poison animals, causes bioaccumulation, may change the pH.
- Warm water – from factories – causes bacterial growth.
- Acid rain – from run off – lowers the pH causes leaching of aluminium.

The air can be polluted by:

- ***Sulphur dioxide*** – from burning fossil fuels – dissolves to form acid rain.
- ***Carbon dioxide*** – from burning fossil fuels – dissolves to form acid rain, causes global warming.

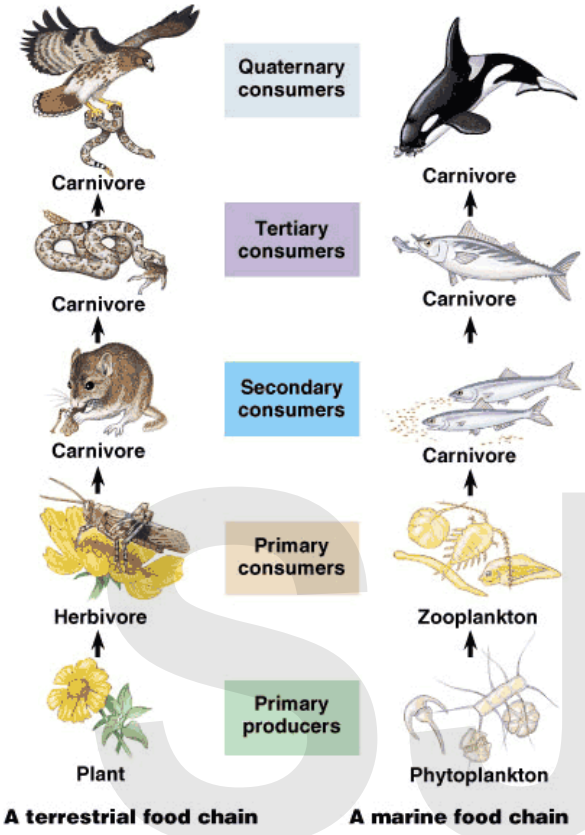
Measuring Pollution.



Scientists can directly monitor the levels of pH, temperature and oxygen in water. These give an accurate measure of the pollutant for that moment in time. Mathematical models can be used to analyse data and predict future effects.

Indicator species are another way of measuring factors in the environment like pollution. These species give an indication of the presence of a pollutant for a long period of time. An example of an indicator species is the rat tailed maggot which indicates low oxygen levels in the water. Another example is the ***lichens***, which live on stones and trees and can be killed by sulphur dioxide in the air. Some lichens are more tolerant than others, so the types of lichen found can be used to assess air pollution.

Food chains and Webs.

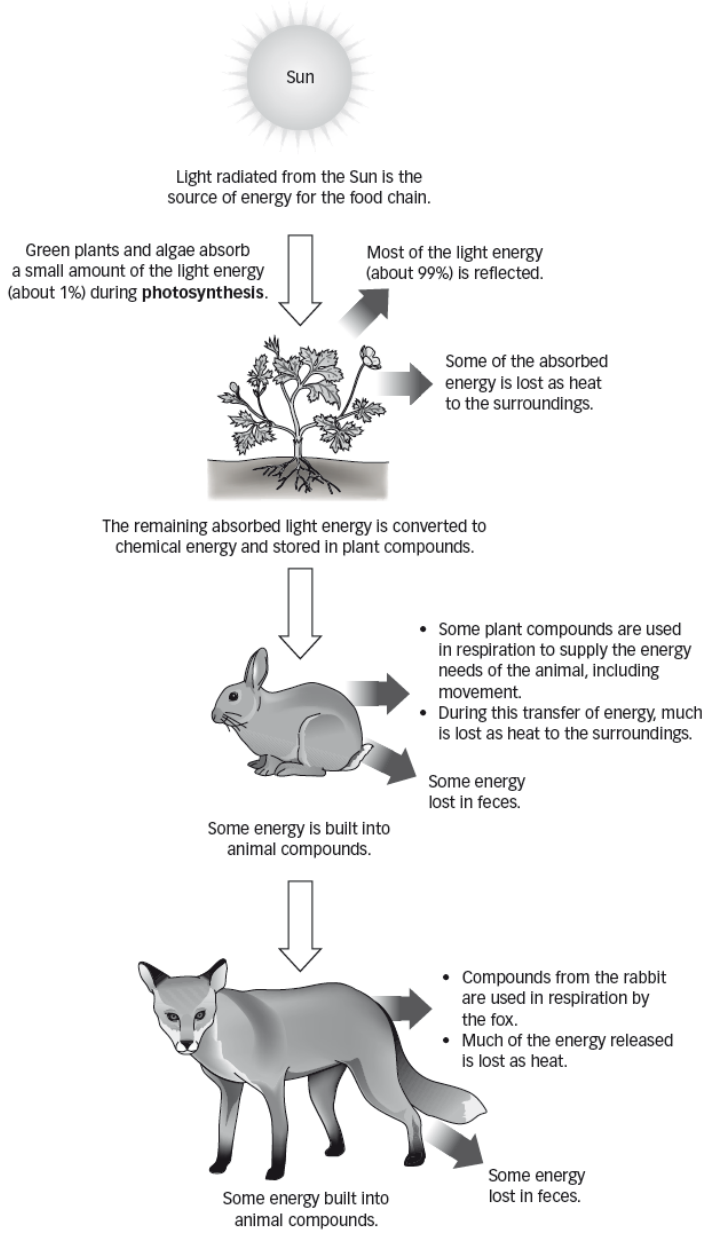


Producer ~ These are plants and algae which make their own food. They get their energy from the sun. They always start the food chain.
Herbivore ~ These eat plants, they are also called primary consumers.
Carnivores ~ These animals, they are also called secondary consumers.
Top carnivores ~ These eat other carnivores.
Omnivore ~ These eat both animals and plants.
Detritivores ~ These eat dead material e.g. dead leaves.

The arrows in the chain show the direction of flow of food and energy.

Food chains only show an animal eating one thing. Most animals have more than one food source. Thus an animal may occur in more than one chain. The chains can then link together. This forms a ***food web***.

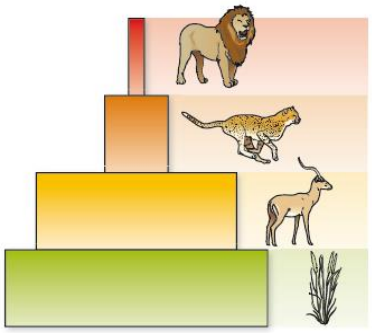
Energy Loss in the Food Chain.



▲ Energy flows through a food chain. Some energy is transferred out at each stage.

Ecological Pyramids.

Food chains show the feeding relationships between organisms, but they give no indication of the population sizes at the different stages. This can be done by constructing an ***ecological pyramid***. Pyramids of number record the numbers in each stage.



▲ Pyramid of numbers for the food chain on the African savannah

If you are asked to draw a pyramid of numbers follow these rules:

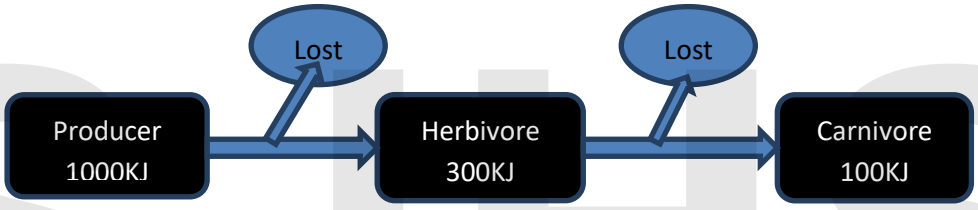
- Always put the producer at the base.
- Make sure that each bar is the same height.
- Label the bars.
- The width of the bars corresponds to the numbers of organisms.

Sometimes pyramids of numbers have an unusual shape. This might be because one producer e.g. a tree feeds a lot of primary consumers. To correct this shape we calculate and plot a ***pyramid of biomass***.

Pyramids of biomass record the total mass of the population at each stage in the food chain and are always pyramid shaped.

Calculations of Energy Flow.(HT only)

You could be asked to perform a calculation about energy flow through the food chain. Below is an example of a food chain.

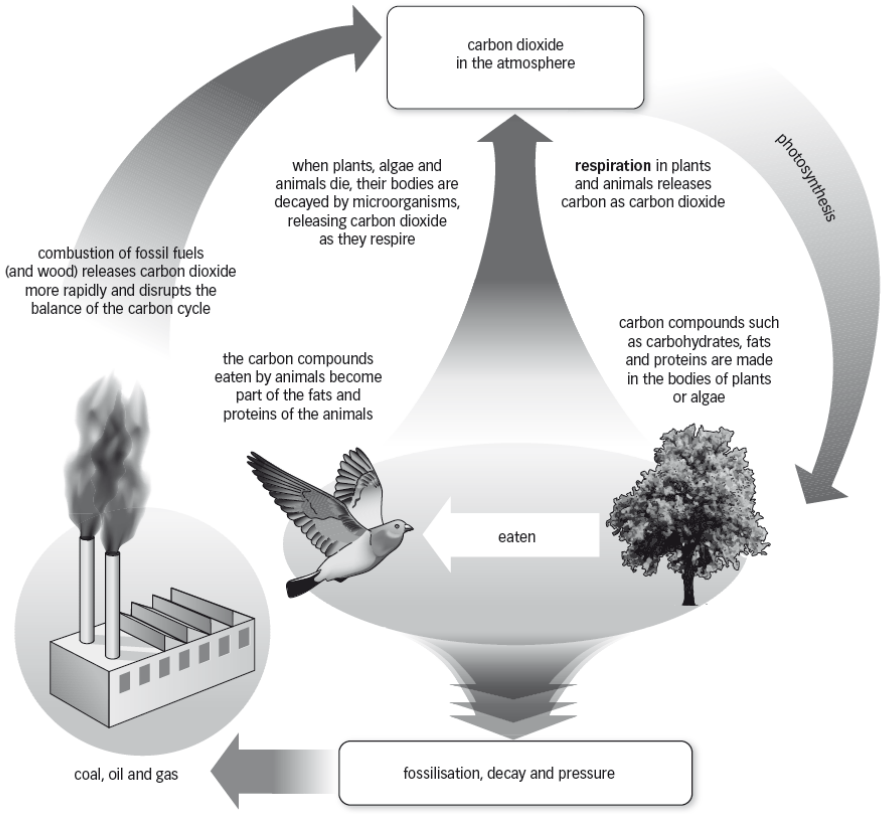


How much energy is lost between the producer and the herbivore? 1000 – 300 = 700KJ

What percentage of energy has been has been lost during the transferred from the producer to the carnivore?

1000 – 100 = 900KJ lost. (900 ÷ 1000) x 100 = 90% energy lost.

The Carbon Cycle.



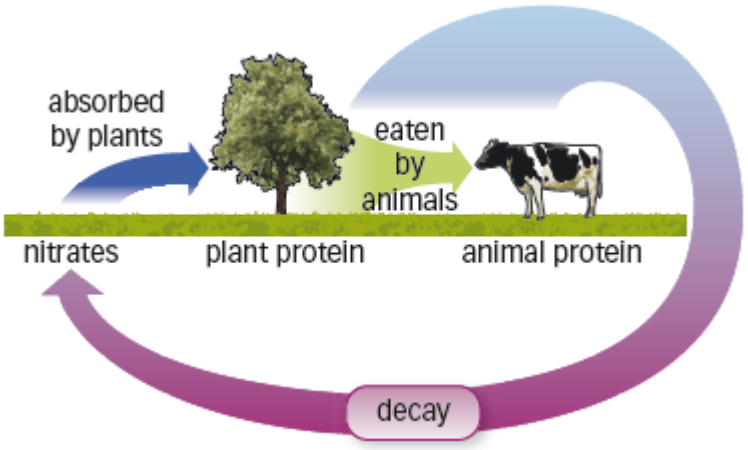
Decay

Decay is the breakdown of dead organisms. It happens best in certain environmental conditions e.g. correct pH, warm temperature, moist and aerobic. The organisms that bring about decay are the micro-organisms ***bacteria and fungi***. Oxygen is used up and carbon dioxide is produced by the respiration of these organisms.

During decay nutrients are released from the dead materials.

In a stable community the processes that remove materials are balanced by others which return them.

The Nitrogen Cycle. [HIGHER TIER ONLY]



Nitrogen moves between the living and non-living world in the nitrogen cycle.

- Nitrogen exists as nitrates in the soil, dissolved in water.
- Dissolved nitrates are absorbed by plant roots.
- The nitrates are used to build compounds such as proteins in the plant.
- These nitrogen-containing compounds pass through food chains to animals.
- Nitrogen compounds (such as proteins) in dead plants and animals are broken down into nitrates for absorption by plants.
- Decomposers return the nitrates in plants and animals to the soil in two ways:
- animal wastes, urea and faeces, contain nitrogen, and are converted to ammonia
- when plants and animals die and decay, their proteins break down, releasing ammonia.
- Nitrifying bacteria in the soil convert the ammonia to nitrates to complete the cycle.

Urea and Urease.

The bacteria which break down urea do so using the enzyme urease. (Enzymes require optimum pH & temperature)

Urea $\xrightarrow{\text{Urease}}$ ammonia + carbon dioxide

Nitrogen fixation

Nitrogen fixation can occur in bacteria in root nodules of leguminous plants or in free living bacteria in the soil. Some other bacteria break down the nitrates in the soil, returning nitrogen to the atmosphere. these are called denitrifying bacteria and they prefer to live in waterlogged or unploughed soil.

Remember the factors that affect enzyme action will also affect the rate of decay in the cycles. Bacteria will also be killed by heavy metals and a lack of oxygen.

1. *(a)* The table below shows changes in the populations of some farmland birds between 1980 and 2010.

bird	population (millions)		percentage fall (%)
	1980	2010	
Starling	85	40	53
Sparrow	53	25	53
Linnet	37	15	59
Dove	13	4	69
Bunting	6	1	83

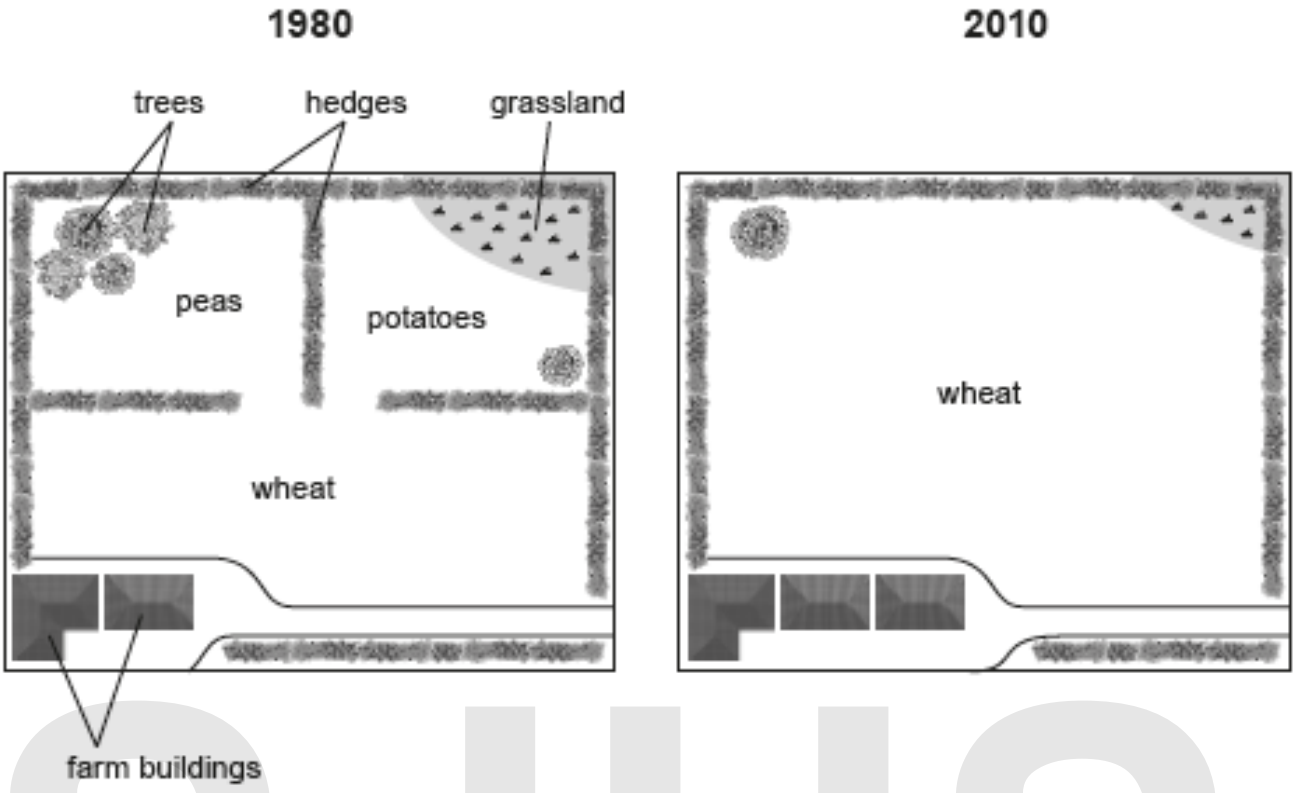
(i) Which bird had the greatest **percentage** fall? [1]

.....

(ii) Which bird had the greatest fall in **population**? [1]

.....

(b) The diagram shows land use on a farm in 1980 and in 2010.



Examiner only

(i) The farmer cut down most of the trees in 1981.

From the diagram, give **two** *other* changes to land use on the farm that affected the farmland birds. [2]

1 .....

2 .....

(ii) The farmer will plant more trees on his farm next year.

Suggest **two** ways that trees help birds to live on the farm. [2]

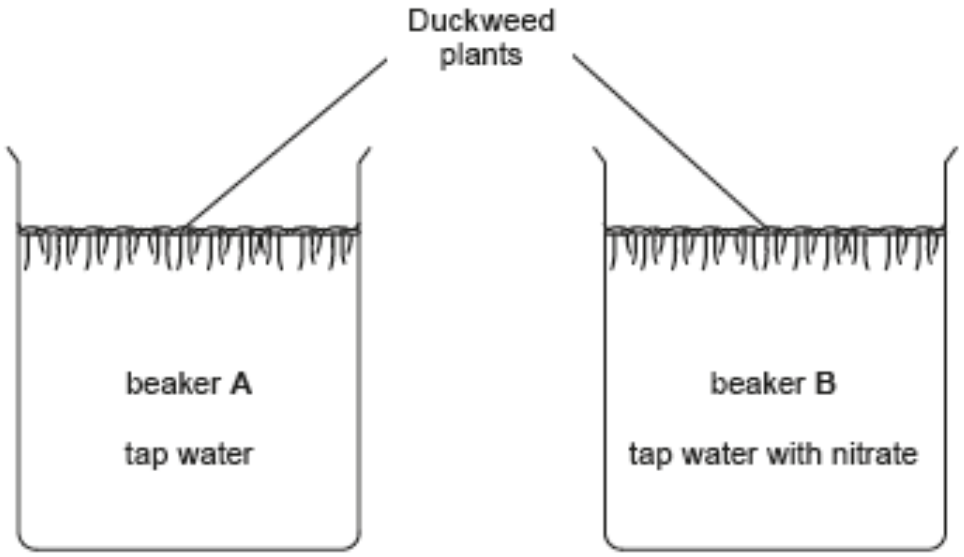
1 .....

2 .....

6

4. The drawing shows some water plants called Duckweed *(Lemna minor)*.

Students investigated the effect of nitrate on the numbers of living Duckweed plants growing in beakers as shown below.



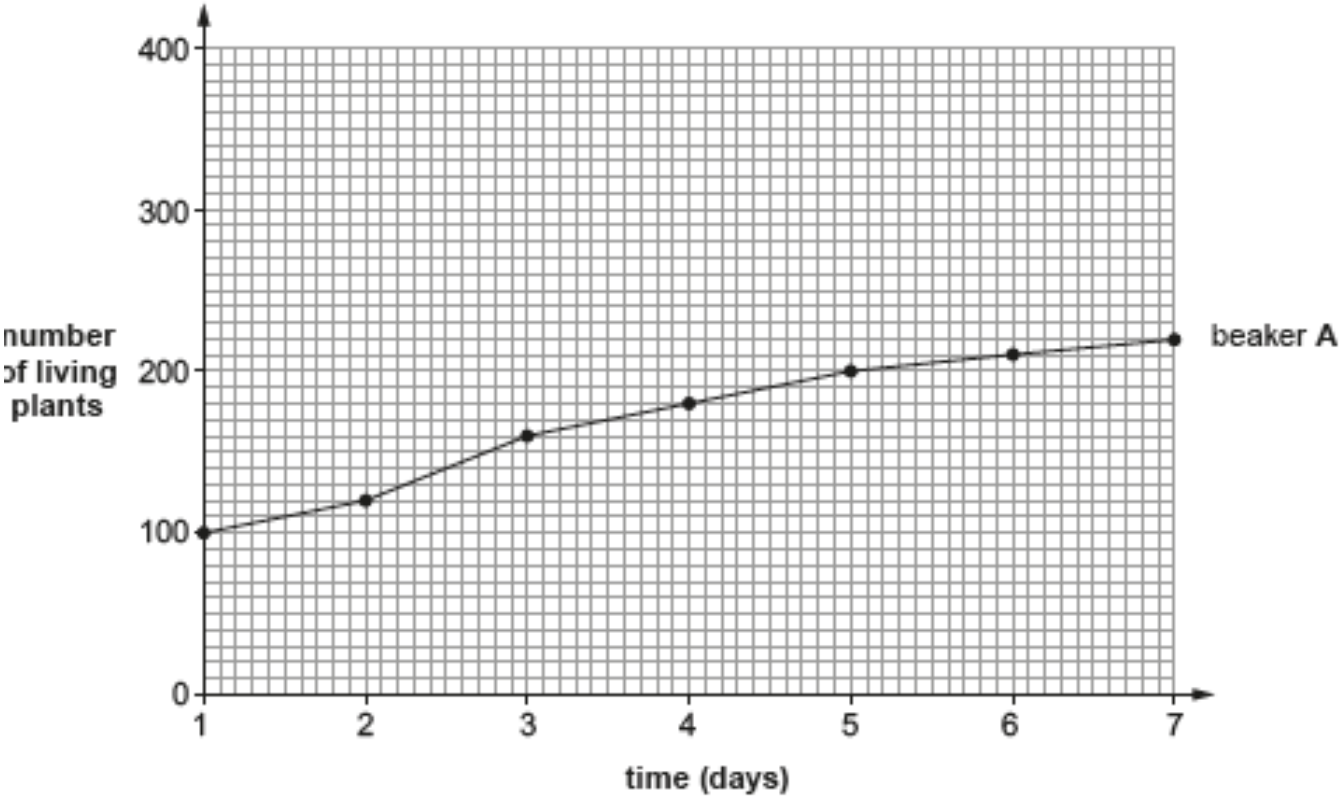
The results are shown in the table below.

day	number of living plants	
	beaker A	beaker B
1	100	100
2	120	140
3	160	180
4	180	280
5	200	360
6	210	340
7	220	300

(a) Complete the graph below to show the changes in the number of living plants in beaker B by:

(i) plotting the points; [2]

(ii) joining the points with a ruler. [1]



(iii) From the graph, describe the changes in the number of living plants in beaker B between days **1** and **7**. [1]

.....

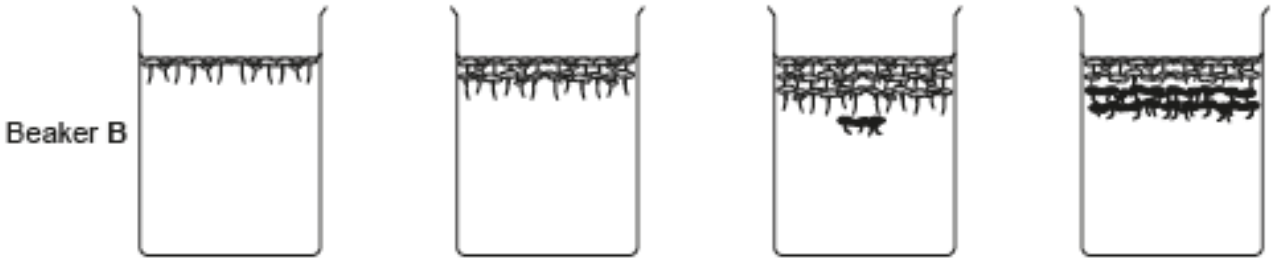
.....

(b) The results in beaker **A** (the control) allow a comparison to be made with the results in beaker **B**.

Why is it necessary to compare the results in this investigation? [1]

.....

(c) The diagrams show the plants in beaker **B** during the investigation.



Key

	living plants
	dead & decaying plants

(i) From the diagram above, on which day (**1, 3, 5 or 7**):

I is the level of dissolved oxygen in the water lowest?

Day ..... [1]

II are the number of bacteria in the water highest?

Day ..... [1]

(ii) Explain why the level of dissolved oxygen in beaker **B** changes during the investigation. [2]

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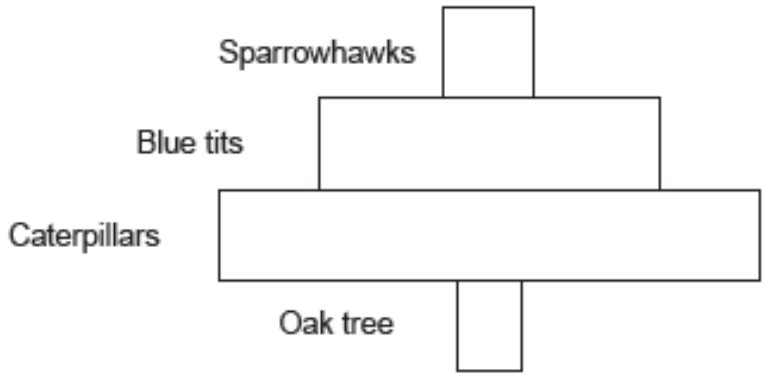
1. The diagram below shows the pyramid of numbers for a food chain found in a small wood.



(a) (i) Show the correct relationship in the food chain by adding **one** of the following numbers to **each** of the feeding levels in the above pyramid of numbers. [1]

1 17 3456 2

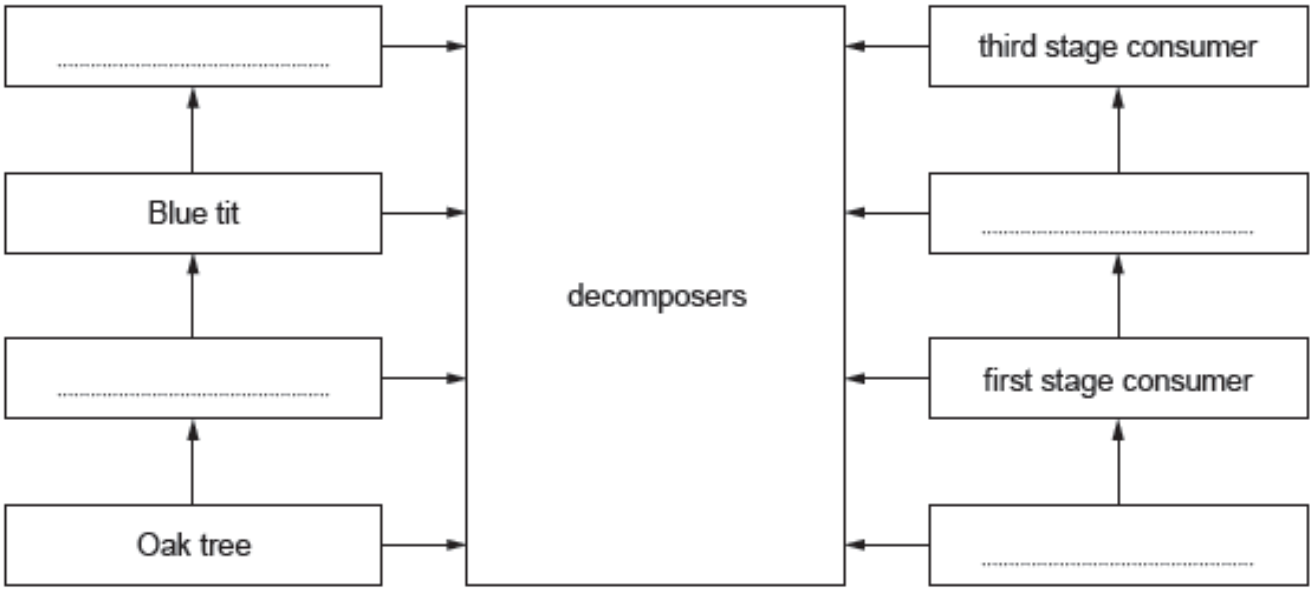
(ii) I In the space below draw a **labelled** pyramid of biomass for this food chain. [1]

II Show the correct relationship in the food chain by adding **one** of the following masses to **each** of the feeding levels in **your pyramid** of biomass shown in a(ii) I. [1]

0.18 kg 5137 kg 1.2 kg 43 kg

only

(b) Use the information on the opposite page and your own knowledge to complete the following diagram. [2]



(c) In which of the following do **all** of the processes **add** carbon dioxide to the air? Underline the correct answer. [1]

(i) decomposition *and* respiration *and* photosynthesis

(ii) decomposition *and* respiration *and* photosynthesis *and* combustion

(iii) respiration *and* combustion *and* photosynthesis

(iv) respiration *and* combustion *and* decomposition

6

3. Intensive farming methods use very large amounts of chemical pesticides to increase crop yields.

The Western flower thrips *(Frankliniella occidentalis)* is an insect which eats crops, including fruit and vegetables, causing world-wide damage.

A Western flower thrips

Scientists at Swansea University have done research into pest control using bacteria which naturally live only in the thrips. The bacteria affect a gene which controls eating in the thrips. The thrips stops feeding and dies. The bacteria pass naturally between the thrips.

(a) Use the information above to suggest **one** advantage to the farmer of using this new method of pest control over the use of chemical pesticides. [1]

.....

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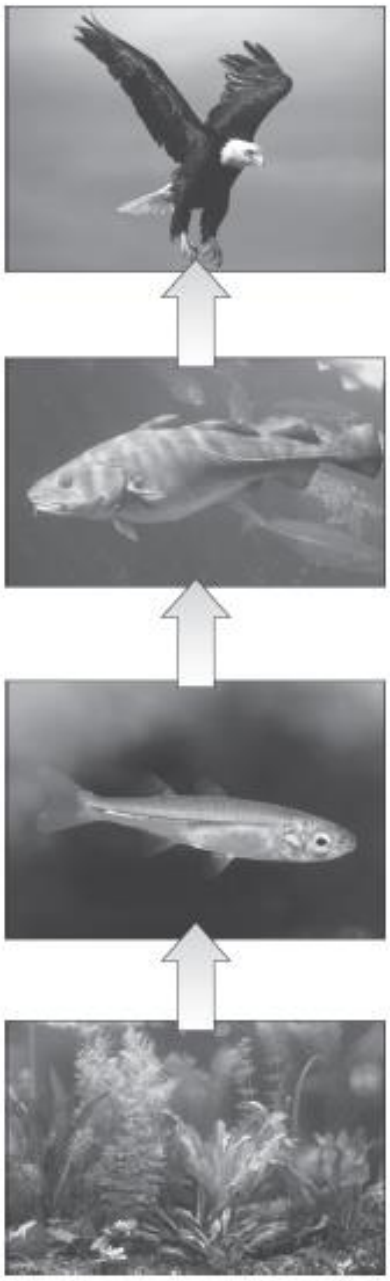
(b) Apart from the use of pesticides state **one** *other* method farmers use to increase crop yields. [1]

.....

.....

(c) DDT is a powerful insecticide which was extensively sprayed onto crops in the middle part of the twentieth century. Its use is now banned in many regions of the world because it resulted in the death of many top predators. One of the top predators affected was the American Bald Eagle *(Haliaeetus leucocephalus)* whose numbers in the USA dropped to only 834 in 1963.

The food chain below shows the concentration of DDT in ppm (parts per million) in the tissues of the organisms in a food chain.



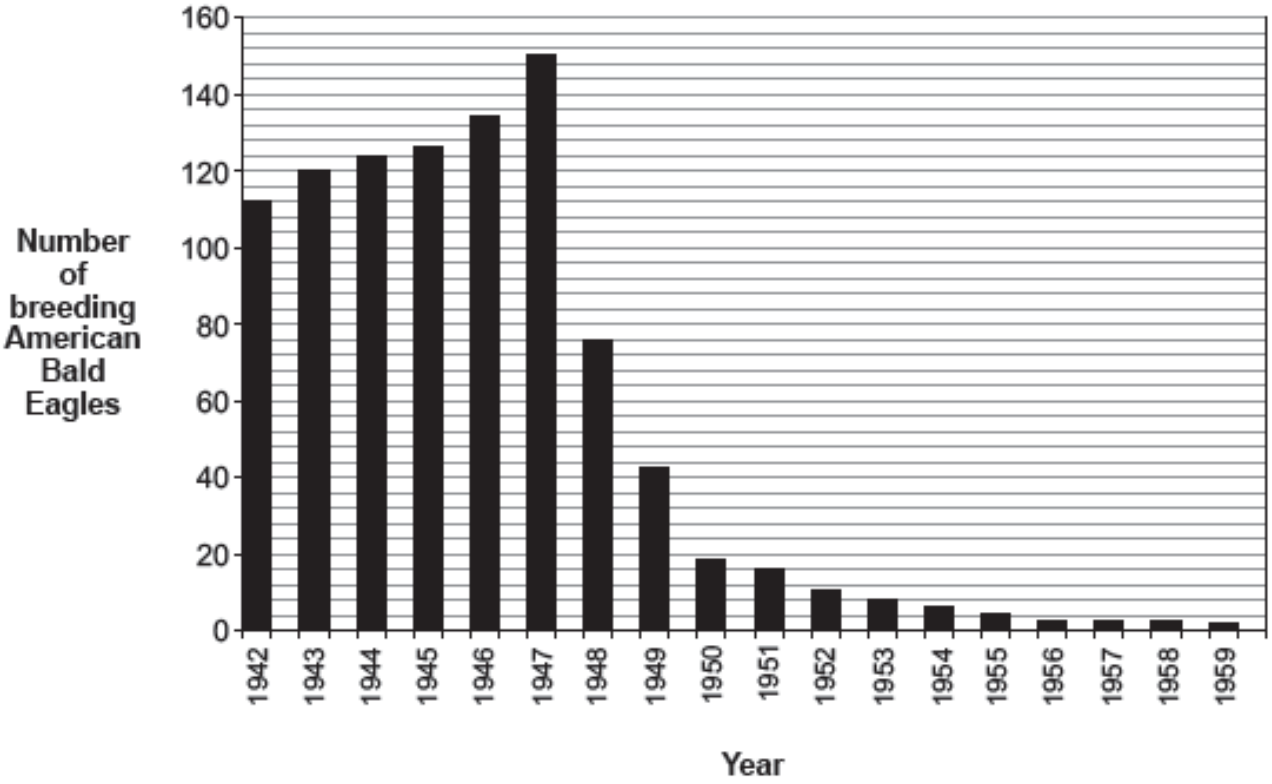
American Bald Eagle
13.8 ppm

large fish
2.07 ppm

small fish
0.23 ppm

aquatic plants
0.04 ppm

The graph below shows the number of breeding American Bald Eagles in Florida between 1942 and 1959.



(i) From the graph, suggest the year in which DDT was first used in Florida as an insecticide. [1]

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(ii) Suggest why DDT is found in the aquatic plants if it is only sprayed onto crops grown on land. [1]

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(iii) The aquatic plants and fish are not killed by the DDT but the American Bald Eagle is. Explain the reason for this. [2]

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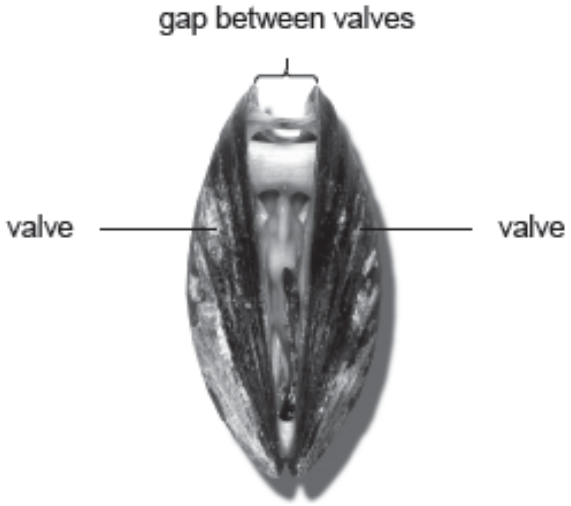
8. Mussels are bivalve invertebrates where the shell is made of two valves.

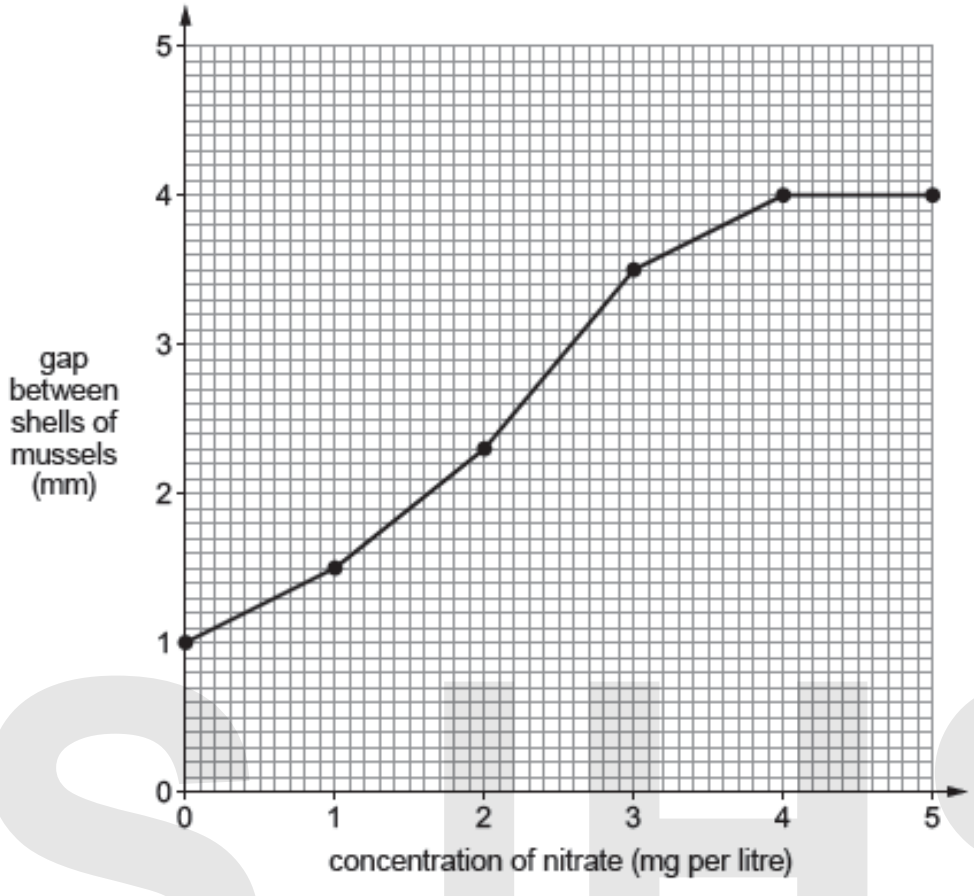


In 2013, scientists investigated whether mussels could be used to monitor nitrate pollution in water.

Mussels feed by filtering food particles out of the water. Mussels open their shells when feeding.

Sensors were placed on mussels in aquarium tanks to measure the size of the gap between the valves in different concentrations of nitrate.

The results of the laboratory investigation are shown in the graph below.



 (4461-02)

only

(a) Describe the trend shown by the graph opposite. [1]

.....

.....

(b) Scientists carried out trials to see if mussels with 'nitrate monitoring sensors' could be used where the Mississippi river meets the Gulf of Mexico.

Suggest **two** factors that may have affected these trials that would **not** have affected the results in the laboratory investigation. [2]

(i) .....

(ii) .....

(c) Scientists think that nitrate pollution could result in 'dead zones' in which marine life could suffocate. Explain how this might happen. [3]

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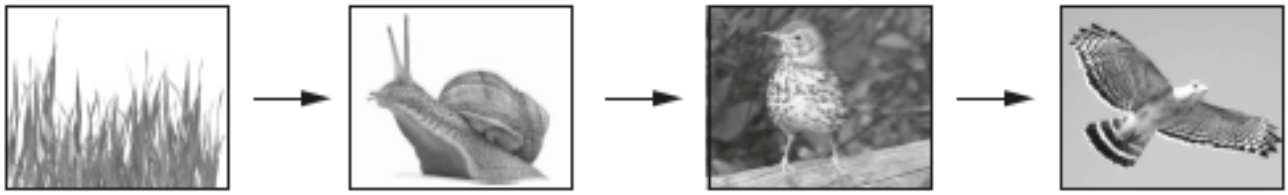
2. The photographs below show a food chain.



grass → snail → thrush → hawk

(a) State the source of the energy used by the grass. [1]

.....

(b) Complete the following sentence:

Arrows in the food chain show the flow of ..... [1]

(c) The table below shows how much energy enters each organism in the food chain in one day.

organism in food chain	energy entering each organism (kJ)	percentage energy in grass passed on (%)
grass	2500	
snail	500	.....
thrush	25	1
hawk	0.5	0.02

(i) Use data in the table to calculate the percentage of the energy **entering the grass** that is passed on to the **snail**. Show your working below and write your answer in the table. [2]

(ii) State the process occurring in cells that releases energy. [1]

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5

1. Some organisms living in a large lake and their total biomass in kg are shown below.

They are **not** drawn to scale.

Snails
4500 kg

Pike
250 kg

Aquatic plants
45 000 kg

Minnows
500 kg

Beetles
800 kg

(a) (i) Which of the organisms above are likely to be present in the least numbers? [1]

.....

(ii) The organisms above all form part of the same food chain.
In the space below, draw a **labelled** diagram to show a pyramid of biomass containing **all** of these organisms. [2]

Examiner only

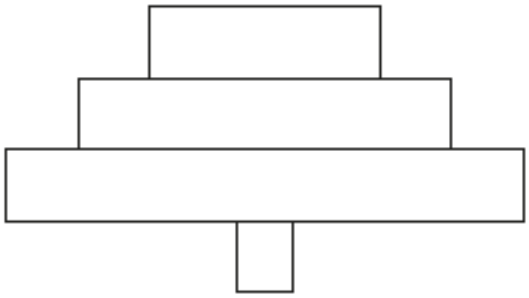
(iii) The pike in the lake are affected by a parasite, called a fish louse, which lives on their skin. There would be many of these parasites on each pike but their biomass would be less than the biomass of the pike.

How would you add this information to the pyramid you drew in *(a)*(ii)?

Tick (✓) the correct answer. [1]

- Place them at the tier above the pike ☐
- Place them at the bottom of the pyramid ☐
- Place them below the minnows ☐
- Place them in the tier below the pike ☐

(b) Explain how a pyramid of numbers, for some organisms living on land, could look like the one shown below: [2]



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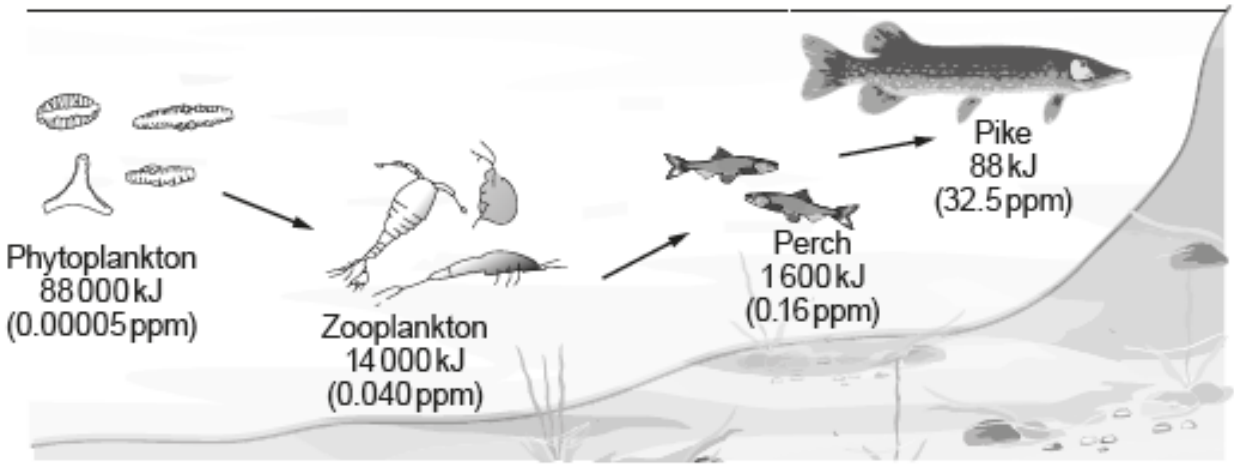
6. The drawing below shows a food chain in a river into which a pesticide has been washed.



The organisms are not drawn to scale.

The unit, kJ, indicates the energy in organisms at each level of the food chain and represents kJ per m^3 of water per year.
The numbers in brackets show the pesticide concentration in parts per million (ppm).

(a) Calculate, the percentage of the energy in the producer that has reached the third stage consumer. **Show your working**. [2]

Answer ..... %

(b) Over a period of three years, the number of fertilised eggs per fish decreased in the river. Use the data shown in the drawing and your knowledge to explain a reason for this decrease. [2]

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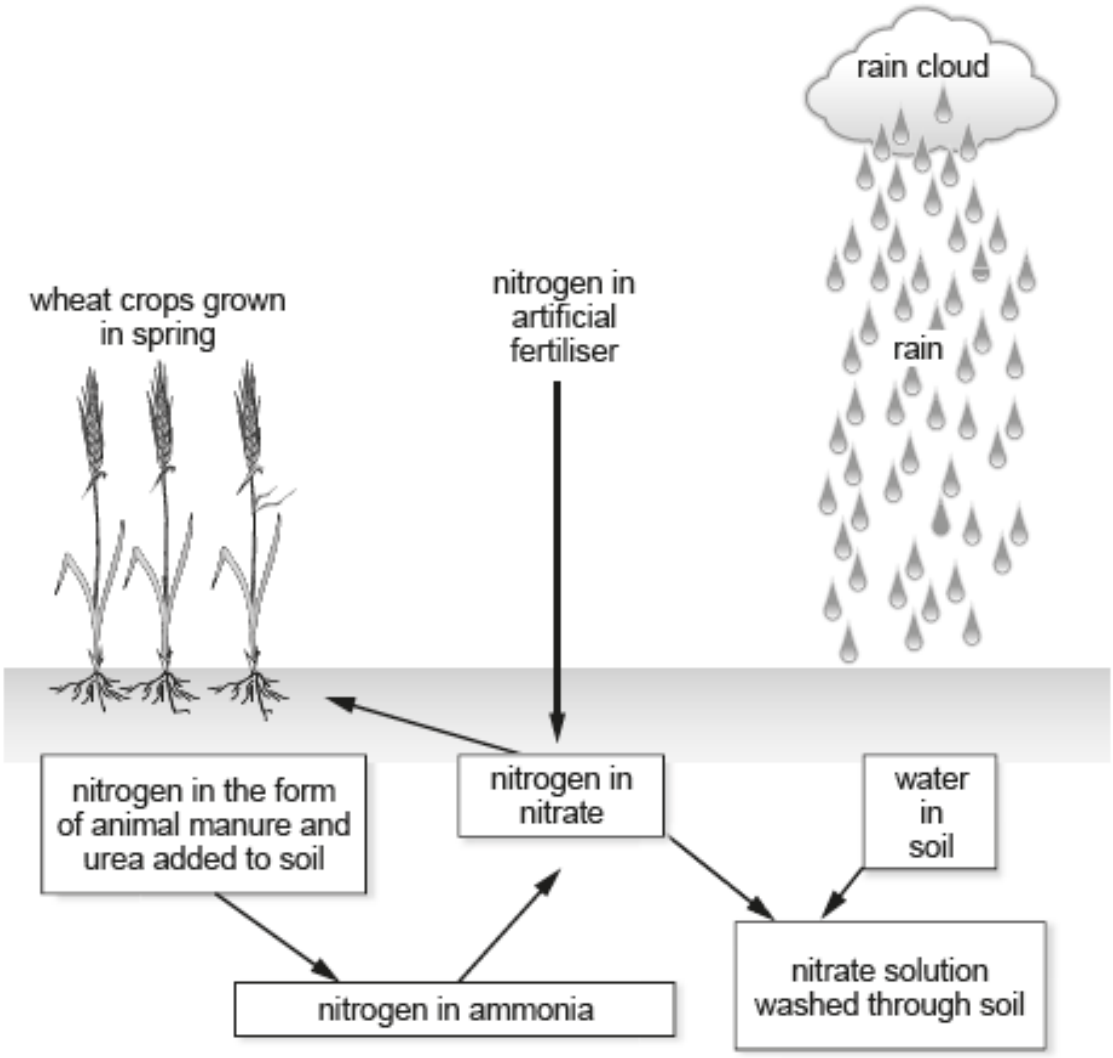
4

9. The diagram below shows how some nitrates enter water in the soil and how some enter the roots of wheat.



(a) Nitrate Vulnerable Zones (NVZs) are areas of land where nitrates in fertilisers are likely to enter water supplies.
Suggest why:

(i) the annual deadline for spreading animal manure (slurry) on NVZs in Wales is October 31st; [1]

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(ii) it is more environmentally friendly to add nitrate fertiliser to wheat crops in the Spring than in the Winter. [1]

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only

(b) Some genetically modified plants are able to absorb nitrates more rapidly than others so that they increase their yield.
State another way in which plants may be genetically modified as an economic advantage. [1]

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(c) Suggest how ploughing dead plants back into the soil may lead to increased nitrate production in the long term. [2]

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5