Year 9 Biology Workbook

<u>The Polesworth School</u>

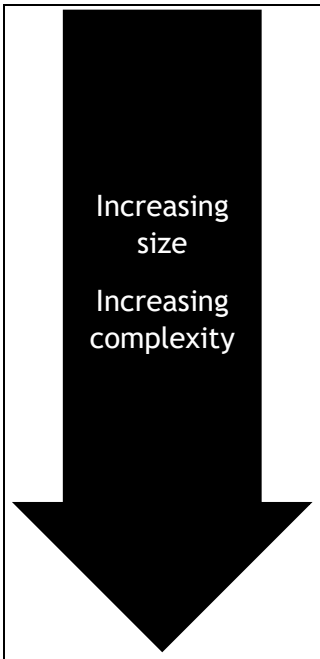
Organisation

Part 1: Tissues and organs

Cells are the building blocks of life. In the previous topic we learnt how prokaryotic life differs from eukaryotic life. With eukaryotes extra complexity it allows them to form multi-cellular life forms, like humans, daisies, mushrooms and grasshoppers. To form a multi-cellular life cells, need to differentiate into specialised cells. This allows groups of cells joined together that perform the same function. A group of specialised cells that work together to do the same job is called a **tissue**. Examples of tissues include muscle tissue (which contracts), epithelial tissue (which covers the outside of the body or around organs) and glandular (which secrete mucus, enzymes or hormones). When more than one tissue is working together to complete a specific function, an **organ** is formed. An example of an organ is the stomach. The stomach is made up of muscular tissue, glandular tissue and epithelial tissue. Other examples of organs include heart, brain, skin, pancreas, and kidney. The pancreas has two important functions creating the hormones that control blood glucose concentration and producing enzymes used in digestion.

A whole multi-cellular organism is made up of a range of **organ systems**. These organ systems are made up of many organs. An example of an organ system is the digestive system and it is made up of organs such as the mouth, stomach, small intestine and large intestine to name a few. Other examples of organ systems include reproductive system, circulatory system and respiratory system.

1. Complete the table (one row has been completed for you)



Organisational levels	Definition	Example
Tissue	A group of specialised cells the perform the same function	Muscle

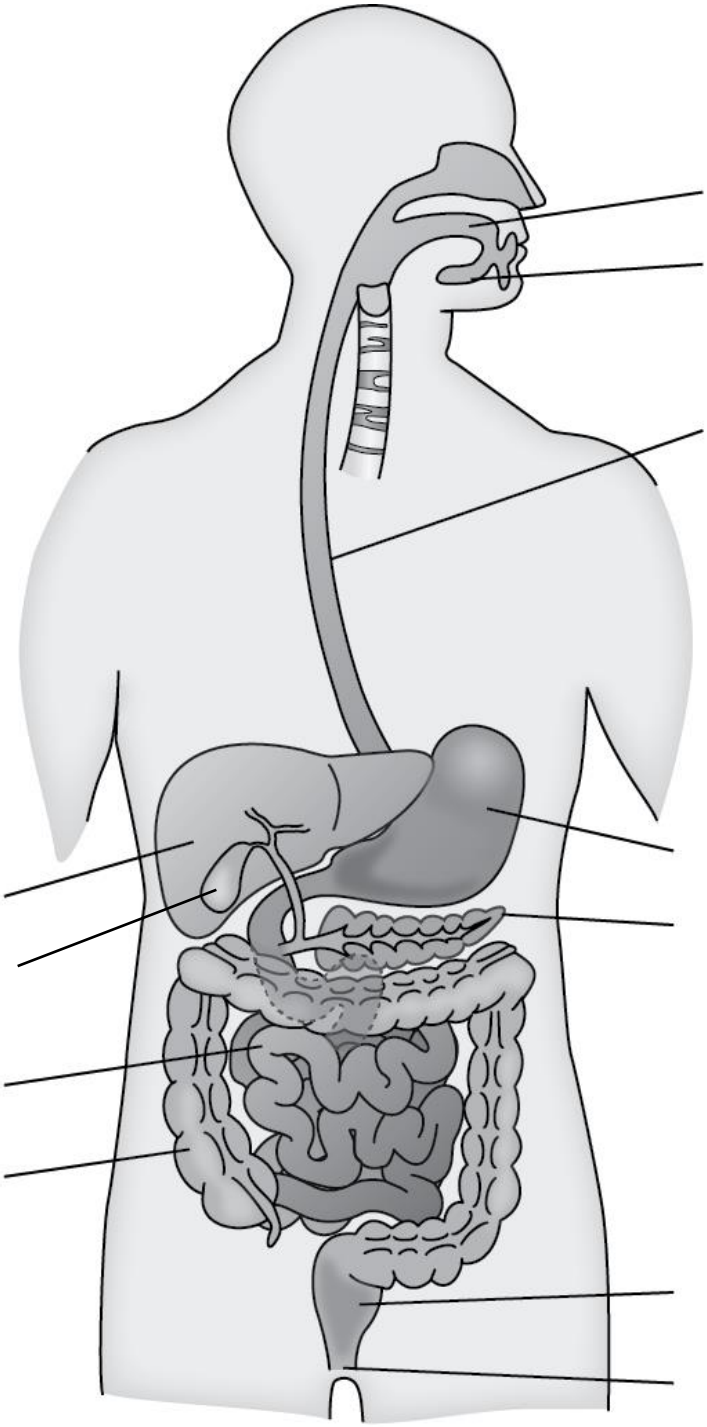
2. Define 'tissue'.
3. Define 'organ'.
4. The stomach contains mainly three types of tissues. State their functions.
   a.) Muscular tissue
   b.) Glandular tissue
   c.) Epithelia tissue
5. Decide for each of the following if they are a specialised cell, tissue or organ. Explain and state their functions.
   a.) Pancreas b.) Neurone c.) Kidney
6. Matt says "The skin is an organ because it is made from epithelial, muscle and glandular tissue." Is he correct? Give a reason.

Part 2- The digestive system

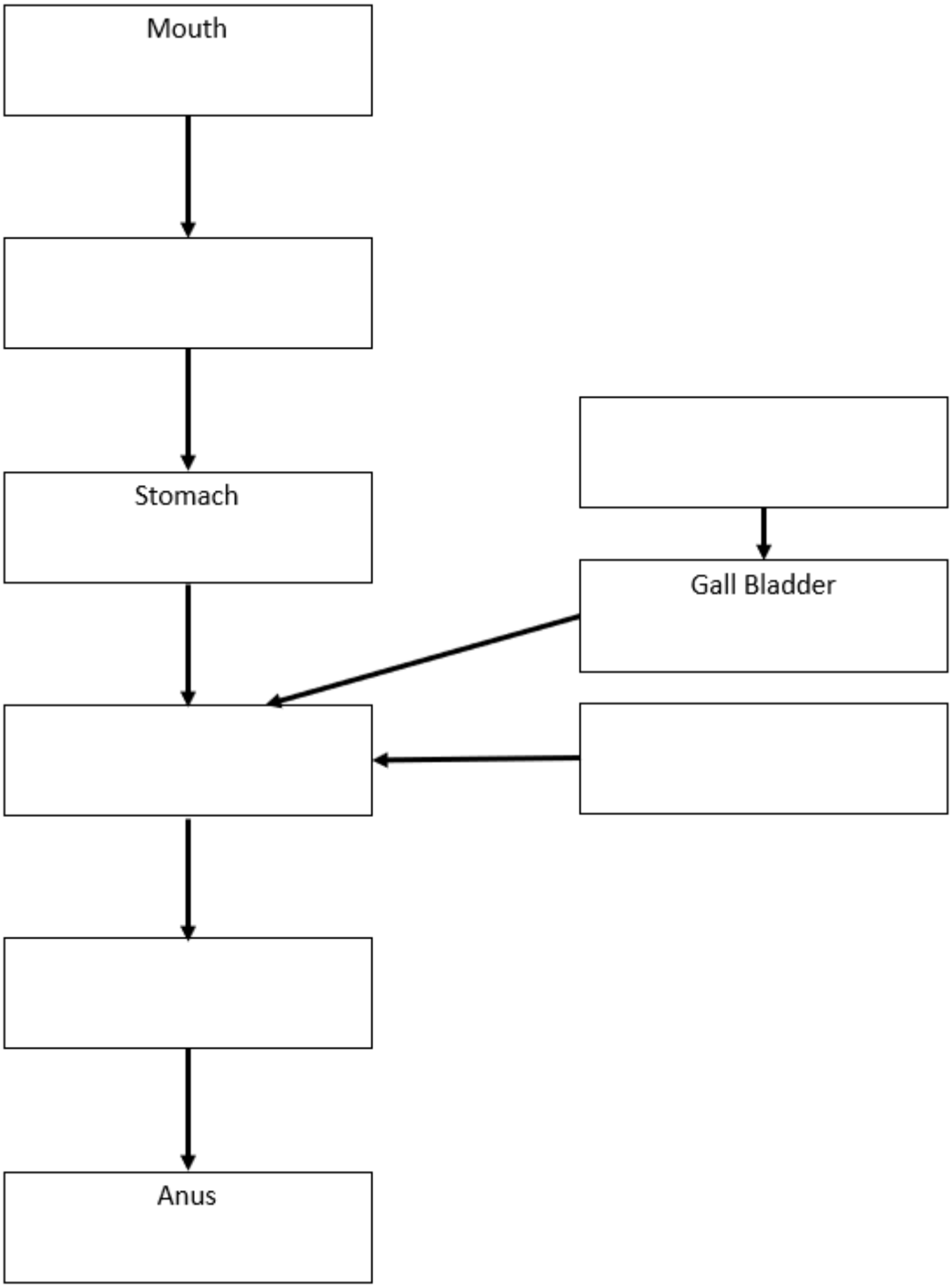
Your digestive system is up to 9m long. The digestive system is an organ system made of many organs that carry out digestion. Digestion is the breakdown of large food molecules into smaller ones. This is important because these large molecules are too big to be absorbed into our blood at the small intestine. These organs include the salivary gland and pancreas that produce enzymes, the liver that produces bile which emulsifies, the stomach that produces certain enzymes and hydrochloric acid. The small intestine is a muscular tube that can contract to move food along it. It

also produces and secretes enzymes. The large intestine absorbs water and contains bacteria to break down any undigested food the inside walls of the small intestine are covered in folds these folds are covered in finger-like projections known as **villi** the folds and finger-like villi **increase** the surface area inside the small intestine. On the villi are also micro-villi which also increase surface area. Like all exchange surface the small intestine has some common adaptations such as a good blood supply to maintain a steep concentration gradient, thin wall/membranes to provide a short diffusion distance and lots of villi and microvilli to increase surface area. All these adaptations speed up the diffusion of digested food. Additionally, cells in the small intestine may have lots of mitochondria to carry out respiration to release energy that is used for active transport of glucose.

7. Label the digestive system with each organ and their function.

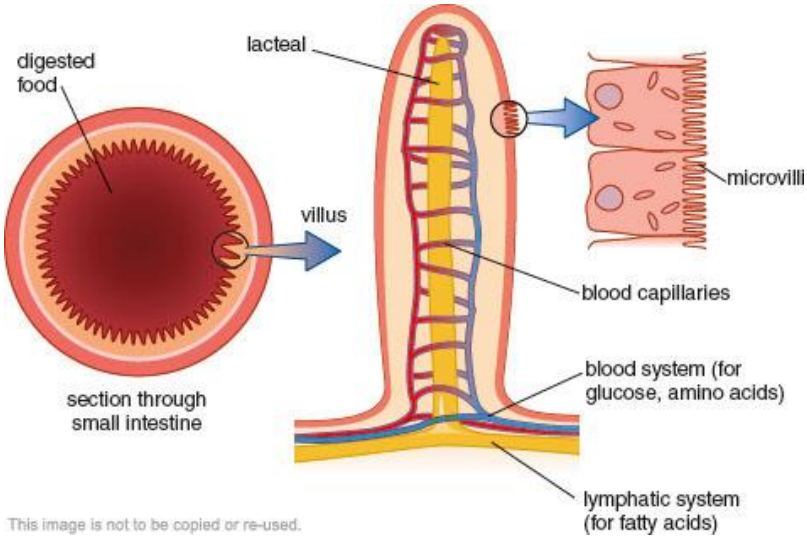


8. Summarise the information above in the flow chart below



9. What is digestion?
10. Why is digestion important to us?
11. Explain why the digestive system is an organ system.
12. Describe and explain the adaptations of the small intestine to help with nutrient absorption.
13. Define 'emulsify'?
14. State the functional difference between the small and large intestines.
15. How is the liver important in helping digestion?
16. Complete the sentences below
    a) The small intestine is long and has a high surface area because….
    b) The small intestine is long and has a high surface area but….
    c) The small intestine is long and has a high surface area so….

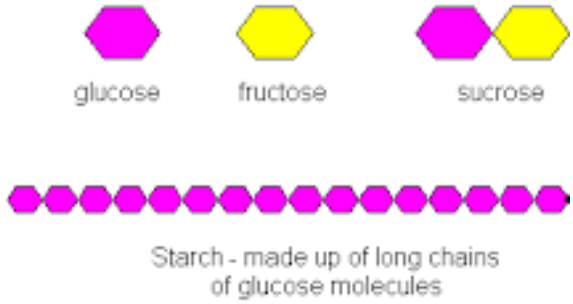
17. What is the role of saliva in the mouth?
18. When someone has diarrhoea they have watery stools when they go to the toilet. What part of the digestive system is most likely not working? Explain your answer
19. What is the name of the organelle where respiration occurs?
20. After a meal there is a high concentration of amino acids in the small intestine. Which process will cause them to move into the bloodstream? Explain your answer.
21. What is the name of the process by which water is absorbed by the large intestine?
22. Why does bile improve the digestion of lipids (fats)?
23. To help diffusion of nutrients from the small intestine should the blood have a high concentration of nutrients or a low concentration of nutrients as it passes the villi?
24. Some people have an illness that needs their gall bladder to be removed. These people can live normal healthy lives. Explain why the gall bladder is not vital for digestion.
25. The picture to the right shows a villus. Explain how they are adapted to absorb nutrients as quickly as possible.



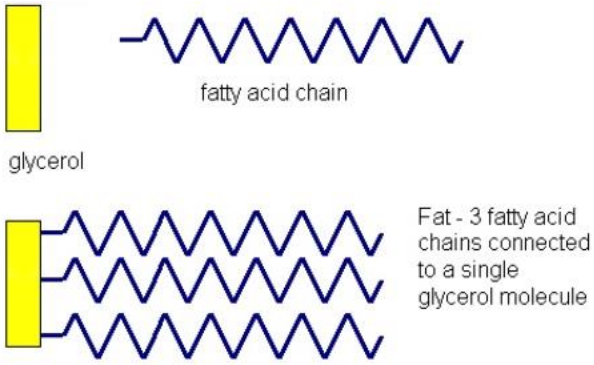
Part 3- The chemistry of food

Carbohydrates, lipids and protein make up most parts of a cell. Therefore, it is important we have lots of them. This makes them the main parts of our diet.

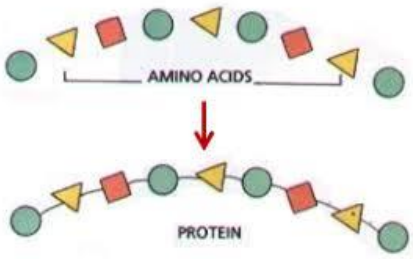
Carbohydrates help provide us with energy. All carbohydrates contain carbon, oxygen and hydrogen. Glucose ($C_6H_{12}O_6$) is a simple carbohydrate made of a single carbohydrate molecule. Sucrose is also a simple carbohydrate made up of two carbohydrate molecules joined together. Glucose molecules can be combined in long chains to form complex carbohydrates. Examples of this include starch and glucagon which act as energy storage molecules in plants and animals respectively. Carbohydrate rich foods include bread, pasta and potatoes.



Lipids are fats and oils. They are an energy store in our cells. When combined with other molecules they can be used to make cell membranes. Like carbohydrates they are made up of carbon, hydrogen and oxygen. They are insoluble in water. Each lipid molecule is made up of three molecules of fatty acids combined with a molecule of glycerol. Olive oil, vegetable oil, cheese, butter and margarine are all sources of lipids.



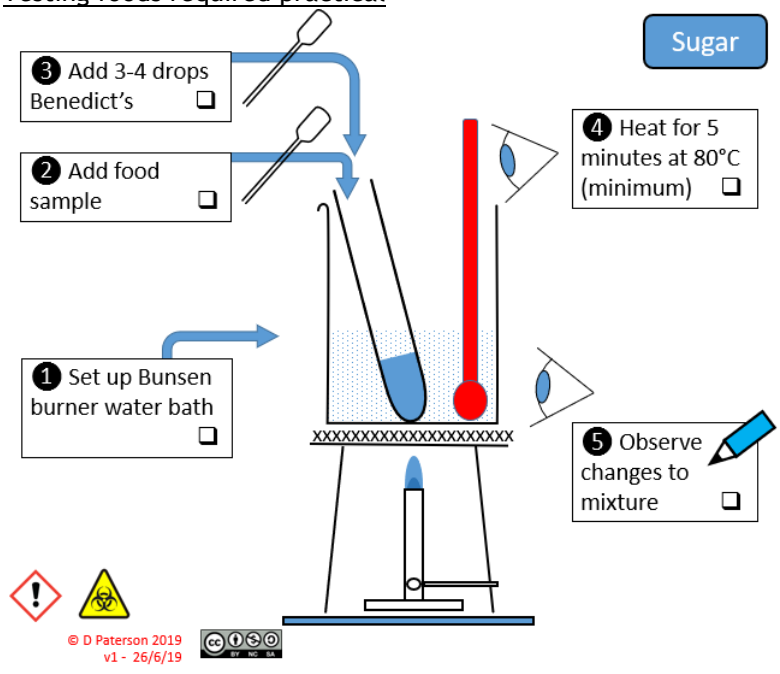
Proteins are polymers made up of amino acids joined together. There are twenty different amino acids which can be combined in different orders to make new proteins. Proteins are used to build our cells and our enzymes. Protein is made up of carbon, hydrogen, oxygen and nitrogen. Protein rich foods include meat, fish and cheese.

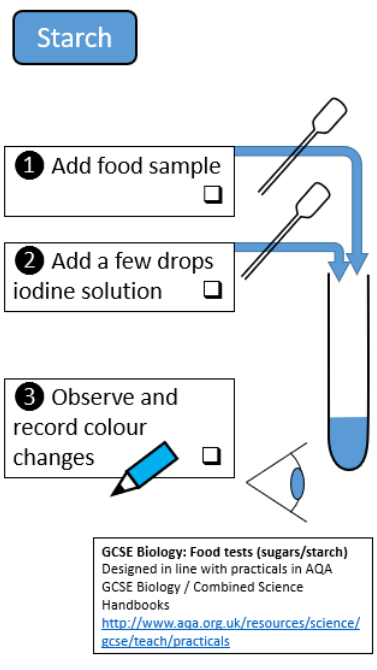


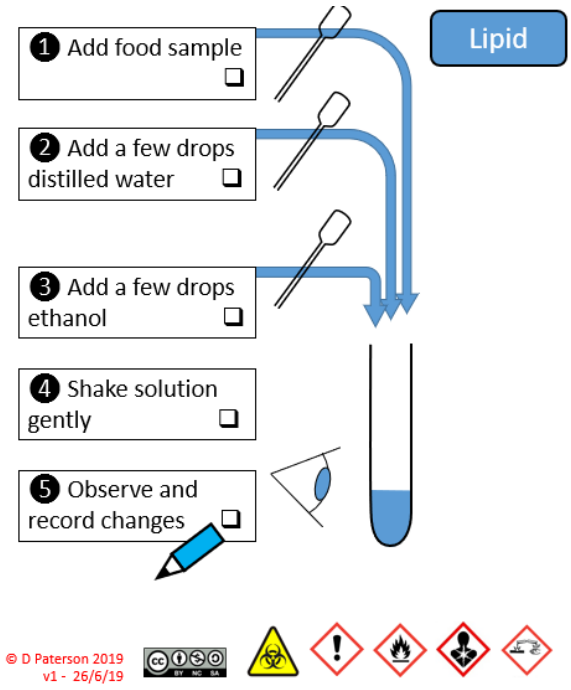
Nutrient	Made of	Uses in living organisms	Sources in our diet
Carbohydrate	Carbon, hydrogen and oxygen		
Lipids (Fats)		Energy store, part of cell membrane	
Protein			Meat, fish, diary

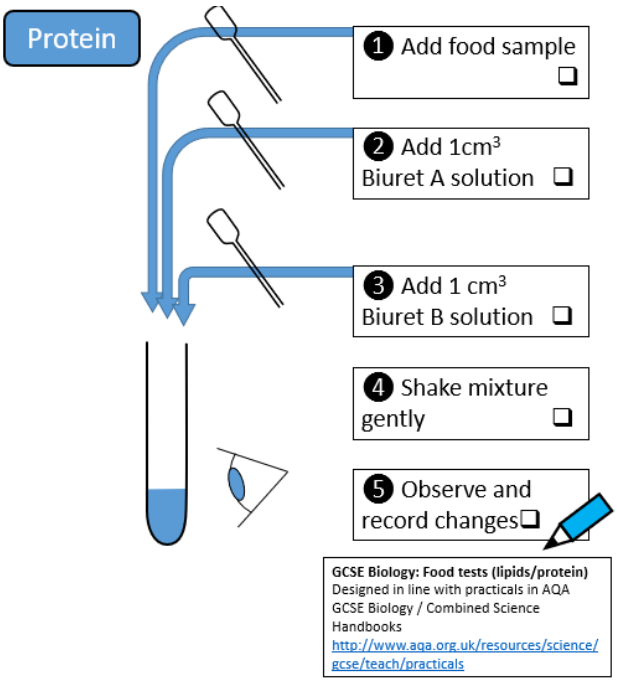
26. Give two functions of carbohydrates.
27. Which atoms make up carbohydrates?
28. State the monomer (the basic unit) of carbohydrates.
29. Glucose is absorbed by the small intestine no matter how low its concentration in the digested food. Which transport process is used?
30. State the chemical formula of glucose.
31. Give two examples of complex carbohydrates.
32. What types of food contain lots of carbohydrates? Give three examples.
33. What are the two types of lipids?
34. Which elements make up lipids?
35. State two functions of lipids.
36. What is the function of the cell membrane?
37. What types of food contain lots of lipids? Give two examples.
38. What process causes water to move across the cell membrane from a dilute solution to a concentrated one?
39. Give two functions of proteins.
40. Which atoms make up proteins?
41. What makes up proteins?
42. Describe how different proteins can be made from the same 3 amino acids
43. If a protein shake is 250g in total advertises it is 40% protein how much protein is in the shake?
44. Whole milk is 4% protein. What mass of whole milk would need to be consumed to get the same amount of protein?

Testing foods required practical

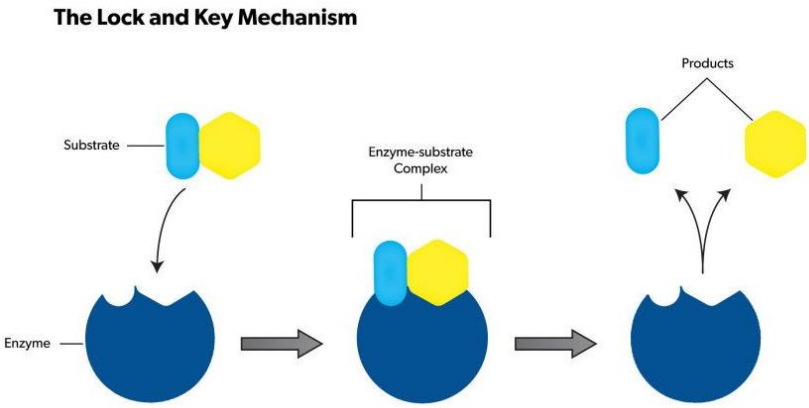








Part 4 Enzymes



Enzymes are proteins. They are incredibly useful and play a role in every process that keep organisms alive. Enzymes are biological catalysts. A catalyst is a substance that speed up a reaction by lowering the activation energy but is not used up. Enzymes can catalyse reactions that break large substances down into smaller ones or build large ones from smaller molecules. Enzyme are incredibly good at doing one specific function. An enzyme is able to bind to only specific molecules (known as the substrate). They have an area called the

active site when the substrate(s) bind. This has a very specific shape. A model people use to explain this is the idea of a lock and key. The enzyme is the 'lock' and the substrate is the 'key'. The main role of enzymes in the digestive system is in the breakdown of large insoluble molecules into smaller soluble ones.

The main enzymes in our digestive system are carbohydrases (amylase), protease and lipases.

Carbohydrases digest carbohydrates. Amylase is the carbohydrase which breaks down starch. Amylase is produced in the salivary glands, pancrease and small intestine. Amylase carries out it's function in the mouth and small intestine. Protease digests protein into amino acids. Protease is produced in the small intestine, stomach and pancreas. Protease is used in the stomach and small intestine. Lipases digest lipids (fats and oils) into three fatty acids and glycerol. Lipase is made in the small intestine and pancreas but is only used in the small intestine. Fats are insoluble in water, so bile is added from the liver to emulsify the fats. This breaks them into small droplets, increasing the surface area so the lipase can work efficiently.

45. Use the information above to complete the table.

Enzyme	Substrate	Products	Made in	Works in
Protease	Protein	Amino acids	Small intestine Stomach Pancreas	Stomach Small intestine

46. Match the following keywords with their functions.

Catalyst	• The enzyme and substrate bound together.
Enzyme	• The special site in the structure of an enzyme where the substrate binds.
Enzyme-substrate complex	• The energy needed for a chemical reaction to take place.
Activation energy	• A substance which changes the rate of a chemical reaction without being changed itself.
Active site	• A biological catalyst.

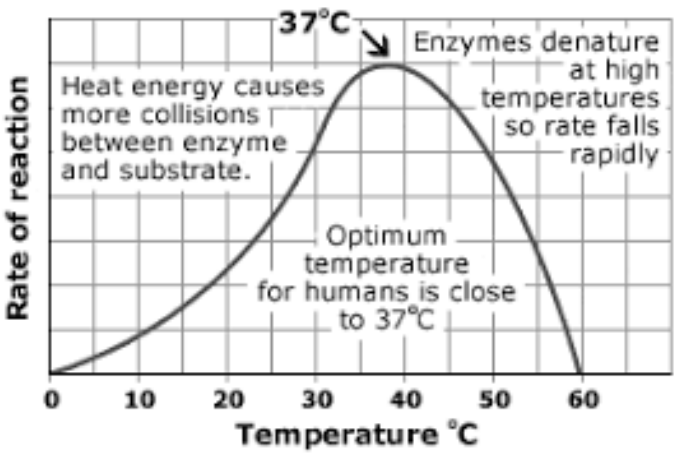
47. What are enzymes?
48. What is the active site of an enzyme?
49. Name the types of enzymes that catalyse the breakdown of:
    a.) Carbohydrates
    b.) Lipids
    c.) Proteins
50. Which organs in the digestive system produce digestive enzymes?
51. Catalase is an enzyme that speeds up the breakdown of hydrogen peroxide. The enzyme increases the rate of reaction so it is 700 times faster. If the enzyme reaction took 1.9s how long would the reaction take if there was no enzyme? Convert the answer to minutes. Give your answer to 4sf.

Part 5 Factors affecting enzyme action

Biological reactions are affected by the same factors as any other chemical reaction: concentration, temperature, and surface area. We are going to focus on the effect of two variables on enzyme-controlled reactions: temperature and pH.

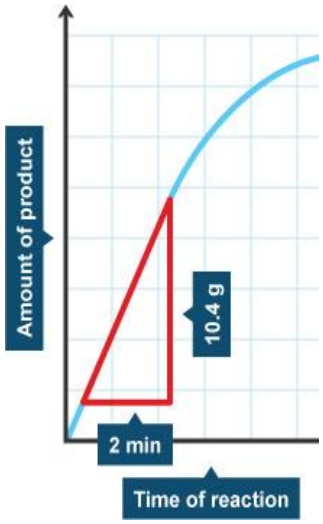
An increase in temperature will increase the rate of an enzyme-controlled reaction up to a certain amount. After about 41°C the enzymes will start to become denatured. When an enzyme is denatured it loses its shape, the active site can no longer bind to the substrate and no enzyme-substrate complexes are formed. When temperature is too low the reaction is slow because the enzymes don't have much kinetic energy and so rarely collide with their substrate

The graph to the right shows how enzymes in the human body are affected by temperature. But some extremophiles (organisms that live in extreme environments) have enzymes that work at temperatures up to 80°C.



Each enzyme has an optimum pH, outside of this pH the enzyme becomes less effective and eventually can be denatured. This is because the forces that hold the enzyme together are weakened and the active site can change shape preventing the formation of enzyme-substrate complexes.

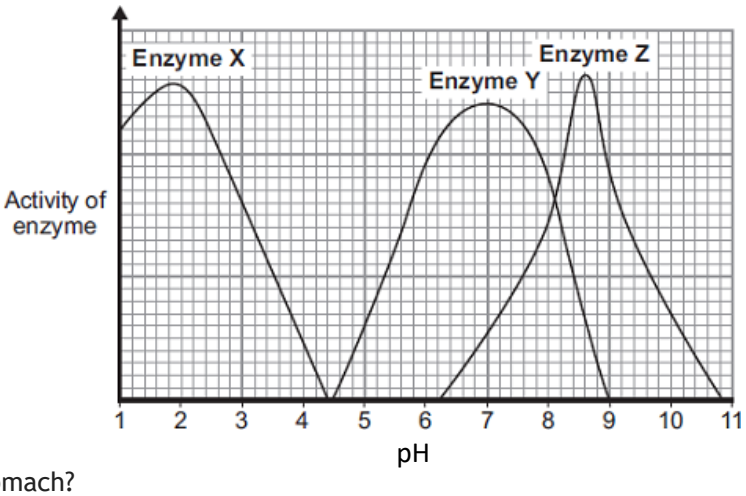
Glands in the stomach release a protease known as pepsin. This pepsin is adapted to work at low pH (acidic). The stomach also produces hydrochloric acid to ensure that pepsin can work most effectively. The stomach produces a thick layer of mucus which coats your stomach and prevents the hydrochloric acid from digesting the walls of the stomach. After being digested in the stomach, food moves into the small intestine. The enzymes in the small intestine, such as pancreatic amylase, prefer an alkaline environment. To produce an alkaline environment bile is produced in the liver. Bile is stored in the gall bladder and is then released into the small intestine to neutralise the acidic solution coming from the stomach. Bile has another job. It emulsifies the fats in our food. This increases the surface area of the fat molecules and allows lipase to break down fats faster.



52. What does *denatured* mean?
53. What happens to enzymes when the temperature is:
    a.) Too low
    b.) Too high
54. Explain the effects of temperature on enzyme action.
55. What is the optimum temperature for enzymes in the human body?
56. What holds enzymes together?
57. How does a change in pH cause enzymes to denature?
58. Using the graph given, calculate the rate of reaction of the enzyme. Remember to include units.
59. What is pepsin?
60. Where is bile produced?
61. State where bile is stored
62. What are two differences between pepsin and pancreatic amylase?
63. What is the difference between pepsin and proteases produced by the pancreas?
64. What are the functions of hydrochloric acid in the stomach?
65. How is the stomach adapted to protect itself from pepsin and the hydrochloric acid?
66. Suggest the optimum pH for enzymes to work in the small intestine.
67. Suggest the optimum pH for enzymes to work in the stomach
68. What happens to an enzyme outside its preferred pH?
69. What else can cause enzymes to be denatured?
70. Which organ produces bile?
71. Describe and explain the functions of bile.

72. Why is emulsification important to lipid digestion?
73. Is it correct to say "the stomach produces hydrochloric acid to digest food"? Explain your answer
74. Is it correct to say "bile breaks down lipids to glycerol and fatty acids"? Explain your answer

75. The graph shows the effect of pH on the activities of three enzymes, **X**, **Y** and **Z**. These enzymes help to digest food in the human digestive system. Each enzyme is produced by a different part of the digestive system.

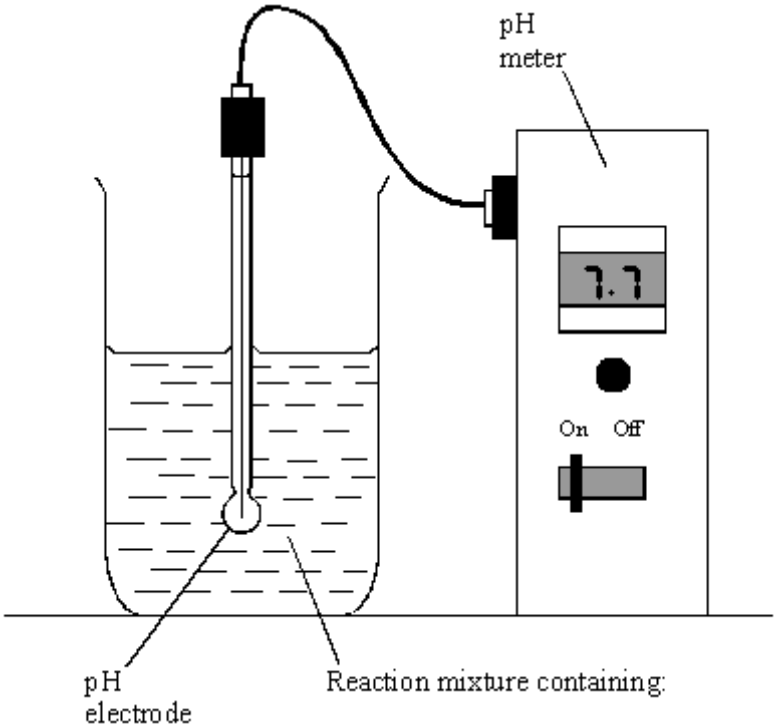


a) What is the optimum (best) pH for the action of enzyme **Z**?

b) The stomach makes a substance that gives the correct pH for enzyme action in the human stomach. Name this substance

c) Which enzyme, **X**, **Y** or **Z**, will work best in the human stomach?

76. The diagram shows the apparatus used to investigate the digestion of milk fat by an enzyme. The reaction mixture contained milk, sodium carbonate solution (an alkali) and the enzyme. In Experiment 1, bile was also added. In Experiment 2, an equal volume of water replaced the bile. In each experiment, the pH was recorded at 2-minute intervals.



Either:

Experiment 1	**or:**	**Experiment 2**
milk (contains fat)		milk (contains fat)
sodium carbonate solution		sodium carbonate solution
bile		water
enzyme		enzyme

The results of the two experiments are given in the table.

Time in minutes	pH	
	Experiment 1: with bile	Experiment 2: no bile
0	9.0	9.0
2	8.8	9.0
4	8.7	9.0
6	8.1	8.8
8	7.7	8.6
10	7.6	8.2

a) Milk fat is a type of lipid. Give the name of an enzyme which catalyses the breakdown of lipids.
b) What was produced in each experiment to cause the fall in pH?
c) For Experiment 1, calculate the average rate of fall in pH per minute, between 4 minutes and 8 minutes. Show clearly how you work out your final answer.
d) Why was the fall in pH faster when bile was present?

Part 6 The Blood

Blood has four main components: **red blood cells**, **white blood cells**, **platelets** all of which are carried in a fluid called **plasma**. Within the plasma dissolved substances like glucose (plus other products of digestion, urea and carbon dioxide will also be carried.

Red blood cells carry the oxygen from the air in our lungs to our respiring cells. Red blood cells have certain adaptations that make them efficient at their job. They are biconcave disks which increases their surface area to volume ratio which increase diffusion. They are packed with haemoglobin which binds to oxygen. They also have no nucleus which makes space for more haemoglobin.

White blood cells form part of the immune system. Some white blood cells (lymphocytes) produce antibodies whilst others produce antitoxins and yet others (phagocytes) engulf and digest invading microorganisms.

Platelets are small fragments of cells without a nucleus. They are involved in the clotting of blood. Blood clotting is a series of enzyme-controlled reactions that results in the conversion of fibrinogen into fibrin. This forms a network of fibres that traps more platelets and red blood cells forming a scan which protects the new skin as it grows.

77. Complete the diagram below to summarise the constituents of the blood

Plasma:

Red blood cells:

White blood cells:

Platelets:

78. What is blood made up of?
79. Name 5 things found in plasma
80. What is the job of red blood cells?
81. What is the job of haemoglobin?
82. State two adaptations of red blood cells
83. Explain how being biconcave is useful
84. How can white blood cells protect us against infection?
85. What type of cell contains 0 chromosomes?
86. How do platelets form scabs?

Part 7 – The blood vessels

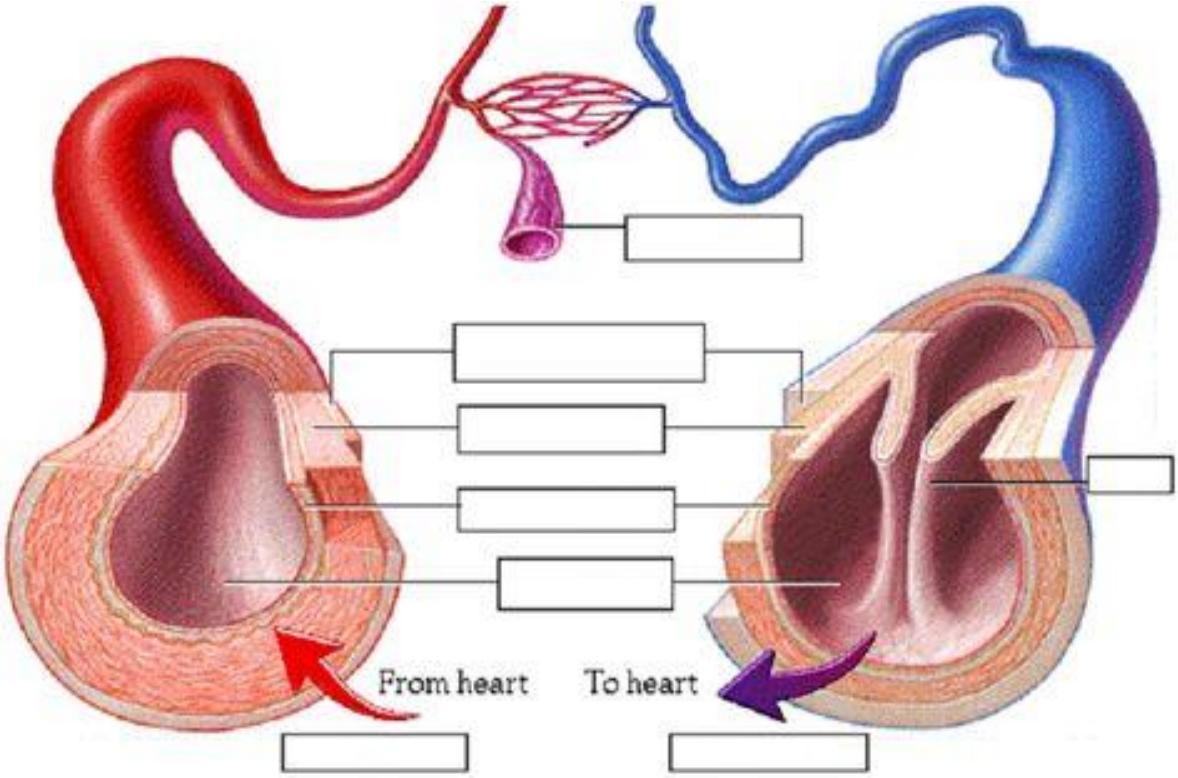
Blood is carried round our body in three main types of vessel. Each vessel is adapted for a different function.

Arteries carry blood away from the heart to the organs or body. The blood is usually oxygenated with the exception of the pulmonary artery. Blood in the arteries is under high pressure. Arteries have a thick layer of muscle and elastic fibres along with thick walls to allow them to withstand the high pressure and to stretch. Arteries have a small lumen.

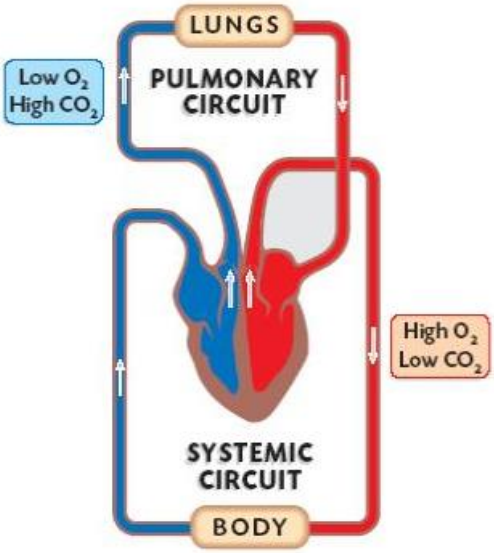
Veins carry blood away from organs towards the heart. The blood is low in oxygen, except for the pulmonary vein. veins have a larger lumen and relatively thin muscular and elastic walls. This is because the blood is under less pressure. Veins have valves to prevent blood flowing backwards.

Capillaries connect arteries to veins. Capillaries are very narrow with thin walls. This ensures there is a short diffusion distance the inside of the capillary and surrounding cells. This enables substances such as glucose and oxygen to easily diffuse out of your blood into cells. Conversely carbon dioxide can easily do the opposite. Capillaries have very narrow lumens which only allow 1 cell to pass through at a time and their walls are only 1 cell thick.

87. Complete the labels in the diagram using the text above



Humans have a double circulation system. One transport system carries blood from your heart to the lungs and back again and the other system carries blood from the heart to all other organs of your body and back again. This double circulation system is advantageous to us as we need lots of oxygen and glucose transported round our body. The double circulation system allows lots of oxygenated blood to be transported quickly where it needs to go.



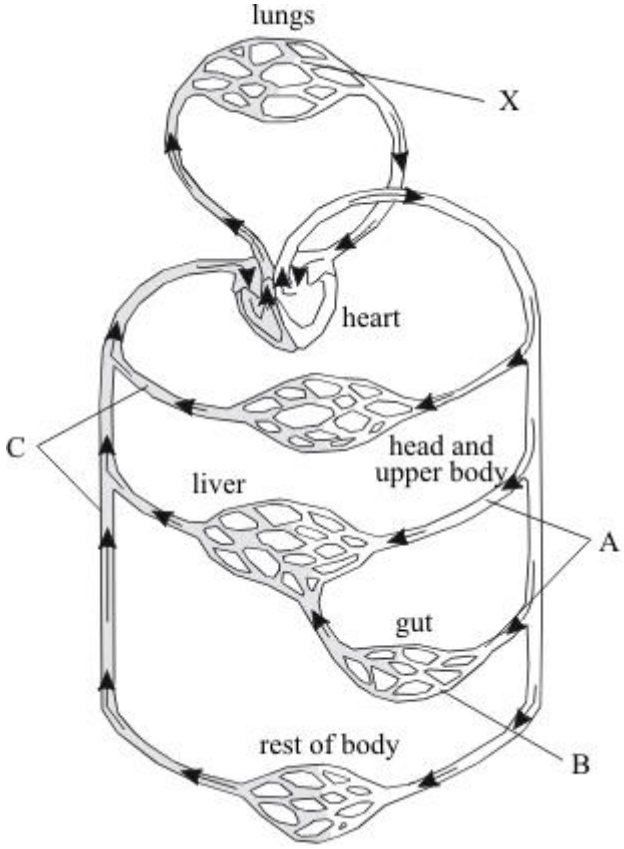
88. What are the three types of blood vessel?
89. What type of blood vessel carries blood away from the heart
90. Why do the arteries have a thick layer of elastic fibres and muscle tissue?
91. What is the pressure like inside the arteries?
92. Red blood cells have no nucleus, What is the function of the nucleus?
93. What do veins have that prevent back flow?
94. How is the pulmonary vein different to other veins?
95. What process will allow oxygen to move from the red blood cells into the muscle cells.
96. Order the blood vessels from largest lumen to smallest lumen

97. What is the benefit of the walls of capillaries only being 1 cell thick
98. Why is our circulation system described as a double circulation system?
99. What diffuses from the capillaries into cells?

100. Name the types of blood vessel labelled A, B and C on the diagram.

101. What is the job of the circulatory system?

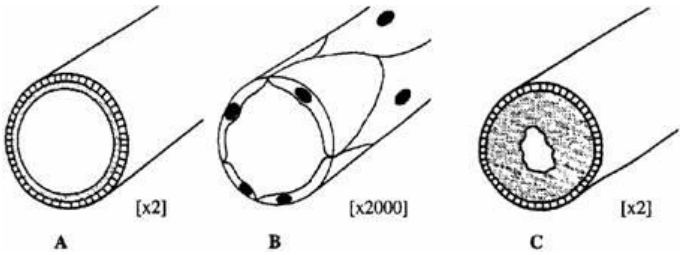
102. Give **two** ways in which the composition of blood changes as it flows through the vessels labelled X on the diagram.



103. The drawings show the structure of three types of blood vessel, **A**, **B** and **C**. They are drawn to the scales indicated.

(a) Name the **three** types of blood vessel.

(b) Describe the job of blood vessel **B**.

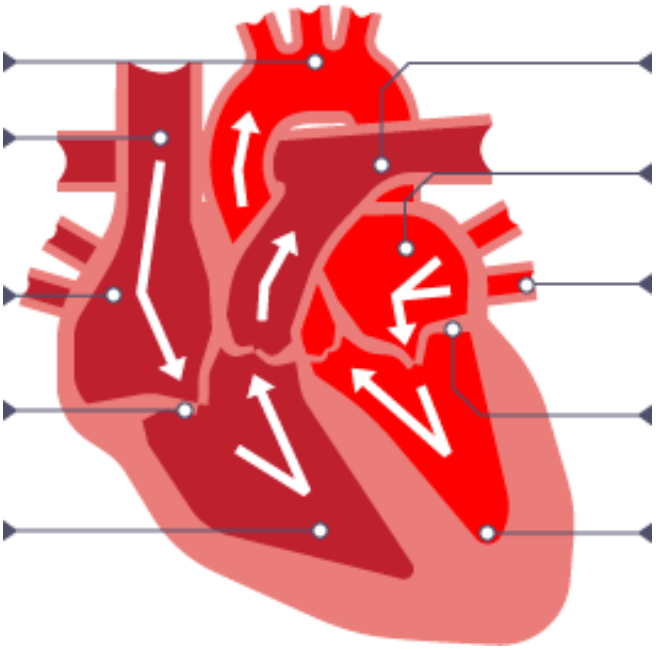


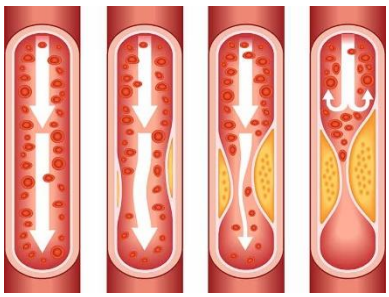
Part 8- The Heart

Your heart is the organ that pumps blood round our body. It is made up of two pumps. The walls of your heart are almost entirely muscle and the blood vessel that supplies the heart with oxygen is called the coronary artery.

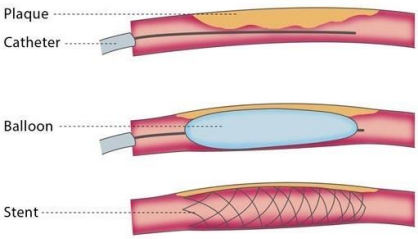
Blood enters the **right atrium** through the **vena cava** (a vein that brings deoxygenated blood back to the heart). Blood will then travel from the **right atrium** to the **right ventricle**. The **tricuspid valve** will then close to prevent backflow. When the **right ventricle** contracts deoxygenated blood is forced into the **pulmonary artery** which travels to the **lungs** to pick up oxygen. This newly oxygenated blood is returned to the heart by the **pulmonary vein** into the **left atrium**. Blood flows into the **left ventricle**, the **bicuspid valve** closes to prevent backflow. The **left ventricle** pumps oxygenated blood around the body via the **aorta**. Whenever blood enters the aorta or pulmonary artery valves at the beginning of these vessels close. The muscle wall of the left ventricle is thicker than elsewhere. This allows the blood leaving the left ventricle to be under the high pressure needed to pump it round the **body**.

104. Label the heart with the structures and relevant information





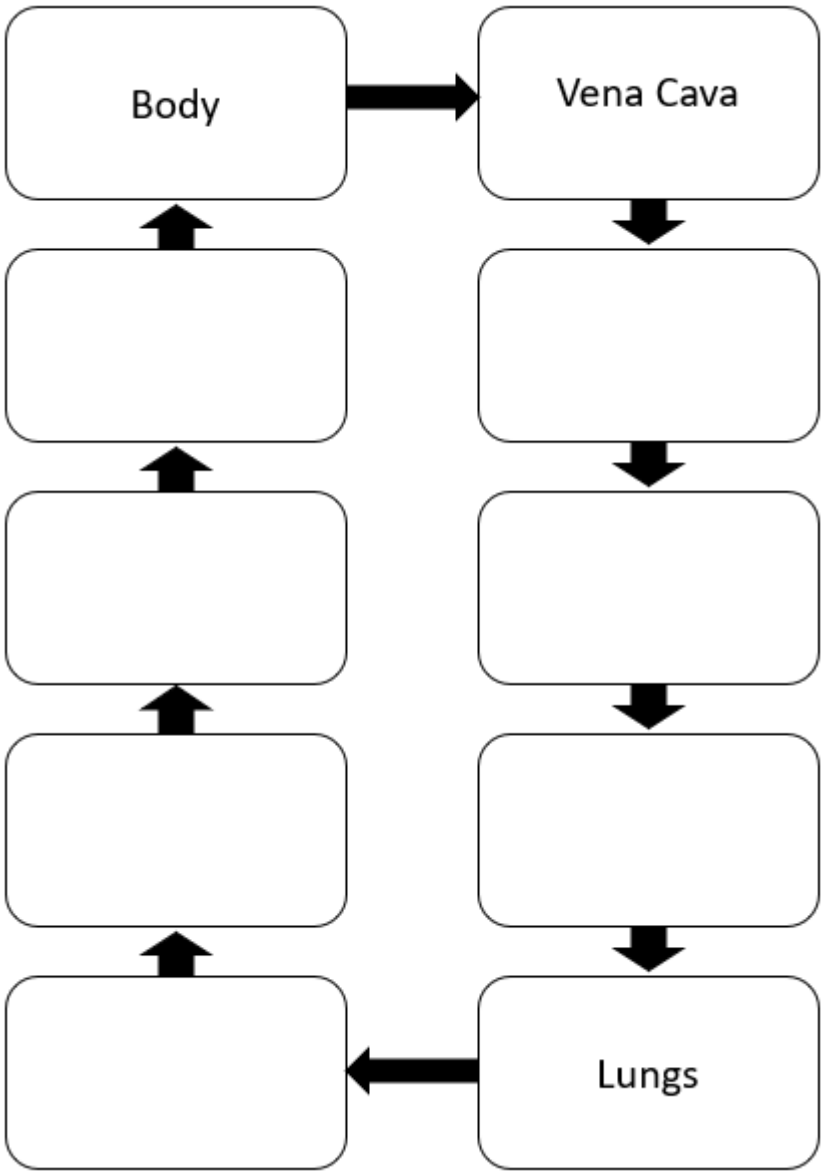
Coronary heart disease is caused by the narrowing the **coronary arteries** that supply the heart. This is caused by a build-up of fatty material on the lining of the vessels which reduces the supply of oxygen to the heart. Coronary heart disease can be treated with a stent. A stent is a metal mesh placed in the artery.



A tiny balloon is then inflated to open the blood vessel and the stent. The balloon is then removed but the stent ensures the blood vessel remains widened. Stents don't require general anaesthetic and can be placed anywhere in the body.

Another option is bypass surgery where the blocked artery is replaced with bits of veins. This require surgery and general anaesthetic but can be used on extremely blocked arteries where stents can't help. Another option is to prescribe statins. Statins reduce blood cholesterol levels and slows down the rate at which fatty material is deposited. However, it can't be used to treat already affected arteries.

105. Add as much detail as possible to this diagram to show the route of the blood

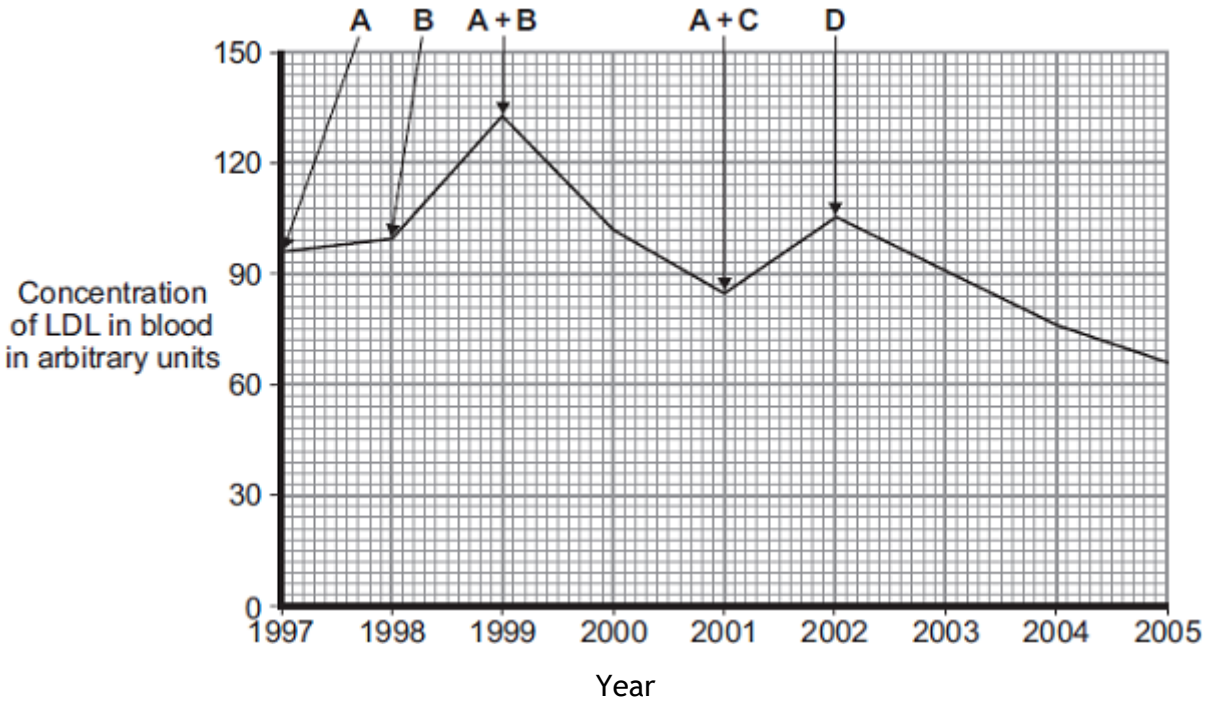


106. What is the name of the blood vessels that supply the heart with oxygen?
107. What is the name given to the top chambers of the heart?
108. What blood vessel supplies the left atrium with blood?
109. What blood vessel supplies the right atrium with blood?
110. What is special about the pulmonary artery?
111. What type of blood is found in the right ventricle?
112. What causes coronary heart disease?
113. What are three methods of treating coronary heart disease?
114. Why does the left ventricle have thick muscular walls?
115. What is an advantage of stents?
116. How do stents work?
117. What is a disadvantage of bypass surgery?
118. Evaluate the use of three methods of combating coronary heart disease (hint: evaluation is pros, cons and then choosing which one is best overall)
119. The circulatory system contains arteries and veins.
    a) Describe how the structure of an artery is different from the structure of a vein.

b) A comparison is made between blood taken from an artery in the leg and blood taken from a vein in the leg.
c) Give two differences in the composition of the blood.

120. LDL is one form of cholesterol found in the blood.

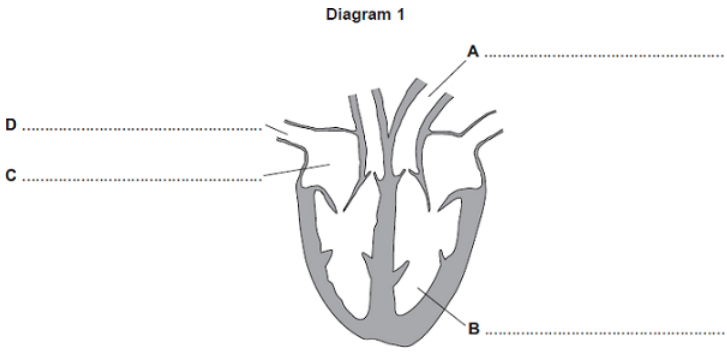
- People with a high concentration of LDL in their blood may be treated with drugs called statins.
- A high concentration of LDL cholesterol in the blood may result in an increased risk of heart and circulatory diseases.
- The graph shows the effects of the treatment of one person with four different statins,
- A, B, C and D, over a period of 8 years. The arrows show when each new treatment was started.
- Each treatment was continued until the next treatment was started.



Compare the effectiveness of the five treatments in reducing the risk of heart and circulatory diseases for this person.

121. Describe the journey of an oxygen molecule from the air into a muscle cell. Try to include the names of all the organs and cells involved.

122. **Diagram 1** shows a section through the heart. Name the parts labelled **A**, **B**, **C** and **D**.



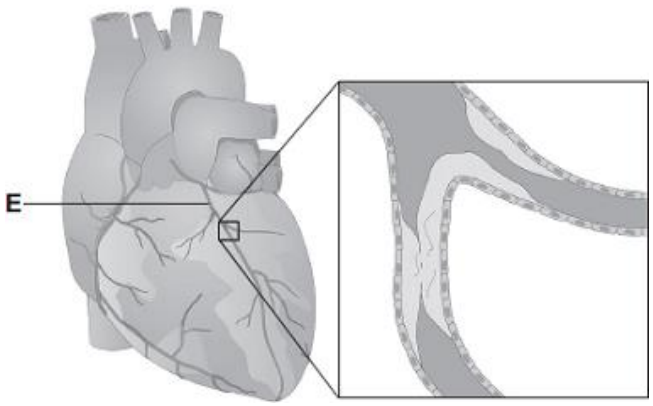
123. **Diagram 2** shows the blood vessels that supply the heart muscle. Part of one of the blood vessels has become narrower.

a) Name blood vessel **E**.

b) Give **one** method of treating the narrowed part of blood vessel **E**.

c) Explain how the method of treatment works.

Diagram 2



124. Read Lewis' answer to the question *How does a fatty deposit in the arteries cause a heart attack*
"When the fat builds up the blood flow through the pulmonary artery becomes blocked. This means the heart muscle will not get enough carbon dioxide. This means that the muscle will not be able to anaerobically respire so will die, This causes the heart attack"
There are three errors in Lewis' answer. Find them and write out the correct version in your book

Part 9 – Helping the heart

Heart valve shave to withstand a lot of pressure. As such they may start to leak. Doctors can operate and replace faulty valves with mechanical valves made of titanium. These mechanical valves are long lasting but require medication to prevent blood clotting around it. Biological valves are based on valves from pigs or even human donors. These do not require any medication but only last 12-15 years.

The heart normally beats at 70bpm. The beating of the heart is controlled by a group of cells found in the walls of the right atrium. This cluster of cells can stop working and needs replacing with an artificial pacemaker. If a persons heart beats too slowly they won't get enough oxygen. The most common disease treated by pacemakers is arrhythmia (abnormal heart rhythm). An artificial pacemaker is an electronic device that weighs between 20-50g and is connected to your heart by two wires. They control when the heart beats by sending strong , regular electronic signals to the heart. Modern pacemakers are very sensitive and only act when something is amiss and can even stimulate the heart to beat faster when you exercise. If you have a pacemaker fitted you will need regular check-ups throughout your life, however, this is a small price to pay when weighed against the increased quality and quantity of life gained by having one.

Artificial hearts are used when a person's heart stops working completely. It can take a long time for a donor heart to become available, so artificial hearts are used to keep the patient alive in the meantime. There is a risk of blood clotting with artificial hearts.

125. What two methods of replacing heart valves?
126. What is an advantage and disadvantage of each method?
127. What is the danger if a persons heart beats too slowly?
128. What is a disadvantage of wearing a pacemaker?
129. Why are artificial hearts used?
130. What is a risk of artificial hearts?
131. **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Every year, many patients need to have heart valve replacements.

The table gives information about two types of heart valve.

Living human heart valve	Cow tissue heart valve
• It has been used for transplants for more than 12 years.	• It has been used since 2011.
• It can take many years to find a suitable human donor.	• It is made from the artery tissue of a cow.
• It is transplanted during an operation after a donor has been found.	• It is attached to a stent and inserted inside the existing faulty valve.
• During the operation, the patient's chest is opened and the old valve is removed before the new valve is transplanted.	• A doctor inserts the stent into a blood vessel in the leg and pushes it through the blood vessel to the heart.

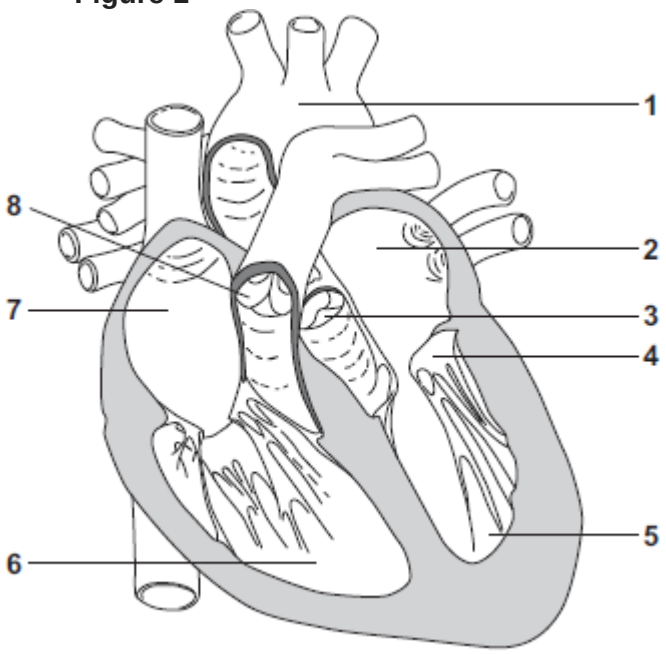
A patient needs a heart valve replacement. A doctor recommends the use of a cow tissue heart valve.

Give the advantages and disadvantages of using a cow tissue heart valve compared with using a living human heart valve.

Use information from the table and your own knowledge in your answer. Make sure you give a conclusion.

132. The diagram in **Figure 1** shows a section through the human heart, seen from the front.

Figure 1



(a) Draw a ring around the correct answer to complete each sentence.

i) What type of tissue is the heart mainly made of?

ii) The resting heart rate is controlled by the pacemaker. Give the number where the pace maker is located?

(b) Write a number, **2**, **5**, **6** or **7**, in **each** of the three boxes to answer this question.

Which chamber of the heart:

pumps oxygenated blood to the head and body ☐

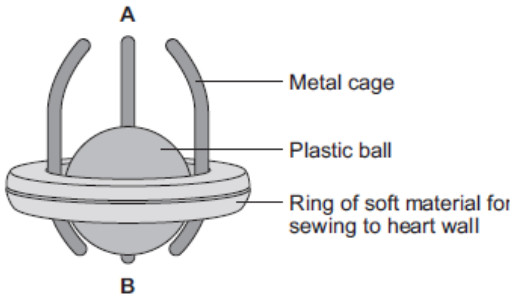
receives deoxygenated blood from the head and body ☐

receives oxygenated blood from the lungs? ☐

(ii) Give the number, **3**, 4 or **8**, of the valve that closes when the blood pressure in the aorta is greater than the blood pressure in the left ventricle.

Write the correct answer in the box. ☐

(c) The diagram shows one type of artificial heart valve. The plastic ball is in the closed position.



This type of artificial valve could be used to replace a faulty valve in the heart.

(i) What is the function of valves in the heart?

(ii) The artificial valve could be used to replace valve **4** shown in **Figure 1**.The artificial valve opens to let blood through when the ball is moved towards **A**.

Which end of the valve, **A** or **B**, should point towards chamber **5**?

Explain your answer.

(d) (i) The artificial heart valve may cause blood clots to form on its surface. Describe what happens during blood clotting.

(ii) Read the information in the passage.

> Replacing a damaged heart valve can dramatically improve the blood circulation and the supply of oxygen to the body's tissues. The operation to replace a heart valve is a long one during which the patient's blood goes through a bypass machine.
> Sometimes the artificial valve can fail to work. If the surface of the valve becomes rough, small blood clots can form on its surface then break away and be carried around the body by the blood.

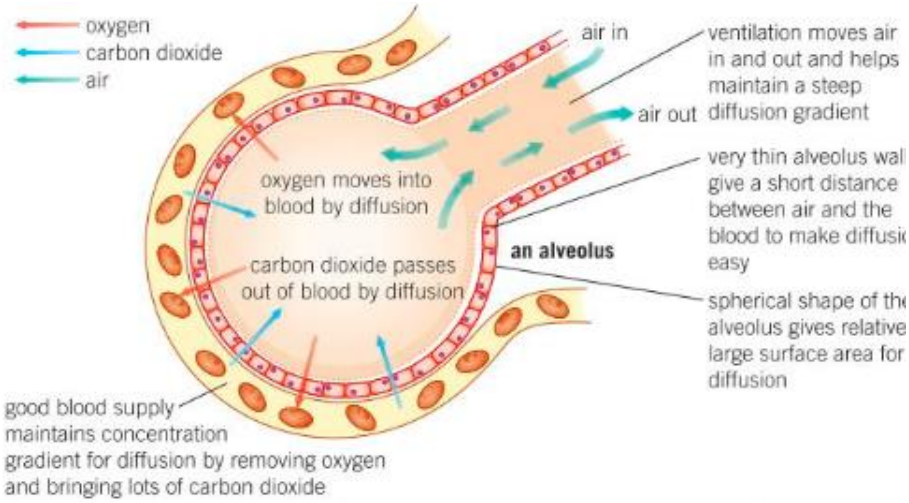
Evaluate the advantages and disadvantages of artificial heart valves.

Part 10 - Breathing and gas exchange

Figure 2 *Ventilation of the l*

Your lungs are found in your chest or thorax and are protected by your ribcage. They are found above the organs of your digestive system and are separated from by a layer of muscle called the diaphragm. The lungs are a part of the gas exchange or ventilation system and the role of this system is to move air in and out the lungs. The lungs are made up of tiny air sacs called alveoli which increase the surface area for gas exchange. The walls of the alveoli are very thin (only 1 cell thick) to provide a short diffusion distance for gas exchange. The alveoli also have a rich supply of blood capillaries to maintain a concentration gradient. Ventilation of the lungs is controlled by the contraction or relaxation of the intercostal muscles and the diaphragm which changes the pressure of the lungs resulting in the movement of gases like oxygen in and out the lungs. Oxygen is used for aerobic respiration and so is important as without it we could not release energy

Shown to the left is the process of breathing in and out. When you breathe in, oxygen rich air will move into the lungs. This means there is a high concentration of oxygen in the lungs and maintains a steep concentration gradient between the lungs and the bloodstream. Diffusion causes particles to go from a high concentration to a low concentration and therefore oxygen moves from the lungs to the blood by this process. Breathing out removes carbon dioxide rich air from lungs maintaining a concentration gradient between the bloodstream and the lungs with the blood stream having a higher concentration of carbon dioxide resulting in carbon dioxide continually diffusing out of the blood stream.



133. What protects your lungs?
134. What makes red blood cells special?
135. What structure makes up the lungs?
136. Give two adaptations of alveoli
137. State two gasses that are moved in and out of the lungs by ventilation.
138. What two sets of muscles control gas exchange
139. What is the relationship between volume of the chest and pressure?
140. Describe the changes that will occur in the lungs when breathing in and out
141. Describe the changes that will occur in the lungs when emerging from a dive in water
142. If the pressure in the lung is high, am I breathing in or out?

143. Label the table below with % of air breathed in and % of air breathed out

Atmosphere gas		
Nitrogen	80	80
Oxygen	16	20
Carbon dioxide	4	0.04

144. Draw a bar chart to show the difference between the air you breathe in and the air you breathe out (use table above)
   a) Describe the changes in the composition gases in inhaled air and exhaled air. (include magnitude of any difference)
   b) A student says "we breathe in oxygen and breathe out carbon dioxide" explain whether the student is correct. Use data from table 1.

Part 11 – Human health issues

Good health is defined as a state of complete physical, mental and social wellbeing. Things that can reduce a person's health include disease, diet and stress.

Diseases can interact to create unexpected consequences. Some examples are:

- Defects in the immune system mean that an individual is more likely to suffer from infectious diseases.
- Viruses living in cells can be the trigger for cancers.
- Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma. Severe physical ill health can lead to depression and other mental illness.

One of the biggest impacts on a person's life is their diet. If a person takes in more calories than they use they will increase in body mass. IF this gets to an extreme level they can be classified as obese. One of the biggest problems with obesity is the chance of developing type 2 diabetes.

Cancer is uncontrolled cell division. A tumour is a group of cells that are dividing uncontrollably. Tumours come in 2 forms, benign and malignant. Benign tumours are normally located in one place and do not invade other parts of the body. A benign tumour can be dangerous if found near an important organ. However, in general they are less likely to cause death than malignant tumours. A malignant tumour can spread around the body by invading other parts. A malignant tumour is often called cancer. Cells from a malignant tumour can break off from the larger tumour and go into the blood to be transported to other places in the body.

Different cancers can be caused by different things. For example, a genetic mutation passed down from parents causes some breast cancers. Chemicals like tar and asbestos can cause our DNA to mutate which can lead to cancer. These chemicals that cause our DNA to mutate are known as carcinogens. Ionising radiation like UV light and X-rays can also cause mutations that lead to cancer.

Due to how it can spread throughout the body, cancer can be hard to treat. Radiotherapy is one way cancer can be treated. This involves using targeted doses of radiation to treat cancer cells. Radiotherapy works by disrupting mitosis. However, it can also affect healthy cells. Another way to treat cancer is chemotherapy which involves using chemicals to stop the cancer cells dividing or make them 'self-destruct'.

145. Define health
146. What is the word to describe someone with a large body mass for their height?
147. What is the main consequence to obesity?

148. Define cancer
149. Define a tumour
150. Distinguish between the two types of tumour
151. State three causes of cancer
152. Define a carcinogen
153. Describe two ways of treating cancer
154. Explain why scientists are still trying to find new ways of treating cancer

Maths Skills

Calculating a mean

Type of cancer	Number of deaths in 2014	Number of deaths in 2015	Number of deaths in 2016	Mean number of deaths	Calculating percentage change
Lung cancer	12,700	10,300	13,000		
Prostate cancer	6478	7220	8001		
Leukaemia	14,300	14,678	11,000		
Bowel cancer	3678	3789	4352		
Breast cancer	9,000	8423	8421		
Skin cancer	766	798	861		

Calculating percentage change (show working in books where necessary)

Model example

Calculate the percentage change in number of deaths between 2014 and 2016 for skin cancer

$$\frac{861-766}{766} \times 100 = 12.4\%$$

152. Describe the trend in number of deaths by breast cancer over time (2)
153. Describe the pattern between number of deaths by bowel cancer and time
154. Compare the change in number of deaths over time for leukaemia and lung cancer
155. A newspaper runs an article with the headline 'deaths by cancer are at an all time high!!!' Evaluate the claims made by this newspaper using the data above

Part 12 – Smoking

There are around 1.1 billion smokers worldwide and about 6000 billion cigarettes smoked each year. About 150 of the chemicals found in cigarettes are linked to disease. Nicotine is an addictive but 'harmless' drug found in cigarette smoke. It produces a sense of calm well-being which is what makes people want to keep smoking. Carbon monoxide is a poisonous gas that binds to our red blood cells in the place of oxygen. After a cigarette around 10% of the red blood cells in the body carry carbon monoxide instead of oxygen. This is why smokers get more breathless than non-smokers.

This oxygen shortage is a particular problem in pregnant women that smoke. This oxygen shortage can lead to premature births, low birthweight babies and even stillbirths. There are around 3500 stillbirths in the UK each year and around 20% of these are attributed to smoking.

Some chemicals in tobacco smoke can anaesthetise the cilia in the trachea and bronchi which stops them working and therefore they don't move mucus, dirt or bacterial away from our lungs. This increases the chance of pathogens getting into the lungs and causing infections. Another chemical found in tobacco smoke is tar. Tar can cause many different diseases including bronchitis and COPD. As well as that tar is also a carcinogen which means tar can cause lung cancer.

152. State three components of cigarette smoke
153. What is the effect of nicotine
154. Describe the effect of carbon monoxide
155. Describe the effects of tar
156. Suggest why oxygen shortage is more of a problem for pregnant woman than a non-pregnant woman
157. What can the effects of smoking on a pregnant woman be?
158. Explain why smoking before a football match is a bad idea (Hint: relate your answer to respiration)

Table 1 *The number of deaths by cardiovascular disease (CVD) by average number of cigarettes smoked a day*

Cigarettes smoked per day	CVD deaths per 100 000 men per year
0	572
10 (range 1–14)	802
20 (range 15–24)	892
30 (range >24)	1025

Math Skills

159. How many cigarettes does each smoker smoke on average?
160. If 20% of 3500 stillbirths are caused by smoking, how many is this?
161. Summarise what the data in table 1 shows
162. Calculate the percentage increase in the number of deaths when someone smokes 20 cigarettes instead of not smoking
163. Display the date in table 1 in a bar chart

164. Gases enter and leave the blood by diffusion.

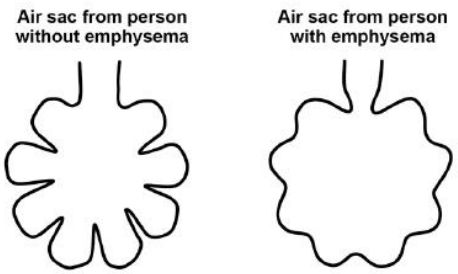
(a) Define the term diffusion.

(b) Name the main gases that diffuse into and out of the blood **in the lungs**.

(c) Smoking can cause emphysema.

Look at **Figure 1**.

Figure 1



Emphysema causes the walls of the air sacs in the lungs to break down

Explain how this will affect the diffusion of gases into and out of the blood.

Smoking during pregnancy can cause low birth mass in babies.

Table 1 shows the World Health Organisation categories for birth mass.

Table 1

Category	**Birth mass in g**
Above normal birth mass	> 4500
Normal birth mass	2500–4500
Low birth mass	1500–2499
Very low birth mass	1000–1499
Extremely low birth mass	< 1000

(d) Complete **Table 2**.

Use information in **Table 1**.

Table 2

Baby	**Birth mass in g**	**Category**
A	2678	Normal birth mass
B	1345	
C	991	

(2)

Figure 2 shows data from a study about pregnancy and smoking in women in the UK.

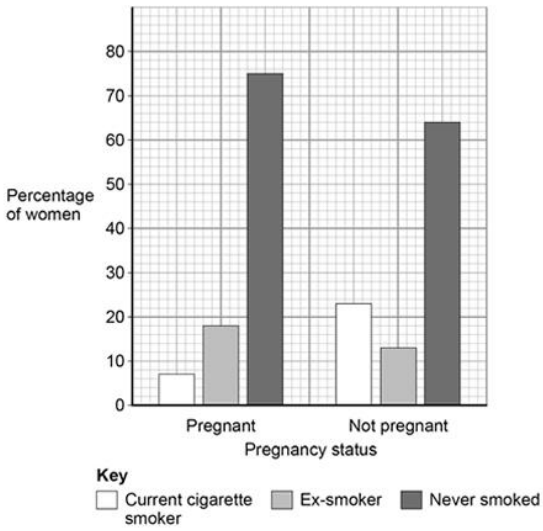
(e) Sampling from the whole UK population would **not** be appropriate for this study.

Give **one** reason why.

(f) Give **three** conclusions that can be made about smoking in pregnant women compared with non-pregnant women.

Use information from **Figure 2**.

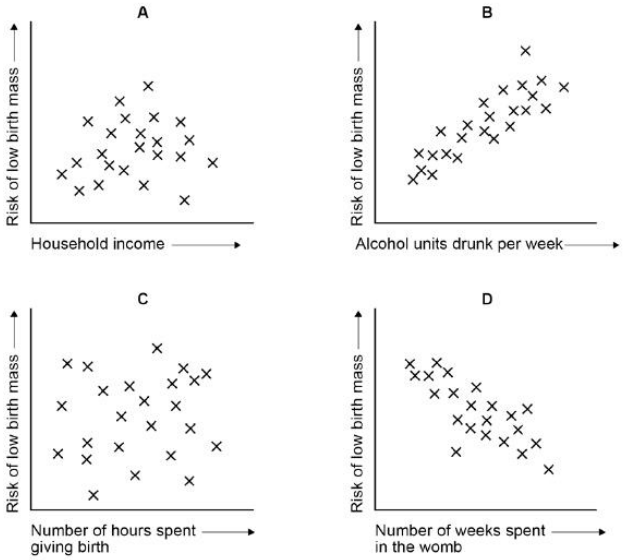
Figure 2



Other factors can also be linked to low birth mass.

Figure 3 shows the relationship between four of these factors and the risk of low birth mass.

Figure 3



(g) What type of graph is shown in **Figure 3**?

Choose from: Histogram/Bar/Scatter/Line

(h) Which of the graphs in **Figure 3** shows a positive correlation?

(i) A student concluded that the longer a woman spends giving birth, the greater the risk of low birth mass.

Give **one** reason why the student's conclusion is **not** correct.

Use evidence from **Figure 3**.

Part 13 – Alcohol

Drinking lots of alcohol can increase your chances of getting a non-communicable disease. Alcohol (ethanol) is poisonous but the liver can usually remove it before permanent damage or death. When you drink alcohol it affects your nervous system, making your reflexes and reactions slower. It also reduces inhibition.

People can become addicted to alcohol which means they need the drug to function. People who drink a lot may develop cirrhosis. Cirrhosis is a disease that destroys healthy cells and replaces them with scar tissue. Alcohol is a carcinogen. Carcinogens are chemicals that cause DNA to mutate. Alcohol can cause lung cancer.

If a pregnant woman drinks alcohol it can pass across the placenta into the developing baby. This can cause miscarriages and still births. The most common disease that babies can get if there parents drink is fetal alcohol syndrome (FAS). Fetal alcohol syndrome may lead to facial deformities, heart and liver problems and learning disabilities.

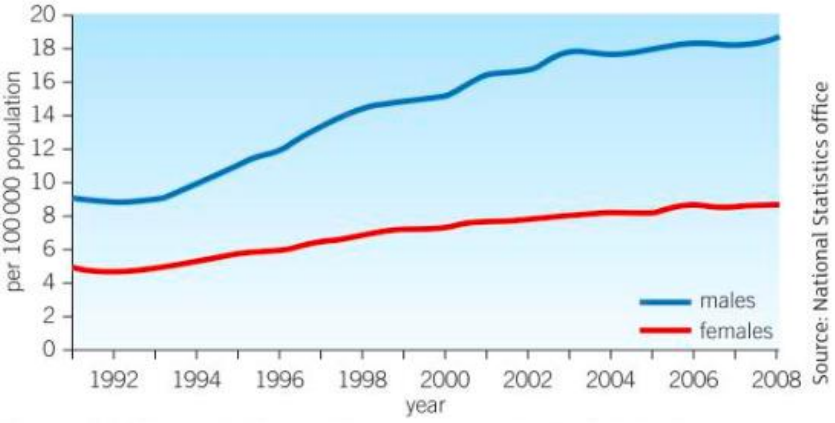


Figure 1 *This graph shows the increase in alcohol-related deaths in the UK between 1990 and 2008*

164. What organ in the body normally removes alcohol?
165. What are the short term effects of drinking alcohol
166. What does addiction mean?
167. What disease might people who drink a lot develop?
168. What is cirrhosis?
169. What are carcinogens?

170. What disease commonly affects the babies of parents that drink
171. What are the symptoms of fetal alcohol syndrome?

Part 14 – Plants

Tissues and organs in plants

The same way that animals contain tissues (a group of similar specialised cells that work together to complete a certain function) so do plants. The main tissues in plants are as follows: epidermal tissues which cover the surface and protect them similar to their function in animals. Palisade mesophyll contains lots of chloroplast. Spongy mesophyll contains large air spaces and has a large surface area to increase diffusion of gases. Xylem carries water and dissolved mineral ions from the roots (water enters the roots by osmosis) upwards and the phloem transports glucose from the leaves around the plant. Another type of plant tissue is the meristem which contains stem cells which can divide rapidly to allow plants to grow.

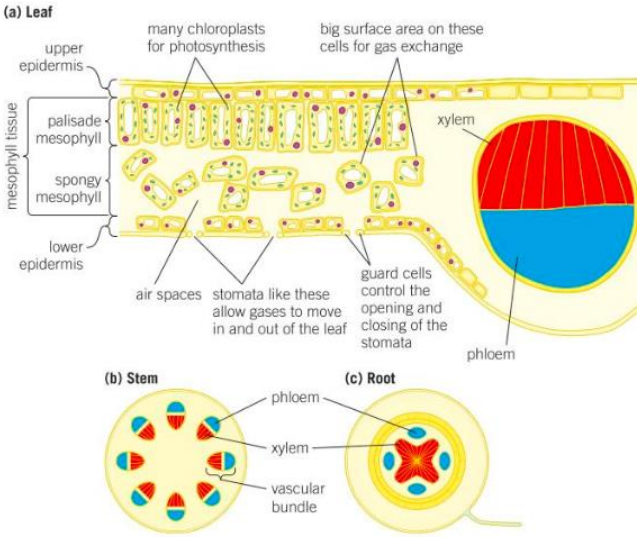


Figure 3 *Plants have specific tissues to carry out particular functions. They are arranged in organs such as the: **a** leaf, **b** stem, and **c** roots.*

Comprehension

1. What is a tissue?
2. What is the function of the palisade mesophyll?
3. What is the function of the xylem?
4. By what process does water enter the roots?
5. What structures in animals have a large surface area ((try to name at least three)
6. What two plant tissues make up the vascular bundle?
7. In what part of a cell does photosynthesis take place?
8. Where are stem cells found in plants?

Extended response questions (Complete graphic organiser first)

1. A large surface area is important for plants and animals. Discuss. Include examples of plants and animals and the function of the cells or structure in question (6 marks)
2. Suggest how the following tissues work together to enable plant roots to grow: meristem tissue, xylem, phloem, palisade mesophyll, and spongy mesophyll (6 marks)
3.

Graphic organiser

Adaptation	What structures /cells in plants and animals has this adaptation?				
Large surface area					
Thin walls					
Lots of mitochondria					
Good blood supply					
Contains haemoglobin					
No nucleus					

Hints: red blood cell, sperm cell, muscle cell, alveoli, villi, palisade mesophyll cell

Transport system in plants

Plants make glucose by photosynthesis. This glucose is used for many things in plants for example it is combined with nitrates to make amino acids. Amino acids then make proteins which are needed for growth and repair of cells. This glucose needs to transported anywhere in the plant it is needed. Similarly water and mineral ions need to travel through the plant. The plant has two transport systems to help with this.

One transport system is called the phloem. The phloem transports glucose and other sugars made in photosynthesis to the rest of the plant. This includes transport to the growing areas of the stems and rots where they are used in the way mentioned above. The movement of these sugars around the rest of the plant is called translocation. The phloem is made up of living tissue. Scientists have used creatures called aphids to determine the function of the phloem. They stylet of the aphid is inserted into the phloem to feed. The aphids body is then removed leaving the stylet in the phloem, sap containing dissolved sugars would flow out of the phloem through the aphids stylet.

The other transport system in plants is called the xylem. The xylem carries water and mineral ions from the soil to the stems and leaves. Mature xylem cells are dead. In woody plants like trees the bulk of the bark is made up of the xylem with the phloem found in a ring just underneath the bark. Young trees have bark which is very thin, animals like deer would eat away this bark resulting in a prevention of translocation and the death of the plant.

These transport systems are vital in plants. Glucose is needed all over the plant for use in respiration and for growth. Water is needed for photosynthesis. Water is also needed to hold a plant upright. When water is plentiful the vacuole pushes against the cell wall making the cells turgid.

Comprehension

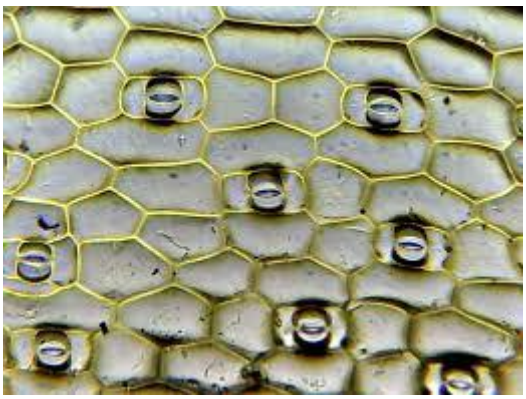
1. State the word equation for photosynthesis
2. State the symbol for glucose
3. List three uses of glucose
4. State two differences between the xylem and phloem
5. If you was to cut open the xylem, what would come out?
6. Why will plants without lots of glucose appear short and stunted?
7. State issues caused by young trees dying due to being eaten.
8. How have scientists used aphids to help them understand the phloem?
9. What is the function of the cell wall
10. Draw and label a plant cell

Extended writing

A local wood land trust has set up a scheme to put protective plastic covers around the trunks of young trees. Some local residents are complaining, saying it spoils the look of the woodlands. Evaluate the effect of this scheme. (6 marks)

Evaporation and transpiration

Water enters a plant in the roots and yet it must reach the highest leaves which in the world's tallest tree can be 87m away. The water travels up the plant in the xylem in a process known as transpiration. The leaves of plants are covered with small openings called stomata. These stomata can be open and closed based on environmental conditions. The opening and closing of stomata is controlled by guard cells. When the plant has a lot of water the vacuoles of the guard cells are full and the plant cells become turgid (opposite of flaccid). This forces the two guard cells apart and the stomata open. The converse happens when plants are low in water. The stomata can open when plants need to carry out gas exchange. Carbon dioxide from the atmosphere diffuses into the air spaces and then into the photosynthesising cells. Oxygen moves in the opposite direction, out of the photosynthesising cells into airs spaces then out into the atmosphere.



When stomata are open, it is not only oxygen and glucose that can move in and out. Water vapour can also be lost through the stomata by diffusion. This process of water moving up the xylem from the roots to the leaves where water diffuses out of the stomata is known as transpiration. The diagram below shows how transpiration occurs.

Due to water loss being a side effect of stomatal opening, it is important that plants can close their stomata to limit the loss of water vapour.

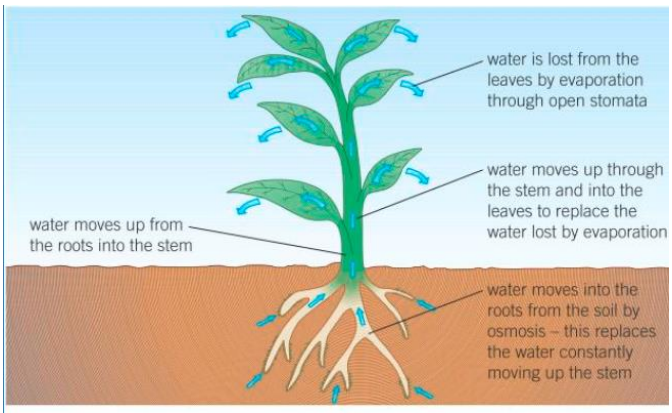


Figure 2 *The transpiration stream*

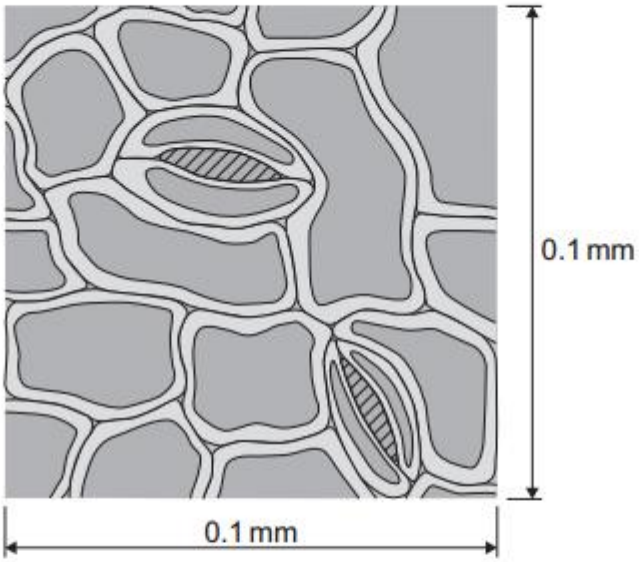
1. What are stomata
2. What is their role in the plant
3. What is the word equation for photosynthesis
4. How does water travel up the plant?
5. How does the plant ensure there is always an unbroken column of water In the xylem
6. How can the cells of the xylem be described?
7. What is the role of the guard cells?
8. What controls whether the guard cells are open and closed
9. Explain how guard cells open or close stomata
10. Suggest why cacti may have fewer stomata than other plants
11. Suggest why there are fewer stomata on the top of the leave than the bottom of the leave.

Experiment – investigating stomata

Exam questions

5 (b) **Figure 5** shows part of the surface of a leaf.

Figure 5



The length and width of this piece of leaf surface are both 0.1 mm.

5 (b) (i) Calculate the number of stomata per mm^2 of this leaf surface.

[2 marks]

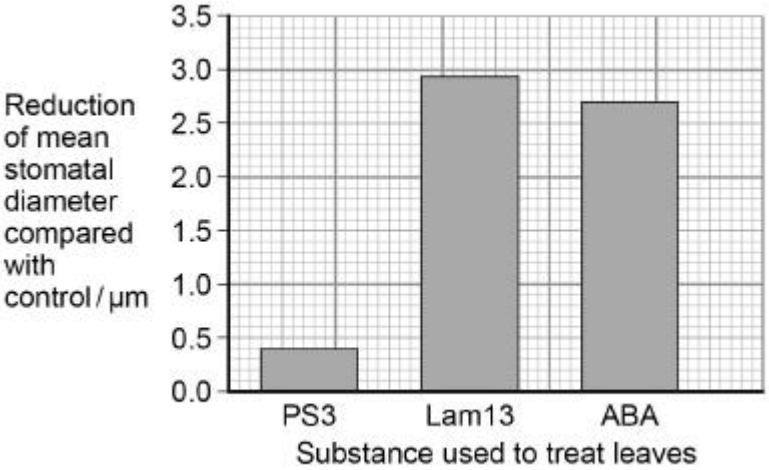
.....

.....

..... per mm^2

A scientist investigated the effect of treating the leaves of one species of plant with three different substances. These substances **reduce** the stomatal diameter. He compared the mean diameter of stomata after treating the leaves with these substances with the mean stomatal diameter on control leaves treated with distilled water.

The scientist's results are shown in the graph below.
The mean stomatal diameter of the control leaves was 7.5 μm.



(b) Calculate the ratio of mean stomatal diameter of leaves treated with PS3 to those treated with ABA.

Answer = _____ : 1

(2)

(c) ABA is a substance that some plant species produce when little water is available.

Explain why producing ABA may help these species survive in dry conditions.

_____

_____

_____

_____

_____

_____

_____

(2)

(d) Many species of plants can be infected by powdery mildew which is spread by microscopic spores in the air.

Suggest how treatment with Lam13 might protect plants against powdery mildew infection.

_____

_____

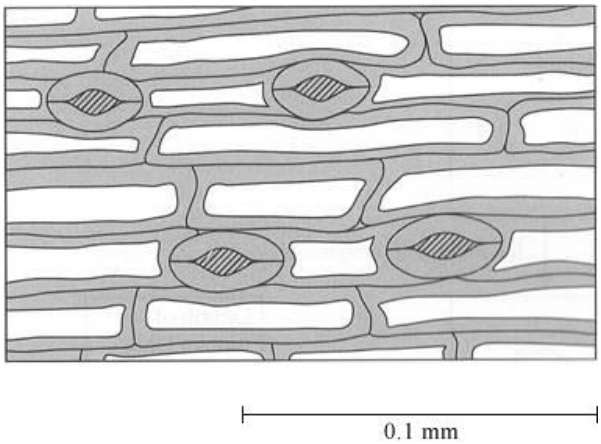
_____

_____

(1)

(Total 8 marks)

The drawing shows part of the lower leaf epidermis of sorghum.



(a) Calculate the number of stomata per mm^2 of the leaf surface. Show your working.

Answer _____ stomata per mm^2

(2)

(b) Sorghum has few stomata per mm^2 of leaf surface area. Explain how this is an adaptation to the conditions in which sorghum grows.

_____

_____

_____

_____

_____

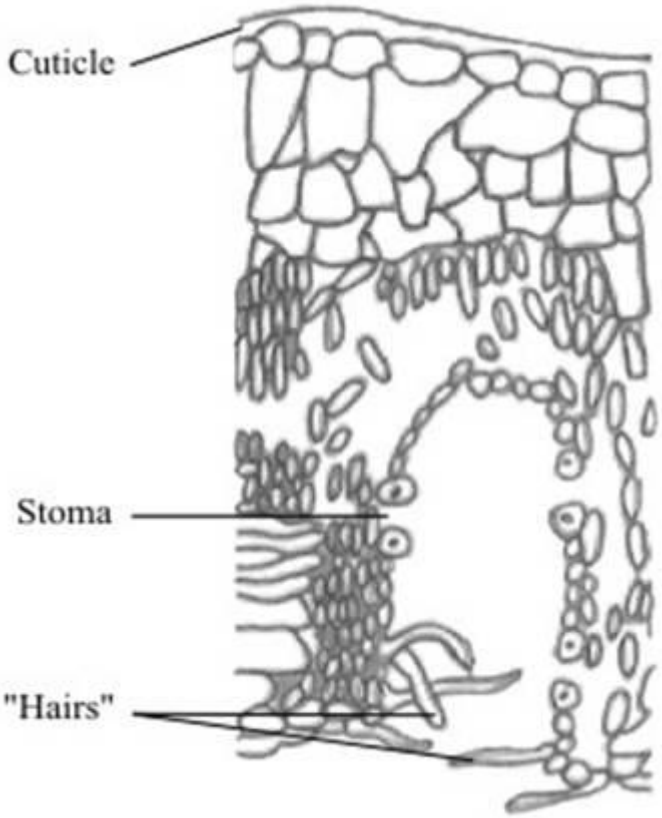
_____

(3)

(Total 5 marks)

Figure 1 shows a single stoma and surrounding cells from the leaf of a xerophytic plant.

Figure 1



(i) Explain how the cuticle reduces water loss.

_____

_____

(1)

(ii) Explain how **one** of the other labelled parts reduces water loss.

_____

_____

_____

_____

(2)

(Total 3 marks)

Factors affecting transpiration

In which of the three images are the clothes going to dry the fastest and why? The same conditions that affect evaporation affect transpiration. These factors are temperature, humidity, amount of air movement and light intensity. Anything that increases rate of photosynthesis will increase rate of transpiration because more stomata have to open to allow carbon dioxide to enter. Which then means more water is lost through the stomata by evaporation. Therefore, an increase in light intensity will increase rate of transpiration.

High humidity decreases the rate of transpiration as there is a smaller concentration gradient between the leaves and the atmosphere thus decrease rate of evaporation. Windy conditions with lots of air movement will increase rate of transpiration and help to maintain a steep concentration gradient. Temperature will increase rate of transpiration as the water molecules will move faster increasing rate of evaporation. Additional rate of photosynthesis also increases therefore more stomata will be open causing an increasing rate of transpiration.

Most leaves have a waxy, waterproof layer; the waxy cuticle; that is impermeable to water. Furthermore most of the stomata are found on the underside of the leaf where temperatures are lower. Xerophytes are plants adapted to live in dry environments. They can be adapted by having stomata that only open at night (known as CAM physiology) or having rolled leaves that trap air making the environment very humid. As previously mentioned, high humidity means lower rates of transpiration.

If plants don't have enough water they may wilt. This is actually a protective measure. The leaves all collapse and hang down. This greatly reduces the surface area available for water loss by evaporation.

The rate of transpiration can be measured using a photometer. A photometer can be used to show how the uptake of water by a plant changes in different conditions.

Comprehension

1. State four factors that affect transpiration
2. Suggest one other factors that might effect transpiration
3. Describe the effect each factor has on trasnpiration
4. Explain the effect each factor has on trasnpiration
5. What will lose more water: a plant in winter or a plant in summer ?
6. what are xerophytes
7. Give two ways xerophytes are adapted to prevent against water loss
8. Explain how wilting helps plants
9. Design an experiment to test the effect of amount of air movement on wind flow. Include a dependent variable, independent variable, control variable and any sources of error.

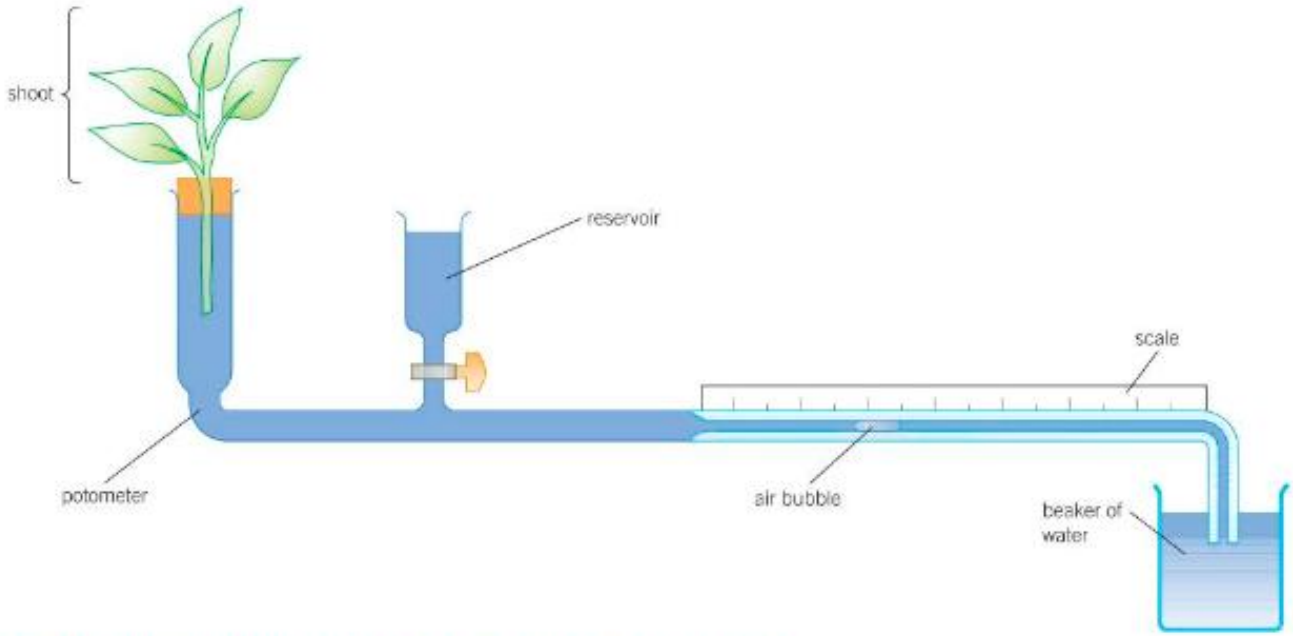
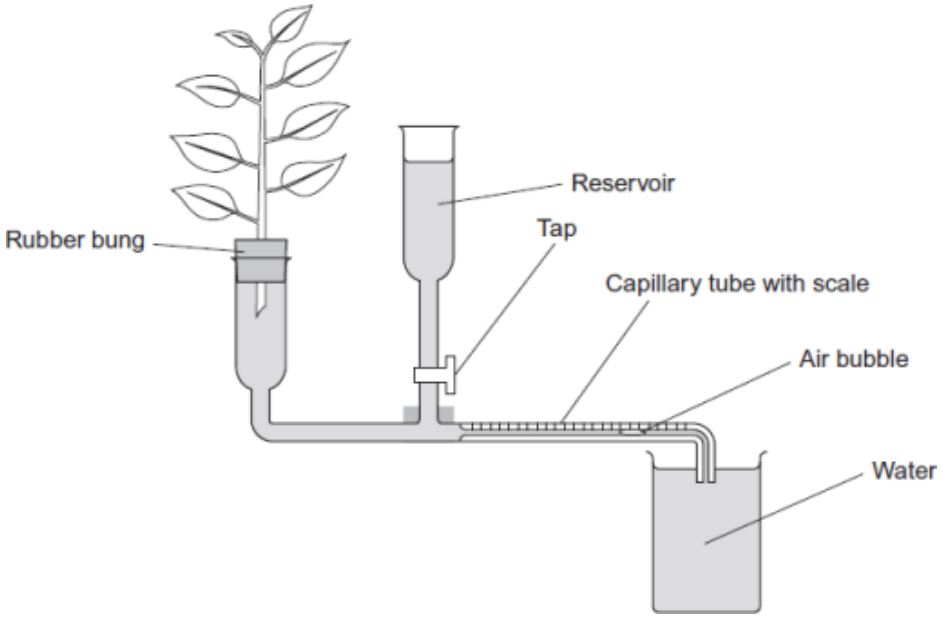


Figure 2 *A potometer is used to show the water uptake of a plant under different conditions*

Exam questions

Q1.

Students investigated the effect of removing leaves from a plant shoot on the rate of water uptake. Each student set up a potometer with a shoot that had eight leaves. All the shoots came from the same plant. The potometer they used is shown in the diagram.



(a) Describe how the students would have returned the air bubble to the start of the capillary tube in this investigation.

_____

_____

_____

(1)

(b) Give **two** precautions the students should have taken when setting up the potometer to obtain reliable measurements of water uptake by the plant shoot.

1. _____

2. _____

(2)

(c) A potometer measures the rate of water uptake rather than the rate of transpiration. Give **two** reasons why the potometer does **not** truly measure the rate of transpiration.

1. _____

2. _____

(2)

(d) The students' results are shown in the table.

Number of leaves removed from the plant shoot	**Mean rate of water uptake / cm^3 per minute**
0	0.10
2	0.08
4	0.04
6	0.02
8	0.01

Explain the relationship between the number of leaves removed from the plant shoot and the mean rate of water uptake.

_____

_____

_____

_____

_____

_____

*(Extra space)*_____

_____

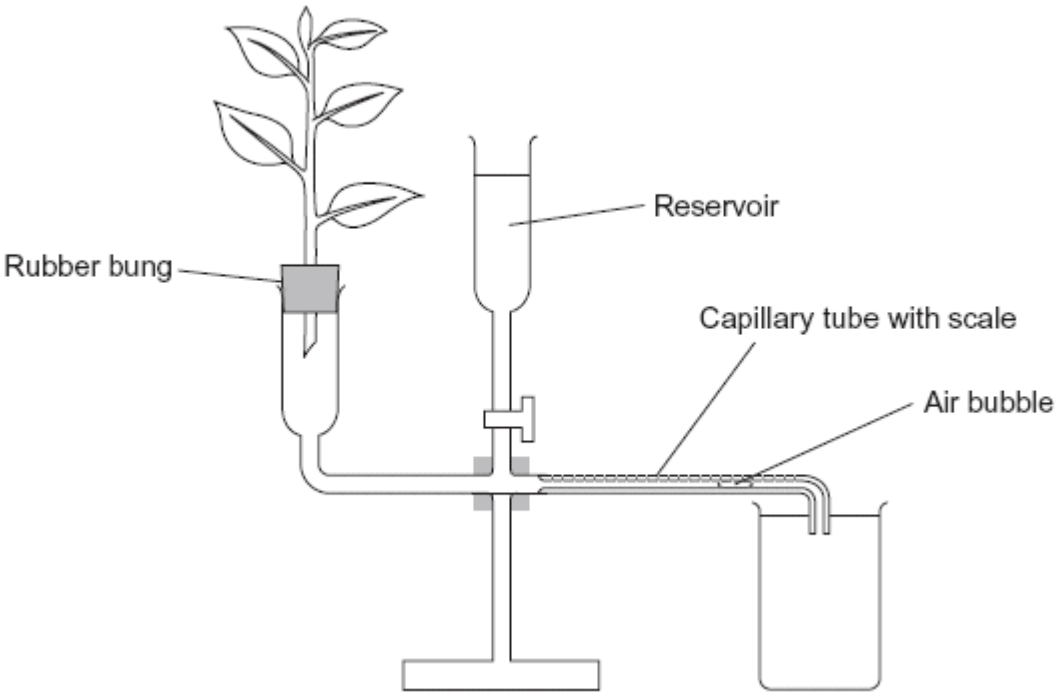
_____

(3)

(Total 8 marks)

Q2.

A student investigated the rate of transpiration from a leafy shoot. She used a potometer to measure the rate of water uptake by the shoot. The diagram shows the potometer used by the student.



(a) Give **one** environmental factor that the student should have kept constant during this investigation.

_____

(1)

(b) The student cut the shoot and put it into the potometer under water. Explain why.

_____

_____

(1)

(c) The student wanted to calculate the rate of water uptake by the shoot in cm^3 per minute. What measurements did she need to make?

_____

_____

_____

_____

(2)

(d) The student assumed that water uptake was equivalent to the rate of transpiration.

Give **two** reasons why this might **not** be a valid assumption.

1. _____

_____

2. _____

_____

(2)

(e) The student measured the rate of water uptake three times.

(i) Suggest how the reservoir allows repeat measurements to be made.

_____

_____

(1)

(ii) Suggest why she made repeat measurements.

_____

_____

(1)

(Total 8 marks)

Mark schemes

Q1.

(a) Open / use tap / add water from reservoir;

1

(b) 1. Seal joints / ensure airtight / ensure watertight;

Answer must refer to precautions when setting up the apparatus

Ignore: references to keeping other factors constant

2. Cut shoot under water;

3. Cut shoot at a slant;

4. Dry off leaves;

5. Insert into apparatus under water;

6. Ensure no air bubbles are present;

7. Shut tap;

8. Note where bubble is at start / move bubble to the start position;

2 max

(c) 1. Water used for support / turgidity;

Accept: water used in (the cell's) hydrolysis or condensation (reactions) for one mark. Allow a named example of these reactions

2. Water used in photosynthesis;

3. Water produced in respiration;

4. Apparatus not sealed / 'leaks';

2 max

(d) As number of leaves are reduced (no mark),

Accept: converse arguments

1. Less surface area / fewer stomata;

3. Less evaporation / transpiration;

4. Less cohesion / tension / pulling (force);

3

[8]

Q2.

(a) Light (intensity) / temperature / air movement / humidity;

1

(b) Prevent air entering / continuous water column;

Allow answer in context of shoot, xylem or potometer.

1

(c) Distance and time;

Reject 'amount bubble moves'

1

Radius / diameter / area (of capillary tube);

1

(d) (used to provide) turgidity / support / description of;

(used in) photosynthesis / (produced in) respiration;

Apparatus not sealed / 'leaks';

2 max

(e) (i) Returns bubble (to start);

1

(ii) Increases reliability (of results) / anomalous result can be identified;

Q *Ignore references to validity / precision / accuracy etc.*

1

[8]