

AQA, OCR, Edexcel

A Level

A Level Biology

**Gas Exchange, Transport, Circulation
and Haemoglobin Questions**

Name:

M

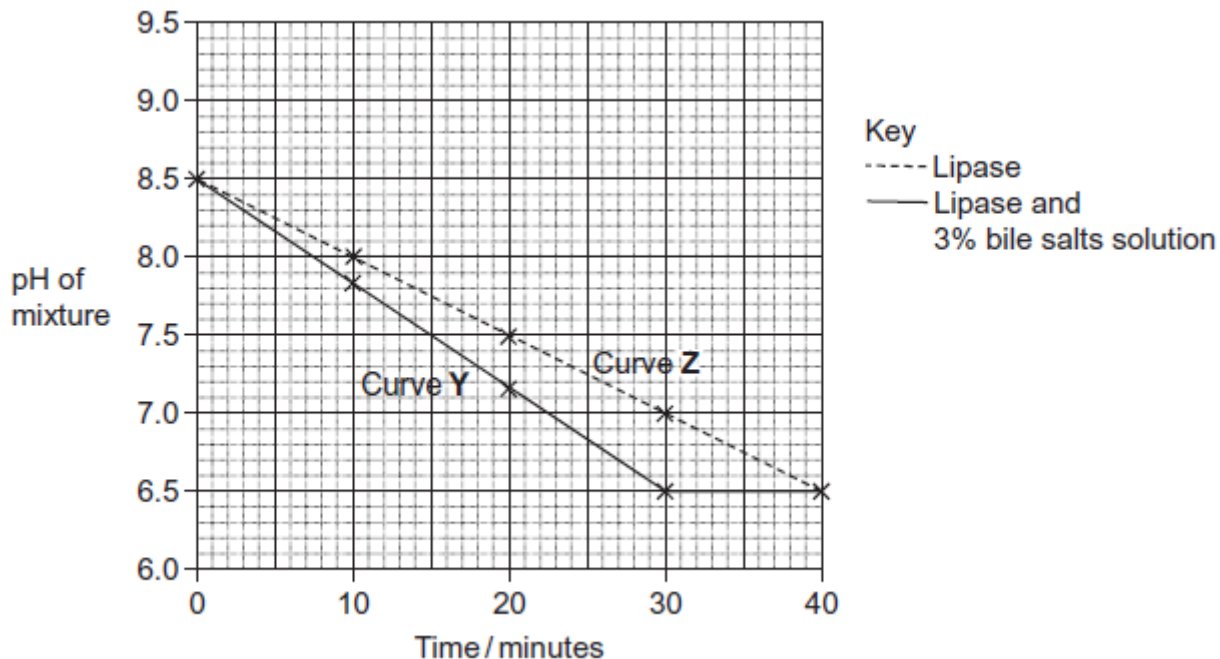
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Total Marks:

Q1. Scientists investigated the effect of lipase and a 3% bile salts solution on the digestion of triglycerides. The graph below shows their results.



The scientists also incubated triglycerides with different concentrations of bile salts. After 30 minutes they measured the diameter of the triglyceride droplets. They used the results to calculate the mean radius of the droplets at each concentration. The table below shows their results.

Concentration of bile salts /%	0	1	2	3	4	5
Mean radius of triglyceride droplet / μm	6	5	4	3	2	1

- (a) Describe how you would use a microscope to find the mean diameter of triglyceride droplets on a slide.

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- (b) (i) The ratio of mean radius of triglyceride droplets in bile salts at a concentration of 0% to the mean radius in bile salts at a concentration of 3% is 2 : 1.

What is the ratio of their surface areas? Show your working.

You can calculate the surface area of a droplet from the formula

$$A = 4\pi r^2$$

Where A = surface area

r = radius

$\pi = 3.14$

(2)

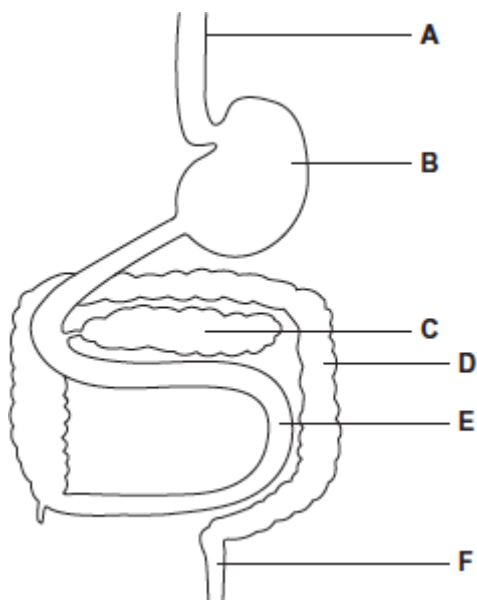
- (ii) Use the data in the table to explain the difference between curves **Y** and **Z** in the graph.

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(3)

(Total 8 marks)

Q2.The diagram represents part of the human digestive system. The organs are labelled **A–F**.



(a) Give the letter of the organ that produces amylase.

(1)

(b) Give the letter of the organ that produces maltase.

(1)

(c) Maltose is hydrolysed by the enzyme maltase. Explain why maltase catalyses only this reaction.

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(Total 5 marks)

Q3. (a) Dietary recommendations are that lipid intake should make up 30% of energy intake. The recommended energy intake for most women aged 19-49 is 8100 kJ day⁻¹. The energy content of lipid is 37.8 kJ g⁻¹. Calculate the recommended lipid intake per day for these women. Show your working.

Answer g (2)

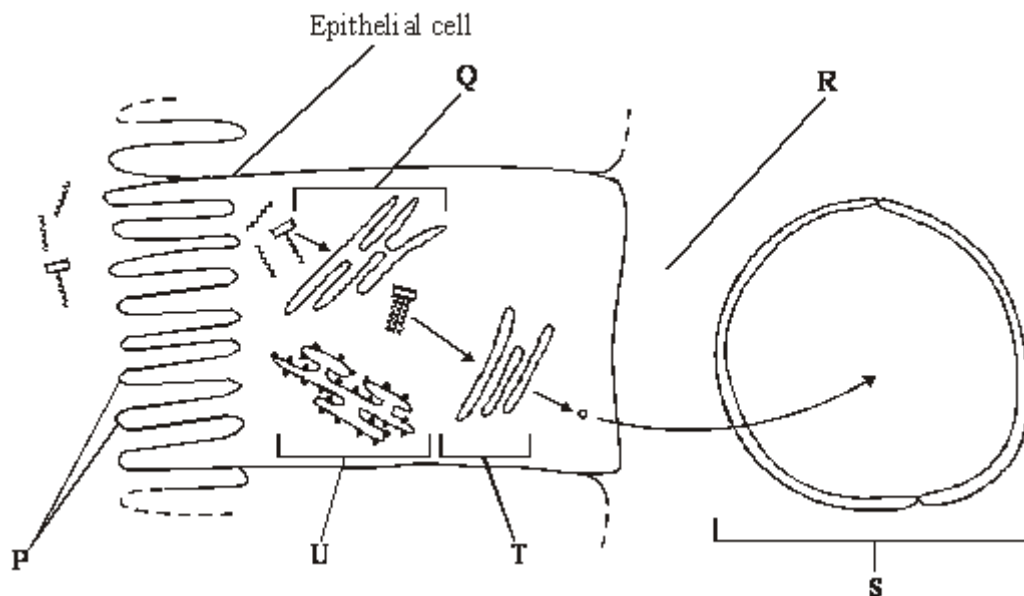
In humans, triglycerides are the main form of dietary lipids. They are digested in the gut and the products of digestion are absorbed by the small intestine.

- S** (b) Describe a biochemical test that could be performed on a sample of food to determine whether it contained triglycerides.

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(2)

- (c) The diagram shows the events that occur in the absorption of monoglycerides and fatty acids. These molecules enter the epithelial cells of the small intestine by diffusion. Once inside they are reassembled into triglycerides in organelle **Q**. The triglyceride molecules are formed into chylomicrons in organelle **T**. Chylomicrons are made from many triglyceride molecules surrounded with protein molecules. The chylomicrons leave the cell and enter vessel **S**.



- S** (i) Explain the importance of the structures labelled **P**.

.....
(1)

- (ii) Name

R;

S.(2)

S (iii) Describe the role played by organelle **U** in the formation of chylomicrons.

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(2)

S (iv) Suggest how the chylomicrons leave the epithelial cell. Give a reason for your answer.

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(2) (Total 11 marks)

Q4.Biologists divided new-born rats randomly into four groups.

They fed the rats in each group on a standard diet which only differed in the carbohydrate content. When these rats were adult, the biologists measured the activity of lactase in the digestive system of the rats. The following table shows the mean results for each group.

Diet	Mean lactase activity / μ mol of lactose digested per hour (\pm standard deviation)
Low sucrose	57.9 (\pm 14.5)
High sucrose	184.2 (\pm 30.8)
Low starch	86.9 (\pm 13.3)
High starch	221.4 (\pm 25.4)

(a) Give **one** piece of evidence from the table that indicates lactase activity is affected by diet.

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(1)

(b) Some students suggested from these data that increasing starch in the diet was the most effective way to increase lactase activity in lactase deficient people. Is this conclusion valid? Explain your answer.

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.....(2)

(Total 3 marks)

Q5. Miner's lung is a disease caused by breathing in dust in coal mines. The dust causes the alveolar epithelium to become thicker. People with miner's lung have a lower concentration of oxygen in their blood than healthy people.

(a) (i) Describe the path by which oxygen goes from an alveolus to the blood.

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(2)

(ii) Explain why people with miner's lung have a lower concentration of oxygen in their blood.

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.....(1)

(b) In healthy lungs, a gradient is maintained between the concentration of oxygen in the alveoli and the concentration of oxygen in the lung capillaries.

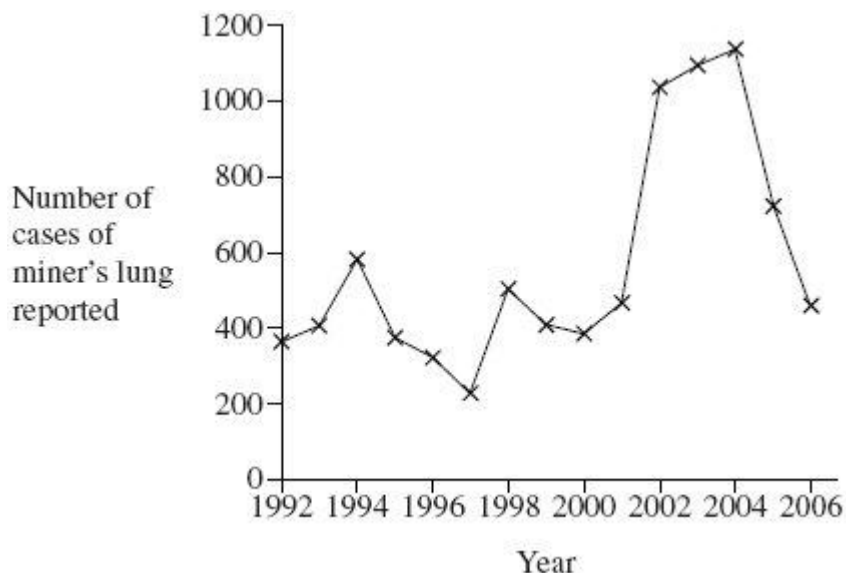
(i) Describe how ventilation helps to maintain this difference in oxygen concentration.

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.....(2)

(ii) Give **one** other way that helps to maintain the difference in oxygen concentration.

.....(1)

(c) Scientists investigated the number of cases of miner's lung reported in Britain between 1992 and 2006.



Coal mining in Britain had been dramatically reduced by 1990. Some scientists concluded that the rise in reported cases of miner's lung after 1992 shows that the disease takes a long time to develop. Evaluate this conclusion.

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..... (2)

(Total 8 marks)

Q6. A scientist used grasshoppers to investigate the effect of composition of air on breathing rate in insects. He changed the composition of air they breathed in by varying the concentrations of oxygen and carbon dioxide.

The scientist collected 20 mature grasshoppers from a meadow. He placed the grasshoppers in a small chamber where he could adjust and control the composition of air surrounding them. The small chamber restricted the movement of the grasshoppers.

His results for three of the grasshoppers are shown in the table below in the form in which he presented them.

		Percentage of oxygen and carbon dioxide in different types of air breathed in by grasshoppers			
		A Air from atmosphere	B Pure oxygen	C Gas mixture 1	D Gas mixture 2
Gas	Oxygen	20.9	100.0	91.0	84.0
	Carbon dioxide	0.1	0.0	9.0	16.0

Breathing rate of grasshopper in different types of air / breaths per minute	Grasshopper 1	53	11	99	107
	Grasshopper 2	48	25	88	99
	Grasshopper 3	61	13	96	93

(a) The percentages of oxygen and carbon dioxide in Column **A** do **not** add up to 100% but in columns **C** and **D** they do.

Suggest **two** reasons for this difference.

1

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2

.....(2)

(b) Use all the data to describe the effect of concentration of carbon dioxide on the breathing rate of grasshoppers.

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..... (3)

(c) One of the different types of air was similar to the air in the meadow where the grasshoppers were collected. It provides data that might be used to calculate a mean breathing rate for grasshoppers in the meadow.

(i) Use the data to estimate the mean breathing rate of the three grasshoppers in the meadow. Show your working.

Mean breathing rate = breaths per minute (2)

(ii) The estimate does not provide a reliable value for the mean breathing rate of all insect species in the meadow. Other than being an estimate, suggest and explain **three** reasons why this value would **not** be reliable.

1

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.....(3)

(Total 10 marks)

Q7. (a) Describe the part played by the diaphragm in causing air to enter the lungs during breathing.

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(3)

Seals are mammals. They have lungs and must breathe air. They can dive and remain under water for a long time. The table shows the flow of blood to the lungs and to the diaphragm in a seal when it is on land and when it is under water.

Organ	Blood flow / cm ³ min ⁻¹ g ⁻¹	
	On land	Under water
Lungs	0.88	0.52
Diaphragm	0.21	0.02

(b) Explain why the figures in the table are given per gram of tissue.

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(2)

(c) Calculate the percentage by which blood flow to the lungs is reduced when a

seal is swimming under water. Show your working.

Answer(2)

(d) There is a greater percentage reduction in blood flow to the diaphragm than to the lungs during a dive. Explain the advantage to a diving seal of

(i) blood continuing to flow to the lungs;

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(1)

(ii) a large reduction in blood flow to the diaphragm.

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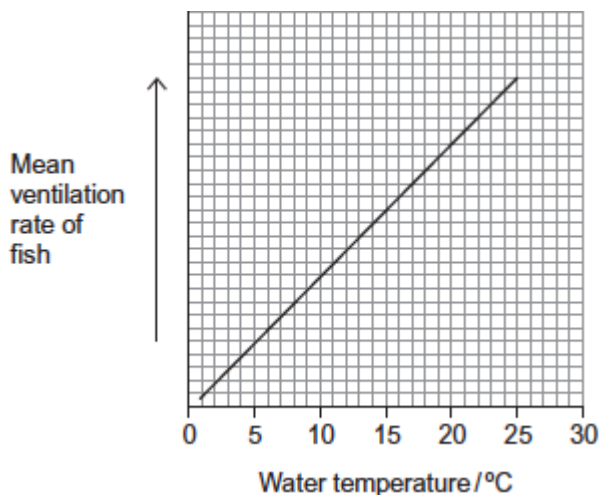
(2)

(Total 10 marks)

Q8.A A biologist investigated the effect of water temperature on the rate of ventilation of gills in a species of fish. She kept four fish in a thermostatically controlled aquarium and measured the mean ventilation rate by counting movements of their gill covers.

Her results are shown in **Figure 1**.

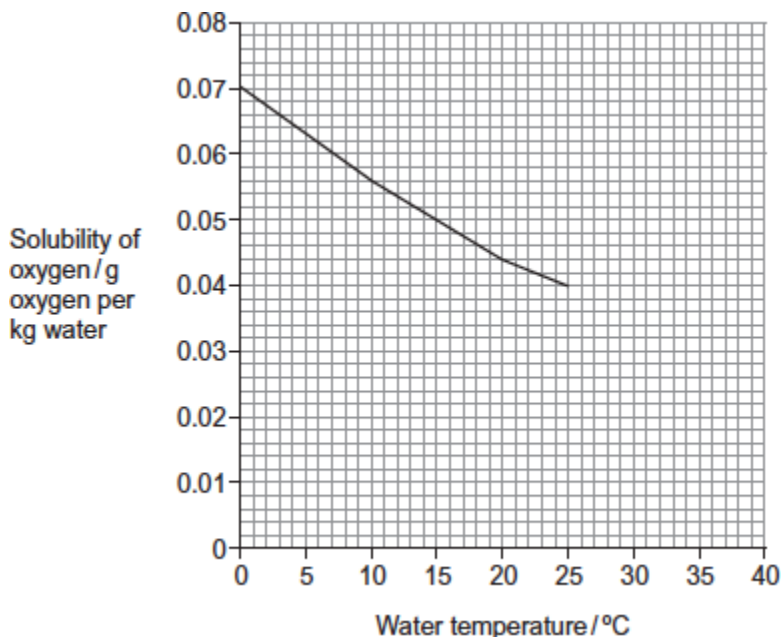
Figure 1



In this investigation, the biologist also monitored the concentration of oxygen in the water in the aquarium. The concentration of oxygen in water changes with temperature of the

water. **Figure 2** shows how it changes.

Figure 2



- (a) Suggest a difficulty of counting movements of gill covers as a method of measuring rate of ventilation in fish.

.....

(1)

- (b) The biologist concluded that there was a correlation between rate of ventilation of the gills and temperature of the water. A scatter diagram can be used to look for a correlation but, in this investigation, it was **not** the appropriate graph for her data. Explain why.

.....

(1)

- (c) (i) Describe the relationship between temperature of water, oxygen in water and rate of ventilation.

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(1)

- (ii) Use **Figure 1** and **Figure 2** to explain the advantage to the fish of the change in its rate of ventilation.

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(3)

(Total 6 marks)

Q9.(a) Describe how oxygen in the air reaches capillaries surrounding alveoli in the lungs. Details of breathing are **not** required.

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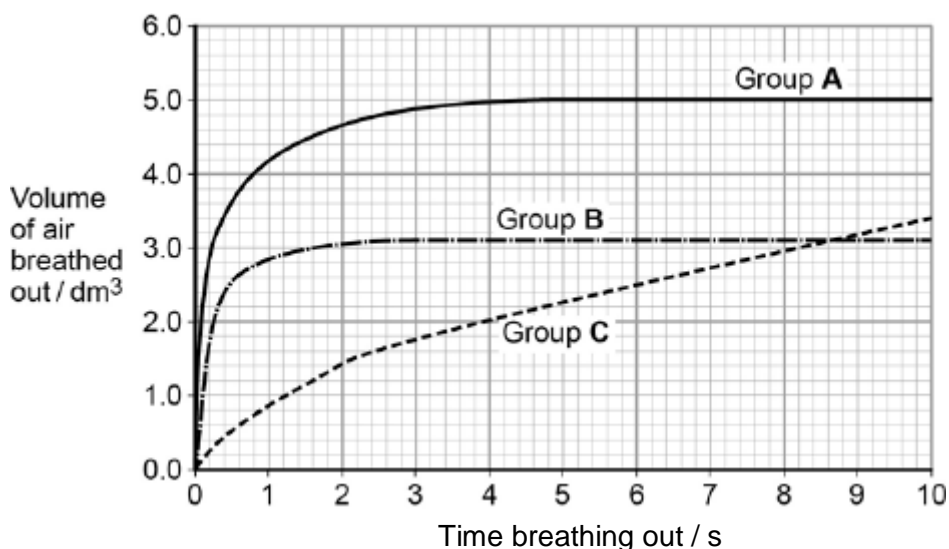
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(4)

Forced expiratory volume (FEV) is the greatest volume of air a person can breathe out in 1 second. Forced vital capacity (FVC) is the greatest volume of air a person can breathe out in a single breath. The figure below shows results for the volume of air breathed out by three groups of people, **A**, **B** and **C**. Group **A** had healthy lungs. Groups **B** and **C** had different lung conditions that affect breathing.



(b) Calculate the percentage drop in FEV for group **C** compared with the healthy people.

Answer =(1)

- (c) Asthma affects bronchioles and reduces flow of air in and out of the lungs. Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, **B** or **C**, was the one containing people with fibrosis of their lungs? Use the information provided and evidence from the figure above to explain your answer.

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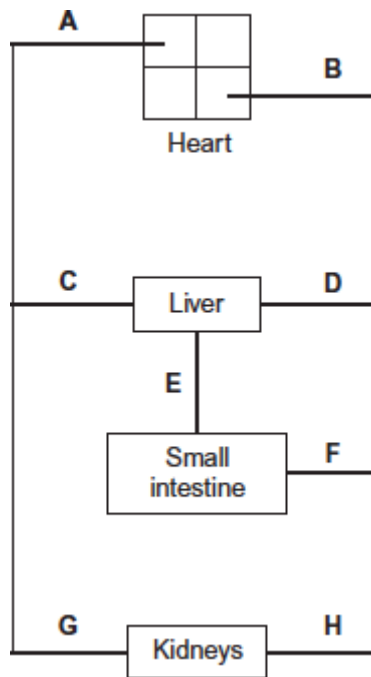
(3) (Total 8 marks)

- Q10.(a)** What is the function of the coronary arteries?

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.....(2)

- (b) **Figure 1** shows some of the large blood vessels in a mammal.

Figure 1



(i) Which of the blood vessels **A** to **H** is the vena cava?

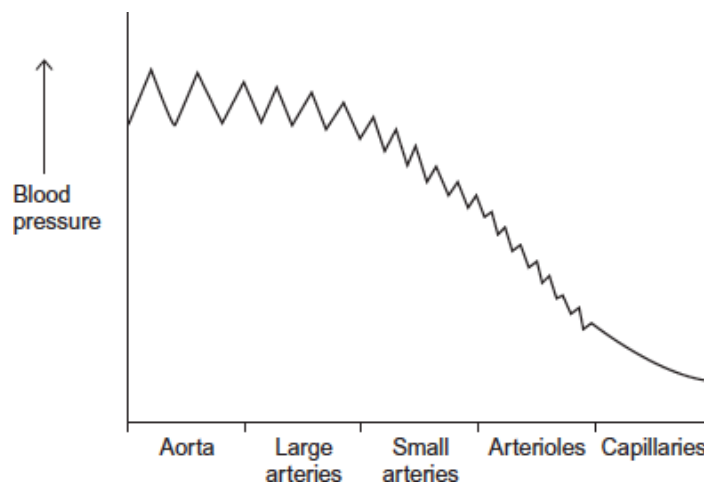
(1)

(ii) Which of the blood vessels **A** to **H** is the renal artery?

(1)

(c) **Figure 2** shows how the blood pressure changes as blood travels from the aorta to the capillaries.

Figure 2



The rise and fall in blood pressure in the aorta is greater than in the small arteries. Suggest why.

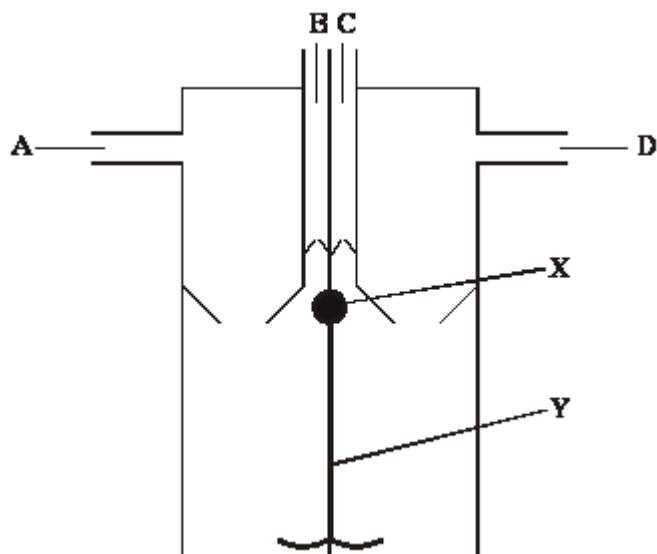
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(3)

(Total 7 marks)

Q11. This diagram shows a human heart seen from the front.



(a) (i) Which **one or more** of vessels **A** to **D** contains oxygenated blood?

.....(1)

(ii) During a cardiac cycle, the pressure of the blood in vessel **C** is higher than the pressure of the blood in vessel **B**. Explain what causes this difference in pressure.

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(1)

(b) What does the diagram suggest about the pressure in the atria compared to the pressure in the ventricles at the stage in the cardiac cycle represented in the diagram? Explain your answer.

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(2)

(c) The wave of electrical activity which coordinates the heart beat is delayed slightly at part **X**. It then passes along part **Y** to the base of the ventricles.

Explain the importance of

- (i) the slight delay at part X;

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(2)

- (ii) the electrical activity being passed to the base of the ventricles.

.....

(2)

(Total 8 marks)

Q12. The mean internal diameter and the mean speed of blood flow for different human blood vessels are shown below in the table.

Blood vessel	Mean internal diameter / mm	Mean speed of blood flow / mm s ⁻¹
Aorta	35	470
Coronary artery	4	380
Arteriole	0.03	110
Capillary	0.001	15
Vena cava	20	270

- (a) Although the speed of blood flow in an arteriole is greater than speed of blood flow in a capillary, blood does **not** accumulate in the arterioles.

Explain why.

.....

(1)

- (b) Other than causing slow blood flow, explain **one** advantage of capillaries being narrow.

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.....(2)

(c) What factor limits the minimum internal diameter of the lumen of a capillary?

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.....(1)

(d) The volume of blood leaving the capillary network into the veins is less than the volume of blood entering from the arteries.

Explain why.

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.....(1)

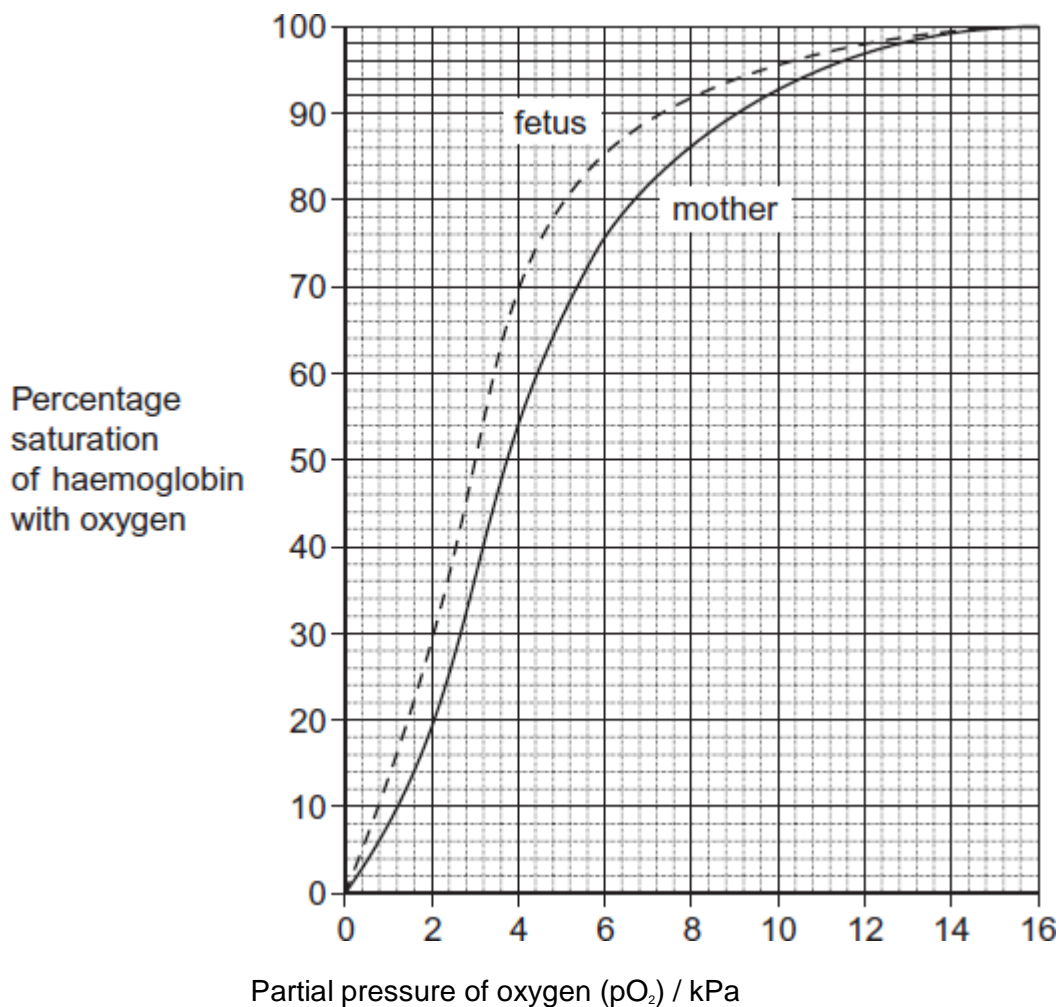
(Total 5 marks)

Q13.(a) The table shows three statements about some biological molecules. Complete the table with a tick in each box if the statement is true for haemoglobin, cellulose or starch.

Statement	Haemoglobin	Cellulose	Starch
Has a quaternary structure			
Formed by condensation reactions			
Contains nitrogen			

(3)

The graph shows oxygen dissociation curves for the haemoglobin of a mother and her fetus.



- (b) What is the difference in percentage saturation between the haemoglobin of the mother and her fetus at a partial pressure of oxygen (pO₂) of 4 kPa?

(1)

- (c) The oxygen dissociation curve of the fetus is to the left of that for its mother. Explain the advantage of this for the fetus.

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.....(2)

- (d) After birth, fetal haemoglobin is replaced with adult haemoglobin. Use the graph to suggest the advantage of this to the baby.

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(2)

(e) Hereditary persistence of fetal haemoglobin (HPFH) is a condition in which production of fetal haemoglobin continues into adulthood. Adult haemoglobin is also produced.

People with HPFH do not usually show symptoms. Suggest why.

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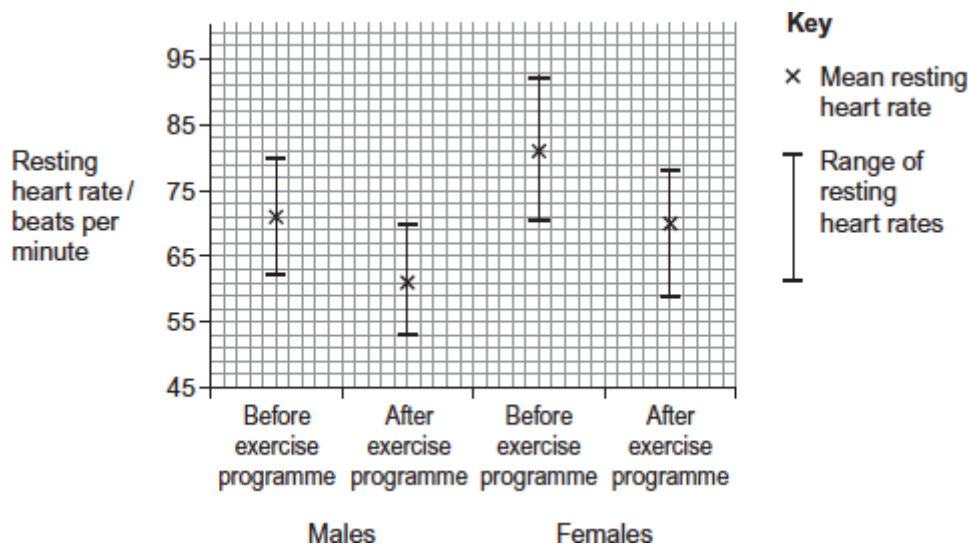
(1)

(Total 9 marks)

Q14. Scientists investigated the effect of a 6-week exercise programme on the resting heart rate of males and females.

The scientists recruited a large group of male volunteers and a large group of female volunteers. They measured the resting heart rate of each volunteer before the exercise programme. Both groups took part in the same exercise programme. The scientists measured the resting heart rate of each volunteer after the exercise programme.

The scientists determined the mean resting heart rate and the range of resting heart rates for each group before and after the exercise programme. The graph shows their results.



(a) What was the range of the resting heart rates in males after the exercise programme?

.....(1)

(b) Calculate the percentage decrease in the mean resting heart rate of females after the exercise programme. Show your working.

Answer = % **(2)**

- (c) The scientists used the percentage change in the mean resting heart rate after the exercise programme to compare the results for males and females.

Explain why they used percentage change in the resting heart rate.

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.....**(2)**

- (d) The scientists calculated the cardiac output of the volunteers before and after the exercise programme. In some volunteers, their cardiac output stayed the same, even though their resting heart rate decreased. Explain how their cardiac output could stay the same even when their resting heart rate had decreased.

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.....**(2)**

(Total 7 marks)

- Q15.(a)** (i) The human heart has four chambers.
In which **one** of the four chambers of the human heart does pressure reach the highest value?

.....**(1)**

- (ii) Explain how the structure of this chamber causes this high pressure.

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.....
.....

(1)

The table shows the volume of blood in a man's right ventricle at different times during one cardiac cycle.

Time / s	Volume of blood / cm ³
0.0	125
0.1	148
0.2	103
0.3	70
0.4	56
0.5	55
0.6	98
0.7	125

- (b) (i) Use the data in the table to calculate the man's heart rate.

Heart rate = beats per minute

- (ii) Use the data in the table and your answer to part (b) (i) to calculate the man's cardiac output. Show your working.

Cardiac output = cm³ per minute

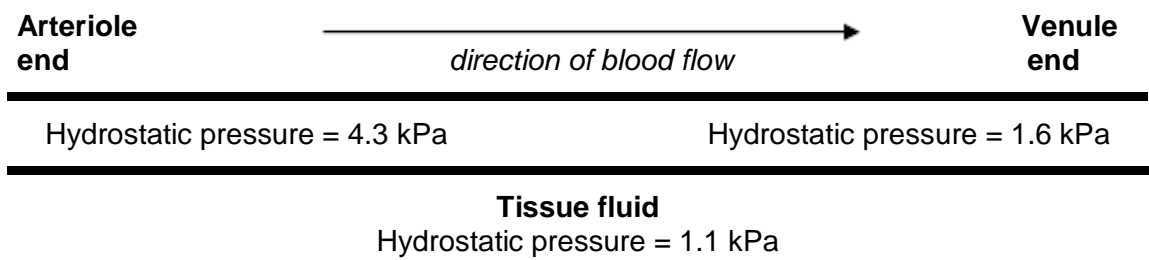
(3)

- (c) Use information from the table to complete the table below to show whether the valves are **open** or **closed** at each of the times shown. Write open or closed in the appropriate boxes.

Time / s	Valve between right atrium and right ventricle	Valve between right ventricle and pulmonary artery
0.2		
0.6		

(2)

Q16. The figure below represents a capillary surrounded by tissue fluid. The values of the hydrostatic pressure are shown.



(a) Use the information in the figure above to explain how tissue fluid is formed.

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.....(2)

(b) The hydrostatic pressure falls from the arteriole end of the capillary to the venule end of the capillary. Explain why.

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.....(1)

(c) High blood pressure leads to an accumulation of tissue fluid. Explain how.

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.....(3)

(d) The water potential of the blood plasma is more negative at the venule end of the capillary than at the arteriole end of the capillary. Explain why.

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.....(3)

(Total 9 marks)

production of red blood cells. Synthetic EPO is made artificially. It is used to treat patients who have a form of anaemia in which there is a reduced number of red blood cells. Scientists investigated the effect of synthetic EPO on volunteers with this form of anaemia.

- The scientists injected synthetic EPO in a salt solution into patients in the experimental groups. They also set up control groups.
- They gave the different experimental groups different doses of synthetic EPO and different lengths of treatment.
- At the beginning and end of the treatment, the scientists measured each patient's haemoglobin concentration. From these measurements, they calculated the mean increase in haemoglobin concentration.

Some of the results are shown in the table.

Number of volunteers	Length of treatment / weeks	Dose of synthetic EPO / units per kilogram per week	Mean increase in haemoglobin concentration / arbitrary units
58	8	85	19.0
18	8	170	26.0
40	12	150	12.5
82	12	450	34.2
46	24	120	23.0
53	24	240	31.0

- (a) Explain why treatment with synthetic EPO affects the haemoglobin concentration in these volunteers.

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.....(2)

- (b) Suggest how the control groups should have been treated in this investigation.

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.....(2)

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- (c) The scientists measured the dose of synthetic EPO per kilogram per week.

Explain why they measured the dose per unit mass and per unit time.

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.....(2)

- (d) Explain how the information that the scientists collected might be useful in treating patients with anaemia.

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.....(2)

- (e) Some athletes have used synthetic EPO as a performance enhancer. Explain how synthetic EPO may improve performance in long-distance events.

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.....(4)

- (f) Athletes may be tested to see if the concentration of EPO in their blood is above normal. Suggest how scientists determine the normal concentration of EPO in blood.

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.....(2)

(g) Synthetic EPO can increase blood pressure. Suggest why.

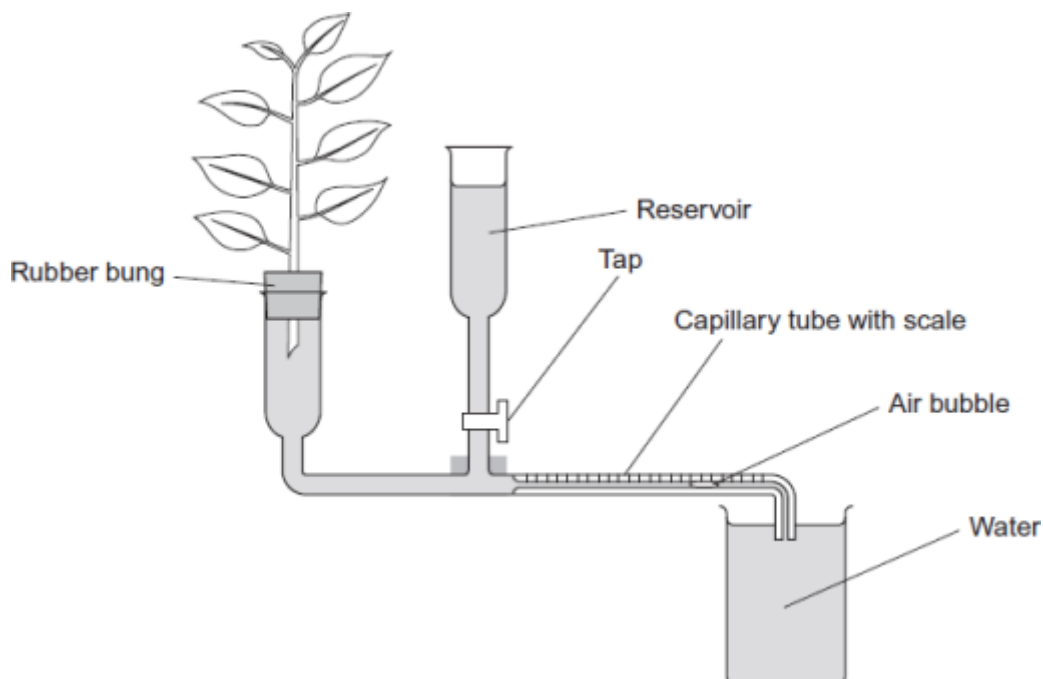
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(1)
(Total 15 marks)

Q18. 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.

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.....(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.

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..... (3)

(Total 8 marks)

Q19. (a) Explain how each of the following is related to the function of xylem tissue.

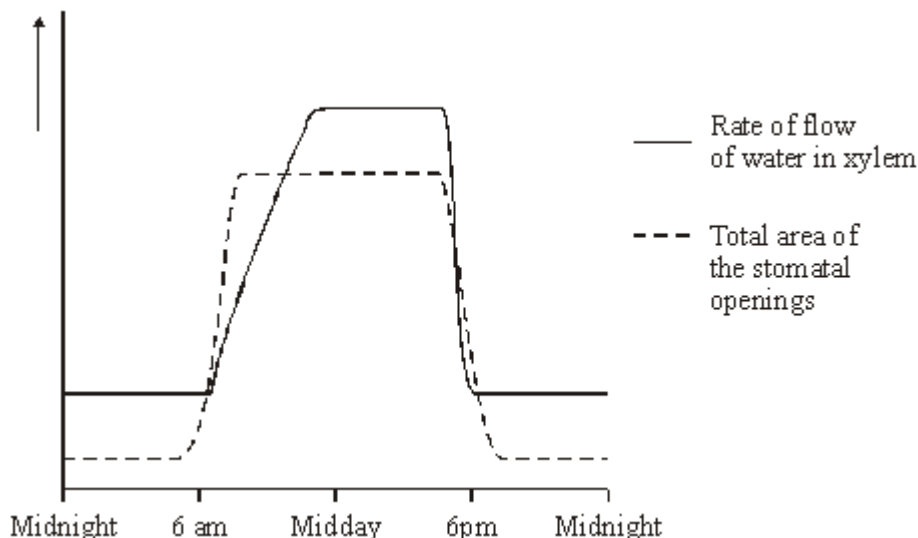
(i) Xylem tissue contains hollow tubes.

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(ii) Lignin is present in xylem cell walls.

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..... (2)

- (b) In an investigation the total area of the stomatal openings and the rate of flow of water through xylem were measured in a plant over a period of 24 hours. The results are shown in the graph.



- (i) Describe the relationship between the rate of flow of water and the total area of the stomatal openings for the period of time between midday and midnight.

.....
(1)

- (ii) Between 8 am and midday the rate of flow of water continues to rise although the total area of the stomatal openings remains constant. Explain why the rate of flow of water rises.

.....(1)

- (iii) How would the curve showing the total area of the stomatal openings differ if the investigation was repeated on a dull day?

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(1)

- (c) Some xerophytic plants have sunken stomata. Explain the advantage of this adaptation.

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(2)
 (Total 7 marks)

Q20. Scientists studied three species of plant.

They selected fully grown leaves from five different plants of each species.

For each leaf they measured:

- leaf surface area
- leaf thickness
- the number of stomata per mm².

The scientists' results are shown in the table below.

Plant species	Mean leaf surface area / mm ²	Mean leaf thickness / μm	Mean number of stomata per mm ²
A	218.0	191.5	380.0
B	17.0	296.3	136.0
C	2.2	354.8	419.0

(a) How did the scientists ensure they could make a valid comparison between leaves from different species?

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(1)

(b) Describe a method you could use to find the surface area of a leaf.

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 (3)

(c) (i) Which species, **A** or **B**, would you predict grew in a drier environment?

Explain **one** feature that caused you to choose this species.

Species

Explanation

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(1)

- (ii) Other than the features of leaves in the table above, give **two** features of leaves of xerophytes.

For each feature explain how it reduces water loss.

Feature 1

Explanation

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Feature 2

Explanation

.....(2)

- (d) Species **C** has a high number of stomata per mm². Despite this it loses a small amount of water. Use the data to explain why.

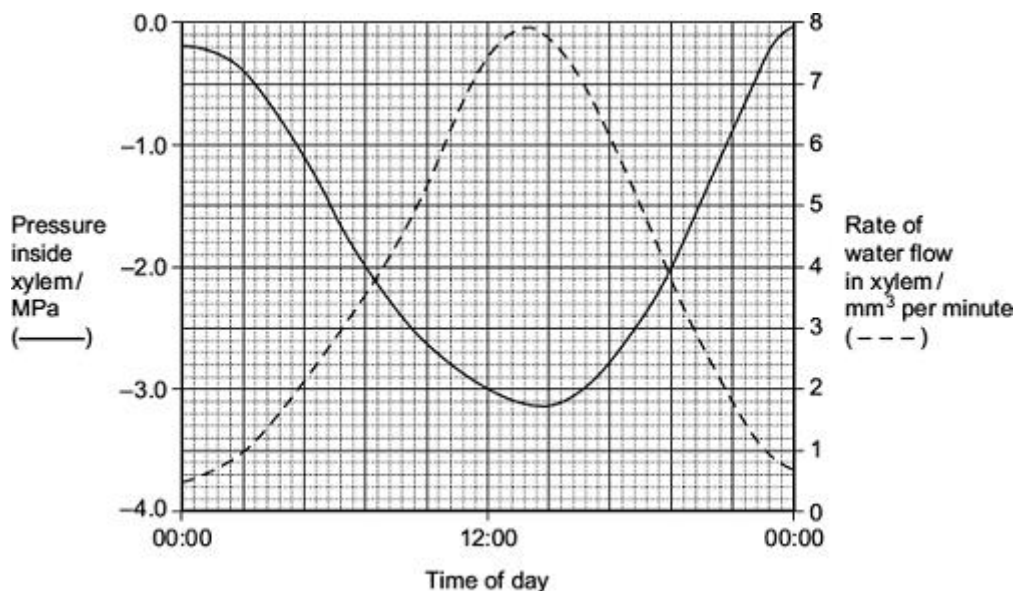
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(Total 8 marks)

- Q21.** (a) Scientists measured the rate of water flow and the pressure in the xylem in a small branch. Their results are shown in the graph.



- (i) Use your knowledge of transpiration to explain the changes in the rate of flow in the xylem shown in the graph.

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 (3)

(ii) Explain why the values for the pressure in the xylem are negative.

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(1)

(b) Doctors measured the thickness of the walls of three blood vessels in a large group of people. Their results are given in the table.

Name of vessel	Mean wall thickness /mm (± standard deviation)
Aorta	5.7 ± 1.2
Pulmonary artery	1.0 ± 0.2
Pulmonary vein	0.5 ± 0.2

(i) Explain the difference in thickness between the pulmonary artery and the pulmonary vein.

.....

(1)

(ii) The thickness of the aorta wall changes all the time during each cardiac cycle. Explain why

.....

 (3)

- (iii) Which of the three blood vessels shows the greatest variation in wall thickness?
Explain your answer.

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.....(1)

- (c) Describe how tissue fluid is formed **and** how it is returned to the circulatory system.

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(Total 15 marks)

- Q22.(a)** (i) Give **two** ways in which the structure of starch is **similar** to cellulose.

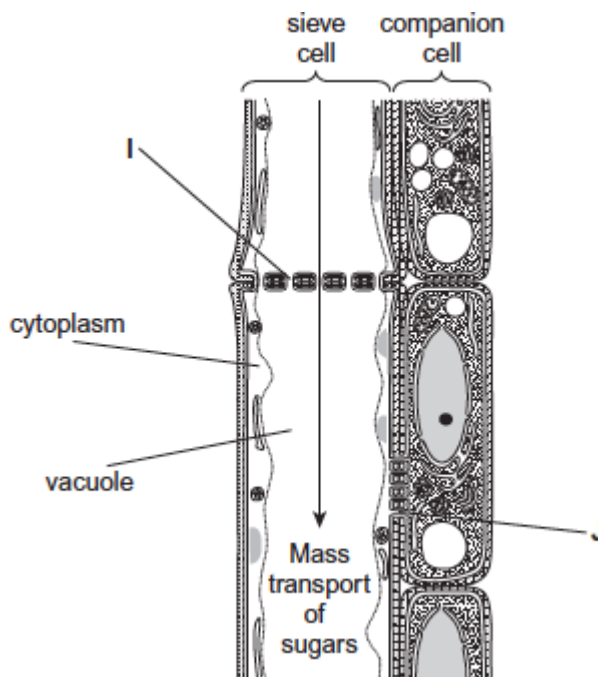
1
2(2)

- (ii) Give **two** ways in which the structure of starch is **different** from cellulose.

1
2(2)

- (b) In plants, mass transport of sugars takes place through columns of sieve cells in the phloem. Other cells, called companion cells, transport sugars into, and out of, the sieve cells.

The diagram shows the structure of phloem.



Structures **I** and **J** allow the transport of sugars between cells.

- (i) Using the diagram, suggest and explain **one** other way in which sieve cells are adapted for mass transport.

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- (ii) Using the diagram, suggest and explain **one** other way in which companion cells are adapted for the transport of sugars between cells.

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(2)
(Total 8 marks)