WJEC EDUQAS A-LEVEL BIOLOGY · COMPONENT 3

BIOLOGY



EXAM QUESTION PACK

3.2 ADAPTATIONS FOR TRANSPORT

SCORE	PERCENTAGE
/320	%

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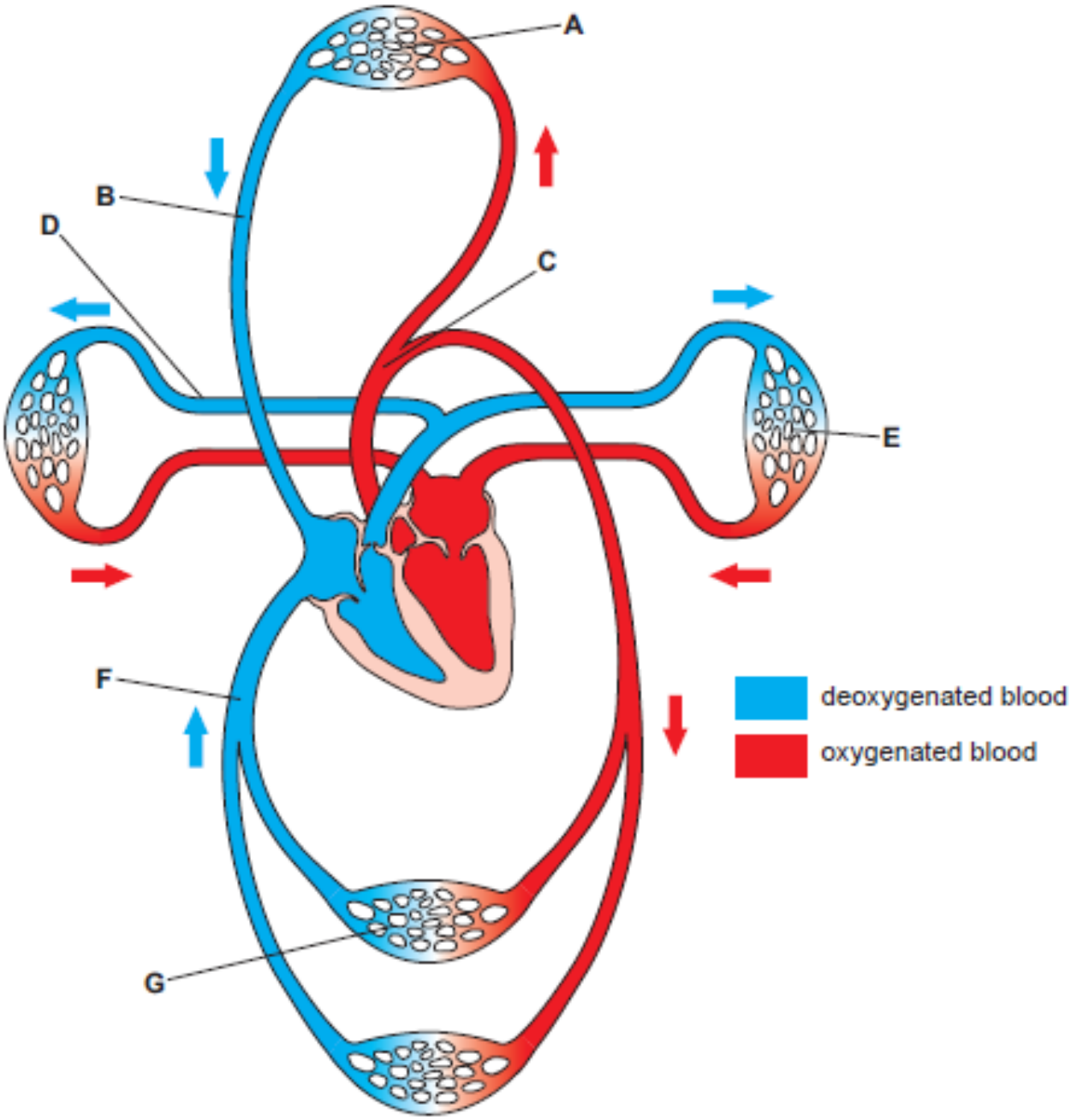
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1. Mammals have a double circulatory system as shown in the diagram below. The arrows show the direction of blood flow.



(a) Using **only** the letters **A** to **G** from the diagram, identify the following (letters may be used once, more than once or not at all): [3]

(i) parts of the pulmonary circulation ....

(ii) blood pressure is maintained by elastic recoil ....

(iii) blood flow is maintained by contraction of skeletal muscle and breathing movements ....

(b) Use the information provided in the table below to answer the questions that follow.

	Total number of vessels	Mean length /cm	Mean diameter /cm	Total cross-sectional area /cm^2	Total blood volume /cm^3	Rate of blood flow /$cm^3\ s^{-1}$
aorta	1	40	1.0	0.8	32	28
other large arteries	40	20	0.3	3	60	7.8
arterioles	4×10^7	0.2	0.002	124	25	1.18
capillaries	1.2×10^9	0.1	0.0008	.....	60	0.036

(i) Using the formula below calculate the total cross-sectional area of the capillaries. **Express your answer to three significant figures.** [3]

cross-sectional area = πr^2

(π = 3.142)

Total cross-sectional area = ... cm^2

(ii) Explain why a low protein diet would result in fluid retention in the tissues. [4]

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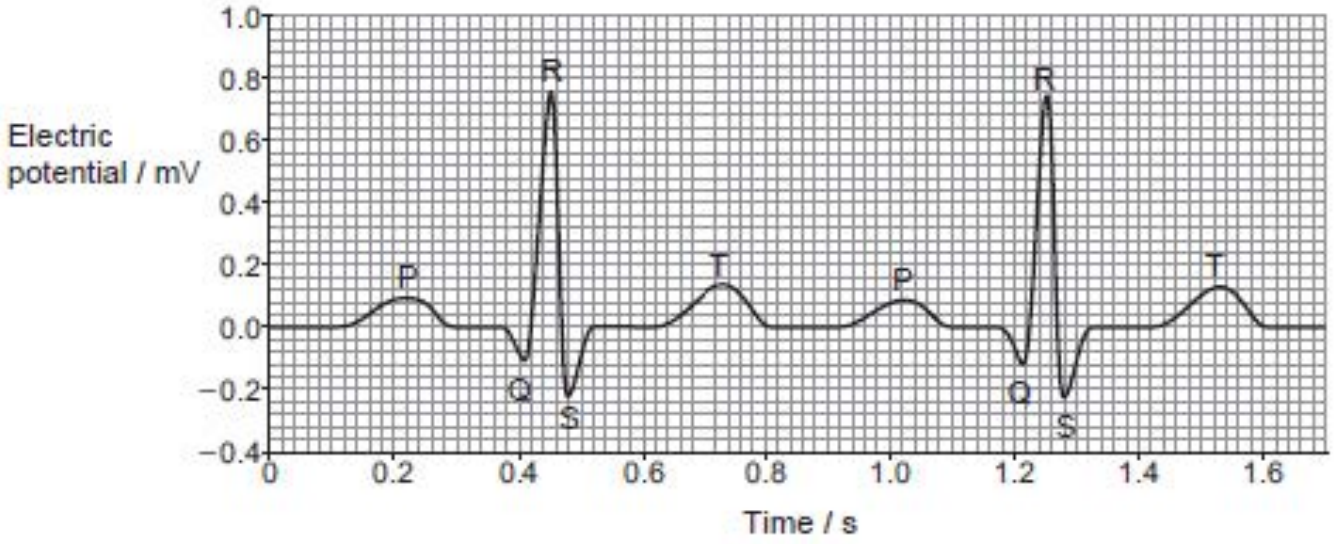
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2. An ECG is a test that can be used to check the heart's rhythm and electrical activity. Sensors attached to the skin are used to detect the electrical signals produced by the heart each time it beats. The graph below shows part of a trace from a healthy person at rest.



(a) (i) What does the abbreviation ECG represent? [1]

.....

(ii) Calculate the heart rate of the person in beats per minute (bpm). [1]

Heart rate = ... bpm

(iii) Explain the events occurring during;

I. The P wave. [3]

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II. The QRS complex. [3]

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III. The T wave. [2]

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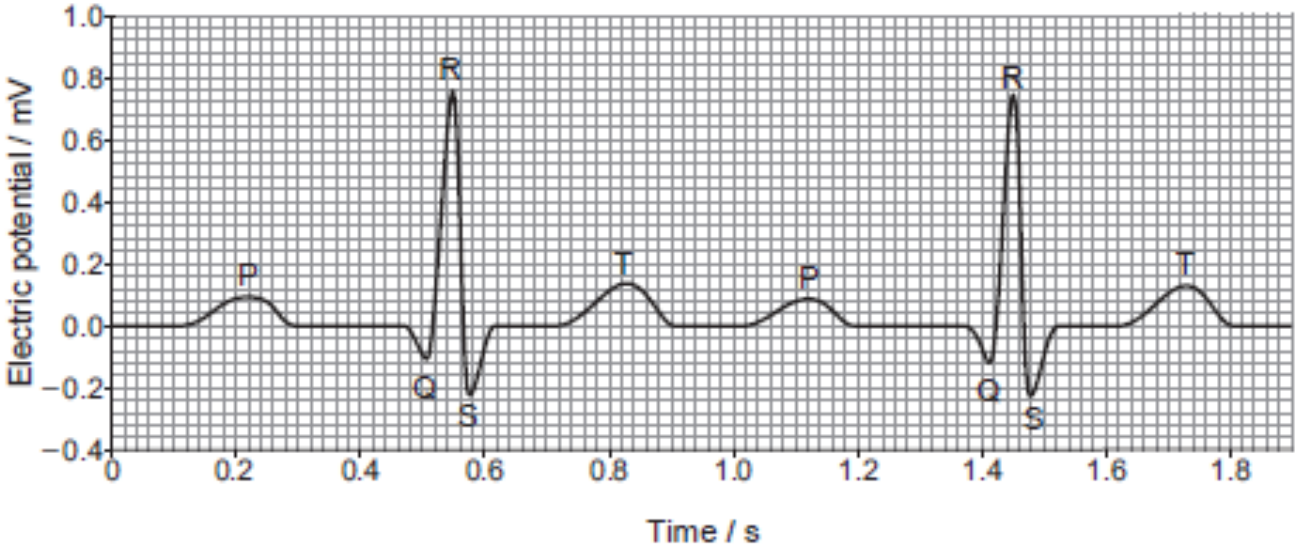
(b) During exercise there is little change to the lengths of the P wave, QRS complex, or T wave. Describe and explain how the distance between consecutive P waves would differ in a person taking exercise. [2]

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(c) The ECG trace below illustrates an abnormality known as a First Degree Heart Block.



(i) On the graph above **circle one** region of the ECG where this abnormality occurs. [1]

(ii) Conclude which region of the conducting tissue of the heart is affected by a First Degree Heart Block. [1]

.....

(iii) Suggest the effect that a First Degree Heart Block would have on the functioning of the heart. [1]

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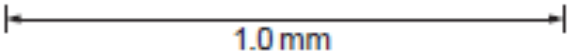
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3. Many plants such as *Quercus* (oak), *Ligustrum* (privet) and *Narcissus* (daffodil), are mesophytes. However, other plants can be classified as xerophytes or hydrophytes.

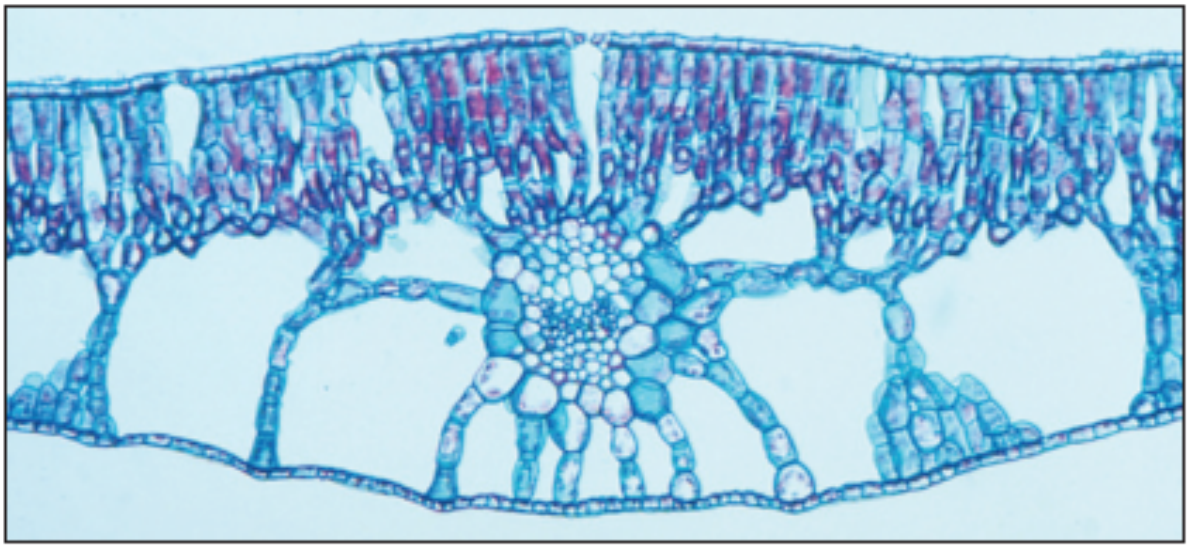
The photomicrographs below show transverse sections through the leaves of *Pinus* (pine) and *Potamogeton* (pondweed).

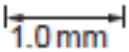
***Pinus* (pine) – a xerophyte.**





***Potamogeton* (pondweed) – a hydrophyte.**





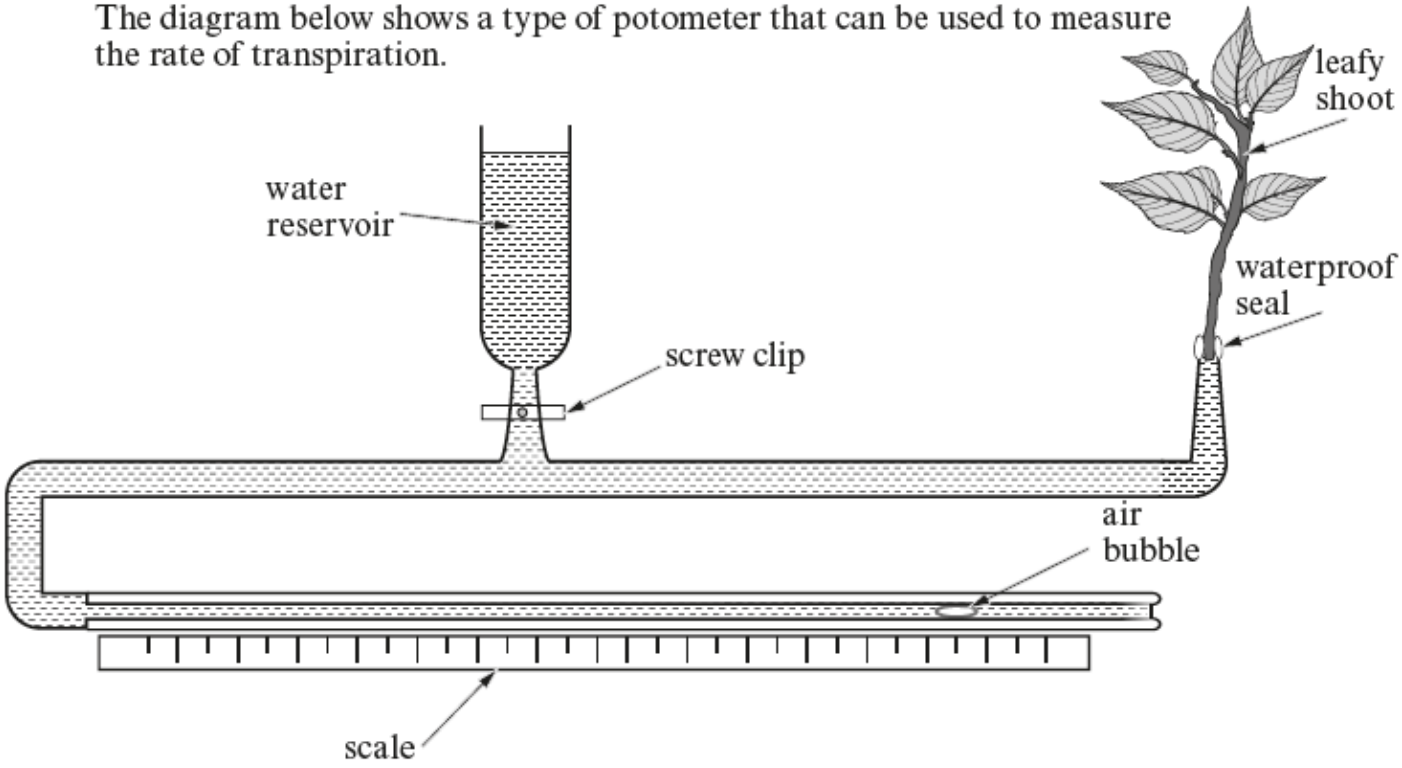
Explain what is meant by the terms mesophyte, xerophyte and hydrophyte.

For both *Pinus* and *Potamogeton* describe and explain how their leaf structure enables them to survive in their respective environments. [9 QER]

4. (a) Plants carry out the process of transpiration. [2]

State what is meant by the term *transpiration.*

The diagram below shows a type of potometer that can be used to measure the rate of transpiration.



(b) State **two** practical measures which should be taken when setting up the apparatus to ensure the potometer functions correctly. Give reasons for your answers.

[4]

(c) Water passes through the xylem of the root and stem of a plant before reaching its leaves.

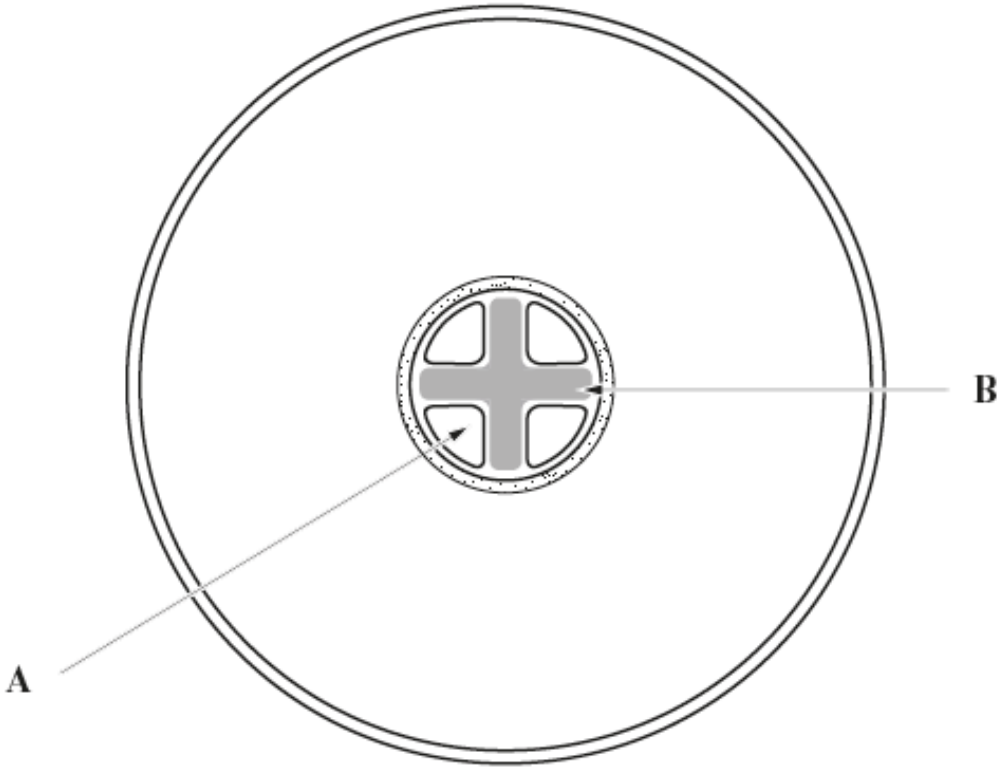
(i) Name the original source of energy that moves water through a plant

[1]

(ii) Explain how water moves up the xylem.

[2]

(d) The diagram below shows the cross section of a root.



(i) Name the **two** tissues labelled **A** and **B** on the diagram above.

[2]

A.....

B.....

(ii) Explain how it is possible to tell that the diagram above is of a root and not a stem.

[2]

5. The atrio-ventricular node (AVN), bundle of His and Purkyne (Purkinje) fibres are specialised cardiac muscle tissues which are involved in the control of heartbeat.

(a) State the function of the following structures in the functioning of the heart.

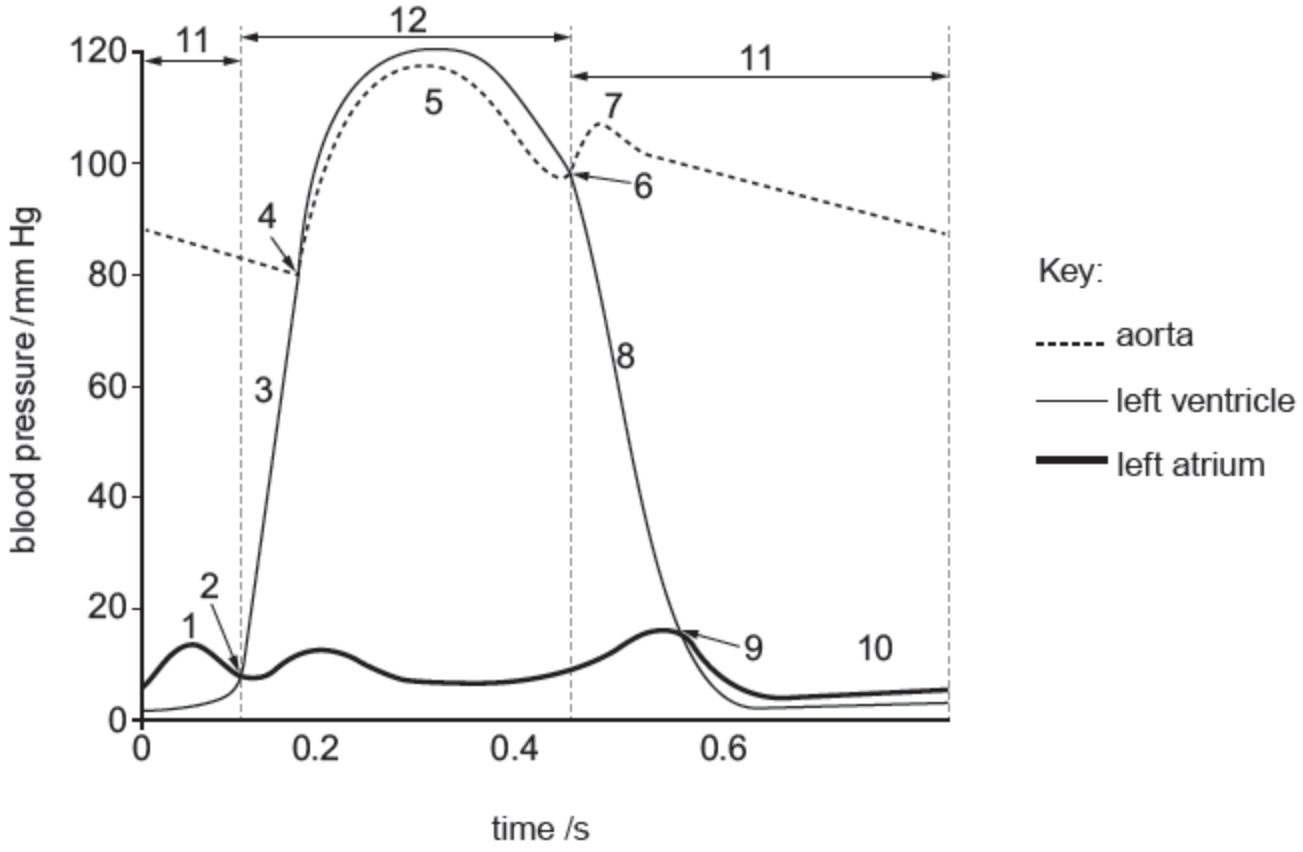
(i) atrio-ventricular node (AVN);

[2]

(ii) bundle of His and Purkyne fibres.

[2]

The graph below shows the pressure changes in the left ventricle, left atrium and aorta during one cardiac cycle.



(b) The following statements list events or phases that occur during a cardiac cycle. State the numbers indicated on the graph above that correspond to each of the following statements.

[8]

(i) ventricular diastole (ventricles are relaxing) . . . . . .

(ii) recoil of aorta . . . . . .

(iii) atrial systole . . . . . .

(iv) closing of semi-lunar valves . . . . . .

(v) opening of semi-lunar valves . . . . . .

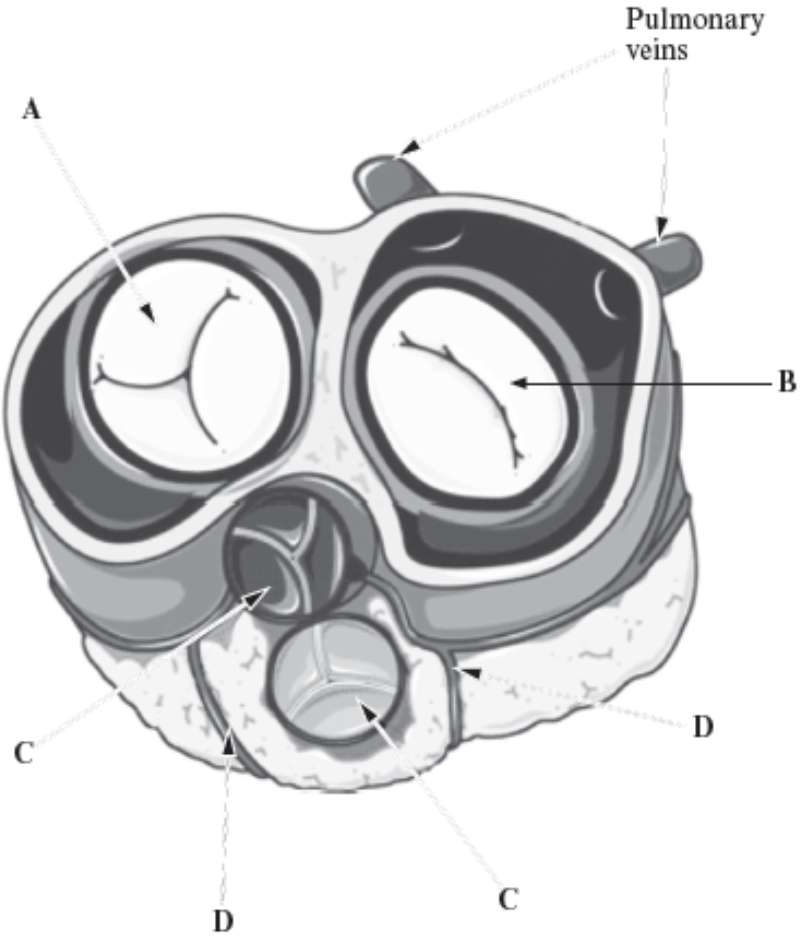
(vi) atrio-ventricular valves close . . . . . .

(vii) ventricular systole (ventricles are contracting) . . . . . .

. .

(viii) passive filling of atrium by venous return . . . . . .

6. The diagram below shows a section of a human heart, cut just above the heart valves, as seen from above.



(a) Name valves A, B and C.

[3]

A

.....

B

.....

C

.....

(b) Name blood vessels D which are found on the surface of the heart and explain their function.

[2]

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(c) (i) Explain why valve B often has to be replaced because it ceases to work effectively and why valve A rarely needs replacing.

[1]

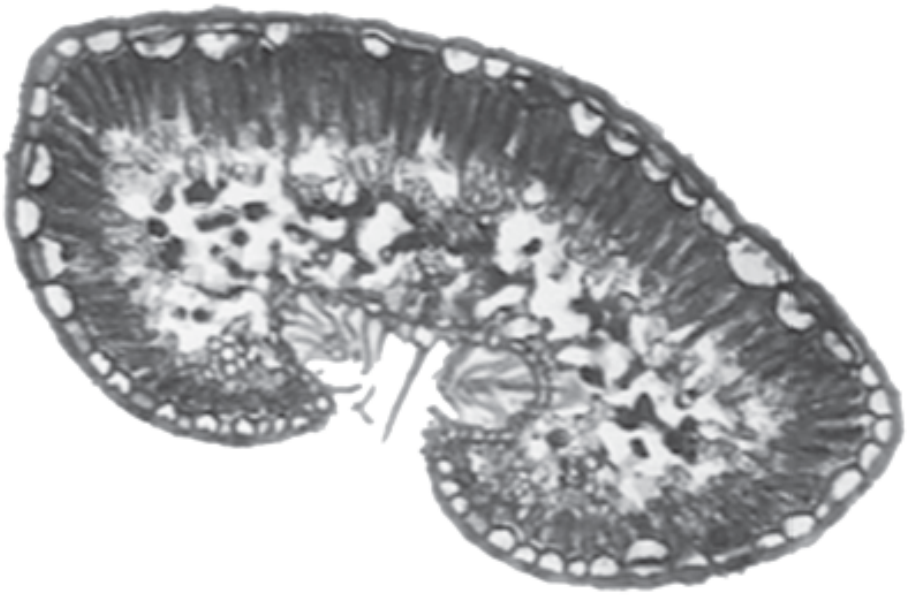
(ii) What would happen to the flow of blood if the valve is damaged?

[1]

(iii) Suggest one symptom a person with a failing valve B may have.

[1]

7. The photograph below shows a transverse section through the leaf of heather (Erica cinerea). This heather lives in a dry, windy environment.



(a) (i) State three features of the leaf shown above which indicate that it lives in a dry environment.

[3]

Feature 1

.....

Feature 2

.....

Feature 3

.....

(ii) Explain how any one of these features help Erica live in a dry environment.

[1]

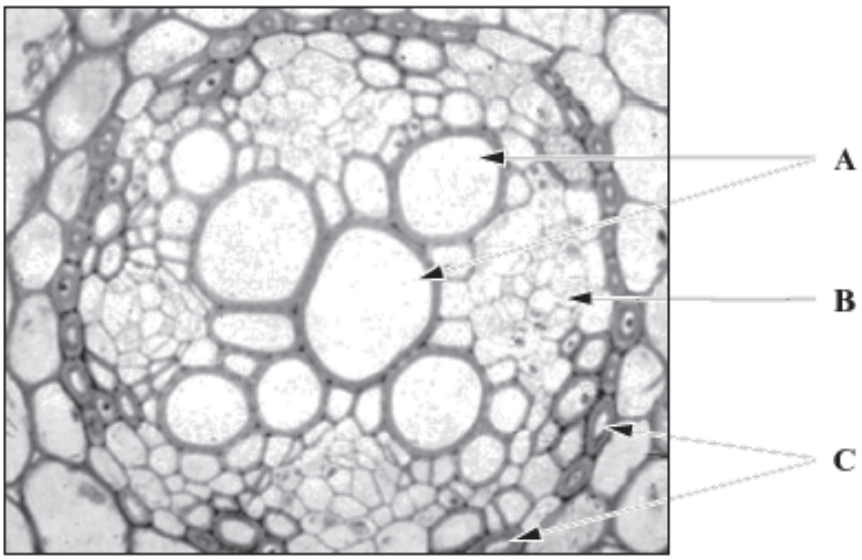
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(b) What name is given to plants that live in dry environments?

[1]

.....

(c) The diagram below shows a transverse section of a buttercup (Ranunculus sp.) root as seen under high power with a light microscope.



(i) Name tissue A and explain its role in the plant.

[2]

.....

.....

(ii) Name tissue B and explain its role in the plant.

[2]

.....

.....

(iii) Name cells C.

.....

(iv) Draw a simple longitudinal section of cell C clearly labelling the special feature of this cell. [2]

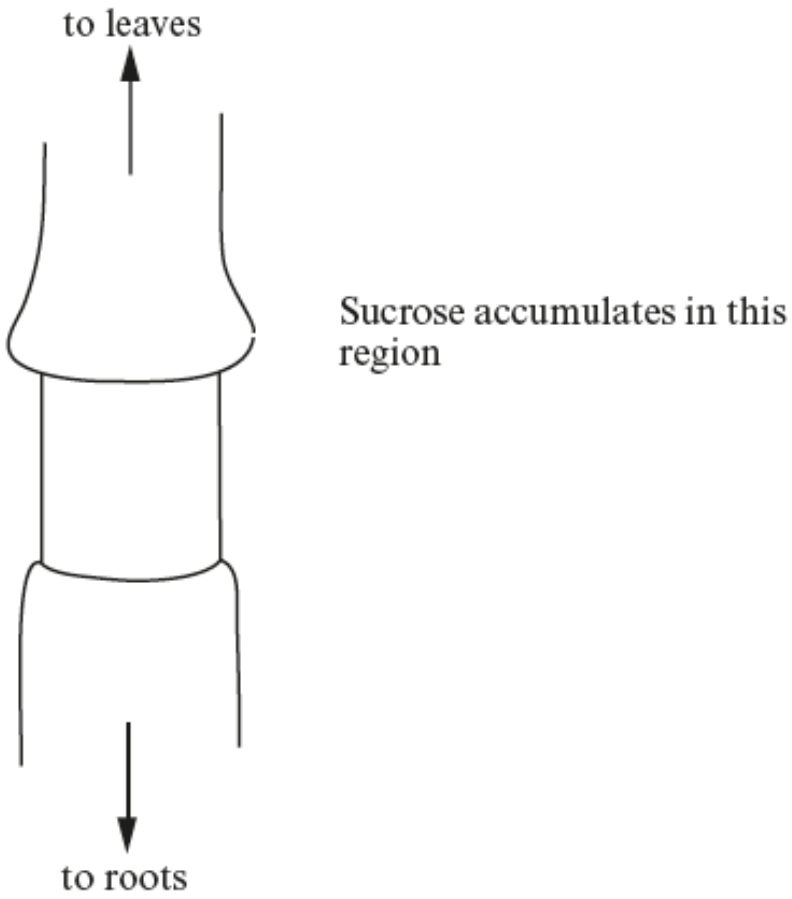
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(v) Explain how cell C carries out its function in the uptake of water and minerals in the plant.

[4]

8. (a) The diagram below shows part of a plant stem with the tissue external to the xylem removed, a technique known as ringing.

An accumulation of sucrose was found in the region shown.



(i) Explain why this accumulation of sucrose occurred.

[3]

(ii) Name **one** other type of organic molecule that is likely to accumulate with the sucrose.

[1]

(b) If the growing points of the shoot of the plant are removed there is a greater accumulation of sucrose.

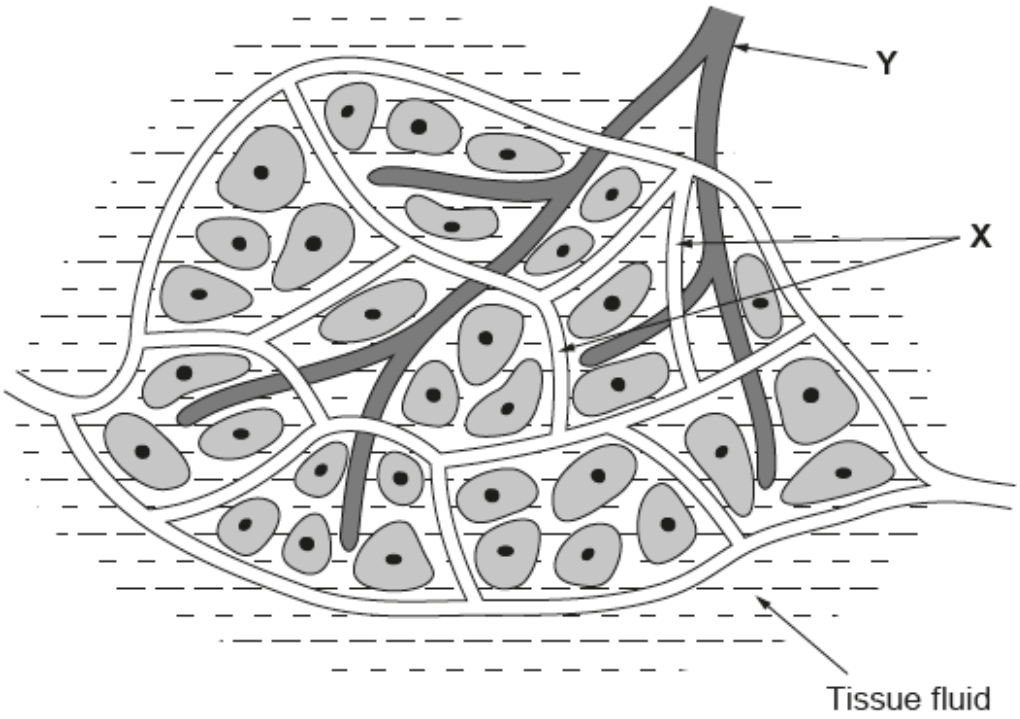
Explain why there is a greater accumulation of sucrose.

[2]

(c) Explain fully the likely effect of the removal of the ring of tissue on the concentration of sucrose **below** the ring.

[3]

9. The diagram shows two different types of vessel found in the tissues of the human body.



(a) Name the type of blood vessel labelled **X** in the diagram

[1]

(b) Name the fluid found in vessel **Y**.

[1]

(c) The movement of water out of the blood vessels into the tissue fluid is caused by high hydrostatic pressure at the arterial end. The reabsorption of most of the water back into the blood at the venous end is due to osmotic pressure.

(i) Name a substance found in the plasma that helps to maintain this osmotic pressure

[1]

10. Answer **one** of the following questions.

Any diagrams included in your answers must be fully annotated.

Either, (a) (i) Describe how carbon dioxide is transported from respiring tissues to the lungs.

[6]

(ii) Explain how changes in carbon dioxide concentrations in the blood can lead to an increased oxygen supply for respiring tissues.

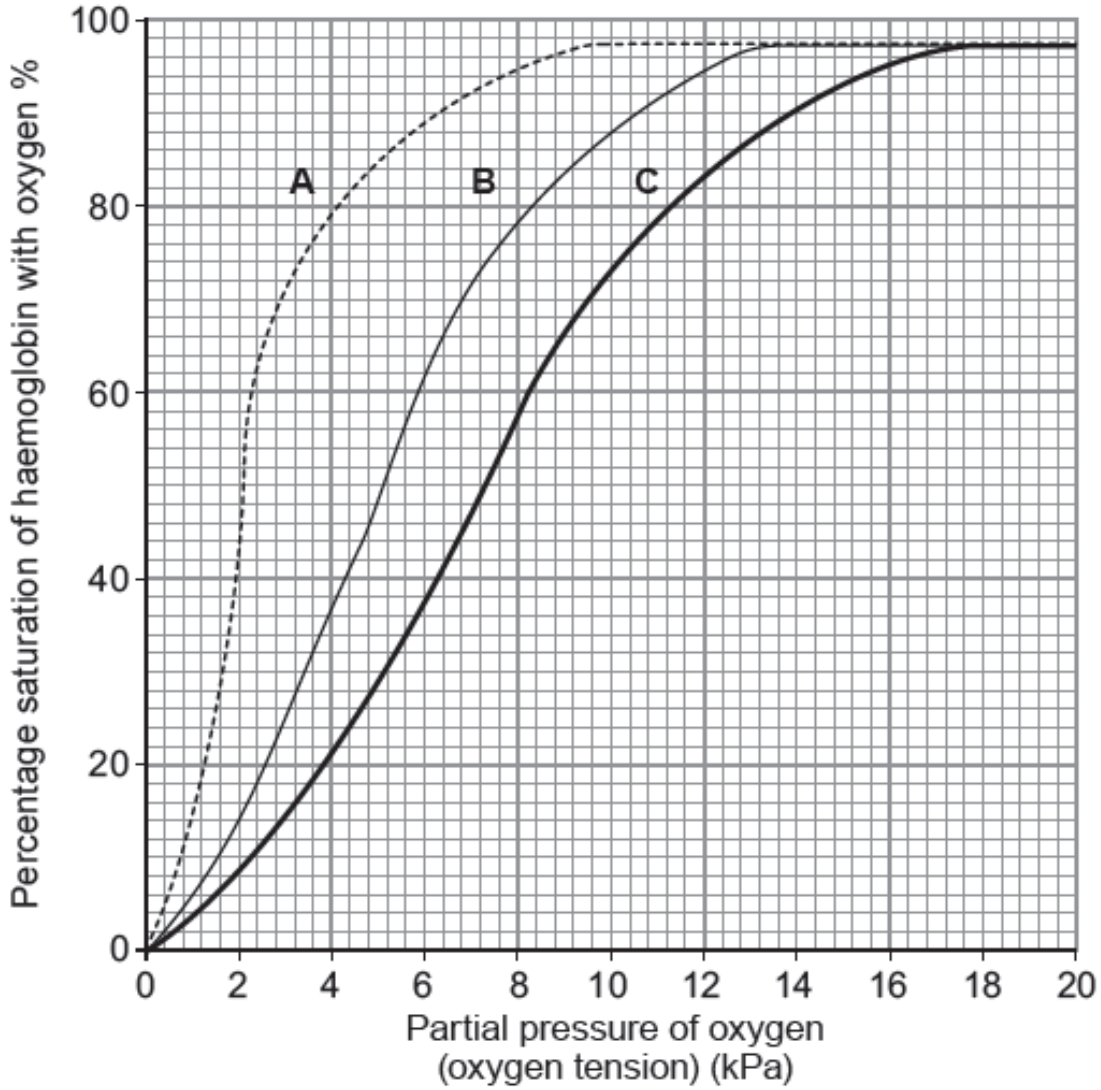
[4]

Or (b) Describe the similarities and differences in the structure and functioning of arteries and xylem vessels.

[10]

11. (a) The graph below shows the oxygen dissociation curve for three mammals.

Graph **A** is the curve for a llama which is a mammal that lives at high altitudes. Graph **B** is the curve for a domestic cat and graph **C** is the curve for a mouse which is a small mammal with a high metabolic rate.



Key:

A = llama

B = domestic cat

C = mouse

(i) What is the percentage saturation of the cat's haemoglobin with oxygen when the partial pressure of oxygen in the muscle tissue of a cat is 3.0kPa.?

[1]

.....

(ii) Explain the circumstances under which the partial pressure of oxygen may fall to 3.0kPa in muscle tissues.

[2]

(b) State which of the three curves represents the haemoglobin with the lowest affinity for oxygen at 3.0kPa.

[1]

(c) If the pH of the blood became more acidic, the position of curve **C** for the mouse would change.

(i) Draw on the graph opposite the new position of curve **C** when the blood becomes more acidic.

[1]

(ii) Explain the benefits to the mouse of this change in position of curve **C**.

[3]

(d) Explain how curve **A** for the llama shows that its haemoglobin is well adapted for its environment.

[3]

(e) State which of the three curves could represent the oxygen dissociation curve of a lugworm.

[1]

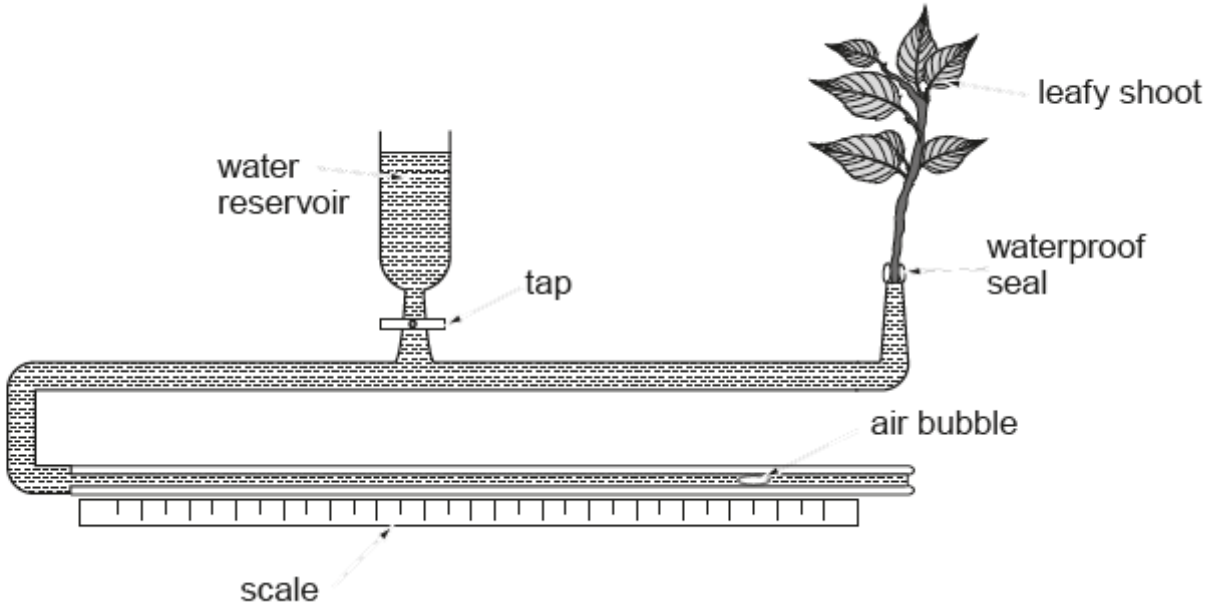
12. (a) (i) State what is meant by the term transpiration.

[2]

(ii) Give **one** benefit of transpiration to a plant.

[1]

(b) The diagram below shows a piece of apparatus called a potometer which is used to measure the rate of transpiration



(i) Suggest why the end of the shoot should be cut under water before being inserted into the potometer.

[2]

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(ii) State what measurements would have to be made, in order to determine the rate of transpiration.

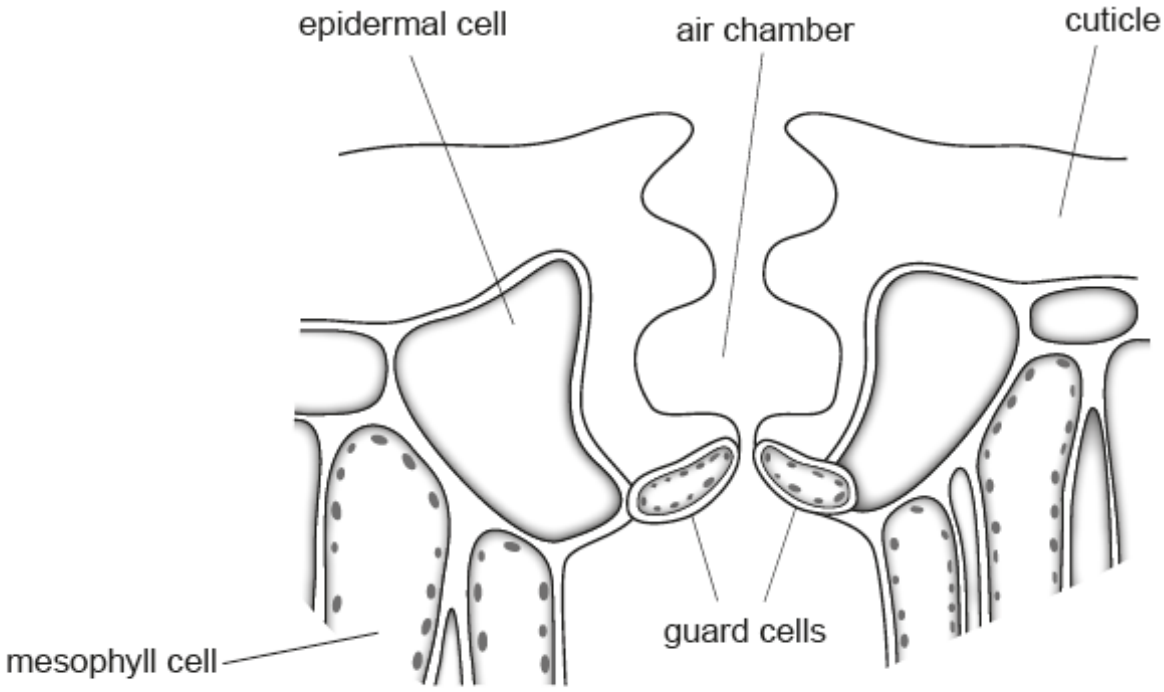
[2]

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(c) The diagram below shows a sunken stoma which is an adaptation found in the leaves of some plants that live in very dry conditions.



(i) State the general name for plants that live in, and are adapted for, dry conditions.

[1]

(ii) With reference to the diagram, explain how a sunken stoma is able to reduce transpiration.

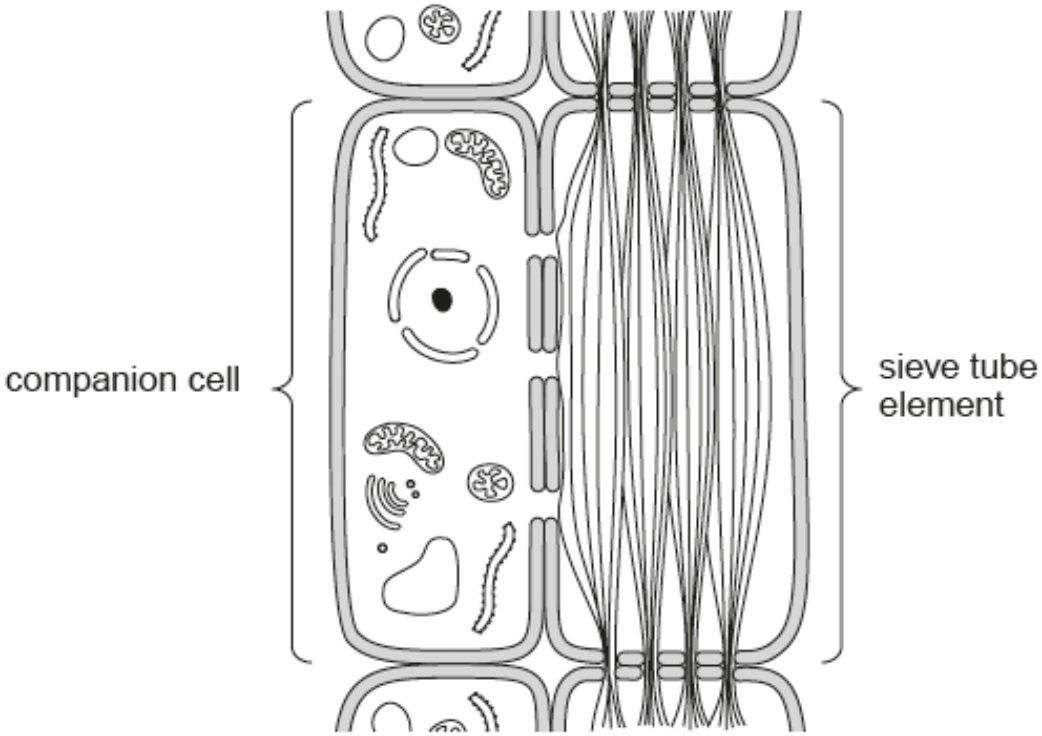
[3]

(iii) Describe and explain **two** other adaptations which reduce the rate of transpiration in plants that live in very dry conditions.

[2]

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13. The diagram below shows two types of cell that are found in phloem tissue.



(a) Name **two** other types of cell that are found in phloem.

[2]

1.

2.

(b) The function of phloem is to transport organic molecules, such as sucrose, in a plant.

Using the diagram only, explain how **two** features of the sieve tube element enable the phloem to carry out its function.

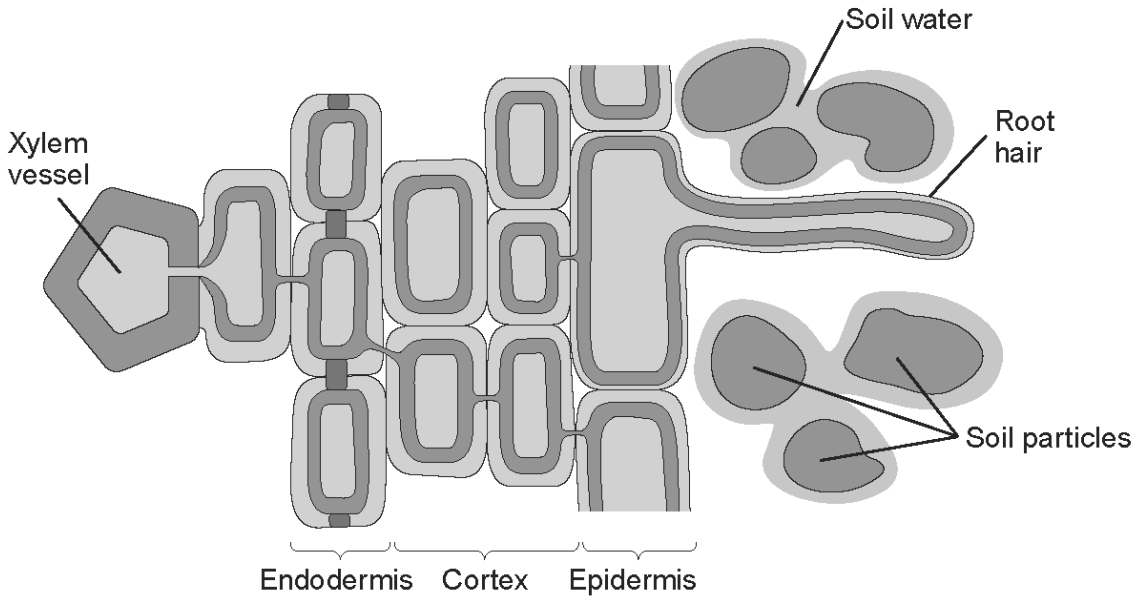
[4]

(c) The mass flow theory is one explanation to account for the movement of solutes in the phloem.

Suggest why the presence of large numbers of mitochondria in the companion cells does **not** support this theory.

[3]

14. Shown below is a diagram of a cross section through a root.



(a) Explain how a root hair cell is adapted to its function. [1]

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(b) Water can travel across the root via the apoplast and symplast pathways. Describe the difference between these two pathways. [2]

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(c) Describe and explain the role of the endodermis in the uptake of water into the xylem vessels and in generating root pressure. [4]

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(d) The transport of organic molecules through a plant can be monitored using radioactive tracers. If a plant is supplied with carbon dioxide containing the radioactive isotope, ^{14}C, then the radioactive carbon will be incorporated into organic molecules which can then be located using autoradiography.

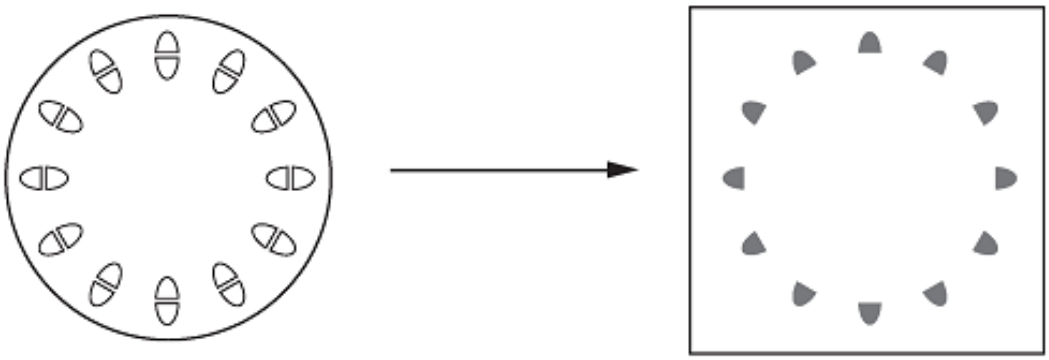
(i) Name the leaf tissue where ^{14}C is incorporated into organic molecules. [1]

.....

(ii) Name the carbohydrate that is transported through the plant. [1]

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(e) Below is a transverse section of a dicotyledon stem and an autoradiogram of the same section.



Transverse section of stem

Autoradiogram

What conclusion about the transport of carbohydrates can be drawn from the autoradiogram? [1]

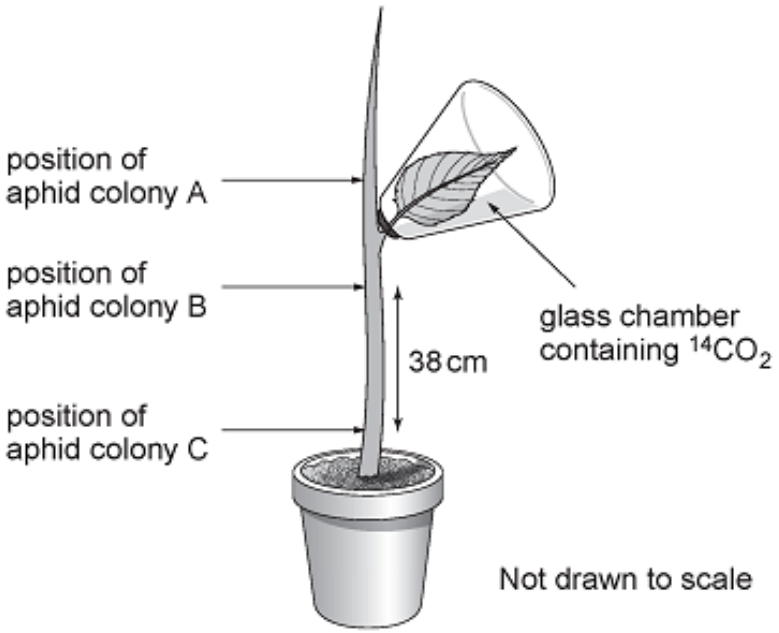
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(f) In an experiment, a single leaf of a plant was supplied with radioactively labelled carbon dioxide. Colonies of aphids were allowed to feed at various locations on the plant, as shown in the diagram below. During feeding, the aphids were anaesthetised and their bodies removed leaving their mouthparts in the plant. The solution of organic molecules flowing out of the mouthparts was then analysed.



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Aphid colony	Time after the start of the experiment when radioactivity was first detected in aphid mouth parts (hours)
A	1.0
B	1.0
C	2.5

(i) How does the evidence from the experiment show that there is bidirectional movement of organic molecules in the plant? [1]

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.....

(ii) Use the information provided to calculate the rate of translocation ($cm\,min^{-1}$) of organic molecules through this plant. [2]

..... $cm\,min^{-1}$

13

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15. *(a)* Cardiac muscle is said to be myogenic (spontaneously active). What does this term mean? [1]

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(b) Describe the role of the following in the cardiac cycle:

(i) the sino-atrial node; [2]

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(ii) the Purkyne (Purkinje) fibres. [2]

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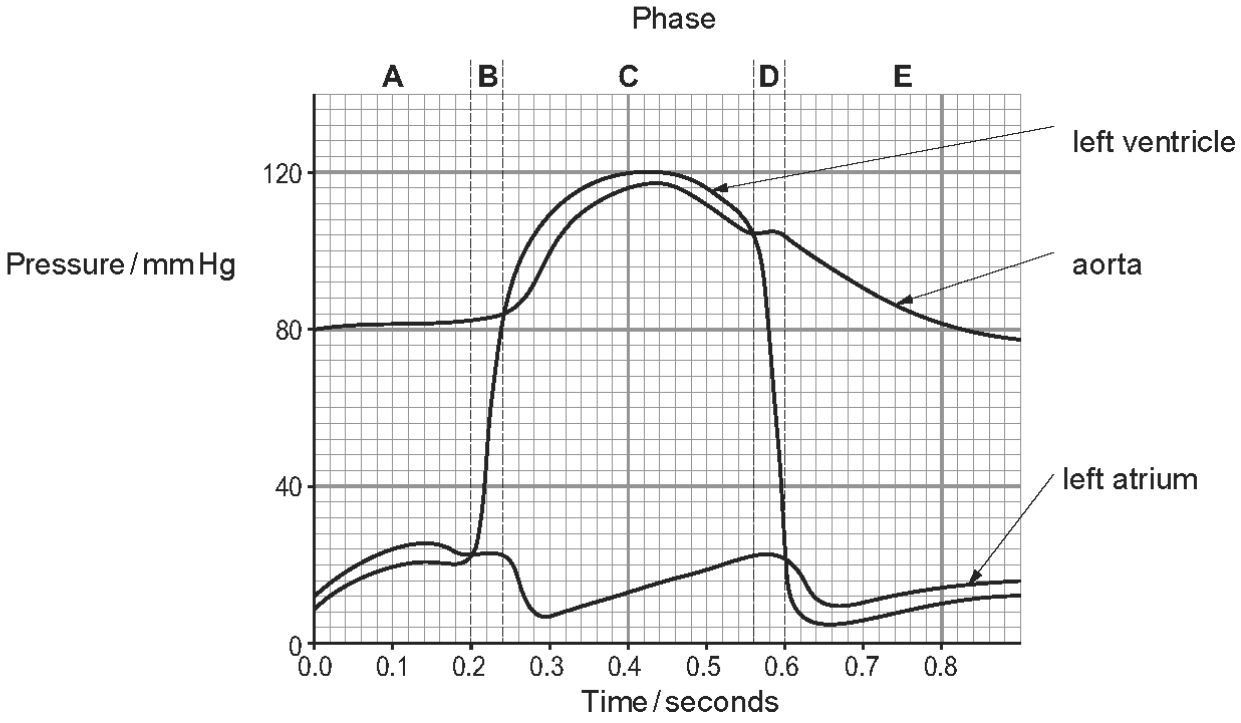
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(c) Below is a graph showing the pressure changes in the left side of the heart during one cardiac cycle.



(i) From the graph state the time when the following events occur. [2]

Event	Time / seconds
The atrio-ventricular (bicuspid) valve closes	
The aortic (semi lunar) valve closes	

(ii) Using the letters **A**-**E** from the top of the graph, state a phase when the following events occur. [3]

Event	Phase
Blood is flowing from the atria to the ventricles	
Blood is flowing from the ventricle to the aorta	
When there is no overall movement of blood through the heart	

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(iii) Explain how blood is prevented from flowing from the left ventricle to the left atrium. [2]

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12

16. *(a)* Complete the following paragraph about the heart and heartbeat by inserting the most appropriate **word or words**. (Abbreviations will not be accepted). [7]

The events occurring during the beating of a human heart are called the cardiac cycle. In an average adult heart, at rest, there are approximately ..... cycles per minute.

Cardiac muscle is ..... which means it can contract and relax without nervous stimulation. Each cycle is started in a specialised part of the muscle in the wall of the ..... called the ..... . This sets up a wave of excitation causing the cardiac muscle to contract.

After a short delay the wave passes to the ventricles via the ..... .

The wave passes to the base of the ventricles via the ..... causing the ventricles to ..... from the base upwards.

(b) The human circulatory system is described as being a closed and double circulation. With reference to the above sentence, state the meaning of the terms:

(i) closed; [2]

.....

.....

.....

(ii) double. [2]

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17. *(a)* Mammals have a double circulation.
State what is meant by the term *double circulation* and explain its advantages to a mammal. [3]

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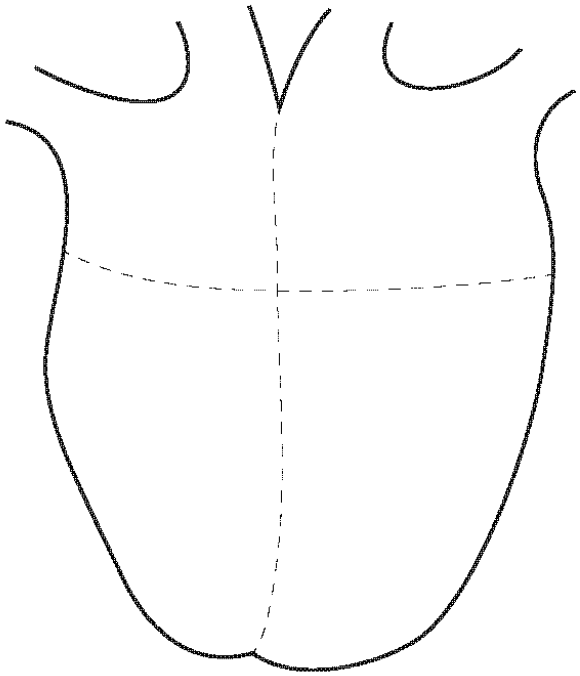
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(b) The sino-atrial node (SAN), the atrio-ventricular node (AVN) and atrio-ventricular septum are tissues found in the heart. They are responsible for the initiation and control of the heartbeat.

(i) In the outline of the heart below use labels with label lines to show the positions of the SAN and the AVN. [2]



(ii) The atrio-ventricular septum is a thin layer of connective tissue between the atria and the ventricles.
Explain the role of the atrio-ventricular septum and the AVN. [4]

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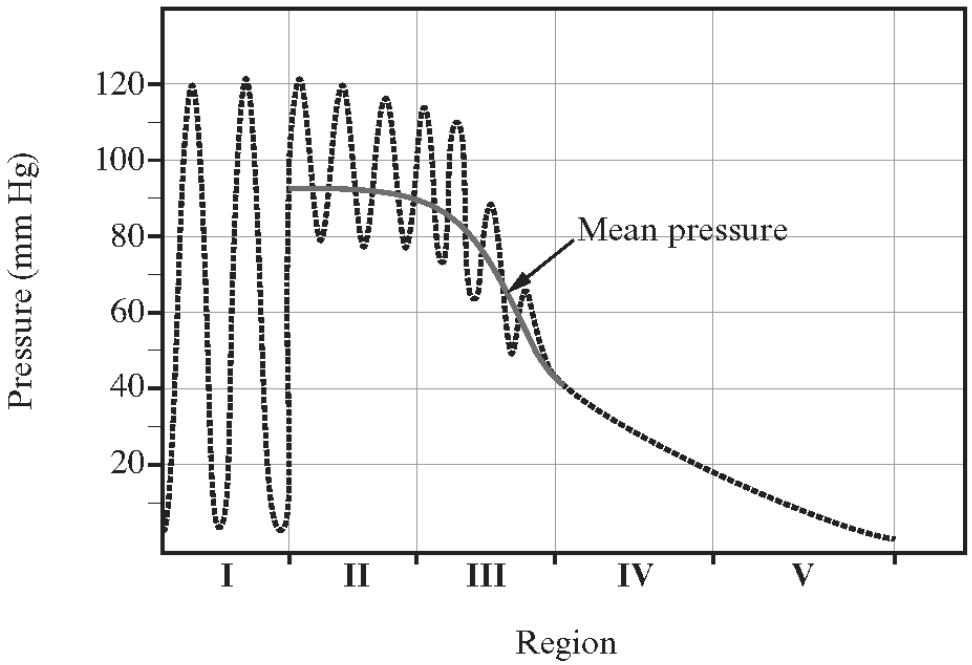
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(c) The SAN produces a wave of excitation every 800 milliseconds in a person at rest and a heartbeat is triggered each time. Calculate the rate of heartbeat per minute of the person at rest. Show your working. [2]

Answer .....

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18. *(a)* The graph below shows how the blood pressure changes as the blood is transported through the human circulatory system.



(i) Region **I** of the graph shows the blood pressure in the left ventricle and region **II** shows the blood pressure in the aorta.

Explain fully the reasons for the differences in the maximum and minimum blood pressure in the left ventricle and the aorta. [3]

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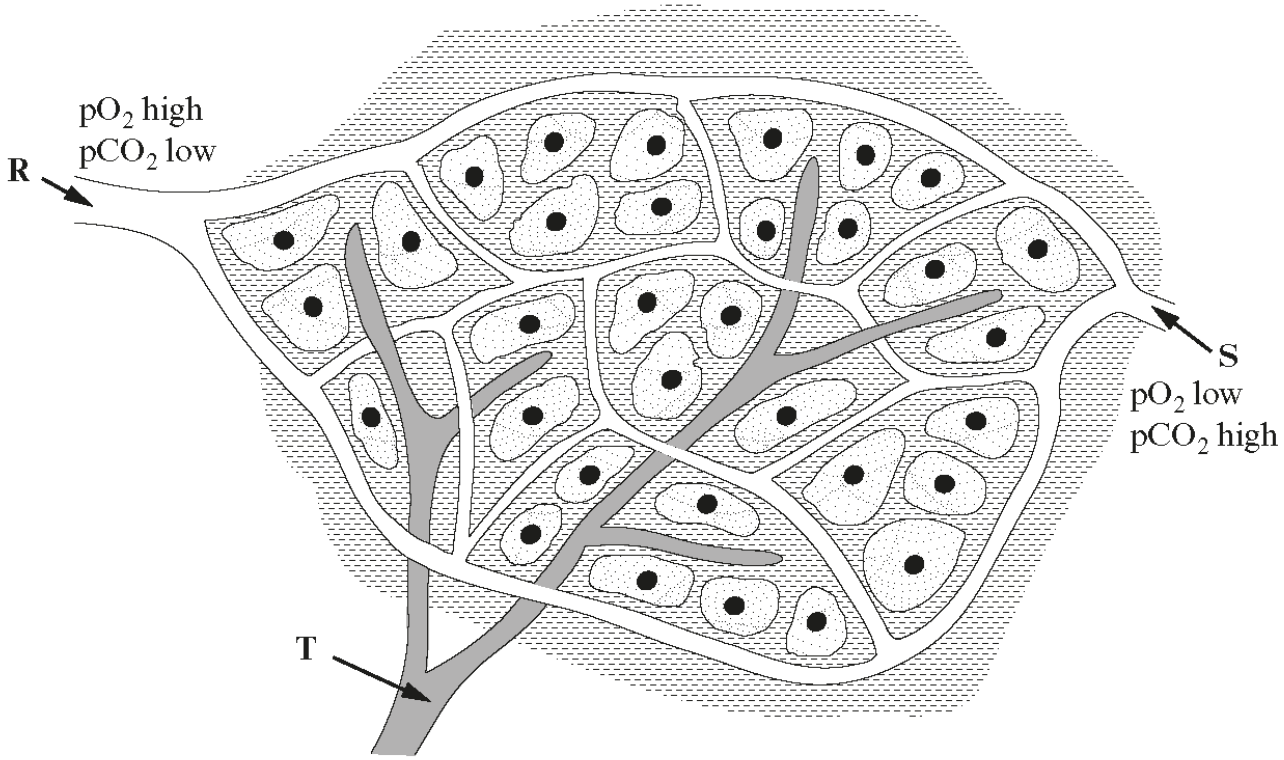
(ii) Why does the blood pressure decrease so rapidly in region **III**? [1]

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(b) The diagram below shows the blood supply to the cells of the body tissues. The relative amounts of oxygen and carbon dioxide in the blood vessels are given.



(i) Which of vessels **R** and **S** represents the arterial end of the blood supply to the tissues? Give a reason for your answer. [2]

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(ii) Explain how differences in the hydrostatic and osmotic pressures between the arterial and venous ends of the blood supply results in the formation of tissue fluid. [3]

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(iii) What is the function of the vessel labelled **T** in the diagram? [1]

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(Total 10 marks)

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19. *(a)* List **four** ways in which arteries differ in structure from veins. [4]

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2. .....

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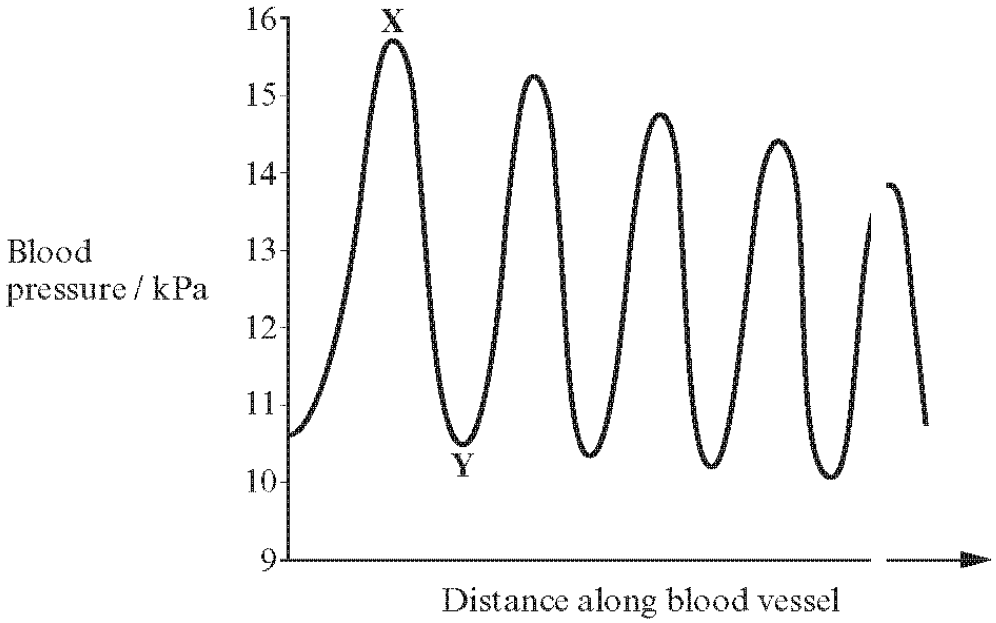
3. .....

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4. .....

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(b) The diagram shows the blood pressure measured at different points along one blood vessel in the human circulatory system.



(i) Name the **type** of blood vessel in which the measurements were made. [1]

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(ii) Explain the difference in blood pressure between **X** and **Y**. [2]

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(iii) Explain the overall decrease in the **maximum** blood pressure. [2]

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20. *(a)* The heart is a muscular pump and the blood is kept moving in the correct direction by a system of valves. Complete the table using a tick (✓) if the statement applies to atrial systole, atrial diastole, ventricular systole or ventricular diastole. [4]

	Atrial systole	*Atrial diastole*	*Ventricular systole*	*Ventricular diastole*
Bicuspid and tricuspid valves open				
Semi-lunar/ aortic valves closed				
Initiated by sinoatrial node (SAN)				
Initiated by Purkyne fibres (Purkinje fibres)				

(b) Explain why a contraction in the left atrium takes place a few milliseconds after that in the right atrium. [2]

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(c) There is a layer of connective tissue between the atria and ventricles. What is the function of this tissue? [2]

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(d) Explain why, during periods of exercise, blood flow through the coronary arteries is increased. [4]

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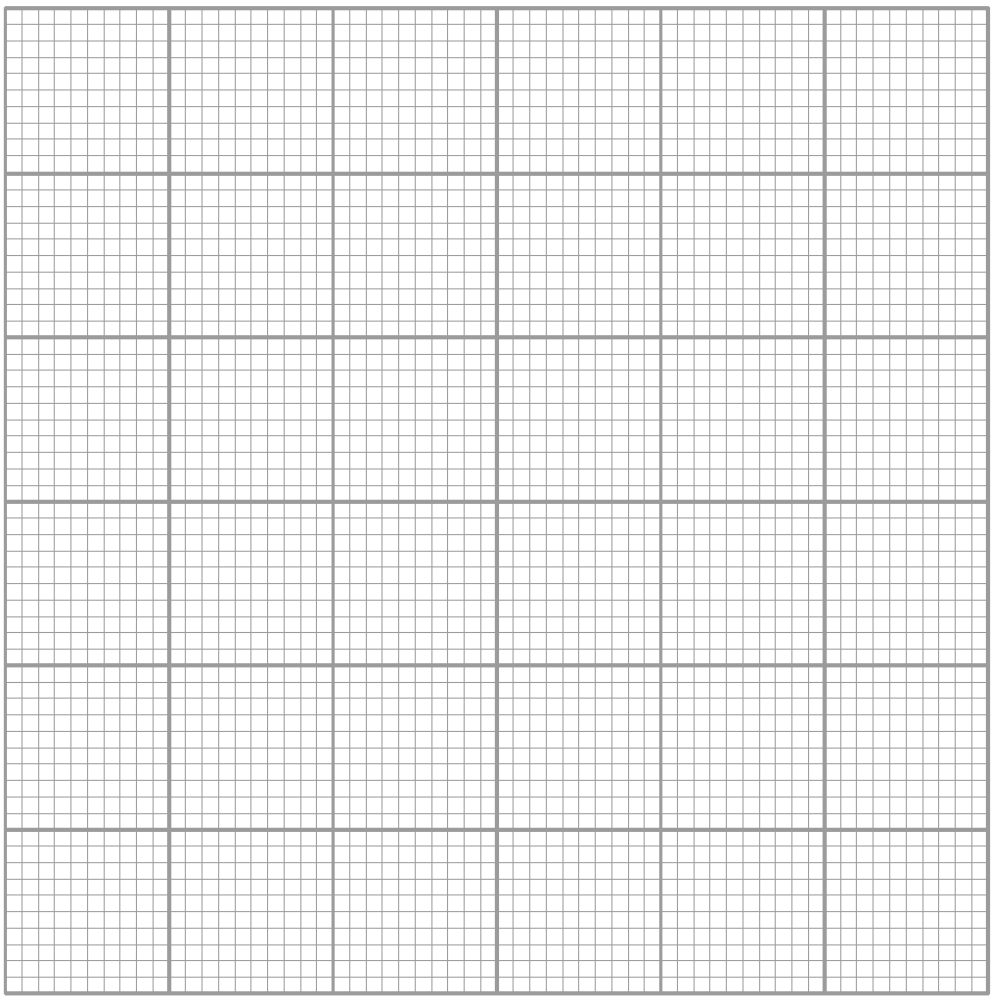
(Total 12 marks)

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21. The table below shows the percentage saturation of human haemoglobin with oxygen at various partial pressures of oxygen (ppO_2).
The readings were taken at two different pH values.

Partial pressure of oxygen (ppO_2)/(kPa)	Percentage saturation of haemoglobin with oxygen (%)	
	pH 7.2	pH 7.4
0	0	0
2	20	35
4	60	70
6	80	85
8	89	93
10	91	93

(a) On the graph paper below use the figures given in the table above to plot a graph of partial pressure of oxygen against percentage saturation of haemoglobin for both pH values. [5]



(b) The ppO_2 in muscle tissue fluid during exercise is 1.5kPa.

(i) On your graph mark this point with an arrow to show the **percentage saturation of haemoglobin**, at **pH 7.2**, in the tissue fluid of muscles. [1]

(ii) What is the name given to the difference between the two curves caused by a change in pH? [1]

.....

(iii) What could account for the lowering of tissue fluid pH in the muscle at this point? [2]

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(iv) Explain how this would be an advantage during exercise. [1]

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(c) (i) On the graph opposite, draw and **label** a curve that would show a dissociation curve for foetal haemoglobin. [1]

(ii) Explain how the position of the foetal haemoglobin curve when compared with that of the mother gives an advantage to the foetus. [2]

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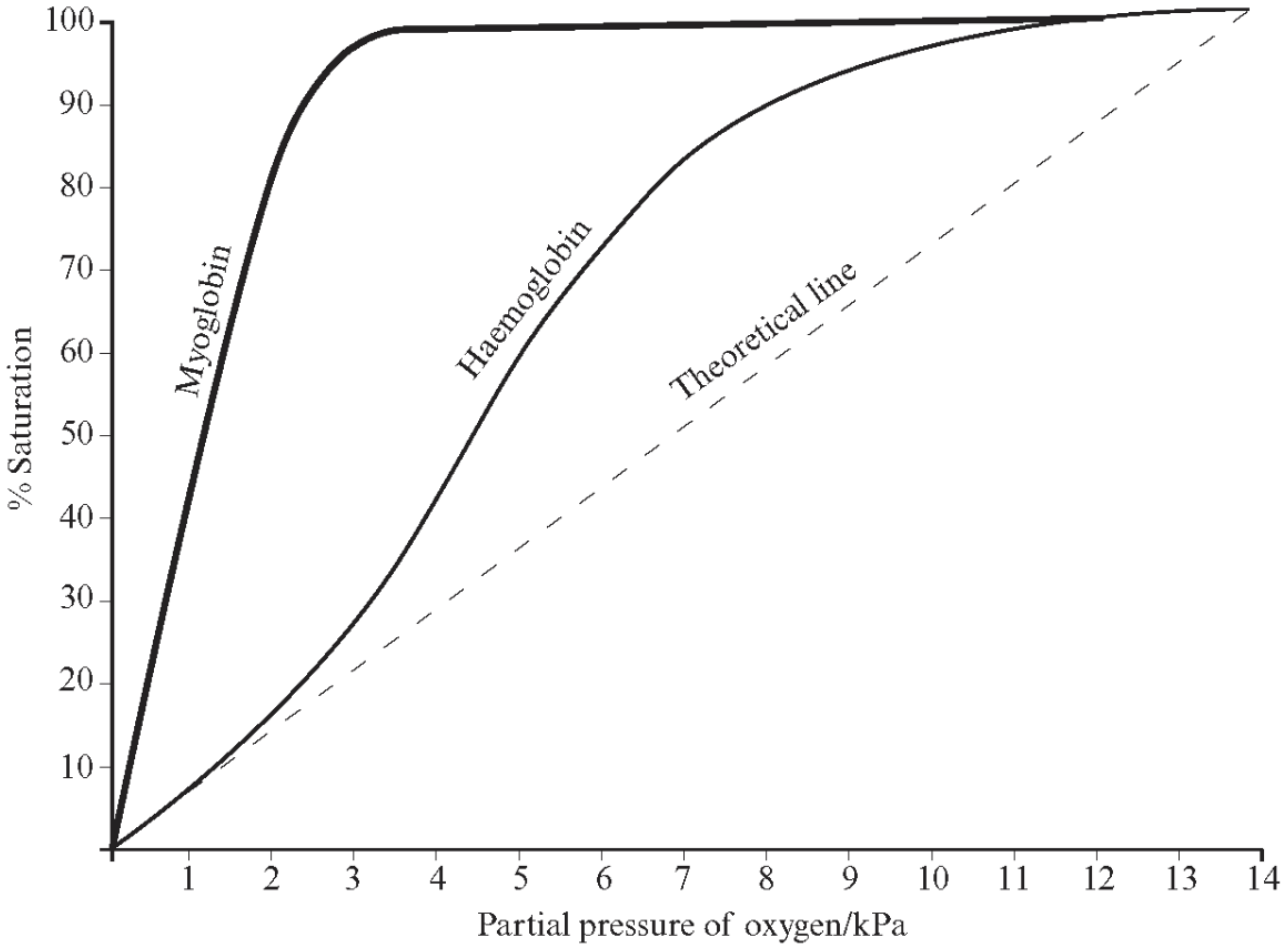
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22. The oxygen requirement of active muscle tissue is normally provided by oxyhaemoglobin. The diagram below shows the uptake of oxygen by haemoglobin at different partial pressures of oxygen. The dotted line represents a theoretical situation in which the rate of uptake was proportional to the concentration of oxygen.



(a) List the **two** ways in which the shape of the haemoglobin dissociation line differs from the theoretical line. [2]

1. .....

2. .....

(b) The partial pressure of oxygen in the lungs is usually about 13kPa and in muscle tissue usually below 5kPa.
Explain the biological significance of the differences between the haemoglobin dissociation line and the theoretical line:

(i) at a partial pressure of 13kPa; [1]

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.....

(ii) at a partial pressure of 4kPa; [1]

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(iii) when the partial pressure changes from 8kPa to 5kPa. [1]

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(c) Describe how oxygen is released from the haemoglobin molecule. [3]

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(d) The other dissociation curve on the diagram is for a myoglobin molecule. Suggest how myoglobin can perform a useful function in muscle tissue. [3]

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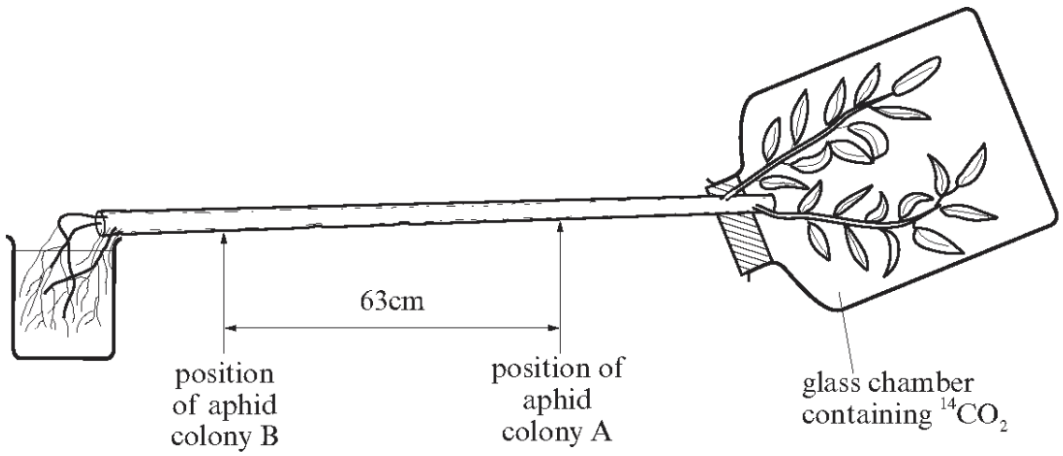
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(Total 11 marks)

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23. The diagram shows an experiment in which the leaves of a plant were exposed to radioactive carbon dioxide. Two colonies of aphids (greenfly) were allowed to feed on the stem of the plant and their excreta was collected at regular intervals. This excreta was scanned for radioactivity.



(a) Radioactivity was first recorded in colony A, 2½ hours after the start of the experiment. In colony B no radioactivity appeared until five hours after the start of the experiment. Calculate the rate of movement of the radioactive carbon along the stem. [3]

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(b) (i) Explain what is meant by the terms *source* and *sink*. [2]

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(ii) Name a source and a sink shown in the diagram. [2]

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(c) (i) Name the radioactive molecule which was transported from source to sink. [1]

.....

(ii) What is the name given to this form of transport in a plant? [1]

.....

(d) Name the tissue and the type of cell where you would expect the greatest amount of radioactivity to be detected. [2]

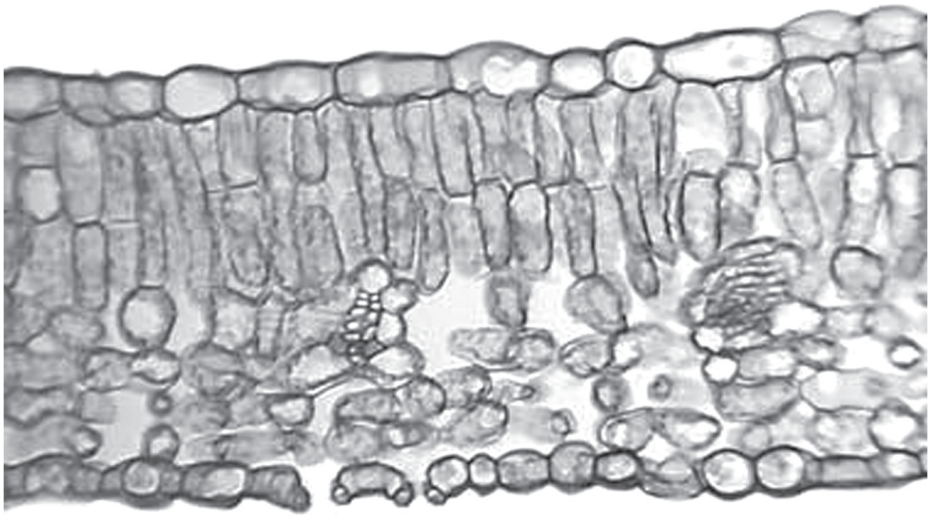
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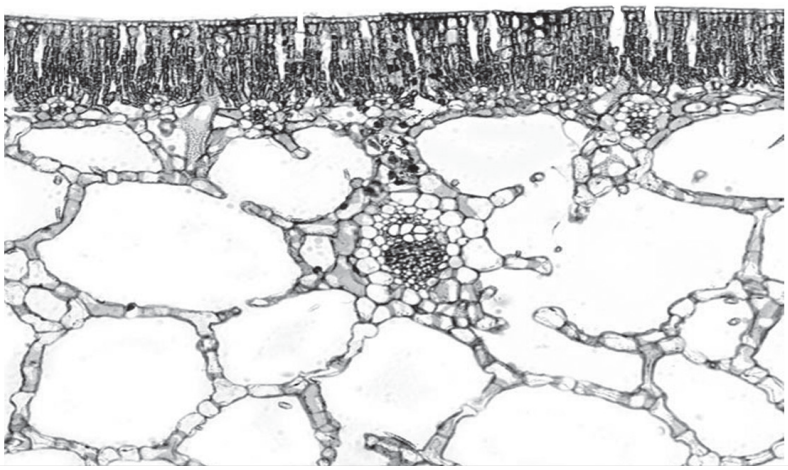
(Total 11 marks)

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24. The photographs below show sections of two leaves from two species of plant. *Ligustrum* is a mesophyte plant.



TS *Ligustrum* leaf (Privet)



(a) What type of plant is *Nymphaea*? [1]

.....

(b) Using the information in the photographs, describe **two** visible differences between the two species. [2]

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(c) State **three** adaptations of *Nymphaea* for living in an aquatic environment and state why each is important. [3]

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(d) Give **one** feature of *Ammophila* (Marram Grass) which shows how it is adapted to its environment. [1]

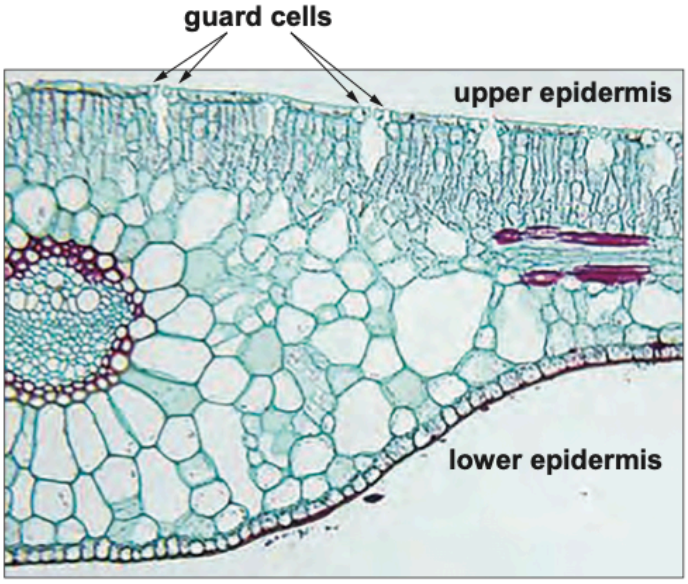
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(Total 7 marks)

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25. For plants to photosynthesise effectively they need to obtain certain resources. Leaves are the main sites of gas exchange and photosynthesis in plants. They are adapted to these main functions in several ways. Figure 1.1 is a photomicrograph showing a transverse section through a leaf.

Figure 1.1



(a) (i) **Label figure 1.1** using the letters **A** and **B** to show the position of the following:

A the main tissue responsible for photosynthesis [1]

B the tissue that transports water to the leaf tissues [1]

(ii) Conclude whether the leaf shown in figure 1.1 is from a hydrophyte or a xerophyte. Identify **two** adaptations that support your conclusion. [3]

Type of plant: .....

Adaptation 1: .....

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Adaptation 2: .....

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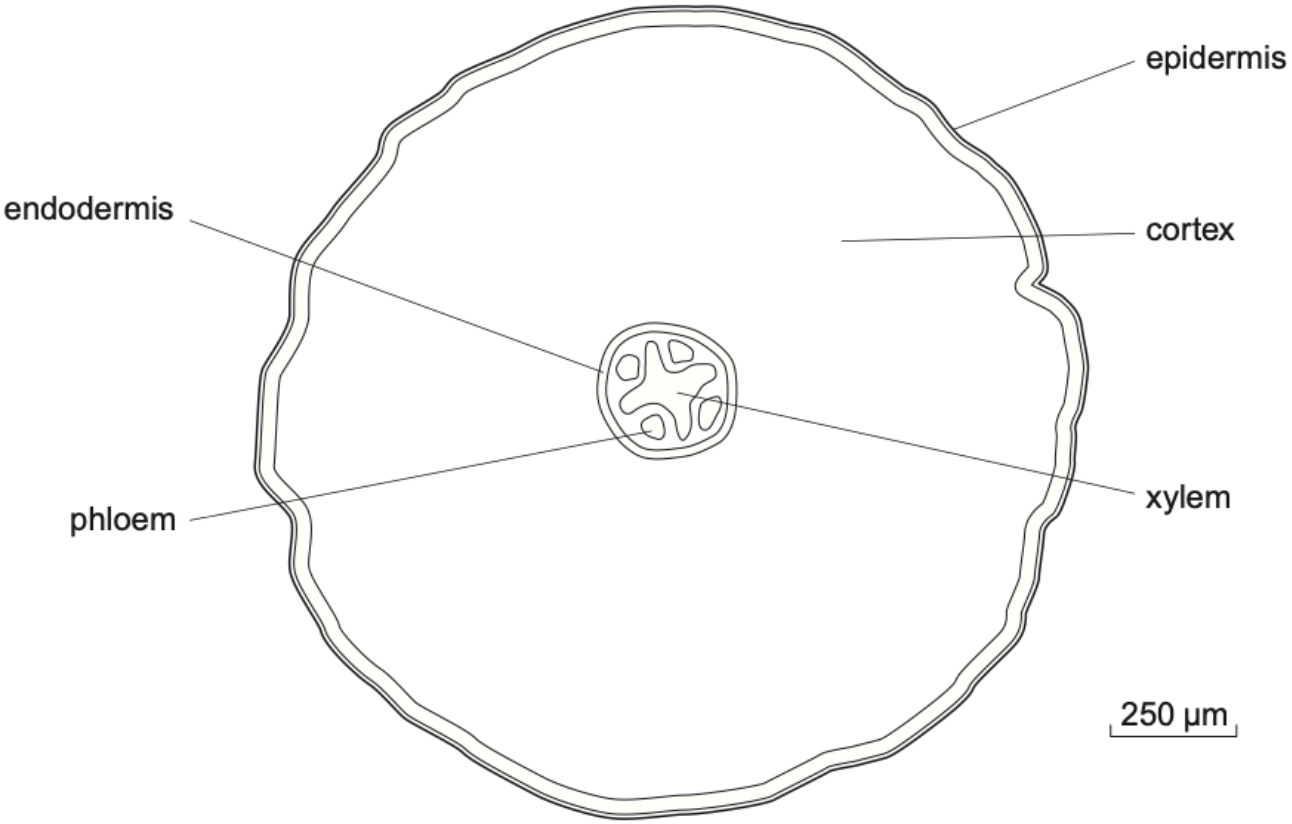
(iii) Explain why leaves and chloroplasts change their orientation during the day. [1]

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(b) Roots are the main site of water and mineral uptake. Figure 1.2 shows a low power plan of the structure of a root of a buttercup, *Ranunculus*, a dicotyledonous plant.

Figure 1.2



(i) **Using only the scale bar**, calculate the magnification of the image in figure 1.2. [2]

Magnification = × .....

(ii) Water and minerals can follow several paths from the soil to the xylem. These are the apoplast, symplast and vacuolar pathways. Both the symplast and vacuolar routes involve water crossing cell membranes. Explain why the vacuolar route is slower than the symplast pathway. [2]

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(c) In the stem of a buttercup, vascular tissues are organised into bundles.

(i) Describe how the arrangement of the vascular tissues in a stem of a buttercup is different from their arrangement in the root. [1]

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(ii) Xylem vessels and phloem sieve tubes are strengthened by different chemicals found in their cell walls. Name these chemicals. [1]

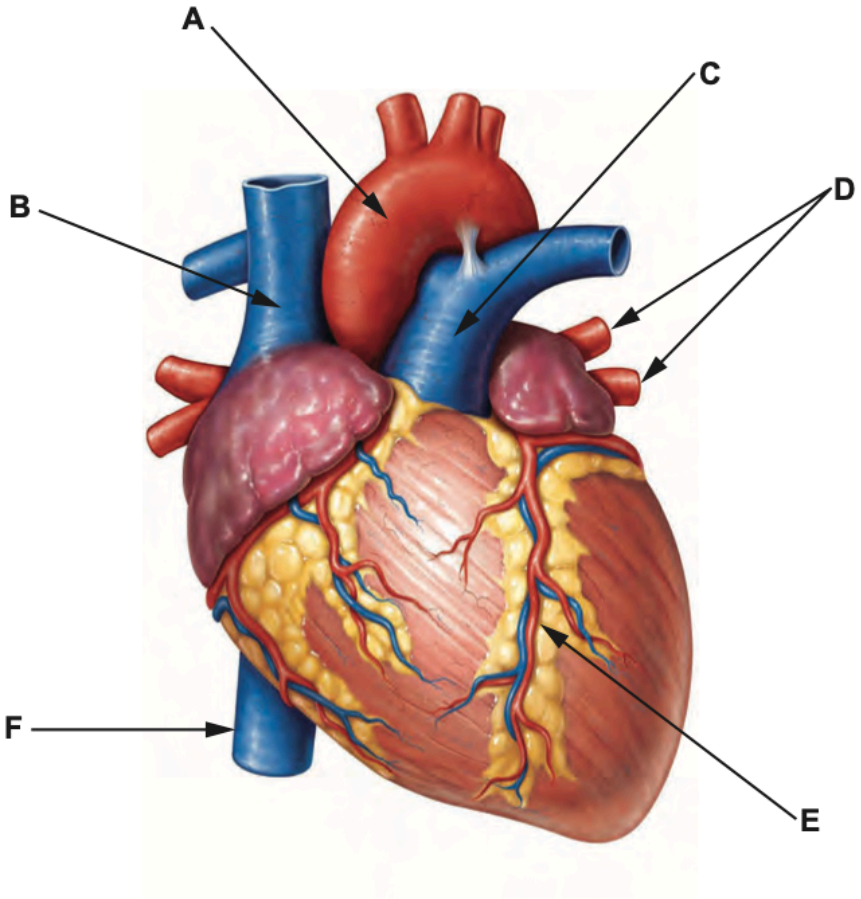
xylem .....

phloem .....

26.

In the UK, coronary heart disease accounts for nearly 73 000 deaths per year and it is estimated that approximately 2.3 million people suffer from a condition called angina. This form of heart disease develops when the blood vessels supplying the heart muscle become narrowed due to the build-up of fatty substances on the inside wall of the vessels. The fatty deposits are called atheroma and cause a condition called atherosclerosis.

The image below shows a model of the human heart together with some of its associated blood vessels.



(a) (i) In which of the blood vessels labelled **A** to **F** on the image could an atheroma develop that could cause angina? Name this blood vessel. [2]

Letter ..... **Name** .....

(ii) Explain why narrowing of these blood vessels could lead to the heart not contracting. [2]

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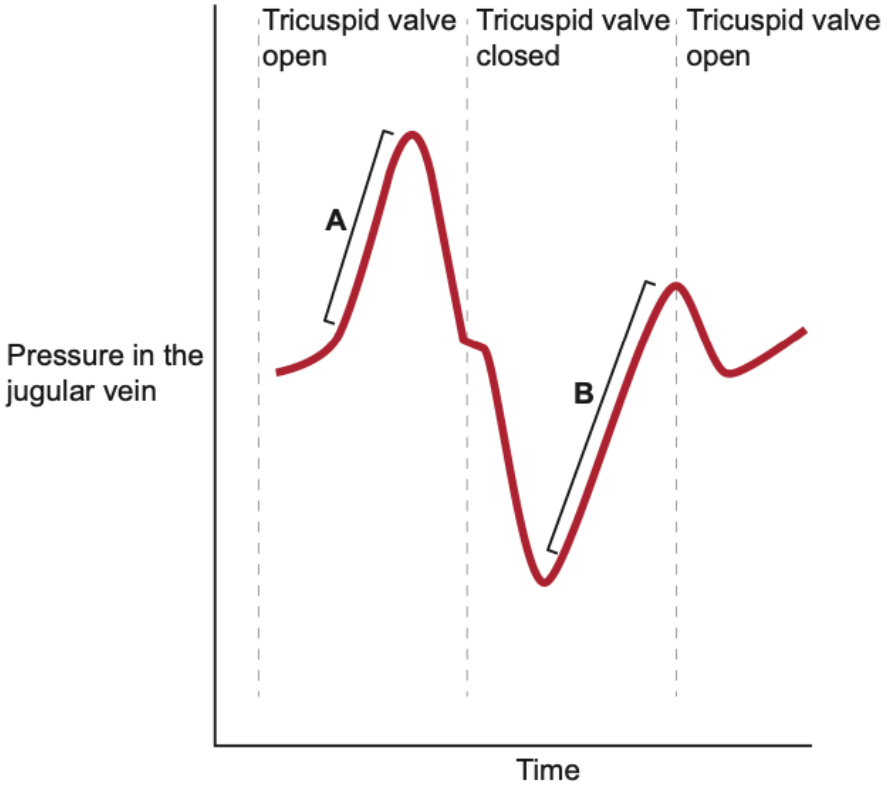
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(b) The jugular vein carries blood from the head back to the heart via the vena cava. There are no valves between the jugular vein and the heart. Therefore, the pressure in the jugular vein can be used as an indication of the ability of the heart to pump blood around the body.

(i) Which of the blood vessels labelled **A** to **F** on the image of the heart opposite will return blood from the jugular vein to the heart? [1]

Letter .....

The graph below shows how the pressure in the jugular vein changes during the course of one cardiac cycle.



(ii) State the name of the stages in the cardiac cycle during which the tricuspid valve is: [2]

I. **open** .....

II. **closed** .....

(iii) Suggest what causes the increase in pressure in the jugular vein in the regions labelled **A** and **B** on the graph. [4]

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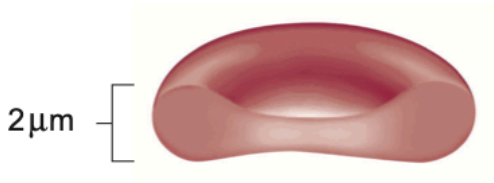
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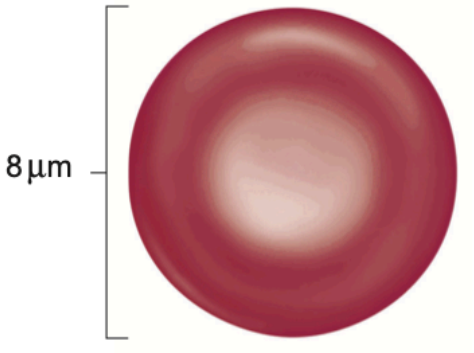
27. The main function of red blood cells (erythrocytes) is to carry oxygen from respiratory surfaces to respiring tissues.

The diagrams illustrate the structure of a red blood cell.

Sectional view



Top view



(a) Describe and explain how the structure of a red blood cell is related to its function. [3]

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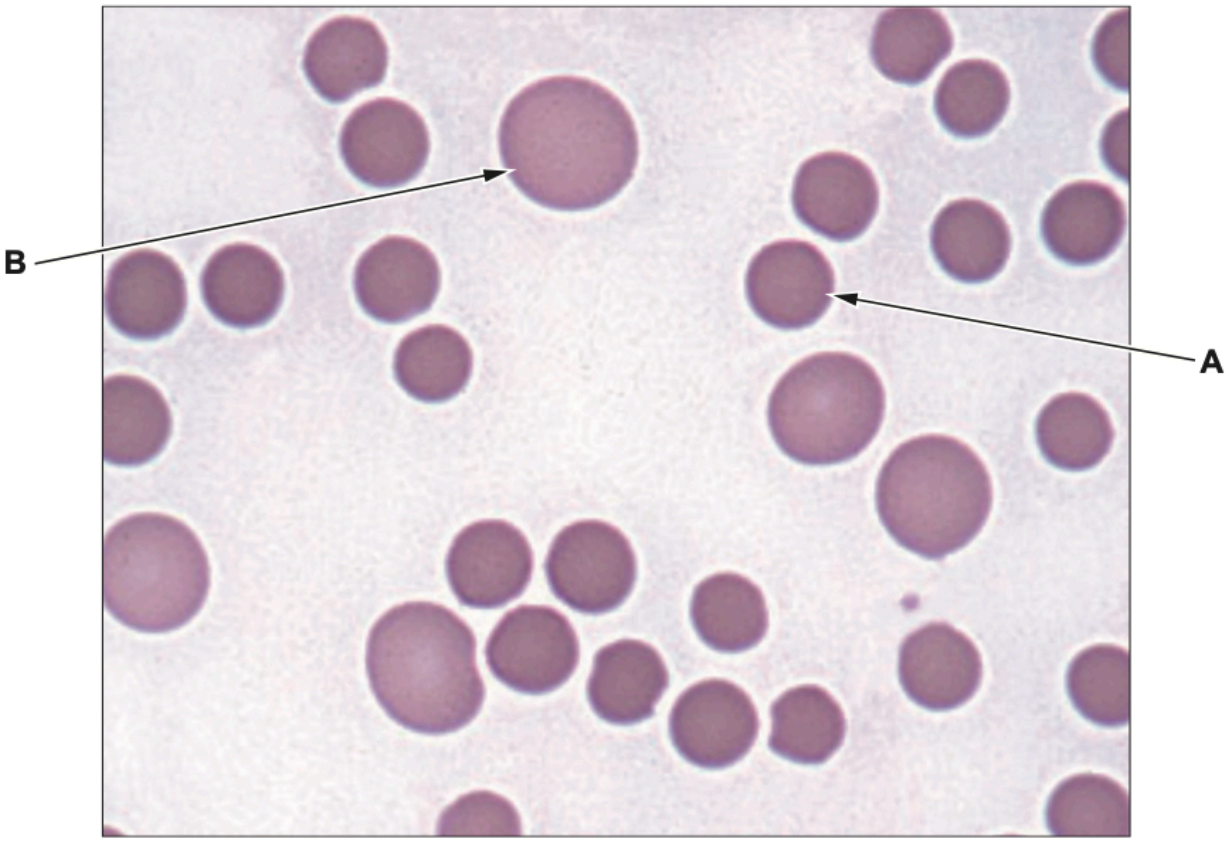
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(b) Anaemia may be defined as a decrease in the oxygen carrying capacity of the blood.

Macrocytic anaemia is caused by a dietary deficiency of vitamin B12 resulting in the production of fewer red blood cells than normal. Some of these red blood cells are very large and are called macrocytes.

The photomicrograph shows red blood cells of an individual with macrocytic anaemia.



Cell **A** is a normal red blood cell. It has a diameter of 8 µm. Cell **B** is a macrocyte. Calculate the diameter of cell **B to the nearest micrometre**. [3]

Diameter = ... µm

(c) A mean red blood cell volume that is higher than normal indicates macrocytic anaemia. The normal range is 80 – 95 μm^3. The mean volume of a red blood cell in μm^3 can be calculated by using the following formula.

$$\text{mean volume of a red blood cell} = \frac{\text{percentage volume of red blood cells in blood}}{\text{red blood cell count (cells per cubic millimetre)}} \times 10^7$$

(i) Calculate the mean volume of a red blood cell for a person with a red blood cell count of 4.5×10^6 cells per cubic millimetre where the percentage volume of red blood cells is 45%. [2]

Mean volume = ... μm^3

(ii) State, with a reason, whether this person has macrocytic anaemia. [1]

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(iii) Using the given information, suggest **two** reasons why macrocytic anaemia would cause a reduction in the oxygen carrying capacity of blood. Explain your answers. [2]

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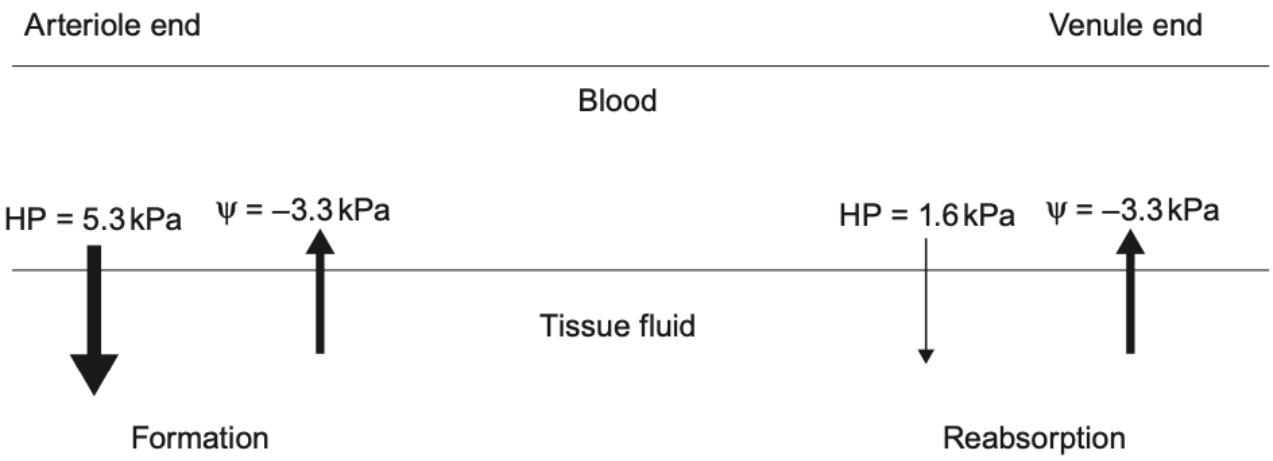
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28.

Tissue fluid is formed at the arteriole end of a capillary bed and water is reabsorbed at the venule end.

The formation of tissue fluid and reabsorption of water occurs as a result of two opposing forces: the hydrostatic pressure of blood and osmotic pressure. Proteins in the plasma maintain a low water potential in the blood.
The diagram illustrates the differences in hydrostatic pressure (HP) and water potential (ψ) between blood and tissue fluid in a capillary bed.



(a) Use the information in the diagram to calculate the pressure difference that results in:

(i) tissue fluid formation; [1]

..... kPa

(ii) water reabsorption. [1]

..... kPa

(iii) Name the vessel that removes excess tissue fluid. [1]

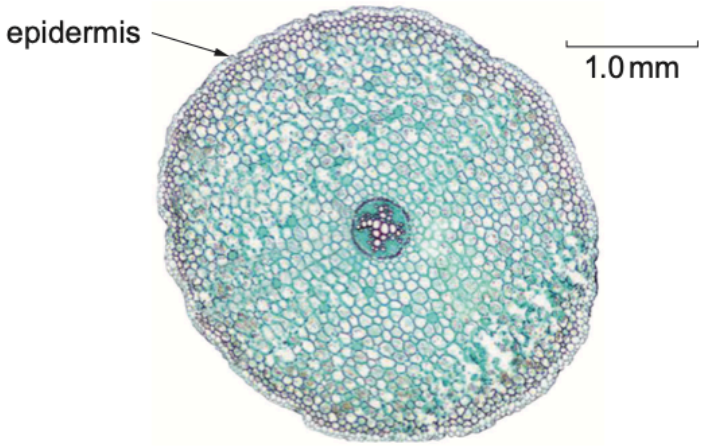
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(b) Explain why fluid will accumulate in the tissues of a person whose diet is poor in protein. [3]

29. Most plants are unable to survive in waterlogged soil because air spaces between soil particles become filled with water.

The photomicrograph shows a transverse section through the root of a dicotyledonous plant.



Describe the pathways by which water passes from the cells of the epidermis across the cortex of the root and then into the vascular tissue of a plant growing in well-drained soil.
Explain why a plant growing in waterlogged soil experiences a reduction in root pressure.

[9 QER]

30.

(a) Some insects are vectors of plant diseases. Two such diseases are Dutch elm disease and potato leafroll.

Elm bark beetles are vectors of Dutch elm disease. These beetles are often contaminated with fungal spores. When the beetles feed on the young bark of healthy elm trees the fungal spores gain entry to xylem vessels. The spores germinate and produce a mycelium which leads to the blockage of xylem vessels. The earliest external symptoms of infection are chlorosis (yellowing) and wilting of leaves above the infection site. These leaves often turn brown and curl up. Symptoms often spread rapidly leading to the death of the tree.

Potato leafroll is caused by a virus carried by aphids. When aphids feed, the virus enters the phloem. The virus infects cells in the leaves and the roots. Symptoms include chlorosis and rolling of leaves, and death of potato tuber cells.

(i) Explain why blockage of xylem vessels by the fungus causes the wilting of leaves above the infection site and the death of elm trees. [4]

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(ii) Explain the difference in the distribution of the symptoms of potato leafroll in a plant compared to those seen in Dutch elm disease. [2]

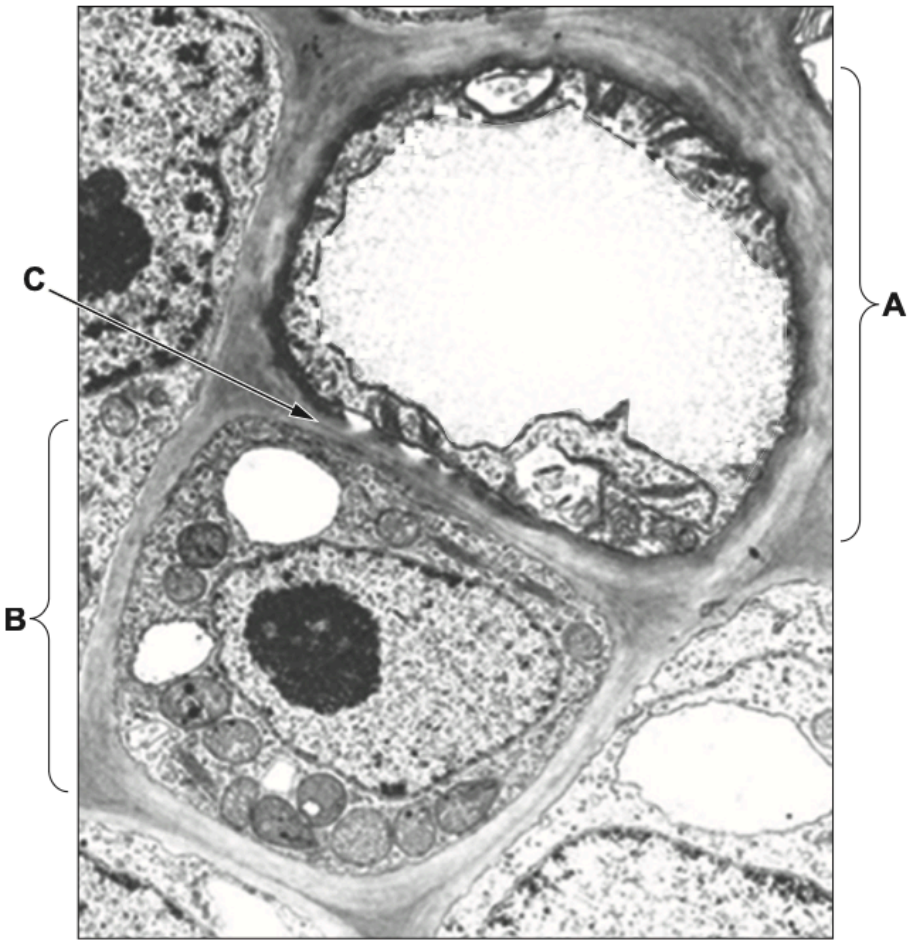
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(b) The photomicrograph below is a transverse section of phloem tissue taken using a transmission electron microscope.



(i) Identify the cells labelled **A** and **B**. [1]

A .....

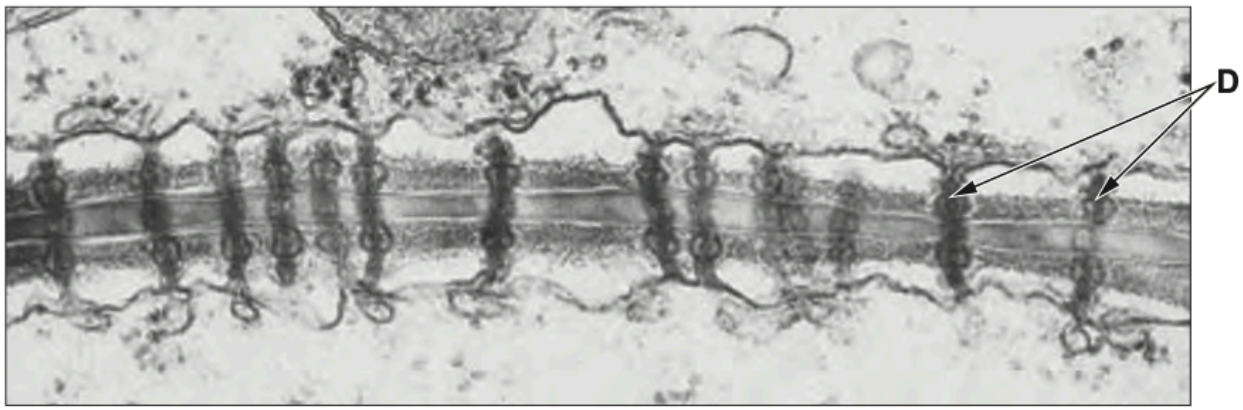
B .....

(ii) Give **one** reason for your choice of answer to *(b)*(i). [1]

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(iii) The photomicrograph below is of region **C** at a higher magnification. It shows the adjoining cell walls of **A** and **B**.



Identify structures **D** and explain their importance in the functioning of phloem. [2]

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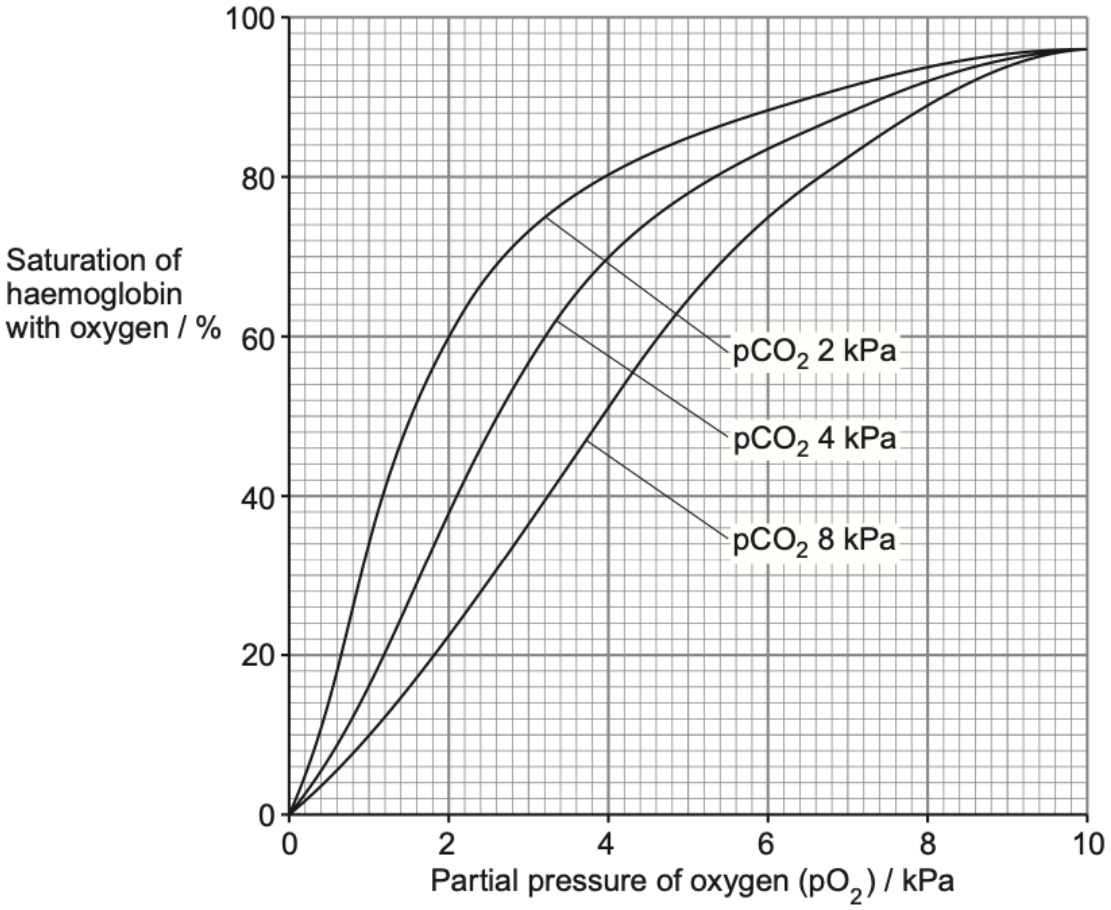
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31.

Carbon dioxide is produced in tissues as a waste product of respiration. The graph shows the effect of increasing the partial pressure of carbon dioxide (pCO_2) on the oxygen dissociation curve of adult human haemoglobin.



(a) State the name given to the difference in position between the three curves as a result of an increase in the partial pressure of carbon dioxide. [1]

.....

(b) The table shows the partial pressures of oxygen (pO_2) and carbon dioxide (pCO_2) at different sites in the human body.

Site	pO_2 / kPa	pCO_2 / kPa
lungs	10	2
muscle tissue fluid at rest	4	4
muscle tissue fluid during exercise	1	8

(i) The graph shows that at the pO_2 and pCO_2 typical in the lungs the percentage saturation of haemoglobin with oxygen is 96%. Give the percentage saturation of haemoglobin with oxygen in muscle tissue fluid when it is: [2]

at rest ..... %

during exercise ..... %

(ii) Explain the significance of the effect of an increase in pCO_2 for respiring muscle tissue. [2]

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(c) Respiratory minute volume is the volume of gas inhaled or exhaled from a person's lungs per minute. The minute volume of a healthy person during normal breathing at rest is 6 – 7 dm^3min^{-1}. In people with chronic diseases, such as heart disease, the minute volume is 12 – 16 dm^3min^{-1}.

(i) Explain how an increase in minute volume results in a decrease in pCO_2 of blood in alveolar capillaries. [2]

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(ii) Suggest why people with reduced blood pCO_2 commonly feel tired and lack energy. [2]

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(d) Most carbon dioxide is carried as hydrogen carbonate ions (HCO_3^-) in the plasma. The following chemical pathway shows how carbon dioxide is converted into HCO_3^- in a red blood cell.

$$CO_2 + H_2O \xrightarrow{X} Y \longrightarrow Z + HCO_3^-$$

(i) Identify the substances shown above: [2]

X .....

Y .....

Z .....

(ii) State **one** *other* form in which carbon dioxide is carried in the blood. [1]

.....

(iii) The table shows the concentrations of hydrogen carbonate ions and chloride ions in the blood plasma of an arteriole entering and a venule leaving a respiring muscle.

Blood vessel	**Plasma concentration / mmol dm^{-3}**	
	Hydrogen carbonate ions	**Chloride ions**
Arteriole	22	106
Venule	30	98

Explain the changes in the concentration of chloride ions as shown by the table above. [3]

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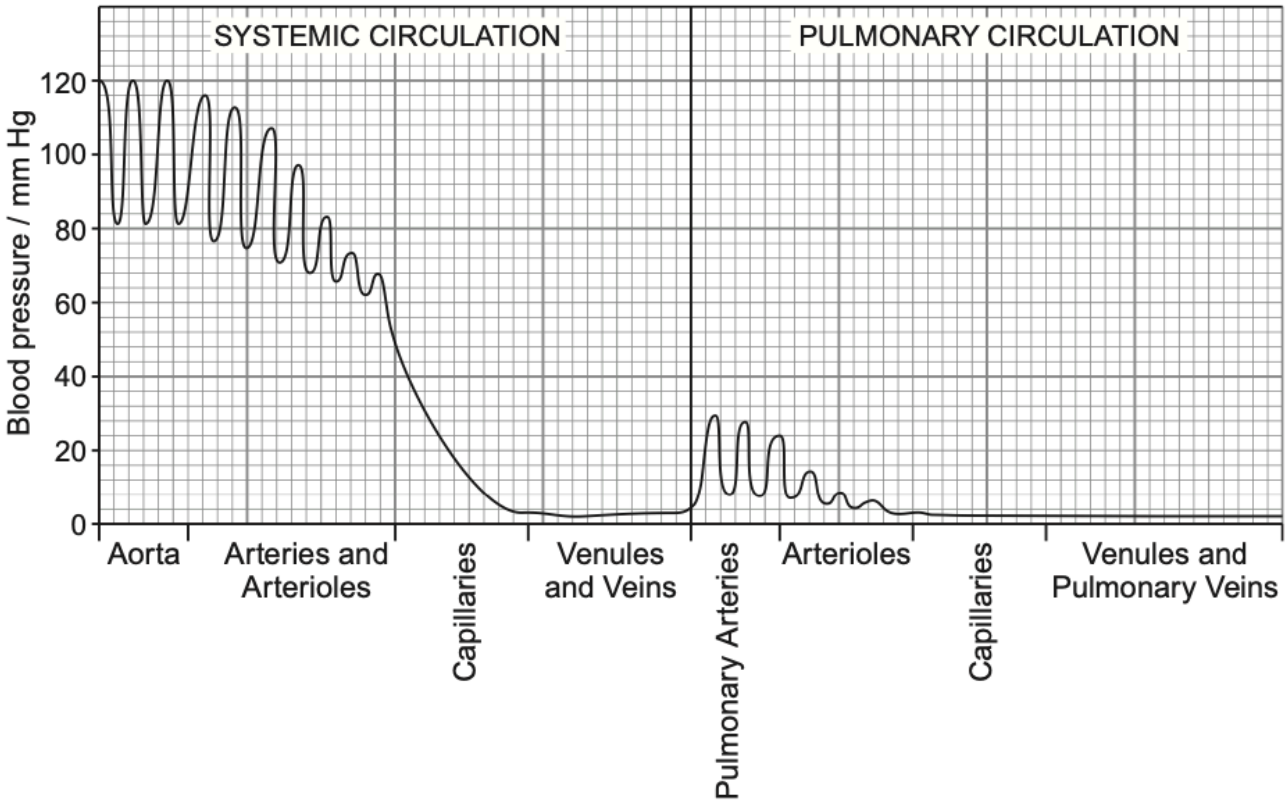
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32.

Mammals have a double circulatory system, whereas fish have a single circulatory system. The graph illustrates pressure changes in the double circulation of a human.



Use the information in the graph to explain the pressure changes in the systemic and pulmonary circulations of a human.
Explain why a mammal's double circulation is considered more efficient than the single circulation of a fish. [9 QER]

1.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		D and E	1			1		
		(ii)		C and D		1		1		
		(iii)		B and F		1		1		
	(b)	(i)		603 = 3 marks If incorrect award 2 marks for 603.264 or [603.1858... if use π on calculator] If incorrect award 1 mark for sight of 3.142×0.0004^2 or 5.03×10^{-7} or 0.00000050272 [not used total cross section] $3.142 \times 0.0008^2 \times 1.2 \times 10^3$ or 2410 or 2412.7 or 2413 [not used radius as 0.0004]		3		3	3	
		(ii)		**Any four (x1) from:** A. low protein diet reduces {plasma protein/albumin} levels (1) B. {plasma proteins/albumin} reduce water potential of blood (1) C. (Lack of protein)water potential of plasma becomes higher (1) D. Decreases water potential gradient (1) E. so less <u>water</u> reabsorbed/ more <u>water</u> remains in tissue fluid/ <u>water</u> moves out of the blood into the tissue fluid (1) Accept blood in place of plasma Accept blood proteins in place of plasma proteins	3	1		4		
				Question 1 total	**4**	**6**	**0**	**10**	**3**	**0**

2.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		electrocardiogram (1) reject electrocardiograph/echocardiogram	1			1		
		(ii)		75 (1)		1		1	1	
		(iii)	I	<u>SAN</u> generates {<u>electrical</u> impulse/wave of excitation/<u>electrical</u> signals} (1) (causes) <u>depolarisation</u> of <u>atria</u> (1) (causes) contraction of <u>atria</u>/<u>atrial</u> systole (1)	3			3		
			II	Any three (x1) from: A. <u>AVN</u> {transmits/relays/passes on} {<u>electrical</u> impulse/<u>electrical</u> signals/wave of excitation}(1) B. Passes through {Bundle of His/Purkinje tissue/septum}(1) C. Depolarisation of <u>ventricles</u>(1) D. Causes contraction of <u>ventricles</u>/<u>ventricular</u> systole(1)	3			3		
			III	Repolarisation of ventricles (1) Causes <u>ventricular</u> diastole/relaxation of <u>ventricles</u> (1)	2			2		
	(b)			Shorter/closer together (1) NOT quicker/faster (due to) shorter isoelectric line/flat part/PR segment/P-QRS interval/T-P interval/less time between {atrial systole and ventricular systole/ventricular systole and ventricular diastole/ventricular systole and atrial systole} (1)		1	1	2		
	(c)	(i)		Circle at any point around the PR segment/flat section of the graph between the endpoint of the P wave and the onset of the QRS complex (1) Circle may extend slightly into QRS complex (NOT further than letter Q) but may extend to the start of the P wave (NOT further than start)		1		1		
		(ii)		AVN (1) Accept bundle of His/Purkyne tissue			1	1		
		(iii)		Slow heart rate/bradycardia/longer for a heart beat/longer between atrial systole and ventricular systole (1)		1		1		
				Question 2 total	**9**	**4**	**2**	**15**	**1**	

3.

Question	Marking details	Marks Available					
		AO1	AO2	AO3	Total	Maths	Prac
3	Indicative content **Definitions:** mesophyte – adapted to conditions of {adequate/moderate/sufficient/owtte} water supply xerophyte – adapted to conditions where water is scarce/groundwater is frozen/named example/dry conditions. hydrophyte – adapted to aquatic conditions/live in water/float on surface of water **Pinus/xerophyte** Adaptations to reduce transpiration/water (vapour) loss **Comments must relate to image Reject adaptations not visible** **Linked points:** • Sunken stomata/stomata in pits + trap humid air/to reduce {diffusion/concentration/water potential} gradient • Small leaves/needle shaped/compact + reduce surface area/SA:vol • {fewer/smaller} stomata + {fewer/smaller} gaps for water loss • Thick cuticle/epidermis + reduce evaporation/water loss • Fibres/sclerenchyma/lignified tissue + provides support/prevents wilting **Potamogeton/hydrophyte** **Linked points:** • Cuticle thin/absent + no need to reduce water loss/evaporation • Stomata on {upper/adaxial} surface/no stomata on {lower/abaxial} surface + for gas exchange with air • Air spaces/Aerenchyma/lacunae + provide { buoyancy/flotation} for {light/photosynthesis}/{act as gas reservoir/for gas exchange} • {Little/no} {lignified tissue/xylem} + water provides support • Poorly developed/little xylem + water provided by surroundings	3	6		9		
	7-9 marks Correct Definitions of xerophytes + hydrophytes + mesophytes. + Full description of Pinus xerophytic adaptations + Full description of Potamogeton hydrophytic adaptations The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with few irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately. **4-6 marks** Any two from: definitions of mesophytes/xerophytes/hydrophytes description of adaptation of the xerophyte description of adaptation of the hydrophyte The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately. **1-3 marks** A definition of xerophyte/hydrophyte/mesophyte or an adaptation of xerophytes or an adaptation of hydrophytes *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
	Question 3 total	**3**	**6**		**9**		

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4.

Question			Marking details	Marks Available
4.	(a)		loss of water <u>vapour</u>/ <u>evaporation</u> of water; from (surface of) leaf /through stomata; Accept lenticels	2
	(b)	(i)	TWO precautions and TWO reasons • Shoot cut under water/inserted under water/flood inside of apparatus with water/ assemble under water; to prevent air entering/ bubbles; • Shoot with large number of leaves; to ensure measurable rate of transpiration; • Avoid wetting leaves/ ensure leaves are dry; blocks stomata/ reduces rate of transpiration; • Leave time for apparatus to settle down; allow plant to adapt to new conditions/ to equilibrate; • Seal joints with Vaseline/ ensure screw clip is closed; to prevent air entering apparatus/ prevent leakage; • Ensure bubble set at appropriate position/ right hand end; to enable a (suitable) reading to be taken; Reference to not allowing air bubbles to enter = 1 mark (if no precautions are given)	4 max
	(c)	(i)	Sun(light);	1
		(ii)	Molecules of water moving together/ water pulled up; Because of <u>cohesion</u> of <u>molecules</u>; <u>adhesion</u> to (walls of) {<u>xylem</u>/ hydrophilic lining/ vessel wall}; root pressure {forces/ pushes} water upwards; IGNORE capillarity	2 max
	(d)	(i)	A= phloem; B= xylem;	2
		(ii)	{Xylem/ vascular <u>tissue</u>} is at the centre/ xylem is star shaped/ central stele; NOT bundle No vascular <u>bundles</u>/ peripheral vascular <u>bundles</u> in stem; Endodermis visible in root/ no pith;	2 max
			Question 4 total	**[13]**

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5.

Question			Marking details	Marks Available
5	(a)	(i)	*atrio-ventricular node (max 2)* {collects/ receives} {wave of excitation/ impulses} from SAN; NOT signal passes on to{Purkyne fibres/Eundle of His}; allows delay before wave passed to ventricles/ stops atria and ventricles contracting at the same time;	2 2
		(ii)	*Bundle of His and Purkyne fibres* conducts wave to {base/ apex} of ventricles/ heart; ensures contraction (from base) upwards;	
	(b)	(i)	11;	1
		(ii)	7;	1
		(iii)	1;	1
		(iv)	6;	1
		(v)	4;	1
		(vi)	2;	1
		(vii)	12;	1
		(viii)	10;	1
			Question 5 Total	**[12]**

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6. (a)

A Right atrio-ventricular / tricuspid. [1]

B Left AV valve / bicuspid / mitral [1]

Award one mark for identifying both Atrioventricular Valves but not right and left.

C Semi lunar valves. [1]

(b)

Coronary;

Supplies oxygen / blood to the heart muscle / wall / tissue / cells OR correct function for vein; [2]

(c)

(i)

Valve {exposed to / works at} a higher pressure (in left ventricle)/

{Right ventricle pumps blood at / valve A exposed to} lower pressures (to lungs); [1]

(ii)

Blood leaks back (from ventricle) to atrium; [1]

(iii)

Breathlessness / fluid retention / fatigue / rapid or irregular heartbeat / blue lips / oedema / lower bp / faint / heart murmur; [1]

Question total [8]

7. (a)

(i)

Any 3 [3]

Has a reduced surface area / surface area:volume ratio;

Thick cuticle;

Curled / rolled (downwards with the stomata inside);

Hairs (to trap water vapour);

(ii)

Any scientifically correct explanation of their chosen feature / cuticle - comment on waterproofing / curled - trapping water /

SA - less area over which water can be lost /

stomata - trapping water vapour; [1]

(b)

Xerophyte; [1]

(c)

(i) Xylem; [2]

Transports water (and minerals);

(ii)

Phloem; [2]

Transports carbohydrates / sugars / products of photosynthesis / sucrose / amino acids;

Not glucose/nutrients

(iii)

Endodermis / starch sheath.

1

(iv)

Decent diagram of endodermis cell; [2]

Endodermis - with Casparian strip/band clearly labelled;

(v)

Any 4 [4]

Waterproof / Casparian strip / band / suberin;

Blocks the apoplast pathway;

Selective uptake / Active uptake / transport of minerals (by endodermis cells);

Into symplast pathway;

Active transport of minerals into pericycle;

Water follows by osmosis;

Water and minerals move into xylem vessels;

Question Total [16]

8.

Question			Marking details	Marks Available
8.	(a)	(i)	sucrose is produced in (photosynthesising) leaf/ leaves are the source of sucrose; sucrose travels in phloem; phloem removed (by the ringing process); sucrose cannot flow to roots/ is blocked;	3 max
		(ii)	amino acids/hormones/ florigen;	1
	(b)		sucrose used for {cell wall formation/ cell division/ mitosis/ respiration}; {Less/ no} sucrose used (by growing areas/sinks as they have been removed); therefore more will pass down stem; NOT accumulation	2 max
	(c)		sucrose not replaced from above (the ring); so concentration decreases; as movement towards root continues; and sucrose used in respiration/storage/ converted to starch/ growth/ active transport;	3 max
			Question 8 Total	**[9]**

9.

Mark Scheme - Summer 2014

Question			Marking details	Marks Available
9.	(a)		Capillary;	1
	(b)		Lymph/ lymphatic fluid;	1
	(c)	(i)	Protein / (serum) albumin;	1
			Question 9 Total	**[3]**

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10.

Question			Marking details	Marks available
10	(a)	A	(some) CO_2 {dissolves directly/ in solution} in the plasma;	
		B	(some)CO_2 {diffuses into/absorbed by} {red blood cells /erythrocytes};	
		C	(some) CO_2 combines with haemoglobin/ to form carbamino {haemoglobin/ compounds};	
		D	(most) CO_2 combines with water to give carbonic acid;	
		E	(catalysed) by carbonic anhydrase;	
		F	carbonic acid dissociates into hydrogen carbonate and hydrogen ions;	
		G	hydrogen carbonate ions pass out (into plasma);	
		H	(chloride shift) allows movement of Cl^- into red blood cells;	
		I	to maintain {electrical/ electrochemical} neutrality;	
		J	increased {conc/partial pressure} of CO_2 (dissolved in blood);	
		K	lowers pH of blood/blood becomes more acidic;	
		L	oxyhaemoglobin {accepts H^+/acts as a buffer};	
		M	reduces affinity of haemoglobin for oxygen;	
		N	more oxygen is released (from oxyhaemoglobin)/ more oxyhaemoglobin dissociates;	
		O	oxygen dissociation curve moves to the right/Bohr {shift/effect}; Accept credit from graph/ diagram	
	(b)	A	Both are tubular/contain a lumen/ OWTTE;	
		B	Both have movement by mass flow/OWTTE;	
		C	Both movement along pressure gradients;	
		D	Both movement in one direction only;	
		E	Artery transports blood, xylem water;	
		F	Movement of liquid pulsatile in arteries, smooth in xylem;	
		G	Arteries living, xylem dead;	
		H	Pressure generated by heart in arteries, no pump for xylem;	
		I	Xylem vessels contain lignin;	
		J	Xylem has support function;	
		K	{Adhesive forces/ hydrophilic lining} in xylem;	
		L	Arteries have {muscle/elastic tissue}; can be shown on diagram	
		M	Arteries distend/recoil;	
		N	Smooth endothelium of artery/ endothelium reduces friction;	
		O	Artery walls composed of layers	10
			Question 10 Total	**[10]**

11.

Question			Marking details	Marks Available
11	*(a)*	(i)	24/ 25/26%;	1
		(ii)	Any two from (vigorous) exercise/ OWTTE; high levels of (aerobic) respiration; oxygen used/ needed (by muscle cells);	2 max
	(b)		C/mouse;	1
	(c)	(i)	curve to right of C;	1
		(ii)	Any three from (move to right) lowers affinity of haemoglobin for oxygen; more oxygen released/ oxygen more readily dissociates; at the same partial pressure of oxygen; for (aerobic) respiration;	3 max
	(d)		Any three from curve shows haemoglobin has high affinity for oxygen; can{ pick up/ absorb} oxygen at {low partial pressure/ high altitude}/ can be become saturated with oxygen {more easily/ lower partial pressure/ at altitude}; Llama lives at high altitudes where oxygen is scarce; small change in partial pressure results in a large change in % saturation;	3 max
	(e)		Curve A;	1
			Question11 total	**[12]**

12.

Question			Marking details	Marks Available
12	(a)	(i)	Loss of water vapour/evaporation of water; From leaf/stomata/lenticels;	2
		(ii)	Cooling effect/{supply/movement} of {mineral (ions)/water} /maintains transpiration {pull/stream} /required for photosynthesis /allows water to reach aerial parts;	1
	(b)	(i)	Prevent entry of air into xylem/ prevent formation of air bubble in xylem; Which would break {transpiration stream/ cohesive forces}/ block movement of water;	2
		(ii)	Diameter of capillary tube; Distance travelled by bubble; Time taken;	Max 2
	(c)	(i)	Xerophytes;	1
		(ii)	{High humidity/ humid atmosphere} in air chamber; Because {water vapour/humid air} not removed by wind/ water vapour trapped; This produces a {less steep / reduces} {water potential/ diffusion/concentration} gradient; Between inside of leaf and air chamber/ inside and outside of stoma;	Max 3
		(iii)	{Smaller/less/ rolled} leaves/spines + reduced surface area (exposed to environment); {Reduced number/closure of stomata} + less openings for water to be lost through; {Hairs on leaves/rolled leaves} + {increases humidity/ reduces {water potential/ diffusion/ concentration} gradient/ traps water vapour}; Thick cuticle + reducing evaporation from surface of leaf;	Max 2
			Question 12 Total	**[13]**

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13.

Question		Marking details	Marks Available
13	(a)	(Phloem) parenchyma; (Phloem) fibres;	2
	(b)	<table><tr><th>Feature</th><th>Explanation</th></tr><tr><td>Presence of sieve {plates/pores};</td><td>Permits bidirectional flow/ permits flow {from cell to cell/ through the plant};</td></tr><tr><td>{Few/no} organelles/ {thin/peripheral} cytoplasm;</td><td>No obstruction to flow of solutes;</td></tr><tr><td>Plasmodesmata;</td><td>Allows transport of {molecules/ ATP/ sucrose} from companion cell (to sieve tube element);</td></tr></table> Maximum of two features with matched explanation Explanation mark only given if feature correct	Max 4
	(c)	Mass flow is {a passive process/ not an active process}; From high to low {concentration/pressure}/ down a concentration gradient; {Mitochondria/energy/ATP} not required (in a passive process);	3
		Question 13 Total	**[9]**

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14.

Question			Marking details	Marks Available
14	*(a)*		• It has a large surface area to absorb {water / minerals / ions} / Accept: for osmosis • many mitochondria for active transport of minerals / ions • thin cell wall for a short diffusion pathway;	1
	(b)		Apoplast pathway – (water travels) through the cell walls; Symplast pathway – (water travels) through the cytoplasm and plasmodesmata;	2
	(c)		1. The casparian strip / suberin; 2. Blocks the apoplast pathway / forces water into the symplast pathway; 3. The (endodermal cells / pericycle) actively transport ions into the xylem vessels; 4. This lowers the water potential in the xylem; 5. Causing water to move into the xylem by osmosis; 6. Producing hydrostatic pressure (forcing water upwards);	Max 4
	(d)	(i)	Palisade / spongy / mesophyll;	1
		(ii)	Sucrose;	1
	(e)		(Sucrose is) transported in the {phloem / sieve tubes};	1
	(f)	(i)	Radioactivity was detected above and below the {source / leaf} / Radioactivity was detected A and {B / C};	1
		(ii)	38/90; 0.42 (cm min^{-1}); Correct answer = 2 marks	2
			Question 14 total	**[13]**

15.

Question			Marking details	Marks Available
15	*(a)*		It can generate its own {impulse / contraction} / it does not need to be stimulated by a nerve to make it <u>contract</u>;	1
	(b)	(i)	Acts as the pacemaker / generates the cardiac impulse/ releases a wave of excitation / generates an electrical stimulation; Brings about atrial {systole / contraction};	2
		(ii)	Transmits impulse to apex of heart / spreads the cardiac impulse through (the walls of) the ventricles; Bringing about ventricular {systole / contraction};	2
	(c)	(i)	The atrio-ventricular valve closes: 0.2 The aortic valve closes: **0.56**	2
		(ii)	Blood is flowing from the atria to the ventricles: A / E Blood is flowing from the ventricle to the aorta: C When there is no movement of blood through the heart: B / D	3
		(iii)	• The {atrio-ventricular valves / bicuspid / mitral} close (preventing backflow of blood); • When the pressure in the ventricles exceeds the pressure in the atria / during ventricular {systole / contraction}; • Tendons prevent valves inverting;	Max 2
			Question 15 total	**[12]**

16. *(a)* 70 (plus/minus 5); 7
myogenic;
right atrium;
sino-atrial node;
atrio-ventricular node;
bundle of His/Purkinje/Purkyne fibres;
contract;

(b) (i) Carried/circulates in a system of tubes/vessels/ 2
veins and arteries;
blood pumped at high pressure;
organs/tissues not in direct contact with blood;

(ii) Separate pulmonary/ lungs and systemic/ body circulation; 2
blood passes through heart twice in one complete circuit;

17. **17.** (a) blood travels through it twice during one complete circuit;
separate {pulmonary/ to lungs} and {systemic/ to body} circulations;
maintains high blood pressure (to body);
rapid circulation of blood; 3 max
no mixing of oxygenated/deoxygenated blood;

(b) (i) position of both in right atrium (accept on dotted lines); 2
AVN below SAN (only if both in right atrium);

(ii) prevents direct transfer of wave of excitation to ventricles/ prevents atria and ventricles from contracting at the same time;
allows time for ventricles to fill;
wave is picked up by AVN; 4 max
which transfers to bundle of His/Purkinje/Purkyne fibres;
causes contraction of ventricles from base;

(c) 60000;
800
75 beats per minute;
2

18. (a) (i) Contraction of {left ventricle/ ventricular systole} causes a {surge / increase in blood pressure}; 3
pressure drops when the {left ventricle relaxes/ ventricular diastole};
pressure in aorta does not fall to zero because of the closing of the {aortic / semi-lunar valve};
{elastic recoil/ elasticity} of the arteries maintains blood pressure.

(ii) Friction/ resistance with vessel walls / increased cross-sectional / surface area of arterioles / blood vessels distance from heart 1

increased causes progressive pressure drop/ Not reference to capillaries

(b) (i) R; 2

highest pO_2 / oxygen level OR lowest pCO_2 / carbon dioxide

(ii) **at arterial end**: max 3

hydrostatic pressure (forcing liquid out of capillaries) greater than the osmotic pressure (drawing water in)

at venous end:

hydrostatic pressure has decreased;

water potential gradient / high osmotic pressure in capillary or osmotic pressure greater than hydrostatic pressure causes an inward flow ORA;

not all water (re)absorbed into capillary, reject all references to blood

(iii) Drains/ removes (excess) tissue fluid from the tissues / prevents build up of tissue fluid / return (excess) tissue fluid to blood via lymphatic system NOT ref to waste products alone 1

Question Total 10

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19.

(a) no valves;

small/narrow lumen;

more elastic in walls;

thick(er)/muscular walls/ tunica media;

less collagen;

(b) (i) artery;

(ii) ventricular contraction/systole at X;

ventricular relaxation/diastole at Y;

(iii) greater distance from heart;

ref to friction;

20.

(a)

	Atrial systole	Atrial diastole	Ventricular systole	Ventricular diastole
Bicuspid and tricuspid valves open	✓		✓	✓
Semi lunar/ aortic valves closed	✓	(✓) neutral		✓
Initiated by SAN	✓			
Initiated by Purkyne fibres (Purkinje fibres)			✓	

[4]

(b) SAN / pacemaker in wall of right atrium;

Wave of depolarisation passes from here across atria; [2]

(c) Prevents depolarisation in atria passing to ventricles;

Therefore stopping ventricles contracting downwards; [2]

(d) Increased oxygen;

Increased glucose/nutrients;

Remove carbon dioxide;

Remove lactic acid;

Aerobic respiration;

Prevent arrhythmia [4]

21. *(a)* (i) suitable axes; 5
axes labelled;
points plotted;; -1 each incorrect plot
lines labelled;

(b) (i) correct point; 1

(ii) Bohr shift/effect; 1

(iii) release of carbon dioxide during aerobic respiration; 2
forming carbonic acid/ more H^+;

(iv) more oxygen released; 1

(c) (i) curve to the left of ones drawn; 1

(ii) more saturated than maternal haemoglobin/greater affinity for oxygen; 2
at all oxygen partial pressures;
oxygen will pass from maternal to foetal blood;

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22.

(a) Haemoglobin line is S-shaped;

Actual line rises much more steeply between 2kPa and 7kPa/is steeper in the middle;

Theoretical line shows no flattening at top;

Haemoglobin shows higher saturation throughout.

(Any two) **[2]**

(b) (i) Only haemoglobin is fully saturated at pp in lung **[1]**

(ii) Haemoglobin carries much more oxygen for the muscle than the theoretical situation. **[1]**

(iii) Compared with theoretical, haemoglobin gives up its oxygen much more readily as oxygen pp falls. **[1]**

(c) Accumulation of carbon dioxide / carbonic acid. **[1]**

causes fall in pH / increased acidity. **[1]**

which releases oxygen from oxyhaemoglobin. **[1]**

(d) Myoglobin is saturated/has high affinity for oxygen at very low pp **[1]**

acts as an oxygen store **[1]**

used when muscle is exercising heavily/working hard **[1]**

[Total 11 marks]

23.

(a) Time to travel 63 cm = 5-2 $\frac{1}{2}$ = 2 $\frac{1}{2}$ hours or 150 minutes **[1]**

Rate = 63 × 2/5 or 63/150 **[1]**

= 25.2 cm/hr or 0.42 cm/min **[1]**

(Correct answer showing no working =3, units missing or incorrect= -1)

(b) (i) Source – region where photosynthate/sugar/carbohydrate is produced and exported. **[1]**

Sink – region where photosynthate is used/stored. **[1]**

(ii) Source – leaves **[1]**

Sink – roots (accept aphid colony) **[1]**

(c) (i) Sucrose **[1]**

(ii) Translocation **[1]**

(d) Phloem and sieve tubes (allow: mesophyll and palisade cells) **[2]**

[Total 11 marks]

24.	**(a)**	Hydrophyte	1
	(b)	Large air spaces in *Nymphaea*, smaller in *Ligustrum* (not: ref. thicker spongy mesophyll / thickness of epidermis / more air spaces) Stomata on upper surface of leaf in *Nymphaea*, not in *Ligustrum* (any 2) Comparison needed. Accept converse of points	2
	(c)	Large air spaces for buoyancy/diffusion/floating Stomata on upper surface so allowing gas exchange with the air Thin cuticle as little water (vapour) loss (not: no cuticle)	
		Little support tissue as buoyed by water Little xylem as surrounded by water Air spaces in stems allowing diffusion of gases (any 3)	3
	(d)	Rolled leaves (not: curled) Hairs Thick cuticle	
		Sunken stomata (allow: in pits not grooves) Deep rooted Extra support tissue in leaf (any 1)	1
			Total 7 marks

25.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
25.	*(a)*	(i)	A B	palisade mesophyll labelled clearly as **A** (1) xylem vessel(s) labelled clearly as **B** (1) Label lines must end in / Letters must be in / on the correct tissue layer / xylem vessel Accept correct names if given.		2		2		
		(ii)		**Type of plant** hydrophyte (1) Mark type and adaptations independently – **no ecf** **Any two (×1) from:** {stomata / guard cells} in upper {epidermis/ surface of leaf} (1) {large / numerous} air spaces (in spongy mesophyll) (1) {Thin / no} cuticle on upper {surface / epidermis} (1)		1 1	1	3		
		(iii)		**Any 1 from:** to {increase/ maximise} absorption of light / so that greater surface area of leaves face the sun / long axis of chloroplasts is in same direction as light (1)		1		1		
	(b)	(i)		× 60 (2) **1 mark for conversion of length of scale bar to µm:** 1.5 cm × 10 000 15 mm × 1 000		2		2	2	2
		(ii)		**vacuolar**: water crosses more membranes than symplast/ water moves in and out of vacuole/ water has to pass through the {tonoplast/ vacuolar membrane}/ water has to pass through vacuole and cytoplasm (1) NOT vacuole to vacuole **symplast**: (moves through cytoplasm and) {cell membrane/ plasmodesmata} / only crosses one membrane (1)		2		2		
	(c)	(i)		arranged around the {periphery / edge} (of the stem) (1) No reverse argument for arrangement in root	1			1		1
		(ii)		**Both needed for 1 mark:** **xylem** lignin (cellulose – neutral) **phloem** cellulose	1			1		
				Question 25 total	**2**	**9**	**1**	**12**	**2**	**3**

26.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
26	(a)	(i)		E (1) coronary artery (1)	2			2		1
		(ii)		{oxygen / glucose} does not reach {cardiac/ heart} muscle (1) (Muscle) unable to respire (aerobically)/ less ATP produced (1)		2		2		
	(b)	(i)		B (superior vena cava)		1		1		1
		(ii)		Open (Atrial) diastole/ atrial {systole/ contraction} (1) Accept ventricular diastole Closed ventricular systole (1)	2			2		
		(iii)		**Any 4 (x1) from**: A. pressure increases in jugular due to increase in atrial pressure B. Because no valves between jugular and atrium/ backflow of blood into jugular **Atrial pressure increases due to:** C. Atrial systole/ atrial contraction(1) D. Atria filling with blood (1) E. ventricle contracts closing {tricuspid/ AV} valve(1) F. increased pressure in ventricle pushes back on atrium (1)			4	4		
				Question 26 total	**4**	**3**	**4**	**11**	**0**	**2**

27.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
27	(a)			• Biconcave + {increases diffusion/ more oxygen absorbed/ increase gas exchange} / large surface area + {diffusion/ oxygen absorbed/ gas exchange} (1) • {Biconcave/ thin} + short diffusion pathway (1) • Enucleate/no nucleus + more space for haemoglobin (1)	3			3		
	(b)			12 or 13 or 14 (μm) = 3 marks If incorrect award 2 marks for answer between 12-15 and shown to a decimal place If both above incorrect award 1 mark for (diameter of B/ diameter of A) × 8 (1)		3		3	3	
	(c)	(i)		100 (2) $(45 / 4.5 \times 10^{6}) \times 10^{7}$ (1)	1	1		2	2	
		(ii)		Yes. Mean volume higher than {normal / 95} (ecf)			1	1		
		(iii)		Any **two** (× 1) from: A. Fewer cells so {less haemoglobin/ lower total surface area} (1) B. Larger cell therefore {smaller SA : vol / increased diffusion pathway} (1) C. Larger cells so harder for red blood cells to pass through capillaries (1)			2	2		
				Question 27 total	**4**	**4**	**3**	**11**	**5**	**0**

28.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
28	(a)	(i)		2		1		1	1	
		(ii)		(-)1.7		1		1	1	
		(iii)		Lymph (capillary / vessel) / lymphatic Reject node/ lacteal	1			1		
	(b)			Any **three** (× 1) from A. Fewer plasma proteins/ not enough protein in blood (1) B. Which {raises/increases} {water/solute} potential of {plasma/blood}/ osmotic pressure is too low (1) C. reduces {water/solute} potential gradient / hydrostatic pressure is greater than osmotic pressure (1) D. less water/ fluid reabsorbed (by osmosis) (1) Ignore concentration of water			3	3		
				Question 28 total	**1**	**2**	**3**	**6**	**2**	**0**

29.

Question	Marking details	Marks Available					
		AO1	AO2	AO3	Total	Maths	Prac
29	Indicative content **Section A: From epidermis and across cortex:** • Apoplast + symplast + vacuolar pathway • (Apoplast) Along cell walls • (Symplast) through cytoplasm/ plasmodesmata • (Vacuolar pathway) passes through tonoplast/ cytoplasm • Down water potential gradient / by osmosis **Section B: Into vascular tissue:** • Endodermis has Casparian strip • Waterproof / composed of suberin • Blocks apoplast pathway • Water {forced / passes} into symplast • Active transport of {salts / minerals} into xylem • Lowers water potential in xylem • Water enters xylem by osmosis / down water potential gradient **Waterlogged soil:** • {Less / no} oxygen (for respiration) • {Less / no} respiration so {less / no} {energy / ATP} • for active transport of minerals in the {endodermis/ root hairs} Must be in context of no oxygen • Lower water potential gradient as a result of less active transport of salts / minerals into xylem • Less water enters xylem which lowers root pressure	5	4				
	7-9 marks Indicative content of this level is detailed content from all three areas *The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.* **4-6 marks** Indicative content of this level is detailed content from two areas or less detail from three areas *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.* **1-3 marks** Indicative content of this level is any correct statement from indicative content *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
	Question 29 total	**5**	**4**	**0**	**9**	**0**	**0**

30.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
30	(a)	(i)		**Any four (x1) from** A. Xylem transports {water/minerals} {from roots / up the plant/ to the leaves}/ xylem allows transpiration (1) NOT nutrients B. Lack of water causes {leaf/ cells} to {lose turgor / become flaccid}/ cells become plasmolysed (1) C. Reduced surface area (1) D. {No/reduced} photosynthesis/ less water for photosynthesis (1) E. Less {products / named products} of photosynthesis (1) F. For respiration / growth (1)		2	2	4		
		(ii)		Phloem transport is bidirectional / up and down plant (1) (so) Symptoms appear in both roots and leaves (in potato leaf roll) (1)		2		2		
	(b)	(i)		A – sieve tube (element) NOT sieve plate B – companion cell (1) **1 mark for both**	1			1		
		(ii)		A - lacks {nucleus / nucleolus } / {fewer/ no} mitochondria / ER / Golgi/ organelles/ less cytoplasm (1) ORA Must be clear which cell is referred to		1		1		
		(iii)		Plasmodesmata (1) {Loading / unloading/ transport/ transfer} of sucrose / Transport of {ATP / proteins / enzymes / macromolecules} (1)		2		2		
				Question 30 total	**1**	**7**	**2**	**10**	**0**	**0**

31.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
31	(a)			Bohr effect / shift (1)	1			1		
	(b)	(i)		70 % (1) 10 % (1)		2		2	2	
		(ii)		Reduced affinity of haemoglobin for oxygen/ (oxy)haemoglobin dissociates at a higher partial pressure (of oxygen) (1) More oxygen {released / unloaded/ dissociates}/ oxygen released (more) readily (1) Allow oxygen more readily dissociated from haemoglobin = 2 marks	2			2		
	(c)	(i)		CO_2 removed faster/ more CO_2 exhaled (1) Increases {diffusion / concentration} gradient (from blood into alveoli) (1)			2	2		
		(ii)		increased affinity of haemoglobin for oxygen / decreased dissociation of oxyhaemoglobin (1) Less oxygen {released/ available} (for respiration) (1)			2	2		
	(d)	(i)		X = carbonic anhydrase Y = carbonic acid / H_2CO_3 Z = hydrogen ion / H^+ / proton 0/1 = 0 marks 2 correct = 1 mark, 3 correct = 2 marks	2			2		
		(ii)		{In solution/dissolved} in plasma / as carbamino compounds / as carbaminohaemoglobin (1)	1			1		
		(iii)		**Any three from:** • Chloride shift (1) must be in context of red blood cells • (chloride ions) {enter/diffuse} into red blood cells in exchange for hydrogen carbonate ions (1) • One to one exchange / reference to figures (1) • To maintain (electrochemical) neutrality (in red blood cell)/ to {equalise/ balance/ maintain} charge (1)	1	2		3		
				Question 31 total	**7**	**4**	**4**	**15**	**2**	**0**

32.

Question	Marking details	Marks Available					
		AO1	AO2	AO3	Total	Maths	Prac
32	**Indicative content** **In systemic circulation:** • {High pressure/ pressure increase} (to 120 mmHg) in {aorta/ arteries} is due to ventricular systole/ contraction of left ventricle. • High pressure needed to pump blood {round body/ long distance} • Pressure decrease (to 80 mmHg) in {arteries / aorta} is due to {diastole/ ventricular relaxation}. • High pressure is maintained due to elastic recoil of artery walls / closure of {semilunar / aortic} valve. • Pressure decrease in {arterioles/ capillaries} is due to {frictional resistance / blood flowing through a greater (total) {cross sectional/ surface area}. • Pressure decrease in capillaries is also due to tissue fluid formation. • low pressure/ flow rate in capillaries necessary for diffusion • Blood flow in veins due to massaging effect of skeletal muscles. **In pulmonary circulation:** • Pressure increase in pulmonary arteries due to {ventricular systole/ contraction of thinner walled right ventricle}. • Lower pressure (than systemic) due to {shorter distance / (only) to lungs}. • Pressure decrease (to about 8 mmHg) in pulmonary arteries is due to diastole / ventricle relaxation. • Pressure in capillaries is lower than systemic to prevent tissue fluid formation in the alveoli / reduce damage to alveoli / allow time for gas exchange.	6	3		9		
	Benefit over single circulation: • Correct description of single and double circulation • Pressure is lost when blood passes through (gill) capillaries. • so blood flow through the systemic circulation of a fish is slower. • Double circulation maintains high pressure (in systemic circulation) • to meet the high metabolic demands of a mammal.						
	7-9 marks Detailed explanation of systemic circulation **And** Detailed explanation of pulmonary circulation **And** Detailed explanation of benefit over single circulation *The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.* **4-6 marks** **Any two from** Explanation of systemic circulation Explanation of pulmonary circulation Explanation of benefit over single circulation *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.*						
	1-3 marks Brief explanation of systemic circulation OR Brief explanation of pulmonary circulation OR Brief explanation of benefit over single circulation *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
	Question 32 total	**6**	**3**	**0**	**9**	**0**	**0**