



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2024

Centre Number

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Candidate Number

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Biology

StemUp Model Solution

Assessment Unit AS 2
assessing

Organisms and Biodiversity



[SBY21]

SBY21

THURSDAY 23 MAY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.

Section A carries 60 marks. Section B carries 15 marks.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

Use accurate scientific terminology in all answers.

You should spend approximately **20 minutes** on Section B.

You are expected to answer Section B in continuous prose.

Quality of written communication will be assessed in Section B.

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Section A

1 Identify the terms described by the following statements which relate to the transport and exchange of oxygen in mammals:

- The liquid medium which bathes cells and enables the transport of oxygen to the cells.

Tissue fluid

- The conjugated protein in muscle which unloads oxygen when partial pressure of oxygen is very low.

Myoglobin

- The specialised cells forming the alveolar wall which minimise distance for oxygen diffusion.

Squamous epithelium

- The disease which reduces alveolar elasticity leading to a lower oxygen concentration gradient.

Emphysema

- The shift of a haemoglobin oxygen dissociation curve to the right due to increased temperature.

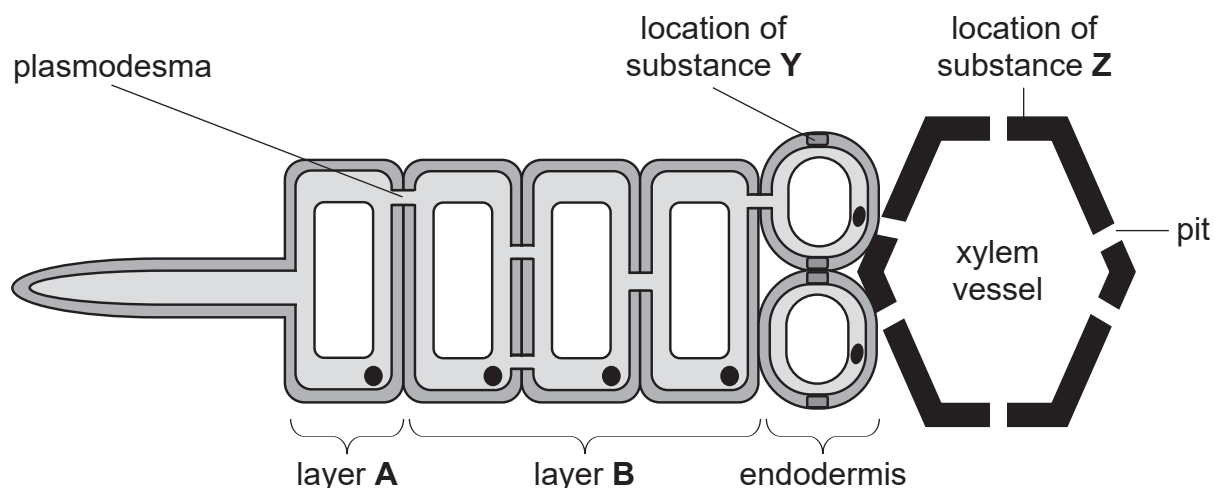
Bohr effect (Bohr shift)

[5]

[Turn over



- 2 The diagram below represents some of the tissues in a plant root.



Source: Principal Examiner

- (a) Identify layers **A** and **B**.

A epidermis

B cortex

[2]

- (b) As shown above, substance **Y** is found in the cell wall of endodermis cells and substance **Z** is found in the cell wall of xylem vessels. Both substances are waterproof.

Identify substances **Y** and **Z**.

Y suberin

Z lignin

[2]

- (c) Using the diagram and your knowledge, describe **two** differences between a pit and a plasmodesma.

Difference 1 A pit contains no cytoplasm, whereas a plasmodesma contains cytoplasm.

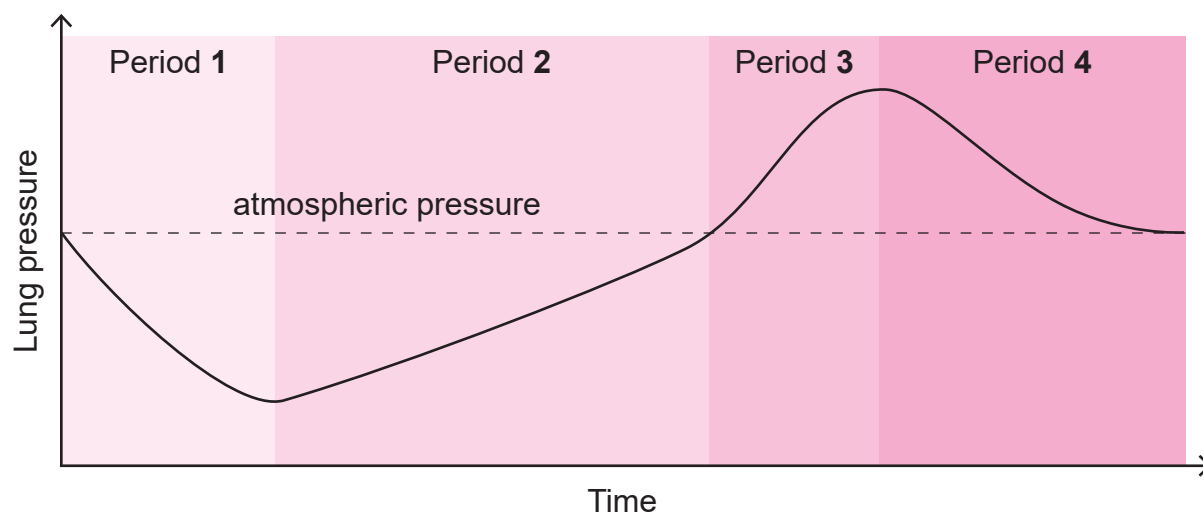
Difference 2 A pit is located in the xylem vessel wall, whereas plasmodesmata are in the walls of other (living) cells.

[2]



- 3 The graph below shows changes in lung pressure relative to atmospheric pressure, over time.

Four distinct time periods (1 to 4) are labelled on the graph.



- (a) Identify the period(s) during which exhalation is occurring.

Periods 3 and 4 [1]

- (b) Describe how structures of the respiratory system bring about a decrease in lung pressure during period 1.

The diaphragm muscles contract, so the diaphragm flattens and moves down.

The external intercostal muscles contract, so the ribcage moves up and out.

This increases the volume of the thorax (chest cavity), so the pressure in the lungs falls below atmospheric pressure. [3]

- (c) State the term used to describe the movement of substances within an organism due to pressure differences.

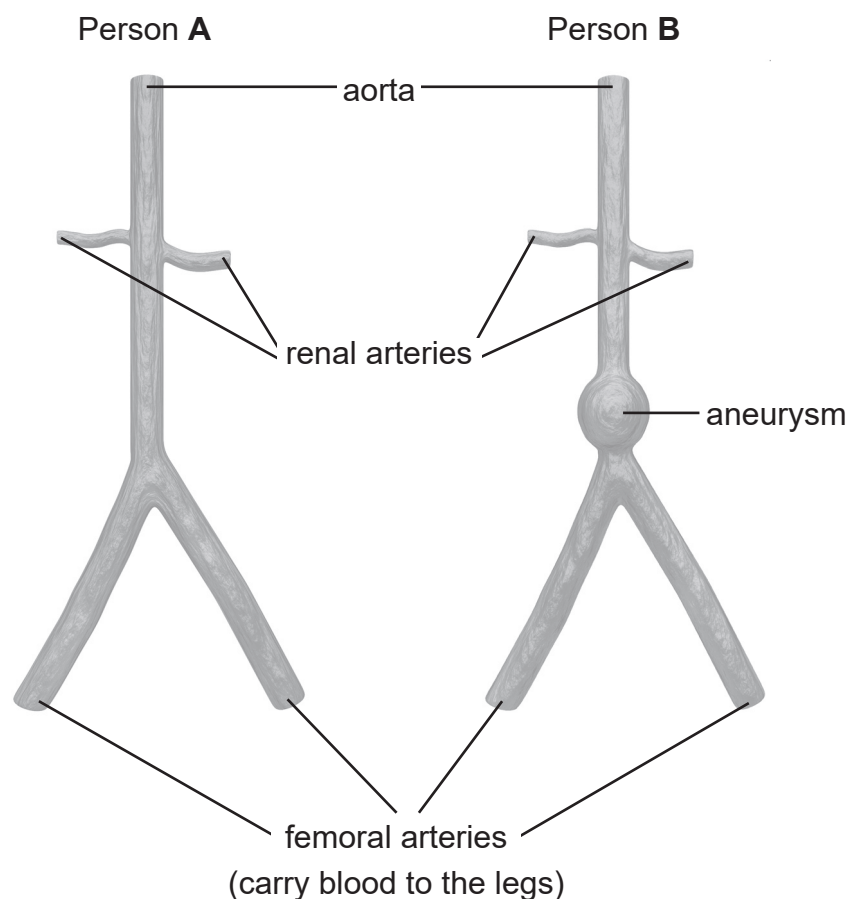
Mass transport (mass flow) [1]

[Turn over]



- 4 Some human diseases cause damage to blood vessels. An aneurysm is a swelling in an artery caused by a weakness in the artery wall.

The diagram below shows some of the major arteries in two people, person **A** and person **B**. Person **B** has been diagnosed with an aneurysm in their aorta.



Source: © Getty Images

- (a) Name the organ which is supplied with blood from a renal artery.

Kidney

[1]



(b) If left untreated, an aneurysm in the aorta may burst (rupture) with fatal consequences. A ruptured aneurysm in another artery, such as the femoral artery, is less likely to cause death.

- (i) Suggest and explain why a ruptured aneurysm in the aorta is more likely to cause death than a ruptured aneurysm in one of the femoral arteries.

Blood in the aorta is under much higher pressure than in a femoral artery, so blood loss would be much greater and faster. Also the whole body would be deprived of oxygenated blood, not just one leg.

[2]

- (ii) The process of blood clotting may begin as a result of damage to blood vessels. Describe the process of blood clotting.

Damage to the blood vessel exposes collagen, which activates platelets.

The platelets and damaged tissue release clotting factors, including thromboplastin.

Thromboplastin, in the presence of calcium ions (Ca^{2+}), vitamin K and other clotting factors, catalyses the conversion of the inactive plasma protein prothrombin into the enzyme thrombin.

Thrombin catalyses the conversion of soluble fibrinogen into insoluble fibrin. The fibrin fibres form a mesh which traps red blood cells and platelets, forming a clot that seals the wound.

[4]

- (iii) Suggest why blood clotting is ineffective at preventing blood loss from a ruptured aneurysm in the aorta.

The blood pressure in the aorta is too high, so the clot is washed away before it can form.

[1]

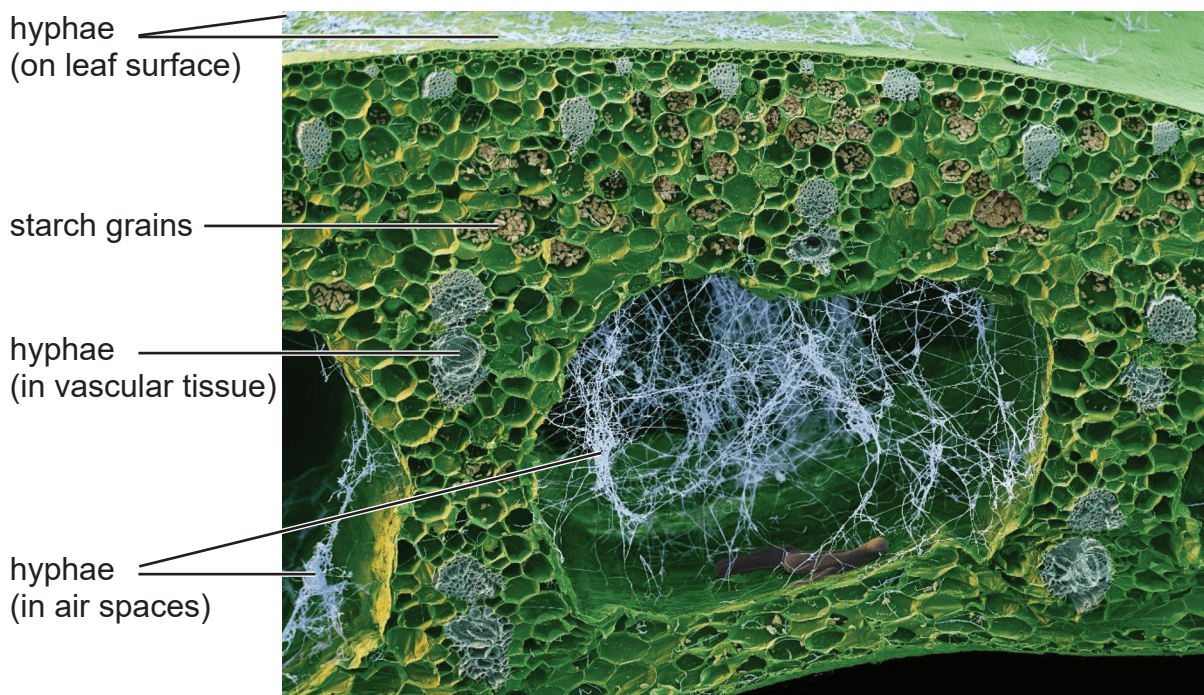
[Turn over]



5 Plant leaves can become infected with a range of disease-causing organisms.

Panama disease is caused by an organism (*Fusarium oxysporum*) which is made up of thread-like structures called hyphae.

The electron micrograph below shows a transverse section through part of a banana leaf infected with *F. oxysporum*. Hyphae can be observed spreading inside the leaf, as well as on the leaf surface.



Magnification $\times 50$

Source: © Eye of Science / Science Photo Library

- (a) (i) Using the information provided, identify the kingdom to which the organism that causes Panama disease belongs.

Fungi

[1]



- (ii) Both the leaf and the hyphae are composed of cells.

State **one** similarity and **one** difference between the outer structure of plant cells and hyphae cells.

Similarity Both have a cell wall outside the cell surface membrane.

Difference The hyphae cell wall is made of chitin, but the plant cell wall is made of cellulose.

[2]

- (b) It can be seen in the electron micrograph that many hyphae are present in the air spaces of the leaf, as well as in the vascular tissue. Eventually the hyphae may completely fill the air spaces.

- (i) With reference to the air spaces, suggest and explain how this could affect photosynthesis in the leaf.

The rate of photosynthesis would be reduced, because hyphae in the air spaces block the diffusion pathway for carbon dioxide to reach the mesophyll cells, so less CO₂ is available for photosynthesis.

[2]

- (ii) Panama disease is also known as Fusarium wilt. Using the information provided, suggest why leaves infected with this disease are likely to wilt.

Hyphae in the vascular tissue block the xylem vessels, so less water is transported to the leaf. The leaf cells lose water and turgor, so the leaves wilt.

[2]

[Turn over]



- (c) Common ash (*Fraxinus excelsior*) is a tree species, often found in hedgerows and woodlands in Europe. Ash trees are an important food source for a range of invertebrates and birds. The trees shed their leaves in autumn, and these rapidly decompose, raising soil mineral levels.

In 2012, the first occurrence of ash dieback disease was recorded in Northern Ireland. This discovery led to further monitoring of ash trees over several years.

Results recorded over a five-year period are shown below.

Year	Number of inspected sites	Number of sites with infected trees
2012	1028	79
2013	1895	12
2014	1306	2
2015	1896	18
2016	2680	68

- (i) Calculate the percentage of inspected sites which had infected trees in 2016.

Give your answer to 3 significant figures.

(Show your working.)

$$\% = (68 \div 2680) \times 100$$

$$= 2.537...$$

$$= 2.54 \% (3 \text{ s.f.})$$

2.54 % [2]



The organism which causes ash dieback disease is found in ash leaves. When infected trees shed their leaves, this organism remains in the decaying leaf litter. From here, it produces spores that can infect other ash trees.

- (ii) When infected ash trees are being removed from hedgerows, it is often advised that they are replaced by native trees other than ash.

Suggest why replacement trees:

should **not** be ash Replanted ash trees in the same location may get reinfected by spores from the decaying leaf litter.

should be native species Native trees provide a suitable alternative food source and habitat for native invertebrates and birds. [2]

Research has shown that temperatures above 35°C decrease the survival rate of the organism which causes ash dieback disease. Climate change modelling suggests that summer weather in southern Europe will become hotter and drier.

- (iii) Suggest **one** advantage and **one** disadvantage of hotter, drier weather for ash trees in southern Europe.

Advantage Temperatures above 35 °C reduce survival of the organism, so lower risk of ash dieback disease.

Disadvantage Higher risk of drought (water shortage) or of damage by fire. [2]

[Turn over]



- 6 Approximately 17% of the land in Ireland is composed of wetland habitats known as peatlands.

In such habitats, the surface layer of soil (peat) is very rich in dead organic matter.

Human activities which damage peatlands include:

- removing peat for use in gardening
- harvesting peat for fuel
- improving drainage to increase agricultural land area.

- (a) Some of the plants found in peatlands have hydrophytic adaptations.

Identify and explain which of the human activities listed above would have the most direct negative effect on hydrophytic plants.

Improving drainage, because it lowers the water content of the soil.

Hydrophytes are adapted to habitats with a high water content, so in

drier soil they would be outcompeted by other plants.

[2]

One method used to restore peatlands damaged by human activity is to block off drainage ditches so that more water is retained in the soil. The mineral levels in the soil are also affected by the increased water content.

- (b) State the term which describes soil-related factors such as water content and mineral levels.

Edaphic

[1]



- (c) Over time, the biodiversity of restored peatlands is likely to improve.

Sampling of vegetation in three damaged peatland areas (**A**, **B** and **C**) was carried out. Simpson's index was calculated before and after each peatland area was restored.

The results are shown in the table below.

Peatland area	Simpson's index	
	Before restoration	After restoration
A	0.88	0.86
B	0.72	0.75
C	0.68	0.67

- (i) Identify the peatland area which had the greatest increase in biodiversity after restoration.

Give a reason for your choice.

Area A. Its Simpson's index showed the greatest decrease after restoration (0.88 to 0.86). Using this formula a lower value of D indicates a higher biodiversity.

[2]

[Turn over]



A different area of peatland was also sampled. This area had been designated as a SAC for 27 years.

The results of the sampling are shown in the table below.

Plant type	% cover (n_i)	($n_i - 1$)	$n_i (n_i - 1)$
Moss	72	71	5112
Lichen	59	58	3422
Grass	46	45	2070
Woody shrub	14	13	182
Broadleaf species	28	27	756
Total % cover (N) = 219			

(ii) Calculate Simpson's index (D) for this peatland using the formula:

$$D = \frac{\sum n_i (n_i - 1)}{N(N - 1)}$$

(Show your working.)

$$\sum n(n - 1) = 5112 + 3422 + 2070 + 182 + 756 = 11\,542$$

$$N(N - 1) = 219 \times 218 = 47\,742$$

$$D = 11\,542 \div 47\,742 = 0.2418 = 0.24$$

$$D = \underline{0.24} \quad [3]$$

(iii) How does the biodiversity of this peatland differ from peatland areas **A**, **B** and **C**?

Suggest an explanation for this difference.

This peatland has a higher biodiversity than A, B or C, as its D value (0.24) is much lower. As a SAC for 27 years it has been protected and left undamaged by human activity such as drainage or peat removal.

[2]



- (d) Mullenakill Nature Reserve is part of the Peatlands Park ASSI in County Tyrone. Several animals on the NI priority species list can be found here, including the Large Heath Butterfly (*Coenonympha tullia*). A partially completed classification of this organism is shown in the table below.

Kingdom	X
Phylum	Arthropoda
Class	Insecta
A	Lepidoptera
B	Nymphalidae
Genus	Y
Species	Z

- (i) Name the taxonomic groups represented by **A** and **B**.

A Order

B Family

[1]

- (ii) Identify the missing information represented by **X**, **Y** and **Z**.

X Animalia

Y Coenonympha

Z tullia

[2]

- (iii) The binomial names of two other insects found in similar habitats are *Coenonympha pamphilus* and *Neurothemis tullia*.

Identify which of these insects is most closely related to the Large Heath Butterfly and give a reason for your answer.

Coenonympha pamphilus, because it is in the same genus

(Coenonympha) as the Large Heath Butterfly, so they share a more recent common ancestor.

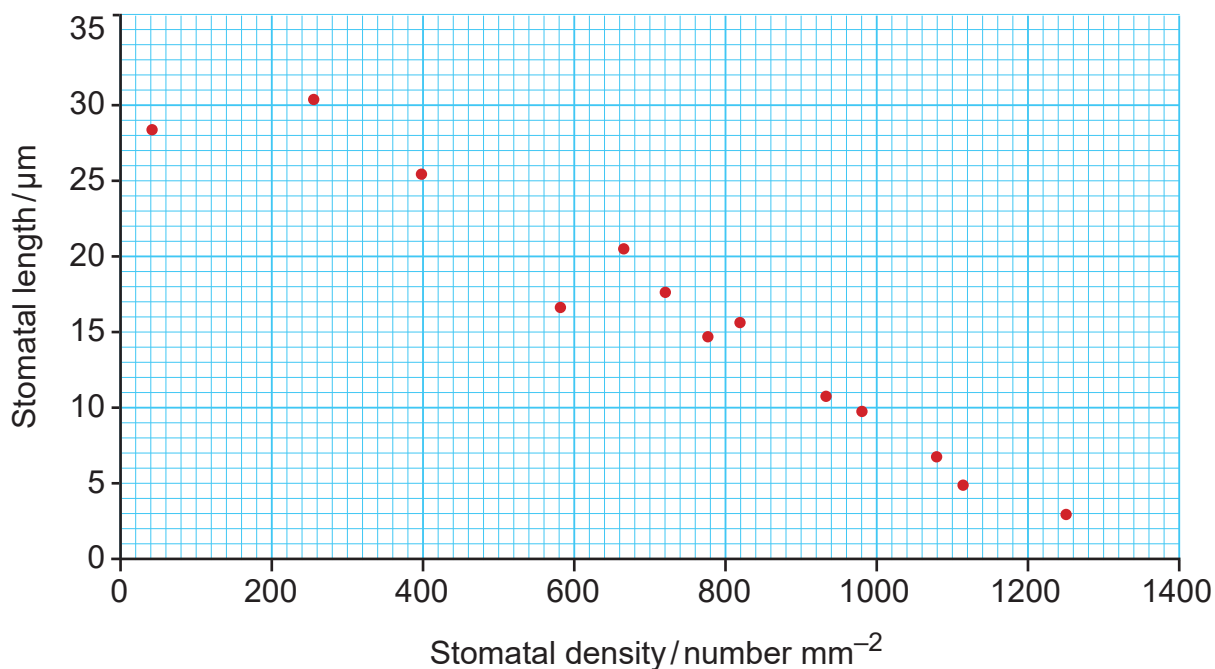
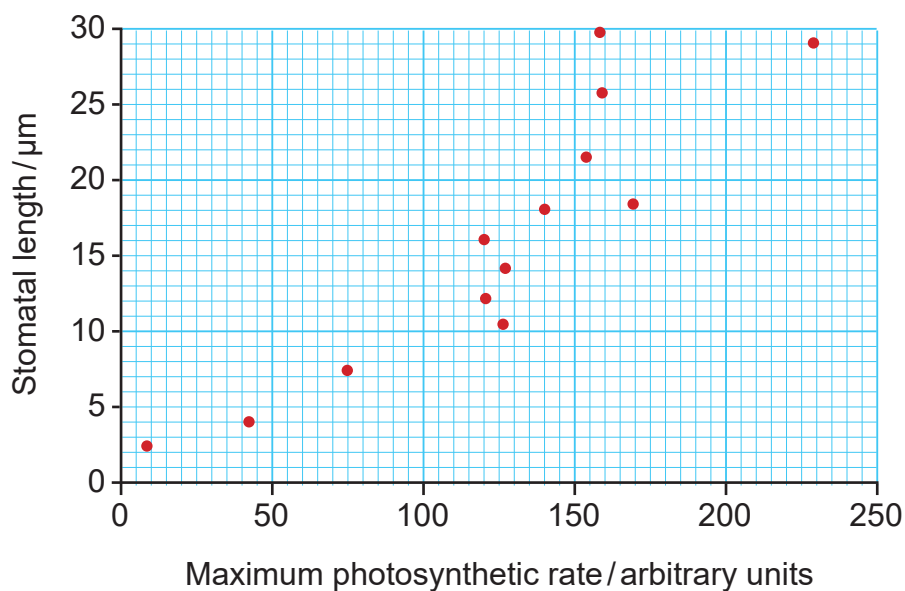
[2]

[Turn over]



- 7 (a) An investigation was carried out to determine whether a relationship exists between stomatal length, stomatal density, and maximum photosynthetic rate in 13 woody plants.

The data is shown in the graphs below. Use these graphs to answer the questions which follow.



- (i) Describe the relationship between maximum photosynthetic rate and stomatal length.

Positive correlation: as the maximum photosynthetic rate increases, the stomatal length also increases.

[1]

- (ii) Describe and suggest an explanation for the relationship between stomatal density and stomatal length.

Negative correlation: as stomatal density increases, stomatal length decreases.

Plants with a high density of stomata have smaller stomata, to conserve water by reducing water loss.

[2]

- (iii) What does the data suggest about the relationship between stomatal density and maximum photosynthetic rate?

They are inversely related: as stomatal density increases, the maximum photosynthetic rate decreases.

[1]

[Turn over]



(b) Gas exchange in a leaf occurs through stomata.

(i) Describe and explain **two** other adaptations which maximise gas exchange in leaves.

1. Thin leaves, which reduce the diffusion distance for gases.

2. Air spaces in the spongy mesophyll provide a diffusion pathway and a large surface area.

[2]

(ii) Specialised stomatal adaptations are observed in both xerophytes and hydrophytes. Outline the stomatal adaptations found in these types of plants.

Xerophytes Stomata are sunken in pits (grooves), trapping moist air.

Hydrophytes Stomata are found mainly on the upper leaf surface.

[2]



Section B

Quality of written communication will be assessed in this section.

- 8 Describe, in sequence, the pathway taken by blood as it makes one complete circuit of the body, beginning and ending with blood in the capillaries of the ileum.

You should include:

- the name of each blood vessel that blood moves through
- the cardiac cycle
- the ways in which unidirectional blood flow is maintained. [15]

Blood moves from the capillaries in the ileum into venules (small veins), and then travels to the liver in the hepatic portal vein. Blood in veins is under low pressure, so unidirectional flow is maintained by valves in the veins, which close to prevent backflow, and by the contraction of the surrounding skeletal muscles, which squeezes the veins and pushes blood along. Blood leaves the liver in the hepatic vein and returns to the heart in the vena cava (inferior vena cava), entering the right atrium.

During diastole the heart muscle is relaxed and blood enters the atria from the veins; the atrioventricular (AV) valves are open, so the ventricles fill passively, and the semilunar valves are closed, preventing backflow of blood from the arteries into the ventricles. During atrial systole the atria contract, which decreases atrial volume and increases atrial pressure above ventricular pressure, so blood is pushed through the atrioventricular (tricuspid) valve into the right ventricle.

In ventricular systole the ventricle contracts, increasing ventricular pressure above atrial pressure, which closes the atrioventricular valve and prevents

[Turn over



backflow into the atrium. The chordae tendinae prevent the AV valve from blowing inside out. When the right ventricular pressure rises above the pressure in the pulmonary artery, the semilunar valve opens and blood exits the heart in the pulmonary artery. In ventricular diastole the ventricular pressure drops below the arterial pressure, so the semilunar valve closes, preventing backflow into the ventricle.

Arterial blood is under high pressure, which keeps it moving away from the heart. The pulmonary artery divides (diverges) into arterioles (small arteries), and blood then passes along the capillaries surrounding the alveoli, where it is oxygenated. It returns to the heart in the pulmonary vein and enters the left atrium. As before, atrial systole forces blood through the atrioventricular (bicuspid) valve into the left ventricle.

During ventricular systole the left ventricular pressure rises above that in the aorta, so the semilunar (aortic) valve opens and blood exits the heart through the aorta, while the closed AV valve prevents backflow into the left atrium. When the ventricle relaxes, the aortic semilunar valve closes. From the aorta, blood under high pressure enters the mesenteric (intestinal) artery, then the arterioles, and finally returns to the capillaries of the ileum, completing one circuit.





Handwriting practice area with 20 horizontal lines.

[Turn over



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THIS IS THE END OF THE QUESTION PAPER

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For Examiner's use only	
Question Number	Marks
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Total Marks	
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Examiner Number

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