Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B400U20-1

S25-B400U20-1

THURSDAY, 22 MAY 2025 – MORNING

BIOLOGY – AS component 2

Biodiversity and Physiology of Body Systems

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**16**	
2.	**12**	
3.	**11**	
4.	**14**	
5.	**13**	
6.	**9**	
Total	**75**	

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ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of quality of extended response (QER) will take place in question **6**.

The quality of written communication will affect the awarding of marks.

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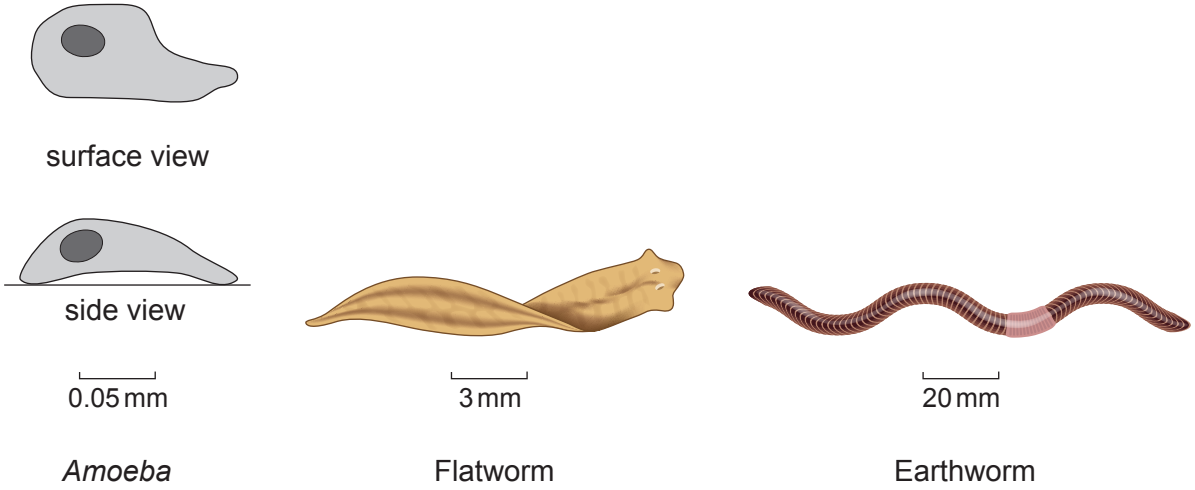
Answer **all** questions.

1. **Image 1.1** shows outline drawings of an amoeba, a flatworm and an earthworm. Gas exchange takes place across the surface of each organism.

Image 1.1



(a) An amoeba and a flatworm have no additional structures associated with their gas exchange surfaces, whereas an earthworm has capillaries close to the surface of its body.
Explain why an amoeba and a flatworm do not need a specialised gas exchange surface or a circulatory system, but an earthworm does. [4]

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(b) Gas exchange in earthworms was investigated by measuring the percentage saturation of their blood with oxygen. They were maintained at 10 °C and were studied in three different conditions:

- in air;
- in moist soil;
- in air, following a low dose of adrenaline.

The readings are shown in **Table 1.2**.

Table 1.2

Earthworm	Percentage oxygen saturation of blood		
	In air	In moist soil	+ adrenaline
1	48	73	not tested
2	40	82	
3	41	65	
4	46	77	30
5	51	not tested	24
6	46		4
7	57		19
8	52		25
9	57		19
10	5		5
11	37		8
Mean	43.6	74.3	.....

(i) Calculate the mean percentage oxygen saturation in the blood of earthworms treated with adrenaline.
Write your answer in Table 1.2. [2]

(ii) Explain why a mean was calculated for each condition, rather than using a single reading from one earthworm. [1]

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(iii) Explain how the readings in **Table 1.2** are consistent with the observation that earthworms are more active in moist soil than in air. [2]

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(iv) When the earthworms are treated with adrenaline, the blood vessels near the body surface become constricted.

Suggest how this might account for the effect of adrenaline on the oxygen saturation of the blood. [2]

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(v) Use **Table 1.2** to suggest **one** limitation in the data collected in this investigation. [1]

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(vi) Earthworms have an optimum temperature range of 10–16 °C.

Suggest how the readings shown in **Table 1.2** might be different if the experiments had been conducted on earthworms maintained at 16 °C instead of 10 °C.

Give **one** explanation for your answer. [2]

Difference: .....

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Explanation: .....

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(c) Bony fish use counter current flow, which increases the percentage oxygen saturation in their blood.

Describe what is meant by counter current flow. Explain how it results in higher oxygen saturation. [2]

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2. Three genetically different barley seedlings were tested to determine how efficient they were at absorbing water. The observations are summarised in **Table 2.1**.

Table 2.1

Barley seedling	Root hair length	Relative efficiency of water absorption
1	normal	high
2	short	low
3	absent	very low

(a) Use **Table 2.1** to conclude the effect of root hair length on the efficiency of water absorption into roots. Explain your answer. [2]

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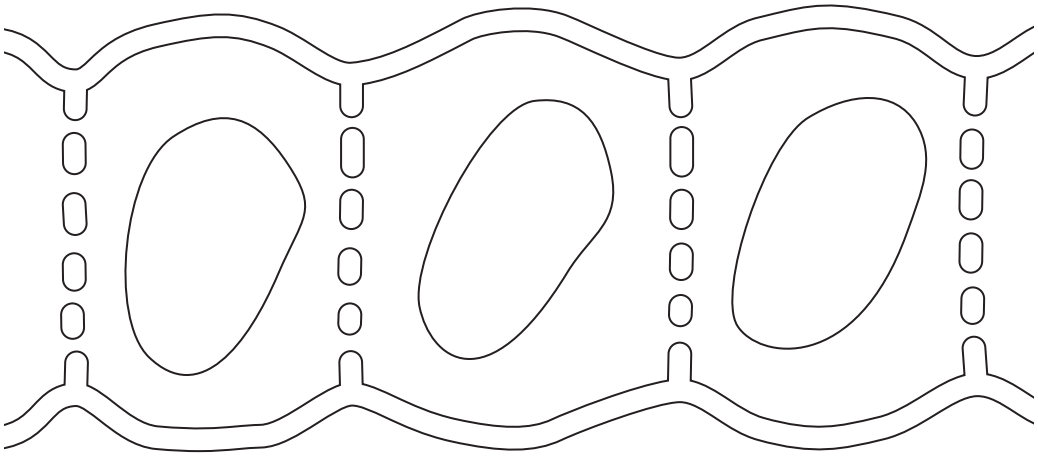
(b) **Image 2.2** shows cells from the root cortex.

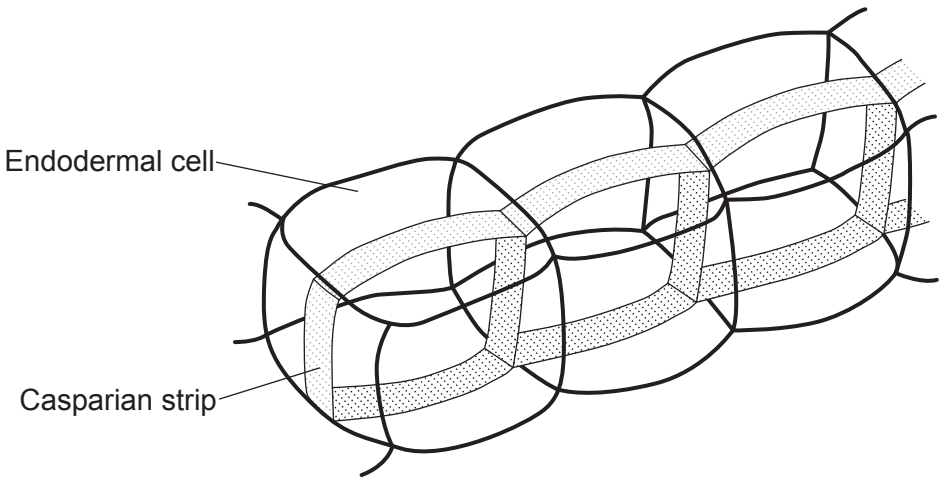
Image 2.2



(i) **Draw arrows** on **Image 2.2** to show the **three** pathways by which water moves across the root cortex. **Label your arrows** with the names of the pathways. [3]

Image 2.3 is a 3-dimensional drawing showing endodermal cells. The endodermis cell walls have a Casparian strip, which contains suberin.

Image 2.3



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(ii) Explain how the Casparian strip directs water towards the xylem of the root. [3]

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(c) Root hairs also take up ions from the soil into the plant. Experiments were performed on *Arabidopsis thaliana* to assess the uptake of phosphate ions into its root hairs. The observations from this experiment are outlined in **Table 2.4**.

Table 2.4

Relative oxygen concentration in soil	Relative phosphate ion uptake into root hairs
high	high
low	low

The phosphate ion concentration in soil is 1–10 $\mu mol\,dm^{-3}$ and in the cytoplasm of *Arabidopsis* cells, it is 60–80 $\mu mol\,dm^{-3}$.

Use **all** the information given to explain how phosphate ions are absorbed into *Arabidopsis* roots. [4]

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3. (a) In 2003, human skeletal remains were found on the island of Flores, Indonesia. Researchers proposed three possible origins for these remains:

- modern humans, *Homo sapiens*;
- a related species of early humans, *Sundanthropus floresianus*;
- a previously unknown human species. The name *Homo floresiensis* was proposed.

(i) **Complete Table 3.1** to show the taxonomy of *Homo sapiens*. [1]

Table 3.1

Taxon	Name
Domain	.....
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
.....	Primates
Family	Hominidae
Genus	*Homo*
Species	*sapiens*

(ii) Use the information above and your understanding of classification to explain the term 'tentative' in relation to the classification of *Homo floresiensis*. [1]

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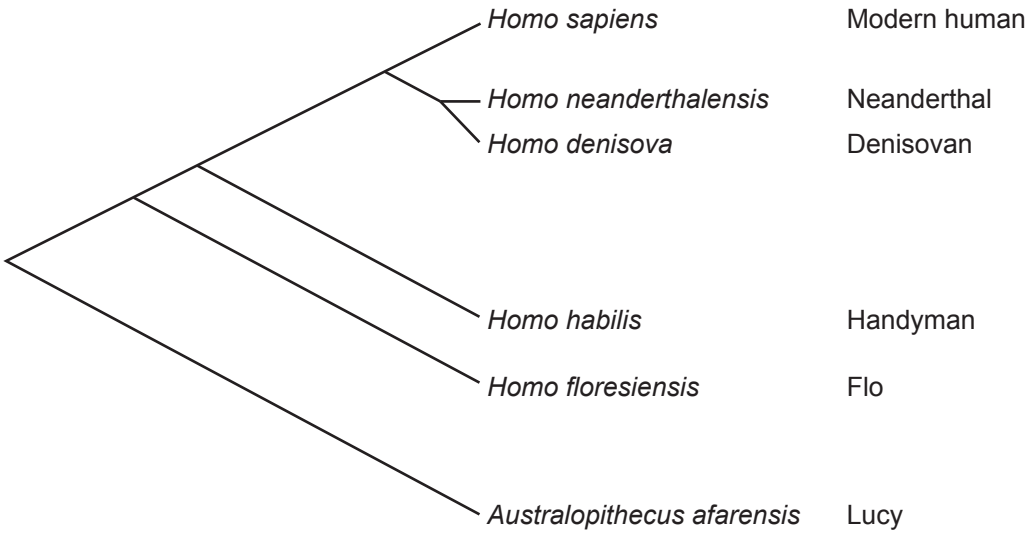
(b) **Image 3.2** is a phylogenetic tree showing the binomial and common names of modern humans and five related species.

Image 3.2



(i) Explain why scientists prefer to use the binomial system for naming, rather than common names as shown in **Image 3.2**. [1]

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(ii) Use **Image 3.2** to describe the evolutionary relationships shown between *H. sapiens*, *H. neanderthalensis* and *H. floresiensis*. Explain your answer. [2]

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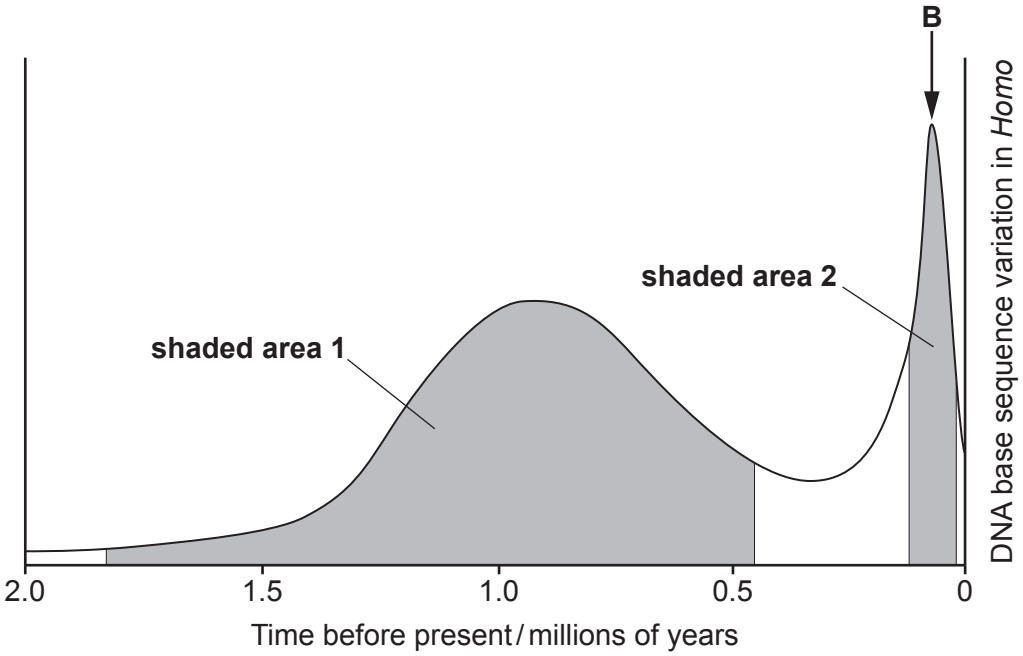
(c) DNA from ancient bones and teeth can be extracted and sequenced. **Image 3.3** shows the variation in the base sequences of DNA from bones of members of the genus *Homo* who lived up to two million years ago.

Image 3.3



Shaded area 1 in **Image 3.3** shows the time when early species of the genus *Homo* were diverging from each other. **Shaded area 2** shows the time when *H. sapiens* and *H. neanderthalensis* both lived.

(i) On **Image 3.3**, **draw an arrow labelled A** to suggest when a common ancestor of *H. neanderthalensis* and *H. sapiens* may have lived. [1]

(ii) Explain why the position of Arrow **B** on **Image 3.3** indicates the time when the genus *Homo* had the highest genetic diversity. [1]

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(iii) DNA analysis and fossil evidence show that:

- 2% of the DNA of modern non-African *H. sapiens* comes from *H. neanderthalensis*;
- 5% of the DNA of modern South Pacific and South and East Asian *H. sapiens* comes from *H. denisova*.

Use this information to explain why *H. neanderthalensis*, *H. sapiens* and *H. denisova* should all be considered to be members of the same species. [1]

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(d) *H. sapiens* and *H. floresiensis* diverged from their common ancestor approximately 1 860 000 years ago.
It has been estimated that *H. sapiens* and their common ancestor differ by 5.92×10^6 mutations. An average human generation time is 22 years.

Calculate the number of mutations per generation.
Give your answer to one significant figure. [3]

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Number of mutations per generation = ...

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4. (a) **Image 4.1** shows a capillary bed in a body tissue.

Image 4.1

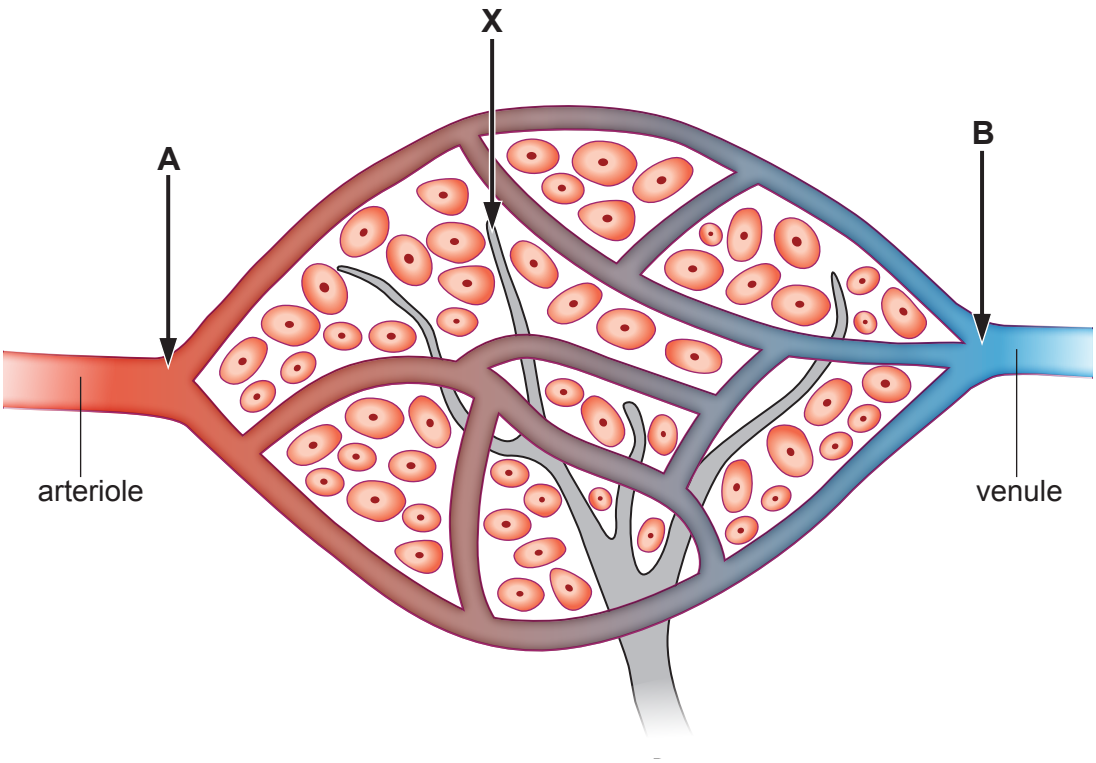

Table 4.2 shows the hydrostatic pressure and solute potential of the blood at positions **A** and **B** on **Image 4.1**.

Table 4.2

	Pressure / kPa	
	Position **A**	Position **B**
Hydrostatic pressure	5.3	1.4
Solute potential	–2.5	–2.6

The hydrostatic pressure of the blood is higher at position **A** than at position **B**.

(i) Give **two** reasons for the high hydrostatic pressure at **A**. [2]

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(ii) Give **two** reasons for the fall in hydrostatic pressure between positions **A** and **B**. [2]

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(b) (i) The resultant force on the fluid in the capillary is the combination of the hydrostatic and solute potential of the blood.
At Position **A** in **Image 4.1**, the resultant force is:

$$= 5.3 + (-2.5) = +2.8\,\text{kPa}$$

The resultant force is **positive** and so fluid moves **out** of the capillary.

Use **Table 4.2** to calculate the resultant force at Position **B**.
Explain the direction of fluid movement at Position **B**. [3]

Resultant force = ... kPa

Explanation

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(ii) Identify the structure labelled **X** in **Image 4.1** and describe its role. [2]

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(iii) **Image 4.3** shows part of a patient's leg, with a clinical condition called oedema. Their plasma has a very low concentration of solutes. Its solute potential is less negative (higher) than normal.

Image 4.3

State the effect of a less negative solute potential on the resultant force at position **B** in **Image 4.1**.

Explain how this might affect the movement of tissue fluid at the venous end of a capillary bed and result in oedema. [3]

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(c) Tissue fluid is formed from the blood.
Complete Table 4.4 by explaining **one** reason for each difference in the properties of blood and tissue fluid. [2]

Table 4.4

Property	Blood	Tissue fluid	Reason for difference
Colour	red	pale yellow	....
Large protein molecules	present	absent	....

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5. (a) **Image 5.1** is a photomicrograph of a transverse section of the stem of a sunflower seedling.

Image 5.1

(i) State the evidence from **Image 5.1** that this section shows a stem. [1]

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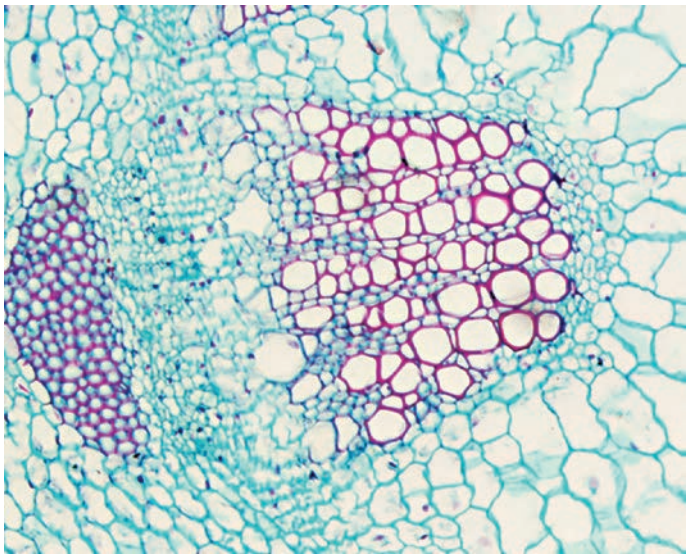
Image 5.2 shows a part of **Image 5.1**.

Image 5.2



(ii) On **Image 5.2**, **draw a line** labelled **X** to identify a xylem vessel. [1]

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(iii) Describe **one structural** characteristic that allowed you to identify a xylem vessel in **Image 5.2**. [1]

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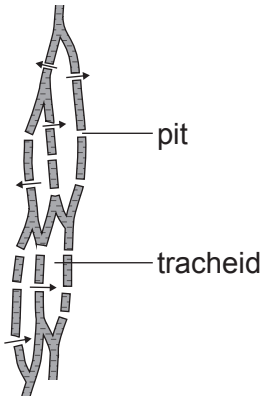
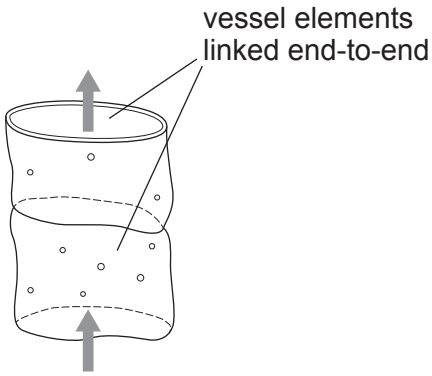
(b) Xylem contains many types of cell, including tracheids and vessels. These are described in **Table 5.3**. The arrows show the direction of water movement.

Table 5.3

	Tracheids	Vessels
Appearance of cells		
Relative length	short	long
Relative diameter	narrow	wide
Ends of cells	end walls present	no end walls
Major direction of water movement	laterally, through pits	vertically
Resistance to water movement	high	low

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Spruce and beech are members of two major groups of plants: spruce is a gymnosperm and beech is an angiosperm. **Table 5.4** shows the types of water-conducting cells in gymnosperms and angiosperms.

Table 5.4

Plant group	Example	Specialised water conducting cells	
		Tracheids	Vessels
Gymnosperm	Spruce	present	absent
Angiosperm	Beech	present	present

Explain how the information in **Table 5.3** and **Table 5.4** supports the observation that water travels upwards faster in beech than in spruce. [4]

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(c) The rate at which liquid moves upwards in the xylem of beech trees was measured. Readings were made over 24 hours during days in summer when there was no wind and no clouds.

(i) Explain why readings were only made when there was no wind. [2]

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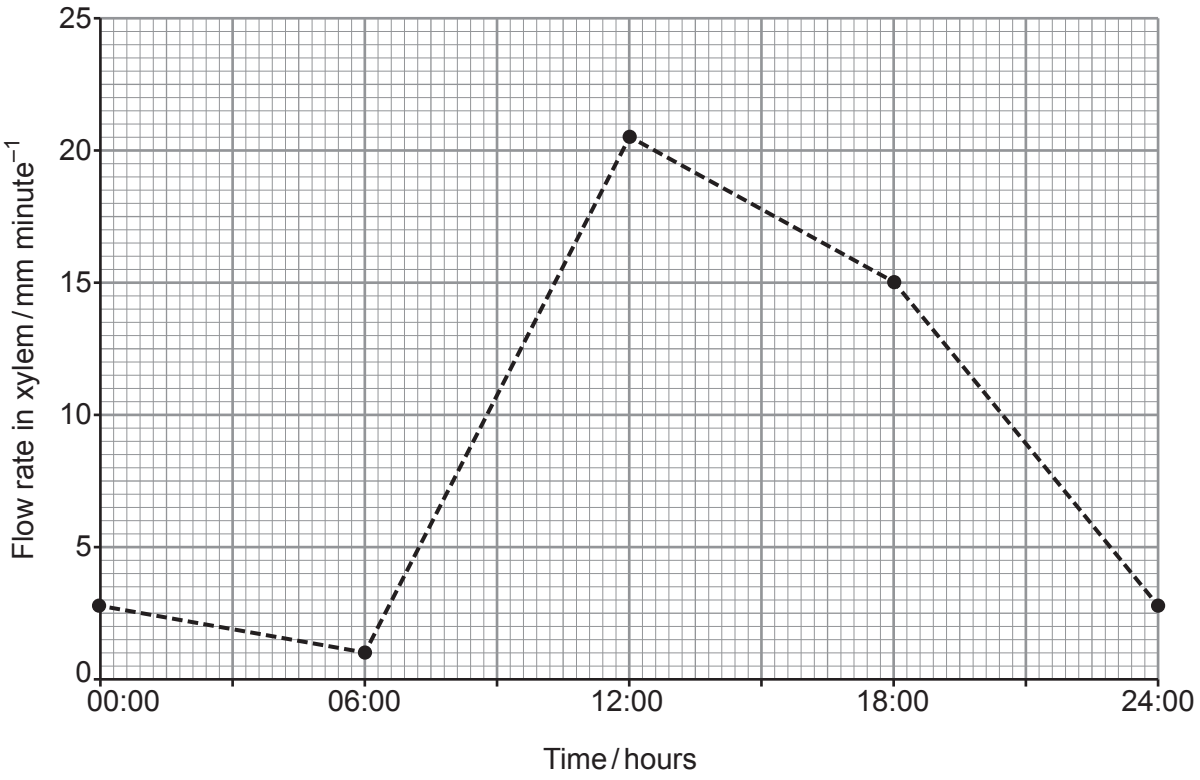
Graph 5.5 shows the flow rate in the xylem of beech trees.

Graph 5.5



(ii) Use readings from **Graph 5.5** to calculate the rate of increase in flow rate in xylem between 06:00 hours and 12:00 hours. State the unit for your answer. [3]

Increase in flow rate = ...

Unit = ...

(iii) Explain **one** reason why the rate of transpiration increases between 06:00 and 12:00 hours. [1]

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6. All plants and some prokaryotes are autotrophs. All animals are heterotrophs and may exhibit holozoic or parasitic nutrition. Fungi are also heterotrophs but have a different way of obtaining nutrients.

Explain the term 'autotroph' and describe the different categories of autotrophs.

Explain the term 'heterotroph' and state the meanings of holozoic and parasitic nutrition.

Describe how fungi obtain their nutrients. [9 QER]

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