B2cD Plant Tissues, Transport and Transpiration: Exam Drill

Total Marks

AQA 8464 · Calculator allowed · about 90 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the tissue in a plant that transports water from the roots to the leaves.

(a) Name the tissue in a plant that transports water from the roots to the leaves. **(1)**

(Total for Question 1 is 1 mark)

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2 State two features of root hair cells that help them absorb water and mineral ions.

(a) State two features of root hair cells that help them absorb water and mineral ions. **(2)**

(Total for Question 2 is 2 marks)

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3 A student draws a labelled diagram to show the movement of water across a root hair cell into the xylem. The diagram shows water moving through the cell membrane and then through the cytoplasm directly into the xylem vessels.

Explain why this diagram is incomplete. Give one additional pathway and one driving process.

(a) Explain why this diagram is incomplete. Give one additional pathway and one driving process. **(2)**

(Total for Question 3 is 2 marks)

4 Describe the functions of transpiration and of stomata in a leaf.

(a) Describe the functions of transpiration and of stomata in a leaf. **(3)**

(Total for Question 4 is 3 marks)

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5 In a potometer experiment, a student measures the distance an air bubble travels in a capillary tube as a proxy for water uptake. The student records the following distances in mm every 5 minutes: 0 min 0 mm, 5 min 18 mm, 10 min 35 mm, 15 min 51 mm. Calculate the average rate of water uptake in mm per minute between 5 and 15 minutes.

(a) Calculate the average rate of water uptake in mm per minute between 5 and 15 minutes. **(3)**

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(Total for Question 5 is 3 marks)

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6 A student investigates how humidity affects transpiration. She places identical potted plants in two clear chambers. Chamber A is humidified so relative humidity is 80%, Chamber B is kept at 30% relative humidity. After 4 hours, the mass loss of the plant and pot (corrected for evaporation from a control pot) is 2.8 g in A and 9.6 g in B.

Calculate the transpiration rate in g per hour for each chamber, and state the factor by which the rate in chamber B is larger than in chamber A.

(a) Calculate the transpiration rate in g per hour for each chamber. **(2)**

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(b) State the factor by which the rate in chamber B is larger than in chamber A. **(2)**

(Total for Question 6 is 4 marks)

7 Describe one control variable that must be kept the same when comparing rates of transpiration between two potted plants, and explain why it must be controlled.

(a) Describe one control variable that must be kept the same when comparing rates of transpiration between two potted plants, and explain why it must be controlled. **(3)**

(Total for Question 7 is 3 marks)

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8 A plant physiologist measures stomatal density by counting stomata under a microscope. She uses a square grid of side 0.5 mm placed on the leaf impression. She counts 35 stomata within the grid. Calculate the stomatal density in stomata per mm2.

(a) Calculate the stomatal density in stomata per mm2. **(4)**

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(Total for Question 8 is 4 marks)

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9 The diagram below shows a cross section of a leaf. Label the following structures on your copy: palisade mesophyll, spongy mesophyll, stomata, and vascular bundle (xylem and phloem). Then state which layer contains most chloroplasts and explain why.

(Note: Diagram not supplied here, question requires labelling on printed sheet.)

(a) State which layer contains most chloroplasts and explain why. **(2)**

(b) Identify where xylem would be found and its role. **(2)**

(Total for Question 9 is 4 marks)

10 Suggest two reasons why cutting stomata on the lower leaf surface with a scalpel would lead to unreliable stomatal counts when using nail varnish impressions.

(a) Suggest two reasons why cutting stomata on the lower leaf surface with a scalpel would lead to unreliable stomatal counts when using nail varnish impressions. **(2)**

(Total for Question 10 is 2 marks)

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11 A student repeats a potometer experiment three times and obtains rates of bubble movement of 4.2 mm min, 3.8 mm min and 4.6 mm min. Calculate the mean rate and the percentage uncertainty given by half the range divided by the mean, expressed as a percentage. Give answers to 2 significant figures for the mean and 1 decimal place for the percentage uncertainty.

(a) Calculate the mean rate and the percentage uncertainty given by half the range divided by the mean, expressed as a percentage. **(3)**

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(Total for Question 11 is 3 marks)

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12 In the required practical to investigate transpiration, a student uses a potometer and records the following distances travelled by the air bubble in the capillary each hour for 4 hours: 0.0 cm, 1.8 cm, 3.7 cm, 5.5 cm, 7.1 cm. Plotting these on a graph of distance against time should produce a straight line through the origin if the rate is constant.

State one practical error that would cause the plotted points to lie below the expected straight line and explain why.

(a) State one practical error that would cause the plotted points to lie below the expected straight line and explain why. **(4)**

(Total for Question 12 is 4 marks)

13 Explain how water moves from the soil to the leaves of a tall tree. In your answer include reference to cohesion, adhesion, transpiration pull, and the structure of xylem vessels. You should use scientific ideas and link them together.

(Total for Question 13 is 6 marks)

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14 A student measures transpiration rate by placing a fan at a fixed distance from a plant to produce a steady wind. After 2 hours the mass loss is 4.8 g. The fan is then turned off and after a further 2 hours the mass loss is 1.2 g. Explain what these results suggest about the effect of moving air on transpiration and give one biological reason for the observation.

(a) Explain what these results suggest about the effect of moving air on transpiration and give one biological reason for the observation. **(4)**

(Total for Question 14 is 4 marks)

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15 A student measures the concentration of mineral ions in the xylem sap using a conductivity probe. He finds that ion concentration increases towards the leaves.

Suggest two biological explanations for this observation.

(a) Suggest two biological explanations for ion concentration increasing towards the leaves. **(4)**

(Total for Question 15 is 4 marks)

16 Evaluate the statement: "Plants in drier climates always have fewer stomata than plants in wetter climates." In your answer consider evidence for and against and reach a balanced conclusion.

(a) Evaluate the statement and reach a balanced conclusion. **(4)**

(Total for Question 16 is 4 marks)

Mark scheme · B2cD Plant Tissues, Transport and Transpiration: Exam Drill

Question 1

- (a) **B1** xylem cao
- **(a) Answer: Xylem**

Question 2

- (a) **B1** large surface area (long projection, root hair) oe
- (a) **B1** thin cell wall / short diffusion distance or many mitochondria for active transport of ions, oe
- **(a) Answer: Large surface area due to long root hair; thin cell wall or many mitochondria for active transport of ions.**

Question 3

- (a) **B1** mentions apoplast pathway (movement through cell walls) or vacuolar pathway as additional pathway
- (a) **B1** mentions osmosis (water potential gradient) as the driving process or active transport for ions creating gradient, oe
- **(a) Answer: There is also an apoplast route (through cell walls) or vacuolar route; water moves by osmosis down a water potential gradient (created by ions entering xylem).**

Question 4

- (a) **B1** transpiration results in loss of water vapour from leaves
- (a) **B1** transpiration helps to pull water up the xylem (transpiration stream) and transports minerals, oe
- (a) **B1** stomata open to allow gas exchange (CO2 in for photosynthesis) and close to reduce water loss, oe
- **(a) Answer: Transpiration is loss of water vapour from leaves and helps pull water up the xylem, transporting minerals. Stomata open for gas exchange (CO2 in) and close to reduce water loss.**

Question 5

- (a) **M1** computes change in distance and time: (51 - 18) mm over (15 - 5) min
- (a) **M1** substitutes and divides: 33 / 10
- (a) **A1** 3.3 mm per minute (to 2 s.f.) cao
- **(a) Answer: 3.3 mm per minute**

Question 6

- (a) **M1** computes rate for A: 2.8 g / 4 h and for B: 9.6 g / 4 h
- (a) **A1** A = 0.70 g per hour, B = 2.4 g per hour cao
- **(a) Answer: A: 0.70 g per hour; B: 2.4 g per hour**
- (b) **M1** computes factor: 2.4 / 0.7
- (b) **A1** 3.43 (3.4 to 2 s.f.) or 3.4286... with ecf cao
- **(b) Answer: About 3.4 times larger**

Question 7

- (a) **B1** identifies a control variable eg same pot size/soil type/plant species/leaf area/light intensity
- (a) **B1** explains how it affects transpiration eg leaf area affects surface for evaporation or light affects stomatal opening
- (a) **B1** links control to valid comparison eg to ensure differences are due to the tested variable, oe
- **(a) Answer: Keep leaf area the same, because larger leaf area increases evaporation area and would change transpiration; this ensures differences are due to the tested variable.**

Question 8

- (a) **M1** calculate area of grid: 0.5 x 0.5 mm = 0.25 mm2
- (a) **M1** compute density: 35 / 0.25
- (a) **A1** 140 stomata per mm2 cao
- (a) **A1** units stated or implied cao
- **(a) Answer: 140 stomata per mm2**

Question 9

- (a) **B1** palisade mesophyll identified
- (a) **B1** reason: cells are packed with chloroplasts and are near the top of the leaf to receive most light, oe
- **(a) Answer: Palisade mesophyll; its cells are packed with many chloroplasts and are near the upper surface to absorb most light.**
- (b) **B1** xylem located in vascular bundle (vein)
- (b) **B1** role: transports water and mineral ions to the leaf, oe
- **(b) Answer: Xylem is in the vascular bundle (vein) and transports water and mineral ions to the leaf.**

Question 10

- (a) **B1** cutting damages cells, destroying stomata or altering appearance
- (a) **B1** cutting causes water loss or closure of stomata affecting count, or smear makes impressions unclear
- **(a) Answer: Cutting damages or destroys stomata so they cannot be counted; cutting causes water loss or stomatal closure and smearing makes impressions unclear.**

Question 11

- (a) **M1** calculate mean: (4.2 + 3.8 + 4.6) / 3
- (a) **M1** calculate percentage uncertainty: half range = (4.6 - 3.8) / 2 = 0.4; percentage = 0.4 / mean x 100
- (a) **A1** mean = 4.2 mm min (2 s.f.); percentage uncertainty = 9.5% (1 d.p.) cao
- **(a) Answer: Mean = 4.2 mm min; percentage uncertainty = 9.5%**

Question 12

- (a) **B1** identifies an error eg air leak in joints, poor seal at cut stem, or bubble introduced by incorrect assembly
- (a) **B1** explains effect: leak reduces measured water uptake so distances are smaller
- (a) **B1** alternative error: not re-cutting stem under water so xylem blocked by air, with explanation
- (a) **B1** links to graph: points below expected straight line because measured uptake less than true uptake, oe
- **(a) Answer: For example, an air leak at the joints means water enters the apparatus without moving the bubble in the capillary, so the recorded distances are smaller and points plot below the expected line.**

Question 13

- **Level 3** (5-6): Detailed and coherent explanation that links cohesion, adhesion, transpiration pull and xylem structure. Uses scientific terms accurately and shows how these processes maintain a continuous water column up the xylem.
- **Level 2** (3-4): Partial explanation that mentions at least two of the required ideas with some links between them. Some scientific terms may be used correctly.
- **Level 1** (1-2): Simple statements about water movement with little linking or scientific detail. May list ideas without explanation.
- **Indicative content:**
  - Water enters root hair cells by osmosis because soil water has higher water potential than the cell.
  - Water moves through root cortex to xylem via apoplast and symplast pathways.
  - Xylem vessels are continuous tubes strengthened by lignin allowing a continuous water column.
  - Cohesion between water molecules (hydrogen bonding) helps maintain the continuous column.
  - Adhesion between water and xylem walls helps pull water up the vessel.
  - Transpiration from leaves creates tension (transpiration pull) that pulls the water column up from roots to leaves.
  - As water evaporates from mesophyll into air spaces and exits via stomata, it lowers water potential in leaf cells, drawing more water up the xylem.

Question 14

- (a) **B1** states that transpiration rate is higher when fan is on (4.8 g in 2 h > 1.2 g in 2 h)
- (a) **B1** quantitative comparison eg 2.4 g per hour with fan, 0.6 g per hour without fan
- (a) **B1** biological reason: moving air removes water vapour from leaf surface lowering local humidity and increasing diffusion gradient
- (a) **B1** link to stomata: increased diffusion gradient increases water vapour loss through stomata or keeps stomata open, oe
- **(a) Answer: Transpiration is higher with moving air: with fan 4.8 g in 2 h (2.4 g per hour) versus 1.2 g in 2 h (0.6 g per hour) without fan. Moving air removes water vapour, lowering local humidity and increasing the diffusion gradient so more water is lost through stomata.**

Question 15

- (a) **B1** active transport of ions into xylem in root and loading into xylem may cause concentration gradients as water is lost by transpiration
- (a) **B1** water loss by transpiration concentrates ions in the xylem sap as it moves up
- (a) **B1** ions may be unloaded into surrounding tissues at lower parts less than at upper parts leading to higher concentration near leaves
- (a) **B1** transpiration stream may carry ions upward and evaporation at leaves reduces volume of water, increasing ion concentration
- **(a) Answer: Possible reasons: active transport loads ions into xylem and transpiration removes water so concentration increases; evaporation at leaves reduces water volume so ions become more concentrated as sap moves up.**

Question 16

- (a) **B1** gives argument supporting statement eg xerophytes have reduced stomatal density or sunken stomata to reduce water loss
- (a) **B1** gives argument against statement eg some dry-climate plants have many stomata but with other adaptations (stomatal crypts, hairs) or CAM metabolism that opens stomata at night
- (a) **B1** considers complexity and need for other traits/environmental interactions eg soil water, humidity, temperature
- (a) **B1** concludes with balanced judgement eg often fewer stomata but not always; depends on suite of adaptations
- **(a) Answer: For: many xerophytes show reduced stomatal density to limit water loss. Against: some dry-climate plants use stomatal crypts, hairs or CAM physiology and may not have fewer stomata. Conclusion: often stomatal density is lower in drier climates, but not always; other adaptations and ecological factors also determine stomatal traits.**