1.14 Plant Tissues, Transport and Transpiration: 1-hour Pack

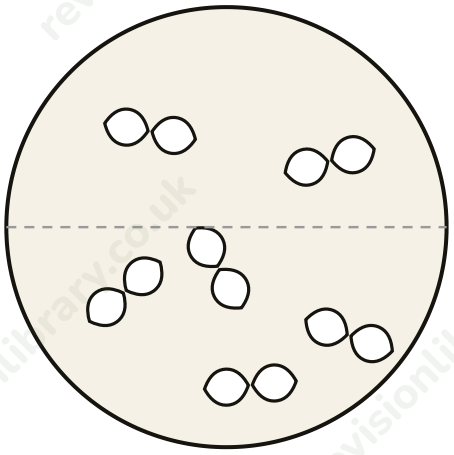
Total Marks

AQA 8464 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student used a light microscope to count the number of stomata on the lower surface of a leaf. She viewed the leaf under a magnification at which the circular field of view had a diameter of 1.5 mm, and counted 6 stomata within it.



Field of view: diameter 1.5 mm

(a) Calculate the area of the field of view, in mm^2. Give your answer to 3 significant figures. **(2)**

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(b) Calculate the stomatal density, in stomata per mm^2. **(2)**

.....

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(c) The student repeated the count on the upper surface of the same leaf and found a much lower stomatal density. Suggest one advantage to the plant of having fewer stomata on the upper surface of the leaf. **(2)**

(d) Suggest and explain how the stomatal density of a leaf might differ between a plant adapted to a hot, dry habitat and a plant adapted to a cool, wet habitat. **(3)**

(Total for Question 1 is 9 marks)

2 Translocation is the movement of substances through phloem tissue.

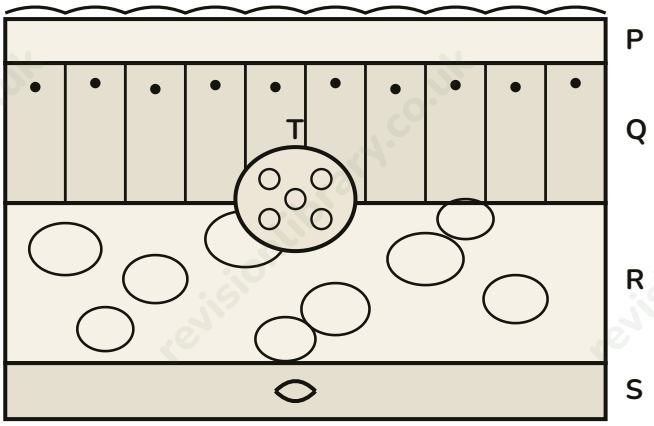
(a) Name the tissue responsible for translocation. **(1)**

(b) Name two substances transported by this tissue. **(2)**

(Total for Question 2 is 3 marks)

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3 A simplified diagram shows a cross-section through a leaf. From top to bottom, the layers are labelled: P (a single layer of transparent cells covered by a thick waxy layer), Q (a layer of tall, tightly packed cells directly beneath P), R (a layer of loosely packed, irregularly shaped cells with large air spaces between them), S (a single layer of cells containing two bean-shaped cells with a small gap between them, on the lower surface), and T (a bundle of specialised transport cells running through the middle of the leaf).



Lower surface of leaf

(a) Identify layers P, Q, R, S and T. **(5)**

(b) Explain why layer Q contains many chloroplasts positioned near the upper surface of the leaf. **(2)**

(c) Suggest why layer R has large air spaces between its cells. **(2)**

(Total for Question 3 is 9 marks)

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4 Stomata are small pores in the leaf surface, each surrounded by a pair of guard cells.

(a) Name the cells that surround and control the size of a stoma. **(1)**

(b) Describe how guard cells cause a stoma to open. **(3)**

(c) Explain why guard cells often close stomata during a water shortage. **(2)**

(Total for Question 4 is 6 marks)

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5 Root hair cells are adapted for the efficient uptake of water from the soil.

(a) Name the process by which water moves from the soil into root hair cells. **(1)**

(b) State two structural adaptations of root hair cells and, for each one, explain how it increases the rate of water uptake. **(4)**

(Total for Question 5 is 5 marks)

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6 Root hair cells use active transport to absorb mineral ions from the soil, even when the concentration of ions in the soil is lower than inside the cell. Explain how this active transport of mineral ions can affect the movement of water into the cell by osmosis.

(Total for Question 6 is 3 marks)

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7 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.

(Total for Question 7 is 4 marks)

8 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.

(Total for Question 8 is 3 marks)

9 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 9 is 4 marks)

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Mark scheme · 1.14 Plant Tissues, Transport and Transpiration: 1-hour Pack

Question 1

(a) radius = 0.75 mm; area = π x 0.75^2, oe **M1**

(a) 1.77 mm^2 (accept 1.76-1.77) awrt 3 sf **A1**

(a) Answer: 1.77 mm^2

(b) density = number counted / their area = 6 / their (a), ft their (a) **M1**

(b) 3.40 stomata/mm^2 (accept 3.38-3.41) awrt 3 sf, ft **A1**

(b) Answer: 3.40 stomata/mm^2

(c) the upper surface receives more direct sunlight and is likely to be warmer than the lower surface, oe **B1**

(c) so having fewer stomata there reduces the amount of water lost by transpiration from the hottest, most exposed surface, helping the plant conserve water, oe **B1**

(c) Answer: The upper surface is exposed to more direct sunlight and is warmer, so having fewer stomata there reduces water loss by transpiration from the hottest surface, helping the plant conserve water.

(d) a plant adapted to a hot, dry habitat is likely to have a lower stomatal density (fewer stomata per mm^2), oe **B1**

(d) this reduces the rate of water loss by transpiration, which is important where water is scarce, oe **B1**

(d) a plant adapted to a cool, wet habitat can have a higher stomatal density, allowing more gas exchange (and a higher rate of photosynthesis), without a high risk of the plant losing too much water, oe **B1**

(d) Answer: A plant from a hot, dry habitat is likely to have a lower stomatal density, reducing water loss by transpiration where water is scarce. A plant from a cool, wet habitat can have a higher stomatal density, allowing more gas exchange for photosynthesis, since there is little risk of losing too much water.

Question 2

(a) phloem **B1**

(a) Answer: Phloem

(b) dissolved sugars/sucrose **B1**

(b) amino acids **B1**

(b) Answer: Dissolved sugars (sucrose) and amino acids.

Question 3

(a) P: upper epidermis **B1**

(a) Q: palisade mesophyll (layer) **B1**

(a) R: spongy mesophyll (layer) **B1**

(a) S: lower epidermis **B1**

(a) T: vascular bundle/xylem and phloem **B1**

(a) Answer: P: upper epidermis. Q: palisade mesophyll. R: spongy mesophyll. S: lower epidermis. T: vascular bundle (xylem and phloem).

(b) light enters the leaf from above, oe **B1**

(b) so positioning many chloroplasts near the top allows them to absorb the maximum amount of light for photosynthesis before it is absorbed or scattered by deeper tissue, oe **B1**

(b) Answer: Light enters the leaf from above, so having many chloroplasts positioned near the top of the palisade layer means they can absorb the maximum amount of light for photosynthesis.

(c) the air spaces allow gases (carbon dioxide, oxygen and water vapour) to diffuse freely to and from the mesophyll cells, oe **B1**

(c) this increases the surface area available for gas exchange within the leaf, and connects the mesophyll cells to the stomata for gas exchange with the air outside, oe **B1**

(c) Answer: The air spaces allow gases such as carbon dioxide, oxygen and water vapour to diffuse freely between the mesophyll cells and the stomata, increasing the surface area available for gas exchange.

Question 4

(a) guard cells **B1**

(a) Answer: Guard cells

(b) when water is available, guard cells take up water by osmosis and become turgid, oe **B1**

(b) the outer wall of each guard cell is thinner than the inner wall, so the outer wall stretches more as the cell swells, oe **B1**

(b) this uneven stretching makes the pair of guard cells curve/bend apart, opening the pore between them, oe **B1**

(b) Answer: Guard cells take up water by osmosis and become turgid; because their outer wall is thinner than their inner wall, it stretches more, making the pair of guard cells curve apart and open the stoma.

(c) closing the stomata reduces the diffusion of water vapour out of the leaf, reducing water loss by transpiration, oe **B1**

(c) this helps to conserve the plant's remaining water and prevents excessive water loss/wilting, oe **B1**

(c) Answer: Closing the stomata reduces water vapour loss by transpiration, helping the plant conserve its remaining water and avoid wilting.

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Question 5

(a) osmosis **B1**

(a) Answer: Osmosis

(b) adaptation 1: a long, thin extension (root hair) giving a large surface area (in contact with soil water), oe **B1**

(b) explanation 1: a larger surface area allows more water to move into the cell by osmosis at the same time, oe **B1**

(b) adaptation 2: a thin cell wall/membrane (any one further valid adaptation, e.g. large numbers of mitochondria), oe **B1**

(b) explanation 2: a thin wall gives a short diffusion pathway/distance so water can move in more quickly (or: many mitochondria release energy by respiration for the active transport of mineral ions, which helps maintain the water potential gradient needed for osmosis), oe **B1**

(b) Answer: Root hair cells have a long, thin extension giving a large surface area, which allows more water to enter by osmosis at once; they also have a thin cell wall, giving a short diffusion pathway so water enters more quickly.

Question 6

active transport uses energy (from respiration) to move mineral ions into the root hair cell against their concentration gradient, oe **B1**

this increases/maintains the concentration of dissolved solutes inside the cell, lowering the water potential inside the cell relative to the water potential of the soil water outside, oe **B1**

this larger water potential gradient increases the rate at which water moves into the cell by osmosis, oe **B1**

Answer: Active transport uses energy from respiration to move mineral ions into the root hair cell against their concentration gradient. This raises the solute concentration (lowers the water potential) inside the cell compared with the soil water outside, creating or maintaining a water potential gradient that increases the rate of osmosis of water into the cell.

Question 7

states that transpiration rate is higher when fan is on (4.8 g in 2 h > 1.2 g in 2 h) **B1**

quantitative comparison eg 2.4 g per hour with fan, 0.6 g per hour without fan **B1**

biological reason: moving air removes water vapour from leaf surface lowering local humidity and increasing diffusion gradient **B1**

link to stomata: increased diffusion gradient increases water vapour loss through stomata or keeps stomata open, oe **B1**

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 8

calculate mean: (4.2 + 3.8 + 4.6) / 3 **M1**

calculate percentage uncertainty: half range = (4.6 - 3.8) / 2 = 0.4; percentage = 0.4 / mean x 100 **M1**

mean = 4.2 mm min (2 s.f.); percentage uncertainty = 9.5% (1 d.p.) cao **A1**

Answer: Mean = 4.2 mm min; percentage uncertainty = 9.5%

Question 9

(a) gives argument supporting statement eg xerophytes have reduced stomatal density or sunken stomata to reduce water loss **B1**

(a) 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 **B1**

(a) considers complexity and need for other traits/environmental interactions eg soil water, humidity, temperature **B1**

(a) concludes with balanced judgement eg often fewer stomata but not always; depends on suite of adaptations **B1**

(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.

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