Chapter 8

Transport in plants

01. 0610_w18_qp_42 Q: 3

(a) Fig. 3.1 is a photomicrograph of some xylem vessels.

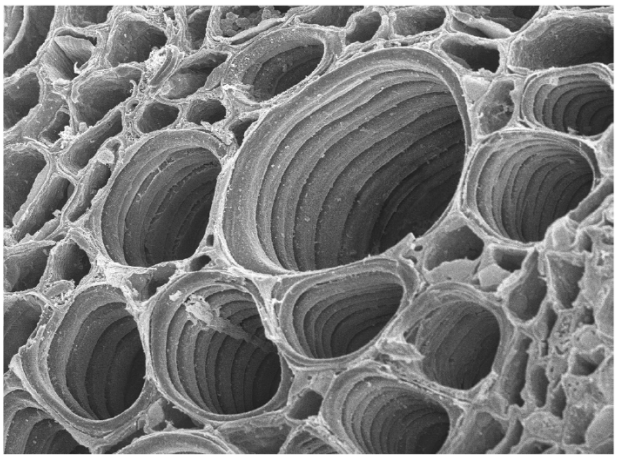

Fig. 3.1

(i) State **one** structural feature of xylem vessels and explain how this is related to the function of water transport.

feature .....

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explanation .....

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..... [2]

(ii) Explain the mechanism that is responsible for the movement of water in xylem vessels.

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..... [4]

(iii) State **one** role of xylem vessels **other than** transport.

..... [1]

(b) The rate of transpiration is affected by several factors including the temperature and the humidity of the air.

State **and** explain the effect of an increase in temperature on the rate of transpiration.

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..... [3]

[Total: 10]

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Fig. 3.1 shows a photomicrograph of a section of a root.

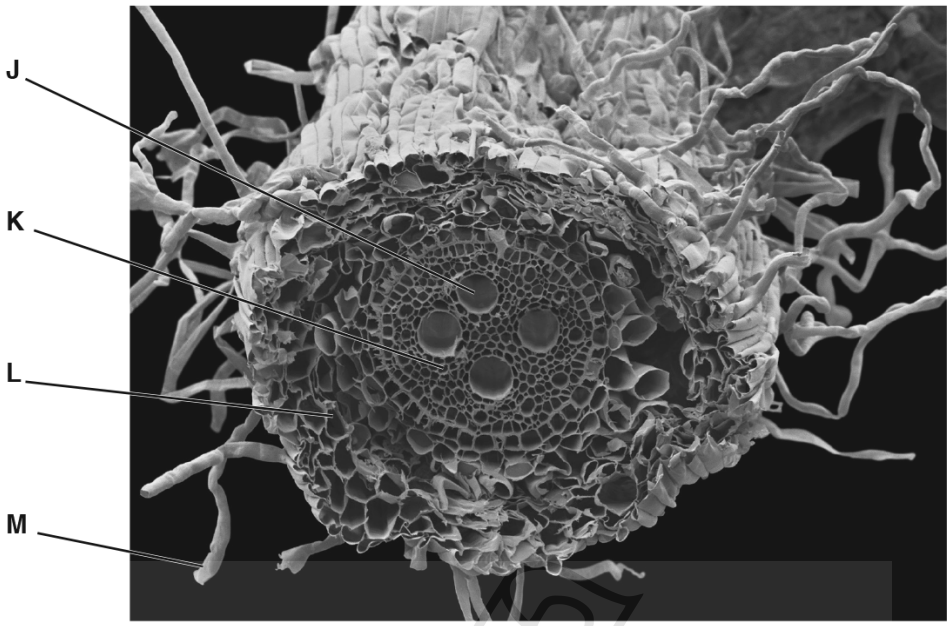

Fig. 3.1

(a) Structure **J** is a xylem vessel.

The xylem vessels conduct water from the roots to the stems.

State the features of xylem vessels that enable them to conduct water.

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.....[3]

(b) Describe the pathway of water from outside the root to the xylem vessels (**J**) at the centre of the root. Use the letters in Fig. 3.1 in your answer.

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.....[5]

(c) Scientists wanted to determine the flow-rate of water in roots.

They measured the flow-rate in three zones of onion roots as shown in Fig. 3.2.

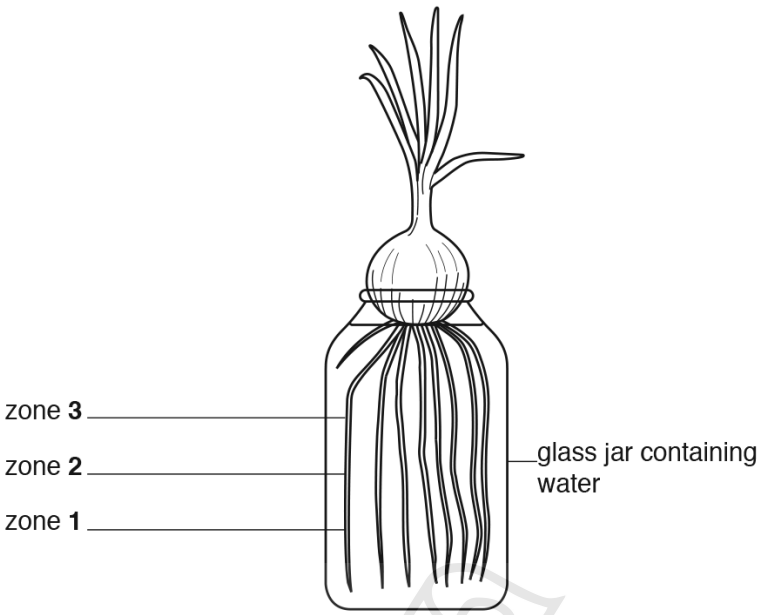

Fig. 3.2

They measured the flow-rate in healthy roots and roots that had been treated with a toxic solution.

Their results are shown in Table 3.1.

Table 3.1

zone in Fig. 3.2	average flow-rate of water / arbitrary units	
	healthy roots	treated roots
1	150	160
2	230	200
3	280	270

(i) Calculate the percentage increase in the average flow-rate between zone **1** and **3** for healthy roots.

Give your answer to **two** significant figures.

Show your working.

..... %
[2]

(ii) The scientists observed that the xylem vessels nearer the root tip were narrower than the xylem vessels higher up the root.

Describe how the width of xylem vessels in different zones of a root affects the average flow-rate of water. Use the information in Table 3.1 in your answer.

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.....[3]

(iii) Suggest why there was little difference in the flow-rate in healthy roots and in roots treated with the toxic solution.

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.....[2]

[Total: 15]

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Fig. 3.1 is a scanning electron micrograph of a vertical section through part of the leaf of a broad bean plant, *Vicia faba*.

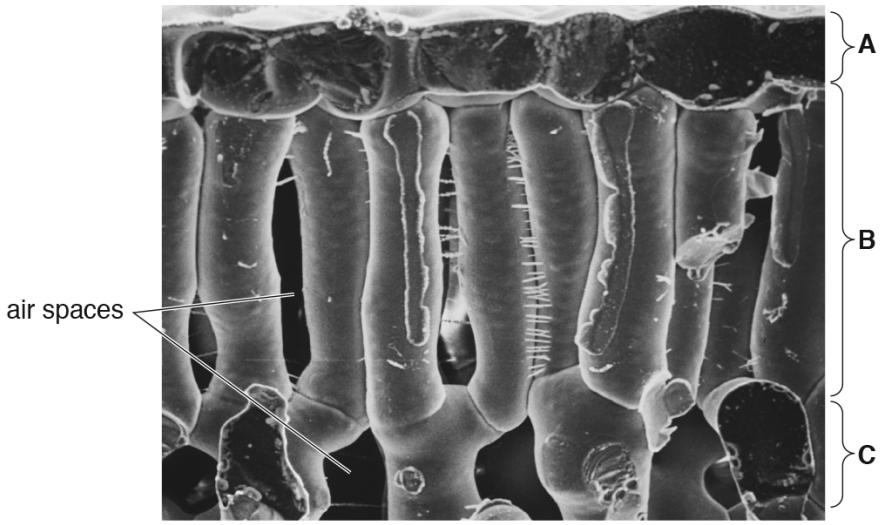

Fig. 3.1

(a) (i) State the names of the tissues labelled **A** and **B**.

A .....

B .....

[2]

(ii) The cells in regions **B** and **C** in Fig. 3.1 have a large surface area.

Explain why this is necessary for the functioning of the leaf cells.

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.....[3]

(iii) Explain why there are many interconnecting air spaces within the leaf.

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.....[2]

(b) When water is in short supply, plants can wilt as shown in Fig. 3.2.

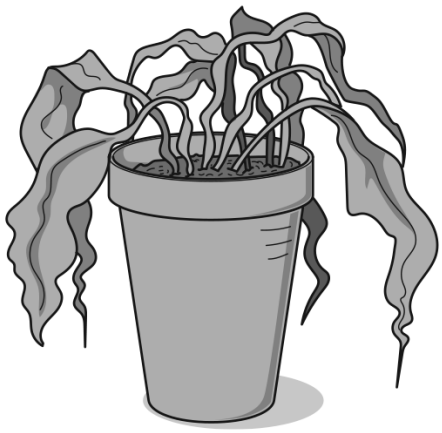

Fig. 3.2

(i) State **two** conditions that are likely to increase the chances of wilting.

1 .....

2 .....

[2]

(ii) Explain what happens to the cells of a leaf to cause wilting.

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.....[4]

(iii) Wilting may look harmful, but it is often a strategy for survival.

Suggest the advantages to a plant of wilting.

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.....[2]

[Total: 15]

(a) Fig. 3.1 is a photomicrograph of part of the upper surface of a broad bean leaf, *Vicia faba*.

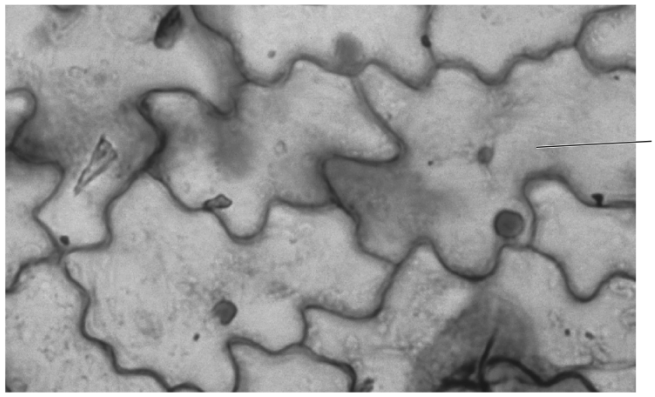

Fig. 3.1

(i) On Fig. 3.1, identify and label **two** structures that are visible in cell **P**. [2]

(ii) State the name of the tissue shown in Fig. 3.1.

.....[1]

(iii) The tissue shown in Fig. 3.1 is transparent.

Explain why it is important to the plant that the tissue shown in Fig. 3.1 is transparent.

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.....[3]

(b) Stomata are found on the lower surface of broad bean leaves.

Describe the function of stomata.

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.....[3]

(c) More than 40 years ago, botanists studied the leaves of broad bean plants and discovered that guard cells control the opening and closing of stomata. They found that stomata were open when the guard cells were turgid.

Table 3.1 shows some of their measurements.

Table 3.1

	closed stomata	open stomata
ion concentration in guard cells / pmol	0.3	2.5
guard cell volume / μm^3	4000.0	6500.0
turgor pressure in the guard cells / MPa	2.0	4.8
width of stomatal opening / μm	0.0	8.0

(i) Ions move into guard cells by active transport.

Describe how the ions move into the guard cells.

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.....[2]

(ii) Describe **and** explain how the change in ion concentration causes the guard cell volume to change. Use the information in Table 3.1 in your answer.

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.....[5]

(iii) The botanists left the broad bean plants unattended for three days. During this time the broad bean plants wilted.

Suggest **two** environmental factors that can cause plants to wilt.

1 .....

2 .....

[2]

[Total: 18]

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Fig. 2.1 shows part of a cross-section of the stem of a young sunflower plant.

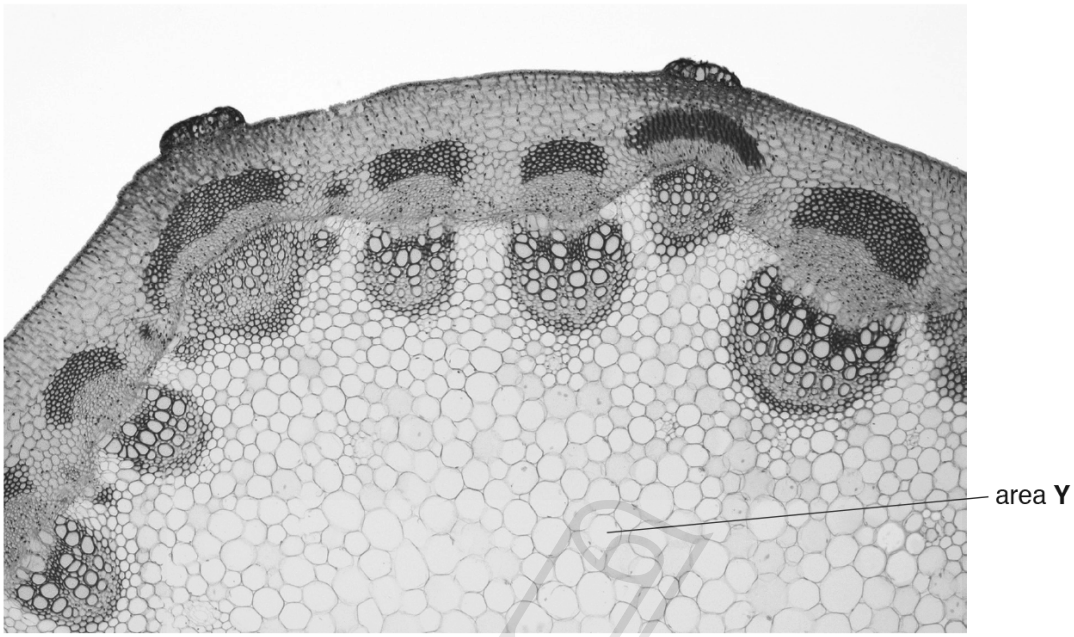

Fig. 2.1

(a) Draw a circle around **one** vascular bundle on Fig. 2.1.

Label the **xylem** in the vascular bundle with the letter **X**. [2]

(b) Explain how the cells in **area Y** are able to support the stem so that it stays upright.

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..... [3]

(c) Researchers used carbon dioxide that contained a traceable source of carbon (^{13}C) to investigate translocation of sucrose from the leaves of bean plants, *Phaseolus vulgaris*.

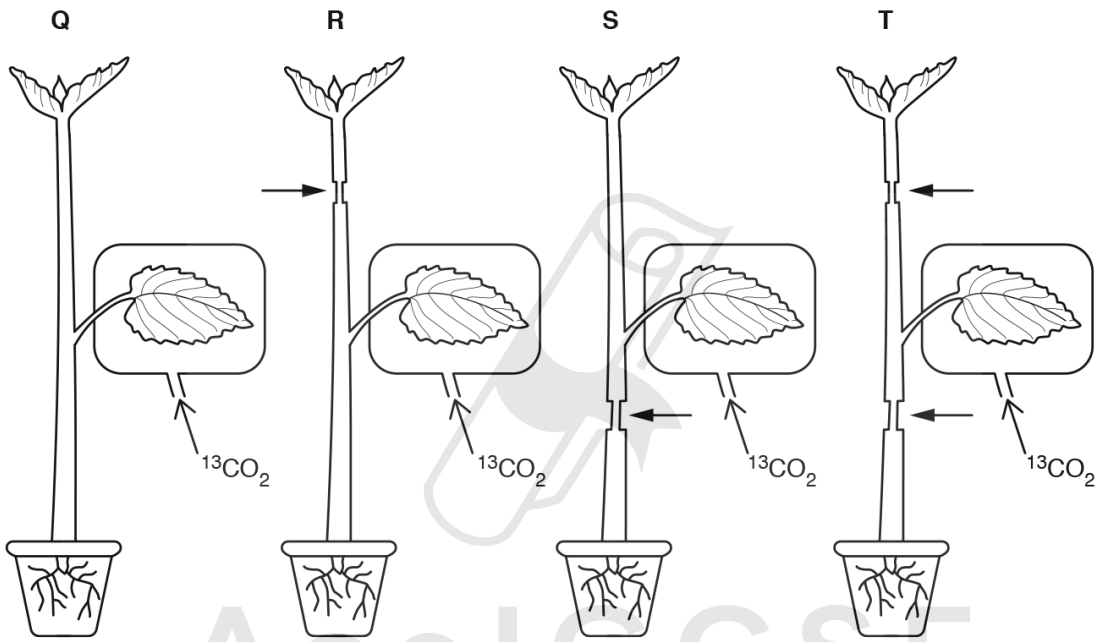
Fig. 2.2 shows that glucose produced in photosynthesis is converted to sucrose for translocation.

carbon dioxide ⟶ glucose ⟶ sucrose

Fig. 2.2

Researchers selected four plants, **Q**, **R**, **S** and **T**, which had leaves that were of similar sizes. The leaves on the four plants were supplied with $^{13}CO_2$.

After the leaves had started to make sucrose, the researchers cut away a ring of tissue in different places as shown in Fig. 2.3. The rings of tissue that were removed from plants **R**, **S** and **T** contained the phloem.



Key: ⟶ the positions on the stems where rings of tissue containing phloem were removed.

Fig. 2.3

The quantities of sucrose containing ^{13}C in the shoot tips and in the roots were determined.

The results are shown in Table 2.1.

Table 2.1

plant	quantity of sucrose containing ^{13}C / arbitrary units	
	shoot tip	root
Q	3.24	0.94
R	0.00	0.44
S	4.14	0.00
T	0.00	0.00

Describe **and** explain the effect of removing the phloem on the translocation of sucrose in plants **Q**, **R**, **S** and **T**.

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..... [5]

[Total: 10]

06. 0610_w19_qp_43 Q: 2

Plants produce glucose in leaves and convert some of it to sucrose.

(a) (i) Explain how glucose is produced in leaves.

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..... [3]

(ii) State the name of the process that plants use to move sucrose from a source to a sink.

..... [1]

(iii) Roots can be an example of a sink.

Explain why sometimes roots act as a source rather than a sink.

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..... [2]

(b) The movement of sucrose in plants can be modelled using laboratory apparatus.

Fig. 2.1 shows the apparatus used to model the movement of sucrose in a plant:

- Partially permeable bags were attached tightly to the ends of tube **Q**.
- The bag representing a **source** was filled with a coloured sucrose solution.
- The bag representing a **sink** was filled with water.
- The containers and tube **Q** and tube **S** were filled with water.

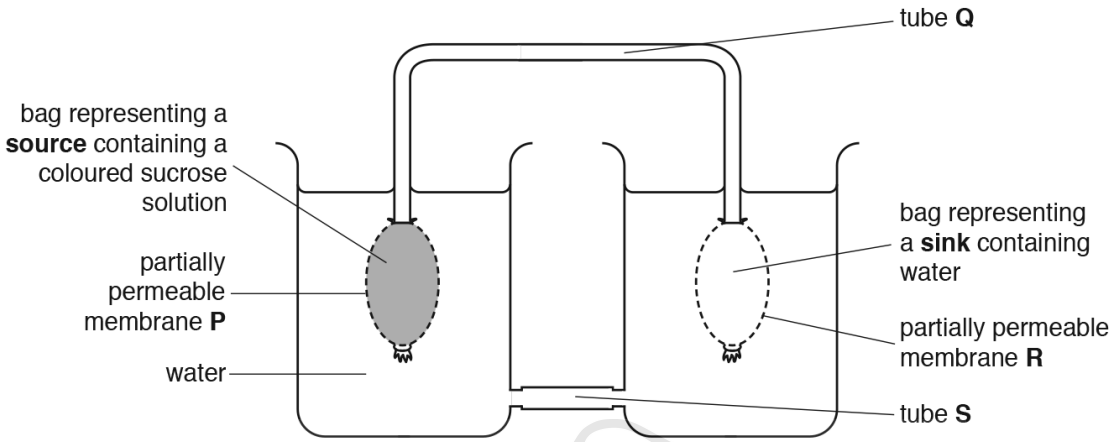

Fig. 2.1

Fig. 2.2 shows the position of the coloured sucrose solution 30 minutes after the apparatus was set up.

The arrows show the direction of the movement of the liquids.

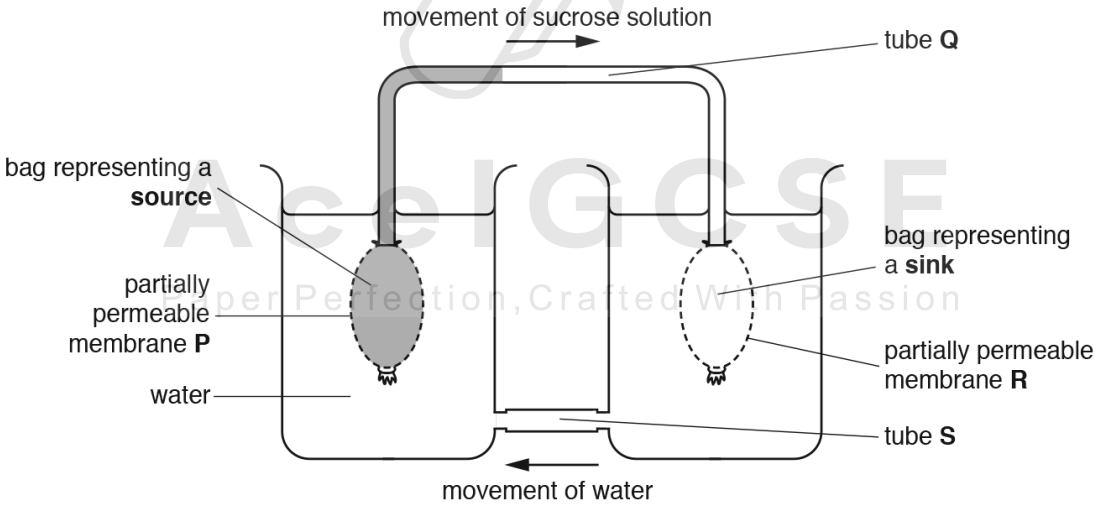

Fig. 2.2

(i) State the name of the tissue represented by tube **Q** and the name of the tissue represented by tube **S** in Fig. 2.2.

Q .....

S .....
[2]

(ii) Explain why the sucrose solution moves along tube **Q** in the model in Fig. 2.2.

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..... [4]

(c) In plants the movement of sucrose is usually continuous. However, after 2 hours the movement of sucrose in tube **Q** in Fig. 2.2 stopped.

Suggest why the movement of sucrose in tube **Q** stopped.

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..... [1]

(d) Amino acids are also transported through plants.

State the name of the mineral ion that is used to make amino acids.

..... [1]

[Total: 14]

01. 0610_w18_MS_42 Q: 3

	Answer	Mark	Partial Marks
(a)(i)	thick / strong, (cell) wall ; withstanding, tension / collapse / hydrostatic pressure / AW ; lignin (in walls) / walls are impermeable ; prevents collapse / waterproofing ; wide / AW ; transport large volumes of water ; no (cell) contents / empty / dead cells / like pipes / like tubes ; no / little resistance to flow of water / allows water to flow easily / lots of water / continuous columns of water / no obstruction ; no, cross walls / end walls ; no / little, resistance to flow of water / allows water to flow easily / lots of water / continuous columns of water / no obstruction ; (bordered) pits ; lateral transport / AW ;	2	
(a)(ii)	evaporation from (cell walls) in mesophyll ; diffusion of water vapour through stomata ; reduction of, pressure / water potential, at top (of plant) resulting in water moving upwards ; continuous column of water (in the xylem) ; cohesion of water (molecules) ; **A** if described incorrectly cohesion described as, forces / attraction, between water molecules ; transpiration pull ; water enters *or* leaves xylem, by osmosis / down water potential gradient ; AVP ;	4	
(a)(iii)	support / described ;	1	
(b)	increase / decrease (in rate of transpiration) ; more / less, evaporation ; increase / decrease, rate of diffusion (of water vapour) ; *ref. to* (kinetic) energy of (molecules of) water ; stomatal pores become, wider / narrower ; guard cells become, turgid / flaccid ;	3	**A** stomata close

02. 0610_w18_MS_41 Q: 3

	Answer	Mark	Partial Marks
(a)	no, cytoplasm / (named organelle) / hollow ; *ref.* to lignin (in walls) (cell walls) are waterproof / water impermeable / AW (secondary) thickening of cell wall ; long / elongated (cells / vessels / tubes) ; (bordered) pits (for water movement between vessels) ; no, (perforated) end / cross walls (between cells) / end plates to connect vessels (end to end) ;	3	
(b)	(water enters) root hair (cells) / **M** ; by osmosis ; the soil has a higher water potential than the root (cells) ; ora water moves from an area of high(er) water potential to low(er) water potential ; active transport of ions to create a water potential gradient ; (across / through partially permeable), membrane(s) ; *ref to* root cortex / **L** – cortex / **M** to **L** to **(K)** to **J** ; AVP ;	5	
(c)(i)	87 ;;	2	
(c)(ii)	the nearer the tip / zone 1, the lower flow rate ; ora flow rate increases (from tip to bulb) in both treated and healthy roots ; flow rate is greater in zone 1 in the treated roots ; flow rate is lower in zones 2 and 3 in the treated roots ; ora comparative data quote with units ;	3	
(c)(iii)	xylem vessels are dead, so toxins / treatment have no effect ; osmosis / water flow into root, does not rely on living cells / energy / is passive / AW ; AVP ;	2	

03. 0610_s18_MS_41 Q: 3

	Answer	Mark	Partial Marks
(a)(i)	label line and **X** pointing to any part of the 'star' in the centre of the root section ;	1	
(a)(ii)	composed of (group of) cells with similar structures ; working together to perform shared functions ;	2	
(b)	xylem supplies water ; air spaces ; large (internal) surface area ; water evaporates from surface of mesophyll cells ; guard cells, open / close, stomata ; water vapour, diffuses / moves, out through stomata ;	3	

04. 0610_s18_MS_43 Q: 3

	Answer	Mark	Partial Marks
(a)(i)	**A** (upper) epidermis ; **B** palisade (mesophyll) ;	2	
(a)(ii)	(cell surfaces are sites of) gas exchange ; movement of gases by diffusion ; *ref. to* efficient / faster / AW, gas exchange / diffusion / photosynthesis ; carbon dioxide is, raw material / needed, for photosynthesis ; absorption of carbon dioxide (when light available) ; loss of oxygen (when light available) / absorption of oxygen ; oxygen is required for (aerobic) respiration ; more evaporation ; *idea of* maximising light absorption ;	3	
(a)(iii)	allows for, movement of (named) gases / diffusion / gas exchange, throughout the whole of the leaf ; *ref. to* faster / efficient / AW, diffusion / gas exchange ; allows / AW, photosynthesis / respiration / transpiration / evaporation ; *ref. to* storage of carbon dioxide ; (air spaces) connect (to outside air) via stomata ;	2	
(b)(i)	no / little, water ; high temperature ; low humidity / dry air ; high wind speed ; long day length / high light intensity ; high salinity / salt ; freezing ; disease ; (soil) waterlogging / low oxygen concentration / pH ; mineral / magnesium, deficiency ;	2	**A** drought / no, rainfall / precipitation / irrigation
(b)(ii)	*ref to* osmosis ; water, lost from / moves out of, cells / vacuoles ; down water potential gradient ; pressure of, water / cell contents, on (inelastic) cell wall decreases ; *correct ref. to* turgor / turgidity / flaccid / plasmolysed ; *ref. to* plants / cells, rely on water, for (structural) support / to prevent wilting ; **ora** water in cells not being replaced as quickly (as it is being lost) ; AVP ;;	4	
(b)(iii)	stomata close ; to prevent more water loss ; water conserved for, other processes / other parts of plant ; decrease surface area, exposed to the Sun / for absorption of heat ;	2	**A** reduces transpiration

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	Answer	Mark	Partial Marks
(a)(i)	cell membrane / cell wall / cytoplasm / vacuole / nucleus ;;	2	
(a)(ii)	epidermis ;	1	
(a)(iii)	allows light through ; (light) reaches chloroplasts / chlorophyll ; in mesophyll / palisade cells ; (palisade / mesophyll / chloroplasts / chlorophyll) need light for photosynthesis / trap energy from light ;	3	
(b)	for gas exchange / diffusion of gases ; for, photosynthesis / respiration / transpiration ;; correct gas with direction for named process ;; controls the rate of, diffusion / transpiration / photosynthesis ; ref. to transpiration pull ;	3	**A** *ref. to* prevent, wilting / water loss
(c)(i)	move against the concentration gradient ; proteins (in membrane) ; using energy ; from respiration ;	2	
(c)(ii)	high(er) ion concentration results in large(r) (guard cell) volume ; ora comparative data quote with units to support any description ; high(er) ion concentration causes low(er) water potential ; ora (high ion concentration causes) water to move into (guard) cells ; across partially / AW, permeable membrane ; by osmosis ; large cell volume correlates with high turgor pressure ; ora because cell water / membrane / cytoplasm / vacuole, pushes more on cell wall ;	5	
(c)(iii)	lack of water ; high temperature ; low humidity / dry air ; wind ; AVP ;;	2	

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06. 0610_w19_MS_42 Q: 2

	Answer	Mark	Partial Marks
(a)	any shape drawn that includes one whole vascular bundle including all of the xylem and phloem with or without sclerenchyma ; label line from **X** to xylem in any of the vascular bundles ;	2	
(b)	cell vacuoles / cells, contain (much) water / have high water potential ; water absorbed, by osmosis / down water potential gradient ; cells, are turgid / have a turgor pressure ; cell contents / vacuole / cell membrane, pushes out (against cell wall) ; cell wall, does not stretch / is inelastic / is rigid ; AVP ; e.g. cells are tightly packed / AW	3	
(c)	**Q** sucrose / ^{13}C, is in shoot and root ; **T** no, sucrose / ^{13}C, in shoot or root ; **R** sucrose / ^{13}C, in root only / (in root but) not in shoot ; **S** sucrose / ^{13}C, in shoot only / (in shoot but) not in root ; *idea that* no transport of, sucrose / ^{13}C, where phloem is removed ; phloem transports (sucrose) in both directions ; leaf is source / carbon (dioxide) is fixed in leaf / sucrose is made in leaf ; roots / shoots, are sink(s) / described ; e.g. of descriptions respired / stored as starch / converted to another (named) compound ; AVP ; e.g. **Q** is a control	5	

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07. 0610_w19_MS_43 Q: 2

	Answer	Mark	Partial Marks
(a)(i)	(glucose is produced by) photosynthesis ; light (energy) is, trapped / AW, by chlorophyll ; light energy is converted to chemical energy ; carbon dioxide and water, are used / react together / AW ; to produce (glucose and) oxygen ;	3	
(a)(ii)	translocation ;	1	
(a)(iii)	(sometimes roots) release / AW, energy / glucose / sucrose / (named) sugar ; for respiration ; example of use of energy in a plant ; e.g. flowering / new, leaves / growth / plant sometimes leaves cannot produce enough, glucose / carbohydrates ;	2	
(b)(i)	**Q** phloem ; **S** xylem ;	2	
(b)(ii)	**1** *ref to* osmosis (of water / across / bag / membrane) ; **2** water moves into, (source) bag / sucrose solution ; **3** from high water potential to low water potential ; **4** sucrose (molecules) cannot cross the (partially permeable) membrane ; **5** sucrose is too large (to fit through partially permeable membrane) ; **6** (water moving in) increases the pressure / volume, of solution in (source) bag ; **7** (increased, volume / pressure / water moving in) forces / pushes, the solution up (tube **Q**) ; **8** volume of bags has not increased / water has moved out of the (sink) bag ; **9** sucrose diffuses (along tube **Q**) ; **10** down a (sucrose) concentration gradient (between source and sink) ;	4	
(c)	the sucrose concentration / water potential (in the two bags) is the same / AW ;	1	
(d)	nitrate (ions) ;	1	