CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

7 TRANSPORT IN PLANTS

SCORE	PERCENTAGE
/	%

STEMUP

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(b) Spruce trees and pine trees are adapted to dry conditions where water can be in limited supply.

Fig. 2.3 shows two stomata in a spruce leaf and Fig. 2.4 shows a vertical section through a stoma from a pine leaf.

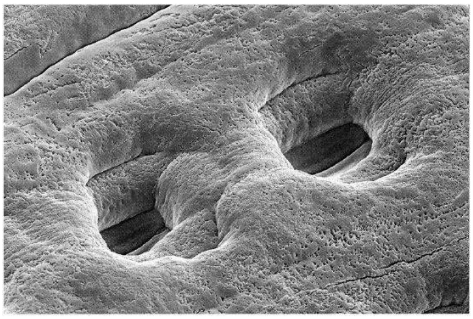


Fig. 2.3

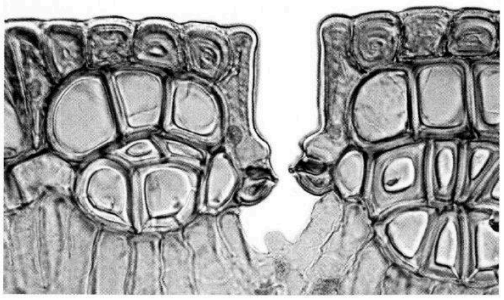


Fig. 2.4

(i) Explain how the stomatal features shown in Fig. 2.3 and Fig. 2.4 give an advantage to plants such as spruce and pine.

.....

.....

.....

.....

..... [2]

(ii) Some plants that live in very dry conditions close their stomata during the day and open them at night.

State **one** disadvantage of this for these plants.

.....

..... [1]

(iii) State **and** explain two adaptations that plant leaves have for survival in dry conditions **other** than those involving number or structure of stomata.

1. .....

.....

2. .....

..... [2]

[Total: 11]

86. 9700_s15_ms_23 Q: 2

(a) (late) interphase / phase / after G1 phase / before G2 phase ;
A after first growth phase / before prophase / before mitosis / after cytokinesis [max 1]

(b) (i) hydrogen / H, (bonds) ; [1]

(ii) Y, single ring structure ; **A** smaller molecule compared to **X** [1]

(c) (i) change in, nucleotide / base, sequence of DNA ;
any one from
new allele fomed ;
deletion / substitution / addition / frame shift , (mutation) ;
change to / altered, mRNA ; **A** altered codon(s)
(causing) change in, primary structure / amino acid sequence, of, polypeptide / protein ;
A different protein / altered function of protein / non-functional protein [max 2]

(ii) cell cycle shorter / interphase shorter / division more frequent ;
(cell cycle) checkpoints not controlled ;
uncontrolled (growth / division) / AW ;
AVP ; e.g. no differentiation (into epithelial cell)
A no cell death / apoptosis [max 2]

[Total: 7]

87. 9700_s20_ms_22 Q: 5

(a)	presence of sucrose (in sieve tube) lowers water potential (of phloem sap) ; **A** makes water potential more negative water enters (sieve tube), by osmosis / down water potential gradient ; increases volume (in sieve tube) ; increases hydrostatic pressure (in sieve tube at source) ; **A** turgor pressure *ref. to* lower hydrostatic pressure (in sieve tube at sink) ; *allow ecf for no ref. to, hydrostatic / turgor* detail ; e.g. sucrose removed at sink water follows sucrose that exits sink movement of, (phloem) sap / sucrose, down pressure gradient / from high to low hydrostatic pressure ; mass flow ;	**4**
(b)(i)	glycosidic ;	**1**
(b)(ii)	nucleotide components are base, pentose sugar, phosphate ; UDP has, uracil and ribose and two phosphates / one extra phosphate ;	**2**
(b)(iii)	*max three if describing breakdown of sucrose* *allow points from diagrams* *any four from* *induced fit* shape of, substrates / UDP and glucose, not (fully) complementary to shape of active site (of sucrose synthase) ; *lock and key* shape of, substrates / UDP and glucose, complementary to shape of active site (of sucrose synthase) ; *allow ecf if no ref. to shape* *induced fit* active site flexible / moulds around, substrates / UDP and glucose ; AW *lock and key* active site does not change shape / is not flexible / AW ; *induced fit* (active site moulds around so) *idea of* provides better fit / fully complementary ; *lock and key* substrate fits into active site ;	**4**
(c)	α-glucose ; **A** glucose **R** β-glucose α, 1-4 ; α, 1-6 ; *bond types either way round* glycogen ;	**4**

88. 9700_s18_ms_21 Q: 2

(a)(i)	**A** – (α-) glucose ; **R** any qualification of glucose other than α, e.g. β-glucose **B** – fructose ; **I** hexose sugar **I** any qualification of fructose, e.g. α	**2**
(a)(ii)	glycosidic ; **R** glucosidic **I** any qualification of glycosidic, e.g. 1–2, 1–6	**1**
(a)(iii)	hydrolysis ; **A** acid hydrolysis	**1**
(b)	*two from:* sucrose is, a non-reducing sugar / non-reducing / not a reducing sugar ; **A** no reducing sugars present no (hydrochloric) acid used (to break down sucrose to reducing sugars) ; **A** sucrose not hydrolysed (to monomers / monosaccharides / reducing sugars) AVP ; (sucrose will not reduce) (blue) copper II ions to (red) copper I ions cannot donate electrons *idea that* reactive groups are not available (to react with Benedict's solution / copper ions) no (free), aldehyde / ketone, group	**2**
(c)	*hydrostatic required once only in the answers* *four from:* 1 diffusion, into phloem sieve tube (element), from companion cell (through plasmodesmata) ; 2 presence of sucrose (in phloem sieve tube element), lowers water potential / makes water potential more negative ; **R** if in context of xylem vessels or companion cells 3 water enters (sieve tubes), by osmosis / down water potential gradient (into sieve tubes) ; 4 increase in, hydrostatic, pressure (in sieve tube elements) ; **A** turgor pressure 5 low hydrostatic pressure in, storage tissues / root / sink, by removal of sucrose ; 6 movement of, (phloem) sap / sucrose (in solution), down hydrostatic pressure gradient / from high to low hydrostatic pressure ; 7 mass flow ;	**4**

89. 9700_w18_ms_21 Q: 5

(a)	*any two from* cell wall made from, peptidoglycan / murein ; **A** not cellulose DNA free in the cytoplasm ; **or** circular / closed loop, of DNA ; **or** naked DNA / no histones ; 70s ribosomes ; AVP ; e.g. no membrane around flagellum **or** flagellum is not 9+2 (microtubule pattern) ;	**2**
(b)	*any two from* transport of sucrose / assimilates / products of photosynthesis (in phloem), is prevented / AW ; *ref.* starch synthesised in root from transported assimilates / AW ; starch not converted in leaf to sugars / sucrose, (for transport) ; idea that pathogen and phloem present in, all organs / many organs / leaves / roots ; AVP ; e.g. reason(s) why it cannot be xylem	**2**
(c)		**5**

feature	DNA nucleotide with adenine	RNA nucleotide with adenine	ATP
contains nitrogen (yes or no)	yes	yes	yes ;
contains a pyrimidine base (yes or no)	no	no	no ;
number of phosphate groups	1	1	3 ;
name of the sugar component	deoxyribose ;	ribose	ribose ;

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90. 9700_m16_ms_22 Q: 5

(a) phosphate ;
ribose ;
adenine ;
adenosine ;
covalent bond ;
} *labels pointing to correct components*

[max 3]

(b) (i) **D** ; [1]

(ii) **D A C B** ; [1]

(iii) source ; [1]

(c) (i) ref. tRNA role in translation ;
e.g. amino acid carried by tRNA molecule to ribosome
anticodon on tRNA (with specific amino acid) binds to codon on mRNA
tRNAs bring amino acids, adjacent to each other / for peptide bond formation

idea that mRNA (sequence of) codons dictate which amino acids will be added (to polypeptide chain) / AW ;
ref. correct, sequence of amino acids / primary structure (of, polypeptide / protein) ;

[max 2]

(ii) hydrogen / ionic, bonds, break / disrupted ; **A** electrovalent for ionic **R** if other bonds named
charges at the active site may be affected ;
changes, shape / (tertiary) structure, of active site ;
A changes, <u>shape</u> / <u>tertiary structure</u>, of enzyme

[max 2]

iii) substrate enters the active site ;
active site, (partially) flexible / changes shape slightly ;
ref. provides a better fit / moulds around ;
allows interaction of R groups (of active site) with substrate ;

[max 2]

[Total: 12]

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91. 9700_s15_ms_23 Q: 5

(a) (light microscope) observe living cells / cells would be killed (with EM) ;
vacuum used in electron microscope ;
(light microscope) can have water on slide (to allow cells to move) ; ora
AVP ; e.g. more readily available for use
organisms move in response to light [max 2]

(b) **(i)** (part of / used in synthesis, of) chlorophyll (molecule) ;
R gives chlorophyll green colour

in translation / joining of large and small subunits (of ribosomes) ;

enzyme, cofactor / activator / described ; *idea of role in enzyme catalysis*
A correctly named enzymes e.g. DNA polymerase

AVP ; e.g. stabilizing, cell wall / proteins / nucleic acids / membranes
important in energy transfers / ATP synthesis
DNA, synthesis / replication
ref. to role in, light absorption / capture (for photosynthesis) [max 1]

(ii) *any two from*
1 good solvent / polar (for substances needed by the organism) ; AW
2 transparent / allows light through, (for photosynthesis) ;
3 liquid over wide range of temperatures ;
4 high specific heat capacity ; **A** description
5 high latent heat of vaporisation ;
6 ref. to density ; e.g. ice / solid, less dense than, water / liquid
circulation bringing nutrients to surface
7 ref. to low viscosity for locomotion ; [max 2]

(c) *assume multicellular organisms unless stated, then accept ora*
1 small, surface area to volume ratio / SA:V ;
A as organisms increase in size, SA:V decreases
2 ref. to (larger size means) long distances (to reach, cells / tissues) ;
3 diffusion, too slow / insufficient / unable to satisfy needs ;
4 transport system decreases time to supply cells ;
5 require, bulk / mass, flow ;
6 ref. to transport system means efficient supply (to cells) of nutrients / named / assimilates / water ; **A** brings supplies close to cells (for transfer) [max 4]

(d) **1** mass flow ; **A** pressure flow
2 sucrose / solutes / assimilates / sugars, decreases, water potential / Ψ;
A more negative / lowers, water potential
A for water potential **A** solute potential
3 water enters (sieve tubes) by osmosis ;
4 (water enters) down water potential gradient ;
5 (increased volume) increase in / high(er), hydrostatic pressure ;
ref. to hydrostatic required once only in mp 5 or mp 7or mp 8
6 unloading / removal, of sucrose / AW, at the sink / named sink ;
7 lowers hydrostatic pressure / low pressure at sink ;
8 movement is, down pressure gradient / from high to low (hydrostatic) pressure ; [max 5]

[Total: 14]

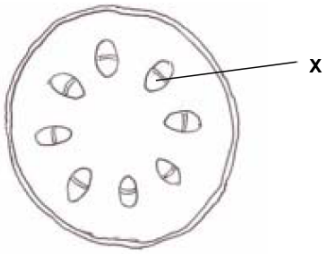
92. 9700_m20_ms_22 Q: 1

(a)	**(F)** **C** **E** **D** **A** **B** ; ; ; ; all five correct = four marks three or four correct = three marks two correct = two marks one correct = one mark	**4**
(b)	1 water, leaves sieve tube (element) / follows sucrose ; *any **two** from:* 2 down the water potential gradient / from higher to lower water potential / by osmosis / sucrose (in companion cell in sink) lowers water potential ; **A** ψ *for water potential* 3 decreases volume in sieve tubes (in sink) ; 4 decreases (hydrostatic) pressure (in sieve tubes in sink) ; 5 pressure higher (in sieve tube) at source than pressure (in sieve tube) at sink / (maintains) pressure gradient from source to sink / sap moves down pressure gradient ;	**3**

93. 9700_m20_ms_22 Q: 6

(a)	*any **two** from:* 1 water moves into, cell / vacuole, by osmosis / down water potential gradient ; 2 (large) vacuole full of, water / sap ; 3 turgid / vacuole exerts outward pressure ; 4 hydrostatic (support) ;	**2**
(b)(i)	number of times an image is larger than, actual / real, size ; **A** image size ÷ actual size **R** increase in size of specimen or object	**1**
(b)(ii)	(×) 2000 ; ; *if incorrect:* one mark for correct working 70 000 / 35 **or** one mark for correct measurement **and** division by 35 e.g. 70 mm / 35 7 cm / 35	**2**
(c)(i)	*transport mechanism:* active, transport / uptake ; *explanation (max 2):* (vacuole) has higher concentration of hydrogen ions (than in cytosol) ; hydrogen ions need to move against the (concentration) gradient ; ATP / energy, needed ; membrane <u>protein</u> needed ;	**3**
(c)(ii)	*any **three** from:* charged particles / ions, cannot cross, hydrophobic core / region of fatty acid tails / AW ; movement through specific membrane <u>protein</u> ; membrane protein only allows one-way movement ; **A** no membrane proteins to allow outward flow AVP ; e.g. suggestion that binding site is on the cytosol side	**3**
(c)(iii)	*any **two** from:* acid hydrolases, break down / digest / hydrolyse ; ref. to leakage from vacuole ; avoids, damage to / breakdown of, cell contents / organelles / molecules (in the cytosol) ;	**2**

94. 9700_s20_ms_23 Q: 1

(a)	any one correct location ; **R** if more than one label line and one is to an incorrect location *allow the mark if more than one label line and all point to xylem locations*  	**1**
(b)	**I** *ref. to* adhesion / H bonding between water molecules and cellulose lining *any three from* (hydrogen bonding causes) cohesion between water molecules ; water molecules attracted to each other /AW ; water leaving xylem (at top), pulls water molecules below ; transpiration pull ; *idea that* contributes to, an unbroken / a continuous, column of water (within xylem vessels) ; AVP ; e.g. allows movement of water against (pull of) gravity	**3**
(c)(i)	*any three from* *description max 2* (movement to adjacent cell) via plasmodesmata ; (movement) through symplasm / cytoplasm / symplastic pathway / cytoplasmic pathway ; (includes) movement through vacuole / vacuolar pathway ; *explanation* cell **B** has a lower water potential than **A** **ora** *or* cell **C** has a lower water potential than **B** ; **ora** *or* water moves down the water potential gradient / from high to low water potential / to lower water potential / from less negative to more negative water potential ; **R** from high to low water potential gradient **R** to lower water potential gradient water moves, into / out of, vacuole by osmosis *or* water crosses tonoplast by osmosis ;	**3**
(c)(ii)	*any three from* cell wall ; large (permanent) vacuole ; tonoplast ; plasmodesmata / cytoplasmic strands between adjacent cells ; nucleus at, edge / periphery, of cell / AW ; AVP ; many small Golgi bodies **A** dictyosomes starch, granules / grains **I** lack of centrioles **I** chloroplasts	**3**

95. 9700_s20_ms_23 Q: 6

(a)	*any three from* *idea that* water moves down a water potential gradient / from a high to low water potential / AW ; sucrose solutions produce differences in water potential inside the cell and externally *or* different concentrations of external sucrose solution produces different gradients of water potential ; high concentration of, sucrose / solutes, is, lower / more negative, water potential ; ora loss of water by osmosis out of potato cells lowers mass of block ; ora for gain of mass no net gain or loss means water potential inside and out are equal ;	**3**
(b)	concentration where the, curve / line, crosses the *x*-axis (and use a reference table) *or* the concentration at which there is zero percentage change in mass (and use a reference table) ;	**1**

96. 9700_w20_ms_21 Q: 4

(a)(i)	plasmodesmata ;	1
(a)(ii)	*any* ***two*** *from:* *ref. to* connecting two cells ; *in context of connecting cytoplasm* (facilitate) movement of substances between cells ; **A** named substances *ref. to* symplast pathway ; cell to cell communication / passage of cell signalling molecules ; AVP ; e.g. removes the need to cross the partially permeable cell surface membrane (when moving between cells) increases the rate of movement of substances between cells	2
(b)(i)	protein coat / capsid ; DNA or RNA / nucleic acid ; **A** genetic material ref. to some viruses have envelope ;	2
(b)(ii)	*allow sucrose for assimilates throughout* *any* ***five*** *from:* viruses / assimilates, enter via plasmodesmata ; movement / diffusion, of assimilates into (phloem) sieve tubes, lowers water potential / AW ; (so) water enters, by osmosis / down water potential gradient / AW ; hydrostatic pressure increases (at source) ; **A** turgor pressure *for hydrostatic pressure* unloading at, sink / named sink, lowers hydrostatic pressure (at sink) ; detail ; e.g. assimilates move out and water follows osmotically pressure gradient created / higher pressure in source (than sink) / lower pressure in sink (than source) ; (so) mass flow; *term to be used in context* from source to sink ; *allow mp if terms source and sink used in correct context within complete response* AVP ; (viruses and assimilates travel) through sieve pores	5

97. 9700_w20_ms_22 Q: 1

(a)(i)	plasmodesmata ; **I** cytoplasmic strands / cytoplasm **R** if other structures also given	**1**
(a)(ii)	(existence of / down, a) water potential gradient ; **I** *ref. to* solute / osmotic, potential **A** lower / more negative, water potential of (cell) **C** (than cell **B**) **A** higher / less negative, water potential of (cell) **B** (than cell **C**) **A** Ψ for water potential	**1**
(a)(iii)	symplastic (pathway) ; **I** vacuolar / vacuole, pathway **A** symplast	**1**
(b)	*max 3 if no ref. to evaporation or water vapour and ref. only to water* *any **four** from:* **1** evaporation of water / water to water vapour ; *must be in context of* **P** **2** **P** described as, surface / cell wall, of (spongy) mesophyll (cell) ; **R** palisade mesophyll cell **A** film / layer, of moisture / water (for surface of cell) **3** water vapour enters (substomatal) air space ; **R** intracellular air space **A** other correct refs. to air space in sequence of events **4** diffusion of water vapour (out) through stoma / stomatal pore (to **Q**) ; **R** through guard cells **R** diffusion by osmosis **5** (towards **Q** because) down water potential gradient / from high to low water potential / to lower water potential ; **I** potential gradient alone **A** down (water) vapour pressure gradient **A** Ψ *for water potential* *context is movement out to atmosphere, not movement from* **P** *to air space* **6** AVP ; e.g. stoma stated as open heat energy required for evaporation / *ref. to* latent heat of vapourisation air space described as, intercellular / saturated / substomatal	**4**
(c)	**1** correct formula ; (magnification) = image length ÷ actual length ; **A** rearranged formula **A** magnification triangle **2** correct working ; **3** correct answer for magnification ; **R** if units given (×) 1440 (36 mm) / 1460 (36.5 mm) /1480 (37 mm) / 1500 (37.5 mm) 1520 (38 mm) / 1540 (38.5 mm) / 1560 (39 mm) ; *if answer given to 2 sig. figs, look for the correct answer at the end of working **or** allow if stated by answer that this is to 2 sig. figs.* *allow ecf for incorrect conversions used in working or incorrect measured value of X–Y*	**3**

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98. 9700_w20_ms_23 Q: 2

(a) *award mp1 and mp8 anywhere in each section of the answer* — **5**

*cell **B** - mesophyll cells*

mp1 photosynthesis / described ;
e.g. conversion of carbon dioxide to sugars using light energy
synthesis of complex organic compounds from inorganic compounds using light energy

adaptation – mp2 and one from mp3 to mp7

mp2 chloroplasts / chlorophyll / chloroplast pigments	to absorb light ;
any **one** from:	
mp3 large vacuole	to keep chloroplasts at the periphery ;
mp4 starch grains	as store of products of photosynthesis ;
mp5 large / moist, surface / cell wall	for evaporation of water for transpiration (stream) ; **A** provides water for photosynthesis in context of water supply transpiration
mp6 thin cell wall	gas exchange / diffusion of gases ;
mp7 isodiametric / (roughly) spherical shape	prevents close packing / gives large air spaces ;

*cell **C** - sieve tube element*

mp8 transport / movement of, (named) sugars / (named) assimilates / photosynthates / organic substances ;
A translocation

(a) *adaptation – any **two** from:*

mp9 peripheral / described, cytoplasm **A** 'at the edge' / 'thin layer'	allowing maximum, volume / space, for transport of, phloem sap / assimilates ; **A** less / little, resistance to flow / AW
mp10 no nucleus / few organelles / little cytoplasm **R** 'no organelles'	allowing maximum, volume / space, for transport of, phloem sap / assimilates ; **A** less / little, resistance to flow / AW
mp11 elongate / elongated (cells, so end to end)	to make (sieve) tubes ;
mp12 plasmodesmata	(un)loading from / AW, companion cells / cell **A** ; **I** 'between cells A and C'
mp13 sieve pores	**A** flow between sieve tube elements ; AW
mp14 sieve plates	prevent, bursting / bulging ; **A** maintaining hydrostatic pressure
mp15 AVP for **C** ; e.g. phloem proteins **and** defence against pathogens / sealing wounds e.g. cell walls with cellulose microfibrils that run around the cells **and** to prevent bursting	

(b) *mp1, 2, 4 and 6 needs idea of increases / more; this is not needed for mp3 and mp5* — **3**

*any **three** from:*

1 increases surface area:volume of cell / increases surface area of (cell surface) membrane ;

2 *idea of* more space for / increased area for / more, proton pumps / carrier proteins in context of moving protons ;

3 pumping protons, from cytoplasm / into cell wall / into apoplast / AW ;
A create / increase, proton / electrochemical / concentration, gradient

4 *idea of* more space for / increased area for / more, cotransporter proteins / carrier proteins in context ;

5 cotransport of sucrose / described, into companion cell / into transfer cell / into cell **A** / from mesophyll cell / from cell **B** ;
A secondary active transport

A *movement of sucrose and protons for cotransport*

6 more space for plasmodesmata (between cell **A** and cell **C**) ;

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99. 9700_m19_ms_22 Q: 1

(a)	**A** = palisade mesophyll ; **B** = epidermis ; **C** = spongy mesophyll ;	**3**
(b)	***accept*** *ora throughout* *any* ***three*** *from:* *Erica v Cedrus:* curled / rolled, leaf (v not, curled / rolled) ; hairs / trichomes (v no trichomes) ; no hypodermis / AW v hypodermis / layer of cells below epidermis / layer of cells between epidermis and palisade mesophyll ; **A** ref. to two layers of outer cells in *Cedrus* AVP ; ; e.g. *Erica* has thicker cuticle *Erica* has larger epidermal cells sunken stoma visible in Cedrus *Cedrus* has cylindrical / needle-shaped, leaf**A** circular <u>in (cross-) section</u> *Cedrus* has lower surface area to volume ratio ;	**3**
(c)	*any* ***three*** *from:* *idea that* stomata, only open during the day / open during the day and close at night ; *statements about gas exchange:* stomata open to obtain (enough) carbon dioxide for photosynthesis ; **A** carbon dioxide not required at night *statement about transpiration*: (most) water vapour lost via open stomata ; very little water (vapour) lost via cuticle ; **I** ref. to temperature	**3**

100. 9700_s19_ms_21 Q: 4

(a)	*any one from:* *idea that* to provide cells that can, differentiate / divide ; for (continued) growth of the, shoot tip / (named) tissues ; **I** 'to produce more meristematic cells'	**1**
(b)	*one mark per row* **stages** / **description** **F** and **G** / cell, elongates / enlarges / grows **and**, a vacuole forms / makes a tonoplast ; **G** and **H** / cell divides (longitudinally) **and** one of the cells has a vacuole ; **H** and **J** / developing sieve tube cell, elongates / enlarges / grows **and** loses its nucleus **or** one (developing companion) cell divides (transversely) to form (two) companion cells ; **A** companion cell divides	**3**
(c)	*any four from:* **1** elongated cells to form, long tubes / AW ; **2** little, cytoplasm / cell contents / fewer organelles, to reduce resistance to flow ; **A** peripheral cytoplasm / no nucleus, to allow transport of maximum volume of, (named) assimilates / sap / nutrients **A** 'more space for …..' **R** no organelles **R** 'no cell contents' **3** sieve (plates have) pores, so little barrier to flow from cell to cell / easy (for phloem sap) to pass from cell to cell / allows mass flow ; **4** sieve plates, support / stop collapse of / stop bulging of, sieve tube elements ; **A** become plugged with, P-protein / callose, to prevent losses / after damage **A** maintain hydrostatic pressure (in sieve tubes) **5** plasmodesmata between sieve tube and companion cell for ease of, loading / unloading / AW ; **6** AVP ; e.g. membrane around sieve tube for osmosis to occur / prevent loss of (named) assimilates	**4**
(d)	*allow assimilates / AW for sucrose* **1** movement of sucrose from, mesophyll / parenchyma / source, cells ; **A** movement of sucrose to (named) sink cells **2** move sucrose, into / out of, sieve tubes (through plasmodesmata) ; **3** pump, protons / hydrogen ions / H^+, out of cell / into cell wall/into apoplast ; **A** *ref. to* secondary active transport **4** provides, ATP / proteins, for sieve tubes ; **A** maintain metabolism of sieve tubes	**2**

101. 9700_s19_ms_22 Q: 1

(a)	stem / not a root, because, transport tissue / vascular bundles / vascular tissue(s) / xylem and phloem / xylem / phloem, around the edges / not in the centre / AW ; **A** stem because, pith / parenchyma tissue, is in the centre	**1**
(b)	*any two from:* (hydrostatic) support / described ; **R** *if incorrect context e.g. support because of thick cell walls* **A** packing tissue (cells), turgid / store <u>water</u> ; storage ; *in context of substances other than water e.g. sucrose / starch / waste*	**2**
(c)(i)	vascular bundle ;	**1**
(c)(ii)	0.65 (<u>mm</u>) ;	**1**
(d)	*mp1-3 must have statements for both xylem and phloem* *mp4-7 need statements for either xylem or phloem* *three from:* *xylem* — *phloem* **1** no cytoplasm / hollow / no contents — (peripheral / little / some) cytoplasm ; **I** protoplasm **R** full of cytoplasm / AW **2** no organelles / hollow / no contents — (a few) organelles ; **A** examples of organelles mitochondria or ER **I** has SER / RER / ribosomes **R** has nucleus **3** lignified **R** idea of lignin within element — no lignin / (only) cellulose ; **4** no end wall(s) / no sieve plate(s) **A** end walls have broken down **or** sieve plate(s) / perforated end wall(s) ; **A** (end walls) have sieve pores **5** (side walls) contain pits **or** no pits (in side walls) ; **6** no plasmodesmata **or** plasmodesmata (to companion cells) ; **7** thick(er), cell wall / walled **or** thin(ner), cell wall / walled ;	**3**

102. 9700_s19_ms_23 Q: 4

<table>
<tr><td>(a)</td><td>

any two from:

note that some mark points must have both xylem and phloem mentioned ('v') and some mark points only need xylem or phloem ('or' – below the line)

<table>
<tr><th>xylem</th><th></th><th>phloem</th><th></th></tr>
<tr><td>no cytoplasm / hollow / no contents</td><td>v</td><td>(peripheral / little / some) cytoplasm I protoplasm
R full of cytoplasm / AW
or
has (a few) organelles
A examples of organelles
mitochondria or ER
I has SER / RER / ribosomes
R has nucleus</td><td>;</td></tr>
<tr><td>lignified
R idea of lignin within element</td><td>v</td><td>no lignin / (only) cellulose</td><td>;</td></tr>
<tr><td>no end wall(s) / no sieve plate(s)
A end walls have broken down</td><td>or</td><td>sieve plate(s) / perforated end wall (s)
A (end walls) have sieve pores</td><td></td></tr>
<tr><td>(side walls) contain pits
R piths</td><td>or</td><td>no pits ;</td><td>;</td></tr>
<tr><td>no plasmodesmata</td><td>or</td><td>plasmodesmata (to companion cells) ;</td><td>;</td></tr>
<tr><td>thick(er), cell wall / walled</td><td>or</td><td>thin(ner), cell wall / walled</td><td>;</td></tr>
</table>

thicker lignified wall = thicker wall mark only (for lignin mark need to state what phloem has)

</td><td>2</td></tr>

<tr><td>(b)</td><td>

any two from:

to hydrolyse / break, glycosidic bonds ;

to produce, reducing sugars / fructose and glucose ;
A to make reactive groups (to Benedicts) available

to be able to test with Benedict's solution to obtain a positive result ;
A description of positive result

sucrose, is a non-reducing sugar / has no reactive groups when tested with Benedict's solution ;

</td><td>2</td></tr>

<tr><td>(c)(i)</td><td>

(large number of mitochondria) provide ATP, for active transport / for protein synthesis ;

(large number of ribosomes) to synthesise the, proton pumps / carrier proteins / AW ;

</td><td>2</td></tr>

<tr><td>(c)(ii)</td><td>

any three from:

H^+, pumped / actively transported (out of companion cell into cell wall)
or
ref. to higher concentration of H^+ (in cell wall) / H^+ gradient builds up (between cell wall and cytoplasm of companion cell) ;

H^+ move back (into companion cell) by facilitated diffusion ; **I** sucrose

through, co-transporter protein / cotransporter ; **A** symporter

H^+ cotransports sucrose / sucrose moves (into cell) with H^+ ;

sucrose is transported against the concentration gradient ;
A sucrose transported by secondary active transport

</td><td>3</td></tr>
</table>

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103. 9700_w19_ms_21 Q: 1

(a)(i)	**A** amino / amine group ; **B** carboxyl (group) ; **A** carboxylic acid	**2**
(a)(ii)	peptide bond joining nitrogen from amine group to carbon of carboxyl group on adjacent amino acid ; C = O and N – H shown correctly in the dipeptide ; formation of water molecule ;	**3**
(b)(i)	label line to any area of the nucleus ;	**1**
(b)(ii)	correct formula ; e.g. actual diameter = image length / magnification 15 (□m) ;	**2**
(b)(iii)	*any one valid suggestion* ; e.g. *idea of* only very thin section of cell mitochondria found in other sections	**1**
(c)	*two from* *idea that* reduces resistance to flow through sieve tube ; *idea that* less space taken up so increased volume of sap / AW, can pass through (per unit time) ; pressure flow / mass flow, does not need energy from the cell / AW; AVP ; (organelles not needed as) metabolic reactions / AW, carried out by the companion cell ;	**2**

104. 9700_w19_ms_21 Q: 3

(a)	between 0 – 0.2 mol dm^{-3} the mass of the potato increases **or** between 0.2 – 1.0 mol dm^{-3} the mass of the potato decreases ; no change in mass at 0.2 mol dm^{-3} ; from approximately 0.2 mol dm^{-3} increasing concentration gives a greater decrease ; comparative data quote including two concentrations and two percentage changes ; *units for concentration of sucrose and reference to percentage change in mass must appear once to award this point*	**3**
(b)	*three from* *decrease in mass because* water (molecules) leave the cells ; by osmosis ; down a water potential gradient / from higher water potential to lower water potential **or** solution has a more negative water potential than the potato tissue ; *ref. to* plasmolysis / loss of turgidity ;	**3**

105. 9700_w19_ms_22 Q: 1

(a)	label line to phloem in one vascular bundle ;	**1**
(b)	transport / translocation, of, assimilates / photosynthates / sucrose / sugars / amino acids / other named nutrient ; **I** food from, source / areas of synthesis, to, sink / areas of growth / areas of (high) activity / areas of storage ; **A** areas where they are needed *for sink* **I** 'where they used'	**2**
(c)(i)	epidermis / epidermal ; **I** upper / lower	**1**
(c)(ii)	eyepiece graticule ; **I** stage micrometre	**1**
(d)	*drawing max 2:* regular shaped cell and cell wall drawn in ; central vacuole drawn ; *labels:* *max 2 if animal structures also labelled* *max 1 for labels if incorrect non-cellular structure included* *e.g. vascular bundle / stoma* large / permanent, vacuole ; **A** central vacuole **A** vacuole *if clearly drawn as large* tonoplast ; **R** *if drawn as double membrane* (cellulose) cell wall ; **R** chitin / murein plasmodesma(ta) ; chloroplast ; **A** granum / thylakoid *i.e. chloroplast not labelled but internal structures correctly labelled* **A** if drawn with a single or double membrane starch, grain / granule ; **A** amyloplast	**5**

106. 9700_w19_ms_23 Q: 3

(a)	*five from* **1** drought-tolerant plants have smaller stomatal aperture **and** lower, transpiration rate / rate of water uptake ; **A ora** **2** comparative data quote for, mean stomatal aperture / transpiration rate + mmol m^{-2} s^{-1} / mean water uptake + cm^3 per shoot + time + h ; *in drought-tolerant plants* **3** smaller (aperture), stomata so less water (vapour) loss ; **4** water vapour diffuses (out) through stomata ; **5** less evaporation from (cell walls of) mesophyll ; **6** so less transpiration pull ; **7** AVP ; suggestion of other adaptations of leaves to reduce water loss e.g. sunken stomata / thicker cuticle / hairs / trichomes / lower stomatal density **R** closed stomata	**5**
(b)	**I** *any ref. to mutation / inhibition of (RNA) polymerase* **1** microRNA binds to mRNA ; **A** forms hydrogen bonds with (bases on) mRNA **2** bases in microRNA are complementary to bases on mRNA ; **3** microRNA makes mRNA too large to leave nuclear pore / mRNA cannot reach ribosomes ; ***mp4*** *and* ***mp5*** *accept alternatives to bind* **4** mRNA cannot, bind / AW, to (small sub-unit of) ribosome ; **A** prevents ribosome moving along mRNA **5** anticodons of tRNA cannot, bind / AW, to (some) codons on mRNA ; **6** no / not all, amino acids are brought to ribosome / AW ; **7** AVP ; e.g. complex of microRNA and mRNA recognised for degrading	**3**

107. 9700_s18_ms_21 Q: 6

(b)	*five from:* 1 water potential gradient, between leaves and roots ; **A** water potential gradient across the root (root hair to xylem / across cortex) 2 diffusion out (via stomata) of water vapour ; 3 evaporation of water from mesophyll cell, surfaces / walls / membranes ; 4 (transpiration from leaves) creates transpiration pull ; 5 tension is, set up / present, in xylem vessels ; 6 cohesion between water molecules (*in xylem or in roots)* ; 7 hydrogen bonding between water molecules ; 8 adhesion of water molecules to cellulose (in wall of xylem vessels) ; **A** to hydrophilic parts of lignin 9 movement of water from apoplast through endodermis by osmosis ; 10 AVP ; e.g. *idea that* water columns extend from centre of root to root hairs (and to soil water)	**5**
(c)	*two from:* *pathway C is slower* ***accept ora*** *for pathway B is faster* greater resistance ; water passes across membranes ; water flows through, cytoplasm / plasmodesmata ; **A** ora ref. to intercellular spaces **A** protoplast osmosis occurs ; **R** through plasmodesmata ref. to water passes through vacuoles ;	**2**
(d)	*assume answer is about facilitated diffusion unless told otherwise – accept* ***ora*** *for active transport* *two from:* movement is, down a concentration gradient ; passive / ATP not required / (metabolic) energy not required ; carrier and channel proteins are involved ;	**2**

108. 9700_s18_ms_22 Q: 1

(a)	one mark for each label to correct structure on Fig. 1.1 ; ; ; *tonoplast line to anywhere on the vacuolar membrane* **R** if two or more different structures stated for a single label	**3**
(b)	ref. to conversion of measured (**X**-**Y**) line to μm / AW ; e.g. line is measured in, mm and then multiplied by 1000 / cm and then multiplied by 10 000 evidence that, 60 (±1 mm) is multiplied by 1000 / 6 cm is multiplied by 10 000 measured diameter is 60 000 μm (and) divide by, magnification / 2000 ;	**2**
(c)	*two from:* rough endoplasmic reticulum ; **A** rough ER / RER smooth endoplasmic reticulum ; **A** smooth ER / SER endoplasmic reticulum ; *acceptable only if the other structure is <u>not</u> SER / RER* 80S / larger, ribosomes ; **A** 25–30 nm range plasmodesma(ta) ; microtubules ; **A** microfilaments **A** cytoskeleton lysosome(s) ; Golgi (body / apparatus / complex) ; secretory / Golgi, vesicles ; AVP ; ; e.g. chromatin EM detail of chloroplast EM detail of mitochondrion **A** mitochondrion nuclear pore nuclear envelope **R** nuclear membrane	**2**
(d)(i)	*two from:* cell wall, pathway / route / AW ; **A** involves only cell walls **R** if only in roots movement / AW, through intercellular spaces / spaces between cells ; further detail ; e.g. water does not, enter cells / cross membranes / cross cytoplasm / move through plasmodesmata osmosis does not occur membranes not involved **R** osmosis once only	**2**
(d)(ii)	*four from:* hydrogen bonding (between water molecules) ; water molecules are polar ; *movement to spongy mesophyll cells* adhesion / attraction, to, cellulose / cellulose fibres / cell walls ; *this is in context of leaf cells but also allow for xylem* **R** cell walls of lignin **A** hydrophilic parts of lignin cohesion between water molecules / (water molecules are) cohesive ; *idea that* movement of water (molecules) towards, spongy / mesophyll, cells, pulls / AW, other water molecules ; **A** transpiration pull / continuous column / unbroken column **I** continuous stream *movement to intercellular air spaces* water molecules absorb heat (energy) ; bonds break between water molecules ; evaporation / water to water vapour ; **I** latent heat of vapourisation from spongy cell, walls / surfaces ;	**4**

(d)(iii)	*two from:* transpiration occurs ; *in context of via stomata or via cuticle* diffuses / moves / AW, to, (external) environment / atmosphere / outside / out of the leaf / from leaf surface ; **R** evaporation / osmosis **R** from cell surface via (open) stomata (for, gas exchange / carbon dioxide entry / photosynthesis) ; *accept* Ψ *for water potential* **I** solute potential / ref. to concentration (movement of water vapour) down water potential gradient ; **A** down water vapour potential gradient **A** high to low water potential / to lower water potential / from higher water potential **R** from high to low water potential gradient	**2**

109. 9700_s17_ms_21 Q: 5

(a)	sugar (molecules) / glucose / fructose, is polar / is water soluble / not lipid soluble / hydrophilic ; cannot pass through, (phospho)lipid bilayer / hydrophobic core / fatty acid 'tails' / hydrocarbon 'tails' ; **A** non-polar regions	**2**
(b)	*accept* H^+ *for proton throughout* **1** (*at* ***Y***) protons, pumped out (of companion cell) / moved out by active transport / move out through proton pump ; **A** protons are moved out against concentration gradient **2** creates a, proton gradient / electrochemical gradient ; **3** protons go into the, cell wall / apoplast ; **R** mesophyll cell **4** (*at* ***X***) protons enter cell by facilitated diffusion ; **5** (**X** is) cotransporter / cotransport protein ; **6** sucrose transported into (companion) cell together with protons ; **7** (sucrose enters) against concentration gradient ; **8** sucrose concentration, increases / maintained, in companion cell ; **9** sucrose diffuses into sieve tube (element) ; **10** through plasmodesmata ; **11** AVP ; e.g. *ref. to*, secondary / indirect, active transport	**max 5**
(c)	*look for names of plant organs other than leaves, ignore names such as potato, iris, onions* **R** leaves unqualified *any two for max 1* root / root tip stem / stem tip / shoot / shoot tip tubers bulbs corms rhizomes buds flowers fruits seeds young / maturing / developing / infected, leaves AVP	**max 1**

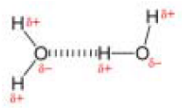
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110. 9700_s17_ms_22 Q: 4

(a)(i)	**1** circle round **5** ; *to max 2 but 4 cells produced = max 1 out of 2* **I** details of telophase leading to cytokinesis **2** { cell plate forms (across equator of cell) **or** cell wall / cellulose, laid down ; **A** cell wall forms (between the two) **3** (so) cytoplasm divided (into two) ; **R** cytoplasm constricts / pinches in / cleavage furrow forms / cleavage forms *(i.e. referring to animal cell)* **4** AVP ; detail of cell plate formation e.g. *ref. to* vesicles transported to equator / involvement of cytoskeletal structures *idea that* organelles shared out	**max 3**
(a)(ii)	circle round **S** ; synthesis of two identical DNA, molecules / double helices (from one) ; each new molecule consists of one, original / parental, strand, and one, new / newly synthesised, strand ; AW **A** daughter *for newly synthesised*	**3**
(b)	*role* **1** form cells that can, differentiate / become specialised ; **A** can develop into other cell types / totipotent **A** named examples **2** for, cell replacement / tissue repair / growth ; **R** for cell growth **I** found in growing region **3** divides to give continuous supply of, meristematic / stem, cells ; **A** divides to forms more, meristematic / stem, cells *feature* **4** (stem cells are) undifferentiated ; **A** not specialised / unspecialised **5** able to divide ; *must be in context of mitosis* **A** able to undergo mitosis **A** can replicate **I** reproduce **R** uncontrolled division **6** *idea that* genes not switched off ; ora	**max 3**
(c)(i)	growing / storage, area / region / correct named part of plant ; *examples of part of plant that stores / growing* root / shoot tip / bud / flower / maturing leaf / tuber / fruit / seed **I** where sucrose, used / used up **I** nutrients unqualified receives, assimilates / sucrose / AW ; **A** area where sucrose unloaded *in context of, via phloem / from source / from leaf*	**max 1**
(c)(ii)	*strong* high requirement for assimilates ; fast growing / highly active ; AW e.g. requires a lot of energy	**max 1**
(d)	*accept H^+ / protons, throughout for hydrogen ions* **1** active process / uses ATP / requires energy ; **2** hydrogen ions, pumped / active transport / move(d), out of companion cells ; *this also gets mp1 if stated as, pumped / active transport / move by proton pump* **3** into cell wall / apoplast ; **A** intercellular space **R** pumped into phloem sieve tube **4** hydrogen ion gradient builds up ; **5** hydrogen ions re-enter companion cell, down gradient / AW ; **A** facilitated diffusion **6** via, cotransport protein(s) / cotransporter(s) ; **A** carrier protein(s) *'hydrogen ions diffuse back into companion cell through cotransport protein' is two marks* **7** cotransport sucrose (molecules) ; **A** secondary active transport **A** idea of bringing sucrose into companion cell if cotransport / er stated for previous mp **R** cotransport if into phloem sieve tube from companion cell **8** transport of sucrose against gradient ; **9** diffusion of sucrose into phloem sieve tube (element) ; **R** facilitated diffusion **A** moves from high to low concentration **10** via plasmodesmata ;	**max 4**
	Total:	**15**

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111. 9700_s17_ms_23 Q: 6

(a)	two water molecules drawn with correct bonding ; **I** Fischer projections partial charges shown as σ+ on at least one H and σ– on at least one O ; hydrogen bond shown ; e.g. labelled or as dashed or dotted lines between H of one molecule and O of another ; 	**3**
(b)(i)	cohesion ;	**1**
(b)(ii)	high / large, latent heat of, vapourisation / evaporation ; **A** takes a large amount of, heat / energy, to evaporate / turn liquid to water vapour	**1**
	Total:	**5**

112. 9700_w17_ms_21 Q: 6

(a)	*mark first two statements given* cellulose, cell wall / lining, allows adhesion of water ; thick (cellulose) cell wall prevents collapse / *idea of* providing support (under tension) ; (cell wall impregnated with) lignin, for waterproofing / prevents water loss ; lignin, rings / spirals / thickening / AW (of walls), prevents collapse / *idea of* providing support (under tension) ; **A** lignified walls no cytoplasm / lack of contents / hollow / empty (lumen), gives, less resistance to / unimpeded / uninterrupted / unhindered / ease of, flow ; **A** greater volume per unit time / faster rate **R** continuous, smooth **R** dead ack of end walls / continuous tube, so, less resistance to / unimpeded / uninterrupted / unhindered / ease of, flow ; AW **R** continuous, smooth pits / pores, for lateral movement / for movement around air bubbles / supplies (water) to (surrounding), cells / tissues ; **R** holes wide / large diameter / large lumen, so large volume of water can be transported ; *if max 2 not gained, allow one mark for two correct explanations or descriptions where accompanying descriptions and explanations are in context*	**2**
(b)	*two from* *accept phloem vessels for sieve tubes* only sieve tubes / one type, v, arteries, veins and capillaries (any two) **A** three types; sieve tubes are composed of cells v blood vessels composed of tissues ; **A** ref. to named tissues sieve tubes, have cytoplasm **or** blood vessels are, hollow / AW; sieve tubes have sieve plates ; **ora** sieve tubes have companion cells (to fully function) ; veins have valves ; **ora** *ref. to* blood vessels and vasoconstriction ; **ora** *idea of transport* open (phloem) v closed (blood vessels) ; **A** sieve tubes have plasmodesmata *ref. to* unidirectional flow in blood vessels ; **ora**	**2**
(c)	*three from* mitochondria, synthesise ATP / carry out aerobic respiration ; more ATP needs to be synthesised / increased ATP synthesis ; **A** need to produce large quantities of ATP to provide more (metabolic) energy ; **R** *in context of water uptake* for active transport / active uptake ; *in context of mineral ions* **A** to move mineral ions against the concentration gradient	**3**

113. 9700_w17_ms_22 Q: 5

(a)	**A** = root hair (cell) ; **B** = Casparian (strip) ; **C** = plasmodesmata / plasmodesma ;	**3**
(b)	xylem has no cytoplasm / symplast pathway is cytoplasmic (and vacuolar) ; **A** empty / hollow / no contents **A** cytosol for cytoplasm xylem (vessel elements) are dead cells / symplastic through living cells ;	**2**
(c)	*three from* stomata close ; **I** stomatal pore smaller / stomata partially open only cuticular transpiration ; no photosynthesis / carbon dioxide not needed ; **I** less photosynthesis transpiration (rate) decreases ; **A** less, transpiration / transpiration pull, **A** described in terms of loss of water vapour from leaves evaporation (rate) (from cell walls of spongy mesophyll cells) decreases ; **R** evaporation, from leaf surface / through stomata water potential gradient between, soil / root, and leaf becomes less steep ;	**3**

114. 9700_w17_ms_23 Q: 5

(a)	*in context of / from a plant* loss of <u>water vapour</u> ; **I** evaporation unqualified from, the aerial parts / leaves ;	**2**
(b)	*description of Fig. 5.1B – accept if correct unit is used only once* *four from* 1 decrease then increases ; 2 data with units and minus sign(s) in support ; i.e. decreases to, –1.35 ± 0.01 MPa at 1400 i.e. –0.35 ± 0.01 MPa at 0600 to –0.58 ± 0.01 MPa at 1800 *explanation to max 3* *overall decrease between 0600 and 1400* 3 water is used *or* lost and is not being replaced ; 4 *idea of* synthesis of (named) solutes increases (so decreasing water potential) ; *0600 to 0900 / 0915 accept any specific time within these time frames* 5 *idea that* not enough water supplied from, xylem / transpiration stream ; 6 (because) stomata are closed / only cuticular transpiration occurs ; *0900 / 0915 to 1400* 7 *idea that there is a* high loss of water (from cell surfaces), by evaporation / because of high rate of transpiration ; *0900 to 1400* 8 photosynthesis occurring, stomata open (for CO_2), water vapour diffuses out / rate of transpiration increases ; *1400 to 1800* 9 less photosynthesis as, stomata closing / lower light intensity 10 (named) solutes converted to, starch / sucrose and transported away ; 11 AVP ; e.g. *0900 to 1400* water is used in photosynthesis so water potential decreases	**4**
(c)	sunken stomata ***or*** stomata in, grooves / crypts / pits ; trichomes / hairs ; rolled / curled, leaves ; **A** folded **R** coiled	**3**

115. 9700_s16_ms_21 Q: 4

(a) *transpiration is an inevitable consequence because*

1 stomata open ;

2 for <u>diffusion</u> in of carbon dioxide / carbon dioxide required for photosynthesis ;

3 water <u>vapour</u>, <u>diffuses out</u> / moves out down the water potential gradient ;

A description of water potential gradient / high to low water potential

A vapour pressure gradient / water vapour gradient

allow water vapour if it is clear that evaporation has occurred

A water evaporates and diffuses out

R water evaporates out

I water (vapour) concentration gradient [3]

(b) **1** adhesion of water to, cellulose / lining / walls (of xylem vessels) **;**
A adhesive force
2 ref to, hydrophilic / polar, property of cellulose (fibres) **;**
A hydrophilic / polar, parts of lignin
3 cohesion between water molecules **;** cohesive force
4 maintains column of water / prevents water column breaking / AW **;**
5 *ref. to* transpiration pull / AW **; I** transpiration *unqualified* [max 3]

(c) *mp3 – units for rates of transpiration must appear once correctly in the whole answer to award this point*

1 rate (of transpiration) of all trees is 0 at, 06.00 / start **; A** no transpiration
2 rates (of transpiration) increase and decrease (in all three) **; A** peaks
3 highest rates:
emergent trees at 14.30 at 8.5 kg h^{-1}
canopy trees at 14.30 at 3.5 kg h^{-1}
suppressed trees at 13.00 at 1.6–1.7 kg h^{-1} **;**
must have units at least once
accept kg / h or kg per hour
4 emergent trees (always) have highest rate **or** suppressed trees have lowest rate **;**
A emergent trees have higher rate than, canopy and suppressed, trees
5 rate of emergent trees is, much / AW, higher than rates for canopy and suppressed trees **;**
6 emergent trees have, steeper / steepest, increase in (transpiration) rate **;**
A emergent trees have, steeper / steepest, decrease in (transpiration) rate [max 4]

(d) *following factors may be given in answers, any three of these factors = 1 mark*

light, intensity / wavelength **I** 'more light'
humidity
temperature
wind speed / air movement
size of tree / height / area of leaves
water availability / depth *or* length of roots
transpiration rate for emergent trees is higher because … accept ***ora*** *for suppressed trees*
accept vapour pressure gradient / water vapour pressure gradient / water vapour diffusion gradient for water potential gradient
1 high(er) light intensity for emergent trees increase in stomatal aperture **;** ora
A more sunlight
A stomata open more
I more stomata open
2 lower humidity for emergent trees so steeper water potential gradient **;** ora
A description of water potential gradient
3 higher temperature / AW, for emergent trees so higher rate of, evaporation / diffusion **;** ora
4 higher wind speed for emergent trees so, steeper water potential gradient / lower humidity **;** ora
A *ref. to* diffusion shells / descriptions of water potential gradient
5 emergent trees have longer roots so take up more water **;**
6 emergent trees have more leaves so, greater surface area / more stomata per unit area (of leaf) **;** [max 4]

[Total: 14]

116. 9700_s16_ms_22 Q: 2

(a) (i) curled / rolled, leaf ; **R** curly / curved / folded
or
trichomes / hairs ; **A** hair / hairy,-like structures **R** cilia / spines / needles **[1]**

(ii) *allow explanations for stomata in pits, thick cuticle and no stomata on outer surface as ecf from (i)*

curled leaf / trichomes / stomata in pits
ref. to (creates) still / non-moving, air ;
(in enclosed area) humid / moist ; AW, e.g. traps water vapour / maintains humidity

water potential gradient less steep **or** decreased rate of diffusion of water vapour (out) ;
A (water) vapour pressure gradient for water potential gradient
I decreased concentration gradient of water vapour
assume in context of between substomatal air space and enclosed area unless stated otherwise

thick cuticle
greater layer impermeable wax / AW ; **A** thicker waterproof layer
increases distance for diffusion ;
of water vapour ;

no stomata on outer surface
most water lost via (open) stomata ;
cuticular transpiration only ;
ref. to where most exposure to, light / air currents / wind ; **[max 2]**

(b) xerophytic / xerophyte ; **[1]**

[Total: 4]

117. 9700_s16_ms_23 Q: 4

(a) label line to wall or lumen of any phloem sieve tube ; [1]

(b) transport of assimilates ; **A** named assimilate e.g. sucrose / amino acids / auxins
from source to sink ; **A** from leaves to named sink e.g. roots / fruits
translocation / mass flow ; [max 2]

(c) lignin for, waterproofing ;
lignin, for support / to prevent (inward) collapse / AW (of vessel or plant) ;
R prevent bursting **I** withstand (high) pressure
cellulose for, adhesion of water / formation of hydrogen bonds with water ;
A hydrophilic parts of lignin
pits for lateral movement of water ;
AVP e.g. rings / spirals, for, extension / growth ; [max 3]

(d) **(i)** *surface area* ($0.1 \times 0.1 \times 6$ =) 0.06 (m^2) ;
volume ($0.1 \times 0.1 \times 0.1$ =) 0.001 (m^3) ; **A** 1×10^{-3}
surface area to volume ratio
(0.06 / 0.001 =) 60 ; **A** ecf using values given for surface area or volume [3]

(ii) *idea that*
diffusion (via, body surface / to cells), cannot satisfy needs / too slow ;
or
transport system delivers materials to cells more quickly ;
A efficient supply of, nutrients / oxygen, to all cells

long(er) distances (to reach some, cells / tissues) ;
takes, materials / AW, close to cells ; [max 2]

[Total: 11]

118. 9700_w16_ms_21 Q: 2

(a) (i) loss of water vapour from the, leaves / aerial parts of a plant ;
R water evaporates from the surface of the leaf [1]

(ii) *each factor 1 mark, explanation for each factor 1 mark*
look for ora for explanation

temperature ; **I** high / low or hot / cold

increased temperature, increased rate as higher rate of, evaporation (from spongy cell surfaces) / diffusion (of water vapour out via stomata)
or
at very high temperature stomata close so transpiration, stops / slows ;

humidity ; **I** high / low

one from
increased humidity, decreased rate as, less steep water potential gradient / decreased diffusion rate (of water vapour out via stomata) ;

wind (speed) / air movement ; **I** fast / slow

higher wind speed steeper, water potential gradient / higher diffusion rate (of water vapour out via stomata) / diffusion shells do not build up / wind moves moist air away / AW
or
at high wind speed the stomata close so transpiration slows ;

water availability ; **I** high / low
reduced water availability causes stomata to close (so reduced rate of diffusion)
or
more water available, steeper water potential gradient between roots and leaves ;

light intensity ; **I** high / low

higher light intensity, increased rate as stomata open more widely
A more light (as ecf from stating factor)
or
at very high light intensity the stomata close so transpiration slows ; **A** stops [4]

(b) *three from*
cohesion and adhesion ; *in correct context*
transpiration stream / transpiration pull ; **A** continuous column of water moving up (to leaves)
attraction / cohesion, between water molecules ; **A** water is cohesive
A stickiness between water molecules
adhesion / AW, of water molecules to lining of xylem (vessels) ;
only needs 'molecules' once
adhesion to / AW, cellulose molecules / hydrophilic parts of lignin ; [3]

[Total: 8]

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119. 9700_w16_ms_22 Q: 2

(a) (i) tubing drawn more swollen ; [1]

(ii) *three from*

1 (mass) increased / AW ;

2 water in by osmosis ; **A** diffuse in by osmosis

if direction of water movement is out in mp2, allow ecf for mp 3

3 lower / more negative, water potential / Ψ **(**inside tubing) ; ora

A down the water potential gradient / from high to low water potential / from less negative to more negative water potential
R across
R water moves from a high water potential gradient to a low water potential gradient
I *ref. to*, solute / osmotic, potential
I water moves down the concentration gradient

4 sucrose too large to leave (tubing) / pores too small for sucrose to leave ;

5 (Visking tubing) partially permeable membrane ; **A** selectively-permeable [3]

(b) *'source' and 'sink' not required but statements should be in correct context*

three from (source)

1 *idea that* sucrose presence in, phloem / sieve tubes, causes, low(er) / more negative, water potential / Ψ ; AW
A assimilates / photosynthates / sugars / named, *for sucrose*

2 water, enters / AW (sieve tube by osmosis) ; *can be in context of direct entry or from surrounding cells* **R** from root hairs

3 presence of water increases hydrostatic pressure ; **A** turgor *(for hydrostatic)*
A *idea of: causes high(er) hydrostatic pressure because of entry of water (hence increase in volume)*

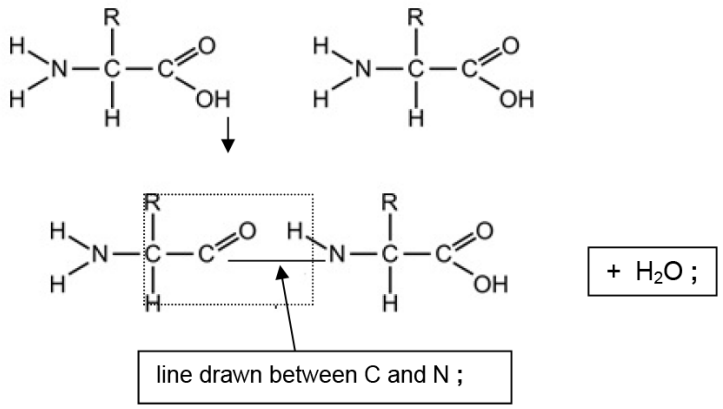
(sink)

4 *idea that* water follows sucrose (via companion cell to sink cells, hence osmosis) ;

5 lower hydrostatic pressure (at sink) ; **A** low *if in context of high at source hydrostatic or turgor needed only once (in mp3 or mp5)*

6 movement / mass flow (of sap), down a pressure gradient / from high to low pressure ; **R** if osmosis implied for mass flow [3]

(c) *can gain 2 marks if printed diagram is clearly modified to show correct bond and formation of water or/and if described as text*



dotted line area is minimum to gain mark
'peptide bond' label not required to gain mark

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bond forms between the C of the carboxyl group and the N of the amino group ;

120. 9700_w16_ms_23 Q: 3

(a) **A** = cortex / parenchyma ; **A** cortical **R** cortical / parenchyma, cells

B = endodermis ; **A** endodermal **R** endodermal cells / pericycle

C = xylem ; **I** vessels / tracheids

D = phloem ; **I** sieve tube (elements) [4]

(b) *allow ecf from incorrect naming of **A** and **B** in (a)*

four from
*from **X** to endodermal cell (**B**) or **X** to **Y** to 3 max*

1 (movement of water) via cell membrane / via tonoplast / by osmosis ;
2 (movement of water) through plasmodesmata ; *do not award **mp1** for 'by osmosis through plasmodesmata'*
3 symplast pathway ; *in correct context only*

*from after **B** to **Y** to 3 max*

4 water moves by apoplast pathway ; *in correct context only*
5 water moves through cell walls ;
6 via pits in cell walls of, xylem (vessel) / **Y** ;
7 down a water potential gradient / described as higher water potential at **X** ; [4]

[Total: 8]

121. 9700_s15_ms_21 Q: 3

(a) increased / faster, movement / diffusion, of, assimilates / amino acids / sucrose / water / solutes / ions / molecules ;
I substances / particles / carbohydrates
I freely / easily / efficiently
I osmosis

(because) more, (symplast) pathways / passages / AW ;
accept in context of blockage of some plasmodesmata

correct ref. to symplast pathway in context of an advantage ;

e.g. of complex plasmodesmata ;
from companion cell into sieve tube (elements) / when loading sucrose into phloem

AVP ; e.g. selectivity / control / regulation, of movement [max 2]

(b) **1** mass flow ; **A** pressure flow

2 sucrose / solutes / assimilates / sugars, decreases, water potential / solute potential ; **A** symbol(s) Ψ

3 water enters (sieve tubes), down water potential gradient / by osmosis ;

4 increase in / high(er), <u>hydrostatic</u> <u>pressure</u> ;

5 unloading / removal, of sucrose at the sink lowers the (hydrostatic) pressure ;

6 movement (from source to sink) is by gradient in (hydrostatic) pressure ; [max 4]

[Total: 6]

122. 9700_s15_ms_21 Q: 5

(a)

structural feature	triglyceride	phospholipid
phosphate (group) / contains phosphorus	×	✓
nitrogen	×	✓
charged / polar	×	✓
(number of) fatty acids	3	2
number of ester bonds	3	2
number of phosphate ester bonds	0	1
award one mark for any of the following comparisons		
number of double bonds (in hydrocarbon chain)	0	1
number of saturated fatty acids / ORA	3	1
presence of double bonds	×	✓
presence of unsaturated fatty acids	×	✓

These are alternatives – award one mark only

[max 2]

(b) *answer may be phrased in the context of amylase / trypsin*
ignore anything before Golgi, e.g. shuttle vesicles from RER

1 vesicles, form from / 'pinch off', Golgi (apparatus / body / complex) ;

2 vesicles moves, through cytoplasm / to cell (surface) *or* plasma membrane ;

3 role of cytoskeleton / microtubules in movement of vesicles ;

4 energy / ATP, is required (movement of vesicles / fusion with membrane) ;

5 vesicle fuses with / AW, cell (surface) / plasma, membrane ;
I bind / attach **A** join / merge / becomes part of

6 exocytosis / vesicle 'opens up' so that enzyme molecules are released ;

7 ref to fluid nature of, membranes / phospholipid bilayer, that makes this possible ; [max 4]

(c)

role of water	property of water
solvent for glucose and ions	dipolar / polar ; **A** description of polarity of water
transport in the xylem	hydrogen bonding ; **I** cohesion / adhesion
helps to decrease body temperature in humans	high latent heat of vapourisation / high specific heat (capacity) / high enthalpy heat of vapourisation / lots of energy required for evaporation ;

[3]

[Total: 9]

123. 9700_w15_ms_21 Q: 4

(a) (i) loss from, leaves / aerial parts of plant ;
of water vapour ; *link to first point*

plus one from:
evaporation of water, from surface of spongy mesophyll cells / into air spaces ;
diffusion of water vapour, out / to atmosphere ; **R** evaporation
movement / diffusion, (out) through (open) stomata ; **R** evaporation
water vapour moves (out) down the water potential gradient ;

[max 3]

(ii) *adaptation for 1 mark, explanation to max 2*

thick (waxy) cuticle ;
explanation
idea that wax is, (mainly) impermeable to water / hydrophobic / barrier to water vapour movement ;
reduces, water loss from parts with no stomata / uncontrolled water loss / cuticular transpiration ;
idea that increased distance decreases rate of diffusion of water vapour
or
reflective cuticle ;
explanation
reduces heat load ;
reduces evaporation (from spongy mesophyll cells surfaces) ;
reduces rate of diffusion of water vapour (through cuticle) ;
or
folded inner surface / AW ; **A** trichomes / hairs ;
explanation
traps water vapour / AW ;
reduces, diffusion / water potential, gradient ;
(water potential gradient) between sub-stomatal air space and outside / AW ;
or
no stomata (visible) on the, outer / exposed, surface ;
explanation
idea that stomata are main route for water loss ;
idea that reduces area where there is a high rate of water loss ;
surface directly exposed to air currents has no stomata ; ora

R curled or rolled *given as adaptation but allow explanation to max 2*
explanation
stomata on inside ;
no / away from, air currents ; **A** increases humidity within enclosed space / AW
reduces, diffusion / water potential, gradient (between sub-stomatal air space and outside); [max 3]

(b) (i) 18 g h^{-1} ;;

one mark if no units given
one mark if incorrect answer but correct values extracted from Fig. 4.2 (60–42 g h^{-1}) [2]

(ii) *describe to max 3*
rate of, transpiration / water absorption, increases and decreases / reaches a peak ;
time delay between high rates of transpiration and water absorption / AW ;
lower values for water absorption until (approx.) 1645 ; **ora** **A** 1630 to 1700
data quote to support ;

explain to max 3
ref. to daylight and night and stomatal, opening / closure / AW ;
higher light intensity / greater stomatal opening, higher rate of transpiration ;
ora
idea that transpiration drives water absorption ;
further detail ; e.g. explanation in terms of water potential gradient
ref. to cohesion-tension from leaf to root [max 4]

(iii) xerophyte ;
example of xeromorphic feature ; **A** *ref. to* adaptation(s) (for dry areas)
high light intensity during middle of day / AW (for species **P**) ;
idea that loss of water during the day needs to be minimised ;
suggestion that (most) stomata, closed during the day / only open at night ; [max 2]

[Total: 14]

124. 9700_w15_ms_23 Q: 2

(a) (i) **A** Ψ *for water potential*
I moisture
A aperture *for stomatal aperture throughout*
both units must be used at least once to award mp3 and mp7

similarities
1 when, stomatal aperture is 0 (μm) / stomata are closed, no, transpiration / water loss **;**
2 as stomatal aperture increases rate of transpiration increases in both groups of plants **;**
3 comparative use of figures with units in support of mp2 for either condition **;**

differences
in moving air
4 stomatal aperture, influences / controls / AW, rate of transpiration at all apertures **;**
in non-moving air
5 at stomatal apertures 15 μm and above rate of transpiration does not increase further / reaches a plateau / remains constant **;**
6 stomatal aperture has most effect on rate of transpiration in non-moving air at low apertures **; ora**

comparing moving and non-moving
7 comparative use of figures with units to show rates of transpiration at the same stomatal aperture **;** [max 3]

(ii) **A** water vapour potential *for water potential*
1 *ref. to* increasing width of stomatal aperture allows more water vapour to diffuse out **; ora**
R osmosis, **R** evaporate out
I evaporation from mesophyll
2 (intercellular) air spaces in leaf, are fully saturated / have high water potential / AW **;**
3 in moving air, water vapour is blown away / does not remain around the leaf **; A** low humidity around the leaf, **A ora** *for non-moving air*
4 in moving air, water potential gradient, is steep / maintained / increases / AW **;** **ora** for non-moving air, **R** concentration gradient
5 so in moving air, high / higher, rate of diffusion of water vapour *in terms of an idea of a* gradient **; A ora** [max 3]

(b) (i) *advantage of having, stomata in pits / AW*
water vapour / moist air, builds up / trapped, in the, pit / groove / crypt **;**
A sunken stoma(ta)
reduces water potential gradient, between air inside the leaf and outside / AW **;**
A diffusion gradient
less transpiration / less diffusion of water vapour out (through stomata) / water is conserved **;**
R prevents water (vapour) loss
less water needs to be absorbed **;** [max 2]

(ii) *treat 'less gas exchange' unqualified as neutral*
cannot absorb carbon dioxide (during the day when photosynthesis occurs) **;**
rate of photosynthesis is reduced / no photosynthesis **;**
AVP **;** e.g. less water / minerals, reaches leaf cells (for other processes)
cooling effect of transpiration does not occur
slow growth [max 1]

(iii) **I** moisture
1 leaves, rolled / curled, so, stomata on inside / humid layer builds up / moist air builds up, (in enclosed area) **;**
A less steep water potential gradient
R coiled / curved
2 trichomes / hairs, create, a layer of non-moving air around the leaf / allow humid area to build up **;**
A less steep water potential gradient
3 (leaves are), thick / succulent, to store water **;**
4 thick(er) (waxy) cuticle reduces, transpiration / water loss **;**
A makes more waterproof, **A** waxy layer for cuticle
5 reflective cuticles, reduce heat load / AW **; A** shiny cuticles reflect heat ;
6 needle-like leaves to reduce surface area (to volume ratio so less, transpiration / water loss) **;**
A small leaves
R spikes / spines, unqualified
7 layers of epidermal cells, to reduce (cuticular) transpiration / water loss **;**
8 thick walled epidermal cells, to reduce (cuticular) transpiration / water loss **;**
9 *ref. to* hinge cells, leaf curling / wilting / AW **;**
A leaves wilt to reduce exposure to the sun **;** [max 2]

[Total: 11]

Q1.

4 Fig. 4.1 shows transverse sections of a root and a stem.

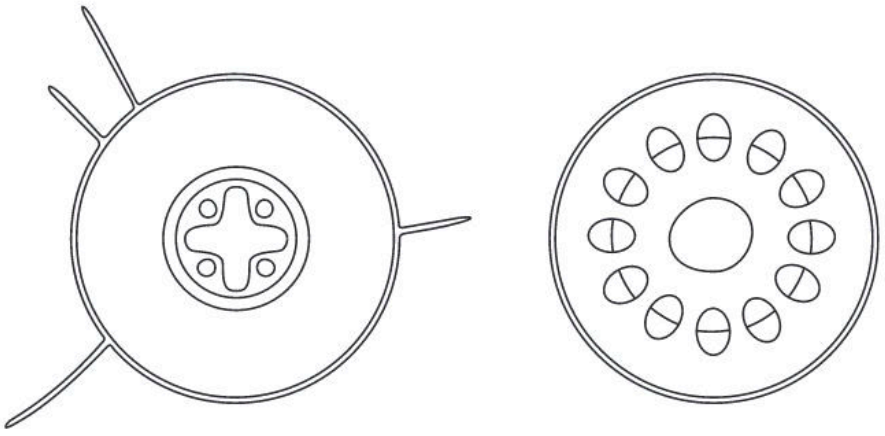


Fig. 4.1

(a) (i) Shade in an area in the transverse section of the root where there are cells specialised for the transport of water. [1]

(ii) Shade in an area in the transverse section of the stem where there are cells specialised for the transport of sucrose. [1]

(b) Suggest why the vascular bundles in the stem are situated towards the outside.

.....

.....[1]

(c) Describe the process by which water passes from the soil into the root hairs.

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.....[2]

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(d) Explain how water passes from the stem to the air surrounding a leaf.

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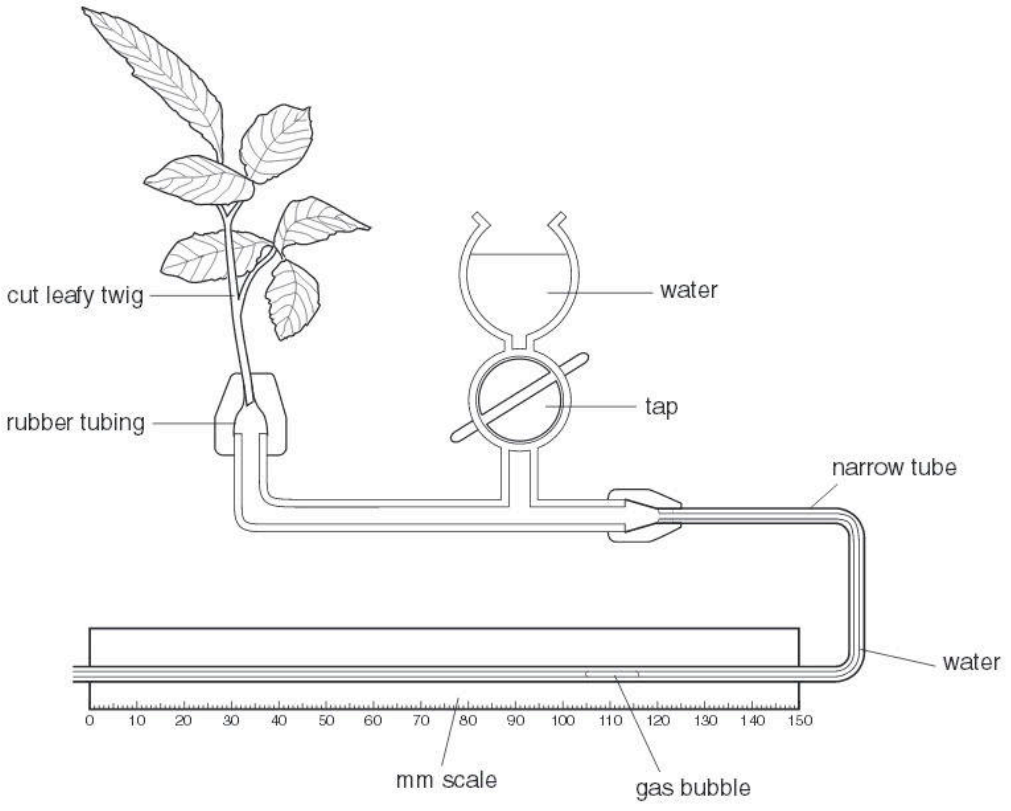
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.....[4]

[Total : 9]

Q2.

Fig. 3.1 shows a potometer that is used for measuring rates of water uptake by leafy shoots.



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A student used the potometer shown in Fig. 3.1 to investigate the rate of water uptake of a leafy shoot under six different sets of conditions. The student changed two environmental conditions around the plant:

- temperature
- wind speed.

For each experiment, the apparatus was left in the conditions until the rate of water uptake by the leafy shoot became constant. The student took several measurements during each experiment and calculated the mean rate of movement of the gas bubble. The results are recorded in Table 3.1.

Table 3.1

experiment	temperature / °C	wind speed	mean rate of movement of gas bubble / mm h^{-1}
1	15	low	12
2	15	high	22
3	25	low	24
4	25	high	45
5	35	low	64
6	35	high	120

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(b) Using the data in Table 3.1, describe and explain the effect of the two conditions that the student changed during the investigation on the rate of water uptake.

temperature .....

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wind speed .....

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.....[4]

The rate of water movement up the leafy shoot was measured before it was cut from the plant. The rate was found to be less than the rate of water uptake from the potometer when kept in the same temperature and windspeed conditions.

(c) Suggest why the rate of water movement in an intact shoot is less than that measured in the potometer.

.....

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.....[2]

[Total: 11]

Q3.

2 Fig. 2.1 is a drawing of a transverse section of a leaf.

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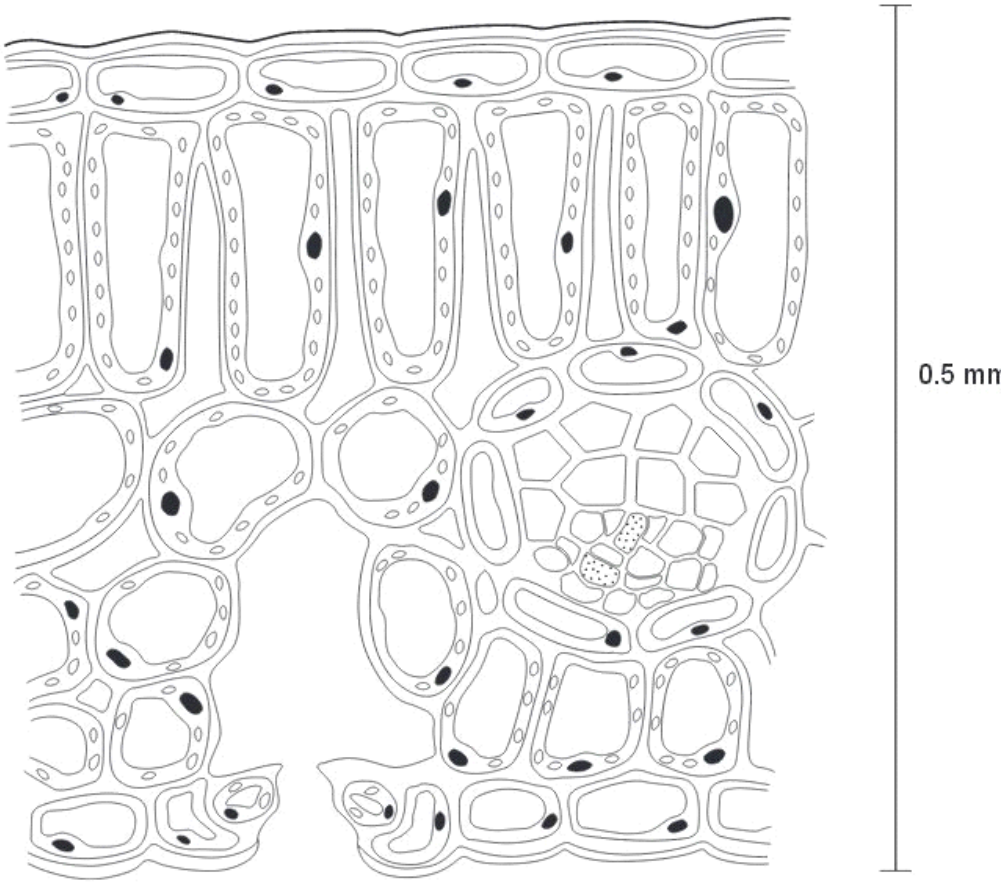


Fig. 2.1

(a) (i) Use label lines and the letters **X**, **S**, **E** and **D** to indicate the following on Fig. 2.1:

X – a xylem vessel
S – a phloem sieve tube
E – a lower epidermal cell
D – a palisade mesophyll cell [4]

(ii) Calculate the magnification of Fig. 2.1. Show your working and express your answer to the nearest whole number.

Answer ..... [2]

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(b) Name **two** assimilates that move from the palisade mesophyll cells to the vascular tissue to be exported from the leaf.

1 .....

2 ..... [2]

(c) Explain, using the term **water potential**, how water moves from the vascular tissue to the atmosphere.

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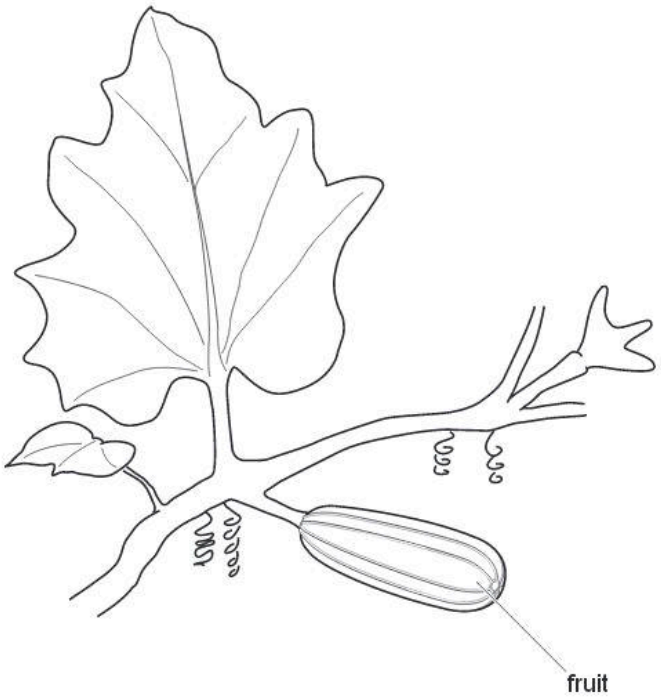
..... [4]

[Total: 12]

Q4.

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2 Fig. 2.1 shows part of a summer squash, *Cucurbita pepo*. Fig. 2.2 is a high power drawing of an area of phloem from a transverse section of the stem of *C. pepo*.



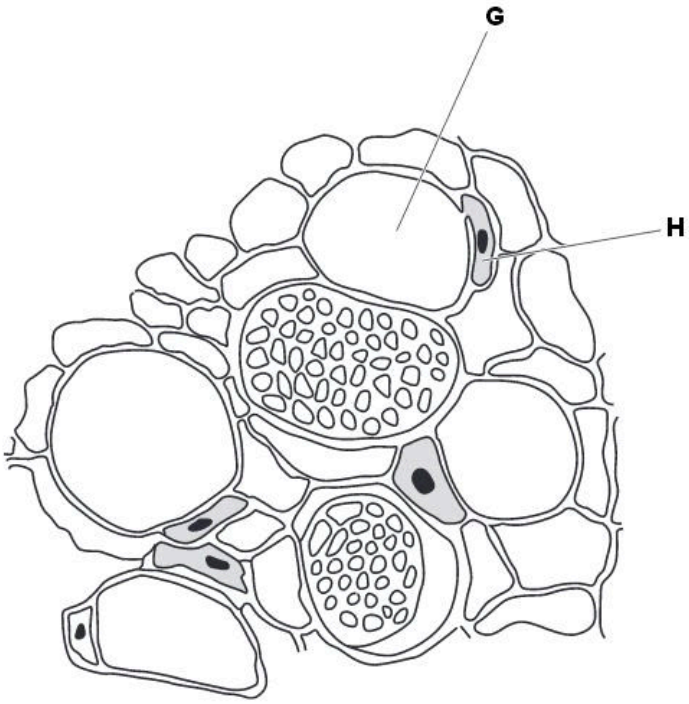


Fig. 2.2

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(a) (i) Name **G** and **H**.

G .....

H .....[1]

(ii) Describe three ways in which the **structure** of a xylem vessel differs from the structure of cell **G**.

1. .....

2. .....

3. .....[3]

(b) The liquid extracted from the phloem of *C. pepo* contains sucrose.

Explain how sucrose is transported in the phloem along the stem from the leaf to the fruit.

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.....[4]

(c) Most of the sucrose transported in the phloem enters the fruit.

Suggest why summer squash fruits are not sweet.

.....

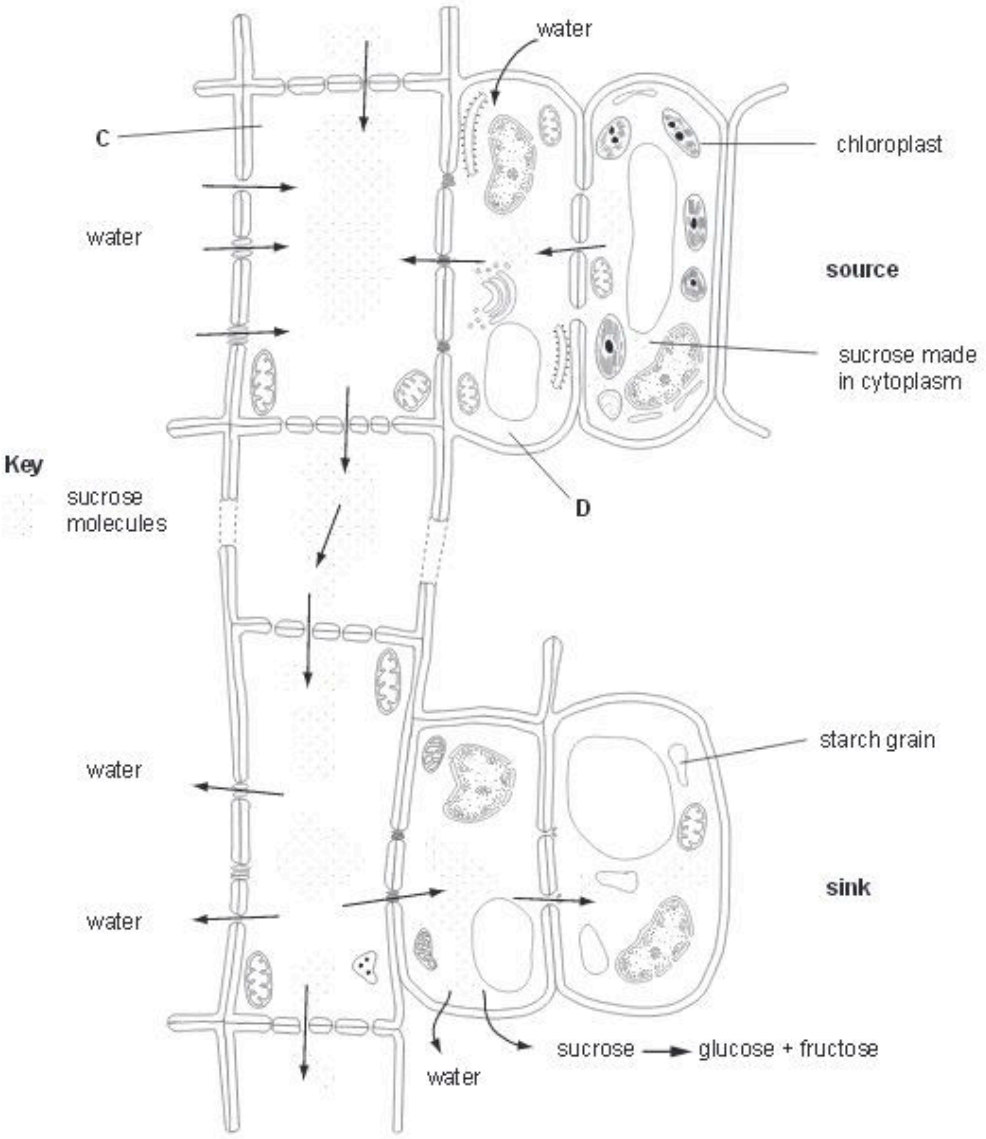
.....[1]

[Total: 9]

Q5.

4 Fig. 4.1 shows the movement of sucrose from source to sink through the phloem in a plant.

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(a) With reference to Fig. 4.1,

(i) name an example of a source and a sink

source .....

sink .....[1]

(ii) name cells **C** and **D**.

C .....

D .....[1]

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(b) With reference to Fig. 4.1, explain how sucrose travels from,

the source to cell **C** .....

.....

.....

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.....

.....

cell **C** to the sink. .....

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.....[4]

(c) Explain why multicellular plants require transport systems for substances, such as water and sucrose.

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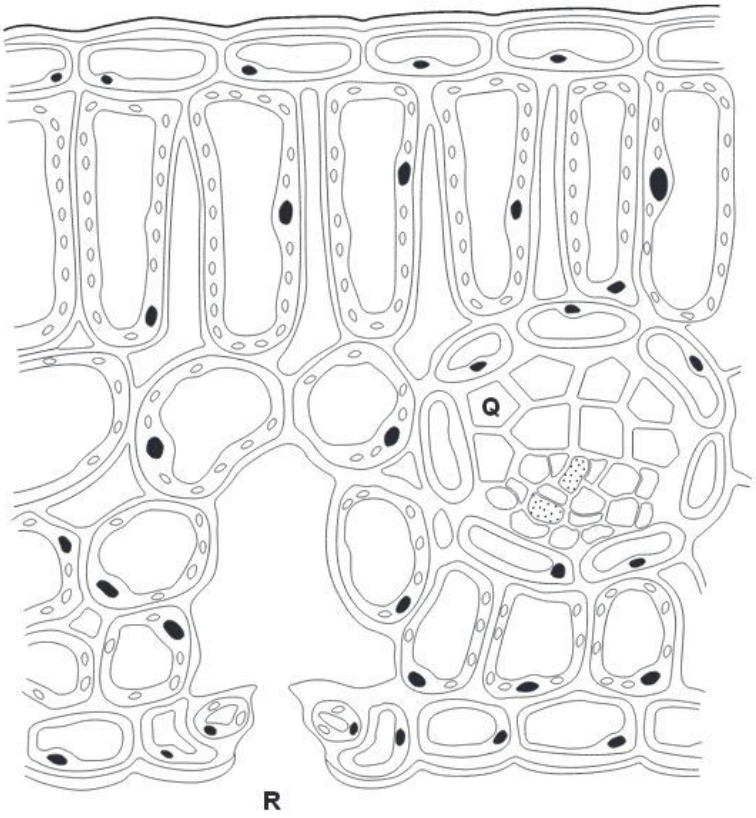
.....[2]

[Total: 8]

Q6.

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5 Fig. 5.1 shows part of a transverse section of a leaf.



(a) Explain, in terms of **water potential**, how water moves from **Q** to **R**.

.....

.....

.....

.....

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.....

.....[4]

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(b) State and explain three ways in which the **structure** of xylem vessels is adapted to transport water.

1. .....

explanation .....

.....

2. .....

explanation .....

.....

3. .....

explanation .....

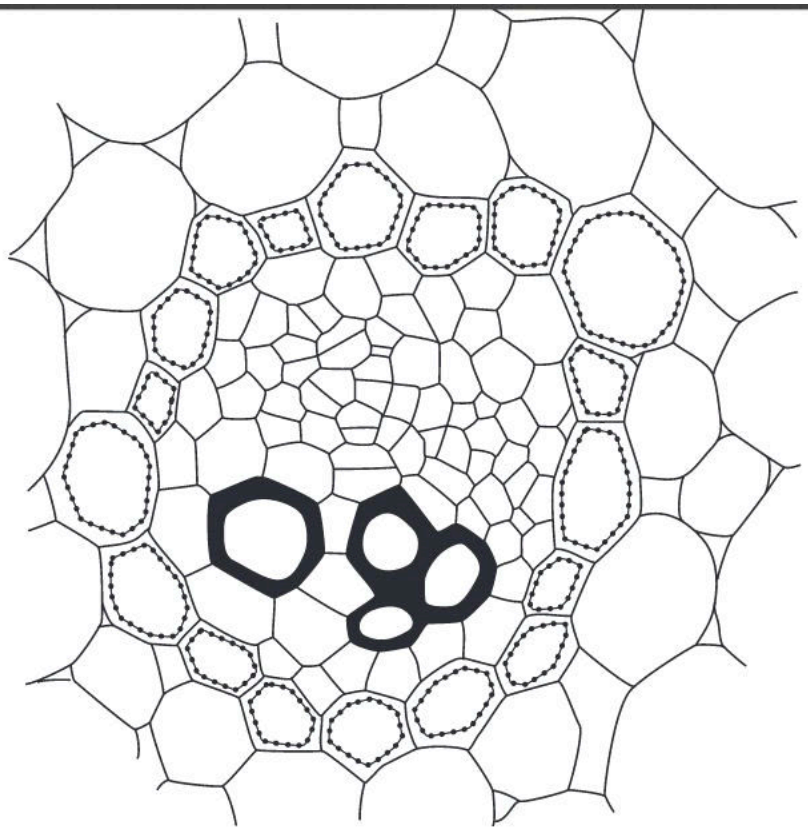
.....[6]

[Total: 10]

Q7.

5 Fig. 5.1 shows a vascular bundle from the stem of *Peperomia dahlstedtii*, a plant from Brazil. The vascular bundles in the stems of *P. dahlstedtii* are unusual because they are surrounded by an endodermis with a Casparian strip.

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(a) Use label lines and the letters **P**, **Q** and **R** to identify the following in the vascular bundle.

P an endodermal cell with a Casparian strip

Q a cell wall strengthened with lignin

R a tissue that transports assimilates [3]

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(b) Vascular tissue in roots is surrounded by an endodermis.

Describe the function of the endodermis in roots.

.....

.....

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.....

.....[3]

(c) State and explain two ways in which the **structure** of a phloem sieve tube is adapted for the transport of assimilates.

1. .....

explanation .....

.....

2. .....

explanation .....

.....[4]

[Total: 10]

Q8.

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3 **(a)** Plants take in mineral ions through their root hair cells. This may happen by a process which moves the ions from a low concentration in the soil to a higher concentration in the root hair cell.

(i) Name and describe this process by which mineral ions are taken in.

name .....

description .....

.....

.....

..... [3]

(ii) Phosphate is an example of an ion transported in this way. State **one** use for this ion in plant cells.

.....

..... [1]

Fig. 3.1 is a plan diagram of a transverse section of a plant root.

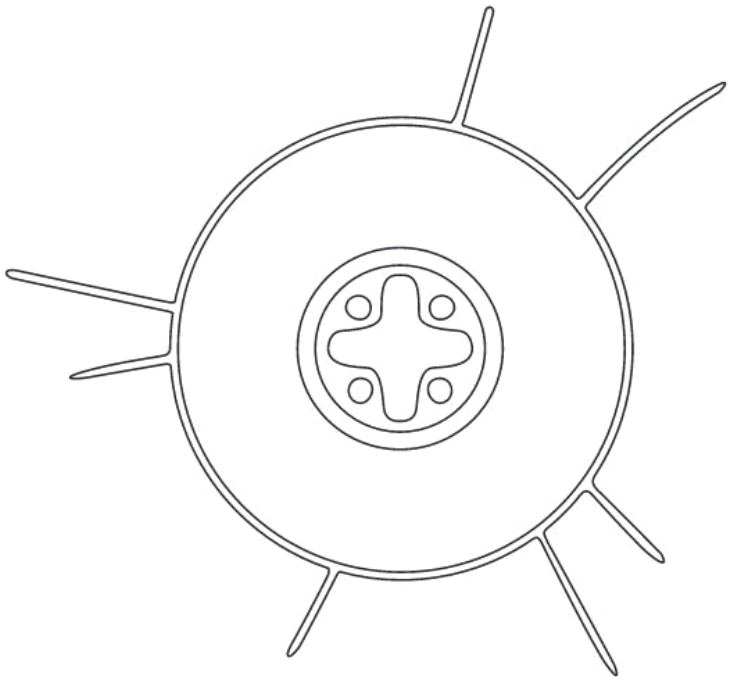


Fig. 3.1

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(b) **(i)** Write the letter **W** on Fig. 3.1 in the area where cells are specialised for the transport of water and mineral ions. [1]

F Exam U

(ii) Water is also absorbed from the soil by the root hair cells.

Outline the mechanism by which this occurs.

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..... [2]

(iii) Describe the pathway taken by water as it passes from the root hair cells into the cells which are specialised for transport of water and mineral ions.

.....

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..... [4]

[Total: 11]

Q9.

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3 **(a)** With reference to the structure of a leaf, explain the difference between evaporation and transpiration.

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.....

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.....

.....

.....[4]

(b) Apple, *Pyrus malus*, sour cherry, *Prunus cerasus*, and peach, *Prunus persica*, are dicotyledonous trees that are of importance to commercial growers for the fruit that they produce.

A student chose a small area of land where all three species of fruit tree were growing. Leaf samples were removed and, using a microscope, the mean number of stomata per square millimetre was estimated for each species.

The rate of transpiration of each species was then measured on each of three separate occasions. The student performed the investigation outside where the trees were located and recorded the weather conditions on each day.

The mean transpiration rate was calculated per unit area of leaf.

The results are shown in Table 3.1.

Table 3.1

fruit tree	mean number of stomata / mm^{-2}	mean transpiration rate / $cm^3\ h^{-1}$		
		hot dry day	warm dry day	warm rainy day
apple	266	0.19	0.35	0.21
sour cherry	284	0.09	0.28	0.25
peach	190	0.03	0.08	0.07

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(i) With reference to Table 3.1, describe **and** explain the results of the investigation.

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U

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.....[4]

(ii) The mean transpiration rate of each species was calculated over a 24 hour period.

Describe how the transpiration rate during the night would differ from the transpiration rate during the day.

Explain your answer.

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.....

.....

.....[3]

(iii) Suggest which of the three species of fruit tree has been described as 'drought-resistant' and would be economical to grow in areas where water is scarce.

..... [1]

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(ii) A diet rich in peaches can help reduce inflammation of the bronchi and bronchioles.

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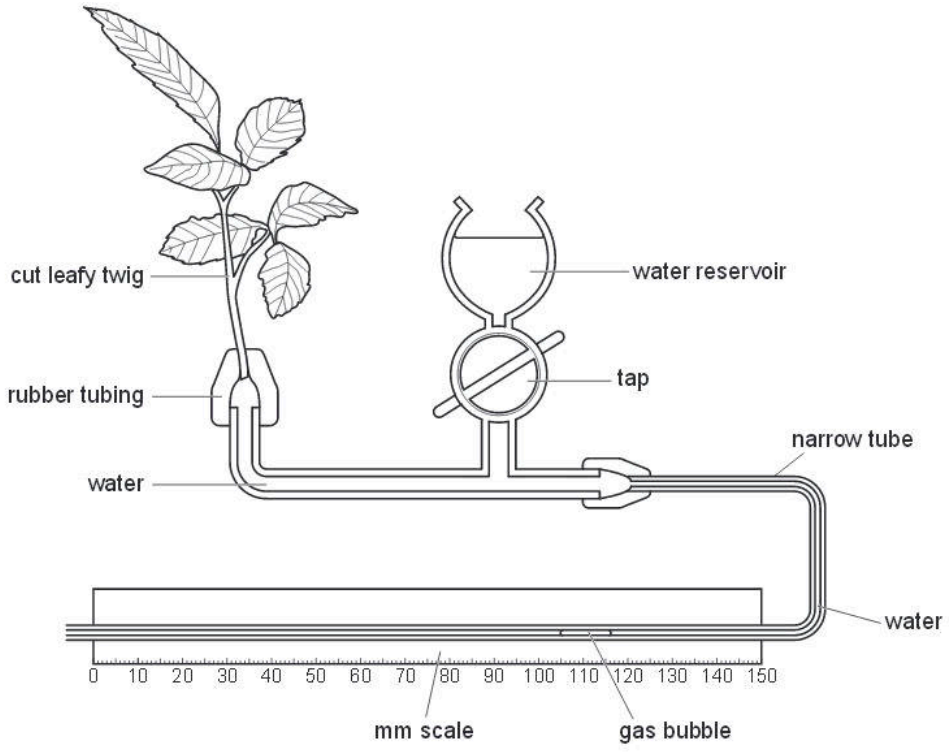
.....

..... [2]

[Total: 16]

Q10.

2 Fig. 2.1 shows an apparatus used to measure the rate of water uptake by leafy parts of plants.



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(a) State the name of this apparatus.

.....[1]

(b) Explain why the rate of water uptake by the leafy part of the plant shown in Fig. 2.1 will **not** be the same as the rate of transpiration.

.....

.....

.....

.....[2]

(c) Using the apparatus as shown in Fig. 2.1, the rate of water uptake at 25 °C was found to be greater than at 20 °C.

For Examiner's Use

(i) Explain the effect of increasing the temperature on the rate of water uptake.

.....

.....

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.....

.....[3]

(ii) State two environmental conditions, **other than temperature**, which will affect the rate of water uptake of a leafy twig as shown in Fig. 2.1.

1. .....

2. .....[2]

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(d) Transpiration is sometimes described as an 'inevitable consequence of gas exchange' in plants.

Explain this statement.

.....

.....

.....

.....

.....

.....[3]

[Total: 11]

Q11.

3 **(a)** Transpiration is often described as an 'inevitable consequence of gas exchange in plants'.

For Examiner Use

Explain what is meant by this statement.

.....

.....

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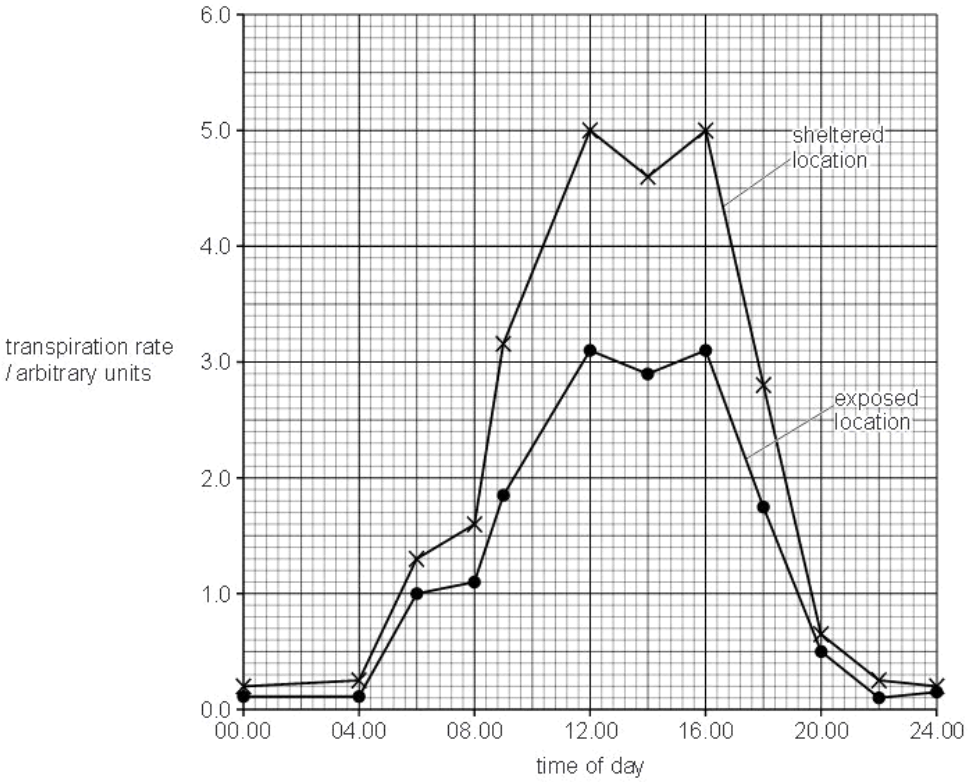
.....

.....[3]

The buttonwood tree, *Conocarpus erectus*, grows in coastal areas of the Americas. A study was carried out on its ability to survive on Socorro Island off the Pacific coast of Mexico. The island is exposed to high winds, which can lead to high rates of transpiration.

The transpiration rates of trees at sheltered and exposed locations at the same altitude on Socorro Island were compared. The results are shown in Fig. 3.1.

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(b) Describe the results shown in Fig. 3.1.

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..... [5]

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(c) The leaves of the buttonwood trees at the exposed site were significantly smaller than those at the sheltered site.

Describe three ways, **other than small size**, in which leaves are adapted to reduce the rate of transpiration.

1. .....

.....

.....

2. .....

.....

.....

3. .....

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..... [3]

[Total: 11]

Q12.

2 **Fig. 2.1 shows xylem tissue in a longitudinal section through the stem of a dicotyledonous plant.**

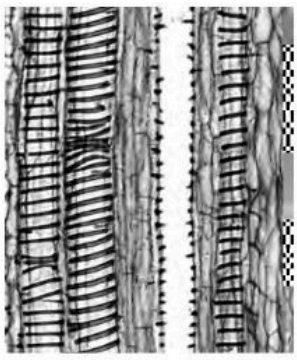


Fig. 2.1

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(a) Describe and explain how the structure of xylem vessels is suited to their function.

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..... [5]

(b) It is possible to obtain images, such as Fig. 2.1, at the same magnification with both the light microscope and the electron microscope.

State the advantages of using the light microscope, rather than using the electron microscope, in studies of tissues.

.....

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.....

..... [2]

[Total: 7]

Q13.

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(d) Palisade mesophyll cells have very large vacuoles.

Explain how water moves from the xylem in the leaf into these vacuoles.

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..... **[3]**

Q14.

3 **(a)** Explain why transpiration is the inevitable consequence of gaseous exchange in land plants.

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.....[3]

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Fig. 3.1 shows some of the cells from the lower part and under surface of a leaf. The water potentials of three cells, **A**, **B** and **C**, are shown.

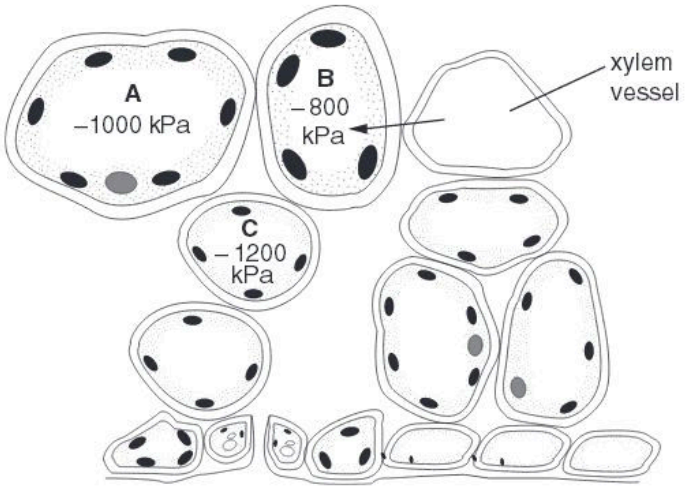


Fig. 3.1

(b) Explain how water moves from the xylem vessel to cell **B**.

.....

.....

.....

.....[3]

(c) Draw labelled arrows on Fig. 3.1 to show the direction in which

(i) water flows between the cells **A**, **B** and **C**; [2]

(ii) water vapour diffuses. [1]

(d) State two features of xerophytic plants that help to reduce the loss of water by transpiration from their leaves.

1. .....

.....

2. .....

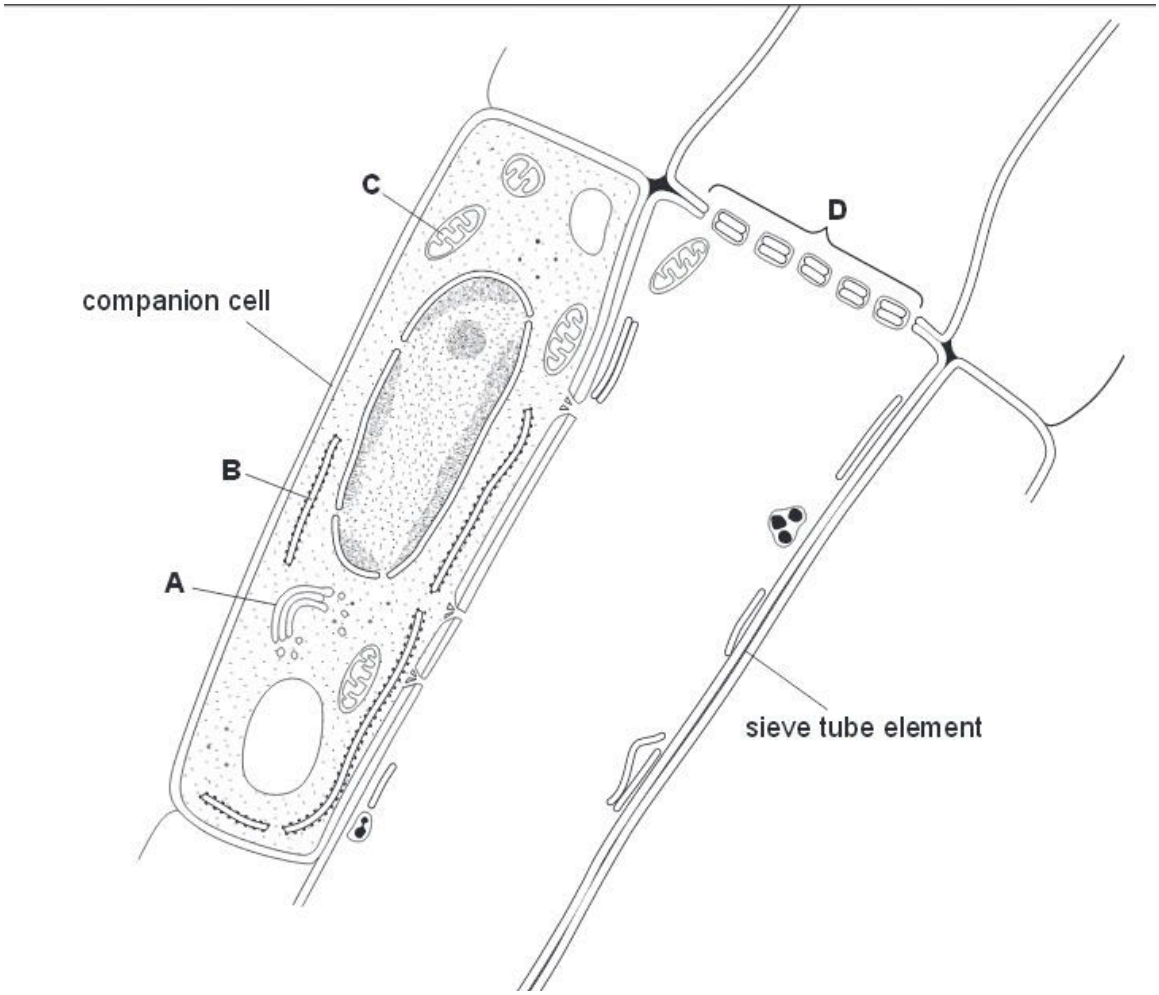
.....[2]

[Total : 11]

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Q15.

1 Fig. 1.1 is a drawing made from an electron micrograph. It shows a longitudinal section through a sieve tube element and a companion cell in the phloem of a flowering plant.



(a) Refer to Fig. 1.1.

(i) Name structures **A** to **C**.

A .....

B .....

C .....[3]

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(ii) State the name given to the region labelled **D** that separates the two sieve tube elements.

.....[1]

(iii) Name **one assimilate** that is transported in the phloem.

.....[1]

(b) Explain how the structure of sieve tube elements helps the translocation of substances in the phloem.

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.....[3]

(c) Describe the role of companion cells in translocation in the phloem.

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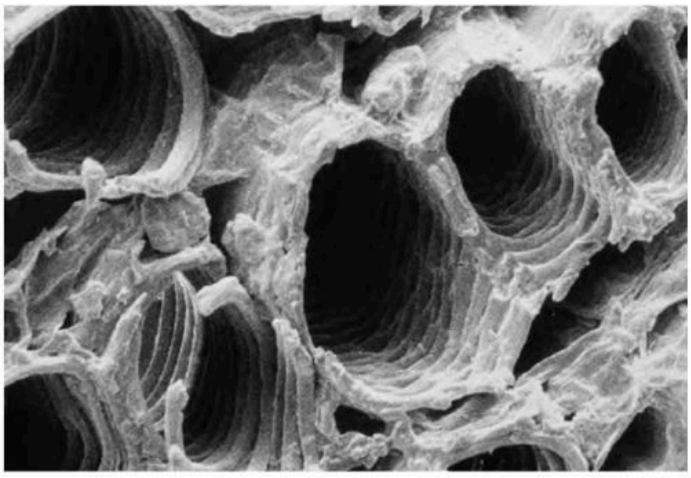
.....[2]

[Total : 10]

Q16.

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3 Fig. 3.1 shows an electron micrograph of some xylem vessels in tobacco leaf fragments in a cigarette.



magnification = ×395

Fig. 3.1

(a) (i) Describe **and** explain two features of the xylem vessels, **visible** in Fig. 3.1, that are adaptations for the transport of water in a plant.

feature .....

explanation .....

.....

feature .....

explanation .....

.....[2]

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(ii) Explain the mechanisms that cause movement of water in xylem vessels.

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.....[4]

(b) When tobacco leaf fragments in cigarettes are burnt, substances that are hazardous to health are released.

Name three of these hazardous substances and for each describe **one** effect on the body.

substance .....

effect .....

.....

substance .....

effect .....

.....

substance .....

effect .....

.....[3]

[Total: 9]

Q17.

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2 **(a)** Plants absorb water from the soil.

Describe the pathways taken by water as it moves from the soil into the xylem of the root.

.....

.....

.....

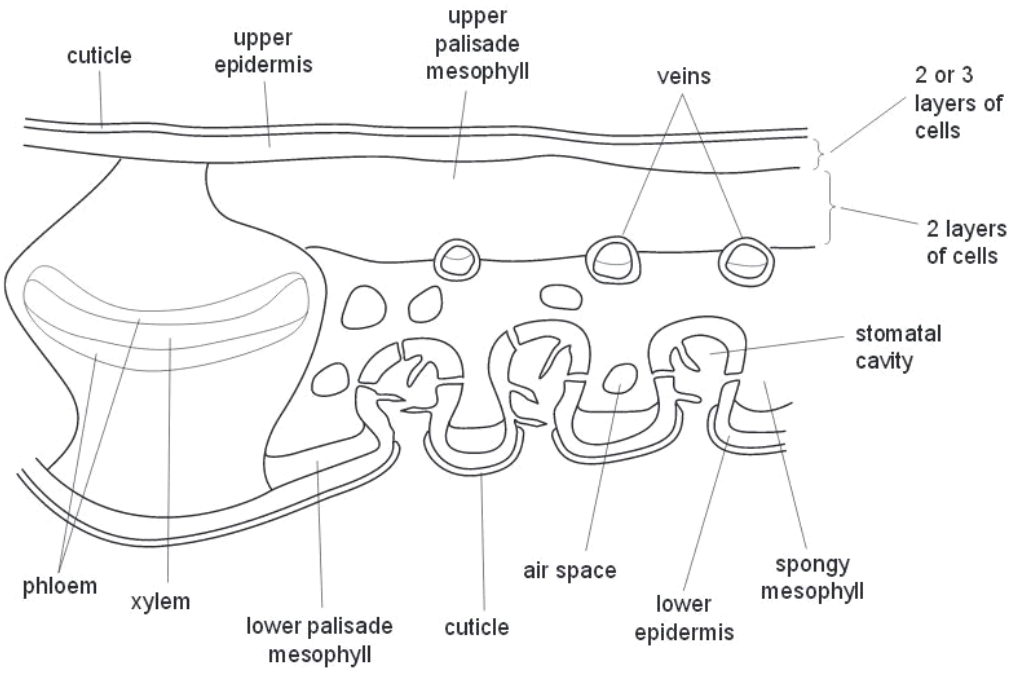
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..... **[4]**

Fig. 2.1 is a plan diagram of a transverse section of a leaf from *Nerium oleander*, a plant that is adapted to survive in dry areas.



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Fig. 2.2 shows detail of the lower epidermis that lines the stomatal cavities of *N. oleander*.

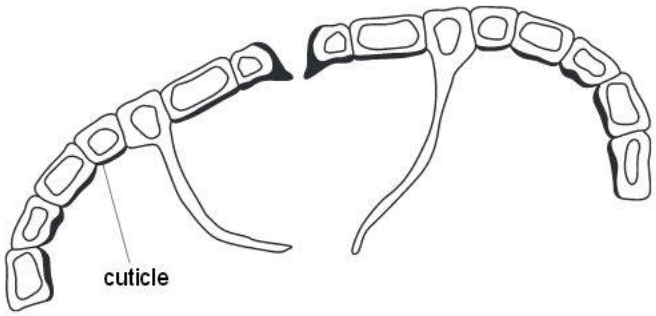


Fig. 2.2

(b) Using information in Fig. 2.1 and Fig. 2.2,

(i) explain why transpiration is considered to be an "inevitable consequence of gas exchange" in plants, such as *N. oleander*

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..... [3]

(ii) explain how the leaves of *N. oleander* are adapted to reduce water loss.

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..... [3]

[Total: 10]

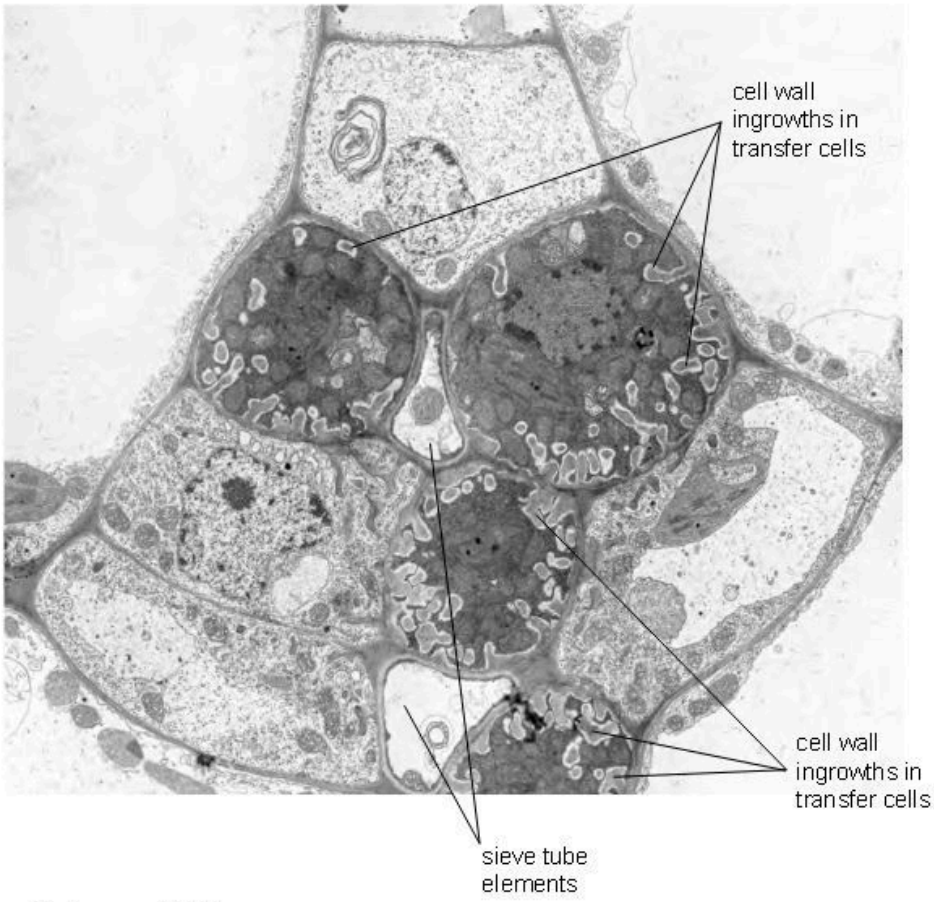
Q18.

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4 Phloem transfer cells are specialised companion cells that load sucrose into sieve tube elements.

Fig. 4.1 is an electron micrograph of a transverse section showing phloem tissue from a leaf of *Senecio vulgaris*. The section shows two sieve tube elements and four phloem transfer cells. The sieve tube elements are small in this section because it is taken at the end of a vein in the leaf.

It is thought that the many ingrowths of the cell walls visible in Fig. 4.1 are related to the movement of large quantities of sucrose.



magnification = ×10,000

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(a) Describe how companion cells load sucrose into phloem sieve tubes.

B

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.....

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..... [4]

(b) Transfer cells move large quantities of sucrose into phloem sieve tubes.

Suggest why these cells have cell wall ingrowths as shown in Fig. 4.1.

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..... [2]

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(c) **(i)** Explain the advantage of studying cells, such as transfer cells, with the electron microscope rather than the light microscope.

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..... [2]

(ii) Describe the appearance of the phloem sieve tubes when viewed in longitudinal section.

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..... [2]

[Total: 10]

Q19.

4 **(a)** **Explain what is meant by the term transpiration.**

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.....**[2]**

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The rates of transpiration of plants of two species, **A** and **B**, were measured over a period of seven hours. The results are shown in Fig. 4.1.

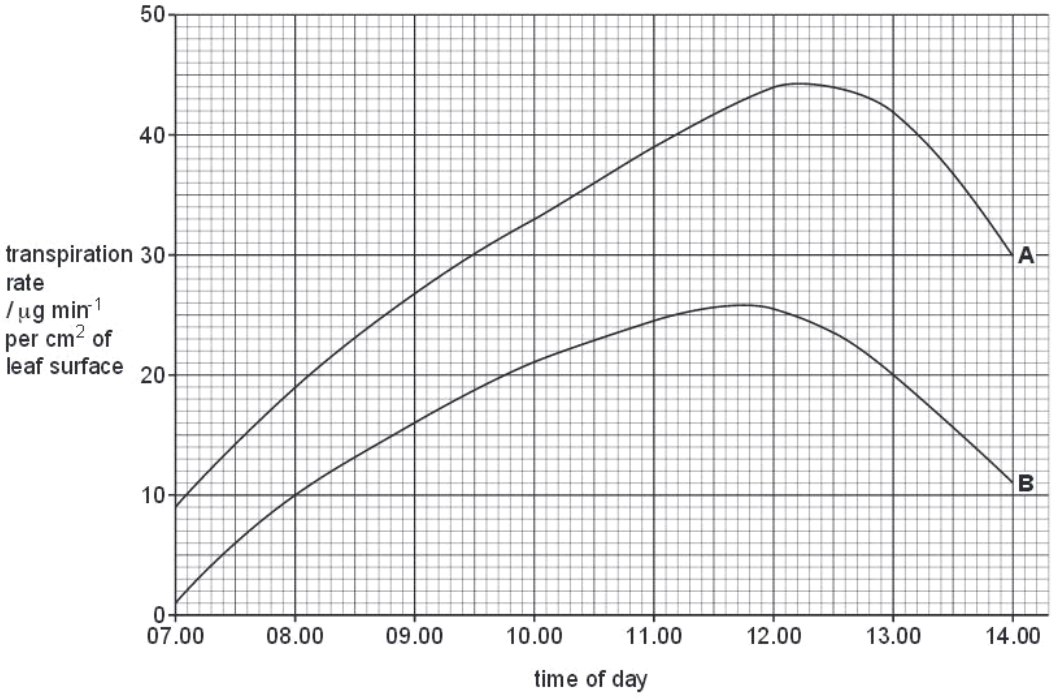


Fig. 4.1

(b) With reference to Fig. 4.1, compare the rates of transpiration of the two species over the seven hour period.

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.....[4]

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(c) State two possible features of the **leaves** of species **B** that could explain the different rates of transpiration in comparison with species **A**.

Explain how each feature acts to reduce transpiration.

feature .....

explanation .....

.....

.....

feature .....

explanation .....

.....

.....[4]

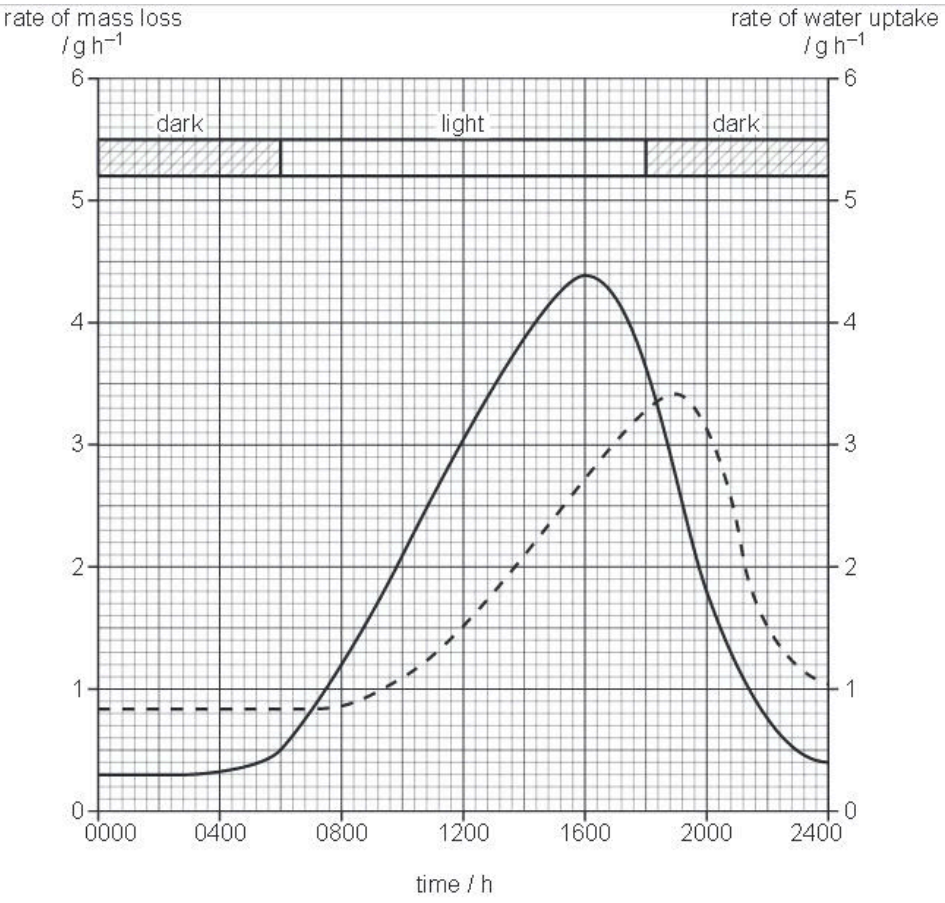
[Total: 10]

Q20.

4 A leafy twig was cut from a tree and the cut end immediately placed into water. The twig was then put into a potometer to measure the uptake of water. The potometer was placed on a balance to record changes in mass.

Fig. 4.1 shows the rate of water uptake and the rate of mass loss over a period of 24 hours. The graph also shows when it was light and when it was dark.

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Key

——— rate of mass loss

– – – rate of water uptake

Fig. 4.1

(a) (i) Explain how water was lost from the leaves of the leafy twig.

E

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.....[3]

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(ii) With reference to Fig. 4.1, describe how the rates of water uptake and water loss change during the 24 hour period.

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.....[4]

(b) Explain the mechanism by which water is transported in the xylem of the leafy twig while in the potometer.

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.....[3]

[Total: 10]

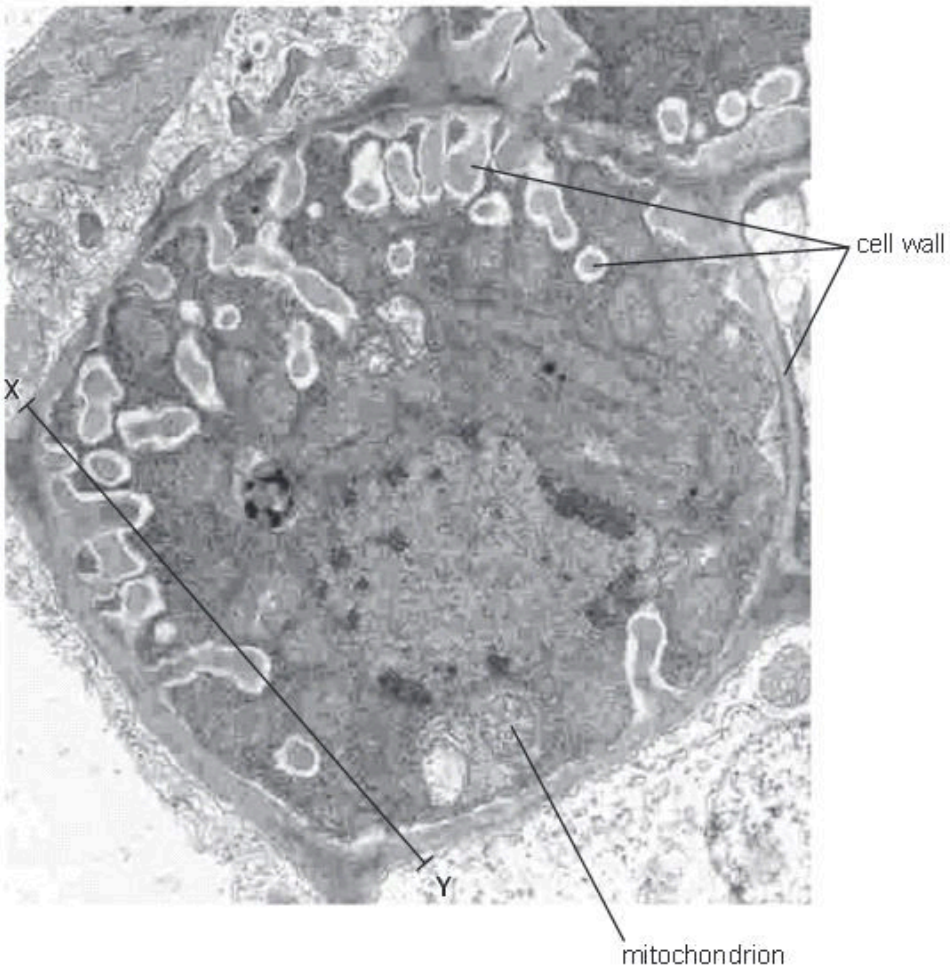
Q21.

5 **Phloem transfer cells are modified companion cells that move sucrose and other assimilates from mesophyll tissue into phloem sieve tube elements.**

Fig. 5.1 is an electron micrograph of a phloem transfer cell.

Fo
Exami
Us

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magnification = ×10 000

(a) Calculate the actual distance across the transfer cell from **X** to **Y**.

Show your working and express your answer to the nearest micrometre.

answer ..... µm [2]

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(b) With reference to Fig. 5.1, explain how phloem transfer cells help in the movement of sucrose from the mesophyll of a leaf into a phloem sieve tube element.

E

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.....[5]

(c) Explain how sucrose in the phloem sap is moved from sieve tube elements in leaves to cells in a sink, such as a root.

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.....[4]

[Total: 11]

Q22.

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6 Fig. 6.1 shows a phloem sieve tube element, its companion cell and a mesophyll cell in the leaf of a photosynthesising plant.

For Examiner's Use

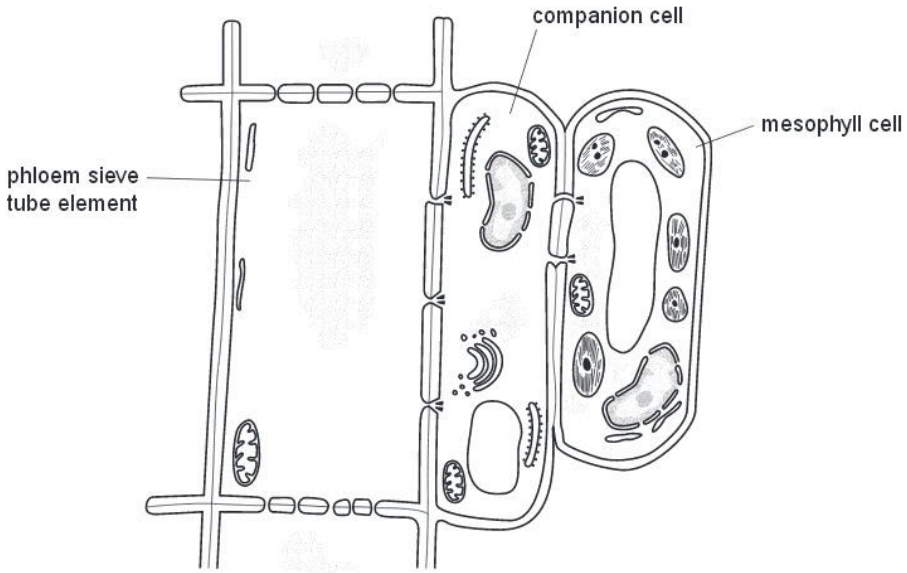


Fig. 6.1

(a) Use label lines and the letters **C** to **E** to identify the following on Fig. 6.1.

C – a structure involved in ribosome synthesis

D – an organelle that is involved in the modification and packaging of proteins

E – an organelle that is involved in aerobic respiration [3]

(b) The concentration of sucrose in the sap of the phloem sieve tube element is much higher than in the cytoplasm of the photosynthesising cell.

Describe **and** explain how sucrose is transported from the photosynthesising cell to the phloem sieve tube element.

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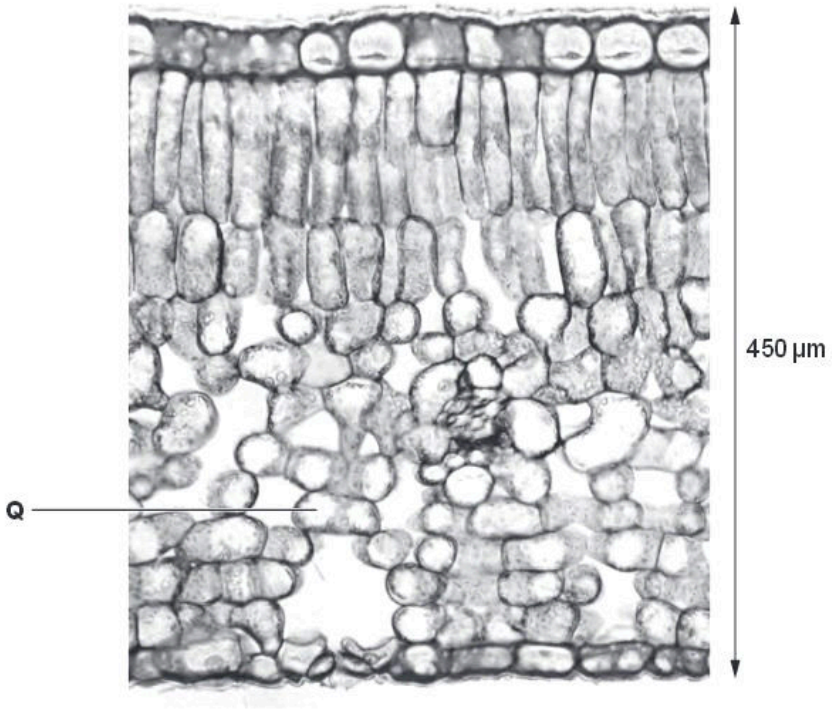
.....[4]

[Total: 7]

Q23.

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3 Fig. 3.1 is a photomicrograph of a transverse section through a leaf from a tea plant, *Camellia sinensis*.



(a) Use label lines and the letters **X**, **Y** and **Z** to label the following features on Fig. 3.1.

X a cell of the upper epidermis

Y a palisade mesophyll cell

Z a guard cell

[3]

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(b) Describe **and** explain how water moves from inside the leaf at point **Q** on Fig. 3.1 to the atmosphere outside the leaf during transpiration.

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..... **[4]**

(c) The leaf of *C. sinensis*, shown in Fig. 3.1, has developed in a sunny position.

State three features of the leaf, **visible in Fig. 3.1**, which show that it has developed in a sunny position.

1. .....

.....

2. .....

.....

3. .....

..... **[3]**

[Total: 10]

Q24.

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2 Thale cress, *Arabidopsis thaliana*, is used to study the roles of genes and proteins in plants.

The cell membranes of the root hairs of *A. thaliana* contain proteins called aquaporins that allow the movement of water between the soil and the cytoplasm as shown in Fig. 2.1.

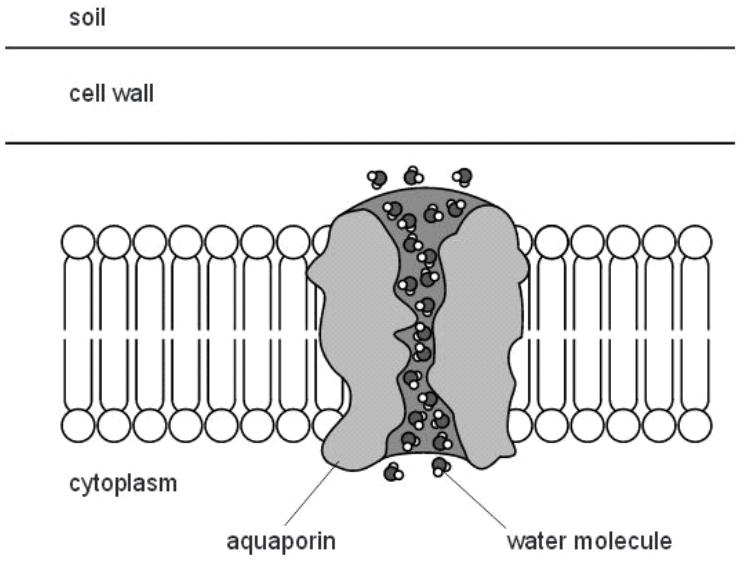


Fig. 2.1

(a) With reference to Fig. 2.1:

(i) explain how water is absorbed by root hairs of *A. thaliana*

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.....

.....

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.....[3]

(ii) state why aquaporins are necessary in cell surface membranes.

.....

.....[1]

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(b) Describe the pathway taken by water from the cytoplasm of the root hair cell to a xylem vessel in the centre of the root.

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.....[3]

An investigation was carried out to find the effect of an enzyme in *A. thaliana* on the composition of the cuticle. The enzyme is involved in the production of lipid that accumulates in the cuticle.

Plants were discovered with a mutation of the gene that codes for the enzyme.

Some of these mutant plants (Group **A**) were grown in pots and their rate of transpiration was determined over three days. They were compared with control plants (Group **B**) in which the gene was switched on and the enzyme present. The results are shown in Fig. 2.2.

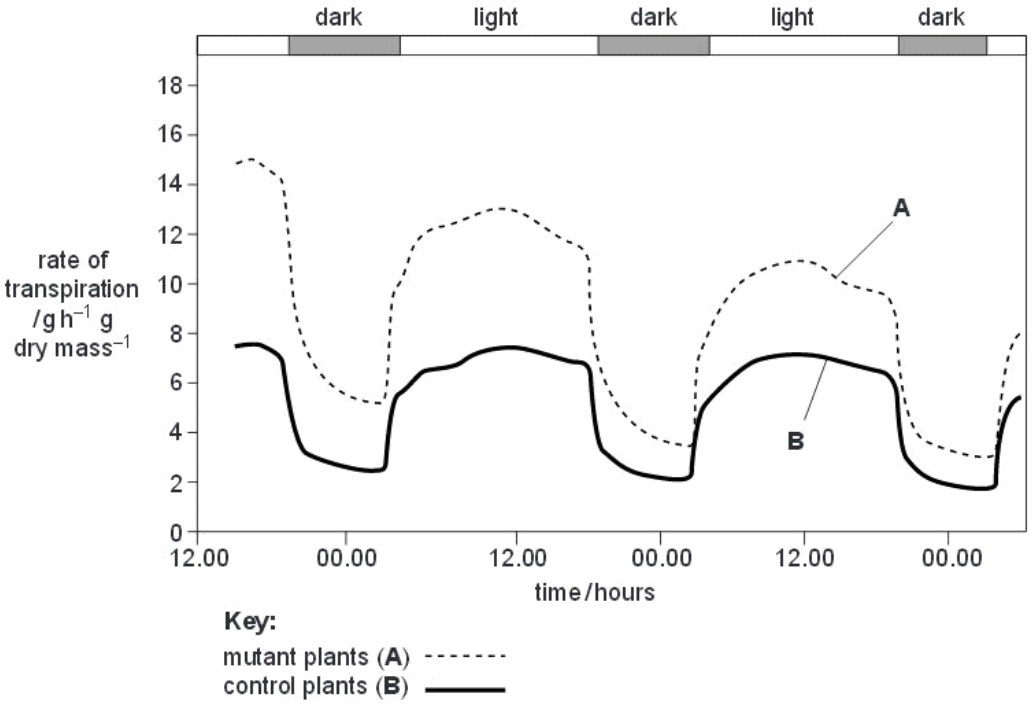


Fig. 2.2

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(c) With reference to Fig. 2.2, explain:

(i) why the rate of transpiration is higher during the day than at night in both groups of plants

.....

.....

.....[1]

(ii) how the results show that the cuticle is less effective in the mutant plants.

For Examiner Use

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.....[3]

[Total: 11]

Q25.

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4 Fig. 4.1 is an electron micrograph of a transverse section through a plant stem. The xylem vessels are clearly visible.

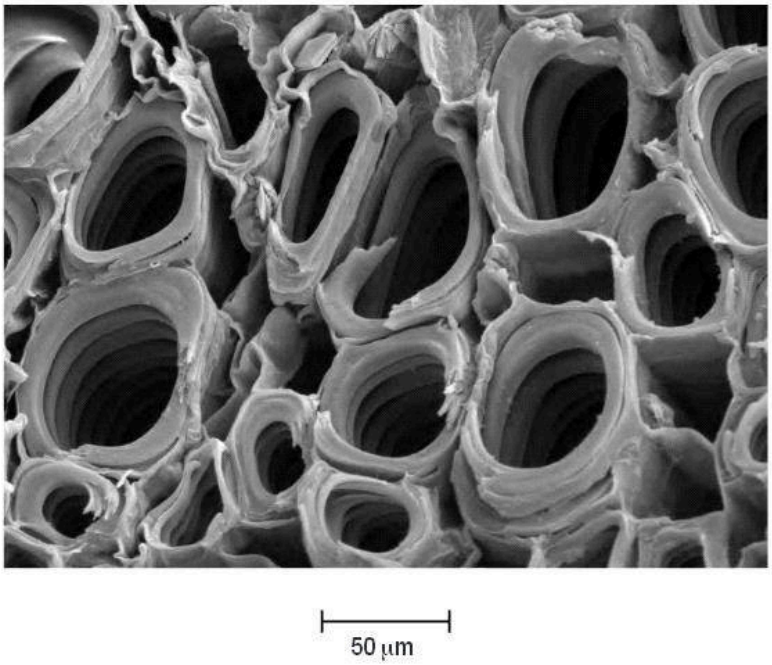


Fig. 4.1

(a) Calculate the magnification of the electron micrograph in Fig. 4.1.

Show your working and give your answer to the nearest 100.

answer .....[2]

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(b) Describe how the structure of xylem vessels is adapted to their function.

.....

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.....[3]

(c) Describe **and** explain how water moves from the xylem vessels in the leaves to the atmosphere surrounding the leaves of the plant.

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.....[5]

[Total: 10]

Q26.

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3 **(a)** Explain the need for transport systems in plants.

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.....[3]

(b) Fig. 3.1 is a drawing of a transverse section through part of the stem of a dicotyledonous plant. Cell **A** and cell **B** are involved in the transport of dissolved organic molecules.

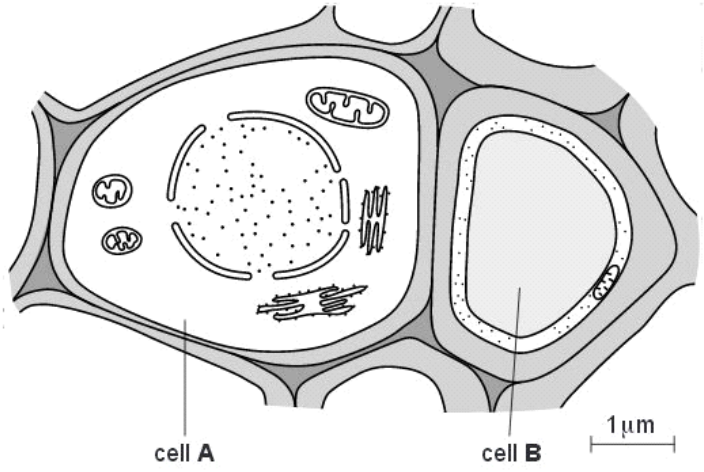


Fig. 3.1

(i) Name cell **A** and cell **B**.

cell A .....

cell B .....[1]

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(ii) **With reference to Fig. 3.1, explain how the different structures of cell types A and B are related to their function.**

For Examiner's Use

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.....**[5]**

(c) Complete Table 3.1 to state four differences between transport systems in mammals and in plants.

Table 3.1

transport system in mammals	transport system in plants

[4]

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Q27.

6 Fig. 6.1 is a photomicrograph of phloem sieve tubes from a plant stem.

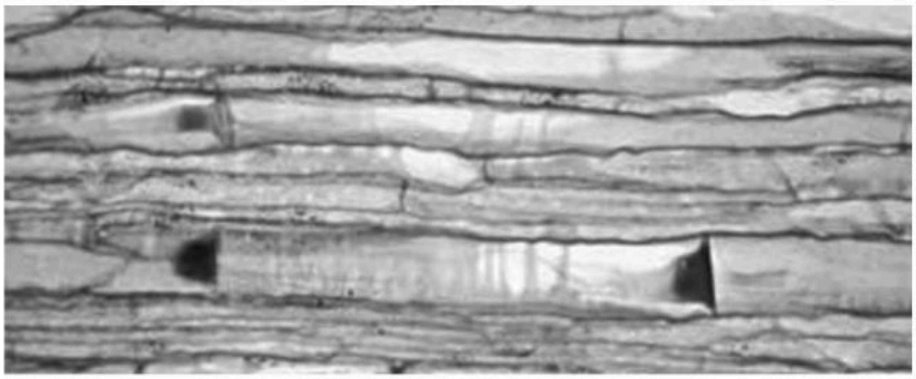


Fig. 6.1

(a) State two features, **visible in Fig. 6.1**, which distinguish sieve tubes from xylem vessels.

1. .....

2. .....

[2]

(b) Explain briefly how sucrose is **moved**, or translocated, **through** sieve tubes.

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..... [2]

(c) Some enzymes are found in phloem tissue.
Describe how enzymes catalyse reactions.

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..... [3]

[Total: 7]

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Q1.

4 (a)	**(i)** shade in xylem; (complete xylem star must be shaded)	**1**
	(ii) shade in phloem; (A. shading of just one phloem group)	**1**
(b)	ref to bending/provide support/strength; R. lignin unqualified R. prevents collapsing	**1**
(c)	osmosis/diffusion; down water potential gradient/from high/less negative to low/more negative water potential/AW; (R. osmotic potential/conc. gradients/ less or more) through partially/selectively/differentially permeable membrane; R. semi-permeable	**max 2**
(d)	transpiration pull/cohesion-tension/cohesion-adhesion/ mass flow in xylem; into spongy mesophyll (cells); many cell walls/surfaces/large surface area; evaporation of water (from damp walls); into (substomatal/intercellular) air spaces; diffusion of water vapour/water as a gas/described; (e.g. movement of water vapour from high to low conc.) through stomata/cuticle (to air/ atmosphere); (ignore ref. to apoplast, symplast, vacuolar pathways)	**max 4**
		[Total 9]

Q2.

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3 (b)

- higher temperature and higher wind speed gives higher / greater / faster (rate of) uptake / transpiration / water loss / movement of, water / bubble;
- both conditions / AW increase water potential / diffusion gradient (between leaf and air);
- = *general points*

temperature

use of figs. (units required) to make a valid comparison;
e.g. expts. 1 and 3 - 12 to 24 mm h^{-1} } **A** appropriate
expts. 2 and 4 - 22 to 45 mm h^{-1} } factor increase
expts. 3 and 5 - 24 to 64 mm h^{-1} } e.g. rate doubles
A figs. once only in temperature or wind speed (see below)

ref to kinetic energy / speed of movement of molecules and rate of evaporation / transpiration / diffusion;
warm air holds more water vapour / molecules than cold air / AW; **R** water

wind speed

use of figs. (units required) to make a valid comparison;
e.g. expts. 1 and 2 - 12 to 22 mm h^{-1} } **A** appropriate
expts. 3 and 4 - 24 to 45 mm h^{-1} } factor increase
A figs. once only in wind speed or temperature (see above)

idea that air blowing over the surface of / around the leaf takes moist air / water vapour / molecules, away / reduces transpiration shells;
(so) air, around leaf / outside stomata, does not become saturated / is less humid; **4 max**

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Question	Expected Answers	Marks
3 (c)	*in intact plant*	
	limited / less water available from the soil; slower rate of water uptake / absorption by the roots; (because) there is resistance to water movement across (root) cortex / apoplast / cell walls / endodermis / Casparian strip; water has to travel further / greater distances, in xylem vessels under tension / in small vessels; other factors (e.g. light intensity / humidity) could affect width / size / opening of stomata; (compared with controlled potometer investigation) **A** reverse arguments for potometer	**2 max**
		[Total: 11]

Q3.

2 (a) (i) **X** to xylem vessel;

S to phloem sieve tube element; **R** companion cell

E to lower epidermal cell; (including guard cells) **R** cuticle

D to palisade mesophyll cell; **[4]**

(ii) Award 1 mark for correct working;

Award 1 mark for correct answer;

Expect 120/0.5 = 240

A 119 - 121/0.5 = 238 - 242 or any working that gives the correct answer

R all others, **[2]**

(b) sucrose;
amino acids; **A** two named amino acids for two marks **[2]**

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(c) lower/more negative, water potential; **A** ref to water potential gradient/xylem has a higher water potential **R** less water potential

(of) spongy mesophyll cell/tissue; **R** leaf cells

large surface area/many cell walls(of spongy mesophyll cells);

(moves through) through cell walls/surfaces; **R** ref to appoplast/symplast

evaporation of water;

from spongy mesophyll cell walls;

into (substomatal/intercellular) air space;

diffusion of water vapour;

through stomata; **[max 4]**

[Total: 12]

Q4.

2 **(a)** **(i)** **G** sieve tube (element),
H companion cell; **[1]**

(ii) *vessels have*

thicker walls;
thickening in walls (e.g. spiral, annular, reticulate);
wider lumen;
no cytoplasm; **R** dead (not structure)
pits;
no cross walls / no sieve plates / no sieve pores;
lignin; **[max 3]**

(b) (sucrose) loaded at, source / leaf;
role of companion cells;
further detail, e.g. H^+ pumped out, sucrose moves in through co-transporter;
absorption of water / water enters by osmosis;
hydrostatic pressure builds up;
mass flow;
(sucrose) unloaded at, sink / fruit / root / AW;
gives a difference in pressure (between source and sink); **[max 4]**

(c) sucrose used in respiration;
stored as starch;
used to make, cellulose; **A** used to make cell walls
stored as / converted to, organic acids (in vacuoles);
converted into named other substances; e.g. lipid / protein / AW **[max 1]**

Q5.

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4 **(a)** **(i)** source = leaf/mesophyll/palisade/spongy qualified
sink = flower/fruit/seed/stem/bud/root/tuber/storage organ/young leaf/meristem/pollen/nectary/AW ; [1]

(ii) **C** sieve, (tube) element/cell,
D companion/transfer, cell ; [1]

(b) ***source to cell C***
correct ref (sucrose) loaded ;
H^+ pumped out, sucrose moves in through co-transporter ;
role of companion cells in moving sucrose into sieve tube element ;
sucrose diffuses down concentration gradient (anywhere) ;
ref to plasmodesmata ; [max. 2]

cell C to sink
water enters by osmosis/water moves down its Ψ gradient ;
hydrostatic pressure builds up ;
(idea that sucrose) unloaded/used at sink ;
water follows by osmosis ;
idea there is a difference in pressure/pressure gradient (between source and sink) ;
mass flow ; [max. 2]

(c) small surface area : volume ratio *ora* ;
accept described

idea of distances too great for diffusion/diffusion rate too slow ;

idea of
cells requiring, substances/named substances, are at a distance from site production/ absorption ;

idea of
mass *or* bulk transport/described ; [max. 2]

[Total: 8]

Q6.

5 **(a)** water moves down water potential gradient ; **A** high(er) to low(er) water potential / less negative to more negative water potential
apoplast pathway / through cell walls ;
symplast pathway / through, plasmodesmata / cytoplasm ;
evaporation ;
from spongy mesophyll cell walls ;
into (substomatal / intercellular) air space ;
diffusion of water vapour ; **A** diffusion of water if evaporation used in correct context elsewhere
through stomata ; [4 max]

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(b) *explanation must correctly relate to structure before marks can be awarded*
any three from the following six pairs

either
cellulose, cell wall / lining ;
allows adhesion of water ;
or
thick (cellulose) cell wall ;
prevents collapse / idea of providing support (under tension) ;

either
lignin ;
waterproofing / prevents water loss ;
or
lignin ; **A** rings / spirals / thickening / AW (of walls)
prevents collapse / idea of providing support (under tension) ;

no cytoplasm / lack of contents / hollow / empty lumen ; **R** dead
less resistance to / unimpeded / uninterrupted / unhindered / ease of / AW, flow / AW ;
A greater volume per unit time / faster rate **R** continuous, smooth

lack of end walls / continuous tube ;
less resistance to / unimpeded / uninterrupted / unhindered / ease of / AW, flow / AW ;
R continuous, smooth

pits / pores ; **R** holes
lateral movement / movement around air bubbles / supplies (water) to (surrounding), cells / tissues ;

wide / large diameter / large lumen ;
so large volume of water can be transported ; [6 max]

[Total: 10]

Q7.

5 **(a)** **P** to one endodermal cell ;

Q to the cell wall of one of the four xylem vessels ;

R to cells immediately above the xylem ; **A** to one cell [3]

(b) Casparian strip / suberin, is impermeable (to water) ;
blocks, apoplast pathway / pathway between cells / cell wall pathway ;
ref. to passage cells ;
water / (inorganic) solutes / minerals / ions, must pass through, endodermal cells / symplast pathway / symplast pathway described ;
cell can select solutes / AW ;
ref. to, active transport / carrier proteins ;
ref. to presence of solutes (at base of xylem) causing increase in root pressure / AW [3 max]

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(c) *explanation must correctly relate to structure before marks can be awarded*

any two from the following six pairs

sieve pores ;
allow easy flow (from sieve tube element to sieve tube element) ; **R** flow of water

sieve plate ;
(may) prevent sieve tubes from bursting / AW ;

cell (surface) membrane / plasma membrane ;
prevents loss, of sucrose / assimilates / phloem sap ;

little cell contents / AW ; **R** no cell contents
little resistance / AW, to flow ; **R** flow of water

plasmodesmata ;
allows flow, to / from, companion cells ;

thin walls ;
for, rapid / easy, entry of water (at source, to build up pressure) ; [4]

[Total: 10]

Q8.

3 **(a)** **(i)** active, transport / uptake ; [1]
carrier / transport, protein ; **A** pump protein **R** channel protein
ref. (protein) changing shape / conformational change ;
ref to specificity ;
ATP / energy, required ; [max 2]

(ii) ATP / ADP / DNA / RNA / nucleic acid / NADP / phospholipid ;
A nucleotide / named nucleotide / nucleoside **A** phospholipid bilayer [1]

(b) **(i)** W in the central X-shaped region ; [1]

(ii) osmosis *in correct context* ; e.g. through, cell surface / partially permeable, membrane or into, cytoplasm / cell
diffusion, into / through, cell walls ;

from (region of), high(er) / less negative, water potential, to (region of), low(er) / more negative, water potential *or* down a water potential gradient ;

transpiration pull ; [max 2]

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(iii) through cortex / via cortical cells ;

apoplast pathway
(by) via cell walls (of adjacent cells) ; **R** *if named as* symplast pathway ;
symplast pathway
via cytoplasm and plasmodesmata ; **R** *if named as* apoplast pathway
ref. vacuolar pathway ;

ref. apoplast to symplast / pathway described, at endodermis ;
(via) passage cells ;
ref to, suberised / Casparian, strip ; *in correct context* [max 4]

[Total: 11]

Q9.

3 **(a)** *max 3 if no attempt at comparison*

evaporation

1 formation of water vapour from water / conversion of water from liquid (form) to gas(eous form) ;

2 requires, energy / heat ;

3 (water loss) from, surface / cell walls, of (spongy) mesophyll (cells);

transpiration

4 idea of loss of water vapour, to external atmosphere / from the aerial parts of a plant ; **A** from leaves

5 ref. diffusion, down water potential gradient / from high to low water potential / from less negative to more negative water potential ; **A** Ψ for water potential

6 through stomata ;

air spaces

7 correct ref. to, intercellular / air, spaces ; e.g. evaporation into air spaces, diffusion from air spaces through stomata [max 4]

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(b) (i) *max 3 if no attempt at explanation*
penalise once for lack of units
mp for describing shown by (D)
mp for explaining shown by (E)

temperature
T1 (D) (mean) transpiration rate hot dry day lower than warm dry day ;
A lower than warm rainy day **A** lowest rate
T2 (D) comparative data quote to support ;
T3 (E) stomata close to prevent excess water loss / excessive water loss causes closure of stomata ; AW

humidity
H1 (D) (mean) transpiration rate warm dry day higher than warm rainy day ;
A highest rate
H2 (D) data quote to support ;
H3 (E) decrease in / low, humidity increases rate of, transpiration / evaporation / diffusion ; ora
H4 (E) more steep / AW, water potential gradient ;

stomatal density
S1 (D) peach (mean) transpiration rate, lowest / lower than, apple / sour cherry ;
S2 (D) data quote to support ;
S3 (E) ref. (far) fewer stomata (mm^{-2}) so less water (vapour) lost ;

AVP ; e.g. ref. ABA and stomatal closure **(T)**
less water (vapour) leaves plant as only cuticular transpiration possible **(T)**
ref. to higher rate for apple (dry days) and suggestion that stomata are larger [max 4]

(b) (ii) decreased / lower, rate during night ; ora
stomata closed at night ; ora
further detail ; e.g. closed to prevent water loss
closed as no photosynthesis
no light for photosynthesis
open (during day) for, gas exchange / CO_2 in [3]

(iii) peach / *Prunus persica* / *P. persica* ; [1]

(c) (i) (repairing damaged DNA) reduces risk of cancer ; **A** prevents

further detail ; *in context of reducing risk*
e.g. because tobacco smoke contains mutagens
because tobacco smoke contains carcinogens
ref. to mutation (as result of damaged DNA) [2]

(ii) reduces risk of, chronic bronchitis / emphysema / COPD ;

further detail ; *in context of reducing risk*
e.g. (reducing inflammation)
reduces risk of infection
prevents excess mucus production **R** if linked to emphysema
prevents alveolar wall breakdown **R** if linked to bronchitis
no / less, scar tissue forms [2]

[Total: 16]

Q10.

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2 **(a)** potometer ; **A** transpirometer **R** photometer **R** spirometer [1]

(b) *idea that*
water taken up may not all be lost in transpiration / transpiration is water loss (as water vapour) from (aerial parts / leaves, of) the plant ;

example of use of water taken up ;; e.g.
photosynthesis
hydrolysis reactions
maintaining turgidity / AW
cell, elongation / increase in size

ref. to water uptake rate and transpiration rate differing because of (changing) environmental conditions ; **A** examples e.g. higher transpiration rate than uptake rate in hot and dry external conditions [max 2]

(c) **(i)** *if no mp 1 and 2, accept increased rate of transpiration for one mark*

1 increased rate of evaporation ; **A** description of evaporation
R evaporation, from leaf / from stomata / through stomata
2 increased rate of diffusion ; *in context of water vapour out through stomata*
3 (rise in temperature), lowers (relative) humidity / decreases water potential of air (outside leaf) ;
4, 5 AVP ;; e.g. increased kinetic energy
steeper water potential gradient established *in correct context*
details of cohesion-tension theory linked to increased, transpiration / water uptake, rate
increased rate of photosynthesis
replacing water lost from cells in leaf [max 3]

(ii) humidity ;
wind (speed) ; **A** air movements
light intensity ;
(air) pressure ; [max 2]

(d) 1 stomata (must be) open for, gas exchange / uptake of carbon dioxide ; **A** release of oxygen
2 carbon dioxide for photosynthesis ; **A** oxygen from photosynthesis (when rate exceeds rate of respiration)
3 (most) water vapour, diffuses / AW, out, via / AW, (open) stomata ;
A most transpiration occurs when stomata are open
R if incorrect transport mechanism used e.g. osmosis [3]

[Total: 11]

Q11.

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3 **(a)** **R** CO_2 diffusion is a consequence of transpiration
stomata open(ings) to allow carbon dioxide in ;
carbon dioxide required for photosynthesis ;
ignore ref. to oxygen
water vapour diffuses out through stomata ;
A water if evaporation (from mesophyll walls) described
A water as a gas [3]

(b) **1** both show, little / low / lowest, transpiration, at night / 22.00 to 24.00 / 00.00 to 04.00 ;
2 both, increase to / peak, at mid day / 12.00 ;
3 ref. to second peak at 16.00 ;
4 both, dip / decrease, at 14.00 ;
5 transpiration (always) lower for trees at exposed site / ora ;
6 both decrease from 16.00 ;
for mps 1–4 and mp 6, allow a description at one site only
R if contradictory description given for the other site
7 comparative data quote to support above marking points ; ;
8 to compare the transpiration rate at two locations at the same time
or transpiration rate at one location at different times
to award data marks arbitrary units (au) must be used at least once [max 5]

(c) *identification of the following features*
1 stomata close (for longer), during the day / when hot / when dry ;
2 stomata in pits / sunken stomata ;
3 stomata only on lower surface of the leaf ;
4 hairs / trichomes ;
5 low number of / few(er) / less, stomata (per unit area) ;
ignore 'less open stomata'
6 thick(er) cuticle;
7 reflective cuticle (on upper epidermis) ;
8 thick(er) epidermis / more than one layer of epidermal cells ;
9 curled / rolled / AW, leaves ; [max 3]

[Total: 11]

Q12.

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2 (a)

1	transport of water and mineral ions ; **A** minerals
2	elongated cells / cells end to end (to form) tubes for transport ; **A** (e)long(ated) tubes for transport
3	no, end / cross, walls *or* end / cross, walls broken down so minimal resistance to / unimpeded / free, flow of water ; AW
4	hollow / no cytoplasm / no contents / no organelles / empty, *ignore* dead so more space for greater volume to flow / greater volume per unit *or* minimal resistance to / unimpeded / free, flow of water ; AW
5	cellulose lining **A** cellulose walls so hydrophilic / adhesion of water molecules / for movement of water up stem / to maintain column of water / AW ; **A** hydrophilic lining, for movement of water up stem / to maintain column of water
6	lignified (walls) / walls contain(s) lignin **A** thickened walls **R** lined with lignin so prevents (inward) collapse / withstands negative pressure **R** prevents bursting
7	lignified (walls) / walls contain(s) lignin **A** thickened walls **R** lined with lignin so waterproof / prevents loss of water / prevents leakage / maintains column
8	additional ref. to lignin ; e.g. for support of plant spiral / annular, thickening allows elongation (of stem) for support of plant
9	pits / pitted walls to allow, sideways / lateral, movement (of water) *or* to connect to all parts of plant / AW ;
10	relevant ref. to diameter of lumen ; e.g. narrow, for adhesion **R** capillarity (relatively) wide to transport maximum volume of water

[max 5]

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(b) *look for ora*

1 can observe living tissue ; **A** observing processes (e.g. like mitosis)

2 ref. portability ; e.g. ref. to size, easy to move, no requirement for special room (e.g. vibration-free)

3 ease of use, qualified ; e.g. no technical training required, slide preparation easier, takes less time

4 see (actual / natural / real-life) colour ;

5 ref. to, differential staining / staining particular types of tissue ;

6 fewer problems with artefacts ;

7 lower cost of, purchase / maintenance / running / AW ; [max 2]

[Total: 7]

Q13.

(d) **1** ref. to movement, down water potential gradient / from high(er) to low(er) ;
2 apoplastic / cell wall, pathway from xylem to cell walls of (palisade mesophyll) cells ;
3 ref. to osmosis ; *in context of* movement, into cell / through cell surface membrane / through tonoplast,
R osmosis from xylem to vacuole
4 symplastic / cytoplasmic, pathway (within cell) ;
5 via plasmodesmata ; *in context of water arriving from adjacent cell*
6 ref. to channel proteins / aquaporins ;
7 solutes / named, in vacuole ; [max 3]

Q14.

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3 (a) stomata (are open) for gas exchange / CO_2 / O_2 uptake / release (for photosynthesis and respiration);
large surface area / many cell surfaces;
in spongy mesophyll;
(so) evaporation from (damp) walls (into air spaces);
(and) diffusion / loss down a conc. gradient, of water vapour;
to air / atmosphere via stomata; **3 max**

(b) ref cohesion / tension (in context of xylem);
hydrogen bonds;
through (freely permeable) cell wall / apoplast pathway;
through partially permeable membrane / AW (in context of cell B);
osmosis;
down water potential gradient / high / less negative to low / more negative water potential / AW; **3 max**

(c) (i) **B** to **A** and **C**;
A to **C**; **2**

(ii) from cell surfaces through air through stomata; **1**

(d) small leaves / small surface area / reduction of leaf surfaces / needle shaped leaves; R. spines
rolled / curled leaves; R. folded
shed leaves;
sunken stomata / stomata in pits / crypts / grooves;
stomata surrounded by hairs / hairy leaves;
waxy / impermeable / thick, cuticle / thick leaves qualified; **2 max**

[Total : 11]

Q15.

1 (a) (i) **A** - Golgi (body/apparatus)/dictyosome; **R** Golgi vesicles

B - (rough) endoplasmic reticulum/ER/RER; **R** SER

C - mitochondrion/mitochondrial, matrix/envelope; **3**

(ii) sieve plate(s); **1**

(iii) sucrose/amino acid(s)/named amino acid; **R** sugar, glucose **1**

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(b) little/watery/peripheral, cytoplasm/no tonoplast/no vacuole/ few organelles/few ribosomes/so little resistance/AW e.g. easy transport/move more easily/minimum obstruction;

pores in sieve plate provide little resistance/permit continuous flow/allows movement/AW e.g. as above;

sieve plate braces/prevents cell bulging under pressure/collapsing;

plasmodesmata only between sieve tube element and companion cell allows pressure to build up;

plasmodesmata allows loading/AW e.g. sucrose to be transported in from companion/transfer cell;

(strong) cellulose walls prevent, excessive/too much, bulging/expansion;

mitochondria (and starchy plastids) for ATP, for repair/maintenance;

R reference to mitochondria in companion cells **3 max**

(c) sucrose/sugars/assimilates, are pumped/loaded (by companion cells);

reference to pumping H^+;

reference to co-transport/AW e.g. H^+ carry sucrose with them;

mitochondria provide, ATP for active transport; **2 max**

Q16.

3 **(a)** **(i)** tube-like / tubular / hollow / empty / no obstructions / no cell contents, so little resistance, easy movement ;
R mass flow, continuous column
wide / large diameter / large lumen, so large volume / amounts of water can be transported ;
thickening of the walls, to prevent collapse (under tension) ; **[2 max]**

(ii) evaporation of water inside, leaf / within mesophyll ;
ref to mesophyll cell walls ;
lowers water potential ;
water moves down water potential gradient ;
cohesion between water molecules /AW ;
adhesion of water molecules to vessel walls / AW;
water pulled up under tension / transpiration pull ;
transpiration, stream / column ; **A** continuous column
(water moves up xylem) from high to low hydrostatic pressure ; [4 max]

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(b) nicotine,
increases heart rate / raises blood pressure / constriction of blood vessels /
increases stickiness of platelets (so cause clots) /
decrease in blood flow to, hands / feet / fingers / extremities /
is addictive / damages, endothelium / lining of blood vessels ;

carbon monoxide,
combines with haemoglobin to form carboxyhaemoglobin / reduces amount of oxygen that can be transported in the blood ;

carcinogens / named carcinogen (e.g. benzpyrene / phenol), cause mutations / AW ;

tar,
inhibits / weakens action of / destroys / paralyses, cilia / stimulates, goblet cells /
mucous glands, to secrete more mucus ;
A excess [3 max]

[Total: 9]

Q17.

2 **(a)** *treat refs to mechanisms as neutral*
(soil to) root hair ;
idea of across, cortex / cortical cells (root) ;
apoplast / along cell walls ;
symplast / via, cytoplasm / plasmodesmata ;
through, endodermis / endodermal cells, by symplast pathway ;
(because of) suberin / Casparian strip ;
ref to passage cells ;
apoplast into the xylem ; [4 max]

(b) **(i)** stomata are open (to allow diffusion / gas exchange) ;
(for) entry of CO_2 / release of O_2 ; AW
large surface area inside leaf (for gas exchange) ;
cell surfaces / walls, in (palisade / spongy) mesophyll ;
moist / damp / wet ;
correct ref to evaporation ;
water vapour, diffuses out / AW; **A** water *if linked to evaporation* [3 max]

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(ii) *adaptations*

(epidermal) hairs / trichomes ; **R** spikes, spines
stomata in, pits / cavities / chambers ; **R** sunken stomata

reduced air movement / still air ;
holds water vapour / has high(er) humidity / AW ; **A** holds moist air
(therefore) less steep, water potential / vapour pressure / diffusion, gradient ;
A qualified ref to diffusion shells between air inside leaf and air in pits ;

thick / waxy, cuticle (on upper, epidermis / surface) ;
multilayered, epidermis / hypodermis ;
thick walled epidermal cells ;
cuticle reflects sunlight ;
stomata only on lower surface / no stomata on upper surface ; [3 max]

[Total: 10]

Q18.

4 **(a)** H^+ pumped out ;
creates an H^+ gradient ;
sucrose moves in with H^+
co-transport / through co-transporter ;
energy / ATP, provided by mitochondria ;
sucrose diffuses down concentration gradient ;
through plasmodesmata ; [4 max]

(b) large surface area : volume ratio / to increase surface area ;
gives large surface area of membrane ;
(so) many, pumps *or* co-transporters ; [2 max]

(c) **(i)** higher / greater resolution / resolving power ; **ora**
A 0.5 nm (0.0005 μm) compared with 200 nm (0.02 μm)
because of shorter wavelength ; **A** smaller
more detail can be seen / much clearer (at the same magnification)
/ can see two points that are close together ;
can see cell structures that are not visible in the LM ;
A e.g. ribosomes / membranes
can see detail of structures just visible in LM with e.g. ;
A mitochondrion / chloroplast [2 max]

(ii) long (length greater than width) ;
sieve plates ;
sieve pores ;
some / less / peripheral, cytoplasm ;
no nucleus / fewer mitochondria / less ER ;
thin wall ; [2 max]

[Total: 10]

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Q19.

4 **(a)** loss of water vapour ;
from leaves / aerial parts of plant ; **R** stomata unqualified
ignore evaporation [2]

(b) **1** rate for species **A** is always higher / ora for **B** ;
similarity
2 the rates of both species, increase and then decrease / reach a peak ;
3 peak is, around midday / around noon / 11.30 to 12.30 ;
difference
4 rate for species **B** decreases earlier than that for species **A** ;
A species **B** at ~11.45 **and** species **A** at ~12.15 +/– 5 mins
5 steeper / faster, increase / decrease, for **A** ;
6 comparative data quote for rates of transpiration ; +/– ½ a square
A $\mu g\ min^{-1}$ for unit [4 max]

(c) *two adaptations plus explanation – explanation may be the same for each answer*
*accept ora for species **A***

f1 sunken stomata ; **A** stomata in, pits / chambers / grooves
f2 hairs / trichomes (on epidermis) ; **R** needles
f3 rolled / curled / AW, leaves ; *ignore curved unqualified*
e1 high humidity / retains moist air / high concentration of water vapour, to reduce diffusion gradient *or* water potential gradient / AW ;
R 'moisture'

f4 small leaves / leaves are spines / leaves are needles ; **R** spikes
R 'no leaves'
e2 reduce surface area (for transpiration) ;
reduce SA explained but unqualified by size of leaf = 1 mark (see F9)

f5 thick leaves ; **A** succulent
e3 reduce surface area : volume ratio ;

f6 thick (waxy) cuticle ;
e4 decreases permeability / is impermeable / provides **a** barrier / ora ; **A** e5

f7 reflective cuticle ;
f8 several layers of hypodermis ; **A** layers of epidermis / described
f9 epidermis with thick walled cells ;
f10 few stomata / low stomatal density ;
e5 reduce (rate of) diffusion of water ; **R** close of stomata [4 max]

Q20.

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4 (a) (i) moist / AW, surface of mesophyll cells ;
water evaporates / evaporation ; *in correct context*
from spongy mesophyll cell walls ;
into (intercellular) air spaces ;
air within leaf is fully saturated ;
water vapour diffuses through stomata ; **A** 'water' if evaporated

down water potential gradient / from a high to a low water potential / from less negative to more negative water potential [3 max]

(ii) mass / water, loss increases from 0400 to 1600 and then decreases ;
0.3–4.4 g h^{-1} ; **A** other correct comparative data quote with units

mass / water, uptake increases from 0800 to 1900–1930 and then decreases ;
0.8–0.9 – 3.4 g h^{-1} ; **A** other correct comparative data quote with units

rate of, mass / water, loss peaks before rate of water uptake ;
A description related to light (mass loss) and dark (uptake)
data quote for times of peaks for both rates ; 1600 and approx 1900

0600 to 1600 rate of mass loss, ref. to steeper gradient ;

(rate of) mass / water, loss is higher than uptake, between 0700 and approx 1830 ;
A ora [4 max]

(b) cohesion-tension ;
cohesion / AW between water molecules ;
hydrogen bonds ; *accept here or for adhesion once only*
transpiration pull / water is pulled up the xylem / water in a continuous column ;

ignore negative / hydrostatic pressure

adhesion to (cell) walls ;
water molecules 'stick' to cellulose / cellulose is hydrophilic ;
A lignin (although it is hydrophobic!) [3 max]

[Total: 10]

Q21.

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5 **(a)** 9 µm ;;
award one mark if 8.9 or 9.1µm given
or
correct measurement is divided by the magnification (x 10 000) but conversion factor incorrect [2]

(b) *explanation to max 4*
hydrogen ion / H^+, pumped / AW, out of, transfer cell / companion cell ;
R if to sieve tube element
active / using ATP / energy requiring ;
hydrogen ion gradient build-up ; AW
hydrogen ions, co-transport / with / AW, sucrose ; *in context of into, transfer / companion cells*
diffusion / facilitated diffusion (of hydrogen ions and sucrose) through co-transporter (membrane protein) ;
A through membrane protein *if 'cotransport' already used*
sucrose, diffuses / AW, through plasmodesmata into sieve tube element ;

ref. to Fig. 5.1
mitochondria for ATP production ;
ref to infoldings of cell wall ;
large surface area of cell membrane ;
for more, protein pumps / co-transporter proteins ; [max 5]

(c) *sucrose / assimilates / phoem sap, in sieve tube (elements) in, source / leaf*
low(ers) / less negative, water potential ;
water enters, qualified ; e.g. by osmosis / from surrounding tissue;

increases the hydrostatic pressure ;

sucrose unloaded at sink ;
lowers water potential in surrounding tissue ;
water moves out and decreases hydrostatic pressure (in source) ; *allow ecf if hydrostatic not used*

pressure difference (causes flow) ;
(pressure difference) forces sap through sieve tubes / causes mass flow (towards sink) ; AW [max 4]

[Total: 11]

Q22.

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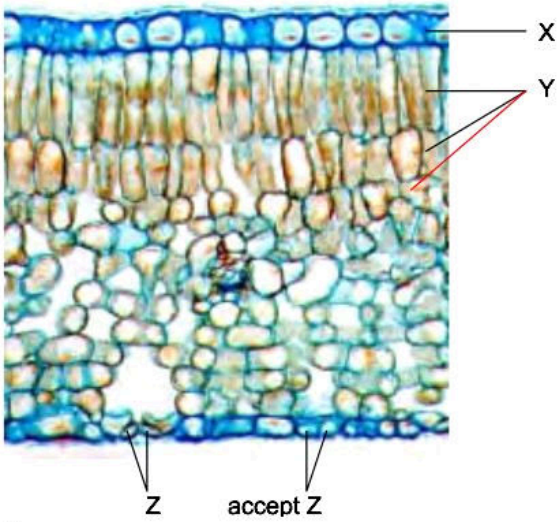
6 **(a)** line to nucleolus labelled **C** ;
line to Golgi apparatus labelled **D** ; **R** to vesicle
line to mitochondrion labelled **E** ; [3]

(b) **1** hydrogen ion / H^+, pumped / AW, out of companion cell ; **R** if to sieve tube element
2 active / using ATP / energy requiring ;
3 against the concentration gradient ;
4 hydrogen ion gradient build-up ; AW
5 hydrogen ions, co-transport / with / AW, sucrose ; *in context of into companion cells*
6 diffusion / facilitated diffusion (of hydrogen ions and sucrose) through co-transporter (membrane protein) ; **A** through membrane protein *if 'cotransport' already used*
7 diffusion of sucrose into (phloem) sieve tube (cell) ;
8 via plasmodesmata ; [max 4]

[Total: 7]

Q23.

3 **(a)** correct labelling



X ;
Y ;
Z ;

A names instead of labels
A if letters put on the appropriate structures without using label lines, letter must be within each cell
ecf max one mark *if use brackets for X* ***and*** *Y enclosing upper epidermis and one, two or three layers of palisade mesophyll* [3]

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(b) **1** (water) moves out of, cell / **Q**, by osmosis / down a water potential gradient ;
2 through the, cell (surface) / plasma, membrane ;
3 to, surface / cell wall of, the spongy mesophyll cell, cell **Q** ;
4 evaporates into (sub-stomatal) air space ; **A** water changes to water vapour
5 water vapour diffuses out through (open) stomata ;
A moves out down a, water potential / water vapour concentration, gradient

if evaporates, then do not insist on vapour [max 4]

(c) thick (waxy) cuticle ;
large / big / thick, upper epidermis / upper epidermal cells ;
many / two / three, layers of palisade cells ;
thick leaf ;
densely packed with spongy mesophyll / many spongy mesophyll cells ;
fewer / small, air spaces ;
no, stomata / guard cells, on upper surface ; ***ora*** only on lower surface
many chloroplasts (within spongy mesophyll cells) ;
R xeromorphic features **NOT** visible, e.g. sunken stomata [max 3]

[Total: 10]

Q24.

2 **(a)** **(i)** 1 diffusion through (freely permeable) cell wall;
2 membrane is partially permeable ; **A** selectively
3 osmosis across membrane (into cell)
4 (only) some water may pass between phospholipids (across membrane);
5 movement across membrane facilitated by aquaporins ;

6 ref. down water potential gradient / from high water potential to low water potential;
A from a higher / to a lower, water potential *if in context*
7 AVP ; e.g. further detail about aquaporin (hydrophilic channel) [max 3]

(ii) 1 increases permeability of membrane to water ;
2 *idea that* osmosis across bilayer does not supply cell rapidly enough with water (that needs to pass on to surrounding cells) ;
3 *idea that* phospholipids are relatively impermeable to water ;
4 *idea that* water cannot pass / only some water passes, through hydrophobic region of membrane / AW ; [max 1]

(b) pathway via, cells of cortex / cortical cells, and endodermis / endodermal cells ;

symplast pathway, described as
cytoplasm and, plasmodesmata / vacuole(s) ;

(out of cell to) apoplast pathway, described as
cell wall pathway ;

Casparian strip / suberised cell wall, of endodermis, impermeable to water ;
(so) pathway only via, symplast / cytoplasm ;

AVP ; e.g. reference to pericycle
reference to passage cells of endodermis
vacuolar pathway *(unless given in mp 2)* [max 3]

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(c) (i) stomata are open (to absorb carbon dioxide for photosynthesis) ; ora [1]

(ii) rate of transpiration, (almost) always / AW, higher / higher at night, in A / mutant plants ; ora
A *expressed in terms of water loss*
at night only cuticular transpiration / no stomatal transpiration ;
idea that during day stomatal transpiration same for both ;
(so) differences because of less effective cuticle ;
comparative data quote ; [max 3]

[Total: 11]

Q25.

4 (a) (×) 400 ;;
if answer incorrect or not to nearest 100 allow one mark for correct working
e.g. (scale bar) 19 000–21 000 divided by 50
award max one mark if a unit (e.g. μm) is included [2]

(b) 1 thick(ened) / lignified, walls prevent, collapse ;
ignore *strenghtened*
A withstands, compression / negative pressure
ignore bursting
2 lignified (wall), prevents leakage / provides waterproofing ;
3 cellulose, wall / lining, allows adhesion of water (molecules) ;
A hydrogen bonding / hydrophilic
4 (relatively) large diameter / large cross-sectional area / wide / large lumen ;
5 hollow / empty / no contents / no cytoplasm ;
6 no end walls / continuous 'tubes' / AW ;
7 elongated ;
A *if referenced to cells or vessels* **A** cells end to end (to make tubes)
only allow mps 4–7 in terms of ease / efficiency of water movement
mp 4 e.g. more space allows a greater volume to flow / greater volume per unit time
or mp 5–6 e.g. minimal resistance to flow, allows unimpeded flow, allows free flow of water
8 pits / pitted walls, to allow lateral movement ;
R pores [max 3]

(c) 1 water moves, down a water potential gradient / from a high(er) water potential to a low(er) water potential, accept ψ for water potential ;
2 apoplast pathway, described / used in correct context ;
3 symplast pathway, described / used in correct context ;
4 evaporation from mesophyll cell walls ;
A surface of mesophyll cells
5 into air space(s) ;
must be linked to evaporation / water vapour
6 water vapour diffuses (out) ;
accept if no vapour but follows from evaporation
7 out / through / via stoma(ta) ;
R 'evaporates from the stomata'
8 **AVP** ; ref. to water leaves unlignified terminals of xylem vessels [max 5]

[Total: 10]

Q26.

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3 **(a)** 1 large (size / volume / organism) ;
A multicellular / many cells
A larger

2 (so) small(er) / low, surface area : volume ;
as size increases, SA:V decreases = 2 marks

3 diffusion (alone), not enough / too slow (to supply needs) ;

4 explanation ; e.g. surface too far from, centre / AW, of plant
distances too far to supply required, nutrients / substances
requires, supplies in bulk / mass flow

5 (so require) xylem and phloem, qualified ;
e.g. transport in different directions
xylem transports water (and mineral ions) and phloem transports, assimilates / photosynthates / sugars / amino acids [max 3]

(b) (i) *cell **A*** = companion cell
A companion ;
*cell **B*** = (phloem) sieve tube element
A sieve tube, sieve tube cell [1]

(ii) *allow ecf from* **(i)** *for incorrect names of cells*
*cell **A** / companion cell*

1 mitochondria for, aerobic respiration / oxidative phosphorylation / ATP, production / AW ;
R ATP energy
A release / supply, ATP / energy (for the cell)
treat as neutral cell B also has mitochondria

2 RER / many ribosomes, for, polypeptide / protein, production ;
if mps 1 and 2 not given, one mark for mitochondria and, ribosomes / RER

3 ref. nucleus and, genes coding for (required) proteins / synthesis of ribosomes
or
nucleolus synthesises ribosomes ;
*cell **B** / sieve tube element*

4 (at least) one main structural feature ;
R hollow
peripheral cytoplasm / AW e.g. pushed against walls
no nucleus / no RER / no vacuole / no Golgi / few organelles / reduced ER / few mitochondria
R no organelles

5 (to) minimise / reduce, resistance to (mass) flow ; AW
e.g. uninterrupted flow / more efficient transport of sucrose

6 (so) maximum volume transported (/unit time) ;
A *idea of*

7 sieve plates, qualified ; e.g. stop bulging
allow mass flow / reduce barrier to flow
become plugged with, P-protein / callose, to prevent losses / after damage

8 no plasmodesmata (*as on Fig. 3.1*) to maintain pressure
or
plasmodesmata (*not shown*) for diffusion of sucrose into sieve tube / AW ; [max 5]

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(c)

	transport system in mammals	*transport system in plants*
1	arteries, veins, capillaries **A** delivery to cells by arteries and capillaries	xylem and phloem ; **A** vascular bundle
2	heart / pump	no heart / no pump / (xylem and phloem) have different mechanisms for (mass) flow ; **A** transpiration pull in xylem / pressure gradients in phloem
3	double circulation	no double circulation / xylem unidirectional flow / phloem source to sink / AW ; **R** single circulation
4	closed circulation	not closed circulation / pits / plasmodesmata ; **A** open
5	one (circulatory) system / water and organic molecules transported in same vessels / AW	two (separate) systems / water transport in separate vessels to organic molecules ;
6	(all) living cells	living and dead cells ; **A** dead cells in xylem
7	transports, (respiratory) gases / oxygen / carbon dioxide	respiratory gases not transported ;
8	transports glucose *accept within correct list*	(phloem) transports sucrose ; *accept within correct list*
9	faster rate of flow	slower rate of flow ;
10	rate of flow controlled by, nervous system control of heart / action of heart / vasoconstriction and vasodilation / AW *accept ref. endocrine system*	rate of flow, not controlled by nervous system / (in xylem) controlled by external factors / (in xylem) controlled by transpiration rate ;
11	components include blood cells	cells not transported / AW ;
12 13 14	AVP ;;; homeostasis involved / concentration of dissolved substances controlled ref. to defence e.g. immune system e.g. blood clotting organ-based valves present	no homeostasis / AW ; no equivalent to immune system callose formation ; tissue-based ; no valves ;

[max 4]

[Total: 13]

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Q27.

6 (a) *look at any labelling on the diagram*

cell contents / cytoplasm / not hollow ; **I** ref. to any organelles (not visible)
A xylem vessels are hollow
thin walls ;
A no, thickened walls / lignified walls / lignin
A xylem vessels have, thick walls / lignin
sieve plates / end walls / cross walls ;
A end walls not broken down
A xylem vessels have no end walls
R 'end' unqualified
I end plates / cell plates
no pits ; **A** xylem vessels have pits [max 2]
I *ref. to companion cells*

(b) dissolved in, water / sap ; **A** in solution
<u>mass flow</u> ;
down (hydrostatic) pressure gradient / moves from high(er) to low(er) pressure (potential) ;
A symbol – ψ_p
AVP ; e.g. from source to sink
loading by, <u>companion</u> / <u>transfer cells</u>, requires ATP / is active ;
I ATP required for mass flow [max 2]

(c) *answers may be general or in the context of phloem transport*

active site (with shape) complementary to substrate ;
A description in terms of lock and key (either way round)
I structure
induced fit / described ;
substrate binds to active site / enzyme-substrate complex forms / ESC forms ;
ref. to specificity of enzymes ;
activation energy of reaction is lowered ;
example of how activation energy lowered ;
e.g. reactants held close together for bond formation
transfer of electrons
strain on bonds
alternative pathway
holding the substrate in such a way that the bonds needed to be broken are exposed
product released from, enzyme / active site ;
A enzyme can be used again / enzyme unchanged at end of reaction [max 3]

[Total: 7]

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Transport in plants – AS 9700 Biology June 2022

1. June/2022/Paper_11/No.26

Which row is correct for the movement of water in a root?

	pathway	molecule present in Casparian strip
A	apoplast pathway through intercellular spaces	suberin
B	apoplast pathway through plasmodesmata	lignin
C	symplast pathway through plasmodesmata	lignin
D	symplast pathway through intercellular spaces	suberin

2. June/2022/Paper_11/No.27

The table contains some information about uptake and movement of water and of mineral ions in plants.

	water	mineral ions
mechanism for uptake	osmosis	diffusion, active transport
site of uptake	root hair cells	root hair cells
mechanism of release	evaporation, diffusion	diffusion, active transport
site of release	stomata	plant cells

Using the information provided, which factors will affect the uptake and movement of water or of mineral ions in plants?

1 humidity

2 surface area of root hair cell

3 oxygen concentration

4 temperature

A 1, 2, 3 and 4

B 1, 3 and 4 only

C 1 and 3 only

D 4 only

3. June/2022/Paper_11/No.28

Which changes to the water potential and the volume of solution in the phloem sieve tube occur when sucrose is moved from a photosynthesising leaf into the phloem sieve tube?

	water potential in the phloem sieve tube becomes	volume of solution in the phloem sieve tube
A	higher	decreases
B	higher	increases
C	lower	decreases
D	lower	increases

4. June/2022/Paper_11/No.29

A student wrote the following statements about a possible mechanism for loading sucrose from a source.

1 When energy is released from ATP, the released energy is used to move sucrose through a co-transporter protein in the companion cell membrane.

2 As sucrose is moved into a companion cell the pH in the cell wall of the companion cell decreases.

3 Proton pumps in the cell membrane of a companion cell move sucrose into the phloem sieve tube element.

Which statements are correct?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

5. June/2022/Paper_12/No.24

Some of the features present in transport tissues are listed.

1 lignified walls

2 cytoplasm

3 mitochondria

4 pits

5 plasmodesmata

Which features are present in xylem vessel elements?

A 1, 2, 3 and 4

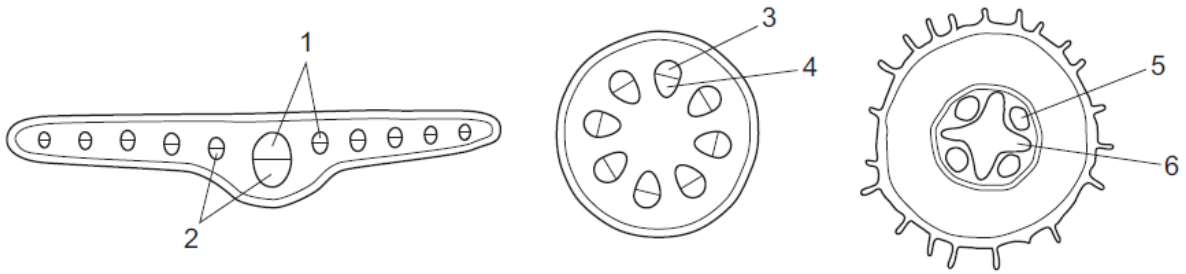
B 1, 4 and 5

C 1 and 4 only

D 2, 3 and 5

6. June/2022/Paper_12/No.25

The diagrams show transverse sections through parts of plants.



Which row is correct?

	contains lignin	transports organic solutes
A	1, 4, 5	2, 3, 6
B	1, 4, 6	2, 3, 5
C	2, 3, 5	1, 4, 6
D	2, 4, 6	1, 3, 5

7. June/2022/Paper_12/No.26

Which molecules form hydrogen bonds with water during transpiration?

1 cellulose in the xylem wall

2 suberin in the xylem wall

3 other water molecules in the xylem

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

8. June/2022/Paper_12/No.27

Some plant species can take up heavy metal contaminants that are dissolved in soil water and then transport them within the plant. Within plant cells, the heavy metals accumulate mainly in the vacuole.

Which suggestions about the transport and accumulation of heavy metals are valid?

1 After initial entry into the root, some of the heavy metals can pass through the tonoplast to be stored in the vacuole of cells in the cortex.

2 The heavy metals take an apoplastic pathway in the xylem but at the endodermis must take a symplastic pathway.

3 The rate of accumulation of the heavy metals in leaf cells will be faster at night, when photosynthesis is not occurring, than during the day.

4 The presence of heavy metals causes the transpiration stream to slow down and reduce the rate of transpiration.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

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9. June/2022/Paper_12/No.28

What is the correct route for the movement of water from cell to cell in the apoplast pathway?

A through adjacent cell surface membranes

B through intercellular spaces

C through plasmodesmata

D through the Casparian strip

10. June/2022/Paper_12/No.29

Which row shows the correct sequence for the movement of sucrose into phloem sieve tubes?

	first	second	third
A	diffusion of sucrose into the companion cell cytoplasm	active transport of protons into the companion cell cytoplasm	cotransport of protons and sucrose into the sieve tubes
B	cotransport of protons and sucrose into the companion cell cytoplasm	active transport of protons out of the companion cell cytoplasm	diffusion of sucrose into the sieve tubes
C	active transport of protons into the companion cell cytoplasm	diffusion of sucrose into the companion cell cytoplasm	cotransport of protons and sucrose into the sieve tubes
D	active transport of protons out of the companion cell cytoplasm	cotransport of protons and sucrose into the companion cell cytoplasm	diffusion of sucrose into the sieve tubes

11. June/2022/Paper_12/No.39

A person's blood group is determined by antigens present on the red blood cells. The table shows the antigens and antibodies in the blood of people with different blood groups.

blood group	presence of A or B antigens on red blood cells	presence of antibodies to A or B in plasma
A	A only	anti-B only
B	B only	anti-A only
AB	A and B	neither
O	neither	anti-A and anti-B

During a blood transfusion, it is essential that the person who receives the blood does **not** have antibodies to the donor's blood.

Which blood groups can be given to a person with blood group B?

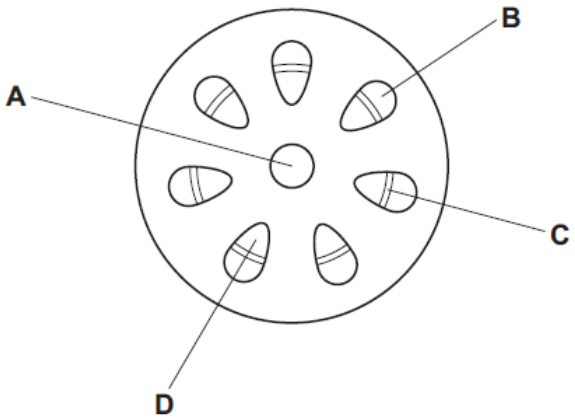
A A and B **B** AB and B **C** AB and O **D** B and O

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12. June/2022/Paper_13/No.26

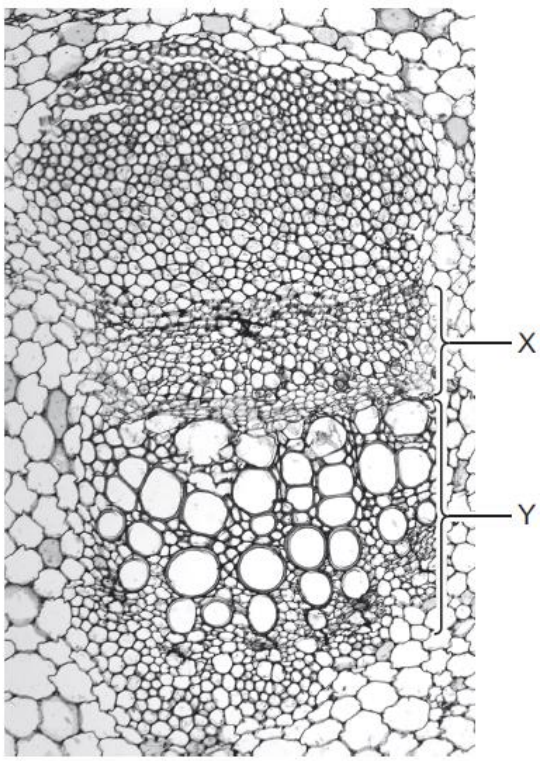
The diagram shows a plant organ.

Which letter correctly labels the xylem?



13. June/2022/Paper_13/No.27

The photomicrograph shows a vascular bundle found in a plant organ.



Which statements about this vascular bundle are correct?

1 The vascular bundle is part of the structure of a root.

2 Some of the cells in region X have very large numbers of mitochondria.

3 Region Y is made up of a number of different cell types.

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

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14. June/2022/Paper_13/No.28

Which changes to the water potential and the volume of solution in the phloem sieve tube element occur when sucrose is moved from the phloem sieve tube element to an actively dividing shoot tip?

	water potential in phloem sieve tube element becomes	volume of solution in phloem sieve tube element
A	higher	decreases
B	higher	increases
C	lower	decreases
D	lower	increases

15. June/2022/Paper_13/No.29

Which processes occur during the loading of sucrose into phloem sieve tubes?

1 Protons are pumped out of the cytoplasm of the companion cell into its cell wall.

2 There is a higher concentration of protons in the symplastic pathway outside the companion cell.

3 Protons are unable to move back into the companion cell.

4 A co-transporter molecule acts as a carrier for protons and sucrose.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

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16. June/2022/Paper_22/No.6

The transport tissues of plants are phloem and xylem.

The role of xylem is the transport of water and mineral ions from the soil solution to the different parts of the plant body.

The role of phloem is the translocation of assimilates and other substances from sources to sinks.

(a) The source of mineral ions for the plant is the soil solution. These mineral ions are transported from the roots in the xylem. Mineral ions are also found in the phloem sap within phloem sieve tubes.

Suggest why mineral ions are found within phloem sieve tubes **and** state how they are transported within phloem sieve tubes.

.....

.....

.....

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.....

.....

..... [3]

(b) Phloem tissue consists of different cell types.

Complete the passage using the most appropriate terms to summarise some of the features of phloem tissue.

The end walls of sieve tube elements are modified to allow efficient flow of phloem sap by the formation of ..... . These structures also prevent the cells from bursting under pressure. The cytoplasm of sieve tube elements is very much reduced and is found at the ..... of the cells. Most of the organelles in the cell are absent. Adjacent to sieve tube elements are ..... cells that carry out the metabolic processes of the missing organelles, allowing the sieve tube elements to function. [3]

[Total: 6]

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17. June/2022/Paper_22/No.7

Hakea spp. are xerophytic plants native to Australia. The leaves of *Hakea* have adaptations for a xerophytic mode of life.

(a) Fig. 3.1 is a photomicrograph of a transverse section of part of a leaf of *H. laurina*.

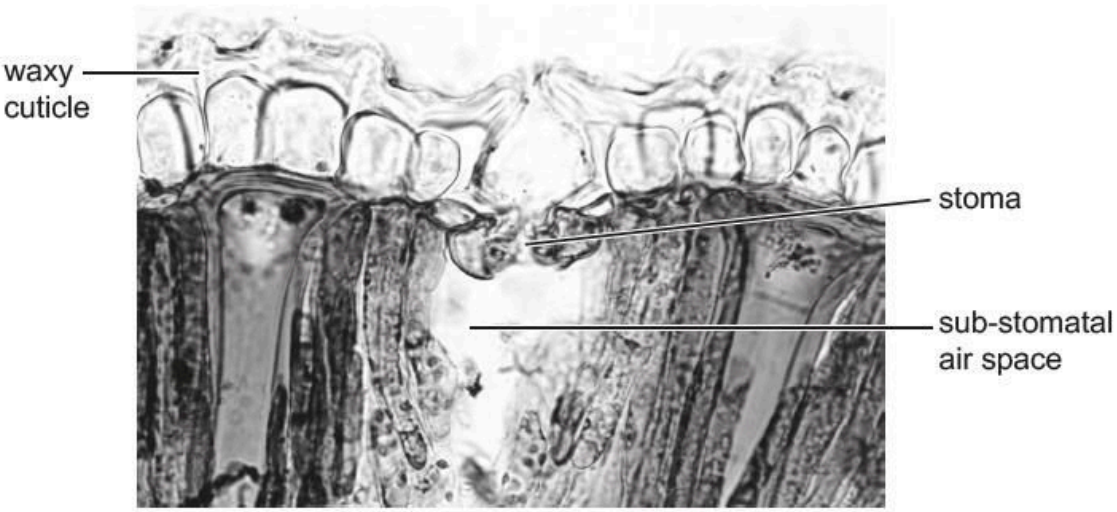


Fig. 3.1

Describe the xerophytic features of the waxy cuticle and the stoma shown in Fig. 3.1 **and** explain how these features adapt the plant to a xerophytic mode of life.

.....

.....

.....

.....

.....

.....

..... [3]

(b) When the availability of phosphate ions and other soil nutrients is limited, a number of changes occur in the roots of *Hakea* spp.:

- Regions of meristematic tissue are active for a few days.
- Root clusters are formed. A root cluster is a dense arrangement of tiny side roots known as rootlets.
- Most of the epidermal cells of the rootlets are root hair cells.
- Rootlets release compounds into the soil that make phosphates and other mineral ions more soluble for uptake.
- Uptake of phosphate ions and the absorption of water from the soil increases.

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(i) Meristem cells have a similar role to stem cells in animals.

Suggest how meristematic tissue activity leads to the formation of root clusters.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Organic anions (negatively charged organic compounds) are released into the soil by rootlets. The concentration of these organic anions can become higher in the soil solution than in the rootlet cells.

Suggest **and** explain how the concentration of organic anions in the soil solution can become higher than in the rootlet cells.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) Explain how the formation of root clusters can lead to an increase in the uptake of phosphate ions and absorption of water from the soil solution.

.....

.....

.....

.....

.....

..... [2]

[Total: 11]

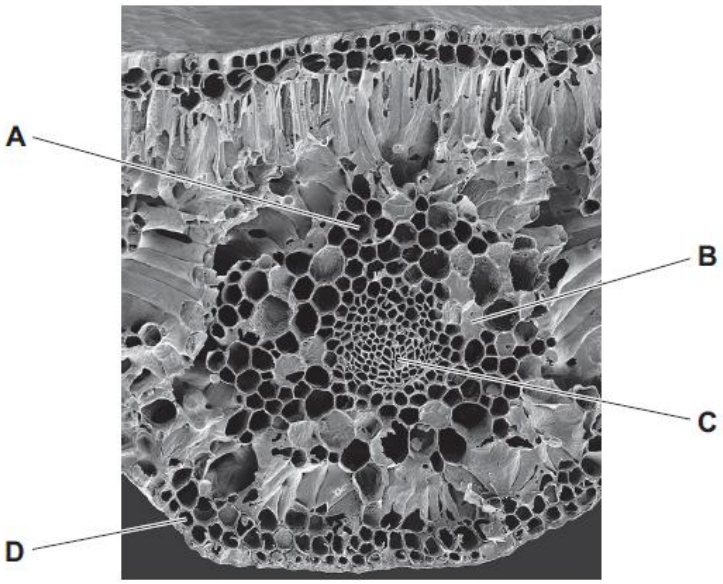
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Transport in plants – AS 9700 Biology Nov 2022

1. Nov/2022/Paper_11/No.26

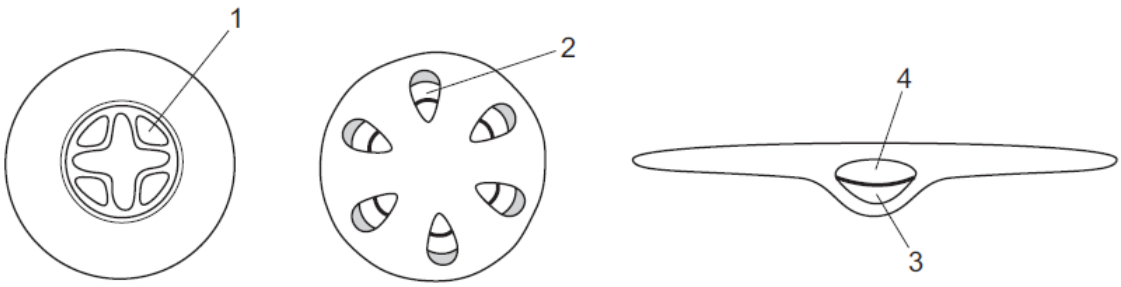
The electron micrograph shows a cross-section of a leaf vein and some neighbouring cells.

Which structure contributes to mass flow by the use of proton pumps?



2. Nov/2022/Paper_11/No.27

The diagrams show some tissue types in plant organs.



Which row identifies the tissue types?

	1	2	3	4
A	phloem	phloem	phloem	xylem
B	phloem	xylem	phloem	xylem
C	xylem	phloem	xylem	phloem
D	xylem	xylem	phloem	xylem

3. Nov/2022/Paper_11/No.28

Which description of xylem vessel elements is correct?

A cells joined to form a tube, pits at intervals, sieve plates between cells, surrounded by the endodermis in roots

B contains cells joined end to end, containing cytoplasm, cell walls with lignin, located to the outside of phloem in vascular bundles

C contains elongated cells with end walls broken down, located in vascular bundles in the stem and leaves

D dead elongated cells, lignified cell walls with pits at intervals, associated with companion cells in the roots only

4. Nov/2022/Paper_11/No.29

Which properties of lignin are important for the function of xylem vessels in the stem of a tall plant, such as a tree?

1 It is inflexible so does not bend easily.

2 It is not permeable to water.

3 It is strong to resist collapse under pressure.

4 It has weaker adhesion to water molecules than cellulose.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

5. Nov/2022/Paper_11/No.30

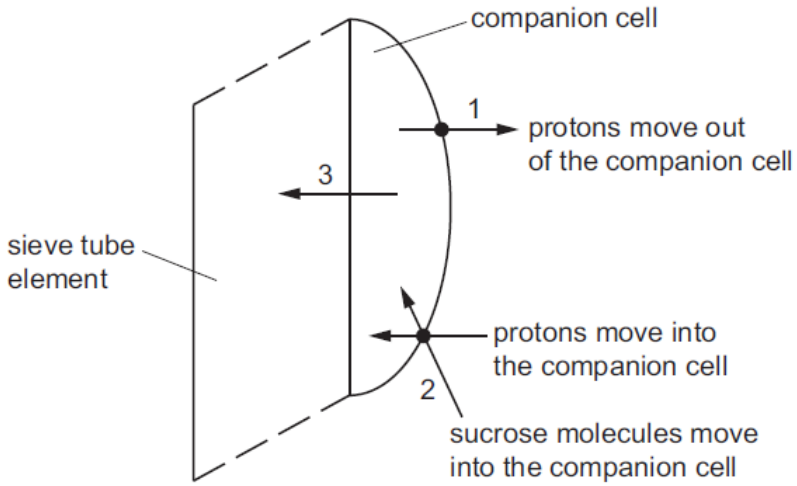
Which row is correct for the sucrose concentrations and the water potentials in a source and a sink in a potato plant, at 12:00 p.m.?

	sucrose concentration		water potential	
	source	sink	source	sink
A	higher	lower	higher	lower
B	higher	lower	lower	higher
C	lower	higher	higher	lower
D	lower	higher	lower	higher

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6. Nov/2022/Paper_11/No.31

The diagram shows one possible way in which sucrose may be loaded into a sieve tube element.

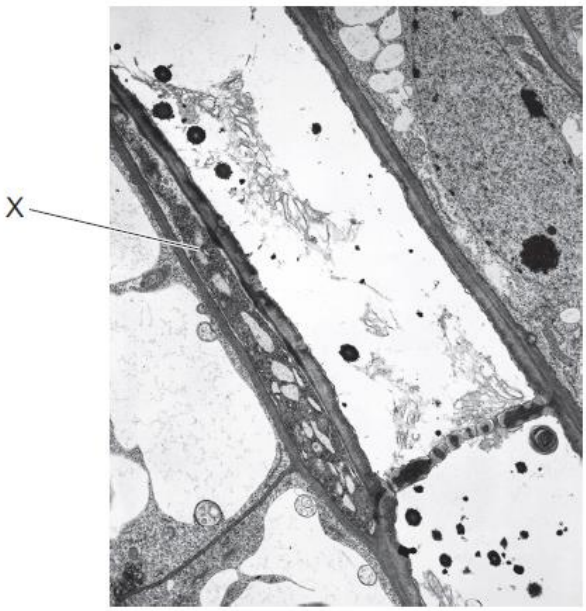


Which steps require ATP?

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 3 only

7. Nov/2022/Paper_12/No.26

The electron micrograph shows a longitudinal section through part of a plant stem.



What is X?

A xylem vessel element

B stem cell

C phloem sieve tube element

D companion cell

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8. Nov/2022/Paper_12/No.27

Sodium chloride is added to a culture solution containing freshwater single-celled plant cells.

What happens to the water potential of the culture solution when the sodium chloride is added and what may happen to the plant cells after 5 minutes?

	water potential of the culture solution when sodium chloride added	single-celled plant cells after 5 minutes
A	becomes less negative	become plasmolysed
B	becomes less negative	become turgid
C	becomes more negative	become plasmolysed
D	becomes more negative	become turgid

9. Nov/2022/Paper_12/No.28

Which statements correctly describe transport pathways in dicotyledonous plants?

1 In the apoplast pathway, water may move through plasmodesmata.

2 In the symplast pathway, water may move through intercellular spaces.

3 The apoplast pathway may be blocked by the Casparian strip.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 only

10. Nov/2022/Paper_12/No.29

Which statement about the movement of water from roots to leaves is **not** correct?

A A continuous column of water is partly maintained by the attraction of water molecules to cellulose.

B Hydrogen bonding between water molecules enables mass flow of water.

C Hydrostatic pressure in xylem vessel elements is higher in roots than in leaves.

D Water potential changes throughout the length of the xylem vessel elements.

11. Nov/2022/Paper_12/No.30

Which terms describe the method by which water is transported within xylem vessel elements?

1 cotransport

2 cohesion-tension

3 osmosis

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

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12. Nov/2022/Paper_12/No.31

What is the main function of a companion cell in phloem tissue?

A providing cytoplasmic contact with the sieve tube element for loading

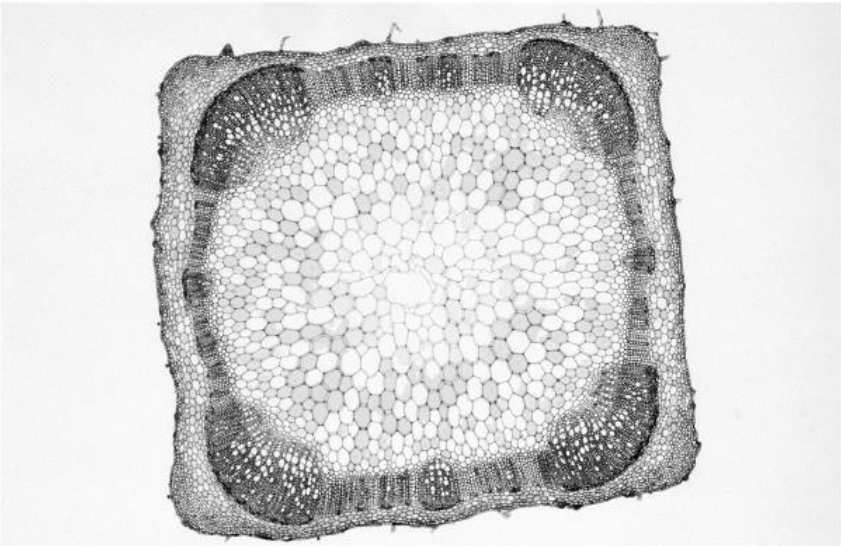
B providing structural support for the sieve tube element

C providing the nucleus for cell division in the phloem

D providing the source of assimilates for storage

13. Nov/2022/Paper_13/No.26

The photomicrograph shows a section through a plant organ.



Which statement could be used to describe this organ?

A The central region of this organ has supporting tissue.

B The endodermis tissue is a thick layer around the edge of the organ.

C The epidermis tissue in this organ has extensions (trichomes).

D The xylem tissue is found in greatest density in the centre of the organ.

14. Nov/2022/Paper_13/No.28

Which xerophytic adaptations reduce the water potential gradient between leaf surface and atmosphere?

1 rolled leaves

2 hairy leaves

3 sunken stomata

4 fewer stomata

5 fleshy leaves

A 1, 2, 3, 4 and 5

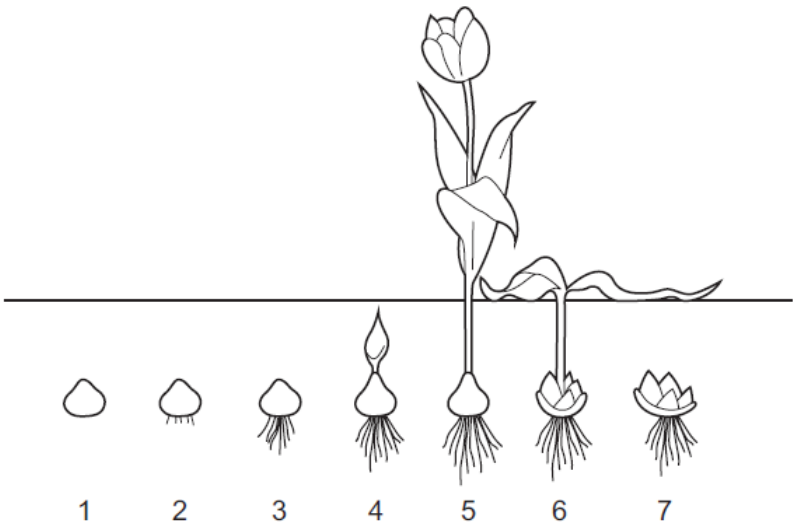
B 1, 2 and 3 only

C 1, 3 and 4 only

D 2 and 5 only

15. Nov/2022/Paper_13/No.29

The diagram shows seven stages of a tulip bulb's growth.



Which row identifies the correct stages in which the tulip bulb is acting as a source only or as a sink only?

	source only	sink only
A	1	5
B	3	4
C	4	6
D	5	7

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16. Nov/2022/Paper_13/No.30

What would be changed if mitochondrial activity was inhibited by a metabolic poison acting on cells in the phloem tissue?

1 concentration of hydrogen ions in the cell wall of companion cells

2 concentration of sucrose in the cytoplasm of cells in a leaf

3 hydrostatic pressure gradient in the phloem sieve tube

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

17. Nov/2022/Paper_13/No.31

By which process does sucrose move through phloem sieve tube elements?

A active transport

B diffusion

C facilitated diffusion

D mass flow

18. Nov/2022/Paper_21/No.5(a_ d)(i)

(a) When water molecules enter a plant through the roots, the molecules cross the cortex and enter the xylem tissue to be transported to other parts of the plant.

There are two pathways that water can take when crossing the root to the xylem tissue.

Complete Table 5.1 with information about the two pathways.

Table 5.1

name of pathway	outline of pathway
	movement of water from cell to cell through plasmodesmata

[2]

(b) Fig. 5.1 is a photomicrograph of a transverse section through the stem of a flowering plant.

On Fig. 5.1, draw a label line and the letter **T** to identify xylem tissue. [1]

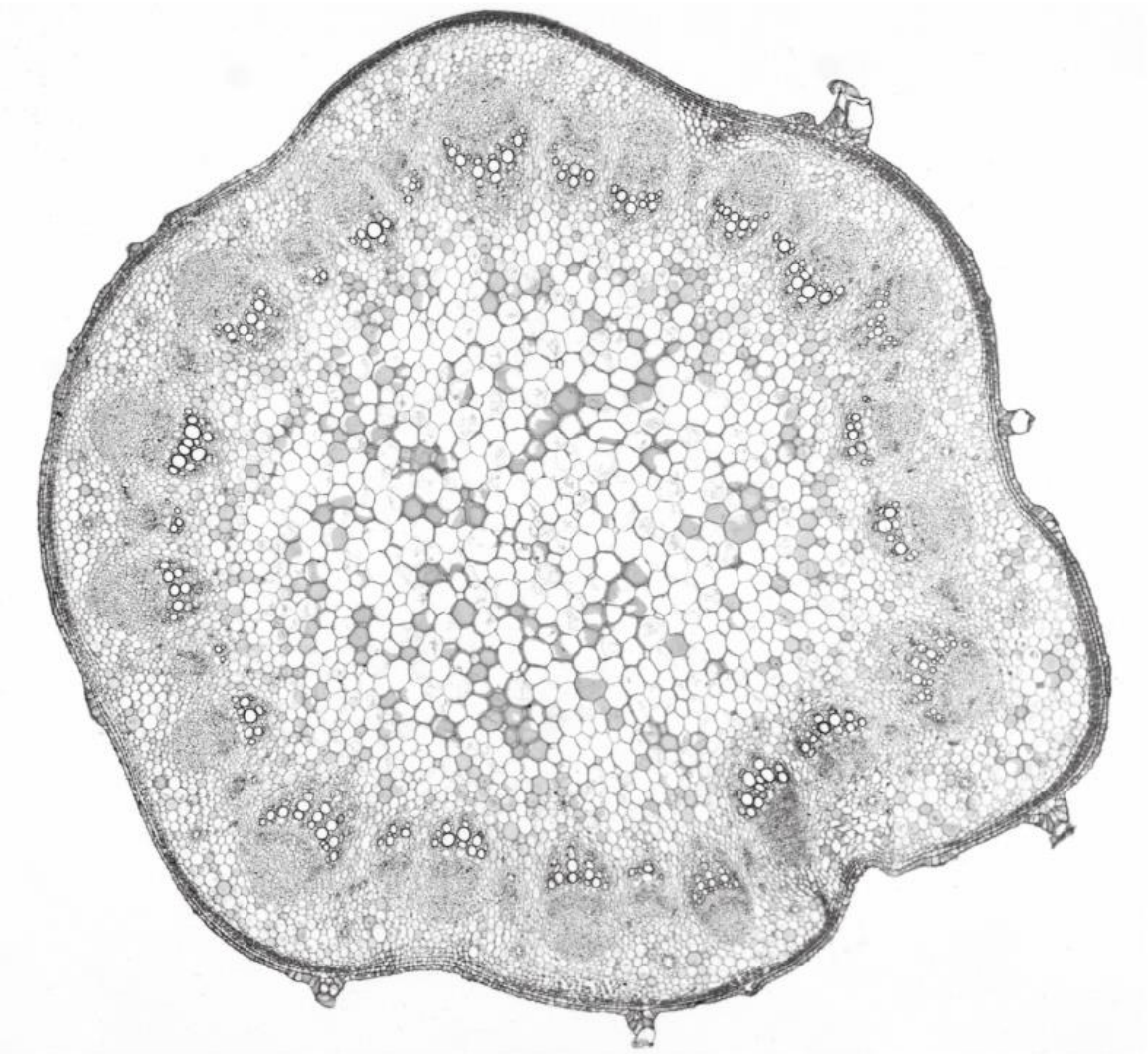


Fig. 5.1

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(c) Scientists have studied the process of cell death that occurs during the development of the cells that become mature xylem vessel elements.

During this development, the tonoplast ruptures (bursts) and releases hydrolytic enzymes contained in the vacuole into the cytoplasm.

(i) Name an organelle found in animal cells that has a similar function to the vacuole in the developing xylem vessel elements.

..... [1]

(ii) The rupture of the tonoplast during development of xylem vessel elements is due to changes in permeability of the tonoplast.

Suggest how the permeability of the tonoplast changes **and** explain how this change could result in the rupture of the tonoplast.

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..... [3]

(iii) During development of the xylem vessel elements the pH of the cytoplasm decreases. This change in pH activates enzymes in the cytoplasm that cause organelles to swell.

Suggest how a change in pH of the cytoplasm can activate enzymes.

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..... [2]

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(d) Some insects are vectors of disease.

(i) When an insect feeds on the xylem fluid it can act as a vector of plant diseases such as Pierce's disease. This bacterial disease affects many fruit trees causing the leaves to turn brown and drop from the plant, resulting in much less fruit being produced.

Explain why Pierce's disease can be described as an infectious disease.

.....

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.....

.....[2]

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19. Nov/2022/Paper_22/No.6

Xylem and phloem are the transport tissues of plants. Both tissues have more than one cell type.

The conducting cells of xylem contain xylem sap and those of phloem contain phloem sap.
The composition of xylem sap differs from the composition of phloem sap.

(a) The main component of xylem sap and phloem sap is water.

Explain why water is the main component of xylem sap and phloem sap.

.....

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..... [2]

(b) Three types of cell associated with the translocation of sucrose are:

- companion cell
- mesophyll cell
- phloem sieve tube element.

A, **B** and **C** are three events that occur at the source. Each event refers to '**the cell**' but does not name the type of cell concerned.

A Sucrose moves through plasmodesmata into **the cell**.
B Hydrogen ions are transported out of **the cell**.
C Sucrose moves into **the cell** through cotransporter proteins.

Complete Table 6.1 by matching the event with a correct cell type.

Each cell type may be identified once, more than once, or not at all.

Table 6.1

event	cell type
A	
B	
C	

[3]

[Total: 5]

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20. Nov/2022/Paper_23/No.3(a, b)

(a) During translation, a polypeptide is synthesised when amino acids are added to a growing chain of amino acids.

Fig. 1.1 shows part of a growing chain of amino acids and the amino acid cysteine.

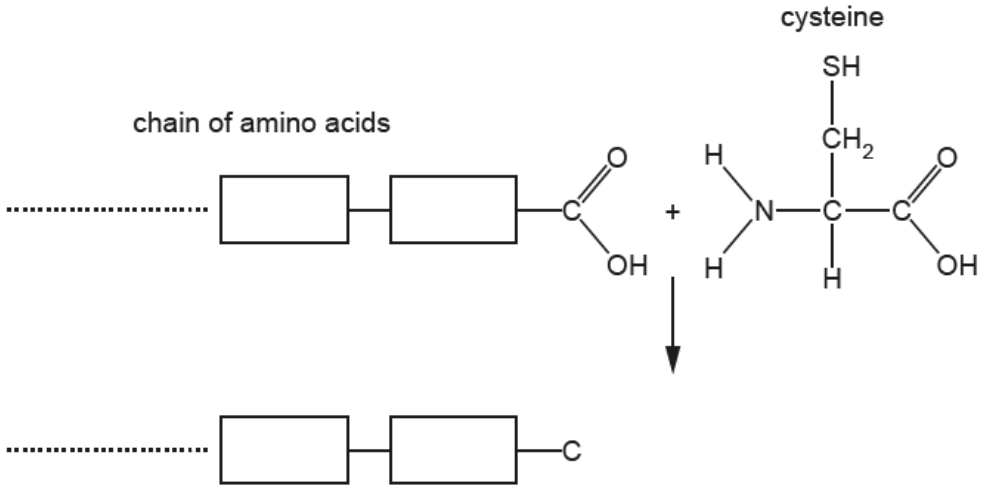


Fig. 1.1

(i) Complete Fig. 1.1 by showing the formation of the bond between cysteine and the growing chain of amino acids in the process of translation. [3]

(ii) State the name of the covalent bond that forms when cysteine is added to the growing chain of amino acids.

..... [1]

(iii) State the organelle where the reaction shown in Fig. 1.1 takes place.

..... [1]

(b) Fig. 1.2 is a ribbon diagram showing the three-dimensional structure of a protein from the bacterium *Streptococcus*.

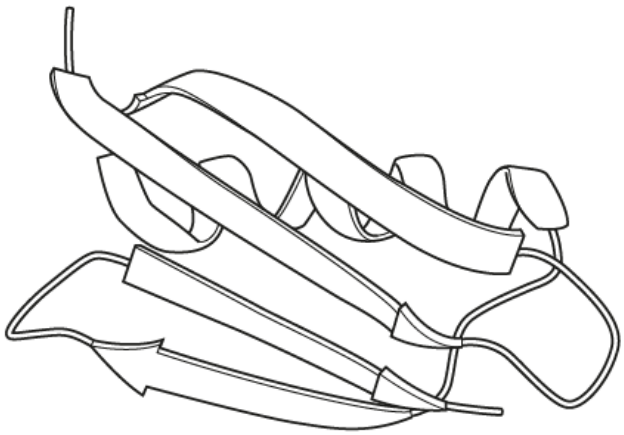


Fig. 1.2

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(i) Describe the secondary structure of the protein shown in Fig. 1.2.

.....

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.....

..... [2]

(ii) Explain why the protein shown in Fig. 1.2 has tertiary structure, but not quaternary structure.

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..... [2]

(iii) An analysis of the amino acid composition of the protein in Fig. 1.2 showed that it does **not** contain any cysteine residues.

Explain how the three-dimensional structure of the protein shown in Fig. 1.2 is held in place.

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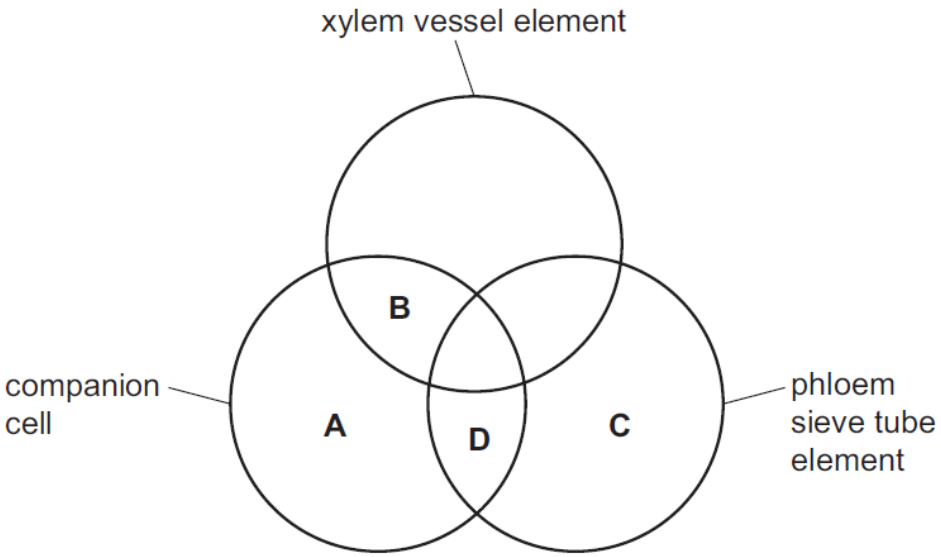
..... [3]

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Transport in plants – AS 9700 June 2022

1. June/2023/Paper_9700/11/No.23

Which structures contain cytoplasm with mitochondria and a nucleus?



2. June/2023/Paper_9700/11/No.24

What is the correct term to describe intermolecular hydrogen bonding between water molecules?

A adhesion

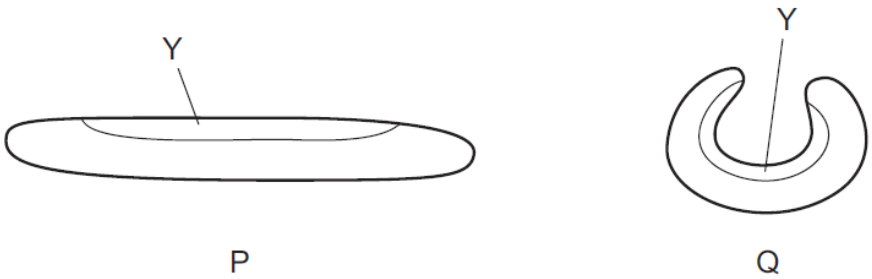
B cohesion

C osmosis

D diffusion

3. June/2023/Paper_9700/11/No.25

The diagram shows the outline of a xerophytic leaf that had been left for 45 minutes in different conditions, P and Q.



Which statements about the cells in layer Y of the leaf in each of the conditions P and Q **after** 45 minutes are correct?

1 There is a less negative water potential in P than in Q.

2 The cells may be turgid in P and plasmolysed in Q.

3 The cells are less turgid in P than in Q.

4 There is no net diffusion of water into Y in either P **or** Q.

A 1, 2 and 4 **B** 1, 3 and 4 **C** 1 and 3 only **D** 2 and 4 only

4. June/2023/Paper_9700/11/No.26

How does sucrose move from chloroplasts to the phloem?

1 diffusion

2 apoplast pathway

3 symplast pathway

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

5. June/2023/Paper_9700/11/No.27

How are companion cells involved in loading sucrose into phloem sieve tube elements?

A actively through cotransporter proteins and passively through plasmodesmata

B actively through cotransporter proteins and plasmodesmata

C passively through cotransporter proteins only

D actively through plasmodesmata only

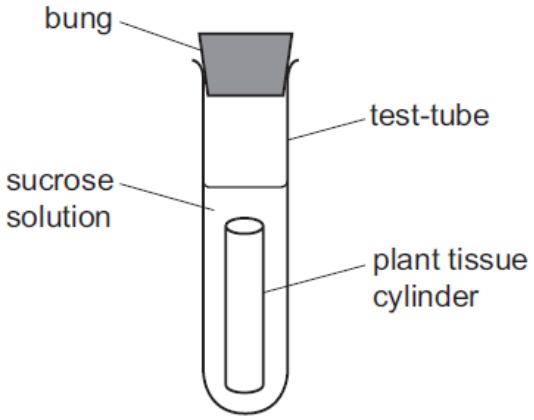
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6. June/2023/Paper_9700/12/No.19

An experiment was carried out to investigate the effect of concentration of sucrose solution on cells in a plant tissue.

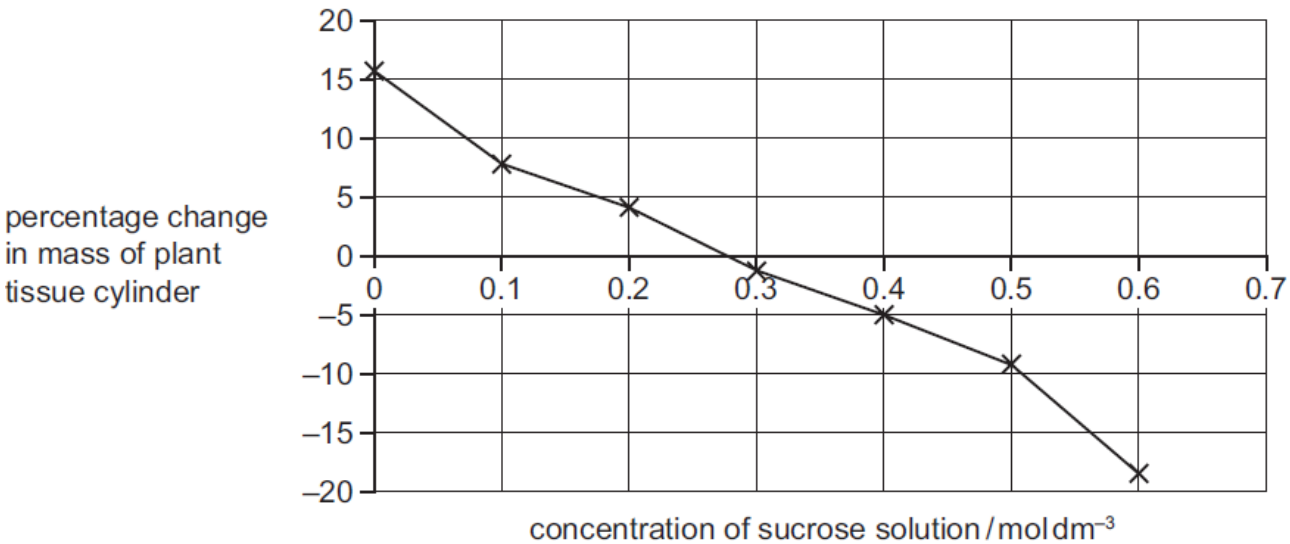
A sample of plant tissue was cut into seven cylinders of equal length and diameter. The mass of each cylinder was recorded.

Each of the seven cylinders was put into a different sucrose solution concentration.



After two hours, the cylinders were removed, blotted dry and reweighed. The percentage change in mass of each cylinder was recorded.

The graph shows the results of this investigation.



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Which row explains the results if plant tissue cells were put in a sucrose solution of 0.45 mol dm^{-3}?

	water potential of the cytoplasm of the cells at the start of the experiment compared with the water potential of 0.45 mol dm^{-3} sucrose solution	change in volume of the vacuoles of the cells at the end of the experiment, that were initially placed in 0.45 mol dm^{-3} sucrose solution
A	less negative	decreased
B	less negative	increased
C	more negative	decreased
D	more negative	increased

7. June/2023/Paper_9700/12/No.27

Which statements about the apoplast and symplast pathways are correct?

1 In the apoplast pathway, water molecules move through free spaces in the cellulose cell walls of plant roots.

2 In the symplast pathway, water molecules diffuse through the cytoplasm and plasmodesmata of cells.

3 Water molecules travelling through plant tissue move by mass flow along the apoplast pathway.

4 The Casparian strip blocks the symplast pathway and forces all water molecules to enter the cytoplasm of endodermis cells.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1 and 2 only

D 3 and 4 only

8. June/2023/Paper_9700/12/No.28

Where does water evaporate from during transpiration?

A intercellular spaces

B leaf surface

C mesophyll cell walls

D stomatal pores

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9. June/2023/Paper_9700/12/No.31

Which statement supports the theory of active loading of sucrose into companion cells?

A The pH decreases in the cell wall of the companion cells compared with the cytoplasm.

B The pH decreases in the cytoplasm of the companion cells compared with the cell wall.

C The pH decreases in the companion cells and sieve tube elements.

D The pH decreases in the sieve tube elements compared with the companion cells.

10. June/2023/Paper_9700/13/No.27

Which row correctly explains how the structures of phloem sieve tube elements and xylem vessel elements are related to their functions as transport systems?

	phloem sieve tube elements	xylem vessel elements
A	contain mitochondria to make ATP for the active loading of sucrose into the phloem	cell walls are thickened and contain lignin which makes xylem vessels waterproof
B	contain no nucleus so that dissolved solutes can move easily through cells	end walls between cells are perforated so that water can move easily through xylem vessels
C	end walls between cells are perforated so that dissolved solutes can move between cells	lignin in cell walls gives strength so that xylem vessels do not collapse due to transpiration pull
D	no end walls between cells so that sucrose solution can move up and down the phloem	contain no cytoplasm so that a continuous column of water can move up the xylem vessels

11. June/2023/Paper_9700/13/No.28

Which component of plants is used by the apoplast pathway as water is moved from the soil to the xylem?

A Casparian strip

B cellulose

C endodermis

D suberin

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12. June/2023/Paper_9700/13/No.29

Which statements correctly describe transport pathways in dicotyledonous plants?

1 In the symplast pathway, water may move through intercellular spaces.

2 The symplast pathway may be blocked by the tonoplast.

3 In the apoplast pathway, water does **not** move through plasmodesmata.

4 The apoplast pathway may be blocked by the Casparian strip.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

13. June/2023/Paper_9700/13/No.30

Plants, such as the tobacco plant, retain very little of the water they take in and the volume of water lost during transpiration is very high. This is because these plants can only absorb carbon dioxide through open stomata.

Plants use carbon dioxide to synthesise glucose molecules. It is estimated that 400 molecules of water are lost for each carbon dioxide molecule gained.

How many water molecules are lost for a plant to synthesise one molecule of glucose?

A 800 **B** 1200 **C** 2000 **D** 2400

14. June/2023/Paper_9700/13/No.31

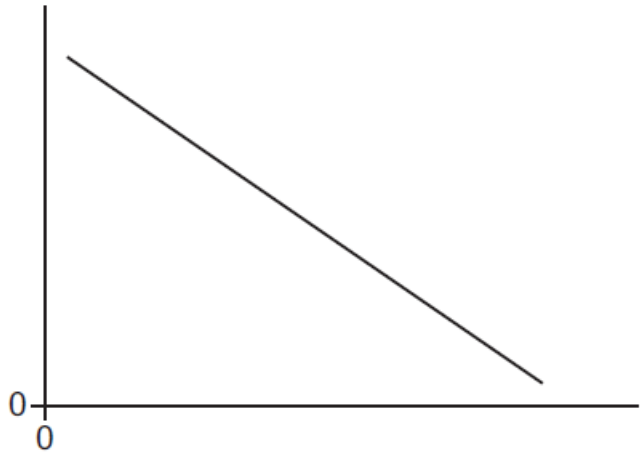
Which changes occur as sucrose is transferred from leaves into phloem sieve tubes to be transported to a sink?

	water potential in phloem sieve tubes becomes	volume of liquid in phloem sieve tubes
A	less negative	decreases
B	less negative	increases
C	more negative	decreases
D	more negative	increases

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15. June/2023/Paper_9700/13/No.32

The graph shown does not have any axis labels.



Which row shows appropriate labels for the axes that would explain mass flow in phloem?

	x-axis	*y*-axis
A	distance from sink / m	hydrostatic pressure / kPa
B	hydrostatic pressure / kPa	distance from sink / m
C	distance from source / m	hydrostatic pressure / kPa
D	hydrostatic pressure / kPa	distance from source / m

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16. June/2023/Paper_9700/21/No.6

Fig. 6.1 is a diagram showing the passage of water through the tissues of a flowering plant from the soil to the atmosphere. The arrows show the direction of water movement.

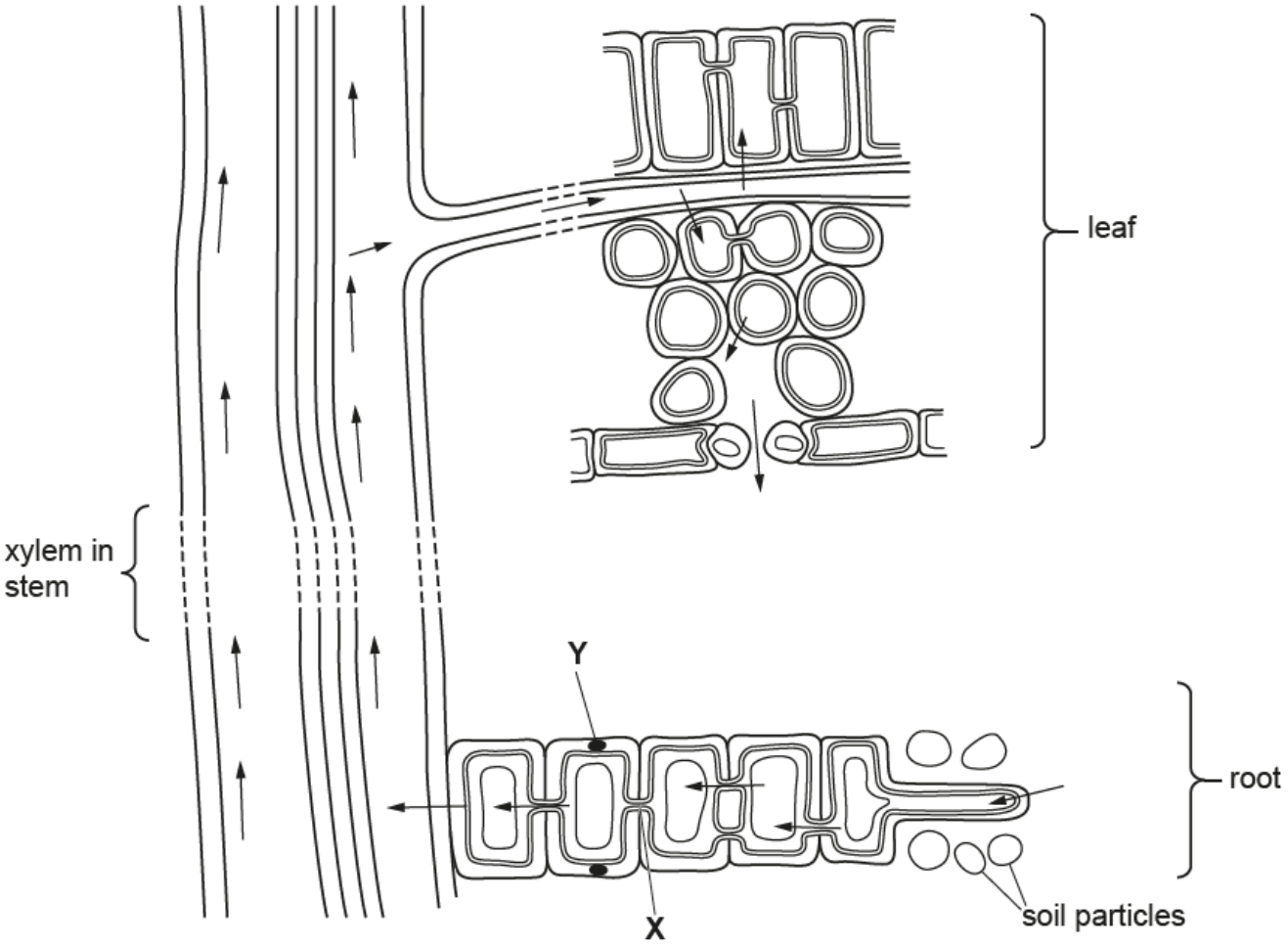


Fig. 6.1

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(a) The structure labelled **X** is part of the symplast pathway. State the name of structure **X**.

..... [1]

(b) The structure labelled **Y** in the cell wall is a barrier to the apoplast pathway. State the name of structure **Y**.

..... [1]

(c) With reference to Fig. 6.1, complete the statements about the movement of water in the flowering plant.

Water moves from the soil solution to the cytoplasm of root hair cells by .....

Water moves from the xylem in the root to the leaf by .....

Water moves from mesophyll cell walls to intercellular air spaces by .....

Water vapour moves from intercellular air spaces to the atmosphere outside the leaf by .....

[4]

[Total: 6]

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17. June/2023/Paper_9700/22/No.6

The Weibel Lung model was developed after an extensive study of the gas exchange system. The model includes detailed measurements of airway diameters (lumen diameters of the airways). In the model, different parts of the gas exchange system are identified with a generation number, as outlined in Fig. 6.1.

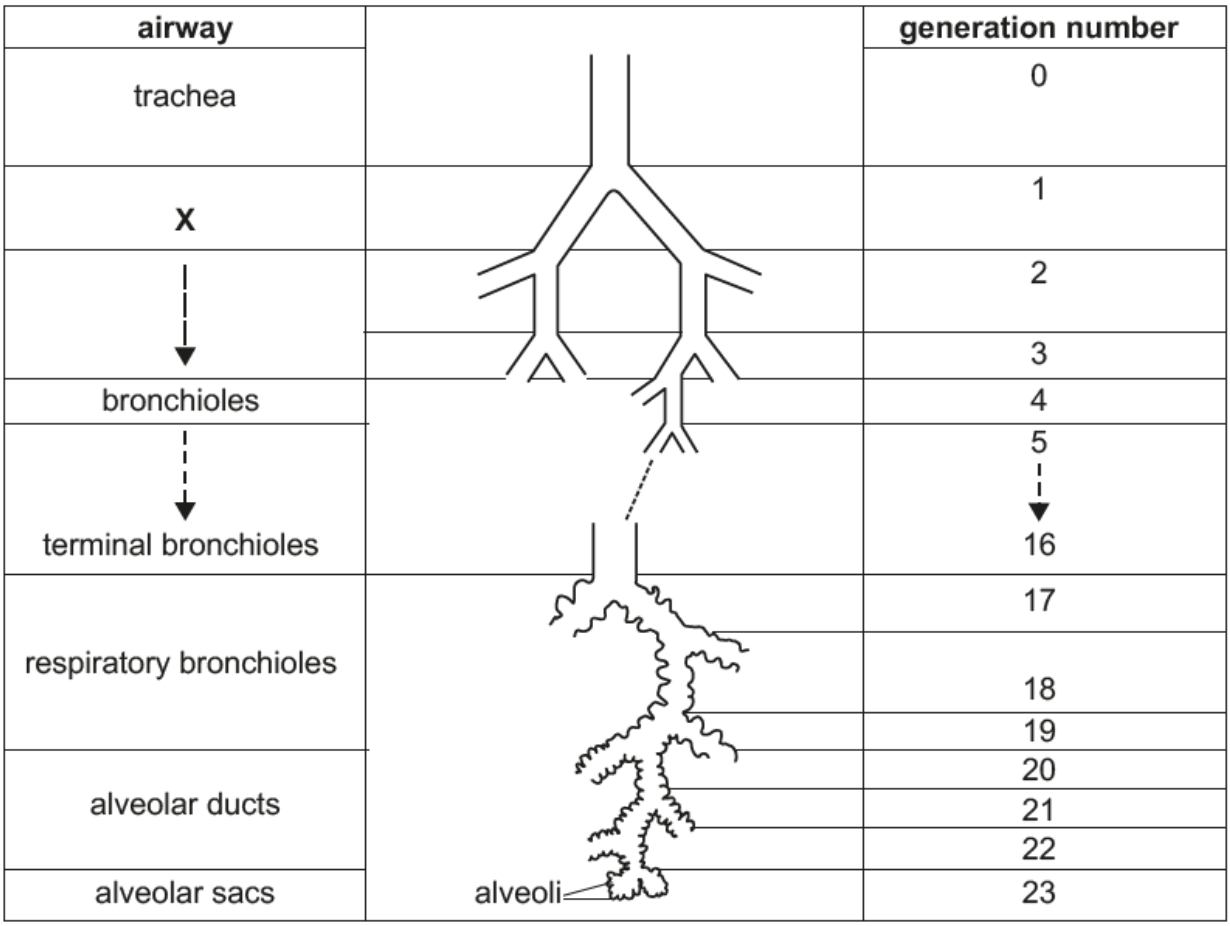


Fig. 6.1

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(a) The Weibel Lung model describes how each airway divides into two.

Name the airways in generation 1, labelled **X** in Fig. 6.1, that branch from generation 0.

..... [1]

(b) The airways are well supplied with blood. However, the airways from generation 0 to generation 16, shown in Fig. 6.1, are **not** able to carry out gas exchange.

Suggest why the airways from generation 0 to generation 16 are **not** able to carry out gas exchange.

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.....

..... [2]

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(c) High-resolution computed tomography (HRCT) is an imaging technique that is used to obtain measurements of airway diameters in people with a pulmonary (lung) disease. Regular, repeated imaging must be avoided because it involves exposure to harmful radiation.

Scientists researched the use of a different technique, HP gas MRI, that does **not** involve harmful radiation. Two types of MRI image, known as projection and multi-Slice, were used to obtain measurements of airway diameters.

Fig. 6.2 shows the results of the HP gas MRI study compared with the Weibel Lung model, for generations 0 to 5. The Weibel Lung model was used as a standard reference for airway diameters.

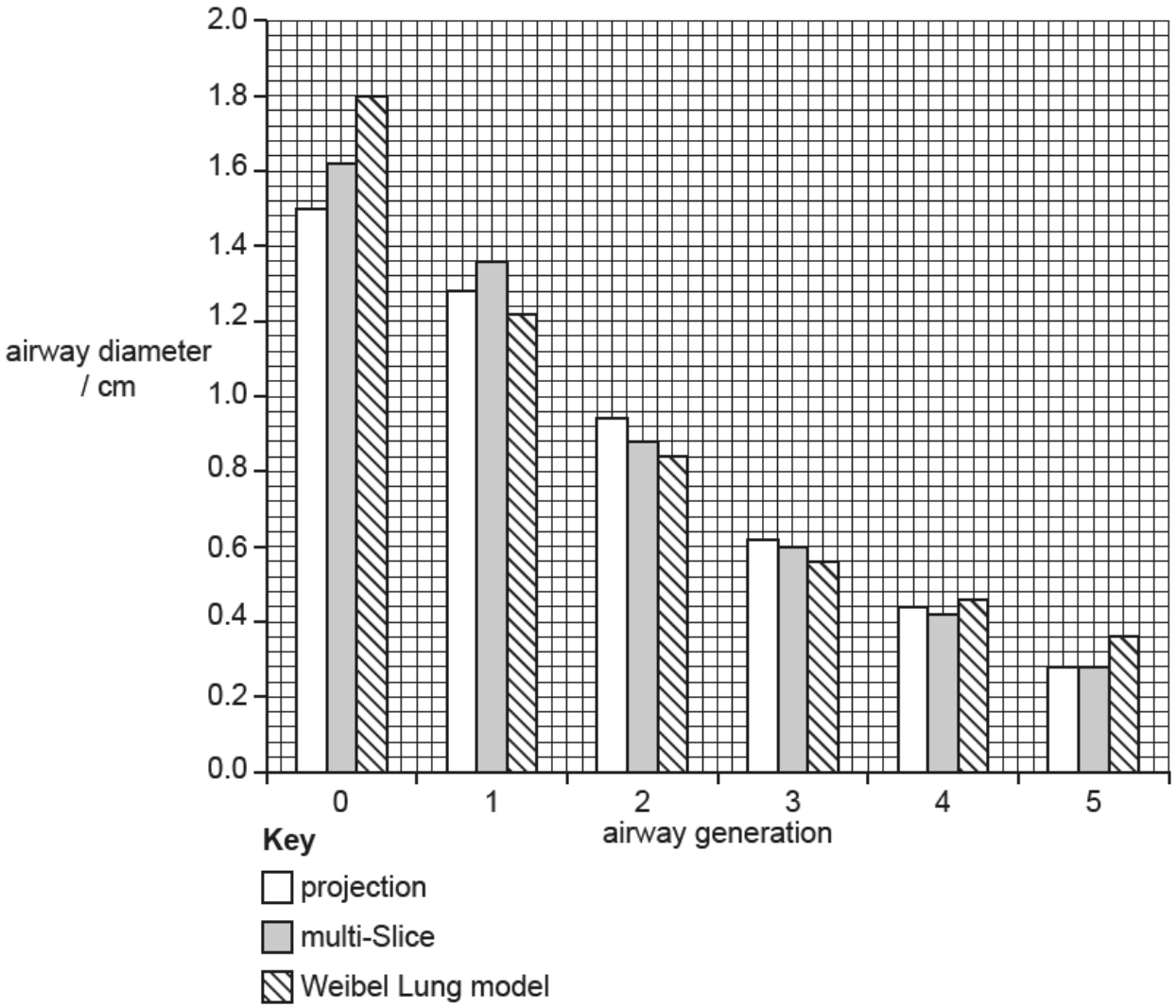


Fig. 6.2

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(i) State the relationship shown in Fig. 6.2 between airway diameter and airway generation for the Weibel Lung model data.

.....

..... [1]

(ii) With reference to the data in Fig. 6.2, explain whether HP gas MRI could be a useful alternative to HRCT in obtaining airway diameter measurements.

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..... [3]

[Total: 7]

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18. June/2023/Paper_9700/23/No.5

Phloem and xylem are specialised tissues involved in the transport of water, ions and assimilates in plants.

(a) A photomicrograph of a transverse section of a dicotyledonous stem is shown in Fig. 5.1.

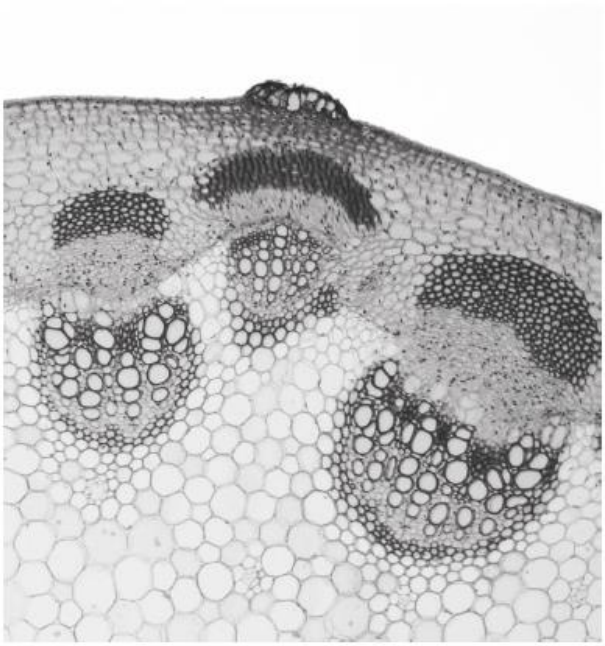


Fig. 5.1

Use label lines and labels to identify the phloem tissue **and** xylem tissue in Fig. 5.1. [2]

(b) **(i)** Describe how sucrose is transported in phloem sieve tubes from photosynthesising leaves to other parts of the plant.

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..... [4]

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(ii) Cyanide ions (CN^-) inhibit the activity of an enzyme involved in respiration.

Suggest why the treatment of photosynthesising leaves with CN^- results in less sucrose being transported into phloem sieve tubes.

.....

.....

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.....

..... [2]

(c) A student was asked to carry out semi-quantitative Benedict's tests on two solutions.

- Solution **A** was extracted from the cytoplasm of cells in the mesophyll tissue of photosynthesising leaves.
- Solution **B** was extracted from the phloem sap in phloem sieve tubes.

The solutions were taken from the same plant, and other variables were standardised.

For each solution, the student measured the time taken for the first colour change to appear.

Suggest which of the two solutions, **A** or **B**, would change colour in the shortest time.

Explain your answer.

.....

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.....

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..... [2]

[Total: 10]

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19. March/2023/Paper_9700/12/No.25

Which row correctly matches the structure and function of phloem sieve tube elements?

	structure	function
A	peripheral cytoplasm with no nucleus	to provide as little resistance to flow as possible
B	end walls modified to form sieve plates	to slow down the rate of transport of solutes
C	elongated cells joined end to end	to form a tube to transport dissolved mineral ions and water
D	cellulose cell wall with no lignin	to prevent loss of water

20. March/2023/Paper_9700/12/No.26

Which feature of xylem vessel elements helps adhesion during transpiration?

A Lignin forms a complete secondary wall.

B New vessels carry extra water as the plants grow.

C There are no cross walls between vessel elements.

D The vessel elements form a narrow tube.

21. March/2023/Paper_9700/12/No.27

Mass flow is the bulk movement of materials from one place to another.

How many of the vessels listed carry fluids by mass flow?

- artery
- phloem sieve tube
- vein
- xylem vessel

A 1 **B** 2 **C** 3 **D** 4

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22. March/2023/Paper_9700/12/No.28

Cellulose, lignin and suberin are components of various plant cell walls.

Descriptions of these cell wall components are listed.

1 a component of the Casparian strip

2 redirects water into the symplast pathway

3 a hydrophobic component of cell walls

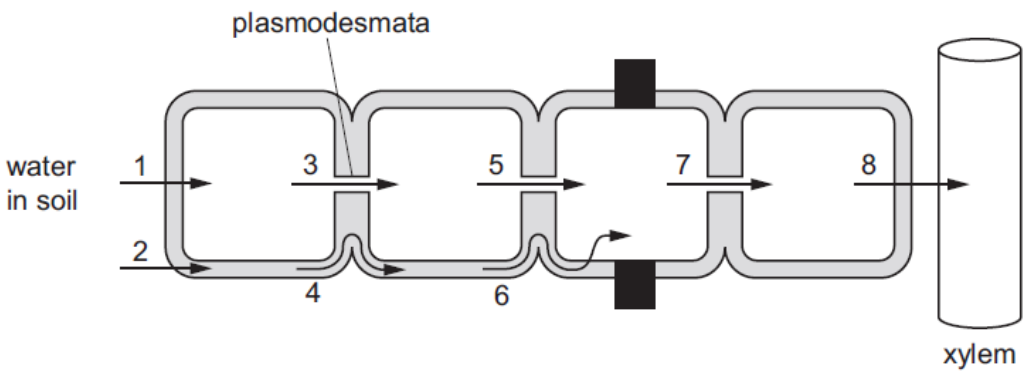
4 water interacts with this molecule in the apoplast pathway

Which row correctly matches three of the descriptions with cell wall components?

	cellulose	lignin	suberin
A	2	4	1
B	3	4	2
C	4	1	2
D	4	3	1

23. March/2023/Paper_9700/12/No.29

The arrows show the direction of water movement across a plant root, from water in the soil to the xylem.



Which arrows show water movement **only** in the apoplast pathway?

A 1, 3, 5, 7 and 8

B 2, 4 and 6

C 2 and 4 only

D 3, 5 and 7 only

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24. March/2023/Paper_9700/12/No.30

Which row correctly identifies sources and sinks of sugars?

	root cells absorbing mineral ions	storage cells of seed that is starting to grow
A	sink	source
B	sink	sink
C	source	source
D	source	sink

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25. March/2023/Paper_9700/22/No.3

(a) Fig. 3.1 is a diagram of an area of phloem tissue from a transverse section through the stem of a squash plant, *Cucurbita pepo*.

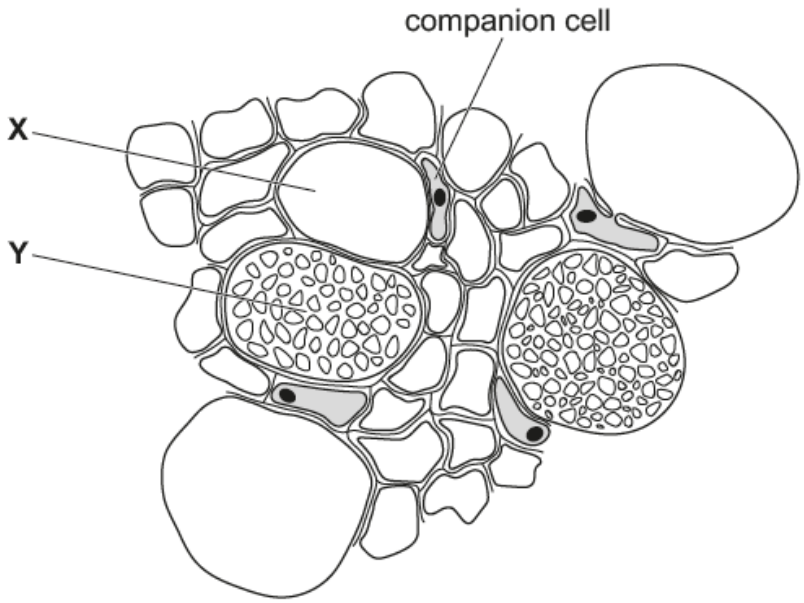


Fig. 3.1

(i) Cell **X** and cell **Y** in Fig. 3.1 are sieve tube elements.

Explain why cell **X** and cell **Y** have very different appearances in this transverse section.

.....

.....

.....

.....

..... [2]

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(ii) Sucrose is formed from the glucose synthesised by mesophyll cells in the leaves of *C. pepo.*

Explain how companion cells are involved in the transfer of sucrose into phloem sieve tubes.

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..... [4]

(b) Hydrogen bonding is important in the movement of water in xylem.

(i) Explain how hydrogen bonding occurs between two water molecules.

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..... [2]

(ii) Outline how hydrogen bonding is involved in water transport in the xylem of a plant stem.

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.....

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..... [3]

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(iii) Hydrogen bonding between water molecules gives water a relatively high latent heat of vaporisation.

Suggest why it is important to plants that water has a high latent heat of vaporisation.

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..... [2]

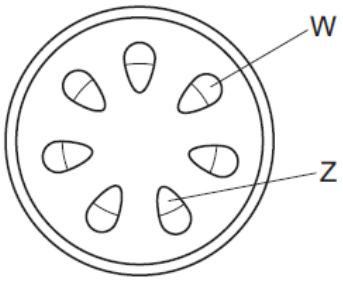
[Total: 13]

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Transport in plants – AS 9700 November 2023

1. Nov/2023/Paper_ 9700/11/No.26

The plan diagram of a transverse section through a dicotyledonous plant stem was drawn by a student. They had stained the section with a chemical that stains lignin.



Which row is correct for tissues W and Z?

	W	Z	stained tissue
A	phloem	xylem	W
B	phloem	xylem	Z
C	xylem	phloem	W
D	xylem	phloem	Z

2. Nov/2023/Paper_ 9700/11/No.28

A plant leaf seen in transverse section with a microscope shows the features listed.

- a thick waxy cuticle on upper surface
- sunken stomata on lower surface
- rolled leaf so the edges curl

What is this leaf adapted for?

A to decrease carbon dioxide uptake

B to increase carbon dioxide uptake

C to decrease water loss by transpiration

D to increase water loss by transpiration

3. Nov/2023/Paper_ 9700/11/No.29

What occurs as carbohydrate is taken out of a sink into a phloem sieve tube element?

	water potential in phloem sieve tube element becomes	volume of liquid in phloem sieve tube element
A	higher	decreases
B	higher	increases
C	lower	decreases
D	lower	increases

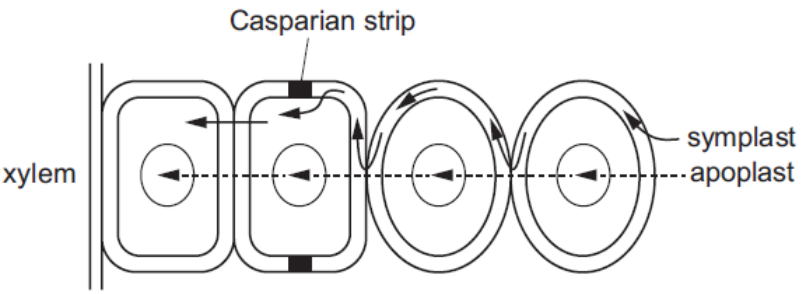
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4. Nov/2023/Paper_ 9700/12/No.24

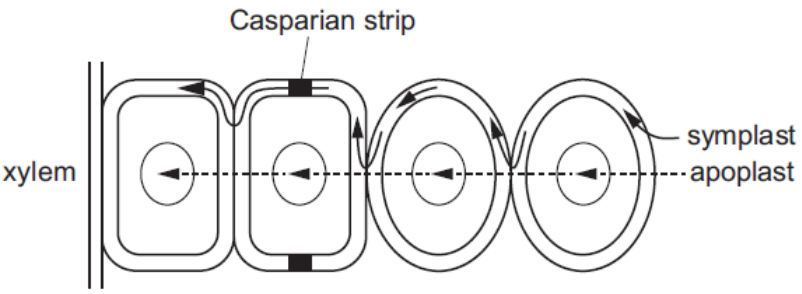
Four students sketched diagrams of the apoplast pathway and the symplast pathway.

Which sketch is the most accurate diagram of the two pathways?

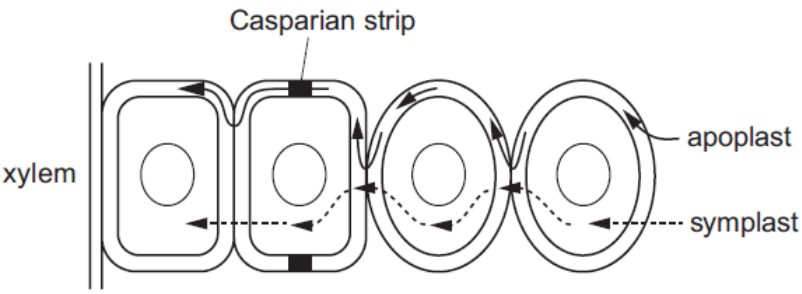
A



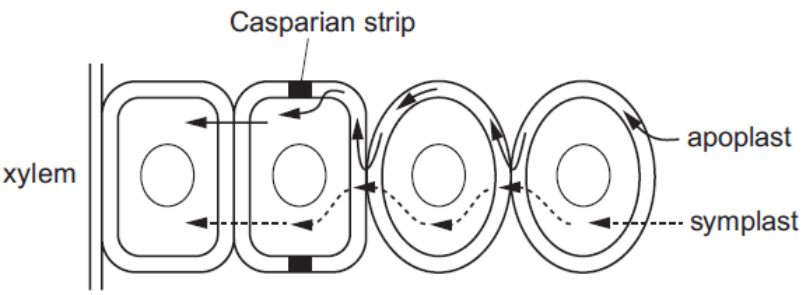
B



C



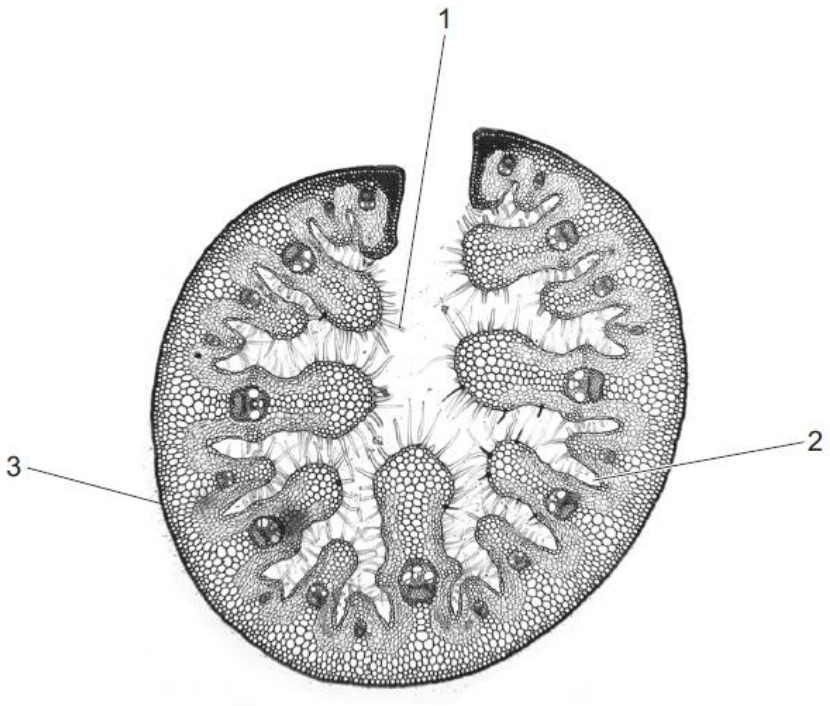
D



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5. Nov/2023/Paper_ 9700/12/No.25

The photomicrograph shows some xerophytic adaptations in leaf tissue.



Which row shows the correct functions for structures 1, 2 and 3?

	reduces the water vapour concentration gradient between the inside and outside of the leaf	reduces evaporation from the epidermis of the leaf	traps a layer of moist air
A	1, 2 and 3	3 only	2 only
B	1 and 2 only	1, 2 and 3	1 and 2
C	1 only	2 and 3 only	1 and 2
D	2 and 3 only	1 and 2 only	1 only

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6. Nov/2023/Paper_ 9700/12/No.27

When sucrose is loaded into the phloem it has to travel from mesophyll cells to a companion cell and then into the phloem.

Which row shows the relative concentrations of sucrose in each type of cell in order for this process to take place?

	relative concentration of sucrose / arbitrary units		
	mesophyll cell	companion cell	phloem sieve tube element
A	5	10	15
B	5	15	10
C	15	10	5
D	15	5	10

7. Nov/2023/Paper_ 9700/12/No.28

Which feature of transport in plants is correct for xylem **and** phloem?

A It is passive.

B It occurs by mass flow.

C It occurs from source to sink.

D It occurs only in one direction.

8. Nov/2023/Paper_ 9700/13/No.25

Which statement about xylem vessel elements is correct?

A Hollow vessels enable the constant movement of water up and down a plant.

B Pits enable the movement of water into adjacent xylem vessels.

C Vessels contain numerous mitochondria to generate ATP for active transport.

D Vessels contain perforated cross-walls called sieve plates.

9. Nov/2023/Paper_ 9700/13/No.26

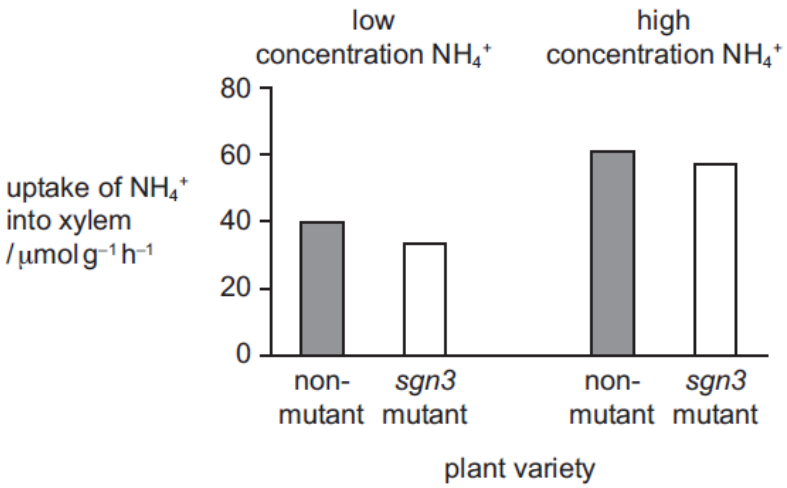
Ammonium ions, NH_4^+, can enter the xylem of plant roots by two pathways.

- In the apoplast pathway, ammonium ions move through cell walls until this pathway is blocked by the Casparian strip. Ammonium ions then enter the cytoplasm of root cells.
- In the symplast pathway, ammonium ions move through the cytoplasm of root cells.

A scientist measured the uptake of ammonium ions into the xylem of *Arabidopsis thaliana*.

The *sgn3* mutant of *A. thaliana* does not have a Casparian strip. In the *sgn3* mutant, ammonium ions can enter the xylem without entering the cytoplasm of root cells.

The bar charts show the scientist's results.



Which conclusion is correct?

A Fewer ammonium ions enter the xylem when they have to move through the cytoplasm of root cells.

B More ammonium ions enter the xylem at low soil concentrations of ammonium ions.

C The Casparian strip acts as a barrier to reduce the movement of ammonium ions into the xylem.

D The loss of the Casparian strip has little effect on the movement of ammonium ions into the xylem.

10. Nov/2023/Paper_ 9700/13/No.27

Which row correctly shows processes required for the movement of water from a root hair cell to the atmosphere?

	cohesion	diffusion	evaporation
A	✓	✓	✓
B	✗	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key
✓ = required
✗ = not required

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11. Nov/2023/Paper_ 9700/21/No.3

Plants have specialised cells for the efficient transport of assimilates.

(a) Table 3.1 shows some of the features of two different types of cell found in plant tissue, which are adapted for the efficient transport of assimilates.

Table 3.1

feature of cell	cell type A	cell type B
cytoplasm	✓	✓
nucleus	✗	✓
mitochondria	few	many
cellulose in the cell wall	✓	✓
ribosomes	✗	✓

Key
✓ present
✗ absent

Many plasmodesmata connect type **A** cells with type **B** cells.

Identify cell type **A and** explain why the plasmodesmata are important.

cell type **A** .....

explanation .....

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.....

.....

[3]

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(b) The polysaccharide callose is found in the cell walls of cells close to plasmodesmata.

Fig. 3.1 is a simplified diagram showing the structure of callose. Not all hydrogen atoms are shown.

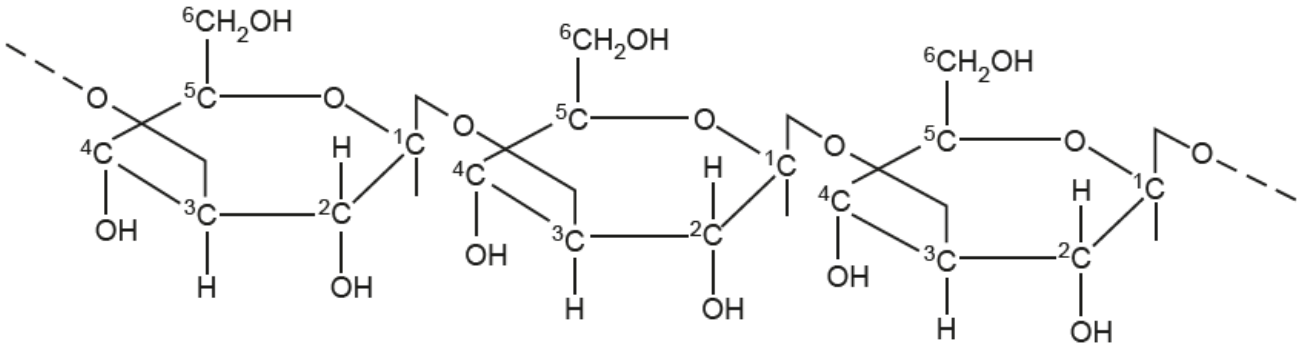


Fig. 3.1

Complete Table 3.2 to compare the structure of a callose molecule with a cellulose molecule.

Table 3.2

feature of polysaccharide	callose molecule	cellulose molecule
monosaccharide used to synthesise the polysaccharide	β-glucose	
bond connecting the monomers		1,4 glycosidic bond
shape of molecule	helix	
orientation of monosaccharides in the molecule		alternate glucose molecules are rotated by 180°

[4]

(c) Hydrogen bonding is important for movement of water through xylem vessels in a plant.

Describe the roles of hydrogen bonding in the movement of water through xylem vessels.

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..... [3]

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(d) Water that has travelled through xylem vessels reaches the leaves. Cooling of the leaf occurs as a result of the evaporation of water during transpiration.

Water has a high latent heat of vaporisation because water molecules form hydrogen bonds.

With reference to hydrogen bonding, suggest why cooling of the leaf occurs as a result of evaporation of water during transpiration.

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..... [2]

[Total: 12]

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12. Nov/2023/Paper_ 9700/22/No.6

Water that is absorbed from the soil solution by the roots of a plant enters xylem vessels and is transported to the leaves and buds.

Fig. 6.1 shows four important requirements for the efficient transport of water from the roots to the leaves of a plant.

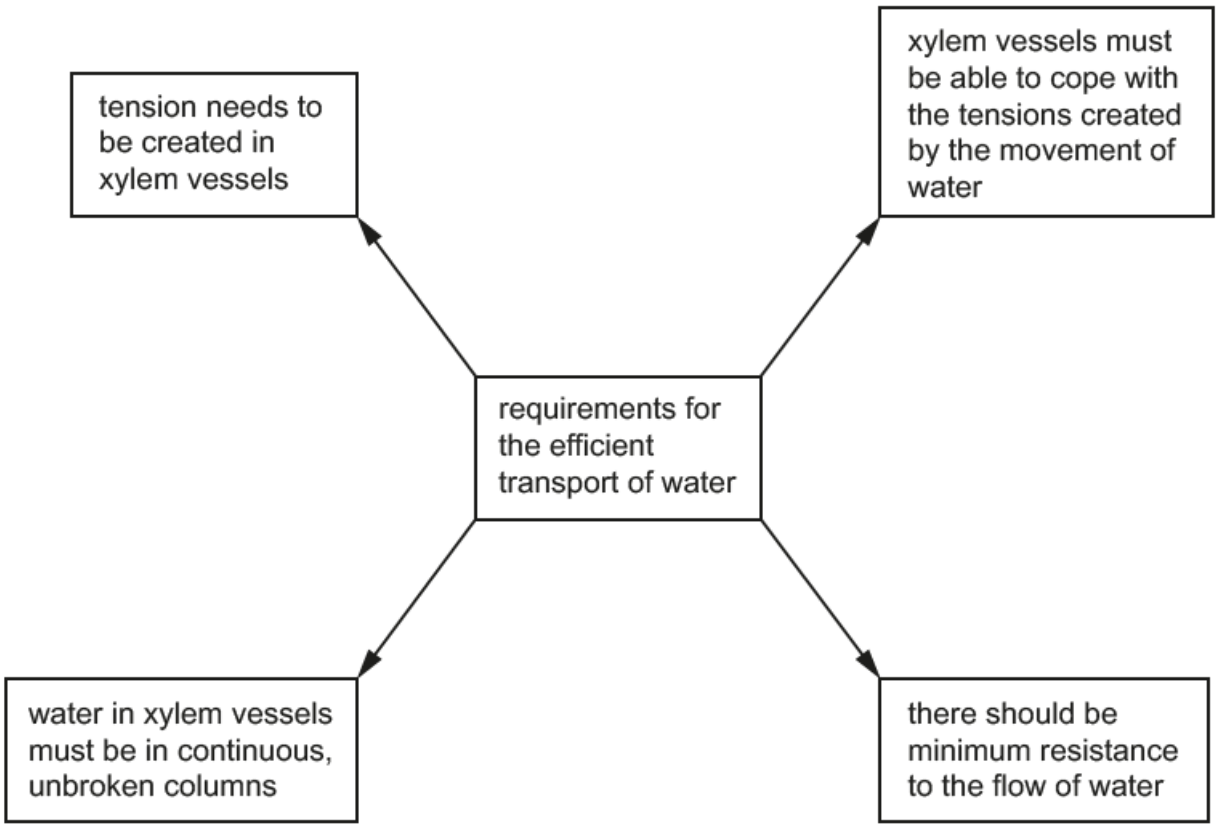


Fig. 6.1

(a) Name the specialised cells that are arranged end to end to form xylem vessels.

..... [1]

(b) Explain how tension is created in the xylem vessels.

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..... [2]

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(c) Fig. 6.1 highlights how the structure of xylem vessels must be related to their function. This means that during the development of xylem vessels changes need to occur to the cells forming the vessels.

(i) The walls of the cells forming the xylem vessel walls become lignified during development.

Explain how this feature is important for the efficient transport of water.

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..... [2]

(ii) During the development of xylem vessels, the end walls of the cells forming the vessels break down. This contributes to minimising resistance to the flow of water.

Describe **one** other main change that needs to occur to these cells so that their structure becomes suited to their function.

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..... [1]

[Total: 6]

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13. Nov/2023/Paper_ 9700/23/No.5

In flowering plants, transport of assimilates occurs in phloem tissue between sources and sinks.

(a) (i) Explain why a root can be a source **and** a sink.

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..... [2]

(ii) State **two** examples of assimilates that are transported in the phloem.

..... [1]

(b) Describe **and** explain the mechanism that is responsible for the movement of phloem sap in sieve tubes.

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..... [4]

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(c) Tobacco mosaic virus (TMV) infects many crop plants. The virus passes between cells in the leaves and can travel throughout plants in the phloem.

The enzyme pectin methylesterase (PME) is involved with the production of cell walls. The enzyme is also known to influence the movement of TMV through plants. Scientists investigated the effect of PME on the transport of TMV through plants.

The scientists used three varieties of tobacco plants. Two varieties, **V1** and **V2**, have small quantities of PME. A third variety, **C**, has the normal quantity of PME and was used as the control in this investigation.

The plants in each group were infected with TMV at the same time. The accumulation of the virus particles transported to the leaves at the top of the plants was determined over 36 days.

The results are shown in Fig. 5.1. The arrow indicates when all the plants were infected with TMV.

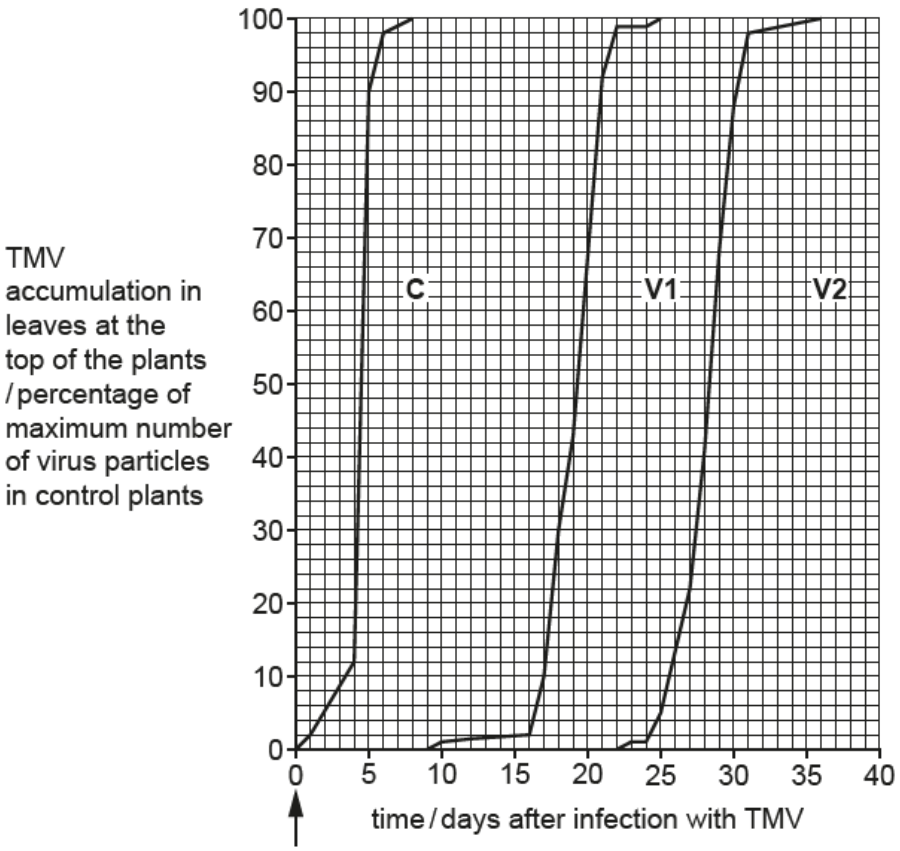


Fig. 5.1

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Compare the results for varieties **V1** and **V2** with the control group of plants, **C**.

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..... [3]

[Total: 10]

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