Week 20

A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

A-Level Biology Name: _____ Score: _____

1. Which statement is correct?
   - ☐ xylem carries water and minerals up; phloem carries dissolved sugars
   - ☐ xylem carries sugars; phloem carries water up
   - ☐ both carry only water
   - ☐ both carry only sugars
2. Water enters a root hair cell by osmosis because the root hair has:
   - ☐ a lower water potential than the surrounding soil water
   - ☐ a higher water potential than the soil
   - ☐ no cell membrane
   - ☐ no cytoplasm
3. Transpiration is:
   - ☐ the loss of water vapour from a plant
   - ☐ the uptake of water at the roots
   - ☐ the making of sugars in the leaf
   - ☐ the transport of sucrose in phloem
4. Translocation in the phloem transports:
   - ☐ sugars (mainly sucrose)
   - ☐ only water
   - ☐ oxygen
   - ☐ minerals only
5. Xylem vessels are strengthened and waterproofed by _____ in their walls.

   _____
6. Water enters root hair cells from the soil by _____.

   _____
7. Water vapour leaves the leaf mainly by diffusing out through pores called _____.

   _____
8. In translocation, a ”source” is:

☐ where the assimilate is made or released, such as a photosynthesising leaf

☐ where the assimilate is used or stored

☐ the xylem

☐ the root hair

9. A mature xylem vessel is a living cell, full of cytoplasm and a nucleus.

   ☐ True ☐ False

10. Sucrose is loaded into the sieve tube at the source by _____ transport (using proton pumps).

7. Transport in plants

Answers · 答案

A-Level Biology

1. **xylem carries water and minerals up; phloem carries dissolved sugars**

   Xylem moves water and mineral ions upward; phloem moves dissolved assimilates (mainly sucrose).

2. **a lower water potential than the surrounding soil water**

   Water moves down the water-potential gradient, into the root hair which has the lower water potential.

3. **the loss of water vapour from a plant**

   Transpiration is water evaporating inside the leaf and the vapour diffusing out through the stomata.

4. **sugars (mainly sucrose)**

   Phloem carries dissolved sugars (assimilates), unlike xylem which carries water and minerals.

5. **lignin**

   Lignin makes a strong, waterproof, hollow pipe — and the cells die, leaving an open tube.

6. **osmosis**

   Water moves down a water-potential gradient into the root hair.

7. **stomata**

   After evaporating from leaf cell surfaces, the vapour diffuses out through the stomata.

8. **where the assimilate is made or released, such as a photosynthesising leaf**

   A source makes/releases the assimilate (e.g. a leaf); a sink uses or stores it (e.g. a growing root).

9. **False**

   Xylem vessels are dead and empty — that is what makes them a fast, open pipe for water.

10. **active**

    Companion cells pump H^+ out, then cotransporters bring sucrose in with the ions — active transport.

A-LEVEL BIOLOGY • EXERCISE SHEET

7.1 Structure of transport tissues

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS xylem 木质部 • vessel 导管 • phloem 韧皮部 • sieve tube 筛管 • companion cell 伴胞

Objective

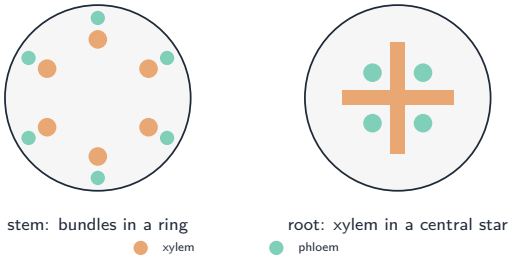
Build the skills to answer exam questions on the **structure of transport tissues** — the distribution and structure of **xylem** 木质部 and **phloem** 韧皮部, and how their cells suit their functions.

You must be able to:

- describe the distribution of xylem and phloem in stems, roots and leaves
- relate the structure of xylem vessels, sieve tubes and companion cells to their functions
- draw plan diagrams and use magnification calculations

1 Worked examples

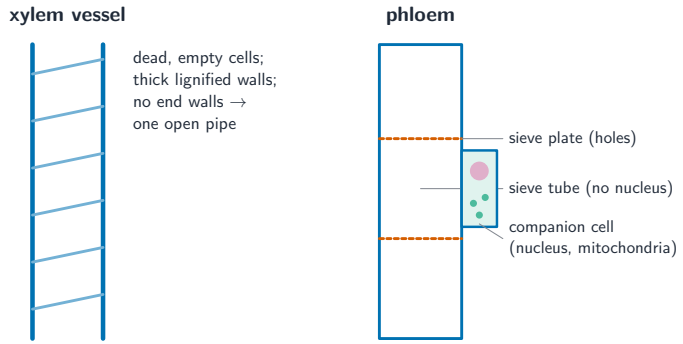
Where xylem and phloem are



Stem: bundles in a ring near the edge, xylem inside. Root: xylem in a central star.

- **stem** — vascular bundles in a ring near the edge; xylem on the inside of each bundle.
- **root** — xylem in a central star, phloem between the arms.
- **leaf** — both in the veins.

Structure suited to function

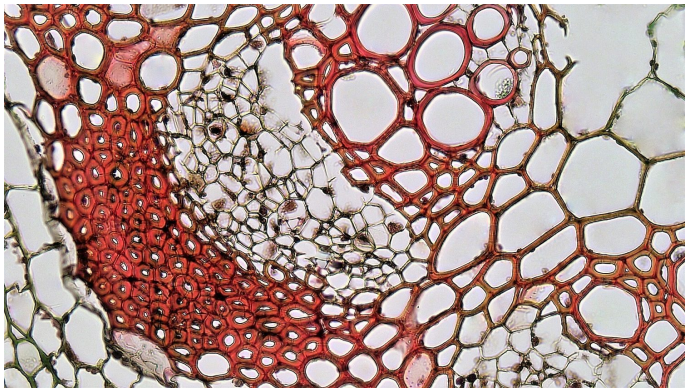


Xylem: dead, open pipe. Phloem: living sieve tubes with sieve plates and companion cells.

- **xylem vessels** 导管 — dead, empty cells joined end to end with no end walls (one open tube); walls thickened with **lignin** 木质素. So water flows fast and the lignin gives support.
- **sieve tubes** 筛管 — living cells with **sieve plates** 筛板 (holes for sap); lose most contents and the nucleus.
- **companion cells** 伴胞 — keep the nucleus and many **mitochondria** 线粒体; do the living work and load sugars.

Drawing plan diagrams

Draw only the **outlines** of the tissue regions (not single cells), in correct proportions, with clear unbroken lines.



A real vascular bundle: large red xylem vessels (lignified) below; smaller phloem above

2 Practice

2.1 State one structural feature of a xylem vessel and explain how it suits the vessel's function. [2]

2.2 State **two** ways a companion cell differs from a mature sieve tube. [2]

3 Exam-style questions

3.1 Which feature is found in xylem vessels but **not** in phloem sieve tubes? [1]

- **A** living cytoplasm
- **B** sieve plates
- **C** lignified walls and no contents
- **D** companion cells

3.2 In a transverse section of a root, the xylem is found: [1]

- **A** in a ring near the edge
- **B** in the centre, often in a star shape
- **C** only in the veins
- **D** outside the phloem

3.3 A xylem vessel is drawn 40 mm wide. The real width of the vessel is 50 µm.

(a) Calculate the magnification of the drawing. [2]

(b) Explain why a xylem vessel having no cell contents and no end walls is an advantage. [2]

3.4 Relate the structure of phloem sieve tubes and companion cells to their function in transport. [4]

Solutions

2.1 e.g. lignified walls → give strength/support and waterproofing; *or* no end walls/empty → continuous open tube for fast water flow.

2.2 any two: companion cell keeps its nucleus (sieve tube loses it); companion cell has many mitochondria; companion cell retains most cytoplasm.

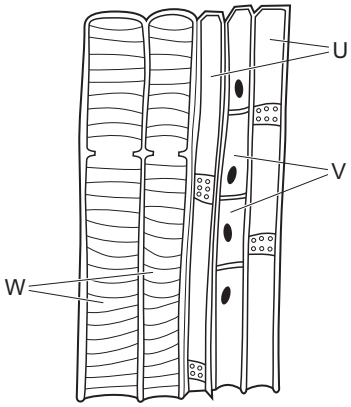
3.1 C. Only xylem vessels have lignified walls and no living contents.

3.2 B. In the root, xylem is central, often star-shaped.

3.3 (a) 40 mm = 40 000 µm; magnification = $\frac{40\,000}{50}$ = ×800.
(b) no contents and no end walls make one continuous open tube, so water flows quickly with little resistance.

3.4 sieve tubes have sieve plates with pores so sap flows through; they lose most contents/nucleus to leave room for flow; companion cells keep a nucleus and many mitochondria to provide ATP and load sugars into the sieve tube.

26 The diagram shows a vertical section through part of the stem of a dicotyledonous plant. Three types of structures are labelled.



What are the structures U, V and W?

	companion cells	phloem sieve tube elements	xylem vessel elements
A	U	W	V
B	V	U	W
C	U	V	W
D	W	V	U

27 Which features of xylem vessels help to reduce the resistance to water flow?

1 Lignin forms an incomplete secondary wall.

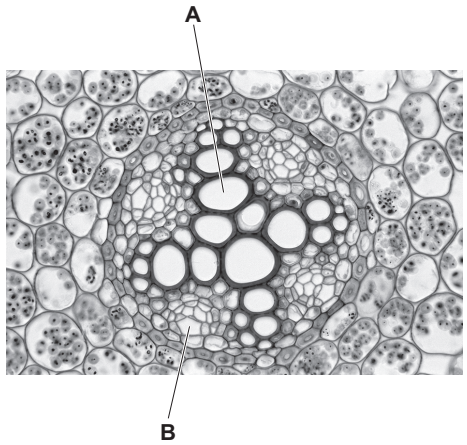
2 There are **no** cross walls between the vessel elements.

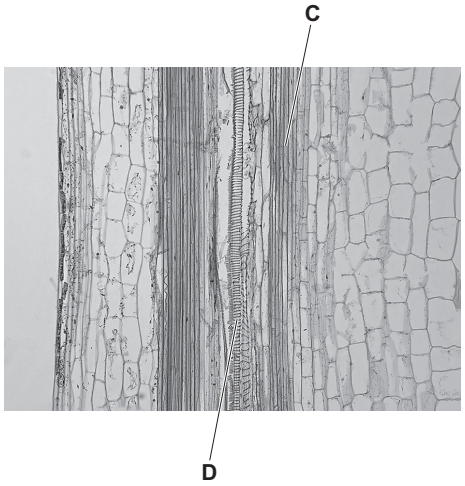
3 The xylem vessels form narrow tubes.

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

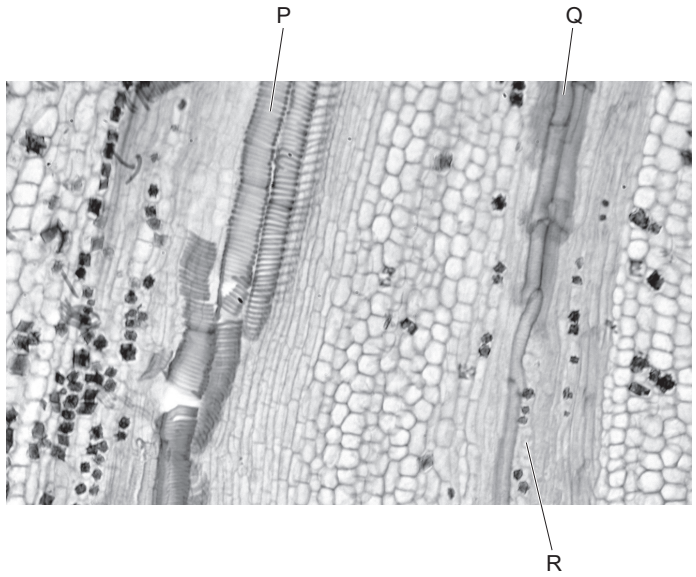
28 The photomicrographs show sections of two organs of a plant.

Which letter identifies a cell found with companion cells in a tissue in a root?





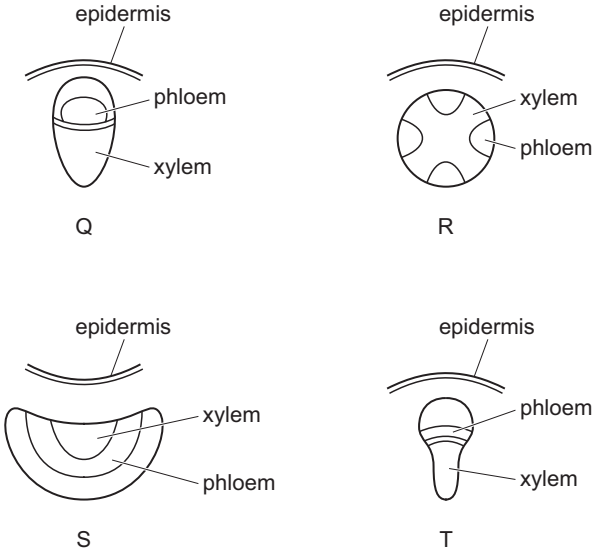
28 The photomicrograph shows a longitudinal section of part of a plant stem.



Which row correctly identifies structures P, Q and R?

	P	Q	R
A	phloem sieve tube element	companion cell	xylem vessel element
B	phloem sieve tube element	xylem vessel element	companion cell
C	xylem vessel element	phloem sieve tube element	companion cell
D	xylem vessel element	companion cell	phloem sieve tube element

26 The diagrams show the arrangements of phloem and xylem tissues in some plant organs.



Where will arrangements Q, R, S and T be found in plants?

	Q	R	S	T
A	leaf	root	stem	root
B	root	stem	root	leaf
C	stem	stem	leaf	root
D	stem	root	leaf	stem

27 Which feature of xylem vessel elements allows them to have reduced resistance to water movement?

A Lignin forms an incomplete secondary wall.

B New vessels transport extra water as a plant grows.

C There are no cross walls between vessel elements.

D Vessel elements join to form narrow tubes.

5 **(a)** Fig. 5.1 is a photomicrograph of a longitudinal section through part of the stem of a plant.

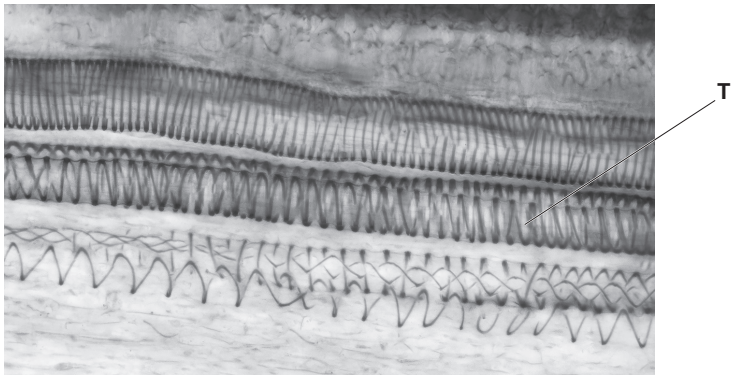


Fig. 5.1

(i) Name **one** substance transported in **T** in Fig. 5.1.

..... [1]

(ii) State the name of the substance that forms the spiral thickening around the structure labelled **T** in Fig. 5.1.

..... [1]

(b) A scientist studied the effect of leaf temperature on the rate of transpiration from the leaves of the wheat plant, *Triticum aestivum*.

The scientist repeated the investigation using the cotton plant, *Gossypium hirsutum*.

The results of the investigation are shown in Table 5.1.

Table 5.1

leaf temperature / °C	rate of transpiration of *T. aestivum* / mmol m^{-2} s^{-1}	rate of transpiration of *G. hirsutum* / mmol m^{-2} s^{-1}
25	7	9
30	12	10
35	15	11
40	22	12
45	31	14

(i) Suggest explanations for the relationship between leaf temperature and the rate of transpiration of *T. aestivum* as shown in Table 5.1.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Suggest **one** difference between the structure of the leaves of *T. aestivum* and the leaves of *G. hirsutum* that could explain the results shown in Table 5.1.

.....

.....

..... [1]

(c) Nematodes are microscopic animals that infect a wide range of economically important plant crops including cotton plants. Nematodes feed on the roots of plants, limiting their growth.

When root cells become infected, the nematodes disrupt the plant mitotic cell cycle. This causes the formation of a special type of feeding cell (cell **G**) in the plant, from which the nematodes absorb nutrients. Cell **G** is formed as a result of multiple cell cycles without any cytokinesis.

(i) Suggest how cell **G** differs from cells produced during a mitotic cell cycle that has **not** been disrupted by a nematode.

.....

.....

.....

..... [1]

(ii) Nematodes can also stimulate a process called endoreplication. This process causes a plant cell to go through multiple S phases during one cell cycle without entering mitosis or undergoing cytokinesis.

State how the nucleus of a cell that has been through endoreplication may differ from the nucleus of a cell in the same plant that has **not** been affected by the nematode.

.....

.....

.....

..... [1]

[Total: 8]

2 **J1** is a slide of a stained transverse section through a plant stem.

(a) **(i)** Draw a large plan diagram of the whole section on **J1**. Use a sharp pencil.

Use **one** ruled label line and label to identify the xylem.

[5]

(ii) Observe the epidermis of the stem on **J1**.

Select a group of **four** adjacent epidermal cells.

Each cell must touch at least **one** other cell.

- Make a large drawing of this group of **four** epidermal cells and waxy cuticle.
- Use **one** ruled label line and label to identify the waxy cuticle.

[5]

(iii) Fig. 2.1 is a photomicrograph of a stained transverse section of a stem from a different type of plant from **J1**.

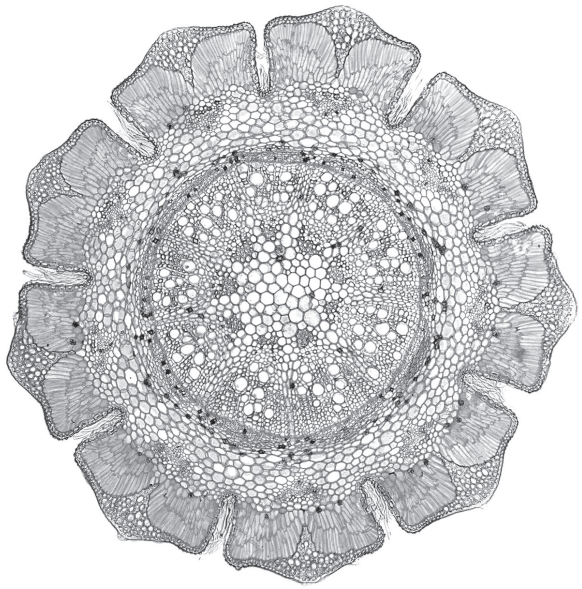


Fig. 2.1

Identify **three** observable differences, other than colour, between the stem section on **J1** and the stem section in Fig. 2.1.

Record these **three** observable differences in Table 2.1.

Table 2.1

feature	J1	Fig. 2.1
1		
2		
3		

[3]

(b) Fig. 2.2 is a photomicrograph of a stained transverse section of a stem from a different type of plant.

You will calculate the density of vascular bundles in the stem section. The circle represents the area of the stem.

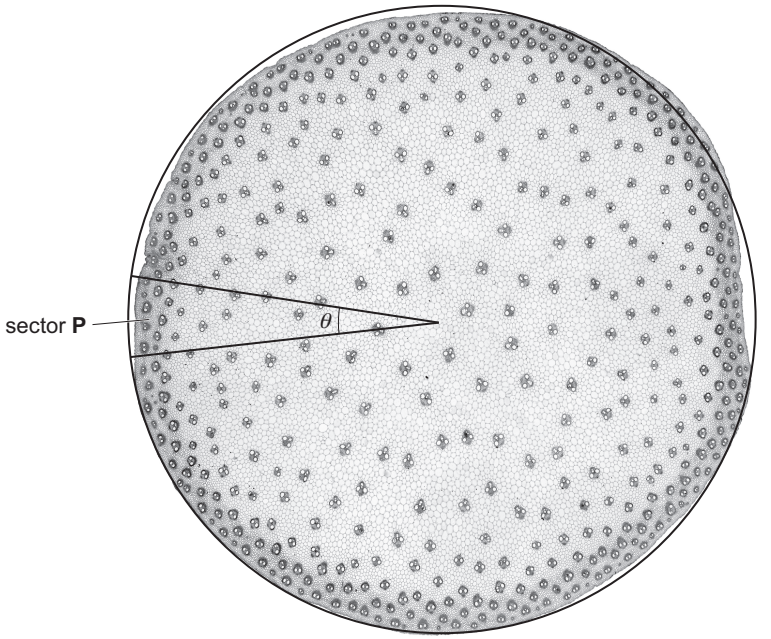


Fig. 2.2

(i) To calculate the density of vascular bundles you will first need to count the number of whole vascular bundles in sector **P**.

number of whole vascular bundles in sector **P** = ... [1]

(ii) Use your answer to **(b)(i)** to estimate the total number of vascular bundles in the stem section shown in Fig. 2.2.

angle $\theta = 15°$

Show your working.

total number of vascular bundles = ...
[2]

(iii) The stem section shown in Fig. 2.2 has an actual area of 44 mm^2.

Use your answer in **(b)(ii)** to calculate the density of vascular bundles in the stem section.

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

Show your working.

vascular bundle density = ... mm^{-2}
[2]

[Total: 18]

A-LEVEL BIOLOGY • EXERCISE SHEET

7.2 Transport mechanisms

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

KEY WORDS source 源 • sink 库 • mass flow 集流 • apoplast 质外体 • transpiration 蒸腾作用

Objective

Build the skills to answer exam questions on **transport mechanisms** in plants — water from soil to xylem, **transpiration** 蒸腾作用 and cohesion–tension, **xerophyte** 旱生植物 adaptations, and **translocation** 易位 by mass flow.

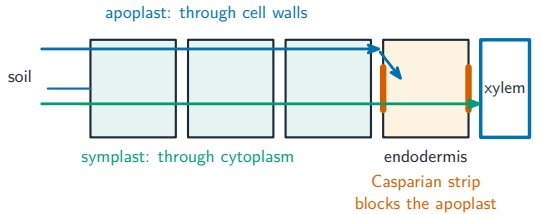
You must be able to:

- describe the apoplast and symplast pathways and the role of the Casparian strip
- explain transpiration and how hydrogen bonding moves water up the xylem
- explain xerophyte adaptations, and translocation from source to sink by mass flow

1 Worked examples

Water from soil to xylem

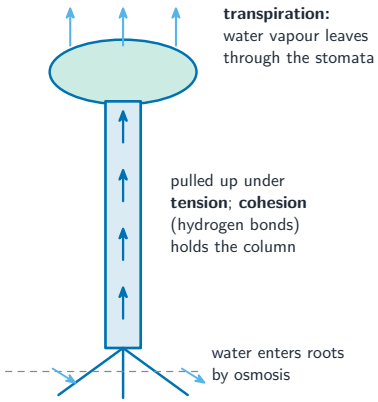
Water enters a root hair by **osmosis** 渗透 then crosses the root two ways:



Apoplast = through the walls; symplast = through the cytoplasm; the Casparian strip blocks the apoplast

- **apoplast** 质外体 — through cell walls (cellulose); fast.
- **symplast** 共质体 — through the cytoplasm via plasmodesmata.
- at the **endodermis** 内皮层, the waterproof **Casparian strip** 凯氏带 (suberin) blocks the apoplast, forcing water through membranes so the plant controls what enters.

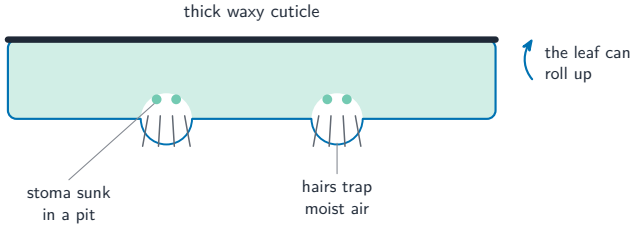
■ Transpiration and cohesion–tension



Water evaporates in the leaf and diffuses out of the stomata; this pulls the whole column up

Transpiration = evaporation of water from leaf surfaces, then diffusion of vapour out of the **stomata** 气孔. Water molecules stick together by **hydrogen bonds** (**cohesion** 内聚力), so the column is pulled up under **tension** 张力; they also stick to cellulose walls (**adhesion** 附着力).

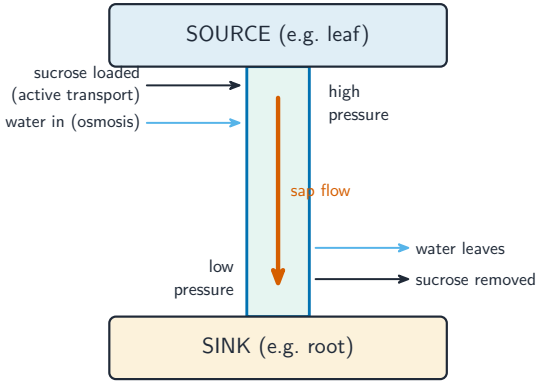
■ Xerophyte adaptations



Xerophytes cut water loss: thick cuticle, sunken stomata, trapped moist air, rolled leaves

■ Translocation by mass flow

Assimilates (**sucrose** 蔗糖, amino acids) move from **source** 源 to **sink** 库. Companion cells load sucrose by **active transport** 主动运输 (proton pumps + cotransporters), lowering water potential so water enters and raises pressure.



Loading sucrose at the source raises the pressure; sap flows by mass flow to the sink

2 Practice

2.1 State the difference between the apoplast and symplast pathways. [2]

2.2 Define a **source** and a **sink** in translocation. [2]

3 Exam-style questions

3.1 What is the role of the Casparian strip? [1]

- **A** to carry water up the xylem
- **B** to block the apoplast pathway so water passes through cell membranes
- **C** to load sucrose into the phloem
- **D** to store water in the root

3.2 Which property of water, caused by hydrogen bonding, allows a continuous column to be pulled up the xylem? [1]

- **A** adhesion to air
- **B** cohesion between water molecules
- **C** high density
- **D** low specific heat capacity

3.3 A potometer measures water uptake. In 10 minutes the meniscus moves 60 mm along a tube of cross-sectional area 2.0 mm^2.

(a) Calculate the volume of water taken up, in mm^3. [2]

(b) Calculate the rate of water uptake, in mm^3 per minute. [1]

3.4 Explain how sucrose is loaded into the phloem at a source and how this drives mass flow. [4]

Solutions

2.1 apoplast — water moves through the cell walls and spaces; symplast — water moves through the cytoplasm from cell to cell via plasmodesmata.

2.2 source — where the assimilate is made/released (e.g. a leaf); sink — where it is used or stored (e.g. a root).

3.1 B. The Casparian strip blocks the apoplast, forcing water through the cell membranes.

3.2 B. Cohesion between water molecules holds the column together under tension.

3.3 (a) volume = 60 mm × 2.0 mm^2 = 120 mm^3.
(b) rate = 120/10 = 12 $mm^3\,min^{-1}$.

3.4 companion cells use proton pumps to pump H^+ out, then cotransporters bring sucrose in with H^+ — active transport; this lowers the water potential in the sieve tube so water enters by osmosis, raising the hydrostatic pressure; sap then flows down the pressure gradient to the sink (mass flow).

28 What causes water to move from the root hair cells to the endodermis?

A diffusion through cell walls and osmosis down a water potential gradient in the cytoplasm

B diffusion through the symplast and osmosis and root pressure through the apoplast

C osmosis from cell vacuole to cell vacuole and active transport into the endodermis

D osmosis through the intercellular spaces and diffusion in cell walls and cytoplasm

29 Which changes occur as carbohydrate is moved into a sink?

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

29 Which row correctly describes the pressure in the xylem and the water potential in the root hair cells used in the transport of water in a transpiring plant?

	pressure in the xylem	water potential in root hair cells
A	positive	negative
B	positive	positive
C	negative	negative
D	negative	positive

30 Which row correctly identifies the definitions for each of the key terms used in transpiration?

	attraction between water molecules and walls of the xylem vessel	effect created by evaporation of water from the surface of the leaf
A	cohesion	adhesion
B	adhesion	tension
C	cohesion	tension
D	tension	cohesion

31 Which combination of features is characteristic of a phloem sieve tube element immediately after it is loaded from a source?

	water potential of the phloem sieve tube element	lignification of the cell wall
A	higher than source	**not** present
B	higher than source	present
C	lower than source	**not** present
D	lower than source	present

29 Which statement about the pathway taken by a water molecule travelling from the soil to the xylem is correct?

A A water molecule in a cortex cell that takes the symplast pathway must enter the next cortex cell by passing between two adjacent phospholipid molecules in a cell surface membrane.

B A water molecule can pass into xylem vessels either through pits or through the cell wall of the xylem vessel elements by osmosis.

C A water molecule would pass into the cytoplasm of the endodermal cell if it always takes the apoplast pathway all the way to the xylem.

D A water molecule that has left the endodermal cells can travel by either the apoplast pathway or symplast pathway.

30 Amino acids move from a phloem sieve tube element into a root cell.

What are the changes to the water potential and the volume of liquid in the phloem sieve tube element at the sink, when this event is happening?

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

28 Which statement describes movement through a plant in the apoplast pathway?

A Water moves through the cell walls.

B Water moves through the cytoplasm.

C Water moves through the plasmodesmata.

D Water moves through the vacuoles.

30 Which row shows the cause of mass flow in the phloem and the direction of movement of phloem sap by mass flow?

	cause of mass flow in the phloem	direction of movement of phloem sap by mass flow
A	hydrostatic pressure gradient	sink to source
B	hydrostatic pressure gradient	source to sink
C	water potential gradient	sink to source
D	water potential gradient	source to sink

6 **(a)** State **and** explain why the same leaf of a plant can be described as a source or as a sink, depending on the stage of maturity (age) of the leaf.

.....

.....

.....

.....

..... [2]

(b) Fig. 6.1 lists seven types of plant cell found in leaves.

1	epidermal cell
2	guard cell
3	palisade mesophyll cell
4	phloem sieve tube element
5	sclerenchyma cell
6	spongy mesophyll cell
7	xylem vessel element

Fig. 6.1

Match the correct type of cell from the list in Fig. 6.1 with each statement, **A** to **E**.

Each cell type can be used once, more than once, or not at all.

The first match has been done for you.

A This is a thick-walled cell that provides support. **5**

B This cell is one of a pair of cells that form a stoma. .....

C This cell receives water to build up hydrostatic pressure for mass flow. .....

D This cell needs water for photosynthesis and is columnar-shaped. .....

E This cell secretes a waxy substance to help prevent water loss. .....

[4]

[Total: 6]