2.4 Plant tissues and transport

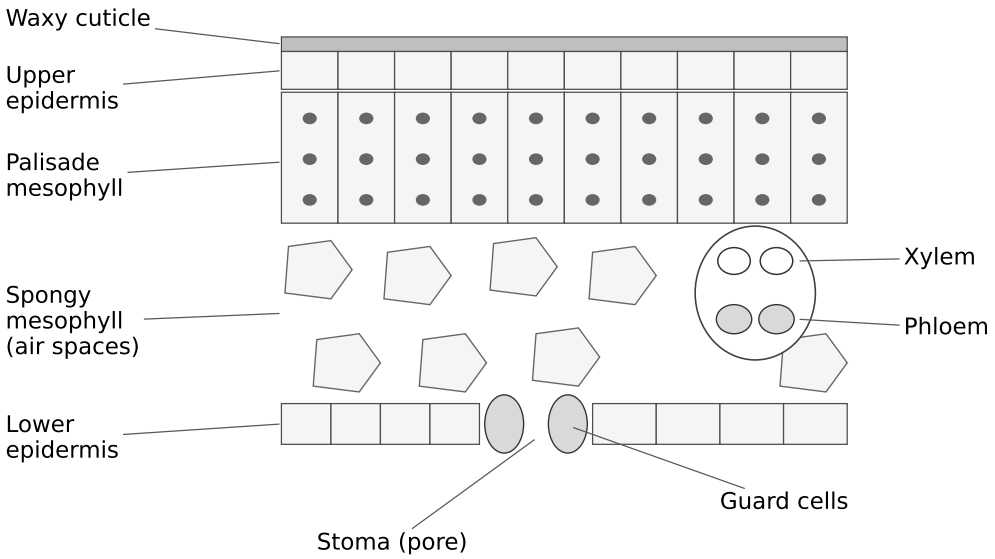
Name: _____ Class: _____ Date: _____ **Total: 18 marks**

KEY WORDS palisade mesophyll • Xylem • Phloem • Guard cells • stomata • Transpiration • translocation

Objective

Relate plant tissues to functions; explain transpiration, translocation and the four environmental factors; interpret water-loss graphs. Original questions for spec statement 4.2.3.

1 Key knowledge and worked examples



Teacher model, not to scale: palisade dots represent chloroplasts. The leaf is an organ containing several tissues. Upper/lower epidermis protects; the waxy cuticle reduces water loss. Palisade mesophyll has many chloroplasts for photosynthesis; spongy mesophyll has air spaces for gas movement. **Guard cells** control **stomata**, balancing gas exchange and water loss. **Meristems** at growing root/shoot tips produce cells that can differentiate throughout plant life.

Original 2024 Q04.1–Q04.3: name palisade mesophyll, spongy mesophyll and meristem tissue in that order; lignin strengthens xylem; **translocation** is sugar transport. "Active transport" alone is not the name for movement through the phloem.

Feature	Xylem	Phloem
Cells	Dead; hollow, no cytoplasm	Living sieve tubes; some cytoplasm
Walls	Lignin-strengthened tubes	Perforated end walls (sieve plates)
Load	Water and mineral ions	Dissolved sugars
Direction	Roots → stems/leaves	Sources → growing/storage regions; can be up or down
Process	Transpiration stream	Translocation

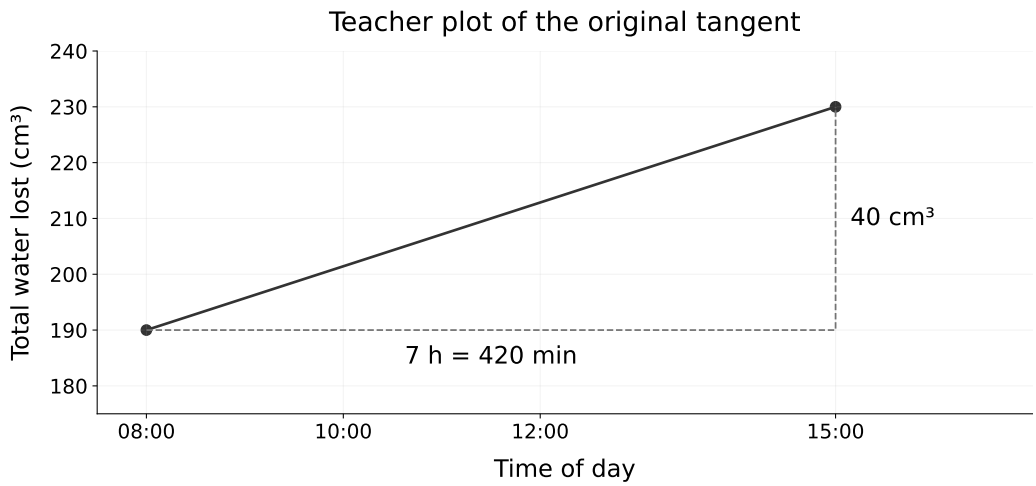
Worked comparison (sheet Q3.1 / original 2021 Q06.6 [6]): both are transport tissues with tube-like cells. Compare dead hollow lignified xylem with living phloem and sieve plates; then compare water/mineral transport upwards with dissolved-sugar transport to growing/storage tissues in either direction. A high-level original answer needs **both structure and function**, not six disconnected facts about only one tissue. "Both directions" describes transport in the tissue, not simultaneous opposite flow in every individual tube.

Root hairs: large surface area; water enters by osmosis; mineral ions are taken up against their gradient by active transport, using respiration energy. The same low-to-high/energy logic explains sugar loading into phloem.

Transpiration: water evaporates from moist mesophyll cell walls into leaf air spaces, then water vapour diffuses through stomata into outside air. Water loss draws more liquid water through xylem in the transpiration stream. Roots, stem and leaves cooperate as a transport system. Keep evaporation (liquid → vapour) distinct from diffusion (vapour moving down its gradient).

Change	Usual effect, with other conditions controlled
Higher temperature	Faster evaporation / particle motion; rate rises
More air movement	Removes humid boundary air; steeper vapour gradient
More light	Stomata usually open more; rate rises
Higher humidity	Smaller vapour gradient; rate falls

These are expected effects under suitable water supply, not guarantees for every stressed plant. Original 2022 Q05.3: greatest rate in **warm, low-humidity** conditions. Sheet Q3.2: moving air removes humid air → maintains the water-vapour gradient → faster diffusion out. Sheet Q3.3: fewer upper-surface stomata can limit water loss from a more exposed surface while lower stomata still permit CO_2 uptake. This proposed advantage depends on the plant and leaf orientation.



Teacher tangent plot: reproduces the given straight-line tangent's readings, not the original measured curve. Original 2021 Figure 10 plots **total water lost (cm^3)** against clock time. Its height is cumulative volume; its gradient is rate. Q06.7 [4] asks for the tangent slope **at 12:00**, in cm^3/min and standard form. Take two well-separated points on the tangent, even away from the contact point; do not use two points on the curved results line.

Known tangent readings: 08:00 / 190 cm^3 and 15:00 / 230 cm^3 (the latter is a point on the extended tangent, not a new measured result).

$$\Delta V = V_2 - V_1$$

$$\Delta V = 230 \text{ cm}^3 - 190 \text{ cm}^3 = 40 \text{ cm}^3$$

$$\Delta t = t_2 - t_1$$

$$\Delta t = 15 \text{ h} - 8 \text{ h} = 7 \text{ h}$$

$$\Delta t = 7 \text{ h} \times 60 \text{ min/h} = 420 \text{ min}$$

$$r = \frac{\Delta V}{\Delta t}$$

$$r = \frac{40 \text{ cm}^3}{420 \text{ min}} = 0.0952 \text{ cm}^3/\text{min}$$

$$r = 9.52 \times 10^{-2} \text{ cm}^3/\text{min}$$

The official scheme uses 40/7 h or 40/420 min, allowing consistent tangent readings. Dividing the total volume by the clock time does not give the requested gradient. Q06.8 [2]: lower nighttime rate links mostly closed stomata to less light/lower temperature; it does not mean cumulative water loss falls overnight.

Potometer reasoning: bubble movement measures water uptake, a proxy for water loss, not an exact direct transpiration measurement (some water is retained/used). Use a water-filled sealed apparatus, avoid air entering the cut stem, allow acclimatisation, change one factor and control leaf area, time and the other environmental factors; repeat. Distance/time compares uptake rates in the same capillary; volume/time additionally needs its cross-sectional area. Do not claim every absorbed drop is immediately transpired.

2 Practice

2.1 Name the tissue that transports sugars and the process. [2]

2.2 Give two adaptations of xylem for its function. [2]

2.3 State two conditions that decrease the rate of transpiration. [2]

3 Exam-style questions

3.1 Compare xylem and phloem in structure and function. [6]

3.2 Explain why increasing air movement increases the rate of transpiration. [3]

3.3 A plant's leaves have fewer stomata on their upper surface than their lower surface. Suggest why this is an advantage. [3]