7.2 Transport mechanisms

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

KEY WORDS source • sink • mass flow • apoplast • transpiration

Objective

Build the skills to answer exam questions on **transport mechanisms** in plants – water from soil to xylem, **transpiration** and cohesion–tension, **xerophyte** adaptations, and **translocation** by mass flow.

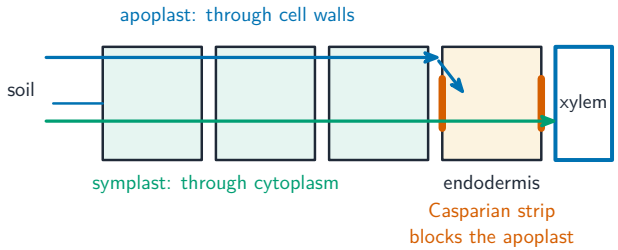
You must be able to:

- 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 Key knowledge and worked examples

Water from soil to xylem

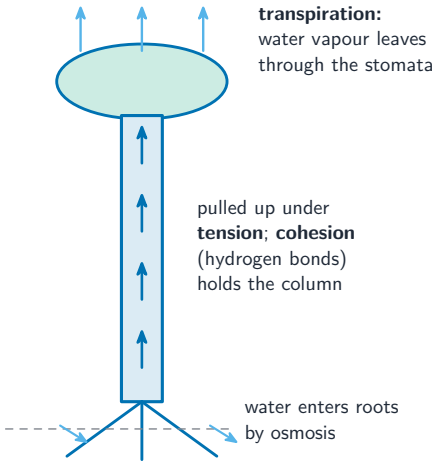
Water enters a root hair by **osmosis** then crosses the root two ways:



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

- **apoplast** – through cell walls (cellulose); fast.
- **symplast** – through the cytoplasm via plasmodesmata.
- at the **endodermis** , the waterproof **Casparian strip** (suberin) blocks the apoplast, forcing water through membranes so the plant controls what enters.

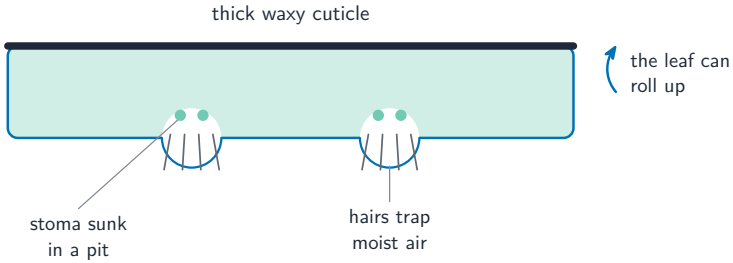
Transpiration and cohesion–tension



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** . Water molecules stick together by **hydrogen bonds** (**cohesion**), so the column is pulled up under **tension** ; they also stick to cellulose walls (**adhesion**).

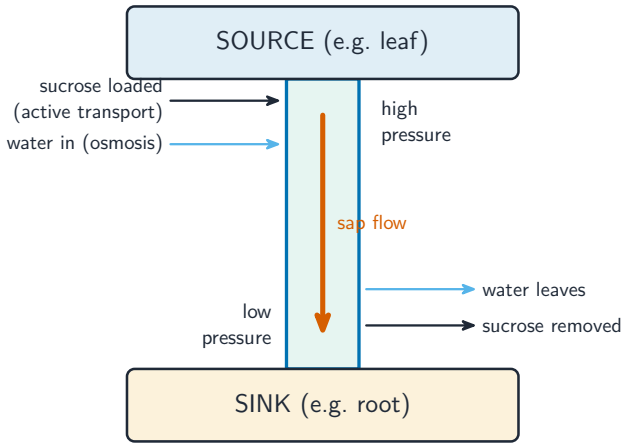
Xerophyte adaptations



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

Translocation by mass flow

Assimilates (**sucrose** , amino acids) move from **source** to **sink** . Companion cells load sucrose by **active transport** (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]