DP Biology – B3.2 Plant Systems

Transport in plants

- Which adaptations help animals and plants move fluids around?
- How does transport in animals compare with transport in plants?

Plant statements B3.2.7–10, SL and HL. Textbook pp. 303–310.



Image: part of a sunflower stem, stained section. Jon Houseman, CC BY-SA 4.0.

Objectives for each class

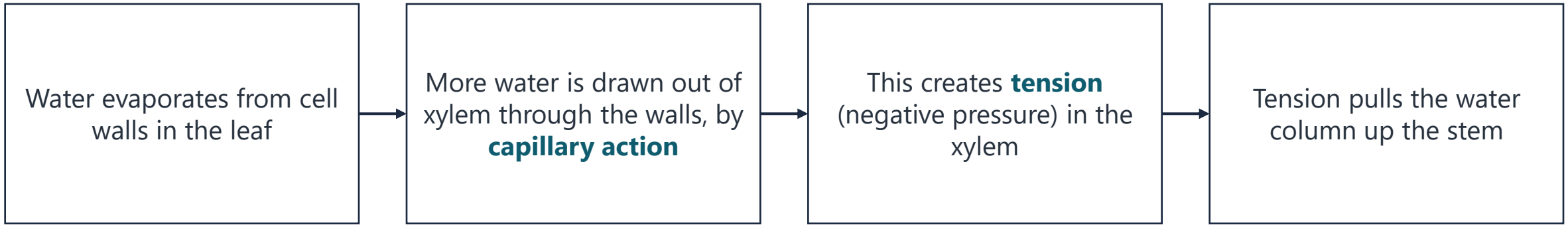
Class	Statements	By the end of the class, you can...
1	B3.2.7–8	Explain how transpiration draws water from roots to leaves, and how xylem is adapted to this
2	B3.2.9–10	Draw and annotate plan diagrams of dicot stems and roots from micrographs

Overview of this chapter

Part	Statements	What it covers
Water transport	B3.2.7	Tension, cohesion and adhesion in the xylem
Xylem vessels	B3.2.8	How their structure suits the job
Stems	B3.2.9	How tissues are laid out across a dicot stem
Roots	B3.2.10	How tissues are laid out across a dicot root

Transpiration pulls water up

B3.2.7



- The plant uses no ATP to move this water: the energy for evaporation comes from the Sun
- The flow of water up from root to leaf is the **transpiration stream**
- This explanation is known as the **cohesion-tension theory**

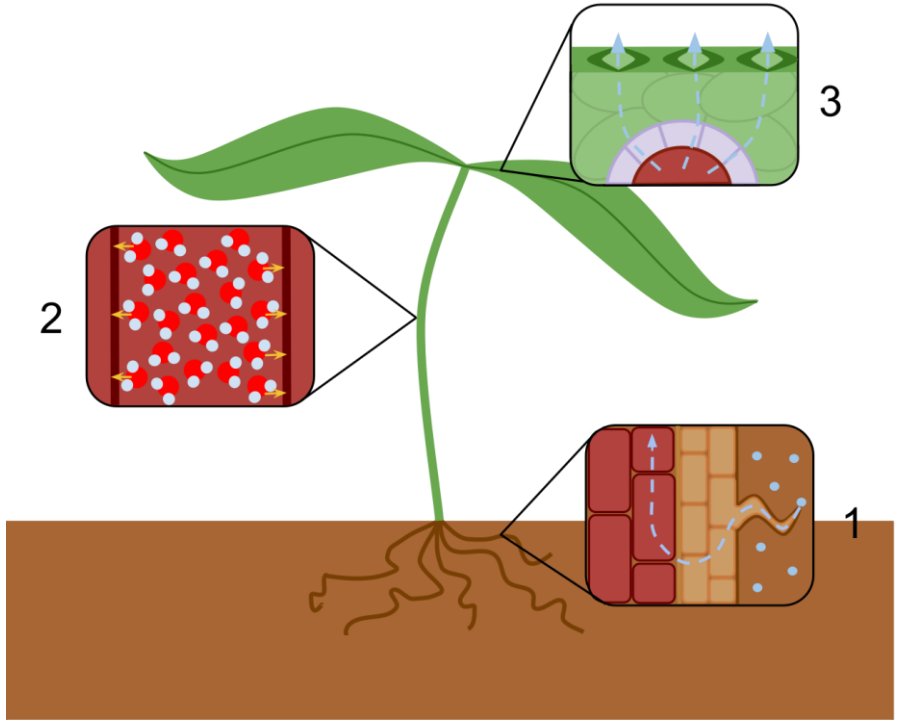
Common mistake

Water is pulled up from above, not pushed from below. Evaporation in the leaves is what drives it.

Cohesion and adhesion

B3.2.7

Property	Role
Cohesion	Hydrogen bonds between water molecules. The column stays continuous and does not break under tension
Adhesion	Hydrogen bonds between water and hydrophilic walls. Draws water through cell walls and helps it up the xylem



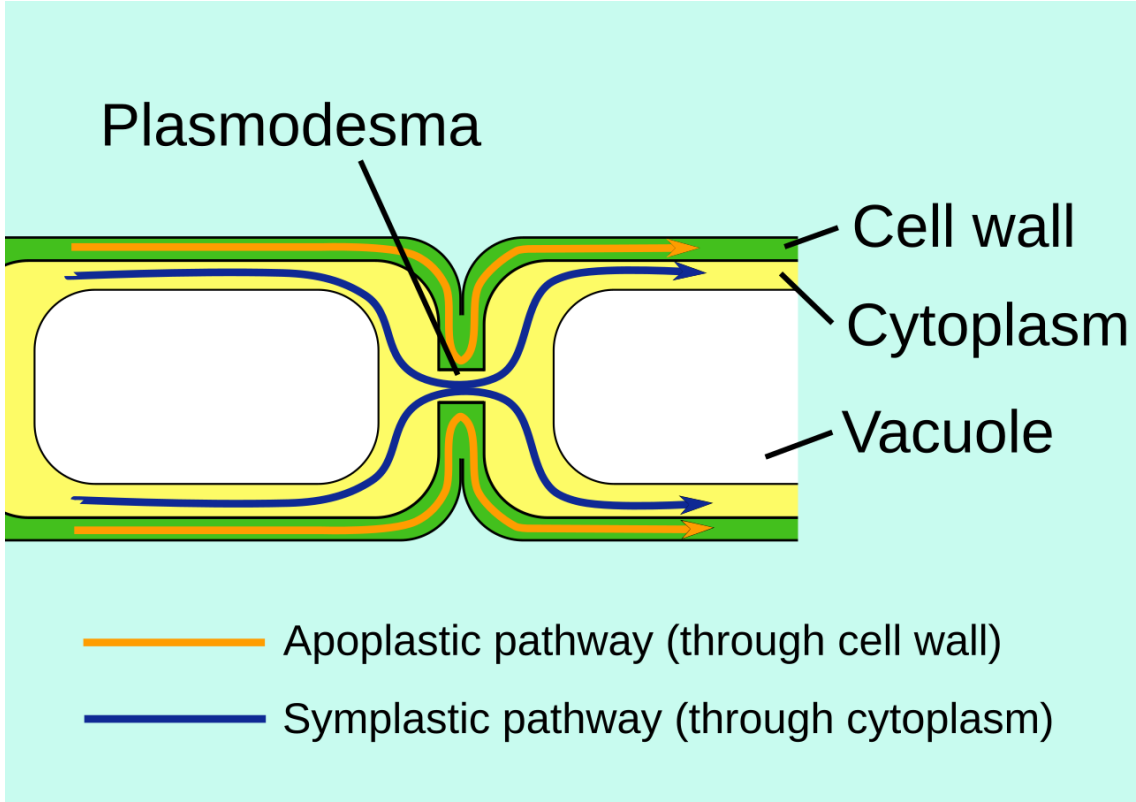
Water moving from roots to leaves. Laurel Jules, CC BY-SA 3.0.

Evidence

The trunk of a tree shrinks slightly in the day, when transpiration is fastest, and recovers at night. If a xylem vessel is pierced, air is drawn in instead of water spurting out. Both show that the water is under tension.

Getting water into and across the root

B3.2.7



Apoplast and symplast routes across a root. Jackacon, Smartse, public domain.

- Root hairs give a huge surface area in contact with soil water
- Most water moves through the cell walls: the **apoplast** pathway
- Some moves through the cytoplasm: the **symplast** pathway
- A waxy **Casparian strip** in the walls of the endodermis blocks the apoplast route, so water passes through cells to reach the xylem

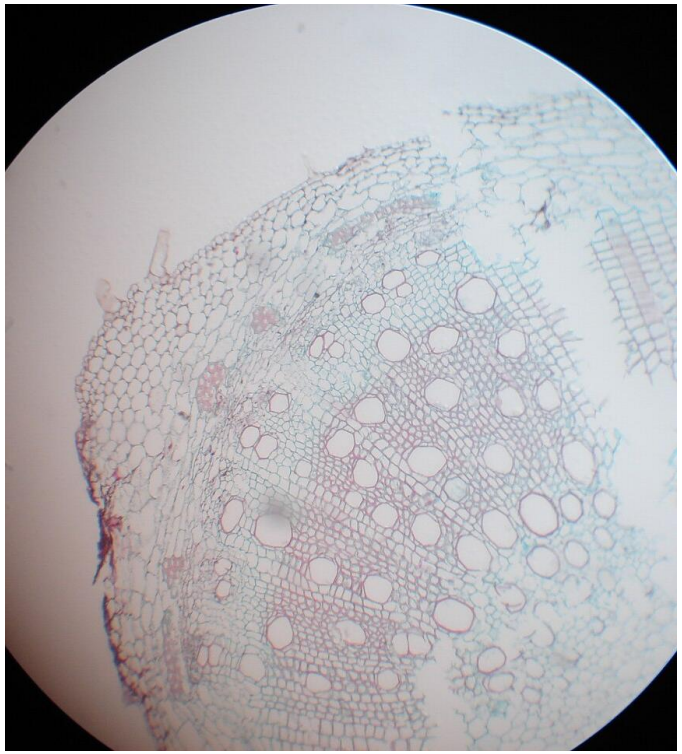
Beyond the syllabus

These routes help you to understand the whole journey, but the statement focuses on tension and cohesion in the xylem.

Xylem vessels are adapted to carry water

B3.2.8

Feature	How it helps
No cell contents	Unimpeded flow
Incomplete or absent end walls	Continuous tube, unimpeded flow
Walls thickened with lignin	Withstand tension without collapsing
Pits in the walls	Water enters and leaves



Xylem vessels with thickened walls. Dante, public domain.

Key idea

Xylem cells are dead when mature. During development, the end walls and contents disappear and lignin is laid down, leaving long, hollow, reinforced tubes.

Tissues in a dicot stem

B3.2.9



Sunflower stem, stained section. Jon Houseman, CC BY-SA 4.0.

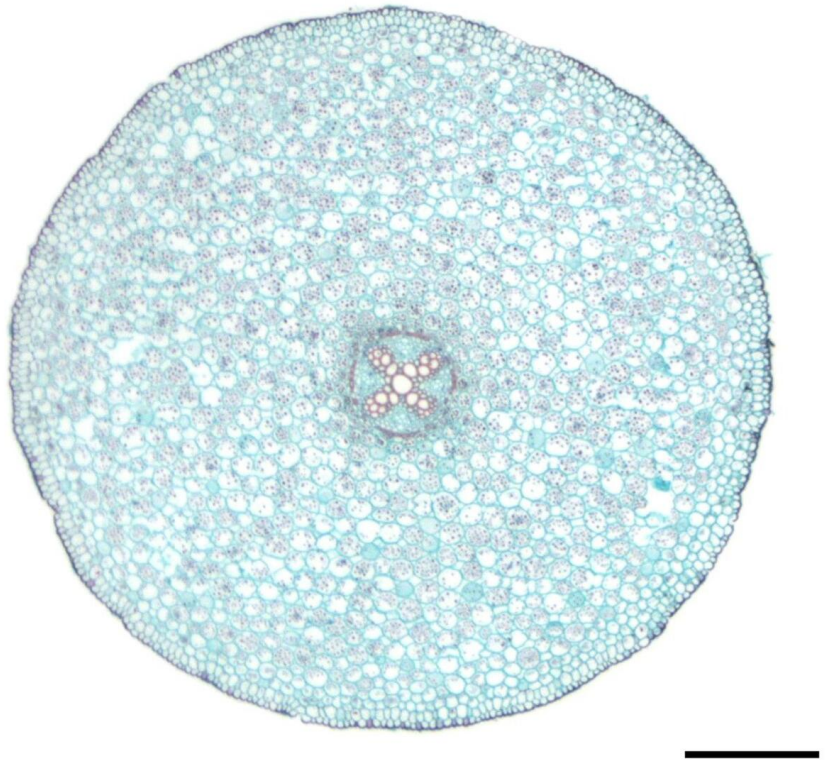
Tissue	Main function
Epidermis	Outer layer that protects and reduces water loss
Cortex	Tissue between epidermis and bundles; gives support
Vascular bundles	In a ring near the outside; carry materials
Xylem	Inner part of each bundle; carries water and ions
Phloem	Outer part of each bundle; carries sugars

How to remember

In a stem, the bundles form a ring near the edge, with phloem on the outside of the xylem.

Tissues in a dicot root

B3.2.10



Buttercup (Ranunculus) root, stained section. Jon Houseman, CC BY-SA 4.0.

Tissue	Position and function
Epidermis	Outer layer, with root hairs that absorb water
Cortex	Large area around the centre; stores food
Endodermis	Layer around the vascular tissue
Xylem	Star or cross shape, at the very centre
Phloem	Between the arms of the xylem

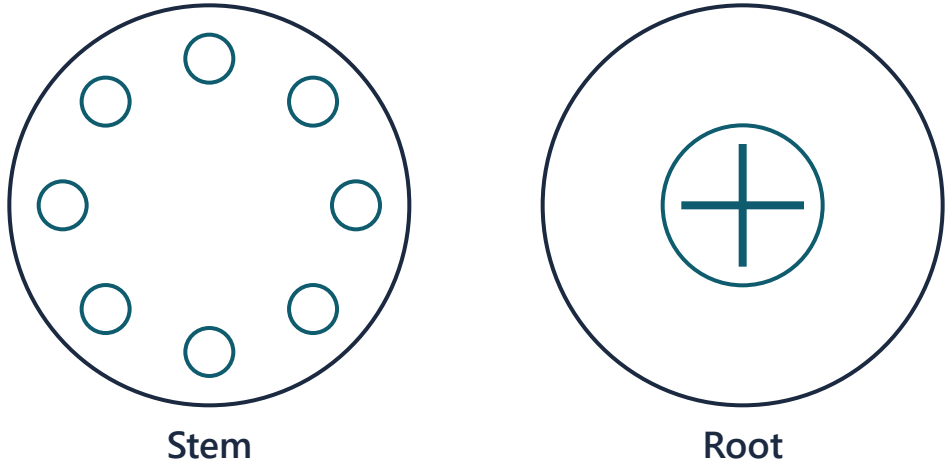
Common mistake

Do not confuse the cells of the cortex with xylem and phloem. In a root, the vascular tissue is in the centre.

Drawing plan diagrams

B3.2.9

1. Show the outlines of tissues, not individual cells
2. Use clear, continuous lines drawn with a sharp pencil
3. Do not shade
4. Keep the proportions of the micrograph
5. Label every boundary, and add the main functions
6. Add a scale bar or magnification



Schematic plan diagrams. Teal lines show vascular tissue.

Activity

Draw plan diagrams of a dicot stem and a dicot root from micrographs. Identify the vascular tissue, xylem, phloem, cortex and epidermis, and annotate each with its function.

Comparing transport in animals and plants

	Mammal	Flowering plant
Vessel	Arteries, capillaries and veins	Xylem vessels
Living cells?	Walls of living cells	Dead, hollow tubes
Driven by	Heart: positive pressure	Evaporation: tension
Energy from	ATP in heart muscle	Sun, driving evaporation
Valves	In veins, to prevent backflow	None; column held by cohesion

Link
This answers the second guiding question. See B3.2.1–6 for the mammal side.

Check that you can explain

1. How evaporation in the leaf generates tension in the xylem
2. What cohesion and adhesion each do
3. Why this needs no ATP from the plant
4. Which features of xylem vessels suit them to transport
5. Where tissues are in a dicot stem and a dicot root
6. How to draw and annotate a plan diagram

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. Put in order: (A) tension pulls water up the xylem. (B) water evaporates from leaf cell walls. (C) water is drawn out of the xylem by capillary action.

2. Why do xylem vessels need lignin in their walls?

3. State one difference between where xylem is found in a dicot stem and in a dicot root.

Image credits

Helianthus stem.jpg – Jon Houseman – CC BY-SA 4.0

Transpiration Overview.svg – Laurel Jules – CC BY-SA 3.0

Apoplast and symplast pathways.svg – Jackacon, vectorised by Smartse – Public domain

Xylem.jpg – Dante – Public domain

Ranunculus root.jpg – Jon Houseman – CC BY-SA 4.0

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