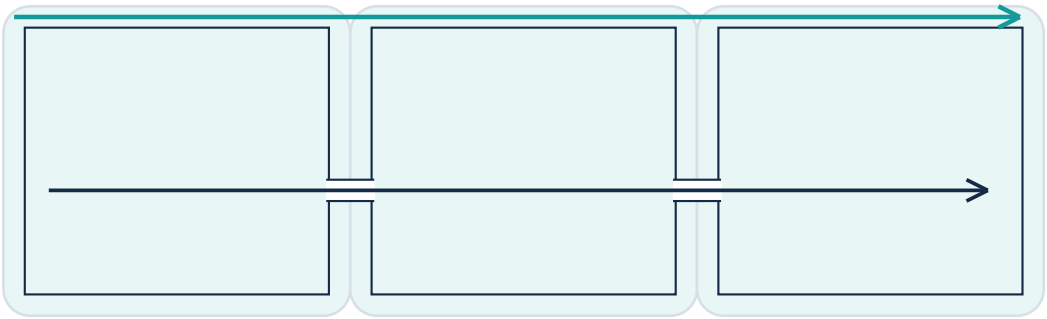
Two pathways across the cortex

Water moves inward from the soil, across the epidermis and cortex, towards the root xylem. Track whether it is outside plasma membranes or inside living cells.

1. THE LOCATION DEFINES THE PATHWAY

Apoplast: porous cell walls



Symplast: cytoplasm linked by plasmodesmata

Schematic cortical cells, not to scale. Inset outlines = plasma membranes. Upper arrow stays in the wall; lower arrow crosses the connecting channels.

2. APOPLAST: OUTSIDE THE PLASMA MEMBRANES

Water travels through cell walls and intercellular spaces. Cellulose-rich walls are porous and water-attracting, so they provide a route for water. No plasma membrane is crossed while water stays in this pathway.

3. SYMPLAST: THROUGH LIVING CYTOPLASM

Water first crosses a plasma membrane to enter the symplast. It then passes between adjacent cells through plasmodesmata, the cytoplasmic channels crossing their walls. It need not cross a new membrane at every cell boundary.

4. ENTRY IS NOT THE SAME AS MOVEMENT BETWEEN CELLS

Entry across a partially permeable membrane is by osmosis when water potential is higher outside. Travel through a cell wall is not osmosis: a cell wall is not a selectively permeable membrane.

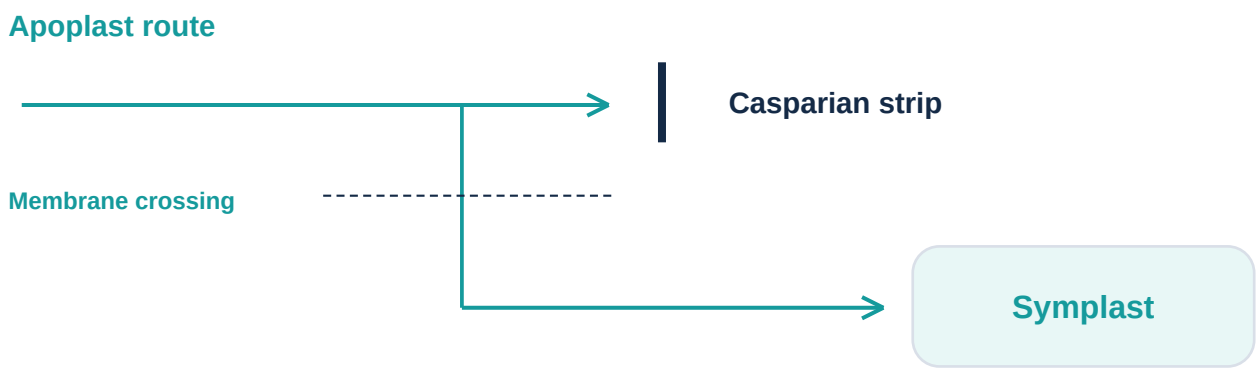
Root organisation: OpenStax Biology 2e, section 30.3.
Water potential and water uptake: OpenStax Biology 2e, section 30.5.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 2, p. 26.

The endodermis closes the bypass

The endodermis is the innermost layer of the cortex, surrounding the vascular cylinder. Casparian strips form a seal in its cell walls that interrupts the apoplast pathway.

1. WATER MUST ENTER A LIVING CELL



Route diagram, not an anatomical section. The water enters the symplast before the blocked wall route; it does not pass through the waterproof strip.

2. NO UNCONTROLLED WALL ROUTE INTO THE STELE

Water following the apoplast must cross a plasma membrane before passing the endodermal barrier. Water already in the symplast can continue through plasmodesmata. The endodermis is not a complete stop to all water movement.

3. MEMBRANES PROVIDE SELECTIVE CONTROL

Membrane transport proteins regulate the passage of dissolved ions. The wall barrier prevents these solutes simply bypassing membranes on their way towards xylem. The strip is a seal, not a pump or a membrane.

4. INCLUDE SUBERIN IN YOUR ACCOUNT

Suberin is a water-repellent wall material associated with endodermal barriers. Its deposition reduces permeability. Keep the main link clear: a waterproof barrier restricts the wall route and makes membrane-controlled entry important.

Endodermis and selective entry: OpenStax Biology 2e, section 30.3.
Water transport and suberin: Calvo-Polanco et al. (2021), New Phytologist.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 2, p. 26.

Complete the route into xylem

Use tissue names for the route, pathway names for the location of water, and water potential for the direction of net movement. These describe different parts of the same process.

1. FROM SOIL SOLUTION TO VASCULAR TISSUE

Soil > **Cortex** > **Endodermis** > **Xylem**

Epidermis lies before cortex; pericycle and other inner tissues lie between endodermis and xylem. This overview omits those intermediate steps, not their existence.

Net water movement follows a water-potential gradient: higher water potential to lower water potential. Water itself is not actively pumped using ATP.

2. AFTER THE ENDODERMIS

Water passes through inner root tissues and leaves the living-cell pathway to enter xylem vessels. Mature vessel lumens lack cytoplasm and belong to the apoplast; water does not remain in the symplast once inside them.

3. CELLULOSE AND LIGNIN HAVE DIFFERENT ROLES

Porous cellulose-rich walls allow water movement. Lignified secondary walls are strengthened and less permeable, helping xylem resist collapse. Water flows along vessel lumens and can move laterally through pits rather than freely through thick lignified walls.

4. PRECISION NOTE - BEYOND THE CORE MODEL

School accounts often associate Casparian strips with suberin. Research distinguishes lignin-rich Casparian strips from additional suberin layers in endodermal cells. Both contribute to barrier function; they are not the same structure.

Water-potential gradient: OpenStax Biology 2e, section 30.5.
Lignin and suberin distinction: Naseer et al. (2012), PNAS.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 2, p. 26.