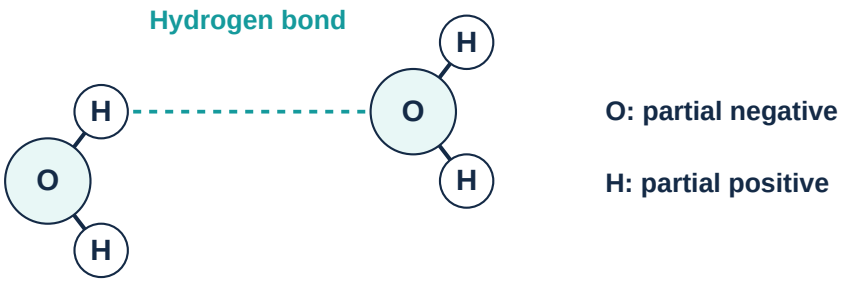
Cohesion: water attracts water

Water molecules are polar. Their partial charges allow hydrogen bonds to form between neighbouring molecules. This intermolecular attraction gives liquid water cohesion.

1. IDENTIFY THE TWO DIFFERENT BONDS



Solid lines: covalent O-H bonds within each molecule

Dotted line: attraction between the partially positive H of one molecule and the partially negative O of another. A few molecules are shown, not the whole liquid network.

2. COHESION HELPS MAINTAIN CONTINUITY

Many hydrogen bonds collectively give the water column tensile strength: it can transmit a pull without readily separating. The column is liquid water, not a chain of permanently joined molecules.

3. DO NOT CONFUSE THE BOND TYPES

The O-H bonds inside a water molecule are covalent. The bonds responsible for cohesion here are hydrogen bonds between molecules. Transpiration does not split water into hydrogen and oxygen.

4. LINK THE MOLECULE TO THE TRANSPORT ROLE

Hydrogen bonding produces cohesion; cohesion helps a continuous water column transmit tension. It does not provide a pump or an energy source that pushes water upwards.

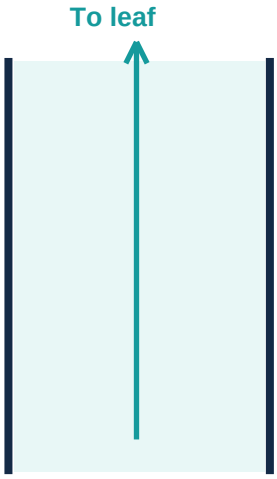
Water polarity, hydrogen bonds and cohesion: OpenStax Biology 2e, section 2.2.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 4, p. 26.

Transpiration creates a pull

Evaporation from moist mesophyll walls removes water from the leaf. Replacement water is drawn from the xylem, creating tension in the connected liquid column.

1. START AT THE LEAF, NOT AT A ROOT PUMP



A. Water evaporates

Loss occurs at internal leaf surfaces.

B. Tension develops

Xylem pressure becomes more negative.

C. The column moves

Cohesion transmits the pull downwards; water flows upwards.

Xylem cutaway, not to scale. The arrow shows liquid flow. Tension is a pulling stress in the water, not upward movement of water vapour.

2. COHESION-TENSION IS A CONNECTED SEQUENCE

Evaporation increases the pull at leaf cell walls. Tension is transmitted through connected water to the xylem and down the plant, drawing replacement water from the roots. This is transpiration pull.

3. THE FLOW IS PASSIVE

The pressure gradient drives bulk flow of liquid through xylem. Mature vessel elements have no living protoplast to pump water. Energy for evaporation comes from the surroundings, ultimately largely sunlight, rather than ATP-powered xylem pumps.

4. KEEP ROOT PRESSURE SEPARATE

Root pressure can push xylem sap under some conditions, but it is not the pulling force described by cohesion-tension. Do not use a root-pressure explanation in place of transpiration pull.

Transpiration pull and tension: OpenStax Biology 2e, section 30.5.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 4, p. 26.

Adhesion: water attracts the wall

Cohesion acts between water molecules. Adhesion acts between water and another material, including cellulose in plant cell walls. Both depend on intermolecular attractions.

1. KEEP THE THREE ROLES DISTINCT

COHESION	ADHESION	TENSION
Water to water	Water to cellulose	Pull in the column
Helps water stay connected.	Helps water wet and adhere to walls.	Transmits the effect of leaf water loss.

2. CELLULOSE CAN HYDROGEN-BOND WITH WATER

Cellulose contains hydroxyl groups that can form hydrogen bonds with water. This attraction helps water remain in contact with cell-wall surfaces. Adhesion complements cohesion; it is not the same attraction under a different name.

3. WALL STRUCTURE SUPPORTS THE CONDUIT

Lignified secondary walls strengthen xylem vessels and help prevent collapse under tension. The lumen provides the flow route. Pits allow lateral water movement where secondary-wall thickening is absent; vessel walls are not uniformly exposed cellulose.

4. DO NOT MAKE ADHESION DO THE WHOLE JOB

Adhesion supports wetting and capillary effects, but capillary rise alone does not explain water reaching the tops of tall trees. The complete account needs transpiration-generated tension and a cohesive liquid column.

Adhesion and cellulose: OpenStax Biology 2e, section 30.5.
Vessel walls, lignin and pits: OpenStax Biology 2e, section 30.2.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 4, p. 26.