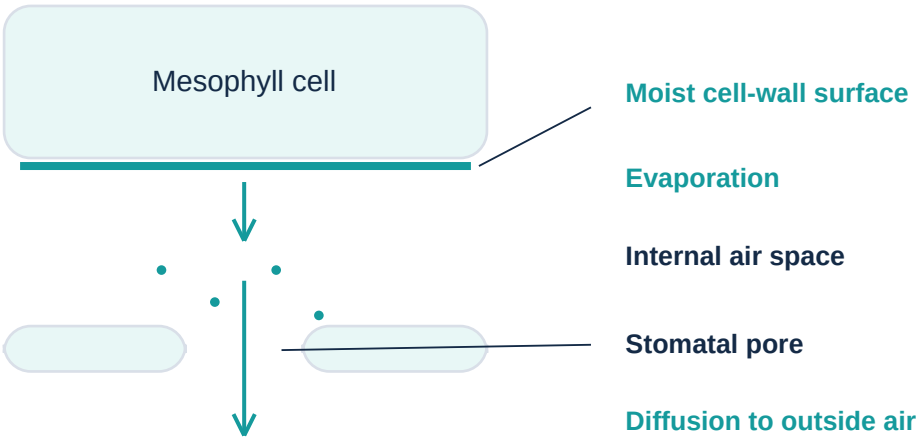
Follow water from leaf to air

Transpiration is the loss of water vapour from a plant's aerial parts, mainly its leaves. The main leaf pathway involves two processes in sequence: evaporation, then diffusion.

1. A SIMPLIFIED VIEW INSIDE A LEAF



Partial section, not to scale. Dots = vapour; teal line = liquid water on the wall. The gap in the lower epidermis represents a stoma.

2. EVAPORATION HAPPENS AT INTERNAL SURFACES

Liquid water evaporates from moist mesophyll cell walls into the air spaces within the leaf. Water changes from liquid to gas; it does not need to boil. These internal surfaces are not the outer waxy cuticle.

3. WATER VAPOUR LEAVES THROUGH STOMATA

Vapour diffuses through the connected air spaces and out through stomatal pores. When vapour concentration inside is higher than outside, the net movement is from the leaf to the atmosphere.

4. REPLACEMENT WATER ARRIVES AS LIQUID

Water lost from cell walls is replaced by water moving from nearby tissues and the leaf xylem. The ascending xylem stream is liquid water, not water vapour. Cohesion-tension is covered in Lesson 7.2.4.

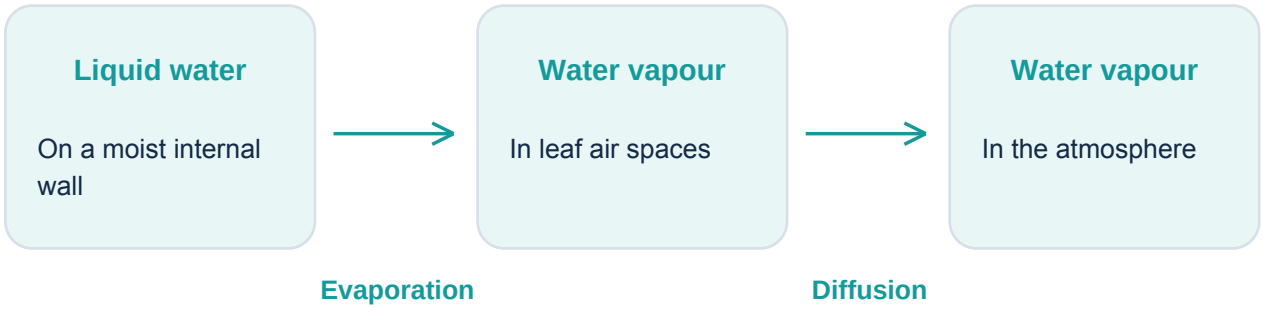
Mesophyll evaporation and xylem supply: OpenStax Biology 2e, section 30.5.
Leaf tissues and stomatal pores: OpenStax Biology 2e, section 30.4.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 3, p. 26.

Two processes, different meanings

Evaporation describes a change of state. Diffusion describes net movement of particles down a concentration gradient. Naming both makes the transpiration explanation complete.

1. KEEP THE ORDER AND THE STATE OF WATER



Only the first step changes liquid to gas. In the second step, the water is already vapour; it spreads through air and exits the pore.

2. EVAPORATION REQUIRES ENERGY

Some surface water molecules have enough energy to escape the liquid. Energy is taken from the surroundings, so evaporation can cool the leaf. This is not active transport using a membrane pump.

3. DIFFUSION IS NET MOVEMENT, NOT ONE-WAY MOTION

Vapour molecules move randomly in both directions. A concentration difference produces greater movement from the more concentrated side, giving a net outward flux when the surrounding air is drier.

4. TRANSPIRATION IS NOT OSMOSIS OR TRANSLOCATION

Osmosis is water movement across a partially permeable membrane. Translocation carries assimilates in phloem. Transpiration refers to vapour loss; neither of those terms replaces evaporation followed by diffusion.

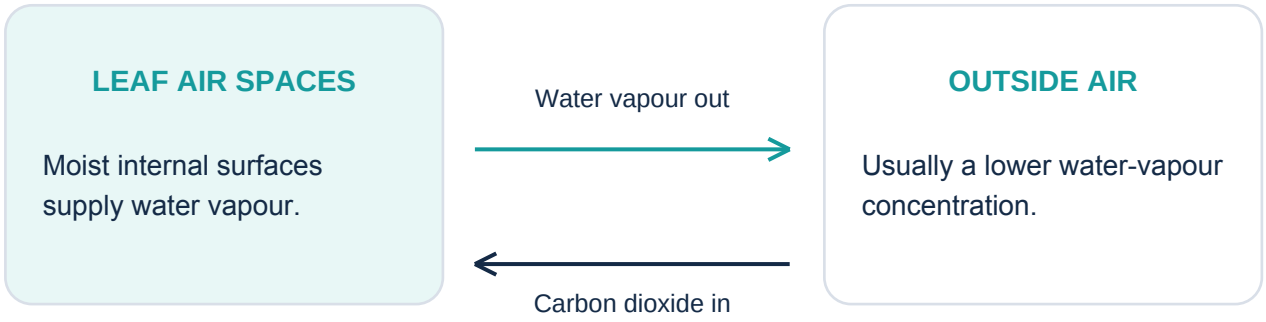
Evaporation, energy and cooling: OpenStax Biology 2e, section 2.2.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 3, p. 26.

Stomata connect the leaf to the air

Supporting context: the pore opening and the difference in water-vapour concentration affect water loss. These links help explain the two-step process, rather than replacing it.

1. A GAS-EXCHANGE TRADE-OFF



Arrows show typical net exchange through an open stoma in a photosynthesising leaf. Guard cells regulate the pore; they do not pump vapour out.

2. A SMALLER PORE RESTRICTS EXCHANGE

Closing stomata increases resistance to vapour diffusion and reduces water loss. It also restricts carbon dioxide entry for photosynthesis. A stoma is the pore; the paired guard cells control its opening.

3. THE GRADIENT MATTERS

At the same temperature and pore opening, more humid outside air usually reduces the vapour-concentration difference and net water loss. Air movement can remove the moist boundary layer, maintaining a steeper gradient.

4. PUT THE COMPLETE EXPLANATION TOGETHER

Water evaporates from moist internal leaf surfaces into air spaces. Water vapour then diffuses through stomata to the atmosphere down a concentration gradient. Do not say liquid droplets are pushed out of stomata.

Stomata and guard-cell function: OpenStax Biology 2e, section 30.4.
Humidity and air movement: USGS, Evapotranspiration and the Water Cycle.

Scope: Cambridge Biology 9700 syllabus, section 7.2, outcome 3, p. 26.