Transport overview

Water potential and water movement

- Water potential ($\Psi$) predicts where water moves
  - Measured in units of pressure: megapascals (MPa)
  - A function of:
    - Solute concentration
    - Pressure (can be either positive or negative)
  - Pure water's $\Psi =$ ? MPa
  - If you add a solute to pure water, $\Psi$ __________
  - Water moves across a membrane from a solution with HIGHER $\Psi$ to one with LOWER $\Psi$
    - Osmosis anyone?

Transport outline

- Transport across membranes
- Absorption of water and minerals by the roots
- Transport up in xylem
- Controlling water loss—transpiration
- Transport down in phloem

An example

- Flaccid vs. turgid cells
- Plasmolysis

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Uptake by roots

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Two possibilities:
1. Pushed up from below
2. Pulled up from above

Pushing up
- Root pressure
  - At night, water keeps entering the roots because the water potential is _____ there due to the accumulation of minerals in the stele
  - This inward movement of water pushes xylem sap up
- Can result in guttation in some herbs
- At most, moves water up a few meters due to root pressure
- Our conclusion?

Pulling up
- Where does the pull come from? “holey” leaves

Transpiration leads to a negative pressure or tension that is applied to the column of water held together by H bonding
Can you ‘see’ negative pressure?
- Is the ‘tension’ pulling water up an adult tree actually measurable at a tree trunk?

Can you see transpiration in a stream?

Webster & Waide 1982

Photosynthesis vs. transpiration
- Transpiration is...?
- What does photosynthesis require?
- So, the two processes depend on...?
- Is there a possible problem?

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Transpiration-Cohesion-Tension Mechanism
- = Bulk flow
- Outside air \( \psi \) = \(-100.0\) MPa
- Leaf \( \psi \) (air spaces) = \(-7.0\) MPa
- Leaf \( \psi \) (cell walls) = \(-1.0\) MPa
- Trunk xylem \( \psi \) = \(-0.8\) MPa
- Trunk xylem \( \psi \) = \(-0.6\) MPa
- Soil \( \psi \) = \(-0.3\) MPa

Regulating transpiration

Buckle outward

Accumulate \( K^+ \)

Release \( K^+ \)
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Transport in phloem: Translocation
- Direction determined by sugar sources and sinks

Pressure flow in phloem
- Still called bulk flow, but a different cause

Can you see pressure flow?
- Higher sugar concentration near the source?