Lec. 5 WATER Uptake

1. How does water move into the root?

Apoplastic pathway
Symplastic & transmembrane pathway

Water enters the cytoplasm at the endodermis

2. How is water transported from roots to the leaves? Pressure-driven bulk flow.

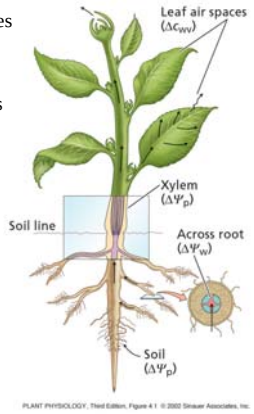
Evidence for a negative pressure in xylem.

Negative pressure is generated by transpiration.

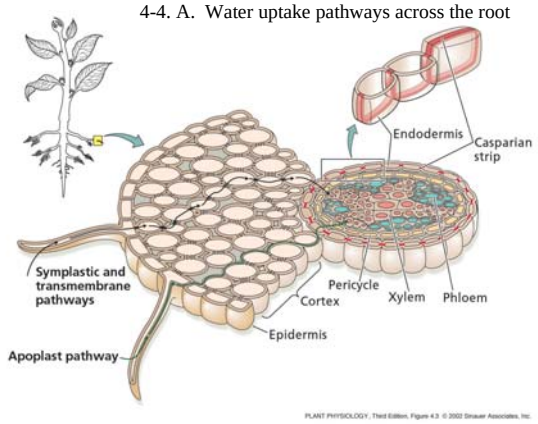
Water moves up a plant by the Cohesion-Tension Theory

4-1. Driving forces for water flow:

3 main water potential gradients



4-4. A. Water uptake pathways across the root

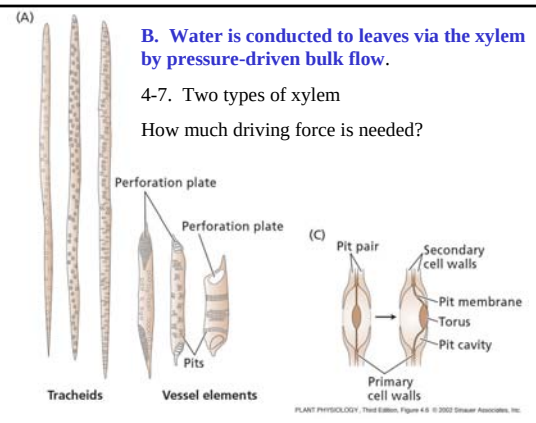


Endodermis:
a layer of cells that prevents ion and water loss.

Because of the Casparian strip, a suberin (waxy) barrier, water enters the cytoplasm at the endodermis (PM contains water channels or aquaporins. Water channel activity may be regulated.)

Water then leaves the endodermis through the plasma membrane and moves to the xylem using both the apoplast and symplast pathways.

Root Pressure:
positive pressure in the root xylem due to ion accumulation

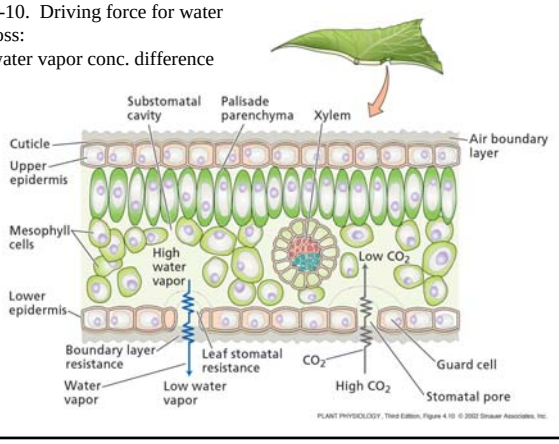


B. Water is conducted to leaves via the xylem by pressure-driven bulk flow.

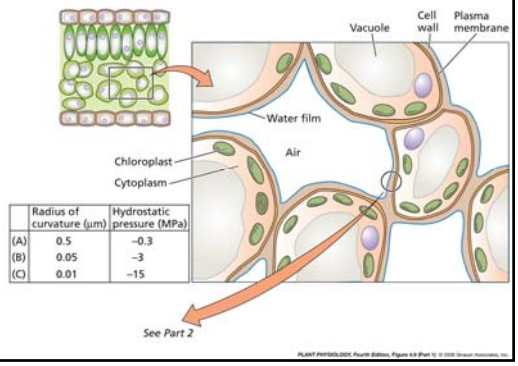
4-7. Two types of xylem

How much driving force is needed?

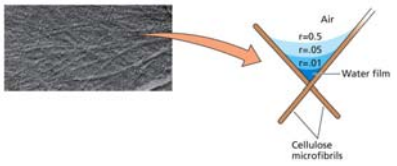
4-10. Driving force for water loss:
water vapor conc. difference



4-9. Tension or negative pressure originates in leaves



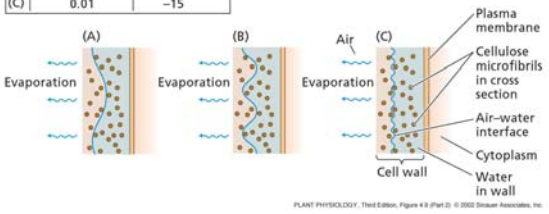
	Radius of curvature (μm)	Hydrostatic pressure (MPa)
(A)	0.5	−0.3
(B)	0.05	−3
(C)	0.01	−15



4-9. Negative pressure of water on curved surfaces depends on radius

	Radius of curvature (μm)	Hydrostatic pressure (MPa)
(A)	0.5	−0.3
(B)	0.05	−3
(C)	0.01	−15

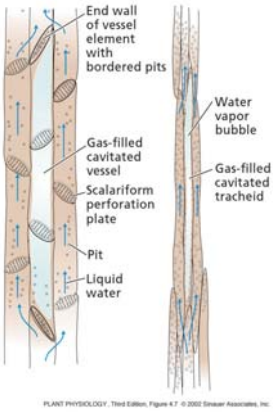
$\Psi p = -2T/r$



4-7. Tension in xylem can cause cavitation.

Estimate:

Need 3 Mpa to lift water up 100 m in xylem of 40 um radius.



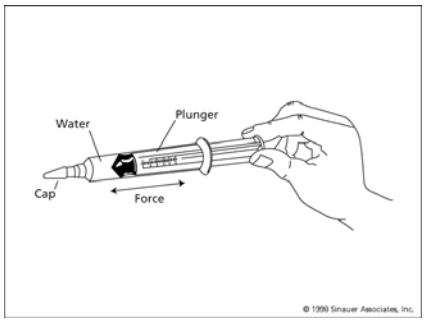
Other theories:

Xylem pressure not – enough, may be a technical limitation.

Cohesion-Tension theory still stands

Steudle 2001 ARPB

Pull: Water is under negative pressure.
Push: Water is under positive pressure



How do we know there is a negative pressure in xylem or in cells?

Expt. Evidence

1. Pressure chamber
2. Pressure probe (single cell)

(see Web: www.plantphys.net)

How is the negative pressure generated?

a) Transpiration: loss of water vapor through stomatal pores

b) Growing cells that take up water

Water moves up by cohesion-tension theory

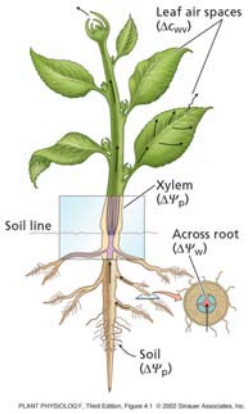
Review:

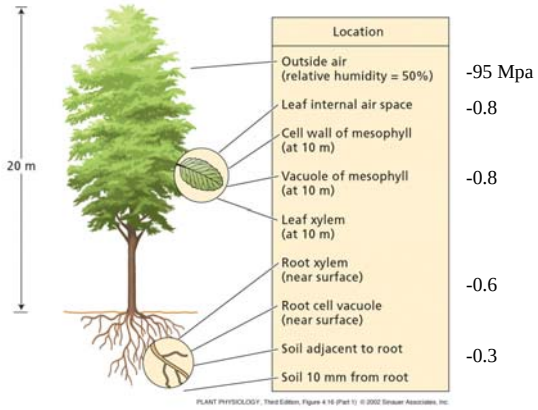
Waters enters the root through the apoplast, symplast and transmembrane pathways.

Water moves from roots to leaves by pressure-driven bulk flow in tube-like structures- xylem.

Negative pressure is generated by transpiration. Transpiration is the loss of water through stomatal pores.

Negative pressure is also formed by growing cells that take up water.





Negative pressure is also generated by growing cells that take up water

When humidity is high

When stomatal aperture is closed

How is water potential measured?

1. **Osmotic or solute potential of tissues**.

Tissue weight as a function of solute concentration

2. **Xylem pressure potential**

Pressure chamber
Pressure probe

3. **Tissue water potential**

Thermocouple psychrometer