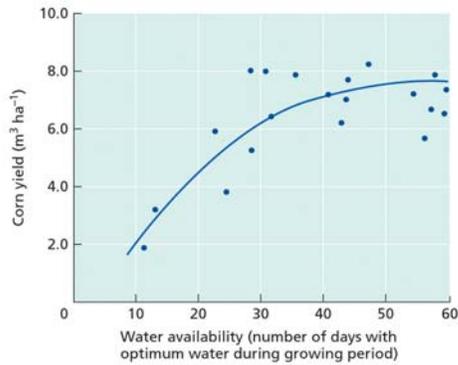
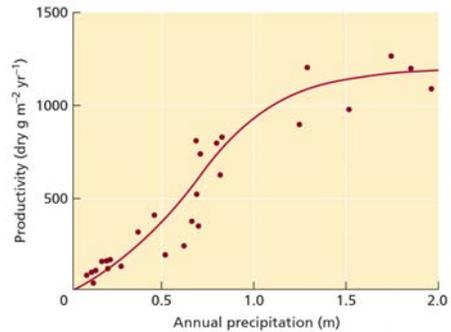


3-1 Taiz. Water is needed for optimal corn yield



Vegetative and reproductive growth depend on water. Why?



Germination: Water needs Outline

1. Water is the single most important molecule in biology.
 - . Why? Unique properties of water
2. How does water move?
 - A. Water moves in 3 ways: diffusion, bulk flow, osmosis.
 - b. Water moves from a region of high water potential to a region of low water potential.
3. Cell expansion is driven by turgor pressure.
4. How is water absorbed by roots?
5. How is water transported up to the leaves?



What do seeds need to germinate?

- 1.
- 2.
- 3.

Why?

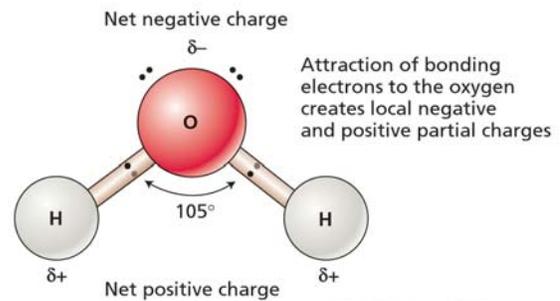
%Water

lettuce?
carrot
seed (nut)

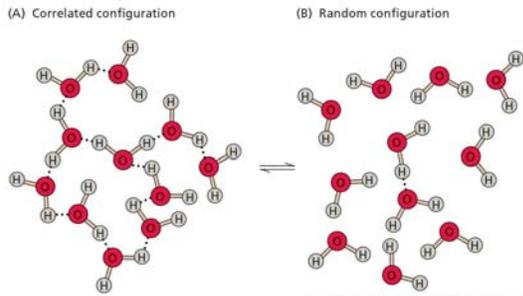
WATER IS THE SINGLE MOST IMPORTANT MOLECULE IN BIOLOGY. WHY?

- Good Solvent
 - Solvent and reactant for biochemical reactions
 - Medium used for transport of all ions and metabolites
 - Incompressible, so its uptake leads to cell expansion
 - Transparent, so it enables light to penetrate cells
 - Well suited for temperature regulation
- What properties make water such an amazing molecule?

3-3 Taiz. Polarity of water leads to H bonding.



3-4. H bonding

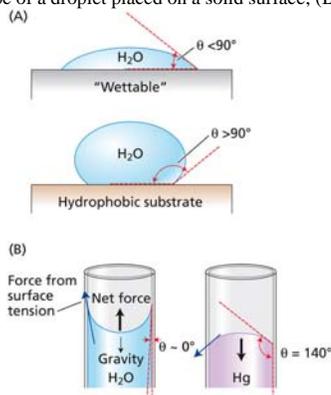


Result of H-bonding:

- High melting point
- High boiling point
- High specific heat of water
- High specific heat of vaporization

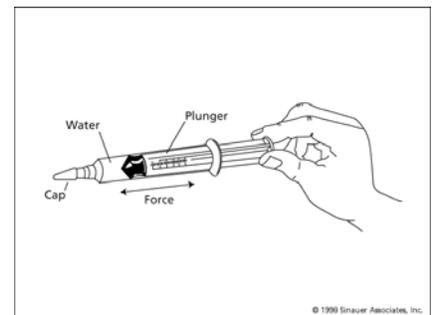
- **Cohesion** – intermolecular attraction results in high surface tension
- **Adhesion** - attraction of water to solid phase (cell wall), results in capillary rise
- **Tensile strength** of water is high.

3.5 (A) Shape of a droplet placed on a solid surface; (B) Capillarity

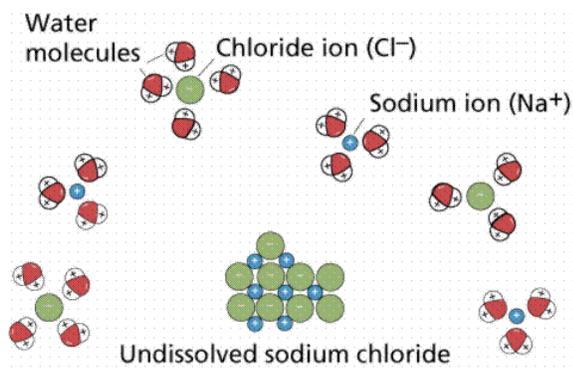


Positive pressure builds up when you **push** the syringe.

Negative pressure results when you **pull** the syringe.



Water is a universal solvent. It forms electrostatic interactions with ions and keeps ions in solution [Farabee, ch. 4]



Water needs for germination:

1. Put metabolites in solution
2. Hydrate enzymes so they fold to active state
3. Breakdown stored food
4. Generate energy for synthesis of new cells
5. Provide turgor pressure for cell expansion

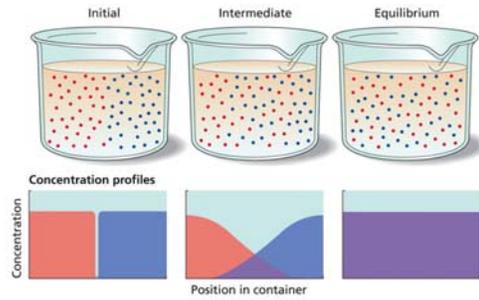
HOW DOES WATER MOVE ? (into & within seed and seedling)
In which direction?

Water movement is **passive**, i.e. energetically downhill.
 Water movement is down conc. gradient and pressure gradient

a. **Three ways water move:**

- 1) Diffusion- movement down a **conc. gradient**
- 2) Bulk Flow: movement down a **pressure gradient**
- 3) Osmosis: movement across a membrane and down both **conc. and pressure gradient**

3-7. Taiz diffusion



PLANT PHYSIOLOGY, Fourth Edition, Figure 3.7 © 2005 Sinauer Associates, Inc.

b) **What determines the direction of water movement?**

The direction depends on the driving force.

Water moves from a region of high water potential to a region of low water potential until the water potential of the two sides are equal. (equilibrium)

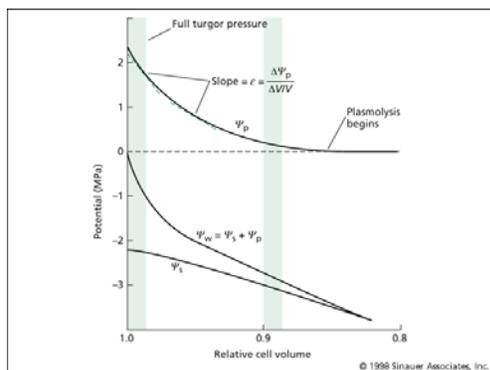
Water potential indicates the free energy of water and the potential to do work. The total driving force of water, the water potential, depends on the **sum** of the pressure potential + the osmotic (or solute) potential.

$$\Psi_w = \Psi_p + \Psi_s$$

Example

See example 3.9

3-10. Taiz. Small increases in volume cause large changes in turgor pressure in a cell. Hydrated cell has + turgor pressure

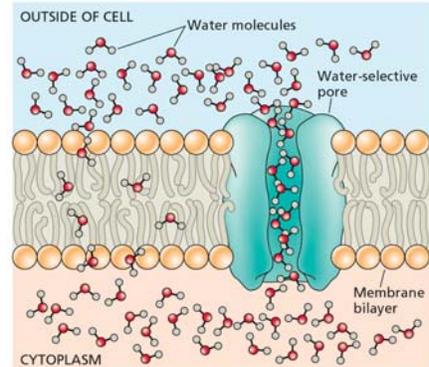


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3-6. How does water cross cell membranes?

Water can cross membranes via

- i) lipid bilayer,
- ii) Protein water channel



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Why is hydrostatic pressure necessary?

1. Positive Pressure causes wall to stretch.
Therefore cells can grow.

Cell expansion is driven by turgor pressure.

2. **Turgor pressure increases mechanical rigidity of cells, and gives plants support.**

Water potential is a measure of the water status of a plant.

I.e. is plant suffering from water deficit or not?

3-12 Taiz. Sensitivity of various processes to water potential of plants

Cell growth is sensitive to water stress. Why?

