Germination: Water needs
Outline
1. Water is the single most important molecule in biology.
   a. Why? Unique properties of water
2. How does water move?
   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?

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?

What do seeds need to germinate?
1.
2.
3.
Why?

% Water
lettuce? carrot seed (nut)
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.

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]
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

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

3-7. Taiz. Diffusion

See example 3.9

3-6. How does water cross cell membranes?

Water can cross membranes via
i) lipid bilayer,
ii) Protein water channel

3-10. Taiz. Small increases in volume cause large changes in turgor pressure in a cell. Hydrated cell has \( P_t \) turgor pressure
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?