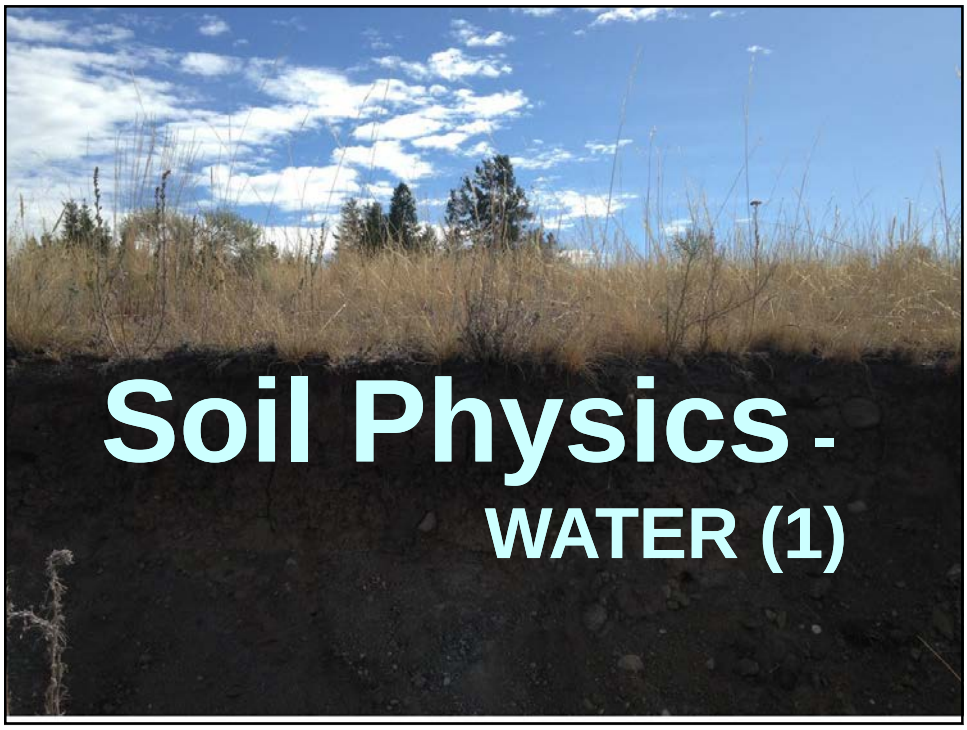

APBI 200
SOIL COMPONENTS


Soil Physics -
WATER (1)

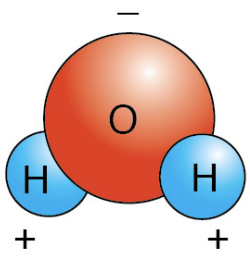
Lecture outline

A. Review properties of water

B. Soil water energy concepts

C. Soil water potential

Water – a polar molecule



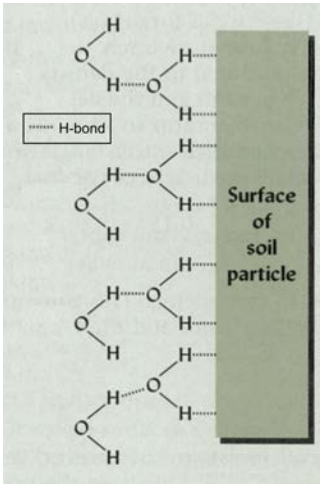
Source: University of Hawaii at Manoa

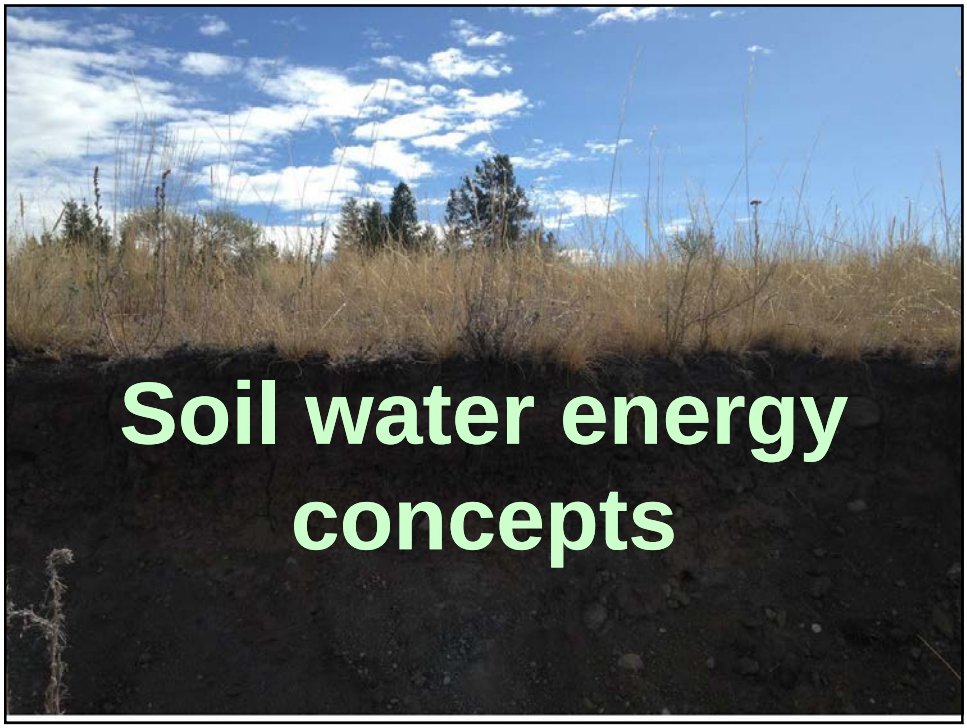
Interactions of water & soil particles

H-bonding

Adhesion: attraction of water molecules to solid surface

Cohesion: attraction of water molecules to each other





Interactions of soil particles & water affect:

- Amount of rain that runs into and through the soil
- Amount of surface runoff
- Water losses by leaching and evapotranspiration
- Water-air balance in soil pores
- Capacity of soil to store and provide water to plant growth
- Rate of change of soil temperature
- Soil organisms

Water movement (and retention) in soils is energy-related phenomenon, controlled by energy gradients

Kinetic energy - related to movement

Potential energy - related to position or internal condition

Potential energy is a measure of the amount of work a body can perform by virtue of the energy stored in it

Water moves from

higher to

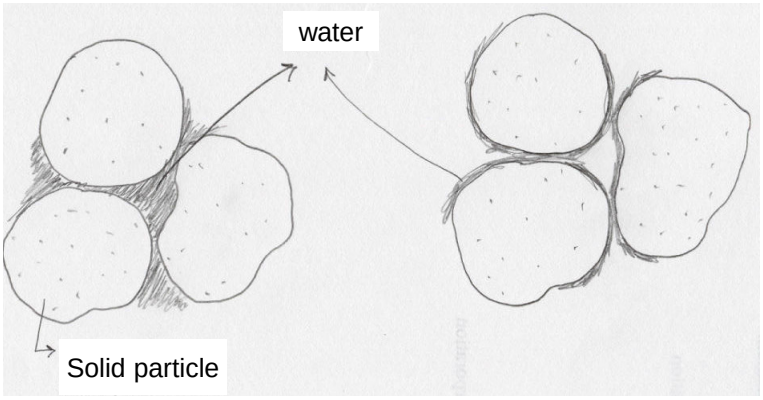
lower energy state

By knowing **potential energy** levels at various points in a soil we can predict direction of water movement

Energy level of soil water is affected by:

- Matric force
- Osmotic force
- Gravity

Wet soil **Dry soil**



Soil water potential - difference in energy levels between the pure water at the reference state and soil water

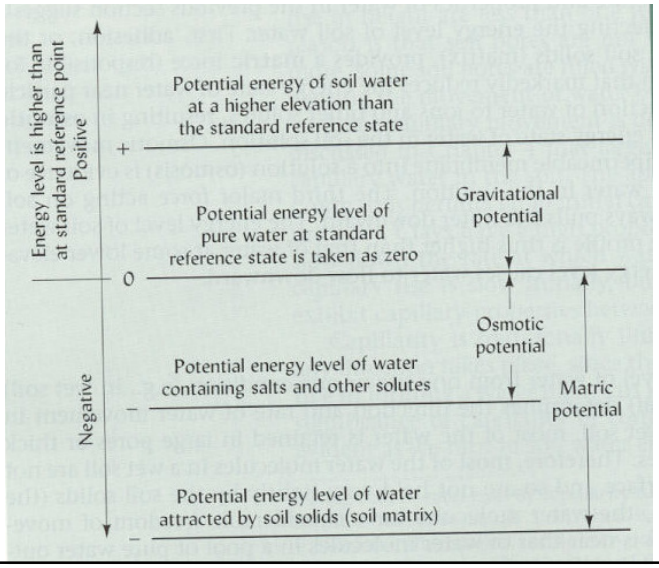
(***Note: term "potential" implies difference in energy status)***

Total soil water potential (Ψ_t) is due to several forces:

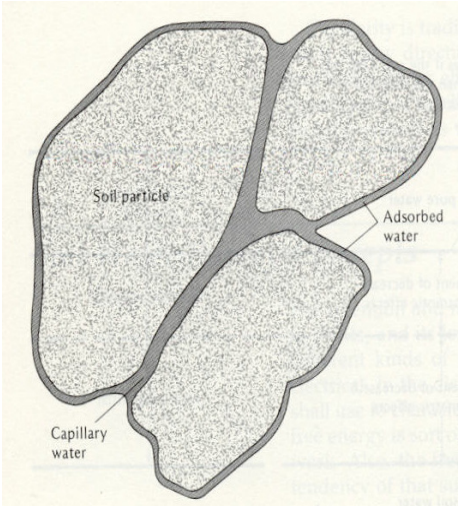
$$\psi_t = \psi_g + \psi_m + \psi_s + \psi_o + ...$$

Ψ_g = gravitational potential
Ψ_m = matric potential
Ψ_s = submergence potential
Ψ_o = osmotic potential

Potential ψ of pure water at a standard reference state & soil water

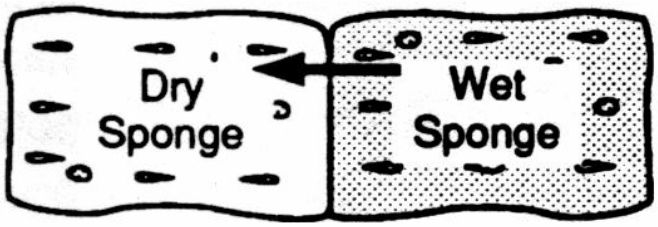


Section 5.3
In textbook



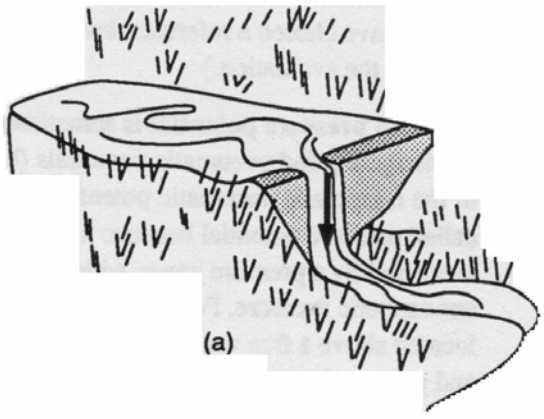
Matric potential (Ψ_m) - result of attraction of water molecules to the soil solids due to **adsorption** and **capillarity**

Matric potential (Ψ_m)

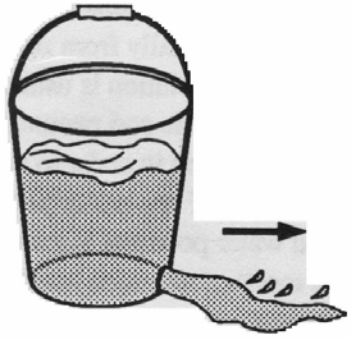


(e)

Gravitational potential (Ψ_g)



Submergence potential (Ψ_s)

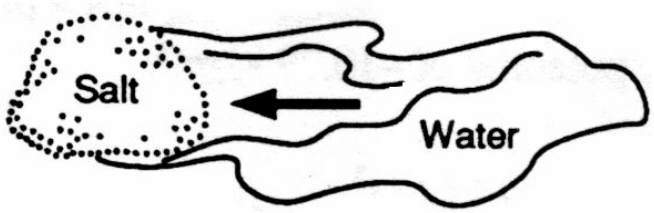


(d)

Soil water

This soil is formed under conditions of water saturation. Water stands in the pit.

Osmotic potential (Ψ_o)



(b)

Osmosis

When semi-permeable membrane is present between zones of

high and

low osmotic potential

water will move in response to differences in osmotic potential

Zero potentials

- Ψ_g = 0 at any reference level
- Ψ_m = 0 at free water surface
- Ψ_s = 0 at free water surface
- Ψ_o = 0 for pure, solute-free water
- **Pneumatic (gas pressure) potential** Ψ_a = 0 under normal atmospheric pressure