Water and solute movement in the body

- Solutes in water (= solutions)
- Diffusion and transport of solutes
- Osmosis of water
- Body water compartments
- Osmolarity - concentration, osmoles/liter
- Tonicity - behavior of cells in solution

Osmosis

- The movement of water across a semipermeable membrane in response to a concentration gradient.
- Water moves to dilute the more concentrated solution.
- Units express as osmolar (OsM) or milliosmolar (mOsM).
• Solution Concentrations
  – Define and calculate percent, grams/l, moles/l, molarity, osmoles/l, osmolarity of a solution.
  – Differentiate between hyper-, hypo-, and isosmotic solutions and predict osmosis between solutions of these types.

  Calculations and predictions in class.

Osmolarity depends on conc of osmotically active particles.

• What happens to 1 mole of glucose dissolved in 1 L of water?
  A) what is its molarity?
  B) What is its osmolarity?
• What happens to 1 mole of NaCl dissolved in 1 L of water?
  A) what is its molarity?
  B) What is its osmolarity?

• Cell has internal osmolarity of 300 mOsM. Solutes in cell cannot leave.
• Membrane is permeable only to water.

A solution of 200 mOsM NaCl is __ osmotic to this cell.
• A) hypo
• B) iso
• C) hyper
Terminology

• Hyposmotic
• Isosmotic
• Hyperosmotic

• Hypotonic
• Isotonic
• Hypertonic

Water movement in the body

• Tonicity
  – Differentiate between hyper-, hypo-, and isotonic solutions and predict osmosis in and out of cells for each.
  – Describe the action of water and osmoles in various solutions using penetrating and non-penetrating solutes (including intravenous solutions).
Cell has internal osmolarity of 300 mOsM.
Membrane is permeable only to water.

What happens to cell volume if placed in solution of 200 mOsM NaCl? The cell…

A) shrinks
B) swells
C) does not change size

Tonicity

- **Isotonic** - solution has same osmotic pressure as ICF, no net water movement
- **Hypotonic** - fewer osmotically active particles than ICF, water moves into cells
- **Hypertonic** - solution had more osmotically active particles than ICF, water moves out of cells.

*"Osmotically active" = non-penetrating, causes osmosis*
Assumptions

• Water distributes evenly across compartments.
• All administered fluids go into the ECF first.
• NaCl is considered non-penetrating for the ICF. Urea and glucose are both penetrating, though glucose (=dextrose) is slowly penetrating.

Problem

• Create a box with compartments A and B. The compartments are separated by a membrane that is permeable to water and urea but not to NaCl. Fill the compartments with:
  • A = 300 mOsM NaCl
  • B = 300 mOsM urea

• And allow the system to go to equilibrium.

• At equilibrium, compartment A will have:
  A) increased volume and incr. osmolarity
  B) increased volume and no change in osmolarity
  C) decreased volume and increased osmolarity
  D) no change in volume and increased osmolarity
  E) no change in volume or osmolarity
Net osmosis based on solute permeability (tonicity)

- Net osmosis in a living organism depends on the relative concentration of NONPENETRATING solutes in the two compartments being compared.

- Same compartments but now A has 300 mOsM NaCl and B has 300 mOsM urea + 300 mOsM NaCl (= 600 mOsM total). What happens to vol and osmol of A at equilibrium?
  - A) vol and osmol increase
  - B) vol increase, osmol not changed
  - C) vol not changed, osmol increased
  - D) vol decreased, osmol increased
  - E) vol decreased, osmol not changed