**Dr. Capers’ Chemistry Highlights**

What are the chemical elements that make up living organisms?

* All matter is composed of atoms
  + Positively charged nucleus (protons and neutrons) around which negatively charged electrons move
    - Protons – positive charge
      * Atomic mass unit (amu) – 1 Dalton
    - Neutrons – zero charge
      * Atomic mass unit (amu) – 1 Dalton
    - Electrons – negatively charge
      * Mass is ignored
* Element – pure substance that contains only 1 kind of atom
  + Arranged on **Periodic Table**
    - Atomic Number - # of protons
    - Mass Number - # of protons + # of neutrons
      * Mass number = ~ mass of atom in Daltons
      * All elements except Hydrogen have one or more neutrons
    - Isotopes – forms of an element with different # of neutrons, thus different mass numbers (protons always stay the same)
      * Atomic weight – average mass of numbers of isotopes in normally occurring proportions
      * Radioisotopes
        + Most isotopes are stable, but some are unstable and are called radioisotopes
        + Spontaneously give off α, β, or γ radiation

Radioactive decay

Radiation can damage cells and tissues

Used to treat cancer

* # of electrons determines how atoms will interact
  + Locations of electrons in an atom are described by orbitals
  + Chemical reactions – involve changes in the distribution of electrons between atoms
    - Orbitals occur in series called electron shells or energy levels
    - Atoms can share electrons, or loose or gain electrons resulting in atoms forming MOLECULES
      * Octet rule – atom will try to add or loose electrons in order to have a stable shell
      * How do atoms bond to form molecules?
        + Compound – molecule made up of 2 or more elements
        + Molecular weight – sum of atomic weights of all atoms in the molecule
        + Bonds (know examples for each):

Covalent bonds – share electrons

Very strong, a lot of energy is needed to break them

Biological molecules are put together this way and are very stable

Ionic bonds – attraction of opposite charges

Ions – electrically charged particles when atoms loose or gain electrons

Cations – positive Na+

Anions – negative Cl-

Salts are ionically bonded together

Interact with polar molecules, salts dissolve in water

Hydrogen bonds – sharing of hydrogen atom

Attraction between the δ- end of one molecule and the δ+ hydrogen end of another molecule

Form between water molecules and are important in the structure of DNA and proteins

Hydrophilic – polar molecules that form hydrogen bonds with water (water loving)

Hydrophobic – nonpolar molecules that don’t interact with water (water hating)

van der Waals forces – attractions between nonpolar molecules

result from random variation in electron distribution

interactions are brief and weak

* + - How do atoms change partners in chemical reactions?
      * Chemical reactions – atoms bond or change bonding partners
        + Matter and energy are neither created or destroyed!!
        + Energy – capacity to do work or capacity for change, can change form during reactions

What properties of water make it so important in biology?

* Water – unique in structure and special properties
  + Polar molecule – forms hydrogen bonds
    - Ice floats – molecules are not densely packed and leaves spaces, making ice less dense than water
      * Why is this important?
    - Unique melting, freezing, and heat capacity
      * Required great amount of energy to melt ice, to break those hydrogen bonds
      * High specific heat – amount of energy required to raise temp 1°C
      * High heat of vaporization – amount of energy required to change from liquid to gas
        + Because of all of this, water helps to moderate the climate of the Earth
    - Cohesion – water molecules resist coming apart from one another
      * Helps water move through plants
      * Results in surface tension – important for plankton
    - Water is solvent of life
      * A solution is a substance (solute) dissolved in a liquid (solvent)
      * Many important biochemical reactions occur in aqueous solutions
        + Human body is over 70% water
        + Biologists study what happens in these reactions

Qualitative analysis – deals with substances dissolved in water and the chemical reactions that occur there

In other words – what substances are present for the reaction

Quantitative analysis – deals with concentrations of products and reactants

Mole – amount of substance (in grams) which is numerically equal to its molecular weight

1 mole of Na+ = 23g

1 mole of H2 = 2 g

1 mole contains 6.02 x 1023 molecules – Avogadro’s Number

Think of buying a dozen

When you buy a dozen of eggs or a dozen of donuts, you know you will get 12 but they won’t weigh the same or take up the same amount of space

* + - * + Aqueous solution may be acidic or basic

Acids – the release hydrogen ions H+

Bases – accept H+

Living organisms must maintain internal conditions, including pH

Buffering capacity