Honors Biology – Unit 1 – Chapter 2
"THE CHEMICAL BASIS OF LIFE"

1. common elements and trace elements in biology

2. elements vs. compounds

3. protons, neutrons, electrons, how to draw orbital diagrams

4. isotopes, radioactive isotopes

5. covalent bonds (sharing) vs. ionic bonds (give and take)

6. electronegativity, polar, non-polar, hydrogen bonds, water molecules

7. 7 properties of water:

    - cohesion, adhesion, surface tension, evaporative cooling, density, universal solvent, capillary action

8. water vs. oil: polar/non-polar, hydrophilic/hydrophobic

9. the pH scale:

    - acids (H+), bases (OH-), neutral (H_2O)

10. acid rain, effect on plants and marine life

11. chemical reactions: reactants vs. products

Honors Biology – Chapter 2 Word Roots
"THE CHEMICAL BASIS OF LIFE"

an- = not (*anion:* a negatively charged ion)

aqua- = water (*aqueous solution:* a solution in which water is the solvent)

co- = together; **-valent** = strength (*covalent bond:* an attraction between atoms that share one or more pairs of outer-shell electrons)

electro- = electricity (*electronegativity:* the attraction of a given atom for the electrons of a covalent bond)

iso- = equal (*isotope:* a variant form of an atomic element having the same number of protons and electrons but a different number of neutrons)

neutr- = neither (*neutron:* a subatomic particle no electrical charge)

pro- = before (*proton:* a subatomic particle with a single positive electrical charge)

PROPERTY OF:

HONORS BIOLOGY – UNIT 1 – CHAPTER 2 NOTES

THE CHEMICAL BASIS OF LIFE

Levels of Organization

3. MOLECULE = a chemical made of 2 or more atoms
   (water = H_2O, carbon dioxide = CO_2)
2. ATOM = the smallest unit made of only one element
   (hydrogen, carbon, helium, nitrogen)
1. SUBATOMIC PARTICLE = particles found inside an atom
   (protons, neutrons, electrons)

Subatomic Particles

1. PROTON
   Location: found in the "nucleus" of an atom
   Function: # of protons determines the type of atom
   Charge: positive
2. NEUTRON
   Location: found in the "nucleus" of an atom
   Function: helps to stabilize the protons
   Charge: neutral
3. ELECTRON
   Location: spin around in "orbitals" that surround the nucleus
   Function: used to form ionic bonds and covalent bonds
   Charge: negative

Three Rules for Orbital Diagrams

1. Write the number of protons and neutrons in the middle.
2. Draw the first 2 electrons in the 1st orbital.
3. Draw up to 8 electrons in each additional orbital.

Types of Chemical Bonds

1. IONIC BOND
   a bond that forms when one atom gives an electron to another atom
   in order to make both outer orbitals filled
   also called a "give and take" bond
   usually occurs between a metal (+) atom and a non-metal (–) atom
   ion = an atom that has gained or lost electrons
   +1 ion = an ion that has lost one electron
   +2 ion = an ion that has lost 2 electrons
   +3 ion = an ion that has lost 3 electrons
   –1 ion = an ion that has gained 1 electron
   –2 ion = an ion that has gained 2 electrons
   –3 ion = an ion that has gained 3 electrons

2. COVALENT BOND
   a bond that forms when atoms must share electrons
      so that their outer orbitals are completely filled
   also called a "sharing" bond
   usually occurs between two non-metal atoms

The Periodic Table

1. Proper notation of elements: first letter capitalized, second letter lowercase
   EX: N = nitrogen
      I = iodine
      Ni = nickel
      NI = nitrogen iodine
2. 4 most common elements in biology: carbon, hydrogen, oxygen, nitrogen
3. atomic number = the number of protons, neutrons, and electrons in an atom (usually)
4. inert gases = He, Ne, Ar, Kr, Xe, Rn = elements that do not react with others because their outer orbitals are already filled with electrons (non-reactive!)
5. metals = located to the left of the staircase, have positive charges
6. non-metals = located to the right of the staircase, have negative charges

The Water Molecule

Electronegativity = certain atoms, such as oxygen, try to steal electrons from nearby atoms. This causes certain atoms to have partial charges. (like a bully stealing lunch money from a freshman!)
   EX: oxygen steals electrons from hydrogen

Polarity = a molecule that has partial positive charges as well as partial negative charges
   EX: in the water molecule, the oxygen atom is partially negative (gained) and the 2 hydrogen atoms are partially positive (lost). Therefore, water is called a "polar molecule"

Charges = The oxygen atom contains TWO partial negative charges because it is stealing an electron from each hydrogen. Each hydrogen atom contains ONE partial positive charge because it is losing the electron to the oxygen. Remember that electrons are negative, so an atom that gains an electron becomes negative and one that loses an electron becomes positive.

Hydrogen Bonds

Hydrogen Bond = a weak chemical bond that is usually associated with the water molecule

It forms between a partial positive charge (the hydrogen atom) and a partial negative charge (the oxygen atom) on different molecules.

1 water molecule can join 4 others using H-bonds

Properties of Water

1. Cohesion = the ability of the water molecules to stick together (because of H-bonds)
2. Adhesion = the ability of the water molecules to stick to other surfaces (because of H-bonds)
3. Surface Tension = an upward pressure on the surface of water (because of H-bonds)
4. Evaporative Cooling = water releases heat when it evaporates (because H-bonds break)
5. Density = ice is less dense than liquid water (because the H-bonds spread apart)
6. Universal solvent = most chemicals can dissolve in water (the chemicals form mini-ionic bonds due to the partial positive and partial negative charges)
7. Capillary Action = the ability of water to rise vertically through narrow areas against gravity (by making H-bonds with the edge of the tube)

The pH Scale

0	strong acid	a lot more H+ than OH-
1	strong acid	a lot more H+ than OH-
2	strong acid	a lot more H+ than OH-
3	strong acid	a lot more H+ than OH-
4	weak acid	slightly more H+ than OH-
5	weak acid	slightly more H+ than OH-
6	weak acid	slightly more H+ than OH-
7	NEUTRAL	EQUAL AMOUNT OF H+ AND OH-
8	weak base	slightly more OH- than H+
9	weak base	slightly more OH- than H+
10	weak base	slightly more OH- than H+
11	strong base	a lot more OH- than H+
12	strong base	a lot more OH- than H+
13	strong base	a lot more OH- than H+
14	strong base	a lot more OH- than H+

Sometimes H_2O splits into two pieces: H+ and OH-
H+ represents ACIDS
OH- represents BASES

ACIDS: usually have an H at the beginning of the formula (EX: HCl, HBr, H_2SO_4)
BASES: usually have an OH at the end of the formula (EX: NaOH, $Ca(OH)_2$, LiOH)