Study guide For chapter 2 (first part)
Chemistry: Atoms, compounds, chemical bonds, and water

Vocabulary list

matter	element	compound	atom	molecule	proton, neutron, electron
atomic number	mass number		atomic weight		isotope/radioisotope
subatomic particle	chemical bond		intermolecular bond		
intramolecular bond	ionic bond		ion		covalent bond
electron orbital	valence electron		the octet rule		single/double bond
hydrogen bond	polar/nonpolar molecule				hydrophilic/hydrophobic
Chemical reaction	reactant/products		heat capacity		evaporative cooling solution
solvent/solute	acid/base		pH		buffer

Lecture outline
Chemistry- definition, scope, and relevance to biology
Classification of matter
The atom and subatomic particles
Chemical bonding & reactions
Chemistry of water
Acids, Bases, and the pH scale

Chemistry
Chemistry is the study of all matter- its forms, its properties, and its reactions & interactions
Biologists need to understand chemical interactions for many reasons
Living things are made out of complex chemicals, often called biological macromolecules
At some level, living things can be regarded as sustained centers of chemical reactions
Earth's environment has been radically transformed by chemical reactions since its formation, catalyzed primarily by living things

Classification of matter
Ultimately, all earthly matter is made of atoms
All matter can be categorized into pure substances and mixtures
Pure substances can be either elements or compounds
Compounds are made of molecules- defined combinations of two or more atoms
The periodic table is an organized list of all the elements which exist

The atom and subatomic particles
All elements are comprised of the same kinds of atoms
Atom means “undividable” (tomos- Greek, to divide)
Atoms are comprised of 3 kinds of subatomic particles- protons, neutrons, and electrons
Massive protons and neutrons reside in the nucleus of atoms; ~massless electrons orbit around
Protons carry a positive electrical charge, electrons a negative charge; neutrons are neutral
The number of protons determines the element
Varying number of neutrons differentiate different isotopes of an element- some of these isotopes are radioactive, and have unstable nuclei which decay over time, giving off radiation

The electrons orbiting in orbitals around the nucleus determine the tendencies of an element to react chemically

Chemical bonding and reactions

Atoms seek stable electron configurations in their outermost (valence) orbital shells
The first orbital holds 2 electrons, the second & third orbitals hold 8 electrons each
Atoms seek to react such that their valence shells are full
There are two categories of intramolecular bonds: ionic and covalent
Ionic bonds- an electron is taken away from one atom by another, forming charged ions
In covalent bonds, pairs of electrons are shared, binding two or more atoms together to form a molecule
Multiple covalent bonds can form between two of the same atoms- double bonds, even triple bonds
Some elements, such as oxygen and nitrogen, exist in pure form as diatomic molecules
There is no limit to the size of molecules formed by covalent bonds
The macromolecules of life are made by covalent bonds
Many macromolecules also have ionic interactions

Electronegativity, Intermolecular forces and the Chemistry of water

Between two atoms of different elements, electrons in covalent bonds are not shared equally
Electronegativity, "greediness for electrons", causes electrons to spend more time close to one partner in a bond, creating polarity- a charge disparity between the atoms in the bond
When two atoms in have very different electronegativities, a polar covalent bond can form
When electronegativities are similar, covalent bonds are nonpolar
Because Oxygen is more electronegative than Hydrogen, water (H_2O) is a polar molecule
Positive regions of one water molecule are attracted to negative regions of another, forming a intermolecular hydrogen bond
Hydrogen bonds serve critically important functions in biological molecules
Because hydrogen bonds are broken with heat, water can serve as a heat sink/reservoir for the earth, and for biological systems which utilize evaporative cooling
Water can hydrogen bond with itself, or with other things, making it cohesive
Water is an "universal solvent" for polar and ionic substances
Nonpolar substances, like oils, are hydrophobic and do not mix with water

Acids, bases, and the pH scale

Atoms in ionic bonds are not physically bound to each other and can disassociate in solution
Hydrogen can form ionic bonds, and when dissolved in water, forms H^+ ions
Occasionally, the hydrogen and oxygen in water molecules disassociate from each other
Any substance which increases the amount of H^+ in a solution is an acid
Any substance which reduces the amount of H^+ (or increases OH^-) is a base
Acidity and basicity is quantified by pH, a scale measuring the amount of H^+ in a solution
Acids have a low pH value, bases have a high pH value
The molecules of living things (such as proteins) can be very sensitive to changes in pH
Buffers pick up H^+ from acids and release H^+ to bases, moderating the pH of solutions
Living things use buffers to control pH in their internal environment, such as bicarbonate in blood