BIOLOGY NOTES

Bio-Chemistry #1: Atoms - Macromolecules

For studying purposes or additional information, most of the following content can be found in....

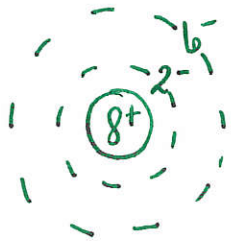
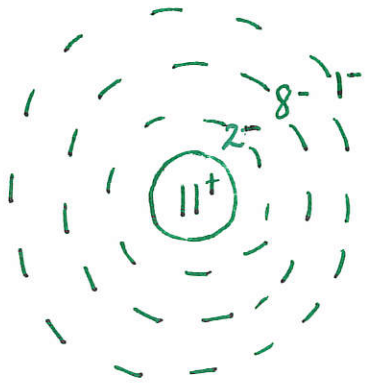
- *Interactive Reader Chapter 2*
- *Biology Book = Chapter 2 (Lesson 1-3)*

- **Living things consists of Atoms of different elements:**
  - Atoms: Smallest unit of matter.
  - Atoms consists of 3 smaller particles =
    - Protons = Positively charged particles.
    - Neutrons = No charge
      - These two are the dense center and form the atomic nucleus
    - Electrons
      - Negative charge. Much smaller than protons and found outside the nucleus in a region called an electron cloud or energy level or energy shell.
  - Elements:
    - Made up of one type of atom.
    - An element can't be broken down into a simpler substance by ordinary chemical means.
    - Atoms of different elements differ in the number of protons that they have.
    - All atoms of a given element have a specific number of protons.
      - Ex:
        - Oxygen = 8 protons
        - Hydrogen = 1 proton

- Of the 91 elements about 25 elements are essential to living organisms.
  - 4 of these make up more than 96 % of the human body's mass.
    - 1. Carbon C
    - 2. Hydrogen H
    - 3. Oxygen O
    - 4. Nitrogen N
  - Trace Elements.

    Elements that are present in living things in very small amounts.
    - However, they do play a vital role in maintaining healthy cells in all organisms. Ex.
      - Iron = Fe (Used to transport Oxygen in blood.)
      - Chromium = Cr (Used by cells to help them break down sugars.)

- **Representing atoms:**
  - Electrons in each atom determine the properties of that element and those electrons are found in different Energy levels:
    - 1st energy level = 2 electrons
    - 2nd energy level = 8 electrons
    - 3rd energy level = 8 electrons
  - **Bohr's atomic model** = Modified Version

Hydrogen (H)	**Oxygen (O)**	**Sodium (Na)**
Atomic # = 1	**Atomic # =** 8	**Atomic # =** 11
		

- Compound = A substance made of atoms of different elements, bonded together in a certain ratio.

  Examples =

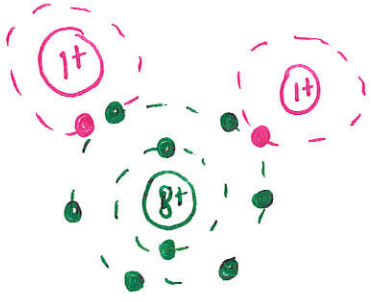
  - CO_2
  - H_2SO_4

Extra Practice and Review:

See Handout = Bohr's Model for Sodium & Chlorine.

- **Ions form when atoms gain or lose electrons.**
  - **Ion:** An atom that has gained or lost one or more electrons.
    - Also known as a Charged particle
    - An Atom's goal: To have its outer most energy level full. It makes them more stable
      - Therefore atoms give away or gain electrons.... And become Ions.
      - Some ions have a positive charge while others have a negative charge.
        - If an atom gives away an electron = Positive Charge (+)
          - Atoms w/ very few electrons on their outer shell are more likely to give them away.
        - If an atom gains an electron = Negative Charge (-)
          - Atoms with nearly full outer energy levels usually end up gaining electrons.
    - Ions play an important role in organisms. For example, Hydrogen ions (H^+) are needed for the production of usable chemical energy in cells. Calcium ions (Ca^{2+}) are necessary for every muscle movement in your body. And Chloride ions (Cl^-) are important for a certain type of chemical signal in the brain.
  - Ionic Bonds = Forms through the electrical force between oppositely charged ions.
    - Example = Sodium Chloride

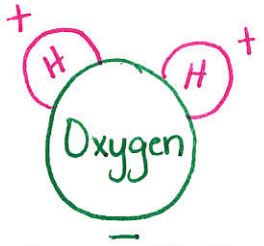
      $Na^+ \quad Cl^- = NaCl$ table salt
  - Covalent bonds = Forms when atoms share a pair of electrons
    - Example = H_2O



- Molecule: Smallest unit of most compounds that displays all the properties of that compound.
  - Examples = CO_2 & H_2O = Both are 1 molecule

- **Life depends on hydrogen bonds in water.**
  - Water is a polar molecule
    - Even though water is formed through covalent bonds, the electrons that are being shared actually spend more time near the oxygen because the oxygen has a stronger positive pull due to the 8 protons in its atomic nucleus.
    - **Hydrogen Bonds:**

      An attraction between slightly positive hydrogen atom & a slightly negative atom.
      - Because water is polar Hydrogen Bonds are produced between different water molecules that actually end up holding them together.
    - Ex. H_2O



      - You can overfill a glass of water and it will not run over. Hitting water with a strong force (feels like you're hitting cement.)
        - It's the Hydrogen Bonds between the water molecules that hold it together.

- **Properties Related to Hydrogen Bonds:**
  - <u>High Specific Heat</u>:
    - Water resist changes in temp.
    - Water must absorb a great deal of energy to increase its temp.
      - Example: Water at the beach vs. Sand at the beach.

- Cohesion = The attraction among molecules of a substance.
  - Cohesion from hydrogen bonds make water molecules stick to each other
  - → Water sticks to water!
- Adhesion = The attraction among molecules of different substances.
  - Example: This is why/how water droplets will stick to a window.
    - This is what helps plants transport water from their roots to their leaves because water molecules stick to the sides of the vessels that carry the water……. And pull up other molecules against the force of gravity. = This is also known as Capillary Action

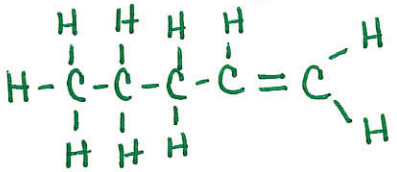
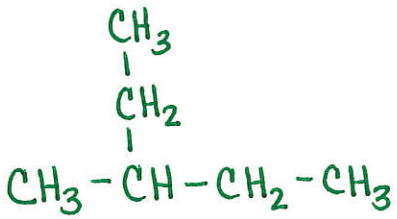
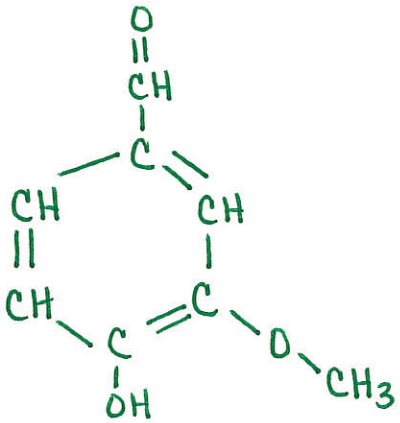
- **Other special properties of water:**
  - Water expands as it freezes.
    - Causing frozen water to be less dense than liquid water.
    - Density (g/ml = Mass / Volume
      - 100 ml of H_20 has a mass of approximately of 100g
      - If you freeze 100 ml of water it actually increases to 108.7 ml but it will still have a mass of 100g.
    - Let's do the math
      - Liquid water….Density = 100g / 100ml = 1g/ml
      - Frozen water…Density = 100g / 108.7ml = 0.92 g/ml
        - Therefore, frozen water is actually LESS dense than water. That is why ice floats.

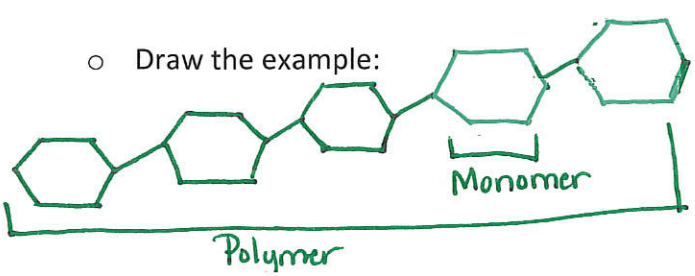
  - Many compounds dissolve in water
    - Many molecules and ions play vital roles in chemical processes inside the cells of living things. However, to do so, they must be ….. capable of being dissolved in water or other water-based fluids
    - Examples:
      - Sugars and Oxygen are dissolved in blood
      - Important compounds that plants need are dissolved in plant sap.

- **Solution:**
  - A mixture of substances that is the same throughout.
  - A solution has two parts.
    - 1. **Solvent**
      - Substance that is present in the greater amount.
      - It is the substance that "dissolves" the other substance.
    - 2. **Solute**
      - Substance that gets dissolved by a solvent.
      - Ex:
        - Kool-aid = Water is the solvent..... the powdered mix is solute.
        - Polar and Ionic Molecules both easily dissolve in water. Read pg. 42
        - Nonpolar molecules = Fats and oils, rarely dissolve in water.

- **Some compounds form acids or bases.**
  - Some compounds break up into ions when they dissolve in water.
    - Acids = Compounds that release H^+ = Hydrogen Ions when dissolved in water.
    - Bases = Compounds that remove H^+ from a solution.
      * They release OH^- = Hydroxide ions when dissolved in water.
    - pH scale : Is used to measure a solution's H^+ concentration.
      - **pH** is usually from 0-14
        - 0-6 = Acid = High H^+ concentration. → 0 = Strongest Acid
        - 7 = Neutral
        - 8-14 = Base = Low H^+ concentration → 14 = Strongest Base
          High OH^- concentration

- Most organisms must keep their pH within a very narrow range (around pH 7). However, some organisms need a different pH.

- **Carbon-based molecules are the foundation of life.**
  - Carbon atoms have unique bonding properties.....
    - Carbon is important due to its structure.
    - Carbon = forms covalent bonds w/ up to 4 other atoms, including other atoms.
    - Carbon-based molecules have three general types of structures.
      - Straight = 
      - Branched = 
      - Ring = 
    - Many carbon-based molecules are made of many small subunits bonded together.
      - Monomers = are the individual subunits.
      - Polymers = are made of many monomers.
        - Draw the example:



Mono = One
Poly = Many

- Four main types of carbon-based molecules are found in living things.
  - Carbohydrates
  - Lipids
  - Proteins
  - Nucleic Acids
    - **Carbohydrates:**
      - Carbohydrates are made of Carbon, Hydrogen + Oxygen.
        - Include : Sugars + Starches
        - Carbohydrates can be: broken down to provide energy for cells.
        - Some carbohydrates are part of the cell structure.
          - Monosaccharides are simple sugars.
            - One single ring.
          - Disaccharides:
            - Two single
          - Polysaccharides include starches, cellulose, and glycogen.
            -

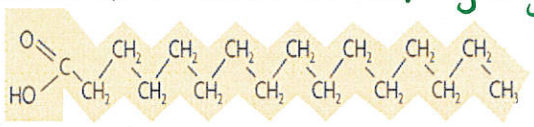
Used 1st for energy before other carbon based molecules. ←

    - **Lipids:**
      - Nonpolar molecules that include fats, oils + cholesterol.
      - Many contain carbon chains called fatty acids.
      - Fats and oils contain fatty acids bonded to glycerol.

- Fatty Acids = Are chains of carbon bonded to hydrogen atoms.

Lard, Butter Bacon fat

Saturated fatty acid = Saturated w/ Hydrogens.

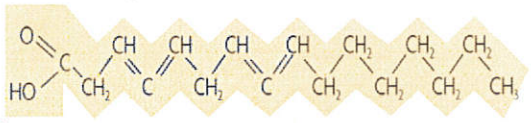


Saturated fats contain fatty acids in which all carbon–carbon bonds are single bonds.

Solid at room temp.

Cooking oil Oils from seeds/nuts & fish.

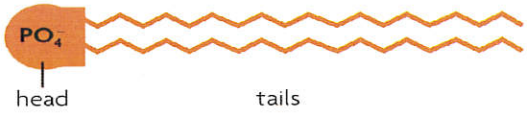
Unsaturated fatty acid



Unsaturated fats have fatty acids with at least one carbon–carbon double bond.

Liquid at room temp

- **Lipids have several different functions.**
  - Energy Storage = Broken down as an energy source,
  - Used to make hormones.
  - Used for Protection & Insulation.
  - Make up cell membranes.
    - **Phospholipids make up all cell membranes.**
      - Polar phosphate: "head"
      - Nonpolar fatty acid: "tails"



    - The polar heads: Allow cells to interact with water.

- **Proteins:**
  - Are composed of Amino Acids
  - Molecules contain: Carbon, Hydrogen, Oxygen, and Nitrogen.
  - Amino Acids:
    - Organisms use 20 different amino acids to build proteins.
    - You can actually make 12.
    - The others come from the foods that we eat.

- **Nucleic Acids:**
  - Detailed instructions to build proteins are stored in extremely long carbon based molecules called Nucleic Acids.
  - They are polymers that are made up of monomers called Nucleotides.
  - Functions of Amino Acids:
    - They make up our genetic information.
    - They work together to make proteins = They contain the protein code.
    - Two types of **Nucleic Acids:**
      - **DNA:**
        - Is the basis of genes and heredity... Our Genetic Code
        - Stores information for ..... putting amino acids together. It is the code for making proteins.
      - **RNA:**
        - Goes into the DNA and gets the code for making proteins.
        -
        - The RNA is responsible for..... getting that copied code to the ribosomes so that proteins can be made.

Synthesize and Apply:

- **Write and analogy for the formation of a polymer from monomers.**

- **What is the relationship between proteins and nucleic acids?**