AP Biology
Unit 1 - Chemistry of Life

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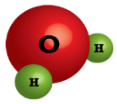
Key Terms:

- Solvent: able to dissolve other substances.
- Solute: the minor component in a solution, dissolved in the solvent.
- Polar: when electrons are not evenly distributed in a covalent bond
- Non-Polar: when electrons are evenly distributed in a covalent bond
- Cohesion: attraction that occurs between identical molecules
- Adhesion: attraction that occurs between molecules of different substances.
- Specific heat: the heat needed in order to raise the temperature of the unit mass of a given substance by a given amount (usually one degree).
- Density: calculated by dividing the mass of a substance by its volume
- Heat of Vaporization: The amount of energy needed to change one gram of a liquid substance to a gas at constant temperature.
- Macromolecules: A large molecule composed of many smaller molecules

1. Structure of water and hydrogen bonding:

- Water: a “universal solvent” due to its ability to dissolve many solutes
- Properties of water:
    - cohesion, ability of adhesion, being a “universal solvent”, the solid being less dense than the liquid, having a high specific heat, and having a high boiling point (212 degrees Fahrenheit, 100 degrees Celsius), and surface tension.
- Hydrogen bond: weak chemical bond
    - Formed when partial charges resulting from polar molecules attract/are attracted to each other
    - Example: cohesion between water molecules are a result of hydrogen bonds
- Water has a high vaporization temperature.
    - Evaporative Cooling: when humans sweat, the water absorbs the body’s excess heat and then evaporates, cooling the body
- Water molecules form hydrogen bonds between each other, forming a strong lattice structure. The result is high surface tension.
- Water has a bent or V-Shaped figure because of its polarity.



2. Elements of life:

- Living system: Open systems that take in raw materials, use certain parts of the system, and then proceed to release waste
- Energy: The ability to do work or cause change
- Constant input of energy: necessary to maintain the complicated organization of a system.
- Matter: Anything that has mass and takes up space.
- Examples of Macromolecules: Carbohydrates, Lipids, Proteins, and Nucleic acids.
- Atoms: matters building blocks or basic units
- Exchange of matter between the environment and organisms allows organisms to grow, reproduce, and retain organization.
- Carbon: backbone of most, but not all, biological macromolecules.
- Nitrogen: A necessary atom in proteins and nucleic Acids, but not in carbohydrates and lipids.
- Taxonomy:
    - biological branch of study that classifies species, establishes the ordering of species into groups based on the characteristics they share.
- Levels of Taxonomy (most to least inclusive):

    1. Domain -- Dear
    2. Kingdom -- King
    3. Phylum -- Phillip
    4. Class – Came
    5. Order – Over
    6. Family -- For
    7. Genus -- Good
    8. Species -- Soup
- Bacteria, Archaea, and Eukarya: Differences
    - Bacteria: Prokaryotic
    - Archaea: Prokaryotic
    - Eukarya: Eukaryotic, 3 groups (Animalia, Fungi, Plantae), includes protists
- Darwin's two main ideas:

    - "Descent with modification"
    - "Natural Selection" - Those who are the most fit and apt have a higher chance of survival and passing on the good genes to their offspring.
- Darwin's Observations
    - Individuals have a variety of traits in themselves and between themselves, with many passed on through offspring
    - Competition is unavoidable because offspring are constantly being created and are in need for resources
    - Species adapt to have advantage within the population and to have better access to the limited resource pool
- "Edits:
    - "Edit": metaphor for natural selection; natural selection cuts out or edits out the unnecessary or disadvantageous traits, as beings with those traits are less likely to survive and reproduce
- Common ancestry and natural selection:
    - First common ancestor or "prototype"is marked as the beginning of all life. All life began from an ancestor, so we are united, but natural selection has changed life throughout time through adaptation and "edits"

3. Introduction to Biological Macromolecules:

- Hierarchy: organizes interacting biological levels of structures
- Monomer: simple compound or molecule that is joined with other molecules to produce polymers.
- Polymer: large and complex compound that is composed of combined smaller compounds, or monomers.
- Hydrolysis: process where a molecule is split through the addition of water
- Dehydration synthesis: Condensation reaction where molecules are joined together by the removal of water

4. Properties of Biological Molecules:

- Protein: A three-dimensional polymer made of conjoined amino acids.
- Amino Acids: Building blocks of proteins.
- Carbohydrate: composed of carbon, hydrogen, and oxygen atoms
    - Acts as a major source of short term energy for the body
    - Monosaccharides: Building blocks of carbohydrates.
- Lipids (fats):Composed of long carbon chains
    - Often used in the body through insulation and long term energy (energy storage)
    - Fatty acids: chains of carbon that build most lipids.
    - Glycerol: A three- carbon alcohol that covalently bonds to fatty acids, forming oils and fats (lipids)
- Nucleic acids: contain hydrogen, oxygen, nitrogen, carbon, and phosphorus
    - Nucleotides: Building blocks of nucleic acids.
    - Five-Carbon Sugar: part of nucleotides
        - Deoxyribose: A Five-Carbon sugar that is a component of DNA nucleotides.
        - Ribose: A Five-Carbon sugar present in RNA.
    - Phosphate: part of of nucleotides, connected to the five-carbon-sugar's 5' end
    - Nitrogen base: part of a nucleotide. Includes adenine, guanine, cytosine, thymine, or uracil; attached to the five-carbon-sugar's 1' end

- Polypeptide: a large protein macromolecule whose conjoined amino acids are held together by peptide bonds.
- Primary structure: The first level of a protein structure; linear sequence of amino acids
    - Amino (or N-) terminus: The end of the protein chain that has an exposed amino group (-NH2).
    - Carboxyl (or C-) terminus: The end of the protein chain that has an exposed carboxylic acid group (-COOH).
    - R group (side chain): Part of amino acid that determines the molecule's physical and chemical properties.
        - R group properties: Non-polar, polar, acidic, basic, or ionic.
- Polysaccharides: complex carbohydrates made of sugar monomers.
    - Examples: Starch, glycogen, cellulose
- Lipid properties:

    -Do not form polymers,

    -Water fearing or hydrophobic

    -Fatty acids are long non polar hydrocarbon chains with an acid group at the end
- Saturated fats: A fat that is solid at room temperature; hydrogens are saturated, or the carbons are all connected with single bonds
    - Examples: animal fats, lards, and dairy products.
- Unsaturated fats: contain at least one double bond resulting in a kink in structure.
    - Cannot pack in an organized manner, and thus they are liquid at room temperature. these are often found in plants and fish
- Phospholipids: composed of two fatty acids, plus hydrophilic phosphate, and glycerol.
    - They play a role in cell membranes

5. Structure and Function of Biological Macromolecules:

- Structure: The directionality and order of subcomponents (monomers) in a macromolecule (polymer)
    - Form = function
- 5' end and 3' end: 5' end – has a 5' carbon attached to a phosphate. 3' end – has a 3' carbon attached to the next nucleotide in the linear chain of DNA or RNA.
- Anti-parallel: Separate strands that run in opposite directions.
- Adenine: The nucleotide that is bonded by hydrogen bonds to the nucleotide thymine in DNA using (two hydrogen bonds).
- Thymine: The nucleotide that is bonded by hydrogen bonds to the nucleotide adenine in DNA (using two hydrogen bonds).
- Cytosine: The nucleotide that is bonded by hydrogen bonds to the nucleotide guanine in DNA (using three hydrogen bonds).
- Guanine: The nucleotide that is bonded by hydrogen bonds to the nucleotide cytosine in DNA (using three hydrogen bonds).
- Growing polypeptide chain: Linear chains of amino acids formed by creating covalent bonds at the carboxyl terminus.
- Primary structure of protein: The amino acid sequence.
- Secondary structure of protein: local folding and twisting of amino acid chains into elements such as alpha-helices and beta-sheets.
    - Alpha-helix: spiral shape
    - Beta-sheet: side by side folding of amino acids with each other through hydrogen bonds
- Tertiary structure of proteins: 3-D structure; formed through hydrophobic and hydrophilic interactions between far off regions in the polypeptide (not local). Shape aims to minimize the free energy
    - Hydrogen bonds, disulfide bonds, ionic bonds, other interactions
- Quaternary structure of proteins: conjoining of multiple polypeptides.
- Carbohydrate structure: made of linear chains of monomers, connected through covalent bonds

6. Nucleic Acids:

- Nucleic acids: formed through the conjoin of nucleotide monomers
- Nucleotides: a nucleic acid monomer, contains 3 parts
    - Nitrogenous base, pentose sugar, phosphate group.
        - Pentose: Ribose (ribonucleotides) or 2-prime-deoxyribose (deoxyribonucleotides).
        - Phosphate: Phosphorous attaches to the nitrogenous base.
- Nucleic acids hold genetic info
- Nitrogenous bases: A, C, T, G, U.
- Complementary bases: A and T, C and G
    - These will always pair together in DNA structure
- Purines: large nitrogenous bases A and G.
- Pyrimidines: small nitrogenous bases T, C (U replaces T for RNA)