CHAPTER 5 BIOLOGY – *The Molecules of Life*

- **Organic molecules =** any molecules that contain carbon
- **Inorganic molecules =** any molecules that do NOT contain carbon (examples: water, oxygen)
- **Carbon atoms** = very common in living things – can form bonds with one or more carbon atoms.
    - Each carbon atom can form four total bonds; therefore, each carbon atom can produce a HUGE variety of carbon based molecules.

- **Functional group** = a group of atoms within a molecule that acts in predictable ways
    - Example: hydroxyl groups (OH) are ALWAYS hydrophilic (water-loving) and therefore always attract water.
        - OH groups tend to become surrounded by water when placed in aqueous (water-based) environments.

- **Monomers =** small molecular units
- **Polymers =** formed when monomers link together.
- Think of a monomer as a bead and a polymer as the entire necklace. The necklace (polymer) can only be formed once the beads (monomers) join together.
- *Every living cell contains thousands of different polymers.*

- **MAJOR ORGANIC MOLECULES USED BY LIVING THINGS:**

    - **Carbohydrates (sugars)**
    - **Lipids (fats)**
    - **Proteins**
    - **Nucleic Acids**

- All four of these major molecules are made the same way (see p. 94, fig. 5-4):
    - **Dehydration synthesis:** the process of making a polymer from monomers (water is removed as each monomer is added to the chain)
- All four of these major molecules are broken down the same way (see p. 94, fig. 5-4):
    - **Hydrolysis**: water is used to break down a polymer into its monomer subunits.

- **CARBOHYDRATES:**
    - **Function**: give us fuel; serve as our primary (first-choice) energy source; provide material to build upon
    - All carbohydrates contain the same ratio of carbons, hydrogen atoms, and oxygen atoms = 1 Carbon: 2 Hydrogen: 1 Oxygen
    - **Carbohydrate monomer is called a monosaccharide** (examples: glucose, fructose, galactose)
    - **Carbohydrate polymers can have various names:**

        - **Disaccharide** = two monosaccharides joined together (example: glucose + fructose = sucrose)
        - **Polysaccharide =** more than two monosaccharides joined together
            - **Starch =** the stored form of glucose found in plants (starch is just a string of glucose monomers)
            - **Glycogen =** the stored form of glucose found in animals
            - **Cellulose =** also made of glucose monomers, found in plants; used as building material in plants
    - Carbohydrates, especially smaller carbohydrates, are hydrophilic (dissolve readily in water).

- **LIPIDS (Fats and Steroids)**
    - **Function** = second choice energy-source, outer boundary of cells, steroids in particular serve as chemical messengers.
    - Hydrophobic (water-fearing, repel water)
    - **Monomer** = fatty acid
    - **Polymers**
        - **Triglyceride =** 3 carbon backbone (glycerol) attached to three fatty acids (see p. 98)
            - Unsaturated fat = carbons found on fatty acid chains do NOT have maximum possible number of hydrogen atoms; double bounds are found on the fatty acid chain
                - Shorter in length – lower melting point – liquid at room temperature
            - Saturated fat = carbons on fatty acid chains have the maximum number of hydrogen atoms; all single bonds found between carbons and hydrogens
                - Longer in length – higher melting point – often solid at room temperature
        - **Steroids =** 4-carbon based rings
            - Act as chemical signals (examples: estrogen, testosterone)
            - Cholesterol = steroid found in cell membranes, also used as building block to make other steroids

- **PROTEINS**
    - **Functions**= form hair, muscles; function in long-term energy storage; last-choice energy source; defend against infection; act as chemical signals; act as enzymes
    - **Monomer =** amino acid (a carbon bound to a hydrogen, a carboxyl group, an amino group, and one functional/side group; the functional group is what makes one amino acid different from another; see page 101)
    - **Polymer = polypeptide** (the bond between two amino acids is called a peptide bond)
        - There are 20 different amino acids; therefore there are MANY different combinations of amino acids that will make MANY different polypeptides.

        - Once a polypeptide is formed, it twists/folds into a unique shape (hydrophilic amino acids usually on the outer surfaces and hydrophobic amino acids buried in the inner core).
        - **Denaturation** = destruction/unraveling of a protein(due to temperature or pH change)
            - Once a protein loses its shape, it cannot work properly.

- **Enzymes =** a special group of proteins that serve as catalysts
    - **Catalysts =** compounds that increase the rate of chemical reactions
        - Catalysts increase the rate by lowering the **activation energy**, which is the energy needed to start a reaction.
        - Typically, you can reach this activation energy only by raising the temperature.
        - Enzymes, however, allow reactions to happen *without* increasing the temperature (if the temperature were raised too high, cells could be destroyed).
        - Each enzyme catalyzes a specific reaction (example: lipase breaks down lipids)
        - **Substrate** = the molecule that an enzyme acts on
        - A substrate fits into the active site of an enzyme.
        - *Only a substrate with a certain shape will fit with a certain enzyme (see p. 104).*
        - Enzymes help lower activation energy by holding two reactants (holding two substrate molecules) in place, which allows them to react with each other more easily (rather than relying on random change that two reactants will bump into each other in the exact right orientation).
        - If an enzyme is denatured, a substrate cannot fit with it and so that enzyme cannot do its job.