

# Chapter 2 The Molecules of Life

## Summary Outline

- 2.1 Atoms and elements
  - A. **Atoms** are composed of **electrons, protons** and **neutrons**
  - B. An **element** is a pure substance.
- 2.2 Chemical **bonds** and the formation of molecules
  - A. The outer orbital of electrons of an atom must be filled for maximum stability
  - B. **Valence** is the number of electrons that an atom may gain, give up, share when bonds are formed
  - C. Bonds form between atoms to fill their outer orbitals
    - 1. **Covalent bonds**—strong bonds formed by atoms sharing electrons
      - a) **Nonpolar**—equal attraction for electrons
      - b) **Polar**—unequal attraction for electrons
    - 2. **Ionic bonds**—electrons leave the orbital of one atom and enter the orbital of another atom
    - 3. **Hydrogen bonds**—weak bonds that result from the attraction of a positively charged hydrogen atom in a polar molecule to a negatively charged atom in another polar molecule
- 2.3. Chemical components of the cell
  - A. **Water**
    - 1. Most important molecule in the cell comprising 70% of all living organisms by weight
    - 2. Hydrogen bonding plays a very important role in the properties of water
  - B. **pH** is the degree of acidity of a solution, measured on a scale of 0-14
  - C. Small molecules in the cell
    - 1. Variety of small organic and inorganic molecules
    - 2. Carbon occurs in all organic molecules
    - 3. **Adenosine triphosphate (ATP)** is modified RNA nucleotide that is used to store energy within a cell and provides energy when the terminal bond is broken to form **adenosine diphosphate (ADP)** and inorganic phosphate
  - D. Macromolecules and their component parts
    - 1. Composed of subunits with similar properties
    - 2. Synthesis of macromolecules occurs by **dehydration synthesis**
    - 3. Degradation occurs by **hydrolysis**
- 2.4 **Proteins**—most versatile of the macromolecules
  - A. Activities of proteins include:
    - 1. Catalyzing reactions
    - 2. Being a component of cell structures
    - 3. Moving cells
    - 4. Taking nutrients into the cell
    - 5. Turning genes on and off
    - 6. Being a part of cell membranes
  - B. **Amino acids**
    - 1. Proteins are composed of **20 major amino acids**
    - 2. All amino acids are carbon compounds containing both a carboxyl group and an amino group
    - 3. The side chain of the amino acid confers unique properties on the amino acid

- C. **Peptide bonds**—amino acids are joined through peptide bonds, joining amino with carboxyl groups and splitting out water
  - D. Protein structure
    - 1. The **primary structure**—amino acid sequence
    - 2. The **secondary structure**—coiling and folding into helices and sheets
    - 3. The **tertiary structure**—the three-dimensional shape of the protein
    - 4. The **quaternary structure** interaction of several polypeptide chains
    - 5. Denaturation of proteins—intramolecular bonds within the protein are broken and the protein changes shape and no longer functions
  - E. Substituted proteins—contain other molecules such as sugars and lipids, bonded to the side chains of amino acids in the protein.
- 2.5 **Carbohydrates**—heterogeneous group of compounds
- A. Perform a variety of functions in the cell
    - 1. Have carbon, hydrogen, and oxygen atoms in a ratio of approximately 1:2:1
  - B. **Monosaccharides**—classified by the number of carbon atoms they contain, most commonly 5 or 6
  - C. **Disaccharides**—two monosaccharides joined by dehydration synthesis
  - D. **Polysaccharides**—consist of monosaccharide subunits
- 2.6. **Nucleic acids**—Macromolecules whose subunits are nucleotides
- A. **DNA**—Carries genetic information of the cell in its sequence of nucleotides
    - 1. Double-stranded helical molecule
    - 2. Composed of covalently bonded sugar, phosphate group and a purine or pyrimidine base
    - 3. The two strands are complementary and are held together by hydrogen bonds between the bases
  - B. **RNA**—involved in decoding the genetic information contained in DNA
    - 1. Single-stranded molecule and contains uracil in place of thymine
- 2.7 **Lipids**—heterogeneous group of molecules that are only slightly soluble in water
- A. **Simple lipids**—simple lipids contain carbon, hydrogen and oxygen and may be liquid or solid at room temperature
    - 1. Fats consist of glycerol bound to fatty acids
    - 2. Lipids may be saturated (contains no double bonds between carbon atoms) or unsaturated (contains one or more double bonds)
    - 3. Some simple lipids consist of a four-membered ring
  - B. **Compound lipids**—contain elements other than carbon, hydrogen and oxygen; example—phospholipids