AP Biology
Unit 2: Chemistry of Life

Topic 1.1 Structure of Water and Hydrogen Bonding

Enduring Understanding SYI-1 Living systems are organized in a hierarchy of structural levels that interact.	
Learning Objective	**Essential Knowledge**
SYI-1.A Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function.	**SYI-1.A.1** The subcomponents of biological molecules and their sequence determine the properties of that molecule. **SYI-1.A.2** Living systems depend on the properties of water that result from its polarity and hydrogen bonding. **SYI-1.A.3** The hydrogen bonds between water molecules result in cohesion, adhesion, and surface tension.

Topic 1.2 Elements of Life

Enduring Understanding ENE-1 The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.	
Learning Objective	**Essential Knowledge**
ENE-1.A Describe the composition of macromolecules required by living organisms.	**ENE-1.A.1** Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. **ENE-1.A.2** Atoms and molecules from the environment are necessary to build new molecules. a. Carbon is used to build biological molecules such as carbohydrates, proteins, lipids, and nucleic acids. Carbon is used in storage compounds and cell formation in all organisms. b. Nitrogen is used to build proteins and nucleic acids. Phosphorus is used to build nucleic acids and certain lipids.

Topic 1.3 Introduction to Biological Molecules

Enduring Understanding SYI-1 Living systems are organized in a hierarchy of structural levels that interact.	
Learning Objective	**Essential Knowledge**
SYI-1.B Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.	**SYI-1.B.1** Hydrolysis and dehydration synthesis are used to cleave and form covalent bonds between monomers.

Topic 1.4 Properties of Biological Macromolecules

Enduring Understanding SYI-1 Living systems are organized in a hierarchy of structural levels that interact.	
Learning Objective	**Essential Knowledge**
SYI-1.B Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.	**SYI-1.B.2** Structure and function of polymers are derived from the way their monomers are assembled – a. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate, and a nitrogen base (adenine, thymine, cytosine, guanine, or uracil). DNA and RNA differ in structure and function. b. In proteins, the specific order of amino acids in a polypeptide (primary structure) determines the overall shape of the protein. Amino acids have directionality, with an amino (NH_2) terminus and a carboxyl (COOH) terminus. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic, or ionic), and the interactions of these R groups determine the structure and function of that region of the protein. c. Complex carbohydrates comprise sugar monomers whose structures determine the properties and functions of the molecules. d. Lipids are nonpolar macromolecules – i. Differences in saturation determine the structure and function of lipids. ii. Phospholipids contain polar regions that interact with other polar molecules, such as water, and with nonpolar regions that are often hydrophobic.

Topic 1.5 Structure and Function of Biological Macromolecules

Enduring Understanding SYI-1 Living systems are organized in a hierarchy of structural levels that interact.	
Learning Objective	**Essential Knowledge**
SYI-1.C Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule.	**SYI-1.C.1** Directionality of the subcomponents influences structure and function of the polymer – a. Nucleic acids have a linear sequence of nucleotides that have ends, defined by the 3' hydroxyl and 5' phosphates of the sugar in the nucleotide. During DNA and RNA synthesis, nucleotides are added to the 3' end of the growing strand, resulting in the formation of a covalent bond between nucleotides. b. DNA is structured as an antiparallel double helix, with each strand running in opposite 5' to 3' orientation. Adenine nucleotides pair with thymine nucleotides via two hydrogen bonds. Cytosine nucleotides pair with guanine nucleotides by three hydrogen bonds. c. Proteins comprise linear chains of amino acids, connected by the formation of covalent bonds at the carboxyl terminus of the growing polypeptide chain. d. Proteins have primary structure determined by the sequence order of their constituent amino acids, secondary structure that arises through local folding of the amino acid chain into elements such as alpha-helices and beta-sheets, tertiary structure that is the overall three-dimensional shape of the protein and often minimizes free energy, and quaternary structure that arises from interactions between multiple polypeptide units. The four elements of protein structure determine the function of a protein. e. Carbohydrates comprise linear chains of sugar monomers connected by covalent bonds. Carbohydrate polymers may be linear or branched.

Topic 1.6 Nucleic Acids

Enduring Understanding IST-1 Heritable information provides for continuity of life.	
Learning Objective	**Essential Knowledge**
IST-1.A Describe the structural similarities and differences between DNA and RNA.	**IST-1.A.1** DNA and RNA molecules have structural similarities and differences related to their function – a. Both DNA and RNA have three components – sugar, a phosphate group, and a nitrogenous base – that form nucleotide units that are connected by covalent bonds to form a linear molecule with 5' and 3' ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone. b. The basic structural differences between DNA and RNA include the following: i. DNA contains deoxyribose and RNA contains ribose. ii. RNA contains uracil and DNA contains thymine. iii. DNA is usually double stranded; RNA is usually single stranded. iv. The two DNA strands in double-stranded DNA are antiparallel in directionality.