CHAPTER 3 – MOLECULES OF LIFE

Lecture Outline

1. Molecules of Life—From Structure to Function

A. What Is an Organic Compound?

1. Life's molecules are _______________________ compounds, with hydrogen and other elements covalently bonded to carbon atoms.

2. Hydrocarbons contain only __________________ atoms covalently bonded to carbon.

3. Only living cells can synthesize __________________, lipids, proteins, and nucleic acids.

4. Each organic compound is characterized by ___________ or more functional groups—particular atoms or clusters of atoms bonded to carbon.

B. Start With Carbon’s Bonding Behavior

1. Oxygen, ________________________, and carbon are the most abundant elements in living things.
   a. Much of the hydrogen and oxygen are linked as ____________________.
   b. Carbon can share pairs of electrons (covalently bond) with as many as _____ other atoms to form organic molecules of several configurations.

2. The orientation of the __________________ attached to a carbon backbone gives rise to the three-dimensional shapes and functions of biological molecules.

C. Ways To Represent Organic Compounds

1. _________________________ is the simplest organic compound.

2. A ball-and-stick model depicts bonding of ________________________; space-filling models convey a molecule's size and surfaces.

3. Larger molecules are best visualized using _________________________ models, such as those generated by computer programs, and even more complex computer models that show local differences in electric charge across molecular surfaces.

3.2 How Do Cells Build Organic Compounds?

A. Four Families of Building Blocks

1. _________________________, fatty acids, amino acids, and nucleotides are the four major families of small building blocks.

2. _________________________ can be joined to form larger polymers.

B. A Variety of Functional Groups

1. Functional groups are atoms or groups of atoms covalently bonded to a carbon
backbone; they convey distinct properties, such as solubility and chemical reactivity, to the complete molecule.

2. The common functional groups in biological molecules are: __________, methyl, carbonyl, carboxyl, amino, phosphate, and sulfhydryl.

3.3 The Most Abundant Ones—Carbohydrates

A. The Simple Sugars

1. ________________—one sugar unit—are the simplest carbohydrates.

2. They are characterized by solubility in water, __________ taste, and have at least two —OH groups and one aldehyde or ketone group.

3. ________________ and deoxyribose (five-carbon backbones) are building blocks for nucleic acids.

4. ________________ (six-carbon backbone) is used by cells as instant energy.

B. Short-Chain Carbohydrates

1. An oligosaccharide is a short chain of __________ or more sugar monomers.

2. Disaccharides—______________ sugar units—are the simplest.
   a. Sucrose (glucose + ________________) is the most plentiful sugar in nature.
   b. Lactose (glucose + ________________) is present in milk.

3. Oligosaccharides with ________________ or more sugar monomers are attached as short side chains to proteins where they participate in membrane function.

C. Complex Carbohydrates

1. A polysaccharide is a ________________ or branched chain of hundreds or thousands of sugar monomers.

2. ________________ is a plant storage form of energy, arranged as unbranched coiled chains.

3. ________________ is a highly-branched chain used by animals to store energy in muscles and liver.

3.4 Greasy, Oily—Must Be Lipids

A. Fats and Fatty Acids

1. ________________ are nonpolar hydrocarbons that do not dissolve in water; fats have one, two, or three fatty acids molecules attached to one glycerol molecule.

2. A fatty acid is a long, ________________ hydrocarbon with a —COOH group at one end.
A. __________________________ fatty acids are liquids (oils) at room temperature because one or more double bonds between the carbons in the tails permit “kinks.”

b. __________________________ fatty acids have only single C—C bonds in their tails and are solids at room temperature.

3. __________________________, such as butter, lard, and oils, are the body’s most abundant and richest source of energy and insulation.

a. These lipids have __________________________ fatty acid tails attached to a molecule of glycerol.

b. Gram for gram, triglycerides yield more than __________________________ as much energy as carbohydrates.

B. Phospholipids
1. Phospholipids have a __________________________ backbone, two fatty acids, a phosphate group, and a small hydrophilic group.

2. They are important components of __________________________, where the hydrophilic heads face toward the inner and outer surfaces and the hydrophobic tails face inward (bilayer).

3.5 Proteins—Diversity in Structure and Function
A. Proteins function as enzymes, in cell movements, as storage and transport agents, as hormones, as anti-disease agents, and as structural material throughout the body.

B. Structure of Amino Acids
1. Amino acids are small organic molecules with an __________ group, a carboxyl group, and one of twenty varying R groups.
   – All of the parts of an amino acid molecule are covalently bonded to a carbon.
   – The R group determines the amino acid.

2. There are __________ kinds of amino acids available in nature.

3. Amino acids __________________________ together to form proteins.
   – It is the sequence of amino acids that determines the protein.

C. Some proteins have other organic molecules attached to their polypeptide chains.

1. __________________________ have side chains of oligosaccharides on the cell surface.

2. Lipoproteins bind and transport lipids.

3.7 Nucleotides, DNA, and the RNAs
A. __________________________ is a double stranded helix carrying encoded hereditary instructions.

B. __________________________ is a single stranded structure and functions in translating the code to build proteins.