AP Biology/The Chemical Building Blocks of Life

Study Time | *X minutes.* (explanation.)

There's a helpful outline of the topic available here.

1 Organic Elements

Of the 92 natural elements, 25 are essential for life. Of these, there are six main elements that are the fundamental building blocks of life. They are, in order of least to most common: sulfur, phosphorous, oxygen, nitrogen, carbon, and hydrogen. An easy way to remember this is SPONCH - a nice mnemonic. The remaining 19 elements are defined as trace elements, which are important, but required only in very small quantities. The basis of life is carbon. Carbon's importance comes mainly from the enormous variety of structures that it can form due to its unusual four valence electrons. Most important of these structures is the carbon chain, which forms the "backbone" of fatty acids and carbohydrates, among other organic molecules. Other elements do share properties similar to carbon, in this regard. However, they are not as prevalent on earth as carbon.

2 The Four Macromolecules

All life is composed mainly of the four macromolecule building blocks: carbohydrates, lipids, proteins, and nucleic acids. The interactions of different polymers of these basic molecule types make up the majority of life's structure and function.

2.1 Carbohydrates

Overview - all Carbohydrates contain these three elements (usually in a 1:2:1 ratio) carbon, hydrogen, and oxygen.

> **Monosaccharides** - the simplest form of carbohydrates, contains one sugar. These are the basic energy sources for living cells. Examples of monosaccharides are glucose and fructose.
>
> **Disaccharides** - two monosaccharides bonded by a glycosidic bond (formed by dehydration synthesis). One example is maltose, which is specifically two glucose bonded together.
>
> **Polysaccharide** - three or more monosaccharides (in repeated units). These are most complex form of carbohydrates. A polysaccharide is a type of polymer. Some examples of polysaccharides, which are commonly used as energy storage molecules in cells, are starch, glycogen, and cellulose.

Dehydration synthesis / Hydrolysis

2.2 Proteins

Proteins are the most abundant of the organic molecules, comprising about 50% of a cell's dry weight. The most basic monomer of a protein is the amino acid. Amino acids share a common structure; all consist of a carbon atom bonded to a carboxyl group, and amino group, a hydrogen atom, and a variable R group. A particular protein's overall conformation can be considered on four levels; primary structure, secondary structure, tertiary structure, and quaternary structure. These levels of structure combine to create a complete protein that may serve many different functions within a cell.

2.2.1 Amino Acid Structure and Function

Amino acids are the most basic units of a polypeptide. They are comprised of four parts; the alpha carbon, the amino group, the carboxyl group, and finally an R group.

Expound on carboxyl-amino peptide bonds, R group types and interactions

2.2.2 Levels of Structure

Protein structure is influenced on four levels; primary, secondary, tertiary, and quaternary.

Primary

> The primary structure is simply the arrangement of amino acids in a single polypeptide chain. This is the part of a protein that is directly coded for by DNA.

Secondary

> The secondary structure is the interaction of the amino acids that make up the primary structure. The most common examples of secondary structure in a polypeptide are the α helix and the β pleated sheet. Most secondary structure is determined by intermolecular interactions between the carboxyl groups and the amino groups of amino acids, interacting to form Structural Biochemistry and Chemical Bonding and Hydrogen bonds hydrogen bonds. α helices are most commonly found in fibrous proteins such as those that make up hair and muscles. β pleated sheets, due to their strength and density, are commonly found in globular proteins like hemoglobin.

Tertiary

> The tertiary structure is highly irregular. It occurs as a result of interactions between the R groups, amino acid side chains, and the aqueous environment. These interactions create the individual conformation of a particular polypeptide chain. The most common interactions include hydrogen bonds, ionic bonds, and hydrophobic interactions. The strongest bonds, however, are due to covalent linkage, usually between two R groups. The most prevalent example of covalent linkage is the disulfide bridge.

Quaternary

> The quaternary structure of a protein describes the interactions between multiple polypeptide chains. Quaternary interactions can only occur in proteins with more than one polypeptide chain.

2.2.3 Functions of Proteins

1. **Structural Support**
2. **Storage**
3. **Transport**
4. **Signaling**
5. **Cellular Response to Chemical Stimuli**
6. **Movement**
7. **Defense Against Foreign Organisms**
8. **Catalysis of Biochemical Reactions**

2.3 Lipids

structure and function, ester bonds,etc

2.3.1 Types of Lipids

saturated, unsaturated, trans fat

2.3.2 Properties of Lipids

hydrophobic and philic, use of in cell

2.3.3 Steroids

Steroids are a family of organic compounds whose multiple rings share carbons. Sports players use steroids to strengthen their muscles. In most competition due to the performance boosting effect they are morally regarded as an unfair advantage and some of the compounds are listed as illegal. structure, use in membrane, use as hormones

2.4 Nucleic Acid

DNA or nucleic acids (structure)

Quick summary of the importance of Dehydration Synthesis + Hydrolysis

3 Articles

- Carbohydrates
- Lipids
- Proteins
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- Nucleic acids

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4.1 Text

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