

College of Biomedical Engineering

Biology

First Stage

Lecture Two

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The Main Features of the Four Main Classes of Important Biological Biomolecules.

Introduction

Biomolecules: are essential for life, and they make up the structure and function of living organisms. There are four main classes of biological molecules, each with distinct characteristics and functions. These classes are:

1. **Carbohydrates**
2. **Proteins**
3. **Lipids**
4. **Nucleic Acids**

In this lecture, we will explore the main features of each class and how they contribute to the functioning of life.

Carbohydrates

Carbohydrates are one of the primary sources of energy for living organisms. They are composed of carbon, hydrogen, and oxygen atoms.

Main Features:

- **Monomers**: Simple sugars like glucose, fructose, and galactose (monosaccharides).
- **Polymers**: Polysaccharides such as starch (plants), glycogen (animals), and cellulose (plants).

- **Structure**: Carbohydrates are made up of sugar molecules linked by glycosidic bonds.
- **Function**:
    - **Energy Storage**: Starch and glycogen store energy in plants and animals.
    - **Structural Support**: Cellulose gives structure to plant cell walls.
    - **Energy Source**: Sugars like glucose are used in cellular respiration to produce energy (ATP).

Examples:

- **Glucose** ($C_6H_{12}O_6$): A primary energy source for cells.
- **Cellulose**: Found in plant cell walls, providing rigidity.

2. Proteins

Proteins are large, complex molecules made up of chains of amino acids. They perform a wide variety of functions in living organisms.

Main Features:

- **Monomers**: Amino acids (there are 20 different types).
- **Polymers**: Proteins, which are chains of amino acids linked by peptide bonds.
- **Structure**: Proteins have four levels of structure:
    1. **Primary Structure**: Sequence of amino acids.
    2. **Secondary Structure**: Folding into alpha helices or beta sheets.
    3. **Tertiary Structure**: 3D shape of the protein.
    4. **Quaternary Structure**: Multiple polypeptides coming together.
- **Function**:

    - **Enzymes**: Proteins that speed up chemical reactions (e.g., amylase breaks down starch).
    - **Structure**: Collagen provides structural support in connective tissues.
    - **Transport**: Hemoglobin carries oxygen in the blood.
    - **Immune Function**: Antibodies defend against pathogens.
    - **Movement**: Actin and myosin are involved in muscle contraction.

Examples:

- **Hemoglobin**: A protein that carries oxygen in the blood.
- **Insulin**: A protein hormone that regulates blood sugar levels.

3. Lipids

Lipids are hydrophobic molecules that are important for energy storage, membrane structure, and signaling.

Main Features:

- **Monomers**: Fatty acids and glycerol.
- **Polymers**: Triglycerides, phospholipids, and steroids.
- **Structure**: Lipids generally have a non-polar hydrophobic tail (fatty acids) and a polar hydrophilic head (glycerol or phosphate group).
- **Function**:
    - **Energy Storage**: Triglycerides store energy in adipose tissue.
    - **Cell Membranes**: Phospholipids form the lipid bilayer in cell membranes, providing structure and selective permeability.
    - **Insulation and Protection**: Lipids, such as fats, provide insulation and protect organs.

    - **Signaling**: Steroids, like hormones (e.g., estrogen and testosterone), are involved in regulating biological processes.

Examples:

- **Triglycerides**: The most common form of fat in the body.
- **Phospholipids**: Essential components of cell membranes.
- **Cholesterol**: A steroid involved in cell membrane stability and hormone production.

4. Nucleic Acids

Nucleic acids are the molecules that carry genetic information and are involved in the synthesis of proteins.

Main Features:

- **Monomers**: Nucleotides, which are composed of a sugar, phosphate group, and nitrogenous base.
- **Polymers**: DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).
- **Structure**:
    - **DNA**: Double helix structure with two strands made up of nucleotides.
    - **RNA**: Single-stranded structure that is similar to DNA but uses ribose sugar and uracil instead of thymine.
- **Function**:
    - **Genetic Information Storage**: DNA stores genetic information in cells.
    - **Protein Synthesis**: RNA helps in the translation of genetic information into proteins (mRNA, tRNA, rRNA).

- **Energy Transfer**: ATP (adenosine triphosphate) is a nucleotide used in energy transfer within cells.

Examples:

- **DNA**: The genetic blueprint of living organisms.
- **RNA**: Involved in protein synthesis and gene expression.