2.4A: Types of Biological Macromolecules

Learning Objectives

- Identify the four major classes of biological macromolecules

Nutrients are the molecules that living organisms require for survival and growth but that animals and plants cannot synthesize themselves. Animals obtain nutrients by consuming food, while plants pull nutrients from soil.

Figure 1: Sources of biological macromolecules: Foods such as bread, fruit, and cheese are rich sources of biological macromolecules.

Many critical nutrients are biological macromolecules. The term “macromolecule” was first coined in the 1920s by Nobel laureate Hermann Staudinger. Staudinger was the first to propose that many large biological molecules are built by covalently linking smaller biological molecules together.
Monomers and Polymers

Biological macromolecules play a critical role in cell structure and function. Most (but not all) biological macromolecules are polymers, which are any molecules constructed by linking together many smaller molecules, called monomers. Typically all the monomers in a polymer tend to be the same, or at least very similar to each other, linked over and over again to build up the larger macromolecule. These simple monomers can be linked in many different combinations to produce complex biological polymers, just as a few types of Lego blocks can build anything from a house to a car.

Monomers and polymers: Many small monomer subunits combine to form this carbohydrate polymer.

Examples of these monomers and polymers can be found in the sugar you might put in your coffee or tea. Regular table sugar is the disaccharide sucrose (a polymer), which is composed of the monosaccharides fructose and glucose (which are monomers). If we were to string many carbohydrate monomers together we could make a polysaccharide like starch. The prefixes "mono-" (one), "di-" (two), and "poly-" (many) will tell you how many of the monomers have been joined together in a molecule.
Figure \( \PageIndex{3} \): The molecule sucrose (common table sugar): The carbohydrate monosaccharides (fructose and glucose) are joined to make the disaccharide sucrose.

Biological macromolecules all contain carbon in ring or chain form, which means they are classified as organic molecules. They usually also contain hydrogen and oxygen, as well as nitrogen and additional minor elements.

Four Classes of Biological Macromolecules

There are four major classes of biological macromolecules:

1. carbohydrates
2. lipids
3. proteins
4. nucleic acids

Each of these types of macromolecules performs a wide array of important functions within the cell; a cell cannot perform its role within the body without many different types of these crucial molecules. In combination, these biological macromolecules make up the majority of a cell’s dry mass. (Water molecules make up the majority of a cell’s total mass.) All the molecules both inside and outside of cells are situated in a water-based (i.e., aqueous) environment, and all the reactions of biological systems are occurring in that same environment.

Interactive: Monomers and Polymers

Carbohydrates, proteins, and nucleic acids are built from small molecular units that are connected to each other by strong covalent bonds. The small molecular units are called monomers (mono means one, or single), and they are linked together into long chains called polymers (poly means many, or multiple). Each different type of macromolecule, except lipids, is built from a different set of monomers that resemble each other in composition and size. Lipids are not polymers, because they are not built from monomers (units with similar composition).

Key Points

- Biological macromolecules are important cellular components and perform a wide array of functions necessary for
the survival and growth of living organisms.
• The four major classes of biological macromolecules are carbohydrates, lipids, proteins, and nucleic acids.

Key Terms
• **polymer**: A relatively large molecule consisting of a chain or network of many identical or similar monomers chemically bonded to each other.
• **monomer**: A relatively small molecule that can form covalent bonds with other molecules of this type to form a polymer.