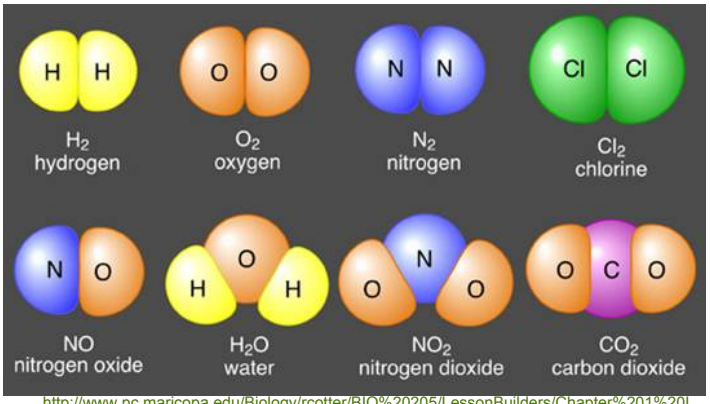
Introduction to Macromolecules (Biological Molecules)
HASPI Medical Biology

The Elements of Life



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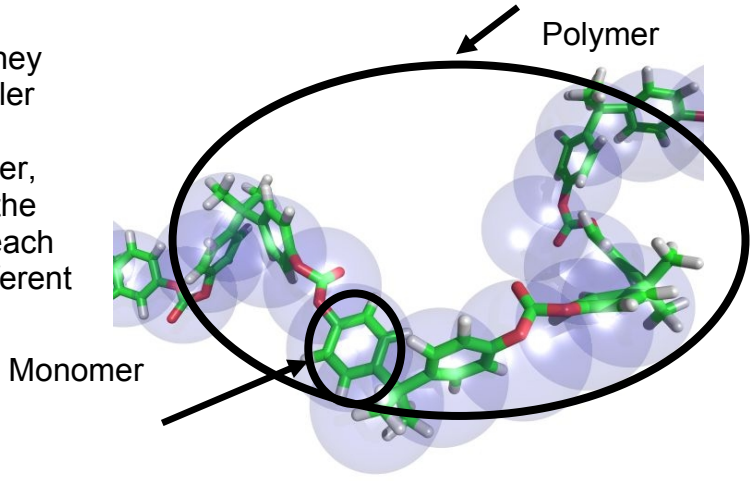
Nearly 99% of the human body is made up of only 6 elements: **oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorous**. Another 0.85% of the body is made up of 5 additional elements necessary for the body to function: potassium, sulfur, sodium, chlorine, and magnesium. The remaining 0.15% is filled by dozens of trace elements. A 150 pound human is made up of nearly $7x10^{27}$ atoms. More than 60% of those are **hydrogen** atoms, 25% are **oxygen** atoms, and 10% are **carbon** atoms. Carbon is often called the building blocks of life because they are the basis of most biological molecules that make up living things. Molecules that are made of carbon are considered **organic molecules**.

Many of these common atoms are bonded together to form important molecules such as water (H_2O), carbon dioxide (CO_2), and oxygen (O_2). The remaining atoms are bonded together to form complex structures that **provide energy, support shape, and perform functions within the body**. These are called **macromolecules**. The four main macromolecules include proteins, carbohydrates, lipids, and nucleic acids. All these macromolecules are needed or made by all living organisms.

Macromolecules are large **polymers**, meaning they are made up of many smaller parts. Those smaller parts are called **monomers**. Think Legos… A spaceship made from Legos would be the polymer, while each individual Lego piece used to create the spaceship would be a monomer. The atoms in each monomer are arranged differently to create a different polymer when they are bonded together.



The Four Macromolecules:

Proteins

Proteins are large macromolecules made primarily of carbon, hydrogen, oxygen, nitrogen and sometimes sulfur atoms bonded together. Proteins perform many important functions within the body, including performing chemical reactions as enzymes, communicating as hormones, initiating movement in muscles, and help to regulate cell processes just to name a few. The monomers of proteins are called **amino acids**. Amino acids are bonded together in long chains to create larger proteins, also called **polypeptides**. Proteins may be a few hundred amino acids long or hundreds of thousands of amino acids long. There are 20 different types of amino acids that can be bonded in different orders to create specific proteins. The basic structure of all amino acids is the same however, the many different shapes of proteins determines its function.

Monomer Amino Acid	**Polymer** Polypeptide	**Example** Muscle Protein
		

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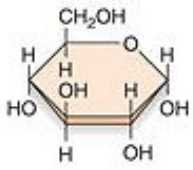
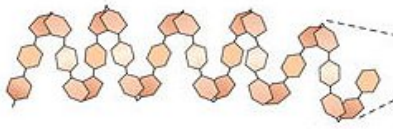
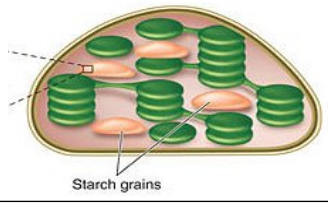
Carbohydrates (Carbo= carbon, saccharo= sugar)

Carbohydrates are large sugar molecules made of carbon, hydrogen and oxygen atoms in a 1:2:1 ratio (1 C: 2 H: 2 O). These atoms are often bonded creating hexagon shaped sugar molecules. The main function of carbohydrates is to provide energy. In fact, carbohydrates are the main source of energy for most organisms. The monomers of carbohydrates are called **monosaccharides**. Monosaccharides are simple sugars that include fructose, sucrose, and glucose to name a few. Energy is stored in the bonds that create monosaccharides, and released during cellular respiration. Monosaccharides are bonded together to form chains called **polysaccharides**. Polysaccharides are complex sugars that include starch (bread, potato, pasta), cellulose (plants), and glycogen (muscle).

Monomer Monosaccharide	**Polymer** Polysaccharide	**Example** Starch in Chloroplast
		

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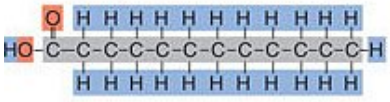
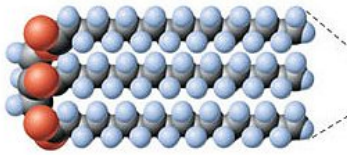
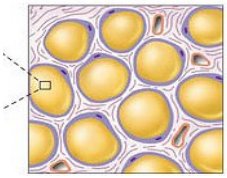
Lipids (fats, oils and cholesterol)

Lipids are large macromolecules made of carbon, hydrogen and a little bit of oxygen atoms bonded together. Lipids function to form the membranes in cells, as hormones and vitamins, and as energy storage. The most common monomers of lipids are called **fatty acids**. Fatty acids can be saturated, meaning they are completely covered in hydrogen atoms, or unsaturated, meaning they have some double-bonds and still have some space available for hydrogen atoms to bond. Fatty acids can be bonded to other molecules such as glycerol and phosphates to form **lipids**. Examples of lipids include triglycerides and phospholipids.

Monomer Fatty Acid	**Polymer** Triglyceride	**Example** Adipose Tissue
		

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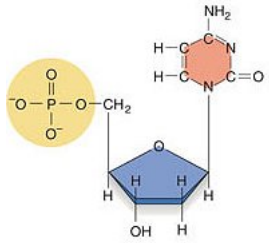
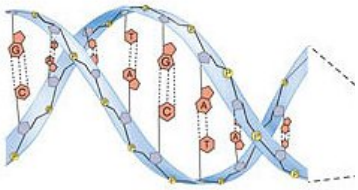
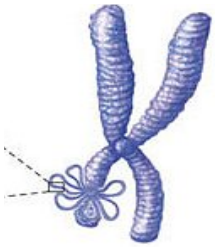
Nucleic Acids

Nucleic acids are macromolecules made of carbon, hydrogen, oxygen, nitrogen and phosphorus atoms bonded together. Nucleic acids contain the instructions for creating proteins within the body, and therefore are essential molecules for life. The monomers of nucleic acids are **nucleotides**. Every nucleotide contains 3 parts: a phosphate, a sugar, and a base. Nucleotides are bonded together to form the two larger major nucleic acids, **DNA** (deoxyribonucleic acid) and **RNA** (ribonucleic acid). An organism's DNA provides the hereditary genetic material and instructions for making proteins. The order of nucleotides in DNA determines the order of amino acids in the protein made by RNA.

Monomer Nucleotide	**Polymer** DNA or RNA	**Example** Chromosome
		

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