

Macromolecules

Slide 2 Macromolecules are large molecules made up of many single units of similar structure. The single units are called monomers. When several monomers are connected together during what is called a condensation reaction, a polymer is formed. These polymers are also referred to as macromolecules. There are four main macromolecules that are essential to the survival of all forms of life on earth. These are carbohydrates, proteins, lipids and nucleic acids and together they make up the four major macromolecules.

Slide 3 The monomers for each of the macromolecules are synthesized by the cell during regular metabolic functions. Some of the twelve key intermediates that you learned about earlier provide the chemical structure that these monomers are based on. (You may want to review lesson 1, module 1).

Slide 4 Regardless of which macromolecule is formed, the combining of monomers happens in basically the same way. A condensation reaction forms a covalent bond between monomers and releases water in the process. This type of reaction is also referred to as dehydration synthesis. The reverse of this reaction can also occur. Addition of water to a polymer results in the hydrolysis of the molecule, which breaks the covalent bond between monomers and adds a hydroxyl group to one monomer and a hydrogen atom to the other monomer. Let's see how this works for each of the four major macromolecules.

Slide 5 Carbohydrates consist of sugar monomers called monosaccharides. These monosaccharides are composed of carbon, oxygen and hydrogen. The carbon skeletons of monosaccharides range in length from 3 to 7 carbons long, and are often arranged in ring structures. Focus on the hydroxyl group from one monosaccharide and the hydrogen atom from the other. These two combine during the condensation reaction to form water. The covalent bond that creates a carbohydrate polymer is called a glycosidic linkage.

Slide 6 The monomers of proteins are called amino acids. Some of you may have seen amino acids bottled in natural foods stores as a nutritional supplement. This is because your body uses available amino acids taken in from the diet and synthesized in your cells to make proteins, which are essential to the function of all cells. Amino acids consist of a central carbon atom surrounded by 1), a hydrogen atom, 2), a side chain or R group, (which we will learn about more later), 3), a carboxyl group, and 4), an amino group. Focus again on the hydroxyl group of the carboxyl end of the amino acid and the hydrogen atom connected to the amino group. As you may have guessed, these will combine to form water during a condensation reaction. This creates a covalent bond known as a peptide linkage.

Slide 7 Nucleic acids include the molecules DNA, (or deoxyribonucleic acid), and RNA, (or ribonucleic acid). The monomers of these nucleic acids are called nucleotides. Each nucleotide consists of three basic parts: a sugar, a phosphate group, and one of five nitrogenous bases (Adenine, Thymine, Cytosine, Guanine or Uracil) We see the same process of formation with these macromolecules as we have with carbohydrates and proteins. This time, a hydroxyl group from the sugar combines with a hydrogen atom attached to the phosphate group. You guessed it, another condensation reaction. The covalent bond that forms is referred to as a phosphodiester linkage.

Slide 8 The fourth macromolecule that we will be looking at is lipids. There are several types of lipids, and no standard monomer, but their formation is based on the same principles we saw in the other macromolecules. For instance, the formation of a triglyceride includes three condensation reactions that covalently bind glycerol to three fatty acid molecules. These are called ester linkages. Another type of lipid is a phospholipid. Phospholipids consist of a molecule of glycerol with two fatty acids attached by ester linkages. In place of the third fatty acid is a compound containing a phosphate group attached to glycerol during a condensation reaction.

Slide 9 As you take a closer look at each of the macromolecules in the following lessons, remember that each one follows the basic pattern of synthesis through condensation reactions, and can be broken down by the reverse reaction of hydrolysis. Take some time after each lesson to practice building the macromolecule you have just learned about.