Organic Compounds

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Printed: January 20, 2015

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CHAPTER 1 Organic Compounds

- Define proteins, carbohydrates, lipids, nucleic acids.
- Recognize the basic structure of organic compounds and explain their basic functions.
- Distinguish the categories of organic compounds, compare and contrast their roles, and analyze the components of each category.
- Summarize in detail the structure and function of the organic compounds, emphasizing the relationship between structure and function.

What makes up a healthy diet?

A healthy diet includes protein, fats, and carbohydrates. Why? Because these compounds are three of the main building blocks that make up your body. You obtain these building blocks from the food that you eat, and you use these building blocks to make the organic compounds necessary for life.

Organic Compounds

The main chemical components of living organisms are known as **organic compounds**. Organic compounds are molecules built around the element carbon (C). Living things are made up of very large molecules. These large molecules are called **macromolecules** because “macro” means large; they are made by smaller molecules bonding together. Our body gets these smaller molecules, the "building blocks" or **monomers**, of organic molecules from the food we eat. Which organic molecules do you recognize from the list below?

The four main types of macromolecules found in living organisms, shown in **Table** 1.1, are:

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

TABLE 1.1: The Four Main Classes of Organic Molecules

	Proteins	Carbohydrates	Lipids	Nucleic Acids
Elements	C, H, O, N, S	C, H, O	C, H, O, P	C, H, O, P, N
Examples	Enzymes, muscle fibers, antibodies	Sugar, glucose, starch, glycogen, cellulose	Fats, oils, waxes, steroids, phospholipids in membranes	DNA, RNA, ATP
Monomer (small building block molecule)	Amino acids	Monosaccharides (simple sugars)	Often include fatty acids	Nucleotides

Carbohydrates

Carbohydrates are sugars, or long chains of sugars. An important role of carbohydrates is to store energy. **Glucose** (**Figure** 1.1) is an important simple sugar molecule with the chemical formula $C_6H_{12}O_6$. Simple sugars are known as **monosaccharides**. Carbohydrates also include long chains of connected sugar molecules. These long chains often consist of hundreds or thousands of monosaccharides bonded together to form **polysaccharides**. Plants store sugar in polysaccharides called **starch**. Animals store sugar in polysaccharides called **glycogen**. You get the carbohydrates you need for energy from eating carbohydrate-rich foods, including fruits and vegetables, as well as grains, such as bread, rice, or corn.

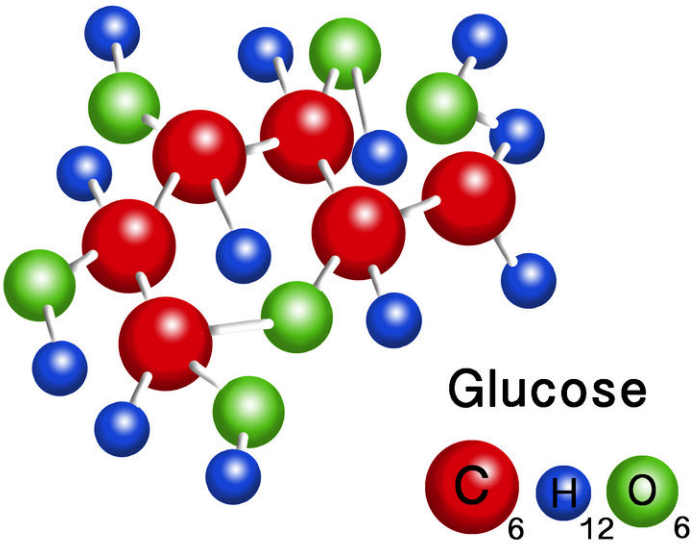


FIGURE 1.1
A molecule of glucose, a type of carbohydrate.

Proteins

Proteins are molecules that have many different functions in living things. All proteins are made of monomers called **amino acids** (**Figure** 1.2) that connect together like beads on a necklace (**Figure** 1.3). There are only 20 common amino acids needed to build proteins. These amino acids form in thousands of different combinations, making about 100,000 or more unique proteins in humans. Proteins can differ in both the number and order of amino acids. It is the number and order of amino acids that determines the shape of the protein, and it is the shape (structure) of the

protein that determines the unique function of the protein. Small proteins have just a few hundred amino acids. The largest proteins have more than 25,000 amino acids.

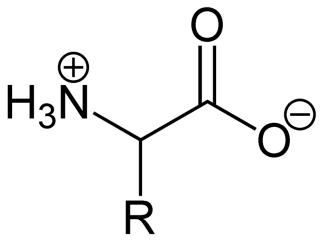


FIGURE 1.2

This model shows the general structure of all amino acids. Only the side chain, R, varies from one amino acid to another. KEY: H = hydrogen, N = nitrogen, C = carbon, O = oxygen, R = variable side chain.

FIGURE 1.3

Amino acids connect together like beads on a necklace. MET, ASN, TRP, and GLN refer to four different amino acids.

Many important molecules in your body are proteins. Examples include enzymes, antibodies, and muscle fiber. **Enzymes** are a type of protein that speed up chemical reactions. They are known as "biological catalysts." For example, your stomach would not be able to break down food if it did not have special enzymes to speed up the rate of digestion. **Antibodies** that protect you against disease are proteins. Muscle fiber is mostly protein (**Figure** 1.4).

FIGURE 1.4

Muscle fibers are made mostly of protein.

It's important for you and other animals to eat food with protein, because we cannot make certain amino acids on our own. You can get proteins from plant sources, such as beans, and from animal sources, like milk or meat. When you eat food with protein, your body breaks the proteins down into individual amino acids and uses them to build new proteins. You really are what you eat!

Lipids

Have you ever tried to put oil in water? They don't mix. Oil is a type of lipid. **Lipids** are molecules such as fats, oils, and waxes. The most common lipids in your diet are probably fats and oils. Fats are solid at room temperature,

whereas oils are fluid. Animals use fats for long-term energy storage and to keep warm. Plants use oils for long-term energy storage. When preparing food, we often use animal fats, such as butter, or plant oils, such as olive oil or canola oil. There are many more type of lipids that are important to life. One of the most important are the **phospholipids** that make up the protective outer membrane of all cells (**Figure** 1.5).

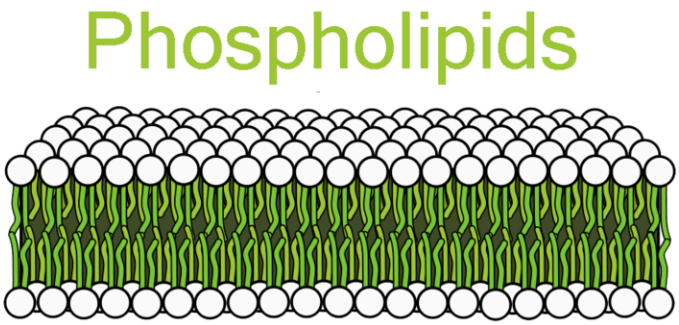


FIGURE 1.5

Phospholipids in a membrane, shown as two layers (a bilayer) of phospholipids facing each other.

Nucleic acids

Nucleic acids are long chains of nucleotides. Nucleotides are made of a sugar, a nitrogen-containing base, and a phosphate group. **Deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)** are the two main nucleic acids. DNA is a double-stranded nucleic acid. DNA is the molecule that stores our genetic information (**Figure** 1.6). The single-stranded RNA is involved in making proteins. **ATP (adenosine triphosphate)**, known as the "energy currency" of the cell, is also a nucleic acid.

FIGURE 1.6

A model representing DNA, a nucleic acid.

Summary

- Living organisms are comprised of organic compounds, molecules built around the element carbon.

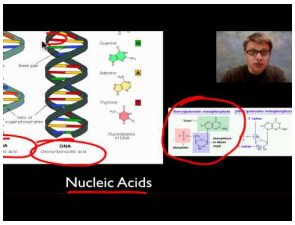
- Living things are made of just four classes of organic compounds: proteins, carbohydrates, lipids, and nucleic acids.

Explore More

Use the resources below to answer the questions that follow.

Explore More I

- **Molecules of Life** at http://www.youtube.com/watch?v=QWf2jcznLsY (10:47)



MEDIA
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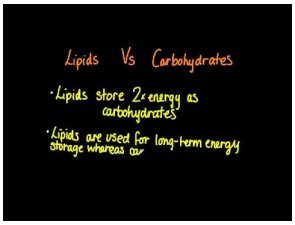
1. What four categories of macromolecules make up cells?
2. What about carbon makes it valuable to organisms?
3. What do functional groups do? How are they important to organisms?
4. What smaller units can proteins be broken down into?
5. What two nucleic acids are used by organisms?
6. What are three different types of carbohydrates?

Explore More II

- **Lipids vs. Carbohydrates** at http://www.youtube.com/watch?v=zTUCEY6CpVI (0:43)



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1. What function do both lipids and carbohydrates share? How do they differ in this regard?
2. How is the solubility of lipids different than the solubility of carbohydrates?

Review

1. What are the four main types of organic compounds that make up living things?
2. What are the monomers used to make carbohydrates, proteins, and nucleic acids?
3. What are examples of lipids?
4. What are examples of proteins?

References

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2. Jürgen Martens. The general structure of an amino acid . Public Domain
3. Sam McCabe. A sample amino acid chain . CC BY-NC 3.0
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5. Mariana Ruiz Villarreal (LadyofHats), modified by CK-12 Foundation. A membrane consisting of a phosp holipid bilayer . Public Domain
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