Macromolecules

Carbohydrates

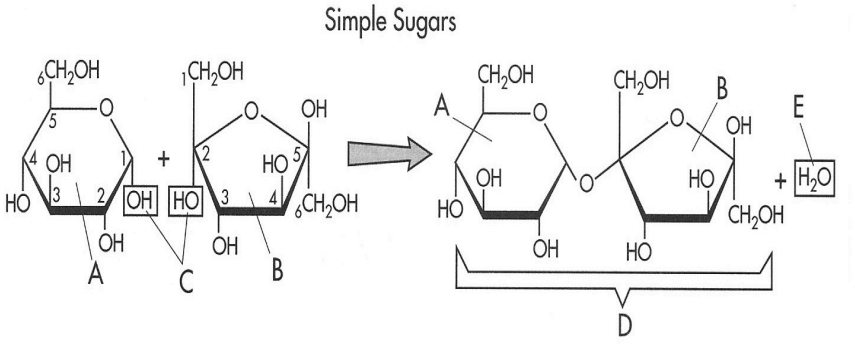
A COMPLEX COLORING EXPERIENCE

Name:

Per: Date:

Answer the questions in complete sentences for full credit.

All plants, animals and microorganisms use carbohydrates as sources of energy. Carbohydrates are also used as structural building blocks. Carbohydrates are made up of **carbon**, **hydrogen**, and **oxygen** atoms. The **glucose molecule (A)** is a basic carbohydrate known as a **monosaccharide** or simple sugar. A second monosaccharide is the fructose molecule (B). Two monosaccharides bonded together forms a **disaccharide**. *Color in the diagram to the right using the same color for like molecules.*



☐ Glucose molecule..... A ☐ Sucrose molecule..... D

☐ Fructose molecule..... B ☐ Water molecule..... E

1. How are fructose and glucose different from one another?

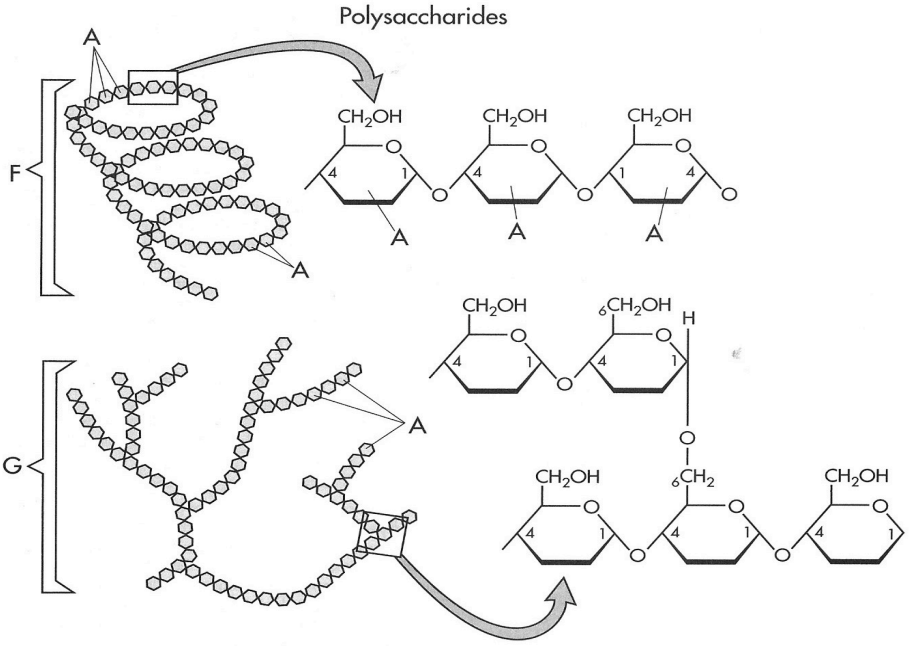
2. By what process do glucose and fructose bond together to form sucrose (D)? What is the by-product of this reaction?

3. What is the general name given to carbohydrates such as sucrose?

Polysaccharides are molecules that can consist of hundreds or thousands of monosaccharide units. *Color in the diagram to the right; using similar colors as in the coloring above, but use different colors for the glycogen and starch molecules.*

The first polysaccharide molecule shown is a **starch** molecule (F), which is found in plants. Starch molecules represent a storage form of glucose. Starch can be broken down into smaller units by enzymes.

4. What are the units that starch is broken down into?



☐ Starch molecule..... F ☐ Glycogen molecule..... G

5. What is the process by which starch is broken down into the smaller units?

The second polysachharide is **glycogen** (G). Glycogen is often referred to as animal starch. It is stored in the liver and muscles when the body has to store excess glucose molecules. Note that like starch, glycogen is made up of units.

6. What are the units that make up a glycogen molecule?

7. What is the process by which glycogen is broken down into smaller units?

8. How are starch and glycogen different? List at least 2 ways.

9. Use your notes from class to describe how cellulose is similar to starch. Include a sketch or at least a description of the shape of the molecules.

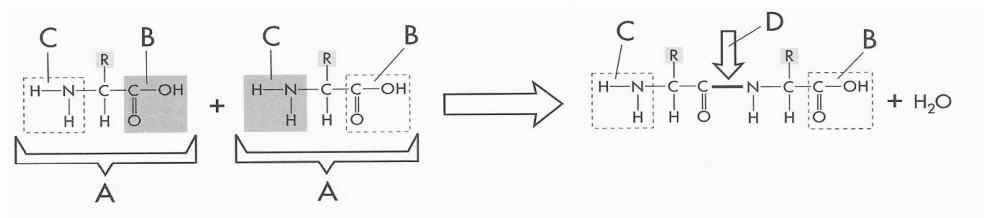
Proteins

Answer the questions in complete sentences for full credit.

Proteins (**polypeptides**) are vital to the formation and function of many cellular structures and processes. They are also among the most diverse organic molecules in living things. Proteins are molecules that are formed from units called **amino acids**. A protein may contain as few as ten amino acids, or it may contain thousands. The sequence of amino acids in proteins gives them unique functional characteristics.

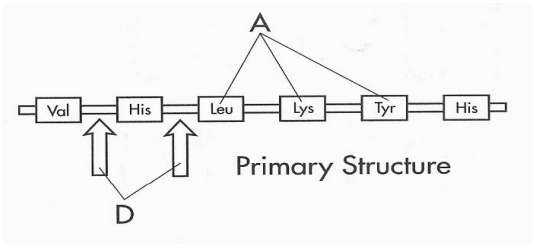
In the picture below, lightly shade the two amino acids (A) and the peptide bond (D).

1. Which elements are present in the amino acids that were not present carbohydrates?

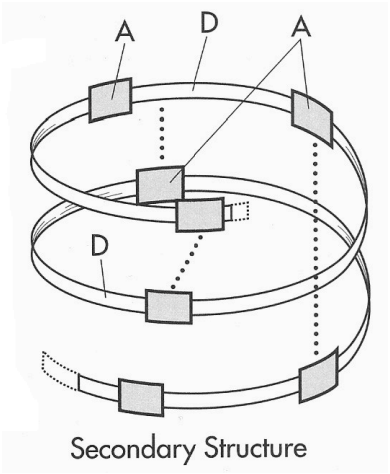


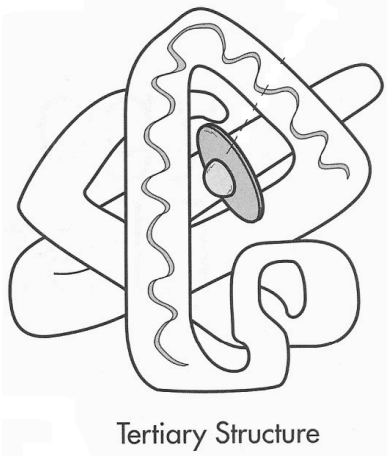
2. By what process does the peptide bond form? What is the byproduct of this process?

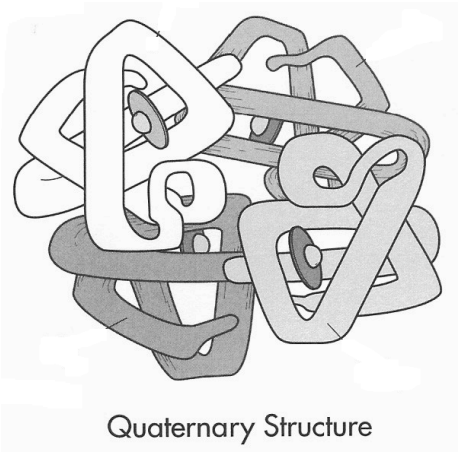
In the picture to the right, lightly shade in the amino acids (A) and the peptide bonds (D). Use different colors for each amino acid.



Proteins take many shapes depending on their function. These shapes be can accomplished by **folding** and **twisting the polypeptide chain**. Color the twisted protein below, using different colors for amino acids (A) and peptide bonds (D). Color the folded protein. And shade in the four chains (using different colors) of the quaternary structure in which multiple **polypeptides** are organized together.







3. What are the monomers of polypeptides?

4. List and explain 5 functions of proteins?

Lipids

Answer the questions in complete sentences for full credit.

Lipids are a group of organic molecules that dissolve in oils, but not in water. Lipids come in three varieties: Fats, phospholipids and cholesterol. Fats are very efficient energy-storage molecules that yield about twice the amount of chemical energy per gram, than do carbohydrates. Fats are important in the construction of plasma membranes and they also provide physical and thermal insulation to animals. We consider two types of fats: **saturated fats** and **unsaturated fats**. The saturated fat is built of two subunits, one of which you have seen when looking at the carbohydrates. *Lightly shade in the boxes in the diagram below using the same color for like molecules.*

In the **saturated fat**, three saturated fatty acid chains (B) are chemically bound to the glycerol molecule (A). A saturated fatty acid contains its maximum number of hydrogen atoms; straight lines represent single bonds.

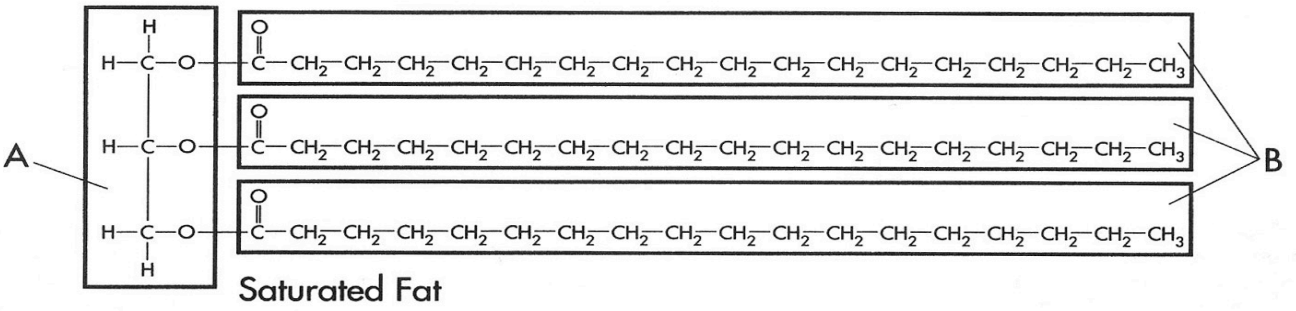
In the **unsaturated fat**, there are fewer than the maximum number of hydrogen bonds in the unsaturated fatty acid chains; there are some double bonds.

1. What is the subunit that saturated and unsaturated fats have in common?

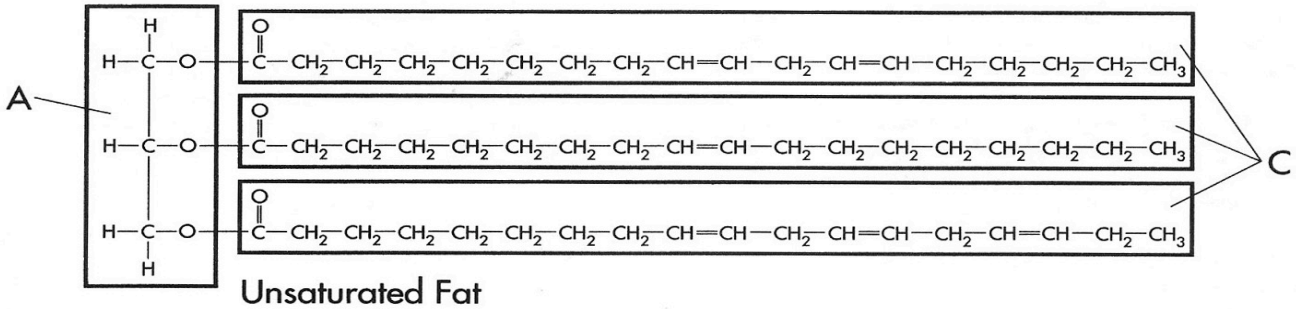
2. Describe how saturated fats are different than unsaturated fats. Circle the bonds in the drawings that make this difference.

3. What is the biologic function of these fats?

☐ Glycerol molecule..... A
☐ Saturated Fatty Acid Chain..... B
☐ Unsaturated Fatty Acid Chain..... C



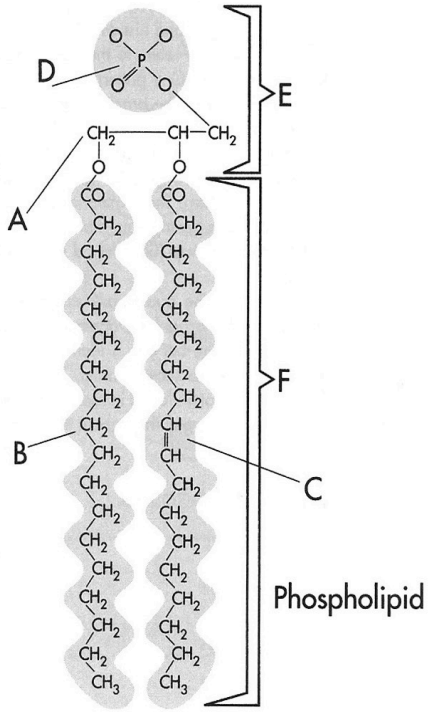
Saturated Fat



Unsaturated Fat

Phospholipids are basically made up of a glycerol molecule (A) with a phosphate group (D) and two fatty acids (B) and (C). The fatty acid on the left is a saturated fatty acid (B), while the fatty acid on the right is unsaturated (C). Phospholipids are crucial in the formation of cell membranes. In a phospholipid bilayer of the cell membrane, the phosphate groups point toward the outside of the cell and the fatty acid chains toward each other. The phosphate end is the polar end (E) because it has a negative charge. The opposite end is the nonpolar end (F), and this section of the molecule lacks an electrical charge. Millions of these molecules stand next to each other in the cell membrane to form a structure similar to a picket fence. This membrane acts as a selective barrier for the cell. ***Shade in the subunits of the phospholipids using the same colors as above.***

- ☐ Glycerol molecule..... A
- ☐ Saturated Fatty Acid Chain..... B
- ☐ Unsaturated Fatty Acid Chain..... C
- ☐ Phosphate Group D
- ☐ Polar End E
- ☐ Non Polar End F



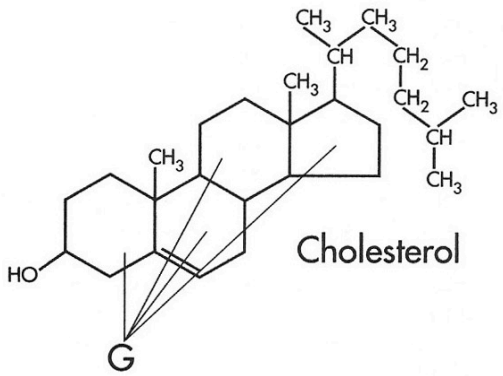
4. Describe the structure of a phospholipid.

5. Why is one end of the phospholipid polar and the other nonpolar?

Steroids comprise an important group of lipids that are insoluble in water and consist of carbon, hydrogen and oxygen atoms arranged in rings. Estrogen and androgens, the sex hormones in humans are steroid hormones.

One familiar steroid is **cholesterol**. In the diagram, *shade in the complex molecule that has a sterol ring (G*). In humans an excess of cholesterol is a problem because it can clog arteries and veins, which results in restricted blood flow. The liver makes cholesterol for the body, but the diet also provides some, and if intake is high, excessive cholesterol accumulates.

6. What is a potential danger of excess cholesterol in the human body?

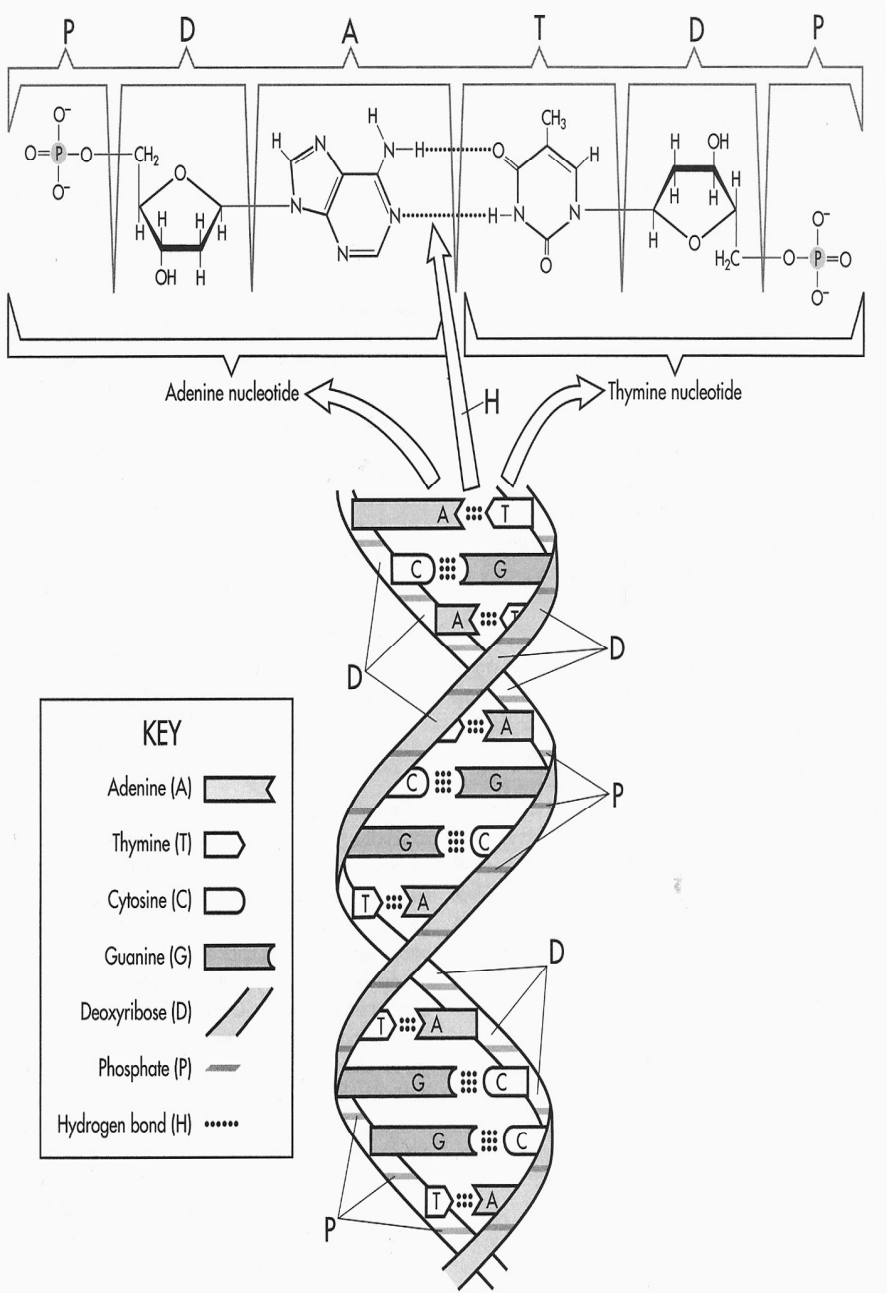


Nucleic Acids

Answer the questions in complete sentences for full credit.

Two types of nucleic acids exist: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). DNA is the genetic material of organisms, while RNA is used during construction of proteins. DNA is composed of repeating units known as **nucleotides**. Each nucleotide has three components: a molecule of carbohydrate **deoxyribose**, a **phosphate group** and a **nitrogenous base**. There are four nitrogenous bases: thymine, adenine, cytosine, and guanine.

At the upper portion of the drawing, two nucleotides are shown. At the left is a nucleotide composed of a phosphate group (P), a deoxyribose molecule (D), and a nitrogenous base called adenine (A). Lightly shade these three different colors to avoid obscuring their individual atoms. At the right, a second nucleotide is shown. It consists of a nitrogenous base called thymine (T), bonded to a deoxyribose, which is inverted. The deoxyribose is in turn bonded to a phosphate group. Lightly shade in the three portions of the nucleotide. On the DNA double helix, lightly shade in the portions of the molecule, using the same colors as before as appropriate.



1. Which elements are present in DNA?
2. Which three molecules make up a nucleotide?
3. Which two molecules make up the backbone of the DNA molecule?
4. What are the four nitrogenous bases?
5. What is the pairing sequence of nitrogenous bases in DNA?
6. What types of bonds holds the nitrogenous bases together in the DNA molecule?
7. Is it always the same number of bonds between bases? Explain.
8. Why are these types of bonds useful in the DNA molecule?