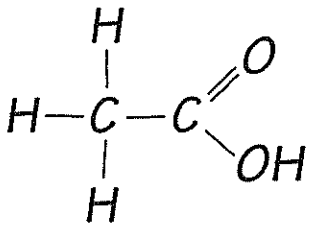
Name_____ Course/Section_____

Date_____ Professor/TA_____

Activity 3.1 A Quick Review of the Properties of Water

1. Compounds that have the capacity to form hydrogen bonds with water are said to be hydrophilic (water loving). Those without this capacity are hydrophobic (water fearing).

	Is the molecule on the left hydrophilic or hydrophobic? Explain your answer.

2. In addition to being polar, water molecules can dissociate into hydronium ions (H_3O^+, often described simply as H^+) and hydroxide ions (OH^-). The concentration of each of these ions in pure water is 10^{-7}. Another way to say this is that the concentration of hydronium ions, or H^+ ions, is one out of every 10 million molecules. Similarly, the concentration of OH^- ions is one in 10 million molecules.

   a. The H^+ ion concentration of a solution can be represented as its pH value. The pH of a solution is defined as the negative $\log_{10}$ of the hydrogen ion concentration. What is the pH of pure water?

   b. Refer to the diagram of the molecule of acetic acid in question 1. The COOH group can ionize to release a H^+ ion into solution. If you add acetic acid to water and raise the concentration of H^+ ions to 10^{-4}, what is the pH of this solution?

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Activity 4.1/5.1 How can you identify organic macromolecules?

Refer to the figure (Some Simple Chemistry) on the next page when doing this activity.

Part A. Answer the questions. Then use your answers to develop simple rules for identifying carbohydrates, lipids, proteins, and nucleic acids.

1. What is the approximate C:H:O ratio in each of the following types of macromolecules?

Carbohydrates	Lipids	Proteins	Nucleic acids

2. Which of the compounds listed in question 1 can often be composed of C, H, and O alone?

3. Which of the compounds can be identified by looking at the C:H:O ratios alone?

4. What other elements are commonly associated with each of these four types of macromolecules?

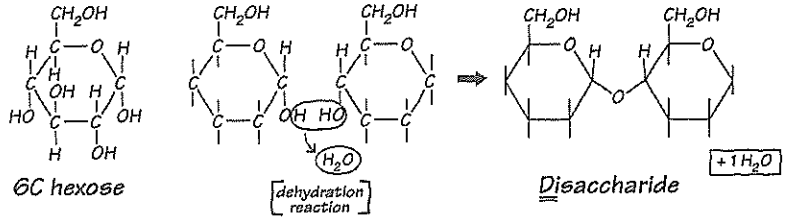
	Carbohydrates	Lipids	Proteins	Nucleic acids
Always contain P				
Generally contain no P				
Always contain N				
Generally contain no N				
Frequently contain S				
Generally contain no S				

Some Simple Chemistry

Compound	Basic components ➡ Reaction ➡ Product

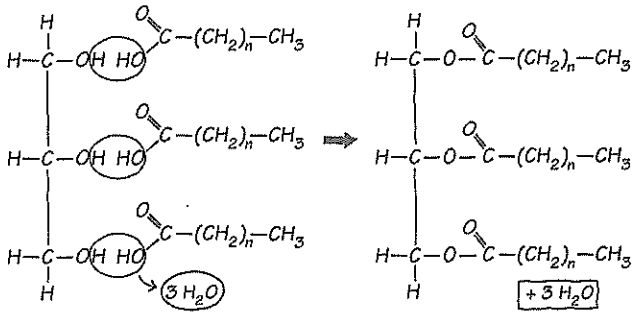
Carbohydrates:

Sugars, starches, glycogen, cellulose



Lipids:

Fats, oils, waxes, cholesterol

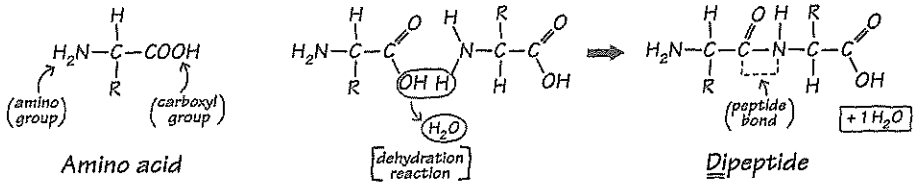


Glycerol + 3 fatty acids ➡ Triglyceride or fat

dehydration reaction

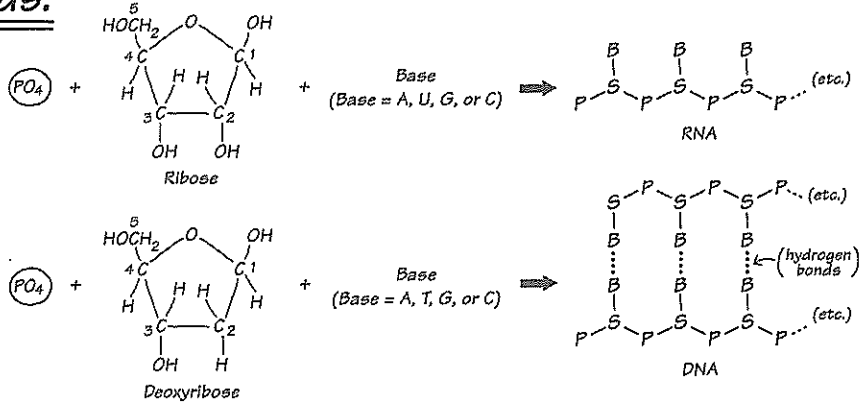
Proteins:

Enzymes, structural proteins



Nucleic acids:

DNA, RNA



5. Functional groups can modify the properties of organic molecules. In the following table, indicate whether each functional group is polar or nonpolar and hydrophobic or hydrophilic. Which of these functional groups are found in proteins and lipids?

Functional group	Polar or nonpolar	Hydrophobic or hydrophilic	Found in all proteins	Found in many proteins	Found in many lipids
—OH					
$—CH_2$					
—COOH					
$—NH_2$					
—SH					
$—PO_4$					

6. You want to use a radioactive tracer that will label only the protein in an RNA virus. Assume the virus is composed of only a protein coat and an RNA core. Which of the following would you use? Be sure to explain your answer.

   a. Radioactive P b. Radioactive N c. Radioactive S d. Radioactive C

7. Closely related macromolecules often have many characteristics in common. For example, they share many of the same chemical elements and functional groups. Therefore, to separate or distinguish closely related macromolecules, you need to determine how they differ and then target or label that difference.

   a. What makes RNA different from DNA?

   b. If you wanted to use a radioactive or fluorescent tag to label only the RNA in a cell and not the DNA, what compound(s) could you label that is/are specific for RNA?

   c. If you wanted to label only the DNA, what compound(s) could you label?

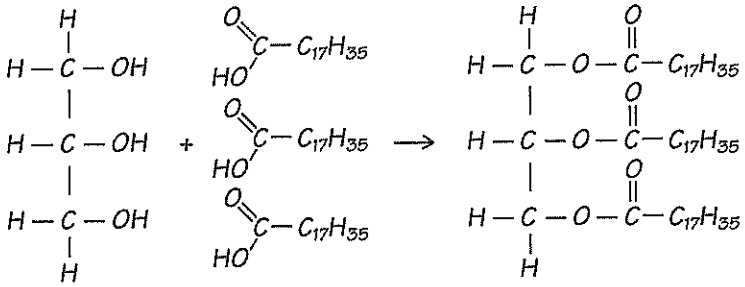
8. Based on your answers to questions 1–7, what simple rule(s) can you use to identify the following macromolecules?

Carbohydrates	
Lipids	
Proteins	
Nucleic acids	
DNA versus RNA	

Part B. Carbohydrate, lipid, protein, or nucleic acid? Name that structure!

Based on the rules you developed in Part A, identify the compounds below (and on the following page) as carbohydrates, lipids, amino acids, polypeptides, or nucleic acids. In addition, indicate whether each is likely to be polar or nonpolar, hydrophilic or hydrophobic.

1)



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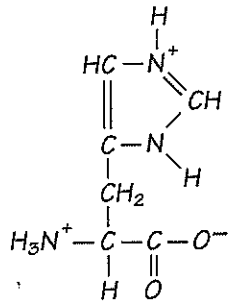

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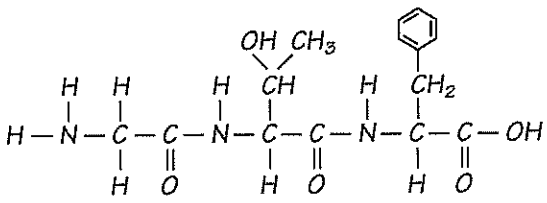

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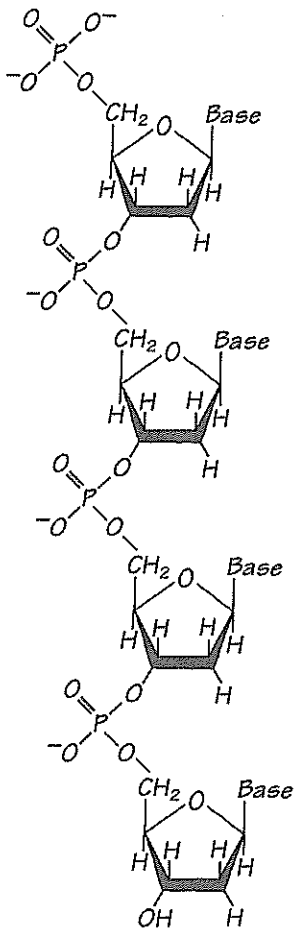
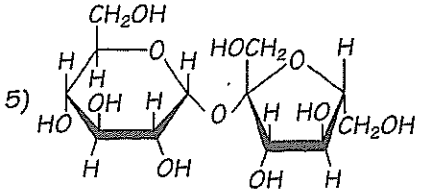
Part B. *Continued*

4)

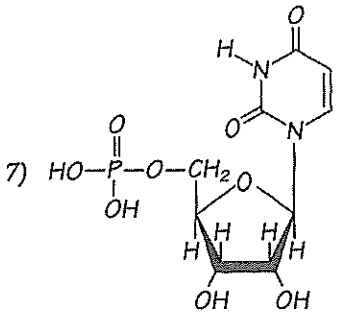


5)



6) $H_3C-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-C(=O)-OH$

7)



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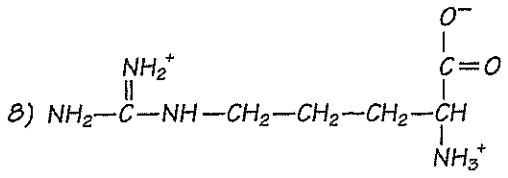

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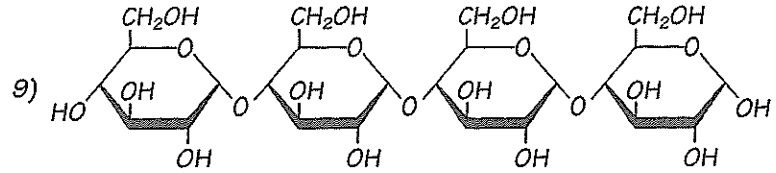
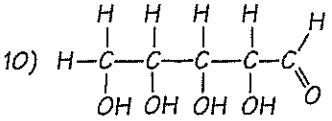


10)



2. Polypeptides and proteins are made up of linear sequences of amino acids. In its functional form, each protein has a specific three-dimensional structure or shape. Interactions among the individual amino acids and their side chains play a major role in determining this shape.

   a. How are amino acids linked together to form polypeptides or proteins? What is this type of bond called?

b. Define the four structures of a protein.	c. What kinds of bonds hold each of these structures together?
Primary:	
Secondary:	
Tertiary:	
Quaternary:	

3. Lipids as a group are defined as being hydrophobic, or insoluble in water. As a result, this group includes a fairly wide range of compounds—for example, fats, oils, waxes, and steroids like cholesterol.

   a. How are fatty acids and glycerol linked together to form fats (triglycerides)?

   b. What functions do fats serve in living organisms?

   c. How do phospholipids differ from triglycerides?

   d. What characteristics do phospholipids have that triglycerides do not have?