Name _____ **Period** _____

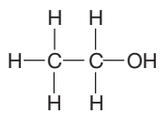
Chapter 3: The Molecules of Cells

Guided Reading Activities

Big Idea: Introduction to Organic Compounds

Answer the following questions as you read Modules 3.1–3.3:

1. Is this molecule an organic compound? Briefly explain your answer.



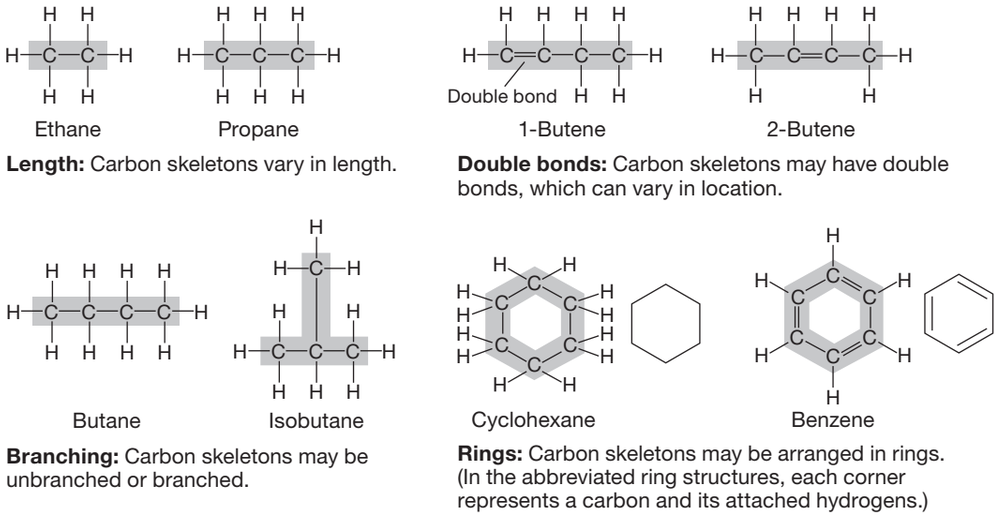
Alcohol

Yes, it is an organic compound because of the carbon and hydrogen present in the molecule.

2. We are a carbon-based life form. List three properties of carbon that make it an ideal element from which to construct a wide variety of complex molecules.
Carbon can form four covalent bonds because it needs four electrons to fill its valence shell. Carbon-based molecules can vary in the number of carbon atoms. Carbon can form covalent bonds with atoms other than H, which leads to a great diversity in molecules.

3. What is meant by a molecule's "carbon skeleton" and how can carbon skeletons vary?
The carbon skeleton refers to the number and arrangement of carbon atoms in a molecule.

4. Look at all of the molecules illustrated in Figure 3.1B on page 38 of your textbook. What chemical property would they all share based on the elements present within those molecules? Hint: This was discussed in Chapter 2 during bonding.



The molecules would all be nonpolar because carbon and hydrogen form nonpolar covalent bonds with each other.

5. An unidentified molecule is found in a sample of water near a chemical plant. An initial analysis finds that the molecule contains only carbon and hydrogen. What type of molecule is this?
This type of molecule is a hydrocarbon because it has only carbon and hydrogen.

6. Two molecules that have the same molecular formula but a different structure would be referred to as a(n) _____.

   a. saturated fat

   b. hydrogenated oil

   c. polypeptide

   d. isomer

7. The molecule in question 1 is ethyl alcohol. The oxygen atom in ethyl alcohol forms a polar covalent bond with the hydrogen atom. What functional group is found on ethyl alcohol and does ethyl alcohol readily interact with water? Briefly explain your answer.
The functional group is a hydroxyl group. Ethanol readily interacts with water because the hydroxyl group imparts polarity to the ethanol, which allows it to be attracted to water.

8. Complete the table that illustrates the different functional groups.

	Hydroxyl	Carbonyl	Carboxyl	Amino	Phosphate	Methyl
Structure	—OH	>C = O	—COOH	—NH_2	—OPO_3^{2-}	—CH_3

9. Which is the only functional group that is nonpolar?

   a. Methyl group

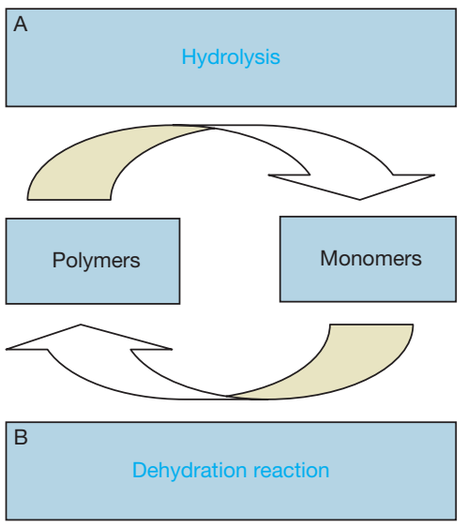
   b. Carboxyl group

   c. Phosphate group

   d. Hydroxyl group

10. Teachers commonly use a train and its numerous cars (engine, caboose, etc.) as an analogy to help students understand the relationship between monomers and polymers. Briefly explain why that is a good analogy.
This is a good analogy because train cars are attached in sequence, and many individual train cars (monomers) are attached together to make the larger train (polymer).

11. Complete the following diagram at right using the following terms: dehydration, reaction, and hydrolysis.



12. Which of the following terms best describes the following reaction: glucose + galactose → lactose + H_2O?

    a. Polymer

    b. Hydrolysis

    c. Metabolism

    d. Dehydration reaction

Big Idea: Carbohydrates

Answer the following questions as you read Modules 3.4–3.7:

1. Which of the following is not a characteristic of monosaccharides?

    a. Generally a multiple of CH_2O

    b. Can be linked together to make polymers

    c. Contain hydroxyl and carbonyl groups

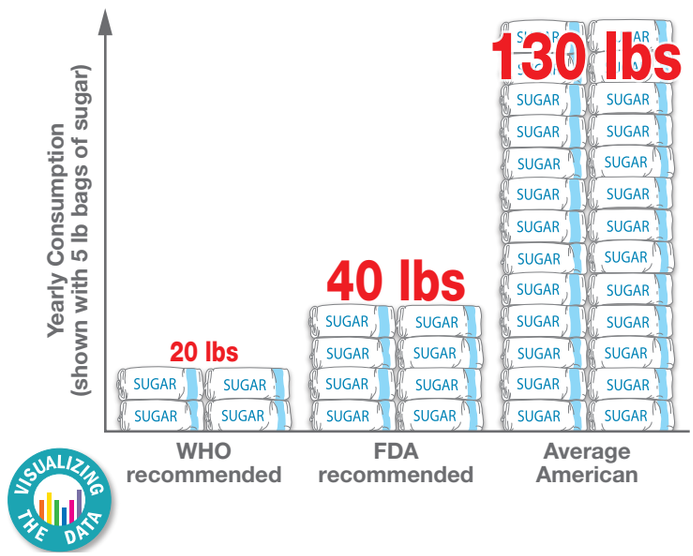
    d. All of the above are characteristics of monosaccharides.

2. Sweetened beverages from coffee to tea to soda are a regular part of almost everyone's daily routine. Briefly explain why sugars, like fructose, readily dissolve in water.
   The sugars readily dissolve in water because they have hydroxyl groups. The hydroxyl groups make them polar, which allows them to be attracted to water.

3. Two monosaccharides joined by a dehydration synthesis would form a(n) __disaccharide__. List two examples.
   Lactose and maltose are two possible examples of dissaccharides.

4. A glucose molecule has a molecular formula of $C_6H_{12}O_6$. When two glucose molecules are linked together to make maltose, the resulting molecular formula is $C_{12}H_{22}O_{11}$. Briefly explain why the molecular formula of maltose is not $C_{12}H_{24}O_{12}$.
To link the two glucose molecules together, a dehydration synthesis must occur. The result of dehydration synthesis is that a molecule of water is removed.

5. Roughly how much more sugar does the average American consume compared with the FDA recommended allowance? Use Figure 3.6 on page 42 of your textbook.



The average American consumes approximately three times the recommended daily allowance for sugar.

6. Complete the following table regarding monosaccharides and polysaccharides.

	Starch	Glucose	Cellulose	Glycogen
Identify as a monomer or polymer	Polymer	Monomer	Polymer	Polymer
Describe the function	Energy storage in plants	Short-term energy and the building block of many biological polymers	Structural role in plants	Energy storage in animals including humans

7. Which of the following is found within the exoskeletons of insects?

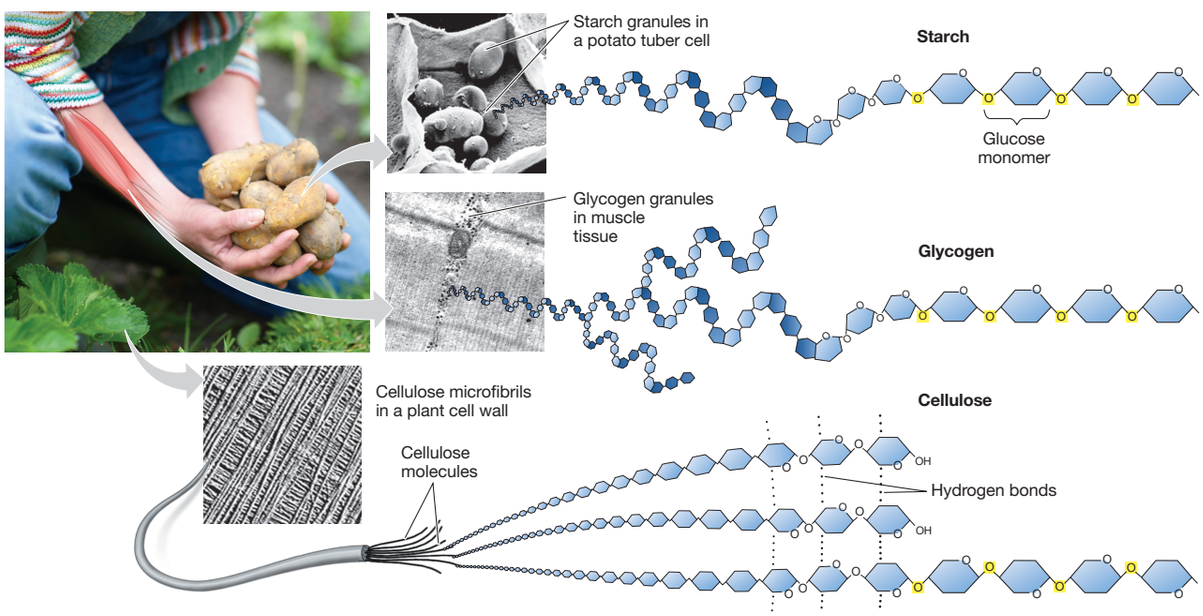
   a. Chitin

   b. Starch

   c. Cellulose

   d. Glycogen

8. What do starch, glycogen, and cellulose all have in common in terms of their molecular makeup? Refer to Figure 3.7 on page 43 of your textbook.



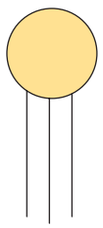
All three polymers are constructed from the same monomer—glucose.

Big Idea: Lipids

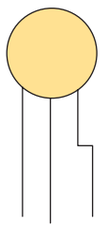
Answer the following questions as you read Modules 3.8–3.11:

1. The one characteristic common to all lipids is that they are hydrophobic, which is in contrast to most other biological molecules.

2. Which fatty acid tail from the illustration is saturated? Which one is unsaturated? Briefly explain your answers.



Saturated because the fatty acid tails are not bent



Unsaturated because the bent tails represent a c = c

3. You are a biochemist working for a food manufacturer. You are working to identify a new fat you have discovered in a plant from the rain forest of Brazil. During your investigation, you determine that the fat tends to be a liquid at room temperature, and a biochemical analysis reveals too few hydrogen atoms for the amount of carbon that is present. What kind of fat have you likely discovered? Briefly explain your answer.
The fat is an unsaturated fat, because having too few hydrogen atoms for the number of carbon atoms present indicates carbon – carbon double bonds.

4. An unsaturated fat can be turned into a solid or semisolid state by _____.

   a. omega-3 fatty acidification

   b. hydrophilication

   c. hydrogenation

   d. unsaturation

5. Two students are studying for their cumulative final exam and begin a discussion of triglycerides. One student tells the other that all fats are bad for a person's health. The second student disagrees with that statement. Which student is correct? Briefly explain your answer.
Although both are high in calories, unsaturated fats are considered better for you than saturated fats. Increases of saturated fats in your diet correlate with an increased risk of heart disease.

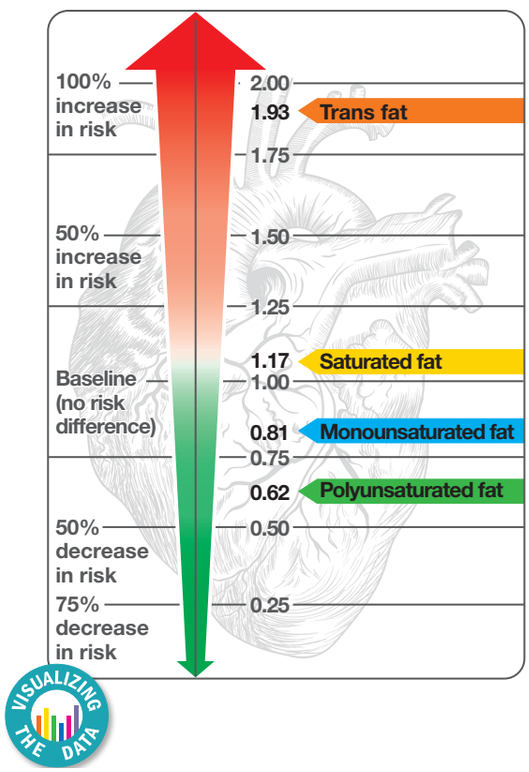
6. Which of the following variables has the least impact on the relative risk for coronary heart disease? Use Figure 3.9 on page 45 of your textbook.

   a. Saturated fat

   b. Trans fat

   c. Monounsaturated fat

   d. Polyunsaturated fat

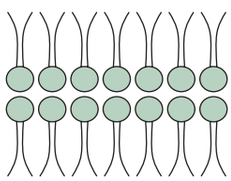


7. Use the same figure from question 6 to answer the following question. What was the increased risk of heart disease associated with a diet high in trans fats?
The data indicate that for every 2% increase in the amount of energy consumed in the form of trans fat that there is a 93% increased risk of heart disease.

8. A cell's membrane consists, in large part, of a molecule called a "phospholipid." Does a phospholipid "love" or "fear" water? Briefly explain your answer.
Phospholipids have regions that are polar and thus hydrophilic, and regions that are nonpolar and thus hydrophobic. This property is known as amphipathic.

9. Cholesterol is used within the cell's membrane and as a precursor to other steroids synthesized by cells.

10. Students, when asked to diagram a simple cell membrane, often draw the structure below. What is wrong with this structure? In other words, why is it incorrect?



This diagram is incorrect because the polar heads are facing each other. This arrangement would create a hydrophobic barrier on either side of the cell rather than an inner hydrophobic core.

11. Which of the following is a risk associated with the use of anabolic steroids?

a. Breast enlargement in men

b. Shrunken testicles

c. Reduced sex drive

d. All of the above

Big Idea: Proteins

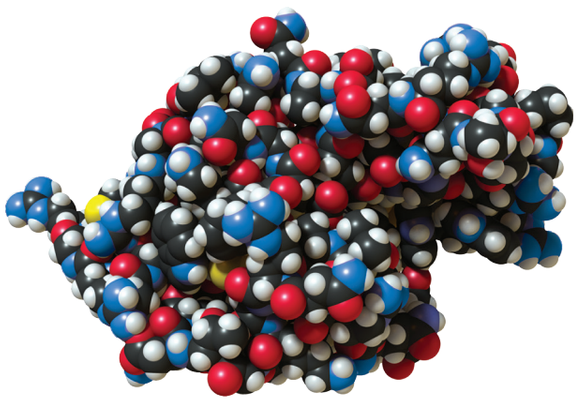
Answer the following questions as you read Modules 3.12–3.14:

1. True or false: Proteins are the most diverse class of biological molecules in terms of their functions and structures. If false, make it a correct statement.
   True

2. Regardless of its specific function, a protein's function is absolutely dependent upon its _____shape_____.

3. Prions are denatured/misfolded proteins that cause progressive degeneration of the brain and ultimately lead to death. Mad cow disease is an example of a disease caused by prions. People believe that cooking meat tainted with prions will make it safe to eat as the prions will be killed by the high heat. Unfortunately, that is not true. Briefly explain why it makes sense that high heat will not cause prions to stop causing brain disease.
   Cooking meat that has been tainted with prions is ineffective because prions are already denatured proteins. Heating them further does nothing because they are already denatured.

4. Would the following protein be globular or fibrous? Use Figure 3.12B from page 47 of your textbook.



   The protein in that figure (lysozyme) would be globular.

5. _____ are the monomers from which large proteins are constructed.

   a. Polymers

   b. Amino acids

   c. Polypeptides

   d. Peptide bonds

6. You are a biochemist working for a pharmaceutical company. You are identifying a new molecule that you have isolated from a species of bat. You determine that the molecule contains a carboxylic acid group and a group of atoms that would give the molecule unique hydrophobic properties at a specific region of the molecule. The power goes out before you can finish your analysis. Based on what you know so far, what kind of molecule is it? What else might you have learned from it if the power had not gone out?
   The molecule is likely an amino acid. You would likely find an amino group.

7. A polypeptide is 107 amino acids in length. How many water molecules were removed during synthesis of the protein?
   106

8. Protein shape is crucial to its proper function. Students have difficulty grasping this idea and how the specific sequence of amino acids determines the shape and how that, in turn, affects protein function. As an example, sickle cell disease is a lethal disorder caused by just a single amino acid change in the primary structure of the protein hemoglobin. Briefly explain how the words *tasty* and *nasty* can serve as a good analogy for a teacher trying to explain this concept to students.
   The word *tasty* has a specific meaning; it likely conjures up images of certain foods in your mind. If you change just one letter in the word *tasty* (the *t* to an *n*), then you change the meaning of the word, and it conjures up an entirely different set of foods. The primary sequence is like this. If you change even one amino acid, it can have several ramifications.

9. Complete the table that compares the different levels of protein structure.

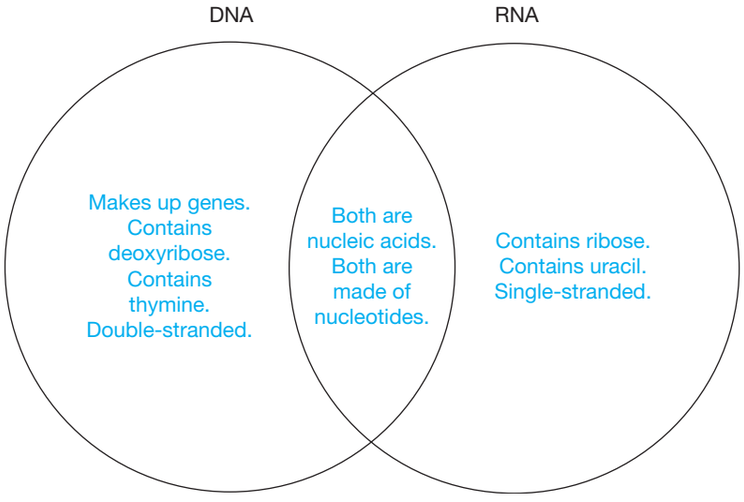
	Primary	Secondary	Tertiary	Quaternary
Description	The sequence of amino acids that make up the protein	The growing polypeptide begins to take specific secondary shapes, like the alpha helix or the beta-pleated sheet.	The final level of structure for a protein that consists of a single polypeptide; the polypeptide achieves its final shape and thus gains function.	The final level of structure for a protein that consists of more than one polypeptide; the polypeptide achieves its final shape and thus gains function.

Big Idea: Nucleic Acids

Answer the following questions as you read Modules 3.15–3.16:

1. A(n) _____gene_____ is considered to be the unit of inheritance, which is actually made of _____DNA_____.

2. Complete the Venn diagram that compares DNA with RNA.



3. Transcription of a _____ results in a molecule of _____.

   a. RNA: DNA

   b. gene: RNA

   c. cytoplasm: gene

   d. nucleus: DNA

4. List the three molecular components that all nucleotides have:
   Phosphate group, pentose (five-carbon sugar), and a nitrogenous base

5. You are analyzing a sample of a nucleic acid and determine that the sample contains the nitrogenous base adenine. Are you able to determine if the sample is DNA or RNA? Briefly explain your answer.
   No, you cannot determine either way because adenine can be found in either DNA or RNA. You would need to know what the sugar is or if it contained uracil or thymine.

6. What would be the complementary sequence to this strand of DNA?

   AGGCGATATAC
   TCCGCTATATG

7. Briefly explain how it was beneficial for northern Europeans to be lactose tolerant when lactose intolerance was normal.
   It allowed them to continue to consume dairy products where they could raise cattle in locations where it was hard to raise crops because of the climate.

CONNECTING THE BIG IDEAS

Use your knowledge of the information contained within this chapter's "Big Ideas" to answer this question.

You go out to dinner with your best friend. During dinner you consume the following meal: spinach greens with sunflower seeds, a Dr. Pepper™, and a piece of unbuttered French bread. Identify the biological molecules that would likely be present and what they would be processed/digested into after they are consumed.

