

# Biological Molecules

What are the building blocks of life?

## Why?

From the smallest single-celled organism to the tallest tree, all life depends on the properties and reactions of four classes of **organic** (carbon-based) compounds—**carbohydrates**, **lipids**, **proteins**, and **nucleic acids**. These organic molecules are the building blocks of all living things, and are responsible for most of the structure and functions of the body, including energy storage, insulation, growth, repair, communication, and transfer of hereditary information. Simple organic molecules can be joined together to form all the essential biological molecules needed for life.

## Model 1 – Molecules of Life

Carbohydrates (monosaccharides)		
Glucose	Galactose	Fructose
Lipids		
Glycerol	Fatty acids	Triglyceride (fat or oil)
Proteins (amino acids)		
Alanine	Cysteine	Amine group Variable R side chain Carboxylic acid group
Nucleic acids (nucleotides)		
Phosphate group	Sugar	Nitrogen base

1. Use Model 1 to show which atoms are present in each type of molecule by listing the symbol for each atom included. Carbohydrate has been done for you.

a. Carbohydrate—C, H, O

c. Amino acid—C, H, O, N

b. Lipid—C, H, O

d. Nucleic acid—C, H, O, N, P

2. Which type of molecule includes an example with a long-chain carbon backbone?

*Lipid.*

3. In the molecule referred to in the previous question, what is the dominant element attached to the carbon backbone?

*Hydrogen.*

4. The fatty acid chain of the lipids is often referred to as a hydrocarbon chain. Discuss with your group why the chain is given this name and write a one-sentence definition for a hydrocarbon.

*A hydrocarbon has a central chain of carbon atoms with hydrogen atoms attached to the carbon.*

5. Which molecule has a central carbon atom with four different components around it?

*Amino acid.*

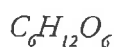
6. Which molecule has a sugar, nitrogenous base, and phosphate group?

*Nucleic acid.*

7. Discuss with your group members some similarities among all four types of molecules. List as many as you can.

*Answers will vary but students should see that all contain C, H, O.*

8. What is the chemical formula of the first carbohydrate molecule shown?



9. What three structural groups shown do all amino acids have in common?

*Amine group, carboxylic acid, and R side chain.*

10. There are 20 naturally-occurring amino acids, and each one only varies in the structure of the R side chain. Two amino acids are shown in Model 1. What are the R side chains in each?

*CH<sub>3</sub> and CH<sub>2</sub>-SH*

## Read This!

During chemical reactions, the bonds in molecules are continually broken and reformed. To break a bond, energy must be absorbed. When bonds are formed, energy is released. If more energy is released than absorbed during a chemical change, the process can be used as a source of energy. A general rule for processes such as respiration is the more carbon atoms there are in a molecule, the more energy that molecule can provide to the organism when it is used as food.

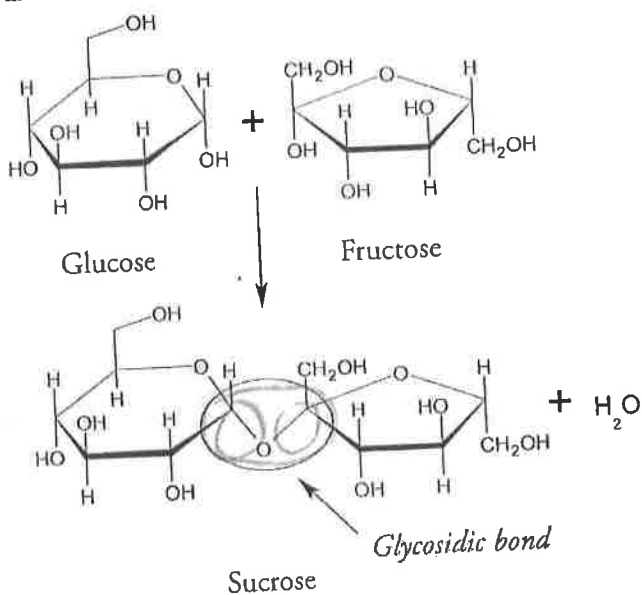
11. Using the information from above, is a carbohydrate or a lipid more likely to be a good source of energy for an organism?

*Lipids. Students should be able to determine that the long hydrocarbon has many more C—C and C—H bonds, which are all a source of energy.*

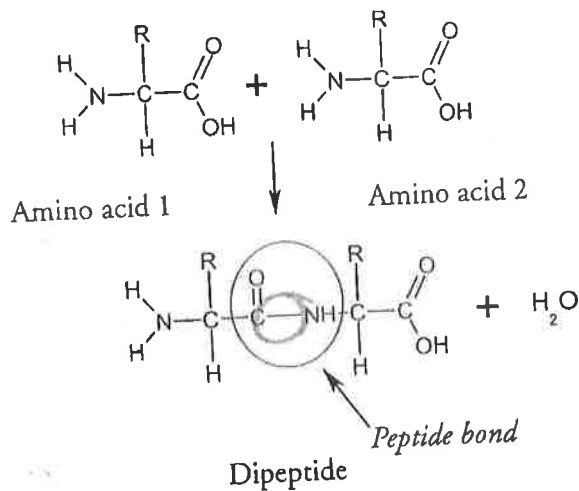


## Model 2 – Biochemical Reactions

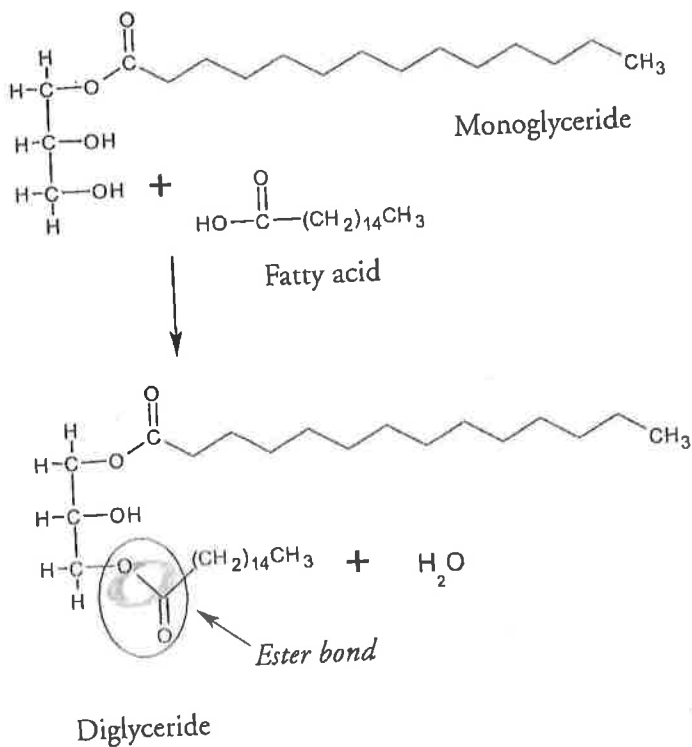
A.



B.



C.



12. What are the reactants of reaction A?

*Glucose and fructose.*

13. What are the products of reaction A?

*Sucrose and water.*

14. Each of the reactants in reaction A is a single sugar molecule, also called a monosaccharide. What prefix before saccharide would you use to describe sucrose?

*Di-*

15. What are the reactants of reaction B?

*Two amino acids.*

16. When the two molecules in reaction B are joined together, what other two molecules are produced?

*Water and a dipeptide.*

~~17.~~ What product do all three reactions in Model 2 have in common?

*They all produce water.*



## Read This!

When sugars are joined together the new bond that forms is a **glycosidic** bond. When amino acids are joined the new bond that forms is a **peptide** bond. When fatty acids are joined to a glycerol the bond that holds them is an **ester** bond.

~~18.~~ On the diagrams in Model 2, circle and label the glycosidic, peptide, and ester bonds.

*See Model 2.*



19. These reactions are all referred to as **dehydration synthesis** or condensation reactions. With your group develop an explanation for why these terms are used to describe these reactions.

*All the reactions cause water to be removed, therefore, the molecule is dehydrated or water is "condensed" from the molecule.*

~~20.~~ These reactions can also be reversed, breaking the large molecule into its individual molecules. What substance would need to be added in order to reverse the reaction?

*Water.*

21. *Lysis* means to split or separate. What prefix would you add to lysis to mean separate or split using water?

*Hydro-*

22. Using your answers to the previous two questions, what word is used to describe the reaction that uses water to break apart a large molecule?

*Hydrolysis.*

