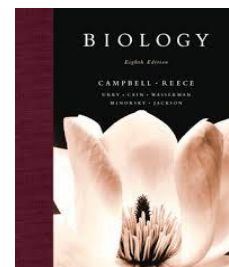




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Chapter 5 -



## The Structure and Function of Large Biological Molecules

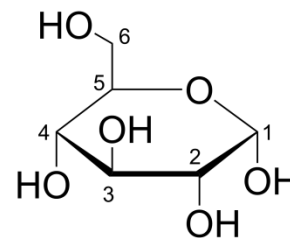
### Guided Reading

Concept 5.1: Macromolecules are polymers, built from monomers

1. The large molecules of all living things fall into just four main classes. Name them.
2. Circle the three classes that are called macromolecules. Define macromolecule.
3. What is a polymer? A monomer?
4. Monomers are connected in what type of reaction? What occurs in this reaction?
5. Large molecules (polymers) are converted to monomers in what type of reaction?
6. What role do enzymes play in the synthesis and breakdown of polymers?
7. The root words of hydrolysis will be used many times to form other words you will learn this year. What does each root word mean? Hydro-                      Lysis-
8. Consider the following reaction:  $C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11}$ 
  - a. The equation is not balanced; it is missing a molecule of water. Write it in on the correct side of the equation.
  - b. So, what kind of reaction is this?
  - c. Is  $C_6H_{12}O_6$  (glucose) a monomer, or a polymer?
9. To summarize, when two monomers are joined, a molecule of \_\_\_\_\_ is always removed.

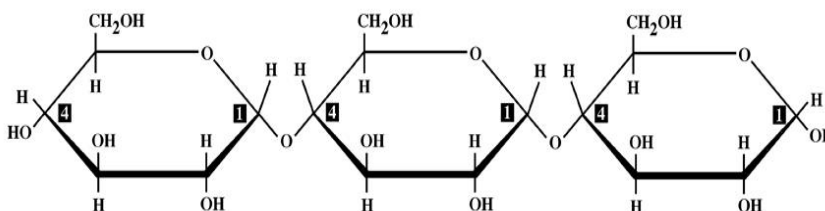
Concept 5.2: Carbohydrates serve as fuel and building material

10. Let's look at carbohydrates, which include sugars and starches. First, what are the monomers of all carbohydrates?
11. Most monosaccharides are some multiple of  $(CH_2O)$ . For example, ribose is a 5-carbon sugar with the formula  $C_5H_{10}O_5$ . It is a pentose sugar. (From the root penta-, meaning 5.) What is the formula of a hexose sugar?
12. Here are the three hexose sugars. Label each of them. Notice that all sugars have the same two functional groups. Name them:
  - a.  $C=O$  \_\_\_\_\_
  - b.  $-OH$  \_\_\_\_\_



13. What is the difference between an aldehyde sugar and a ketone sugar?
14. So, as a quick review, all of these sugars have the same chemical formula:  $C_6H_{12}O_6$ . What term did you learn in Chapter 3 for compounds that have the same molecular formulas but different structural formulas?
15. Here is the abbreviated ring structure of glucose. Where are all the carbons? Pay attention to the numbering system. This will be important as we progress in our study. Circle the number 3 carbon. Put a square around the number 5 carbon.
16. What is a glycosidic linkage?
17. Here is a molecule of starch, which shows 1-4 glycosidic linkages. Translate and explain this terminology in terms of carbon numbering.

### $\alpha$ 1-4 Bonds Between 3 Molecules of Glucose



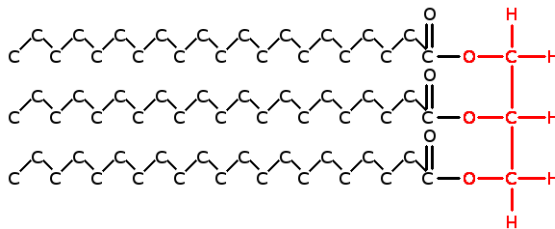
18. There are two categories of polysaccharides. Name them and give examples.
19. Why can you not digest cellulose? What organisms can?
20. Let's review some key points about the carbohydrates. Each prompt below describes a unique carbohydrate.

Name the correct carbohydrate for each.

- a. Has 1–4 B glucose linkages
- b. Is a storage polysaccharide produced by vertebrates; stored in your liver
- c. Two monomers of this form maltose
- d. Glucose + \_\_\_\_\_ form sucrose
- e. Monosaccharide commonly called “fruit sugar”
- f. “Milk sugar”
- g. Structural polysaccharide that gives cockroaches their crunch
- h. Malt sugar; used to brew beer
- i. Structural polysaccharide that comprises plant cell walls

Concept 5.3: Lipids are a diverse group of hydrophobic molecules

21. Lipids include fats, waxes, oils, phospholipids, and steroids. What characteristic do all lipids share?
22. What are the building blocks of fats? Label them on this figure.

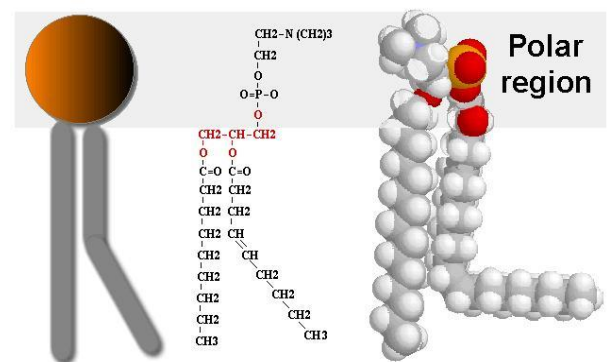


23. If a fat is composed of 3 fatty acids and 1 glycerol molecule, how many water molecules will be removed to form it? Again, what is this process called?
24. On the figure with question 22, label the ester linkages.
25. Draw a fatty acid chain that is 8 carbons long and is unsaturated. Circle the element in your chain that makes it unsaturated, and explain what this means.
26. Name two saturated fats. Name two unsaturated fats.
27. Why are many unsaturated fats liquid at room temperature?
28. What is a trans-fat? Why should you limit them in your diet?
29. List four important functions of fats.

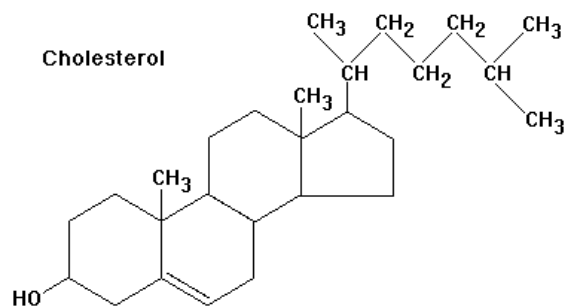
30. Here is a figure that shows the structure of a phospholipid. Label the sketch to show the phosphate group, the glycerol, and the fatty acid chains. Also indicate the region that is hydrophobic and the region that is hydrophilic.

31. Why is the “tail” hydrophobic? Answer in terms of the phospholipid bilayer as a whole.
32. Which of the two fatty acid chains in the figure with question 30 is unsaturated? Label it. How do you know it is unsaturated?

## Phospholipids



33. Some people refer to the cholesterol molecule, as seen to the right, as three hexagons and a doghouse. Where can cholesterol be found within an animal cell? Why is cholesterol such an important molecule in animals?



34. What are other examples of steroids?

35. Why are hormones considered lipids?

Concept 5.4: Proteins have many structures, resulting in a wide range of functions

36. Table 5.1 on page 76 is loaded with important information. Select any five types of proteins and summarize each type here.

| Type of Protein | Summary |
|-----------------|---------|
|                 |         |
|                 |         |
|                 |         |
|                 |         |
|                 |         |

37. Enzymes are an important type of protein. They will be studied in Chapter 8. For now, use this sketch to review what you know about enzymes. Label the active site, the substrate, and the products. Show what happens to water.

38. Is the reaction to the right dehydration synthesis or hydrolysis? How do you know?

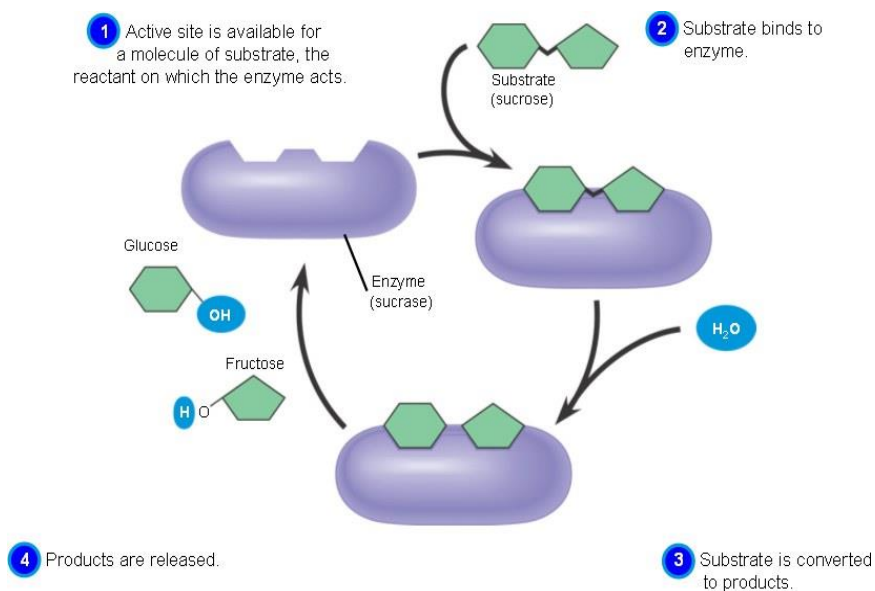
39. The monomers of proteins are amino acids. Sketch an amino acid here. Label the alpha or central carbon, amino group, carboxyl group, and R group.

40. What is represented by R? How many are there?

41. Study the figure. See if you can understand why some R groups are nonpolar, some polar, and others electrically charged (acidic or basic). If you were given an R group, could you place it in the correct group? Work on the R groups until you can see common elements in each category.

42. Refer to figure 5.18 on page 80 as you define these terms:

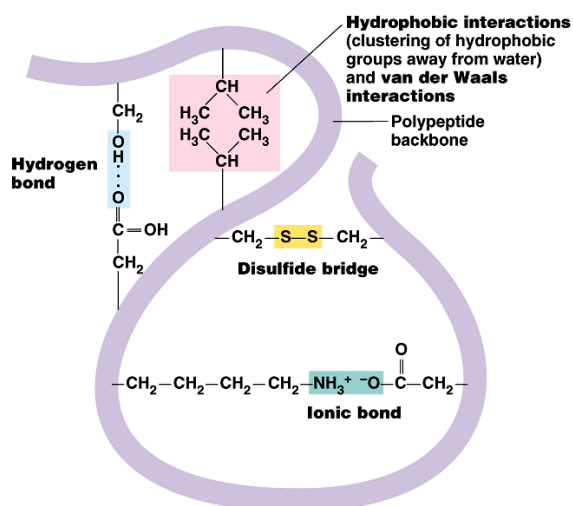
- dipeptide
- polypeptide
- peptide bond



43. There are four levels of protein structure. Refer to Figure 5.21, and summarize each level in the following table.

| Level of Protein Structure  | Basic Diagram | Explanation | Example |
|---|---------------|-------------|---------|
| Primary (I <sup>o</sup> )   |               |             |         |
| Secondary (II <sup>o</sup> )<br>Alpha helix<br>Beta pleated sheet |               |             |         |
| Tertiary (III <sup>o</sup> )                                      |               |             |         |
| Quaternary (IV <sup>o</sup> )                                     |               |             |         |

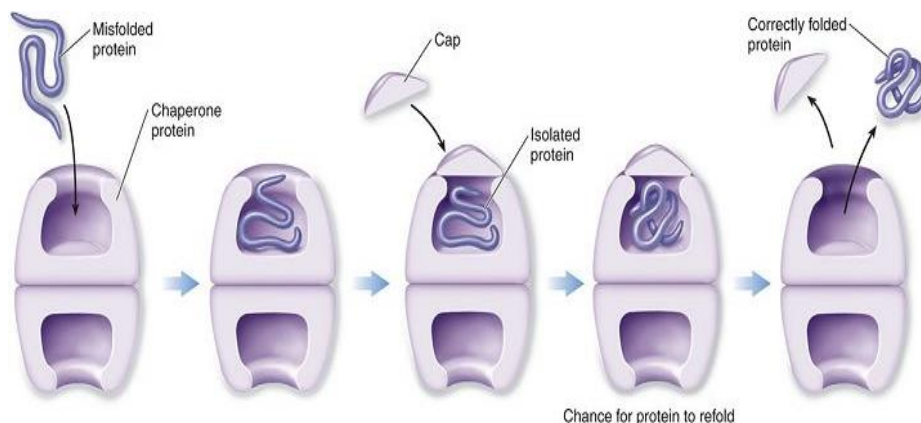
44. Enzymes are globular proteins that exhibit at least tertiary structure. Using the figure below, explain each interaction that folds this portion.



45. Do you remember when, in Chapter 4, we said, “Change the structure, change the function”? Explain how that principle applies to sickle-cell disease. Why is the structure changed?

46. Besides mutation, which changes the primary structure of a protein, protein structure can be changed by denaturation. Define denaturation, and give at least three ways a protein may become denatured.

47. Chaperone proteins or chaperonins assist in the proper folding of proteins. Annotate this figure to explain the process.



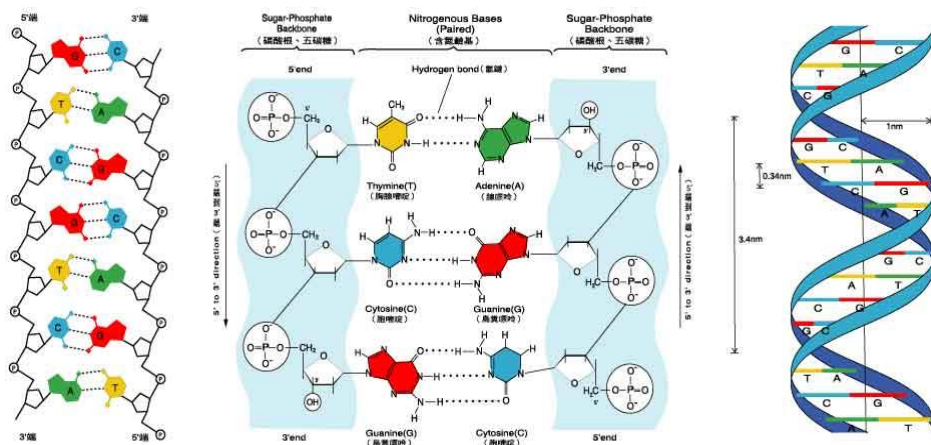
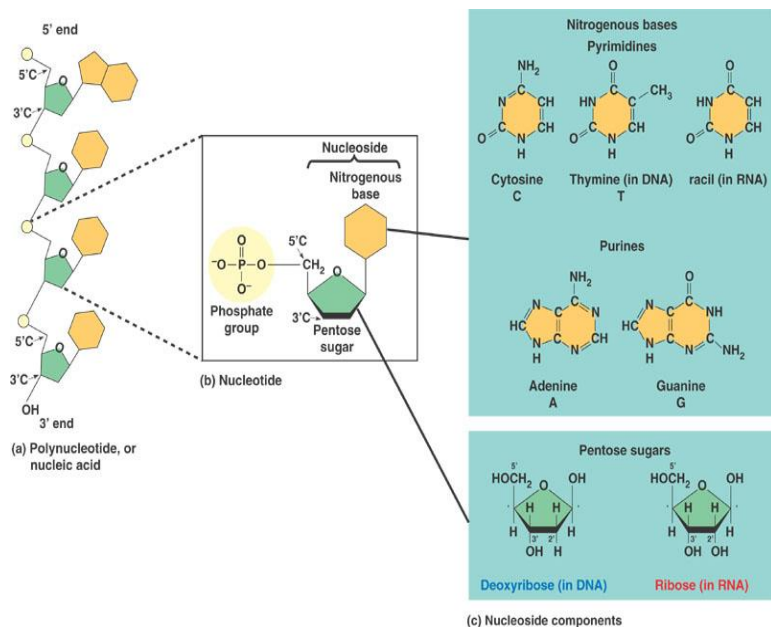
48. The flow of genetic information is from DNA → RNA → protein. Refer to figure 5.26 on page 87 to review the flow of genetic information from nucleus to ribosome. Make sure you remember the components of this general diagram.

49. I know you recall that the components of a nucleic acid are a sugar, a nitrogenous base, and a phosphate group. You should also recall that early in this chapter we looked at the numbering system for the carbons of a sugar. Why is one end labeled 5' and the other end of the chain 3'? What would the complimentary side be? In other words, would the opposite strand be 5' to 3' or 3' to 5'? Why?

50. Which four nitrogen bases are found in DNA? Which four are found in RNA? What are the base pairing rules for DNA? RNA?

51. How do ribose and deoxyribose sugars differ?

52. Why are the strands in a double helix said to be antiparallel?



## Testing Your Knowledge -Self Quiz Answers

1. \_\_\_\_\_  
 2. \_\_\_\_\_  
 3. \_\_\_\_\_  
 4. \_\_\_\_\_

5. \_\_\_\_\_  
 6. \_\_\_\_\_  
 7. \_\_\_\_\_

## Write About It –

- Comparisons of amino acid sequences can shed light on the evolutionary divergence of related species. If you were comparing two living species, would you expect all proteins to show the same degree of divergence? Why or Why not?
- Sometimes steroids are given for medical reasons and sometimes they are used by athletes. The health risks of steroids has been documented as well as studied. What is your opinion on steroid use?
- Proteins, which have diverse functions in a cell, are all polymers of the same subunits – amino acids. Explain how the structure of amino acids allows this one type of polymer to perform so many functions.
- What questions, if any, do you have regarding the material covered in this chapter?