

Name _____ Period _____

Chapter 5: The Structure and Function of Large Biological Molecules

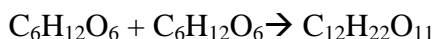
Concept 5.1 Macromolecules are polymers, built from monomers

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. 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

7. Consider the following reaction:

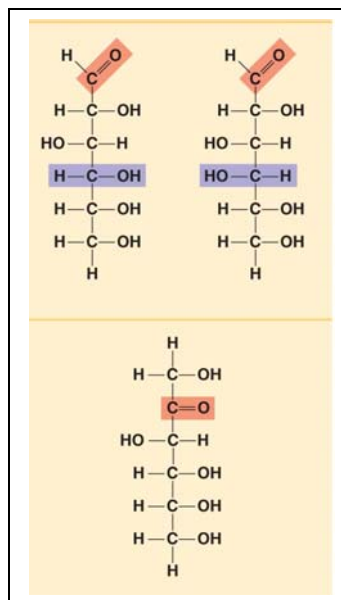


- a. The equation is not balanced; it is missing a molecule of water. Write it in on the correct side of the equation.
- b. So, what kind of reaction is this?
- c. Is $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) a monomer, or a polymer?
- d. To summarize, when two monomers are joined, a molecule of _____ is always removed.

Concept 5.2 Carbohydrates serve as fuel and building material

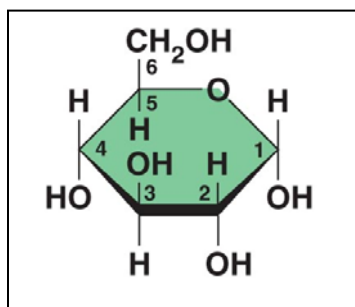
8. Let's look at carbohydrates, which include sugars and starches. First, what are the monomers of all carbohydrates?
9. Most monosaccharides are some multiple of (CH_2O) . For example, ribose is a 5-carbon sugar with the formula $\text{C}_5\text{H}_{10}\text{O}_5$. It is a pentose sugar. (From the root *penta-*, meaning 5.) What is the formula of a hexose sugar?
10. Here are the three hexose sugars. Label each of them. Notice that all sugars have the same two functional groups. Name them:

$\text{C}=\text{O}$ _____
 $-\text{OH}$ _____



11. What is the difference between an *aldehyde sugar* and a *ketone sugar*?
12. So, as a quick review, all of these sugars have the same chemical formula: $\text{C}_6\text{H}_{12}\text{O}_6$. What term did you learn in Chapter 3 for compounds that have the same molecular formulas but different structural formulas?

13. 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.

14. Let's look at our reaction in question 7 again: $C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$

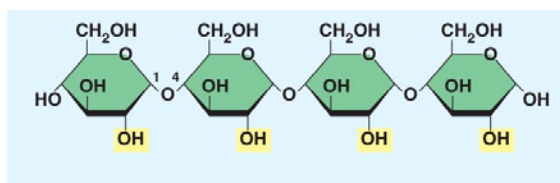
Notice that two monomers are joined to make a polymer. Since the monomers are monosaccharides, the polymer is a *disaccharide*. Three disaccharides are important to us with the formula $C_{12}H_{22}O_{11}$. Name them below and fill out the chart.

Disaccharide	Formed from which two monosaccharides?	Found where?

15. Have you noticed that all the sugars end in *-ose*? This root word means _____.

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.



18. There are two categories of *polysaccharides*. Name them and give examples.

Type of Polysaccharide	Examples

19. Why can you not digest cellulose? What organisms can?

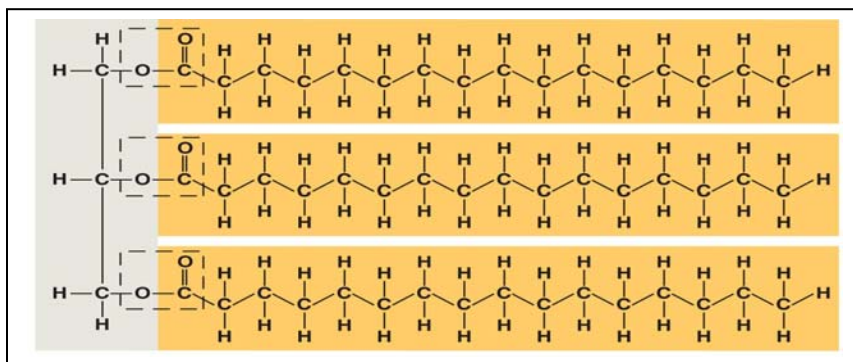
20. Let's review some key points about the carbohydrates. Each prompt below describes a unique carbohydrate. Name the correct carbohydrate for each.

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

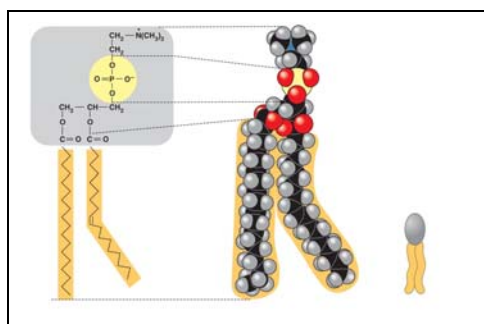
Concept 5.3 Lipids are a diverse group of hydrophobic molecules

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.

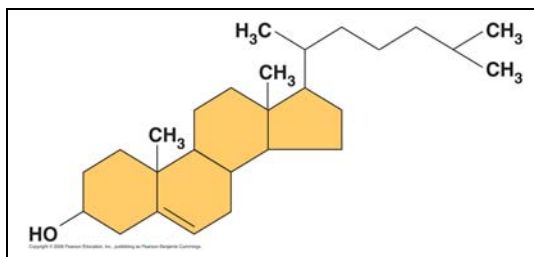


23. If a fat is composed of 3 fatty acids and 1 glycerol molecule, how many water molecules will be removed to form it? Again, what is this process called?
24. On the figure with question 22, label the ester linkages.
25. Draw a fatty acid chain that is 8 carbons long and is *unsaturated*. Circle the element in your chain that makes it unsaturated, and explain what this means.
26. Name two saturated fats.
27. Name two unsaturated fats.
28. Why are many unsaturated fats liquid at room temperature?
29. What is a *trans fat*? Why should you limit them in your diet?
30. List four important functions of fats.
31. 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*.



32. Why is the “tail” hydrophobic?

33. Which of the two fatty acid chains in the figure with question 31 is unsaturated? Label it. How do you know it is unsaturated?
34. To summarize, a phospholipid has a glycerol attached to a phosphate group and two fatty acid chains. The head is hydrophilic, and the tail is hydrophobic. Now, sketch the phospholipid bilayer structure of a plasma membrane. Label the hydrophilic heads, hydrophobic tails, and location of water.
35. Study your sketch. Why are the tails all located in the interior?
36. Some people refer to this structure as three hexagons and a doghouse. What is it?



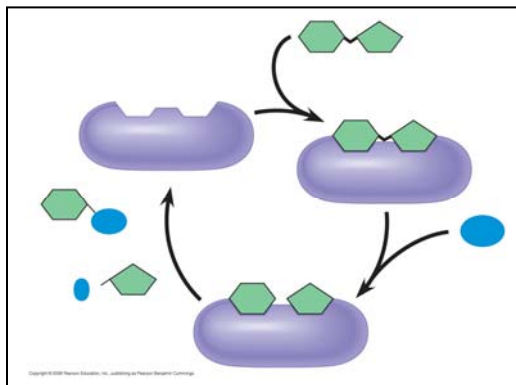
37. What are other examples of steroids?

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

38. Table 5.1 is loaded with important information. Select any five types of proteins and summarize each type here.

Type of Protein	Function	Example

39. *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.

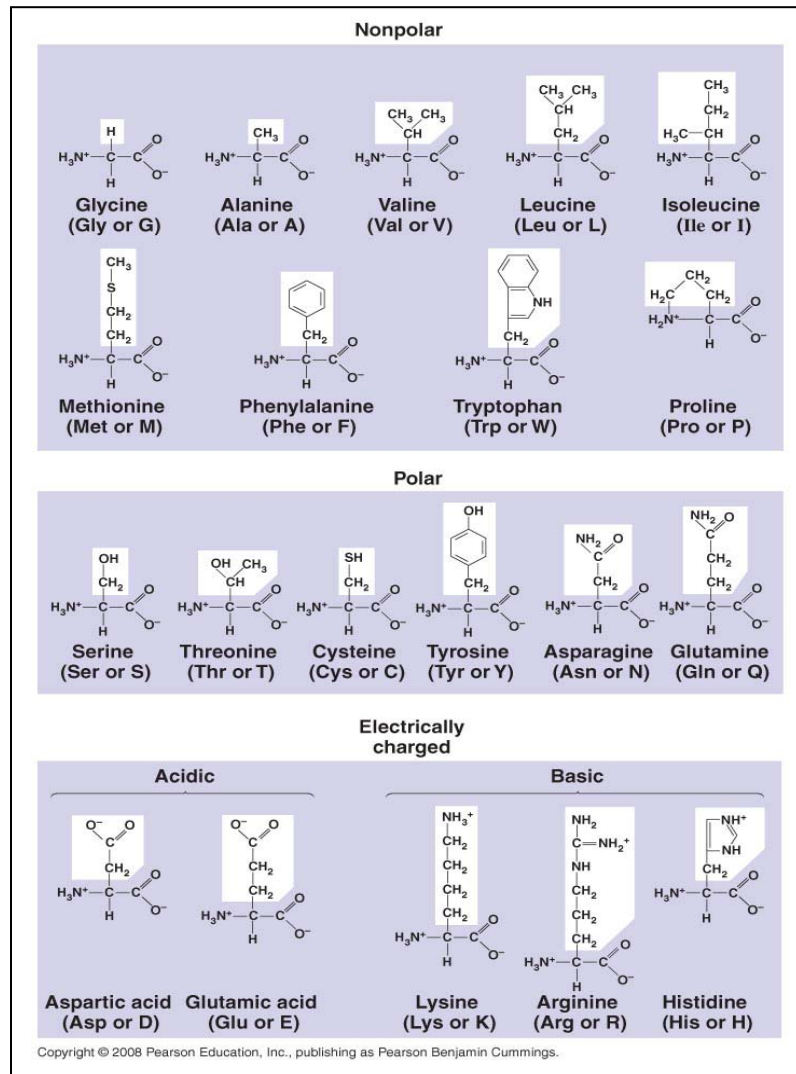


40. Is this reaction dehydration synthesis or hydrolysis?

41. 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*.

42. What is represented by *R*? How many are there?

43. 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.

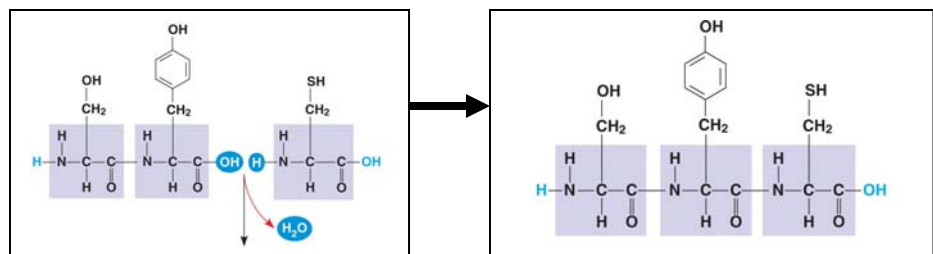


44. Define these terms:

dipeptide

polypeptide

peptide bond

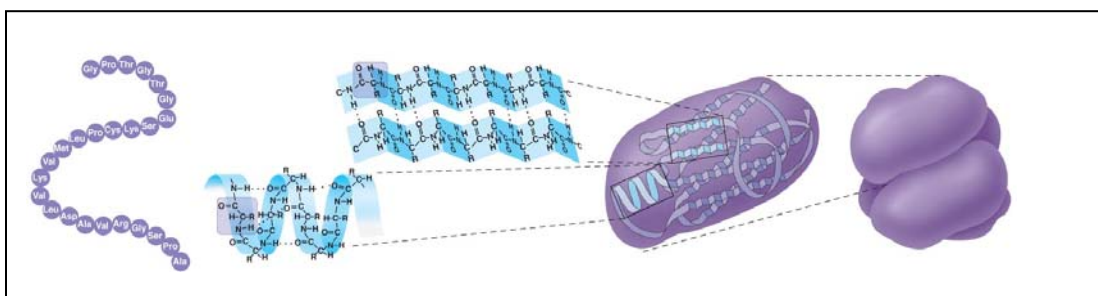


Label each of these terms on the diagrams.

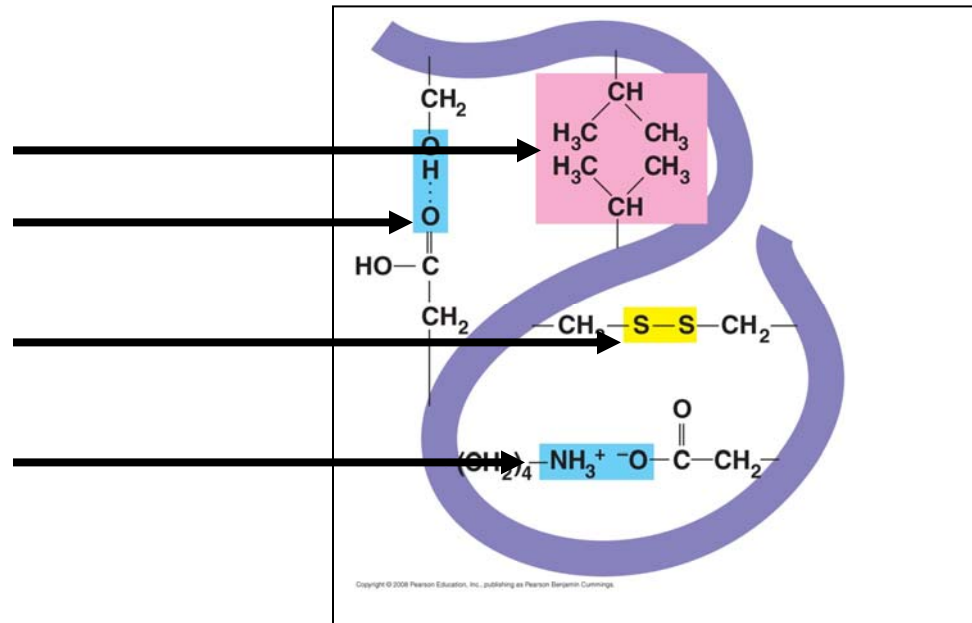
45. There are four levels of protein structure. Refer to Figure 5.21, and summarize each level in the following table.

Level of Protein Structure	Explanation	Example
Primary (I ^o)		
Secondary (II ^o) <i>Alpha helix</i> <i>Beta pleated sheet</i>		
Tertiary (III ^o)		
Quaternary (IV ^o)		

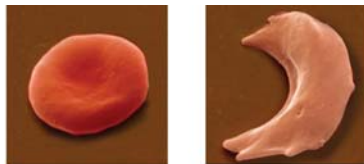
46. Label each of the levels of protein structure on this figure.



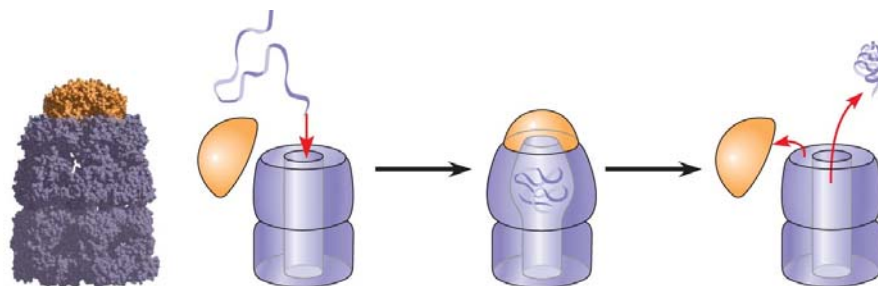
47. Enzymes are globular proteins that exhibit at least tertiary structure. On this figure, identify and explain each interaction that folds this portion.



48. 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?



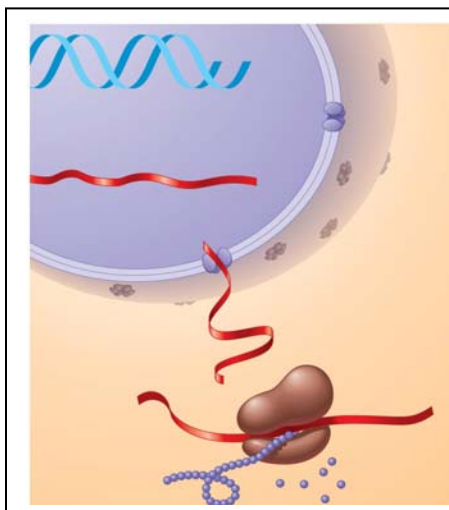
49. Besides mutation, which changes the primary structure of a protein, protein structure can be changed by denaturation. Define *denaturation*, and give at least three ways a protein may become denatured.
50. *Chaperone proteins* or *chaperonins* assist in the proper folding of proteins. Annotate this figure to explain the process.



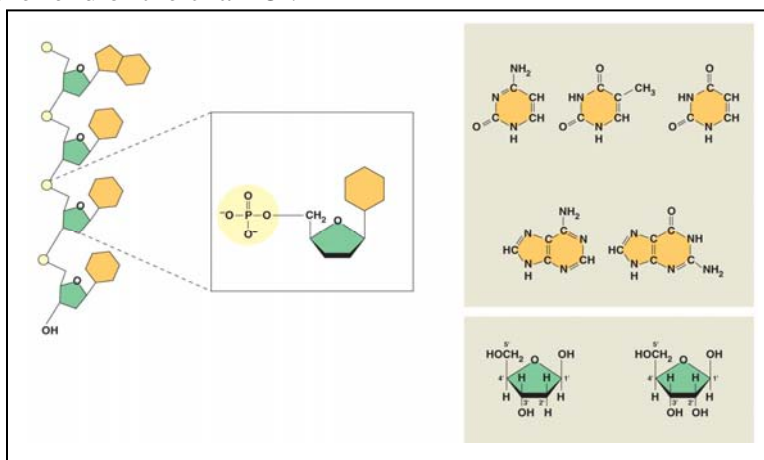
Concept 5.5 Nucleic acids store and transmit hereditary information

DNA and RNA will be the core topics of Chapter 17. For now, you should just review the general functions and know the components.

51. The flow of genetic information is from DNA \rightarrow RNA \rightarrow protein. Use this figure to explain the process. Label the *nucleus*, *DNA*, *mRNA*, *ribosome*, and *amino acids*.



52. The components of a nucleic acid are a *sugar*, a *nitrogenous base*, and a *phosphate group*. Label each on the figure below.
53. You may recall that early in this chapter we looked at the numbering system for the carbons of a sugar. Label the end of the strand on the left side of the figure below that has the number 5 sugar **5'** and the other end of the chain **3'**.



54. Notice that there are five nitrogen bases. Which four are found in DNA?
55. Which four are found in RNA?
56. How do ribose and deoxyribose sugars differ?
57. To summarize, what are the three components of a nucleotide?
58. Here is a model of DNA, which was proposed by James Watson and Francis Crick. What is this shape called?



59. Why are the strands said to be *antiparallel*?
60. What two molecules make up the “uprights”?

61. What molecules make up the rungs?

62. For the two nucleotides of DNA below, provide the complementary base.

A —

C —

63. In a DNA double helix, a region along one DNA strand has this sequence of nitrogenous bases:

5'-T A G G C C T-3'

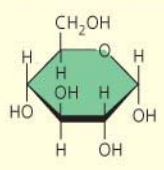


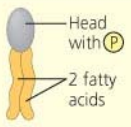
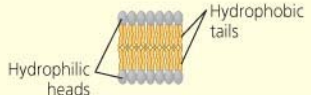
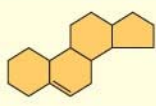
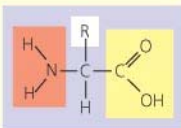
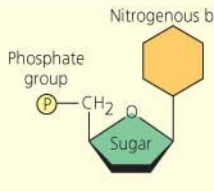


Write the complementary strand. Indicate the 5' and 3' ends of the new strand.

Testing Your Knowledge: Self-Quiz Answers

Now you should be ready to test your knowledge. Place your answers here:

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____

This summary table from the Chapter 5 Review is an excellent study tool. Use it to organize material from this chapter in your mind.

Large Biological Molecules	Components	Examples	Functions	
Concept 5.2 Carbohydrates serve as fuel and building material	 <p>Monosaccharide monomer</p>	Monosaccharides: glucose, fructose Disaccharides: lactose, sucrose Polysaccharides: <ul style="list-style-type: none"> • Cellulose (plants) • Starch (plants) • Glycogen (animals) • Chitin (animals and fungi) 	Fuel; carbon sources that can be converted to other molecules or combined into polymers <ul style="list-style-type: none"> • Strengthens plant cell walls • Stores glucose for energy • Stores glucose for energy • Strengthens exoskeletons and fungal cell walls 	
	Concept 5.3 Lipids are a diverse group of hydrophobic molecules and are not macromolecules	Glycerol  <p>3 fatty acids</p>	Triacylglycerols (fats or oils): glycerol + 3 fatty acids	Important energy source 
	 <p>Head with P 2 fatty acids</p>	Phospholipids: phosphate group + 2 fatty acids	Lipid bilayers of membranes  <p>Hydrophilic heads Hydrophobic tails</p>	
 <p>Steroid backbone</p>	Steroids: four fused rings with attached chemical groups	<ul style="list-style-type: none"> • Component of cell membranes (cholesterol) • Signals that travel through the body (hormones) 		
Concept 5.4 Proteins have many structures, resulting in a wide range of functions	 <p>Amino acid monomer (20 types)</p>	<ul style="list-style-type: none"> • Enzymes • Structural proteins • Storage proteins • Transport proteins • Hormones • Receptor proteins • Motor proteins • Defensive proteins 	<ul style="list-style-type: none"> • Catalyze chemical reactions • Provide structural support • Store amino acids • Transport substances • Coordinate organismal responses • Receive signals from outside cell • Function in cell movement • Protect against disease 	
Concept 5.5 Nucleic acids store and transmit hereditary information	 <p>Nitrogenous base Phosphate group Sugar Nucleotide monomer</p>	DNA:  <ul style="list-style-type: none"> • Sugar = deoxyribose • Nitrogenous bases = C, G, A, T • Usually double-stranded 	Stores all hereditary information	
		RNA:  <ul style="list-style-type: none"> • Sugar = ribose • Nitrogenous bases = C, G, A, U • Usually single-stranded 	Carries protein-coding instructions from DNA to protein-synthesizing machinery	

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