Name: _____ **AP Biology**
Mr. Croft

Chapter 3 Active Reading Guide
Carbon and the Molecular Diversity of Life

Section 1

1. Make an electron distribution diagram of carbon. It is essential that you know the answers to these questions:

   a. How many valence electrons does carbon have? _____

   b. How many bonds can carbon form? _____

   c. What type of bonds does it form with other elements? _____

2. Carbon chains form skeletons. List here the types of skeletons that can be formed.

3. What is a *hydrocarbon*? Name two. Are hydrocarbons hydrophobic or hydrophilic?

4. Define *functional group*.

5. There are seven chemical groups important in biological processes that you should know. Using Figure 3.5 in your text, complete the following chart.

	Hydroxyl	Carbonyl	Carboxyl	Amino	Sulfhydryl	Phosphate	Methyl
Structure							
Example							
Functional Properties							

6. You will need to master the chart and the information in it. Using the functional groups above, see if you can answer the following prompts:

   a. —NH_2 _____

   b. Can form cross-links that stabilize protein structure _____

   c. Key component of ATP _____

   d. Can affect gene expression _____

   e. CH_3 _____

   f. Is always polar _____

   g. Determines the two groups of sugars _____

   h. Has acidic properties _____

   i. —COOH _____

   j. Acts as a base _____

Section 2

7. The large molecules of all living things fall into just four main classes. Name them.

8. Circle the three classes that are called *macromolecules* in #8. Define *macromolecule*.

9. What is a *polymer*? What is a *monomer*?

10. Monomers are connected in what type of reaction? What occurs in this reaction?

11. Large molecules (polymers) are converted to monomers in what type of reaction?

12. 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–

13. 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.
    $C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11}$

    b. Polymers are assembled and broken down in two types of reactions: *dehydration synthesis* and *hydrolysis.* Which kind of reaction is this?

    c. Is $C_6H_{12}O_6$ (glucose) a monomer, or a polymer? _____

    d. To summarize, when two monomers are joined, a molecule of _____ is always removed.

Section 3

14. Let's look at carbohydrates, which include sugars and starches. First, what are the monomers of all carbohydrates?

15. 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 five.) What is the formula of a hexose sugar?

16. Notice that all sugars have the same two functional groups. Name them:
    C=O

    –OH

17. What is the difference between an *aldehyde sugar* and a *ketone sugar*?

18. So, as a quick review, all hexose sugars have the same chemical formula: $C_6H_{12}O_6$. What is the term for compounds that have the same molecular formulas but different structural formulas?

19. Refer to Figure 3.8 (b) in your textbook showing 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.

20. Let's look at our reaction in question 14 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 have the formula $C_{12}H_{22}O_{11}$. Name them below and fill out the chart.

Disaccharide	Formed from Which Two Monosaccharides?	Found Where?

Have you noticed that all the sugars end in –*ose*? This root word means sugar.

21. What is a *glycosidic linkage*?

22. Refer to Figure 3.11 (b), which shows 1–4 glycosidic linkages. Translate and explain this terminology in terms of carbon numbering.

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

Type of Polysaccharide	Examples

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

25. 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 _____

Section 4

26. Lipids include fats, waxes, oils, phospholipids, and steroids. What characteristic do all lipids share?

27. What are the building blocks of *fats*?

28. If a fat is composed of three fatty acids and one glycerol molecule, how many water molecules will be removed to form it? Again, what is this process called?

29. What are ester linkages?

30. Name two saturated fats.

31. Draw a fatty acid chain that is eight carbons long and is *unsaturated*. Circle the element in your chain that makes it unsaturated, and explain what this means.

32. Name two unsaturated fats.

33. Why are many unsaturated fats liquid at room temperature?

34. What is a *trans fat*? Why should you limit them in your diet?

35. List four important functions of fats.

36. Why are the "tails" hydrophobic?

37. Which of the fatty acid chains in Figure 3.13 (b) in your textbook is unsaturated? How do you know it is unsaturated?

38. 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 hydrophilc heads, hydrophobic tails, and location of water.

39. Study your sketch. Why are the tails all located in the interior?

40. Refer to Figure 3.15 in your textbook. Some people refer to this structure as three hexagons and a doghouse. What is it?

41. What are other examples of steroids?

Section 5

42. Figure 3.16 is an important one! It shows many different functions of proteins. Select any five types of proteins and summarize each type here.

Type of Protein	Function	Example

43. 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*.

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

45. Study Figure 3.17 in your textbook. 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.

46. Define these terms:

Term	Definition
peptide bond	
dipeptide	
polypeptide	

47. There are four levels of protein structure. Refer to Figure 3.21, and summarize each level in the following table.

Level of Protein Structure	Explanation	Example
Primary		
Secondary		
α Helix		
β Pleated Sheet		
Tertiary		
Quaternary		

48. Enzymes are globular proteins that exhibit at least tertiary structure. As you study Figure 3.22 in your text, explain each interaction that folds this protein fragment.

49. Do you remember when we said, “To change the structure, change the function”? Explain how this principle applies to sickle-cell disease. Why is the structure changed?

50. 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.

51. Chaperone proteins or chaperonins assist in the proper folding of proteins. Explain the process.

Section 6

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

52. The flow of genetic information is from DNA → RNA → protein. Use Figure 3.25 to explain the process.

53. The components of a nucleic acid are a *sugar*, a *nitrogenous base*, and a *phosphate group*. Make a quick sketch of a nucleotide.

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. Here is a model of DNA, which was proposed by James Watson and Francis Crick. What is this shape called?

58. Why are the strands said to be *antiparallel*?

59. What two molecules make up the “uprights”?

60. What molecules make up the “rungs”?

61. 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.