AP Biology **Name:** **P:**

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

How to use this reading guide: Look over the entire reading guide—read each question to prepare yourself for reading the chapter. Read the chapter carefully and thoroughly. Make sure to look at all of the figures and pictures and read their captions. Then…answer the questions posed below.

Carbon—The Backbone of Biological Molecules

1. Draw a BRIEF diagram that shows how Carbon comes into a system and would get passed on to the snail. What form is the carbon in before it gets passed on? What form (s) is it in when it does get passed on?

2. What macromolecules are composed of carbon? What other atoms are bonded to carbon to make these molecules?

Carbon atoms can form diverse molecules by bonding to four other atoms

3. Draw picture of a carbon atom that shows the nucleus (with the correct number of protons and neutrons) and the electron shells with the correct number of electrons in each shell.
    a. What is unique about its electron arrangement? What does this mean about the type of bonds Carbon usually forms?

4. What is a tetrahedron? How is this related to carbon molecules?
    a. Compare the shape of methane (CH_4), ethane (C_2H_6) and ethylene (C_2H_4). How are they similar? How are they different?

    b. Why is the shape of molecules important?

5. Carbon Dioxide and Urea are two very simple organic compounds (okay….okay…so…carbon dioxide may actually be inorganic). Draw the structural formulas for Carbon Dioxide and Urea.
    a. How do both of these molecules show the tetravalence and versatility of carbon?

Molecular Diversity Arising from Carbon Skeleton Variation

6. Define the term "carbon skeleton."
    a. How can "carbon skeletons" differ from each other? How does this make carbon so versatile?

Functional groups are the parts of molecules involved in chemical reactions

7. Define the term "functional group."
    a. What are they responsible for? What does this really mean (think back to your chemistry classes---think about the types of reactions!!!!)?
    b. How do functional groups compare in DIFFERENT molecules? Why is this so COOL (cuz, it IS totally COOL!)?
        i. Give an example to illustrate "THE COOL"! (HINT: Think "roids").

8. Functional groups can modify the properties of organic molecules. In the table below, indicate whether each functional group is polar or non-polar, hydrophobic or hydrophilic, and whether it is soluble or insoluble identify the types of molecules these functional groups would be part of.

Functional Group	Polar? Non-Polar?	Hydrophilic? Hydrophobic?	Soluble in Water? Insoluble in Water? Soluble in Fat?	What types of molecules would you find it in? Give a SPECIFIC name for each one!
-OH (Hydroxyl)				
-C=O (Carbonyl)				
-COOH (Carboxyl)				
$-NH_2$ (Amino)				
-SH (Sulfhydryl)				
$-PO_4$ (Phosphate)				
$-CH_3$ (Methyl) (look this one up on the internet!)				

Most macromolecules are polymers, built from monomers

1. Define the terms polymer and monomer.
    a. Which of the four classes of macromolecules are polymers?

2. Condensation reactions (also known as dehydration synthesis) is the mechanism by which monomers are linked together to make a polymer. Explain why this reaction is a "condensation" reaction. Be sure to identify ALL of "parts" involved (functional groups, bonds, energy, etc…).
    a. Study Figures 3.6 and use it to help you explain.

3. What does the term "hydrolysis" refer to? Explain IN DETAIL.
    a. Why is this process important in the human body?

4. After you eat a slice of apple, which reactions must occur for the amino acid monomers in the protein of the apple to be converted into proteins of your body?
    a. So….are you REALLY what you eat?

5. There are thousands of different kinds of macromolecules and it is this diversity that makes cells, siblings, strangers, and species different from each other. Explain how this diversity could exist given that there is a very limited number of monomers (only 40-50!).

Carbohydrates serve as fuel and building material

6. Distinguish between monosaccharides, disaccharides, and polysaccharides.

7. For monosaccharides, give the following information…
    a. Greek root meanings
    b. General formula
        i. Use the general formula to solve each of the following
            1. n = 6 carbons
            2. n = 10 carbons
            3. n = 3 carbons
    c. Functional groups

d. Difference between an aldose and a ketose sugar
    i. Give an example of each.
e. Common sugar variants
f. The two IMPORTANT functions of monosaccharides. Explain these in detail.

8. What is a disaccharide? What is a “glycosidic linkage” and how is it involved?

9. For each of the disaccharides listed below, describe
    a. What two monosaccharides are linked to form it.
    b. Where is it found? What is it usually used for?
    c. Find a picture of the structure and draw it below.
        i. Maltose

        ii. Sucrose

        iii. Lactose

10. Polysaccharides are polymers of a few hundred to a few thousand monosaccharides linked together. How are the structure (“architecture”) and the function of polysaccharides determined? Explain.

11. What is starch?
    a. Find a picture of the structure of starch and draw it below. Make sure it shows the glycosidic linkages.

        i. What type of glycosidic linkages are seen in starch? Explain what this means.

    b. What is the purpose of starch? What does it do for a plant?
        i. Where is it found in a plant?
        ii. What types of plants and/or plant organs contain starch?
            1. Why are these important to humans?
            2. How do we use the starch we get from these plants?

12. What is glycogen? What other carbohydrate is it like? What do these two carbohydrates have in common?
    a. Where is glycogen stored in animals?
    b. What is its purpose?

13. Cellulose is a structural polysaccharide.
    a. Find a picture of the structure of starch and draw it below. Make sure it shows the glycosidic linkages.

        i. What type of glycosidic linkages are seen in starch? How is this different from starch? BE VERY SPECIFIC!!!!
            1. How does the structure of cellulose explain its function?

    b. What is the purpose of cellulose? What does it do for a plant?
        i. Where is it found in a plant?
            1. Why is it important to humans?
            2. What can break down cellulose? Where can these organisms be found?

14. What is an exoskeleton? What types of organisms have one? What is it made of?

<u>Lipids are a diverse group of hydrophobic molecules</u>

15. Lipids are not polymers and they are the most diverse class of macromolecules. What DO they all have in common?
    a. What is this property related to?

16. Fats are also known as triacyglycerols and are made of 1 glycerol bonded to 3 fatty acids.
    a. Draw a picture of a glycerol and a fatty acid.
        i. Idenitfy the functional groups in each molecule.
        ii. What type of bond holds the glycerol and fatty acids together? What is its specific name?
        iii. Describe how the structure of these molecules (when bonded to each other) make fats INSOLUBLE in water. Be sure to include the property of water that is involved!

17. Draw a picture of a triacylglyerol (triglyceride). What part of this molecule determines the "type" of fat you have? In what ways can this part differ to account for the variety of fats that exist?

18. CHEMICALLY, what is the difference between a saturated and an unsaturated fatty acid?
    a. Explain how this chemical difference accounts for the different physical appearance of fats vs. oils at room temperature.
    b. Give examples of "fats" and "oils" and identify the types of organisms that produce each.

19. Describe what "partially hydrogenated" means. Use a picture to show what is being done.
    a. What does this process do for food?
    b. How is this related to "trans" fats?

20. Now that I have scared you with heart disease and "trans" fats (MUUAAAHAHA MUUAAHAHAHA---insert evil laugh here), fats have kind or gotten a bad rap! Fats are also very useful to you. List and describe 3 very important functions of fat.
    a.

    b.

    c.

21. Draw a picture of a phospholipid.
    a. Label the: phosphate, glycerol, fatty acids
    b. Identify the hydrophilic and hydrophobic portions of the phospholipids. How do these parts explain the "ambivalence" and the production of a "bilayer" when phospholipids are placed in water?

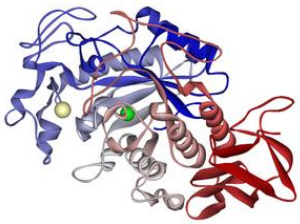
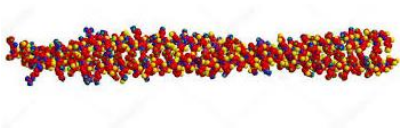
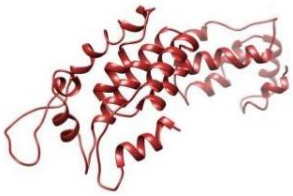
22. Cell membranes are made of phospholipids. Why is the membrane a bilayer? (be sure to talk about where "water" would be found.

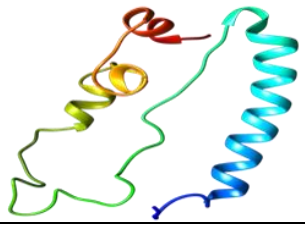
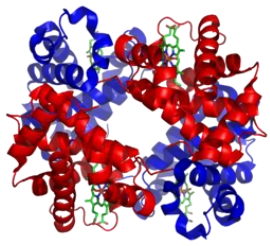
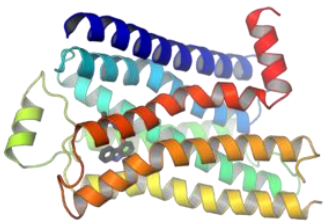
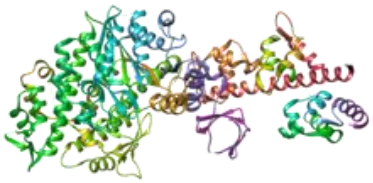
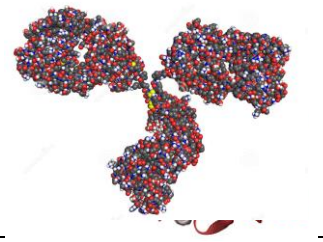
23. What are steroids? What is characteristic about their structure?
    a. Cholesterol is a very important steroid. Where you can find cholesterol in nature? Why is it important?

24. What is "atherosclerosis"? Explain what happens in this condition.
    a. Which type of "fats" contribute most significantly to this condition?

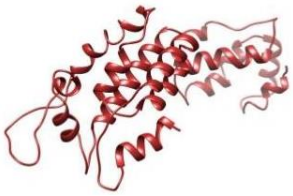
Proteins have many structures, resulting in a side range of functions

25. Proteins are VERY, VERY important molecules in the body. They make up 50% of the dry weight of most cells and have the most diverse functions. Study the Figure 3.16 on page 52 and use the information to complete the chart below.

Example	Picture	Type of Protein	Function
Amylase			
Keratin			
Casein			

Insulin			
Hemoglobin			
G-protein Receptor			
Myosin			
IgE Antibody			

26. Proteins are polymers made of amino acid monomers. Draw a picture of a “typical” amino acid in the space below. Label the: amino group, the carboxyl group, and the R-group or side chain.



a. Describe what properties the amino group give the molecule.
b. Describe what properties the carboxyl group gives the molecule.
c. For each of the "categories" of amino acids given below, draw one example and explain what features of the side chain give it the "category" property.

28a. Where would you expect to find each of these amino acids in a "globular" protein that is immersed in water?

1. Non-polar
2. Polar
3. Electrically charged

Acid:

Base:

27. Study figure 3.18 carefully! Describe what a peptide bond is and how it forms.

28. Why aren't the words "polypeptide" and "protein" synonymous? Explain how this is related to the protein's "functionality."

29. Structure being related to function is an important theme in biology. Explain how the structure of a protein is related to its function and how this usually involves other molecules.

30. Study Figure 3.21 very carefully!!! Use the information to complete the chart below. KNOW THIS VERY WELL!!!!!

Level of Protein Structure	Types of bonds involved? Which part of amino acid involved (C-terminus, N-terminus, Side Chain)?	Shape(s) made
Primary		
Secondary		
Tertiary		

Quaternary		

31. Sickle Cell Anemia is a disorder which causes red blood cells to "deform" and therefore lose their ability to carry oxygen. Explain how this is related to a change in the protein structure of hemoglobin. Be SPECIFIC—mention changes in primary structure (which amino acids?) and explain how the properties of these two amino acids are different; mention how the difference in these amino acids changes the secondary, tertiary and quaternary structure!

32. Define the term "denaturation." What does "denaturation" do to a protein's function?
    a. How and why do each of the following conditions cause denaturation?
        i. Moving a protein from a polar solvent (e.g. water) to a non-polar solvent (e.g. alcohol)

        ii. Heat (give two biological examples of when this might happen!)

        iii. placing a protein in a solution with a pH out of its "normal range."

<u>Nucleic acids store and transmit hereditary information</u>

33. Proteins are made from a "recipe" that is written in the language of nucleic acids. What are the two types of nucleic acids?
    a. How are DNA and RNA involved in "heredity"? What is each molecule's specific role in "passing on" information from one generation to the next?

    b. How do you summarize the flow of genetic information?

34. Draw a picture of a nucleotide and label the: phosphate, sugar, and nitrogenous base. Describe the chemical properties of each part (polar? Non-polar? Why? Hydrophilic? Hydrophobic? Why?).
    a. Based on these properties where would you expect to find each part of this molecule in an aqueous solution?

35. Distinguish between the terms nucleotide and nucleoside.

36. There are two “families” of nitrogenous bases: purines and pyrimidines. How are they different from each other. Look closely at figure 5.26. Which ones would be “longer” and why? Why do you think this might matter?

37. List the differences between DNA and RNA in structure.

38. Nucleic Acids are nucleotide polymers. Describe how each of the following is involved in the nucleic acid structure.
    a. Phosphodiester Linkage

    b. 3’ and 5’ ends (distinguish between them)

    c. base sequence (order of bases)

    d. double helix (what causes this?)

    e. antiparallel

    f. base pairing and complementarity

39. Explain how DNA and proteins may be “tape measures” of evolution.
    a. How would this support the statement that humans and gorillas are more closely related to each other than humans and frogs?