

General Biology: Cells and Molecules

Summer 2005

Week 1 Workshop **Answers**

1. Differentiate between primary, secondary, tertiary, and quaternary structures as they relate to proteins. If a protein is immersed in a pH solution far from its optimum, which structures are most likely to disassociate first, and why?

See Figure 3.6 in your text for diagrams of primary, secondary, tertiary, and quaternary structures. The quaternary structure is the least stable and breaks down first in non-optimum conditions. Protein structures continue to denature by unfolding the tertiary structures, then secondary structures. Primary structure is maintained by covalent bonds and is the last to break down. Disruptions in tertiary and quaternary structure are often reversible. Disruptions in primary or secondary structure are generally irreversible.

2. Dietary guidelines encourage people to stay away from saturated fats. What is meant by the term "saturated fat"? Why is this fat type of more concern than unsaturated fats in the diet? How are the two fats structurally different?

Saturated fats contain only single bonds and are "saturated" with hydrogen. This allows saturated fat molecules to pack together densely. This characteristic is easily seen in that most saturated fats are solid at room temperature. Unsaturated fats contain double bonds that affect the shape of the molecule. They are not "saturated" with hydrogens. This characteristic keeps them from packing together tightly, and they tend to be liquid at room temperature. Saturated fats are dangerous because of this "packing" ability.

3. Draw a phospholipid. What characteristics of phospholipids make them perfectly suited for membranes? What do you think might happen if phospholipids did not form a bilayer? How might they arrange themselves in an aqueous environment?

See Figures 3.20 and 3.21 in your book for drawings of phospholipids. The hydrophilic head and the hydrophobic tail of phospholipids allow them to have an "inside" that resists an aqueous environment and an "outside" that can reside in such an environment. When they exist as a bilayer, the hydrophobic tails aggregate together. If they did not exist in two layers the tails would still try to aggregate. This would result in a spherical aggregation of phospholipids called a micelle in which the tails are arranged toward the center of the sphere, away from the aqueous environment, and the heads are immersed in the aqueous environment.

4. Complex carbohydrates should be a mainstay of your diet. What properties make them excellent food sources?

Complex carbohydrates are easily broken down into glucose monomers, which provide nearly all cellular energy. By storing glucose monomers in large carbohydrates, the osmotic strain on any given cell is reduced without sacrificing availability of energy.

5. Discuss how a protein's three-dimensional structure makes it perfect for acting as a carrier and receptor molecule. Why are proteins uniquely suited for this function, whereas other macromolecules are not?

The three-dimensional nature of proteins allows them to form binding sites. These binding sites are uniquely shaped to interact with other molecules.

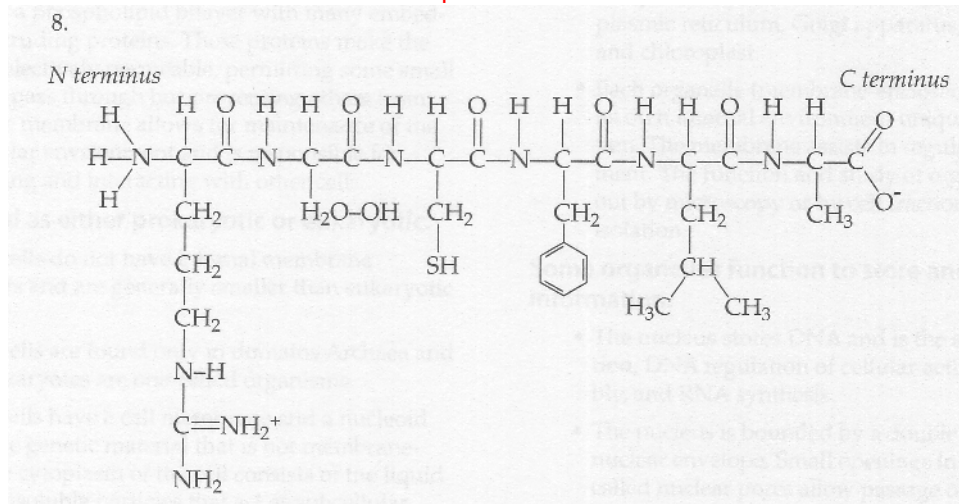
6. What properties of DNA structure make it well suited for its function as an informational molecule?

DNA structure is highly regular and conserved, which makes it usable by all cells, but the different bases allow it to encode specific genetic information.

7. Amino acid R groups have a variety of chemical properties. How do these different properties contribute to the final three-dimensional shape of the molecule?

The size of the R group, the charge of the R group, and any special binding properties all contribute to the final orientation of a protein molecule.

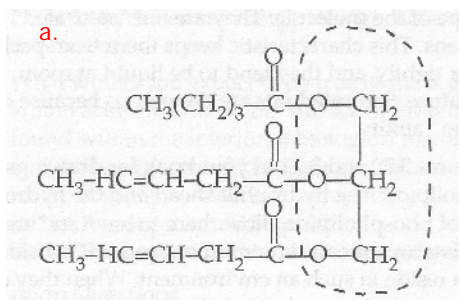
8. You have isolated a protein with the following amino acid sequence: RSCFLA. Using Table 3.2 in your book, draw this protein. In your drawing, label the N terminus and the C terminus and show all peptide linkages. How many water molecules were generated in the synthesis of this protein? **Five waters were lost and the protein would look like this:**



9. Explain how the pattern of charges in a macromolecule can affect its final form and function. You may use any of the four macromolecule classes to illustrate your point.

In proteins, for example, charge distribution affects folding, with hydrophobic regions turning inward and hydrophilic regions turning outward. Another excellent example is phospholipids. See the answer to Question 3.

10. Consider the triglycerides depicted below (A and B) in answering a-d.
- In B, circle the remnant of the glycerol portion of the triglyceride.
 - Which triglyceride (A or B) is probably a solid at room temperature? Explain your answer.
 - Which triglyceride (A or B) is probably derived from a plant? Explain your answer.
 - How many water molecules result from the formation of triglyceride B from glycerol and three fatty acids?



b. Triglyceride A is probably solid at room temperature; its fatty acid chains are saturated (no double bonds) and relatively long, both characteristics of solid, animal-derived triglycerides.

c. Triglyceride B is probably derived from a plant; its fatty acid chains are unsaturated (double bonds) and relatively short, both characteristics of liquid, plant-derived triglycerides.

d. Three water molecules will result. A water molecule results for each of the three fatty acids added to glycerol by a condensation reaction.

11. Use the base-pairing rules for DNA and RNA to label the complementary strand of RNA (right) to the single strand of DNA (left) shown following, where C = cytosine, G guanine, A = adenine, T = thymine, and U = uracil. Circle and label an example of a nucleotide and a nucleoside in the figure showing the double-stranded DNA and RNA hybrid. Based on the orientation of the sugar molecules, label the four ends of the molecule as 3' or 5' in the figure showing the double-stranded DNA and RNA hybrid.

