

Chapter 3 Project

A Tale of Four Carbs

Project Goal + Timeline

This three-part project will review your knowledge of biomolecule structure by modeling four carbohydrates using pipe cleaners and beads. Then, as a group or individually, you will consider the limitations of using the same modeling system—pipe cleaners and beads—for modeling other classes of biomolecules. Finally, you will apply what you’ve learned to complete a dehydration/hydrolysis puzzle.

This project should be completed by yourself or in a group of two within a two-hour time frame.

Directions

Part 1: Build Four Carbohydrate Models

For carbohydrate #1, select ten beads of the same color. String those beads onto a pipe cleaner. Bend the ends to secure the beads. The full-beaded pipe cleaner is your carbohydrate #1. Use your knowledge of biomolecular structure, especially the relationship between monomer and polymer, to answer the following questions about your model.

1. Of the following list, which object from your model best represents a monomer? Select the correct answer.
 - a. the individual beads
 - b. the full-beaded length of the pipe cleaner
 - c. the pipe cleaner
 - d. This model does not have an object representing a monomer.
2. In assembling your polymer, have you better demonstrated a dehydration reaction or a hydrolysis reaction? Explain your answer.

Now, suppose instead you wished to demonstrate the other reaction—dehydration or hydrolysis—what action could you take with your model to do so? Be sure to answer using complete sentences.

Next, use a small piece of masking tape to label carbohydrate #1 as “Starch.” Knowing now that this carbohydrate #1 represents starch, answer the following questions.

3. Which of the following *best* describes starch? Select the correct answer.
 - a. Starch is a type of carbohydrate called a polymer.
 - b. Starch is a type of nucleic acid called a galactose.
 - c. Starch is a type of carbohydrate called a polysaccharide.
 - d. Starch is a type of nucleic acid called a polymer.
4. Which bead color did you choose for building your polymer? Different bead colors will represent different types of monosaccharides. If this molecule is starch, what kind of monosaccharide does this specific bead color now stand for?
5. Assign this bead color to the correct monosaccharide in Table 1. Then assign the other two bead colors to the remaining monosaccharides.

TABLE 1: Monosaccharides Represented by Bead Color

Monosaccharides	Bead Color
glucose	
galactose	
fructose	

For carbohydrate #2, consider a different, albeit similar, kind of carbohydrate—amylopectin. Review the structural differences between starch and amylopectin. Then, using pipe cleaners and beads, build a second model to represent an amylopectin polymer. (Hint: Feel free to use more than one pipe cleaner if necessary. Also, be sure to use the correct bead color.) Use a small piece of masking tape to label your model “Amylopectin.”

Then, answer the following questions pertaining to your model.

6. Describe a shape difference between amylopectin compared to the starch. Explain how you achieved this difference using the materials provided.

7. Come up with one aspect of this model that remains unchanged.

For carbohydrate #3, start by cutting a pipe cleaner into pieces about 2 inches long. Consider how a disaccharide differs in structure from starch and amylopectin. Review the structural differences between disaccharides and polysaccharides if necessary. Then, use your knowledge to build a single disaccharide model using pipe cleaners and beads. Use a small piece of masking tape to label this model “Disaccharide.”

8. Describe a major structural difference between carbohydrate model #3—the disaccharide—compared to carbohydrates #1 and #2. Explain this difference.

9. What colors of beads did you use? What monosaccharides do they represent? If you aren’t sure, refer to Table 1 where you assigned bead colors to monosaccharides.

For carbohydrate #4, build another disaccharide. This time, start by selecting a specific disaccharide. Then, choose the beads you need. Review examples of disaccharides in your text if necessary. Be sure to choose a disaccharide that you can build from the monosaccharides in Table 1. Write down the name of your chosen disaccharide. Then, assemble your model. Use masking tape to label your model with the correct disaccharide name.

After you complete your carbohydrate model #4, answer the following questions.

10. Explain your choice of bead color.

11. How many glycosidic bonds does your model contain?

To complete Part 1, take pictures of your models and paste them into a document. Submit this document along with your answers to the questions.

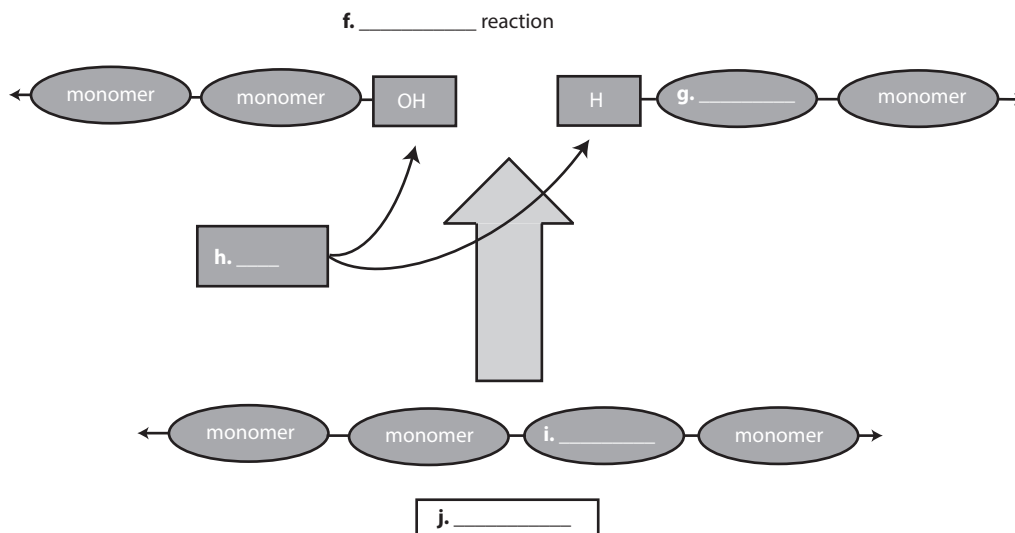
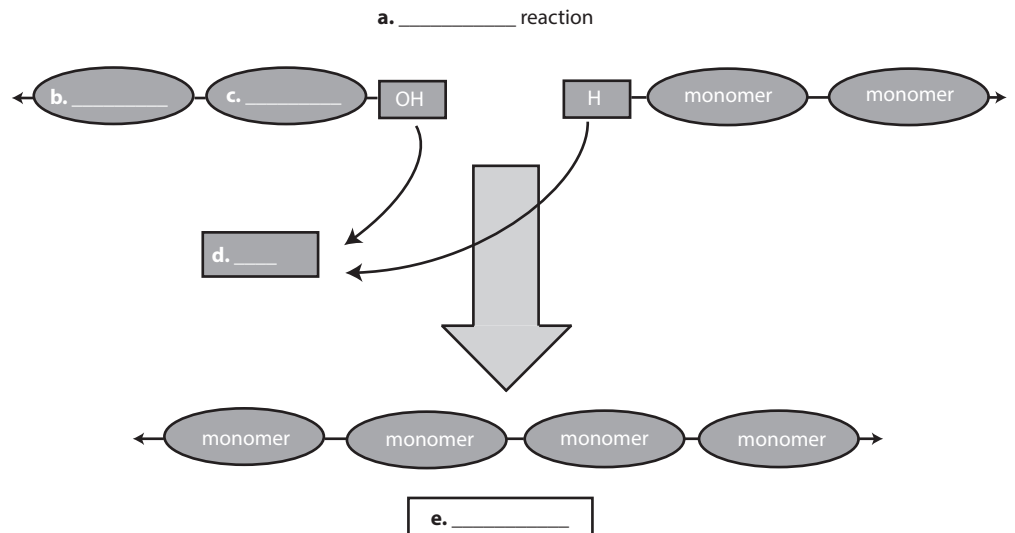
Part 2: Structure and Modeling of Other Classes of Biomolecules

1. In your opinion, how well would the pipe cleaner/bead system from Part 1 work to represent protein structure? What kind of monomer would each bead then represent? Would three bead colors be enough? Explain why or why not. To have enough colors to represent all of a protein’s monomer-types, how many bead colors would be needed?
2. In your opinion, how well would the pipe cleaner/bead system work for modeling lipids? What challenges would you run into if you tried to use the beads to represent the monomer units?
3. In your opinion, how well would the pipe cleaner/bead system work for modeling nucleic acids? What monomer would the beads represent? Are three bead colors sufficient to represent most nucleic acids? Explain your answer.

Part 3: Hydrolysis and Dehydration Reactions

The following diagram shows two types of reactions. Fill in the missing labels for letters a–j. Use terms from the following list: H_2O , monomer, polymer, hydrochloric, dehydration, hydrolysis. Terms can be used more than once, and some terms may not be used at all.

1.



2. You may have heard this common warning for people training in cold-climate survival, “Even when thirsty, don’t eat snow.” Of course, snow contains water. So, what’s the problem? Some people warn that consuming snow may accelerate dehydration, partly due to the lowering of body temperature and the body’s need to elevate metabolism to compensate. Considering what you know about dehydration and hydrolysis reactions, how might an increased metabolism, such as generating extra body heat, result in less free water in the body?

3. Imagine your friend attempts to explain dehydration/hydrolysis reactions using the following (flawed) demonstration. Your friend uses toothpicks and marshmallows. The marshmallows represent monomers, he explains. The toothpicks represent water molecules. Then, he connects the marshmallows together with toothpicks in a straight line. Your friend claims that this demonstrates dehydration reactions because putting the marshmallows together consumes a toothpick (water molecule), whereas separating the marshmallows (hydrolysis) liberates a water molecule. What is flawed about your friend's demonstration? What could you say to correct his understanding of hydrolysis and dehydration reactions?

To complete Part 3, submit answers to the previous questions.

Project Materials

- 5 pipe cleaners
- 60 beads in three colors, 20 of each color
- Masking tape
- Scissors
- Pen or pencil

Student Checklist

- ☐ Complete four carbohydrate models and submit pictures
- ☐ Answer Part 1 questions concerning carbohydrate models
- ☐ Answer Part 2 questions concerning other biomolecules
- ☐ Complete the diagram in Part 3
- ☐ Answer Part 3 questions concerning dehydration/hydrolysis