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II. Activities

Inquiry A: *Pipe Cleaner Proteins*

Objective: Students will understand the four levels of protein structure, construct models that simulate protein folding, and evaluate the accuracy of such models.

Time Frame for Activity: 20 minutes

Materials: The following materials in bags: two each of white, yellow, and green pipe cleaners, four blue pipe cleaners, clear tape or velcro, and small binder clips. A set is provided to each student or in small groups if desired.

Procedure:

1. Read *New York Times* article (appendix) and discuss how protein folding is important and relevant.
   Distribute the bags of materials to individual students or groups.

2. Tell the students that different colored pipe cleaners represent different amino acids. Twist a loop in the center of each pipe cleaner to represent an R-group.

3. Tell the students to attach velcro or tape to the loops of the blue pipe cleaners. Velcro or tape with sticky ends exposed represents R-groups that can hydrogen bond. R-groups that have no tape or velcro cannot hydrogen bond (H-bond).

4. Tell the students to attach binder clips to the yellow pipe cleaner loops. These represent sulfhydryl groups.

5. Have students twist the ends of the pipe cleaners together in the following color order: (1) white, (2) yellow, (3) blue, (4) green, (5) blue, (6) yellow, (7) blue, (8) white, (9) blue, and (10) green. Ask the students what level of protein structure this represents?

6. Attach the sticky ends of the tape together on amino acids three and five. Attach the sticky ends of the tape together on amino acids seven and eight. What level of protein structure does this represent? What types of bonds are these? What is this shape called?

7. Break the H-bonds by detaching the blue loops from each other. This could represent a process that occurs in proteins. What is it called? Reform the helical shape. Attach the binder clips so that the two yellow pipe cleaners are connected. Which of the two types of bonds are stronger? What do the stronger bonds represent in a protein? What level of protein

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structure does this represent? If this was an enzyme, what might some of these looped regions represent?

8. Place your model on top of another group's model. What level of protein structure does this represent?

9. Using a Slinky® and Tangles®, demonstrate a helix and pleated sheet. What level of protein structure do these models represent? How are they different from the other models? What property of proteins do these models show best?

Formative Assessment:

1. Ask students to explain the models and evaluate their accuracy (orally or in writing).

Inquiry B: *Perms*

Objective: Students will understand relevance of protein structure to their daily lives.

Time Frame for Activity: 5 minutes for assignment, 10 minutes for demonstration or 20 minutes if involve students during the following class period.

Materials: Pipe cleaners (1 white, 1 green, and 5 yellow), binder clips, and two paper towel tubes.

Procedure (for demonstration):

1. After completing the preceding activity, make the following assignments for the next class period: Write a paragraph that explains how a home hair permanent produces curls in hair. During the next class, take up explanations, elicit guided discussion, and demonstrate with a model as discussed in steps 2-4.

2. Twist a loop in the center of each pipe cleaner to represent an R-group.

3. Attach binder clips to the loops of the yellow pipe cleaners.

4. Twist the ends of the pipe cleaners together in the following color order: yellow, white, yellow, yellow, yellow, green, and yellow. This model represents a hair, which is quaternary and composed of three tertiary helices.

5. Wrap the model around the paper towel tube (curler) and where binder clips (sulfhydryl groups) are in close proximity, attach them together.

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6. Remove these from the tube. What causes curls to form? Why might some people have hair that is curlier than others?

7. Ask students if they can explain how a home hair permanent works? Ask them if the model helped in their understanding. Once students indicate that they understand the process, proceed to suggested assessment activity.

Formative Assessment:

1. Allow students who turned in the initial assignment to turn in a second paragraph (if needed) that more clearly explains the process at the beginning of the next class.

Inquiry C: *Poisons*

Objective: Students will understand why protein shape is critical to the induced fit model of enzyme action, apply these concepts to other proteins, and relate how these concepts are relevant to their lives.

Time Frame for Activity: 20 minutes

Materials:

The following materials are needed to demonstrate catalase activity: two test tubes or jars, a saturated solution of yeast or the suspension of crushed, fresh potatoes, a portion of the preceding extract that has been boiled, 3% hydrogen peroxide, transparency of catalase structure, transparencies of models of proteins. Some of the protein models that might be used include: actin, ATPase, catalase, cytochromes, DNA polymerase, hemoglobin, insulin, microtubules, myosin, ribosomes, Pepco, RNA polymerase, Rubisco, or others.

Procedure:

1. Show transparencies of several enzyme models. Discuss level of structure, type of bonding, how shape relates to function, and theories about enzyme activity.

2. Tell the students that living cells produce toxins during metabolism such as hydrogen peroxide. However, cells contain an enzyme called catalase or hydrogen peroxidase that can break down this toxic by-product. These tertiary enzymes prevent accumulation of hydrogen peroxide from the many metabolic reactions that occur in the cell by breaking it down into harmless oxygen and water by-products.

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3. Fill two test tubes 2/3 full of hydrogen peroxide. Add unboiled yeast or potato extract to one tube and boiled extract to the other tube. Why is the hydrogen peroxide decomposing faster in the tube containing unboiled yeast or potato cell extracts?

4. After a discussion of active sites, allosteric sites, competitive and noncompetitive inhibition, discuss poisons and antidotes in general. Ask students how this relates to the antibiotic penicillin.

Formative Assessment:

1. Have students explain how shape accounts for the action they observed in the demonstration.