Structural Worksheet Answers

Part A. Inquiry and Research

Go to the *Learn Genetics* website at http://learn.genetics.utah.edu/content/basics/proteintypes/ and click on "structural proteins." Then answer the following questions.

1. What is the function of a structural protein?

   Structural proteins strengthen cells, tissues, organs and more.

2. List three structural proteins and what they do.

   Example answers: **MaSp** (major ampullate spidroin protein) makes up the black widow spider web; **collagen** strengthens human bones, cartilage, tendons, ligaments and skin; **tubulin** forms hollow tubes called microtubules that support the cell structure; **fibroin** is used by silkworms to build cocoons.

Part B. Engineering Challenge

A couple has given birth to a child with three different diseases due to faulty proteins. One is a brittle bone disease called Type 4 Osteogenesis Imperfecta in which the body makes enough collagen but it is malformed. The second disease, hypoxemia, results when hemoglobin does not bring the correct amount of oxygen to the cells. Finally, the child also has severe combined immunodeficiency (SCID) and must remain in a sterile environment because his/her ability to fight disease is very weak. As a team of biological engineers, your job is to "cure" this child by creating proteins that can replace the defective proteins in the child's body.

The first disease to tackle is *Type 4 Osteogenesis Imperfecta*, which results in brittle bones. You will be given amino acids (building materials) to build the *structural protein* needed to support the weight of the child as it grows. Then, test to see if you have made a healthy protein or a mutated protein.

Step 1: Brainstorm. Below, write down ways you might create a strong, supporting structure.

Example answers: Incorporate columns, triangles, arches and/or domes in the supporting structure.

Step 2: Design. How might any of the ways you have brainstormed in step 1 be applied to creating a strong, supportive structure? Write/draw your ideas below. Available materials include: Ideas will vary.

- 10 sheets of paper
- 1 roll masking tape
- 10 drinking straws
- 10 paper clips

Ideas-drawings from a notebook or paper

Step 3: Design selection. From your step 2 ideas, decide on a design that you think will meet the design requirement—to support the weight of a child as it grows. Your protein must hold books 1.5 to 2 inches from the floor and its strength will be tested by setting the pre-weighed books on top of it. Sketch your protein design and label the amino acids (with what you used to build that part) below so that someone else could recreate it.

Look for labeling and that the drawing accounts for the height.

Ideas-drawings from a notebook or paper

Step 4: Before you start building, have the teacher approve your design. **teacher initials:**
_____

    Amount of weight you hypothesize that your protein will hold: _____ Estimates will vary.

Step 5: Build. Next, use the amino acids (materials) to build a protein. **NOTE:** Build it on the floor so that you have enough room above it to accommodate a tall stack of books/weights or even a person standing on it! *Remember:* The function of this protein is to support the child as it grows.

Step 6: Test and evaluate. *Did your model protein design hold as many books/amount of weight as you thought it would?* Circle: yes or no   *How much did it hold?*
_____

Explain why it did/did not meet your expectations. *How effective was your protein model? Was it strong enough? What about balance? Did you encounter other problems?*

Explanations will vary. Expect students to record the amount of weight the protein model held and discuss the design strengths and weaknesses.

Data collection: Fill in the data table with the maximum weight each group's protein held.

Group #	Trial 1	Trial 2

Group #	Trial 1	Trial 2

Step 7: Redesign. *How will you change your design?* In the space below, write/draw your adjustments.

Have the teacher approve your revised design.   **teacher initials:**
_____

Amount of weight you hypothesize that your revised protein will hold: _____ Estimates will vary.

written/drawn adjustments here

Step 8: Test and re-evaluate. *Did your revised design hold as many books/amount of weight as you had thought it would?* Circle: yes or no   *How much did it hold?*
_____

Explain why it did or did not meet your expectations. *How effective was your protein model? Was it strong enough? What about balance? Did you encounter other problems?*

Explanations will vary. Expect students to record the amount of weight the protein model held and discuss the design strengths and weaknesses.

Step 9: Compare. Examine the data for all teams. Graph the data. *What does the data tell you?*

What is the average weight held by all of the re-engineered proteins? Answers should be the same for everyone.

How did your structural protein perform compared to the other proteins that were built? What is an idea from a different protein model that you could have incorporated into your design, and why would you use it? What is another group's idea that you would not have done, and why? Answers will vary.
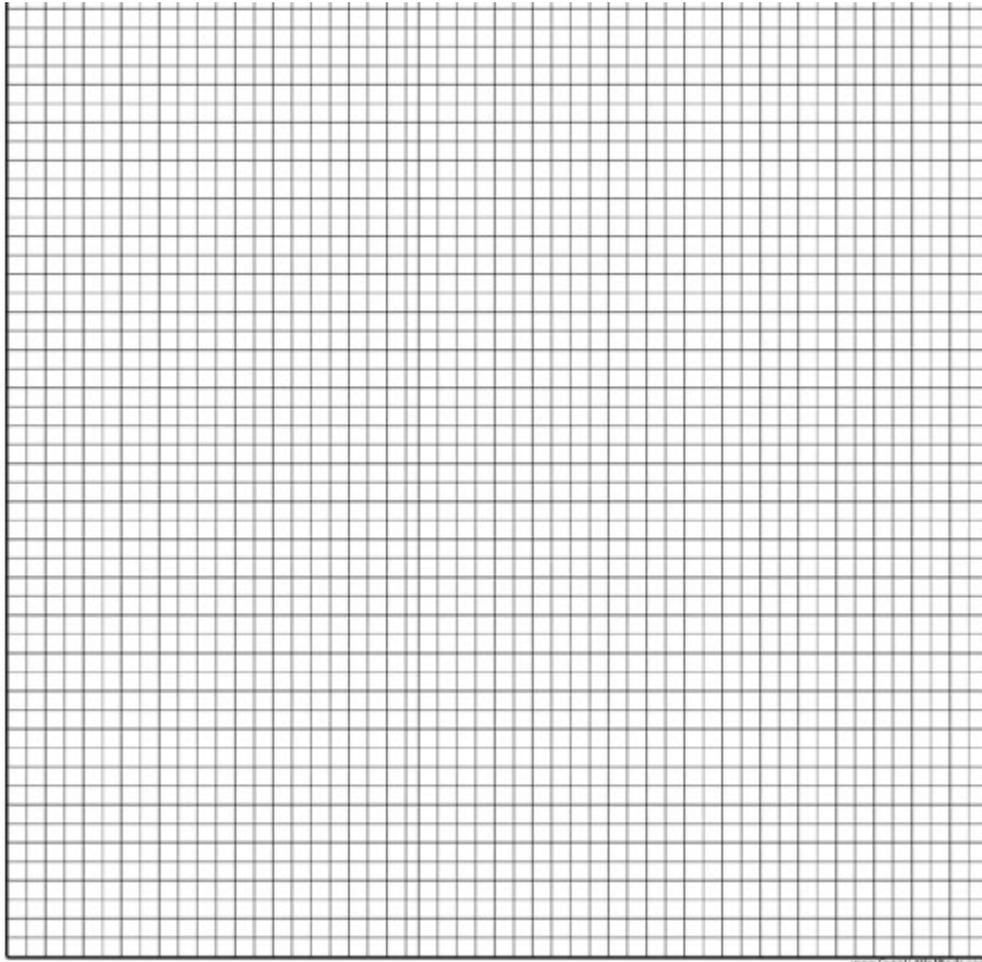
Comparison of Weight Each Protein Held

Weight (pounds)

Group Number

Step 10: Conclusion. When DNA has errors in it (mutations that cause disease), it produces faulty proteins or no proteins. *If your structure was a real collagen protein that strengthens bones, would it be able to cure the child with brittle bones? Would it have any limitations to the size to which the child could grow? Or did you simply make another mutated structural protein?* Use your knowledge of how proteins are constructed to explain.

Answers will vary. Expect students to critique the effectiveness of the protein model and conclude it was determined by the amino acids they used and how they put them together.