

## Protein Shapes Affect Their Functions

# Defense 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 “defense proteins.” Then answer the following questions.

1. What is the function of a defense protein?

Defense proteins help organisms fight infection, heal damaged tissue and evade predators.

2. List three defense proteins and what they do:

Example answers: **Antibodies** battle the bacteria and viruses that can make us sick. They attach to invading microbes, marking them for destruction. **Fibrin** proteins form blood clots and scabs at a wound site. Fibrin is a sticky, rope-like protein that plugs a wound and stops bleeding. **TD** (threonine deaminase) is made by the tomato plant to scare off leaf-eating caterpillars. TD makes the caterpillar sick by disrupting its digestion.

### Part B. Engineering Challenge

A couple has given birth to a child with a damaged immune system. The baby has SCID—severe combined immunodeficiency, informally called the “boy in a bubble” disease. As engineers, your challenge is to “cure” this child by creating an antibody that the child’s body is not making. You will be given amino acids (building materials) to build the antibody needed to keep the child free of bacteria. Then you will test to see if you have made a healthy *defense protein* or a mutated one.

**Step 1: Brainstorm.** Write down ways “things” can be captured, attacked or removed in the space below.

Example answers: Scooping, sweeping away, using adhesives, vacuuming/sucking, squashed, etc. Students may also suggest using fire and acids. Remind them that their job is to design *the capturing tool* so that later the bacteria can be destroyed by another team.

**Step 2: Design.** Your *challenge* is to use the amino acids (materials) listed below to design a model defense antibody protein. The design *requirements and constraints*: Your protein model will be tested on a 2 x 5-foot floor area covered with shredded paper. Your model must pick up the bacteria (shredded paper) off the floor where they lie. You may not “sweep” the bacteria into a pile and pick it up from the pile. You may not use your hands to pick up any bacteria off of the floor. In the space below, clearly draw and label the planning diagram for your design so that someone else could recreate it. Available materials:

Answers will vary.

- 1 roll of masking tape
- twine/string
- paper
- aluminum foil
- saran wrap
- 1 paper bag
- balloons
- Popsicle sticks

labeled drawing-sketch-diagram here

**Step 3:** Before you start building, have the teacher approve your design. **teacher initials:** \_\_\_\_\_

*Amount of bacteria* you hypothesize that your protein will capture: \_\_\_\_\_ Estimates will vary.

**Step 4. Build.** Next, use the amino acids (materials) to build a protein. *Remember:* The function of this protein is to keep the child free of bacteria.

**Step 5: Test and evaluate.** *Did your model pick up as much bacteria (paper) as you thought it would?*  
 Circle: **yes or no**                      *How much did it pick up?* \_\_\_\_\_

Explain why it did/did not meet your expectations. *How effective was your protein model? How much paper did it pick up? Did it drop any paper? Did you encounter other problems?*

**Explanations will vary. Expect students to discuss the strengths and weaknesses of their designs.**

**Step 6: 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 bacteria* you hypothesize that your revised protein will capture: \_\_\_\_\_ **Estimates will vary.**

*written/drawn adjustments here*

**Step 7: Test and re-evaluate.** *Did your design pick up as much bacteria (paper) as you thought it would?*  
 Circle: **yes or no**                      *How much did it pick up?* \_\_\_\_\_

Explain why it did/did not meet your expectations. *How effective was your protein model? How much paper did it pick up? Did it drop any paper? Did you encounter any other problems?*

**Explanations will vary. Expect students to discuss the strengths and weaknesses of their designs.**

**Data collection:** Record the amount of bacteria (paper) collected by each group.

Group #	Trial 1	Trial 2

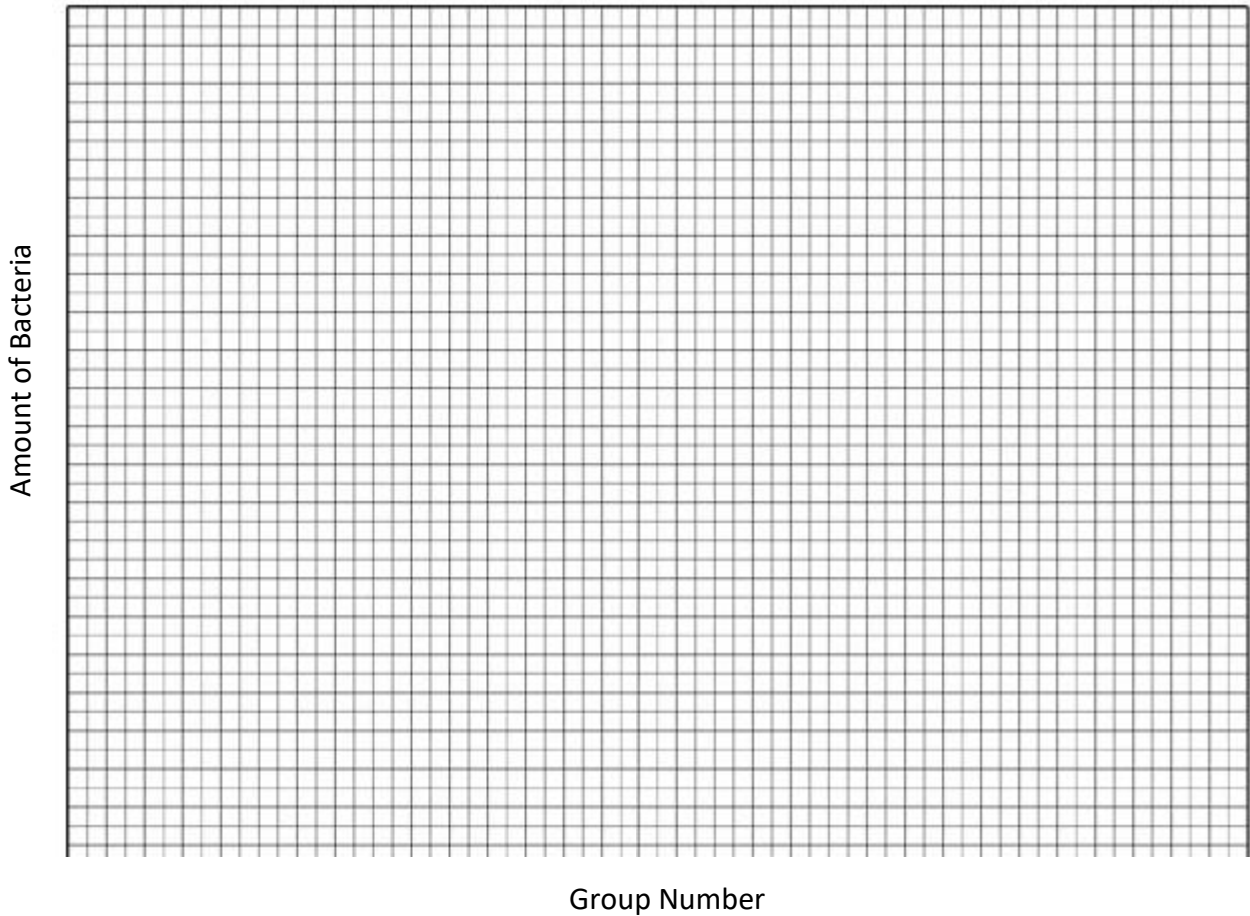
Group #	Trial 1	Trial 2

**Step 8: Compare.** Examine the data for all teams. Graph the data. *What does the data tell you?*

*What was the class average amount of bacteria collected?* **Answers should be the same for everyone.**

*How did your antibody perform compared to the other antibodies that were built? What is an idea from a different antibody that you could have incorporated into yours, and why would you use it? What is something another group did that you would not have done, and why?* **Answers will vary.**

### Amount of Bacteria Collected



**Step 9: Conclusion.** When DNA has errors in it (mutations that cause disease), it produces faulty proteins or no proteins. *If your structure was a real antibody capturing bacteria so that you wouldn't get sick, would it do a good-enough job that it would keep you healthy? Or, if you had to use the antibody you created to keep you healthy, would you die because it is a mutated antibody?*

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.