INTRODUCTION

Have you ever heard of the disease smallpox? Smallpox is an infectious disease that caused millions of deaths before it was finally eliminated in 1980. In this activity, you will learn how people infected with smallpox reacted to the infection and how the disease was ultimately eradicated. What you will learn will help you understand how your body responds to infectious diseases and how vaccines work.

PART 1: What Is Smallpox?

Observe the photos in Figure 1.

Figure 1. Three photos of individuals with smallpox. (Credits: “a” by the National Museum of Health and Medicine, CC BY 2.0.)

1. Write down at least two questions you have about what you observed in Figure 1.

2. Read the “Smallpox Comic.”
   a. Which of your questions, if any, were answered by reading this comic?
   b. Write down at least two new questions that you have.
PART 2: How Does the Body Respond to Smallpox?

In the comic, you read about a young woman named Anne who recovered from a smallpox infection. Smallpox is caused by the variola virus, which is a type of microbe and a pathogen. Microbes are microscopic organisms that include bacteria, viruses, and fungi. Not all microbes cause disease, but the ones that do are called pathogens.

How does the body recover from infection with a pathogen? To answer that question, you need to know something about the body’s response to pathogens, the immune response, which depends on a group of cells called immune cells.

To learn more about specific immune cells and their actions, examine the “Immune Cell Cards.” Immune cells have receptors that recognize pathogens. Think of a receptor as an antenna on top of the cell that receives different signals. In the case of immune cells, pieces of pathogens called antigens are the signal. When immune cells’ receptors recognize an antigen, the immune cells can take different actions.

3. Using the information in the “Immune Cell Cards,” arrange the cards to show what happens in Anne’s body in response to the variola virus over time. Some cards could be in the same or multiple spots in the sequence. You can write or draw the sequence of cards in the space below.

Scientists divide the immune response into two phases. The first phase is the innate immune response, and the second is the adaptive immune response. Each phase involves different immune cells. Innate immune cells have receptors that recognize many different antigens, and adaptive immune cells have receptors that recognize specific antigens.

4. Using the information on the “Immune Cell Cards,” list the cards for the cells that are part of the:
   a. innate immune response
   b. adaptive immune response

Figure 2 represents how Anne’s immune cells may have responded to smallpox infection. Examine the graph and answer the questions following it.
Figure 2. A graph of Anne’s immune response to smallpox infection.

5. Based on your analysis and interpretation of Figure 2:
   a. Approximately when was Anne exposed to the virus that causes smallpox? Indicate this point in the graph.
   b. After Anne is exposed, at which points in the graph does her body have the highest and lowest amount of virus? Indicate these two points in the graph and label them.
   c. Describe the relationship between the amount of virus and the immune response.

6. Using the information in Figure 2, make changes to your sequence of cards from Question 3 as needed. Write your revised sequence below or describe the changes that you made.

7. The adaptive immune response is more powerful than the innate immune response. Based on the information on the “Immune Cell Cards,” what makes it more powerful?

8. Which type of immune cell is responsible for communicating between the innate and adaptive immune responses?

9. Some immune cells stay in the body even after the virus is gone. What are these cells called?
10. The table below shows some scenes from the “Smallpox Comic” in chronological order. Using the information from the “Immune Cell Cards” and Figure 2, identify the type(s) of immune cells involved at each stage of Anne’s infection. In the “Explanation” column, support your choice of immune cells by explaining what happens inside Anne’s body in each scene. The first row has been completed as an example.

<table>
<thead>
<tr>
<th>Stage of Infection</th>
<th>Immune Cells Involved</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>Phagocytes</td>
<td>Anne does not have any symptoms, but the virus is in her body. Phagocytes ingest the variola virus. They produce cytokines to call other cells to the scene.</td>
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PART 3: How Do Immune Responses Differ?
Anne survived the smallpox infection, but Mr. Conti did not. The two graphs in Figure 3 represent how Anne’s and Mr. Conti’s immune cells might have responded to the virus that causes smallpox.
Figure 3. Graphs of Anne’s (left) and Mr. Conti’s (right) immune responses to smallpox infection.

11. Examine Figure 3.
   a. How are the two graphs similar?
   b. How are the two graphs different?
   c. Explain how the differences you identified could explain why Anne survived and Mr. Conti died.

12. Is Anne likely to get sick if she is exposed to the variola virus again? Why or why not?

PART 4: How Does the Smallpox Vaccine Work?
Read the “Vaccine Comic.” The comic describes three different methods that were used to protect people from smallpox:
1) blowing ground-up scabs into a person’s nostrils
2) scratching fluid and pus from smallpox pustules into a person’s skin
3) injecting a milder virus related to the variola virus

13. Discuss the following questions with other students or as directed by your instructor.
   a. What do all three methods have in common?
b. What is one difference between the three methods?

c. How would the immune response to smallpox infection be the same or different for these methods?

14. Explain how getting a disease (or a vaccination for a disease) such as smallpox protects a person from this disease in the future.

15. After receiving the smallpox vaccine, would a person also be protected from other infectious diseases, such as infection with the influenza virus? Why or why not?

PART 5: Reflection

16. List three things you learned about how the immune system responds to pathogens, such as the variola virus.

17. List two questions you still have about the immune system.

18. List one thing you enjoyed learning while doing this activity.