Acting Out the Immune Response

An Activity for the Middle School Life Science Classroom

by

Lindsay E. Porter

Pollard Middle School
200 Harris Avenue
Needham, MA 02492
lindsay_porter@needham.k12.ma.us

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I. Overview

Concepts covered in this activity are innate and adaptive (learned) immunity by acting out the nonspecific and then specific response of the immune system toward an invading pathogen. The topics to be covered in this activity are: the first line of defense with the skin, inflammation, macrophage response, T helper cell response, cytokine messaging, B cell response and antibody recognition of antigen, antibody and memory cell production, and T killer cell destruction of the antigen.

The goal of this activity is to have a class of middle school aged students act out the immune response to bacteria and viruses in order to better understand how it works. Each student will have a given role in this activity, and props will be provided. By having a role in the immune response it personalizes the actions of the immune system

Specific antibody recognition of antigen is crucial in the body's ability to combat a pathogen. The body cannot rely solely on non-specific recognition and destruction of pathogens by phagocytes alone. It needs to use a specific targeted response in order to fight infection.

III. Student Outcomes

Content material will include a class demonstration of the immune response as well as discussion to follow. From this activity students will learn the lines of defense the body has including: the skin, macrophages, T cells, B cells, antibodies, and the ability to create memory cells. They will also learn the function of each line of defense as well as its role in fighting foreign invaders. Each student role in the activity will demonstrate a segment of the immune response.

IV. Learning Objectives

The students will be able to:

1. Demonstrate by acting out:
    - How pathogens enter the body.
    - The role of macrophages in destroying pathogens.
    - The role of T helper cells in the immune response.
    - The messenger role of cytokines.
    - B cell activation and antibody recognition of antigen.
    - The role of T killer cells.
    - The production of antibody by B cells.
    - The production of memory cells.
2. Describe the overall process of the immune response.
3. Distinguish between innate and acquired (learned) immunity.
4. Describe how vaccination prevents a pathogen from causing illness. (optional)

V. Time Requirement

This activity may be played out in one class period and processed in another, or it may be played out in steps and processed in between each step. Either way, it will take two to three 45 minute class periods.

It may be most useful to break the activity into separate steps and to provide the students with a step-by-step question guide that will lead them through the process. This way, breaks can be taken in between each portion of the process, and the class can discuss what has happened in each step before answering the guiding questions on their sheet. Then, the whole process can be run through again with no interruption.

VI. Advance Preparation and Materials

In order to prepare, you will need a script. This will help you to lead students through their roles. A sample one will be provided here. You may hand out copies of the script, or read and guide the students yourself for the first round through. Students should also have a description of what their role is so when the time comes they can explain what function their role is performing. Their description may be pasted onto the back of their prop.

Props for each student will also be needed. For a class of twenty four, you will need cut outs of the following objects:

- Five bacteria cells with the same specific antigen on each cell surface.
- One set of non-white blood cell blood components. Cut outs of platelets, plasma, and red blood cells.
- . Two to three cut outs of macrophages.
- Multiple antigen shaped cut-outs that the macrophage will present to the T helper cells.
- One T helper (Th) cell with a T helper receptor on its surface that matches the shape of the antigen pieces presented by the macrophage.
- One T cytotoxic (Tc) cell with a T cell receptor on its surface to recognize virus fragments.
- One virally infected cell with virus fragments on its surface to match the Tc cell receptor.
- One cytokine messenger.
- Four B cell cut-outs with antibodies, three that don't match the antigen, and one that does.
- Three cut outs of matching unattached antibodies that match the antigen.
- Four new memory B cells with antibodies that match the antigen.
- One or more virus cut-outs.
- One or more virally infected body cells with virus fragments on the cell membrane.

By color coding each category of cut-outs, students will have an easier time visually remembering the process.

Each cut-out should also have the name of the object on the front as well as a description of its function on the back.

These numbers of props and roles can be adjusted depending on personal need and class size. The props may be made from construction paper cut-outs.

6. Once B cells arrive on the scene, what is on the pathogen that will help the B cells recognize it?
7. What structure is on the B cells that helps them recognize the pathogen?
8. What must happen between the B cell a

One day you were out planting in your garden when OUCH!!! you got stuck with an old nail in the soil. You ran inside to rinse the wound, but the nail had pushed some bacteria into your skin and it entered your bloodstream. What did your immune system do about this?

Note: You may change the story so that it is a different pathogen such as a cold virus invading a body cell. However, the way the virus is fought is slightly different. This is why in the following section both macrophages and T killer cells are involved in the destruction of the pathogen. See bottom of next section for further explanation.

XIII. Materials and Procedure

Hand out all the props to the students, and designate areas for each student or group of students to stand. Then begin reading the script.

BACTERIAL INFECTION

1. The bacteria has entered the body through the skin! Students with bacteria roles enter through the door.

2. Inflammation occurs and the blood rushes to the area of infection in order to help fight it. The T helper cell, macrophages and other blood components rush to where the bacteria is.

3. The macrophages gobble up some of the bacteria, but can't get it all. They need help! Only two of the bacteria cells are destroyed. (A discussion of phagocytosis could take place prior to the activity so that students can explain how these bacteria are being "gobbled up".) Or, an explanation of phagocytosis could be placed on the information card on the back of the macrophage cut-out for students to refer to while acting out the process.

4. The macrophages show the T helper cell the parts of the bacteria that it ate up.

5. Now that the T helper cell knows there is a problem, it sends a messenger, the cytokine to get the B cells. The cytokine goes over to where the B cells are waiting and calls for them to help.

6. The B cells rush to the scene, but only the B cell with the matching antibody can really help. The others have to go find another infection to fight.

6.

7.

8. The B cell makes multiple antibodies that match the virus fragments and bind to the fragments and deactivate them.

9. Macrophages then recognize these tagged viruses with antibody as being something that needs to be cleaned up, and ingest them.

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