

Outbreak!

Grade Level 8

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Group Size: Individual Work

Time to complete: 45-60 min per day, over 3 days.

SYNOPSIS

Using your knowledge of the body's three levels of defense and the immune system, construct a video game that simulates the three levels of defense in the immune system.

Next Generation Science Standards

LS1.A: Structure and Function

- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

LS1.D: Information Processing

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8)

Systems and System Models

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6-8 builds on K-5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)

OBJECTIVES

By the end of this project, students will be able to:

- Identify the three levels of defense the body uses to defend against foreign invaders.
- Recognize how viruses and bacteria attack the immune system.
- Identify and explain the three steps the internal immune system use to attack microbes.
- Explain the importance of keeping a healthy immune system.

INTRODUCTION

The immune system is essential to maintain everyday good health. Without an immune system, our bodies would have no way to defend against *microbes* found everywhere! The body has three levels of defense against foreign invaders. These three levels include the skin and mucous membranes, inflammation and fever, and the internal immune system.

The skin and the mucous membranes are the outer layer to prevent microbes from easily entering our bodies. The epidermis acts as a physical barrier against microbes, such as bacteria, that is not able to penetrate the surface of healthy skin. *Pathogens* may enter the body if the skin is cut, burned, or punctured.

Mucous membranes line the body cavities and help trap microbes and foreign substances. Hair may also work with these mucous membranes to trap and filter microbes, dust, and pollutants. Coughing and, sneezing, and vomiting help accelerate the rate at which these microbes are moved out of the body. Though, some pathogens are able to pass this second level of defense, then initiating the second level of defense of swelling and fever.

Inflammation and *fever* are nonspecific responses to microbes and tissue damage. This acts as an attempt to dispose of the microbes to prevent spread throughout the body. Fever occurs due to infection or inflammation. Fevers increase the body temperature, which then prevents the growth of microbes, speed up reactions to aid in repair, as well as kill off the microbes. While a fever and/or inflammation occur, the body is already undergoing the third level of defense with the internal immune response.

The internal immune also includes three steps in defending the body. These three steps include: Identifying the microbe, tagging the microbe to be killed, and remembering the microbe for future defensive strategies.

Identifying the microbe starts with a *White Blood Cell*, called a *macrophage*, surrounding the microbes. Macrophages engulf the microbe to be degraded. These macrophages attack anything noticed as foreign. Sometimes microbes are able to pass the by the macrophages. Once the microbes are identified as foreign by the macrophage, other cells called *helper T cells* recognize the foreign invaders as *antigens* (***antibody generators***). Once the T cells have recognized the antigens, the T cells recruit *B cells* to produce *antibodies*. These antibodies tag the antigens to be destroyed by *natural killer cells*. Once the antigen has been destroyed, *Memory cells* are able to recognize that same antigen if it ever enters the body again. This allows the body to react and respond to that antigen much faster than the initial

invasion. The second invasion may not even display signs or symptoms because the response is so swift.

Bacteria and viruses attack the body in different ways, causing different immune responses. Bacteria attack the body's tissue directly, or release toxins to cause damage. In such a case *antibiotics* are administered to help fight off the bacterial infection. Antibiotics are able to kill bacteria, block their vital processes, or stop them from multiplying. Alexander Fleming first discovered antibiotics in the 1940's with penicillin. Since then antibiotics have been developed to work against the different types of bacteria. However, bacteria have the ability to evolve, allowing them to survive against antibiotics.

Viruses are dormant until they find a host cell to infect. Viruses reprogram the healthy cells to make thousands of copies of the virus. These copies then go on to infect other cells. These cells then damage certain parts of the body depending on the type of virus. For example, HIV (Human Immunodeficiency Virus) damages the helper T cells. The body's defenses then attack the infected cells, killing off the helper T cells. This causes the immune system to slowly collapse. Viral diseases do not have cures, but symptoms may be treated as therapy. Certain viruses have *vaccinations* to prevent the viral infection before the body encounters the virus. Vaccinations imitate an infection but do not cause illness. A vaccine contains *attenuated* or weakened viruses, so the body's immune system is able to establish a response. This allows the body to recognize and fight certain viral infections if the body encounters them in the future.

This video explains the concepts students should understand.

<http://www.youtube.com/watch?v=6uwVhn-APsQ>

This video could be helpful for instructors/ Near Peer Mentors:

<http://www.bozemanscience.com/immune-system>

The Castle analogy from the above video is a good way for students to visualize the defenses of our immune system.

VOCABULARY:

- **Microbes**- a disease causing microorganism, such as a bacterium or virus
- **Pathogens**- a disease causing microorganism, such as a bacterium or virus
- **Inflammation**- a localized physical condition in which part of the body becomes reddened, swollen, hot, and often painful, especially as a reaction to injury or infection
- **Fever**- an abnormally high body temperature
- **White Blood Cell**- One of the cells the body produces to help fight infection. Also known as a leukocyte.
- **Macrophages**- a large white blood cell that ingests foreign particles and infectious microorganisms
- **Antigens**- a toxin or other foreign substance that induces an immune response in the body. Named because they are antibody generators.
- **Antibodies**- blood proteins produced in response to and counteracting a specific antigen. Antibodies combine with substances that the body recognizes as alien, such as bacteria, viruses, and foreign substances in the blood.
- **Helper T cells**- a type of white blood cell that influences or controls the activity of other cells of the immune system. Processed by the thymus gland.

- **B cells**- the cells responsible for producing antibodies. B cells attack microbes that are free floating in the fluids of our body.
- **Memory cells**- a long-lived cell capable of recognizing a particular antigen long after the initial exposure. Memory cells are able to respond to familiar antigens.
- **Natural killer cells**- a white blood cell able to kill certain virus-infected cells without the stimulation of antigens.
- **Antibiotics**- agent that either kills or inhibits the growth of a microorganism, such as bacteria.
- **Vaccines**- biological preparation that improves immunity to a particular disease. Contains a weakened virus for the body to recognize and stimulate an immune response.
- **Attenuated**- weakened in force or effect

Information for this lesson plan was found at:

www.niaid.nih.gov/topics/immunesystem/Pages/default.aspx

Derrickson B, Tortora GJ. *Principles of Anatomy and Physiology*. John Wiley and Sons, 2012. Ed.13:22(875-917).

CAREER CONNECTION

- **Immunologist**
 - Research scientists or practicing specialists who study, analyze, and treat disease processes that involve the immune system. Immunologists are interested in diseases that affect natural immunity such as allergies, sinus inflammations, and pneumonia.
 - Ph.D. or M.D. needed
 - High School Classes to Take: Biology, chemistry, calculus, statistics, physics.
- **Medical & Clinical Laboratory Technician**
 - Medical and Clinical Laboratory Technicians collect information on a patient's health by running routine laboratory tests. This information help doctor's to better diagnose and treat patients based on the blood cell counts. These laboratory tests can determine if an infection is bacterial or viral.
 - Vocational or Associate's degree
 - High School Classes to Take: Biology, chemistry, algebra, geometry, pre-calculus, English
- **Cytotechnologist**
 - Cytotechnologists take sample cells from a patient, make slides from them, and examine them under a microscope. When examining the cells, cytotechnologists look for abnormalities in cells to make a diagnosis of cancer or other diseases. These professionals help save lives by notifying doctors and pathologists the early detection of disease or cancer, allowing patients to receive treatments early.
 - Bachelor's Degree
 - Biology, chemistry, physics, algebra, geometry, biotechnology

MATERIALS

For this activity the students will be creating their own virtual immune system game. They will need a project plan to follow as well as a manual as to how to use the software.

Extra Activity: Use the Glo Germ!

- Glo Germ Lotion <http://www.teachersource.com/product/glo-germ/biology-germs?gclid=COrpzYylxr8CFWMQ7AoduQYATg>
- UV light

SETTING UP THE LAB

1. Be sure the students have access to Multimedia Fusion 2 software.
2. Prepare a manual for each of the students to follow step-by-step instructions on how to make their own virtual game.

PROCEDURE/PROJECT PLAN

1. Each student will receive a project plan outlining the work they need to complete. Students will also receive a manual with instructions on how to create the game.
2. Following the directions of the manual and the outline of the project plan, students will need to make at least three levels representing the body's immune system trying to fight against bacteria and viruses.

Project Plan

Students may create their game as a bacteria or virus trying to infect a body's immune system, or as a body trying to fight off microbes with the immune system.

Title and Instructions Screens - 10 points

- The title screen should appear at the beginning of the game and should include a creative name for the game related to the immune system.
- The instructions screen should include a story line on what is happening to the immune system.
- This screen should also include an explanation and display of game objects, how they move, what they do, how you score points, the number of lives the game starts with, how you lose lives, what each of the power-ups do, and how to win the game.

Level 1- 20 points

- Students should select a hero to build a barrier that microbes (bacteria and viruses) are unable to penetrate.
- Students may also build a trap to prevent the microbes from traveling further.
- Students should set a time limit to this level. If the hero successfully protects himself from the microbes during this time limit, the hero moves to Level 2.
- Students should create a way to lose lives if microbes penetrate the wall or escape the trap and catch the hero.
- This level should simulate the first level of defense the body has against microbes.

Level 2- 20 points

- This level should simulate the second level of defense the body has against microbes.
- Student should simulate a fever working against the microbes. The hero may use a weapon for this.
- Students also need to simulate inflammation inhibiting the microbes from reaching the hero. This can be achieved through the creation of a narrowing maze while the hero fights off the microbes with fever as well.
- Students need to create a way to move onto the next level. This could be based on the number of microbes destroyed, or an established time limit in which the hero has to survive.

Level 3- 20 points

- Students must simulate the internal immune system in this level.
- Macrophages, B cells, and T cells must be utilized in this level. The hero may collect these items while avoiding oncoming bacteria and viruses.
- Students should create a maze or trail the hero must follow.
- An object counter must be established.
- The hero may move onto the next level once collecting a certain number of cells.

Level 4- 20 points

- Students must establish a boss enemy (large bacteria or virus) the hero must fight against.
- Using the collected objects from the previous level, the hero will destroy the boss enemy.
- Students must establish the number of hits it takes to destroy the hero.

Winner and Game Over Screens-5 points

- Students must establish a screen that appears once all lives are lost.
- This screen must allow for the gamer to return to the home screen.
- Students must establish a screen that appears once the gamer has completed all levels successfully.

Power-Ups- 5 points

- Students must establish power-ups, such as antibiotics or vaccines to regain health or lives during each of the levels.

HELPFUL HINTS AND DISCUSSION MATERIAL

Remind the students of the way our body defends against microbes with the three levels of defense, as well as the three steps in the internal immune response. Ask questions to remind the students of the many key players in the immune response. Mention that it is all relevant to maintain good everyday health.

After testing each of the students' "immune systems" have each of the students apply Glo Germ lotion to their hands. Then use a UV light to illuminate the microbes on the hands of the students. This will illustrate how many microbes are on our hands.

QUESTIONS TO ENGAGE STUDENTS/ANALYSIS

- **What are the body's three levels of defense in an immune response?**

- **What are the three steps the internal immune system takes to defend against microbes?**
- **Can you think of any other defense systems your body uses to fight off bacteria and viruses?**
- **How can we better protect our immune systems and defend against foreign invaders?**
- **Based on your knowledge of the Immune System, how do you think antibiotics work in fighting off infections?**
- **What problems might our body run into with fighting off microbes? Hint: Think about if an antibiotic may not work.**

STUDENT SHEET

Students will not need to complete a student sheet for this activity. Instead, they will receive a project plan to create their video game.