Gammagauntlet: Fighting Infection
Activity 1B

Activity Objectives:

By simulating the immune response, students will be able to:

- Differentiate between non-specific and specific immune responses
- Model the disease fighting process of some major immune cells in the body
- Explain that structure is related to function
- Construct antigen/antibody complexes and understand their basic role in human immune responses
- Model the interaction of the immune subsystems when fighting infection
- Identify strengths and weakness of a simulation

Activity Description:

Student teams will race to fight, and ultimately resolve, infections in a human body model by playing out the roles of various immune cells and antibodies, then constructing antigen/antibody complexes.

Activity Background:

Immune Defense: Nonspecific and Specific

Every day we are exposed to substances that can potentially make us sick, fortunately, we have a very advanced defense system called our ***immune system***. Our immune system is made up of white blood cells (***leucocytes***) of various types which have the ability to signal each other through chemical signals or cell-to-cell contact in an elaborate cooperative effort to defend our bodies against harmful invaders. Our immune system works because it is able to tell the difference between ***self*** (belongs in the body) and ***non-self*** (does not belong in the body). Human defense against disease-causing agents (***pathogens***) is categorized into ***nonspecific*** and ***specific immunity***. ***Nonspecific defense*** against infection refers to a general response to any pathogen and includes our skin, mucous membranes, scavenger cells (phagocytes), fever, substances that have antimicrobial action, and inflammation. ***Specific defense*** or resistance to individual types of pathogens is mediated by special white blood cells (lymphocytes) called ***B cells*** and ***T cells*** along with ***antibodies*** (immunoglobulins/gammaglobulins). The components of our specific immune response are able to organize individualized attacks against invaders such as bacteria or viruses.

Bodily Barricades and Scavenger Cells: Nonspecific Immunity

Your body has a lot of ways to protect against invaders like viruses and bacteria. The ***first strategy*** the body uses is to prevent invaders from

Activity Overview

CAST YOUR NET: ADVENTURES WITH BLOOD

ever entering the body. Your skin, mucous membranes, and friendly microbes that live on them are your *first line of defense* against *pathogens* (disease causing organisms) or harmful substances.

Nevertheless, you breathe in and ingest (eat or drink) thousands of germs (*pathogens*) everyday. They are everywhere! They are floating around in the air you breathe, growing in the food you eat and living on almost every surface you touch during an average day. The ones you eat or drink are usually trapped by mucous and destroyed by acids in your digestive tract. The ones you touch are usually stopped by your skin and friendly microbes living there. The mucous membranes and friendly organisms of your respiratory tract trap and destroy most of the pathogens you breathe in. But what happens if disease-causing bacteria or viruses get past the first line of defense through a cut or other break as in *Figure 1* First Line of Defense? If that happens, your body has a *second* and a *third line of defense!*

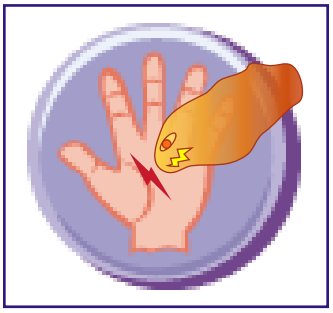

Figure 1 First Line of Defense

The *second line of defense* is fever, inflammation, and special cells called *phagocytes*. Phagocyte means "eating cell". These scavenger cells track down and eat the invaders! This process is called *phagocytosis*. The names of some phagocytes from your second line of defense system are *natural killer cells* and *macrophages*. *Dendritic cells* (not to be confused with dendrites of neurons) are found in most tissues of the body and are often the first cells to detect the presence of foreign invaders, see *Figure 2*. They present markers (*antigens*) from foreign invaders to the immune system. *Natural killer (NK) cells* seek and destroy any cells that have been invaded by bacteria or viruses. *Macrophages* are white blood cells that, moving like amoeba, can leave the blood stream to enter tissues of the body. In these body tissues, macrophages act as scavengers, seeking and destroying foreign invaders, see *Figure 3*. Your first and second line of defenses against pathogens is called your *nonspecific resistance to disease* or *nonspecific immunity*. It is called non-specific because it defends against any pathogen that enters or attempts to enter your body and cause an infection.

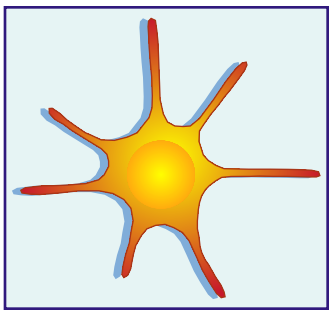

Figure 2 Dendritic Cell

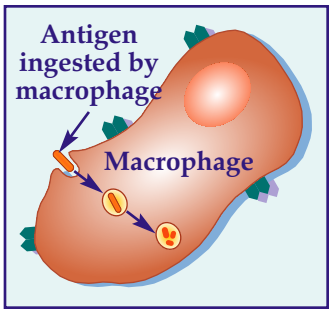

Figure 3 Macrophage

Specific Immunity

Your *third line of defense* is different. It is a customized attack on pathogens. The cells that make up this specific response to invaders have special sites on their surfaces that allow them to recognize, communicate about, and target a particular invader.

Macrophages communicate with other white blood cells called Helper T cells by presenting identifiable parts of the invader to the Helper T cell, see *Figure 4*. As shown on *Figure 5*, Helper T cells then let white blood cells called B cells know what antibodies to make during the specific immune response. *Antibodies* are special molecules that identify and target invaders so they may be destroyed by other cells. The Helper T cells also communicate with other immune cells. The second is the *Killer T cell*. The *Killer T cells* are phagocytes like the macrophages and natural killer cells. The *Killer T cells* are used to destroy viruses, virus-infected body cells, and cancer cells, as shown in *Figure 6*. *Memory T cells* and *Memory B cells* remember the invader in case it tries to cause trouble again in the future. This system of cells and antibodies is known as *specific resistance to disease or specific immunity*.

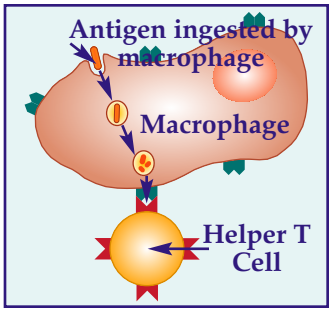

Figure 4 Macrophage and Helper T Cell

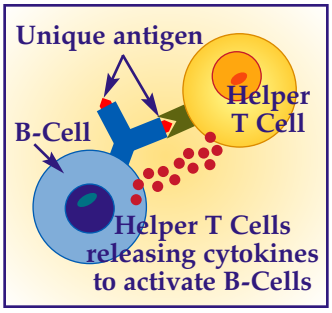

Figure 5 B Cells

Antibodies are used to tag or identify pathogens like bacteria and viruses so that *phagocytes* can destroy them. They have areas with very specific shapes that can bind only to pathogens with the correct fit, much like a lock and key fit together. *Figure 7* is an illustration of a bacterium and an antibody. The antibody has a special site (variable region) that perfectly fits the corresponding site on the antigen and locks together with it. Once locked together, they are known as an antigen-antibody complex.

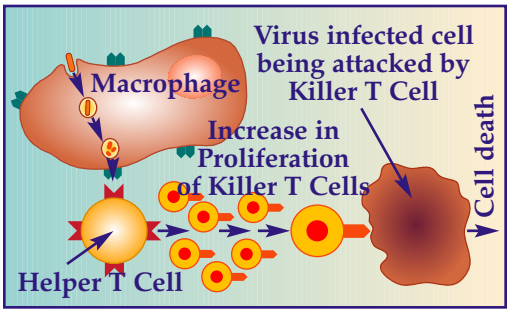

Figure 6 Killer T Cells

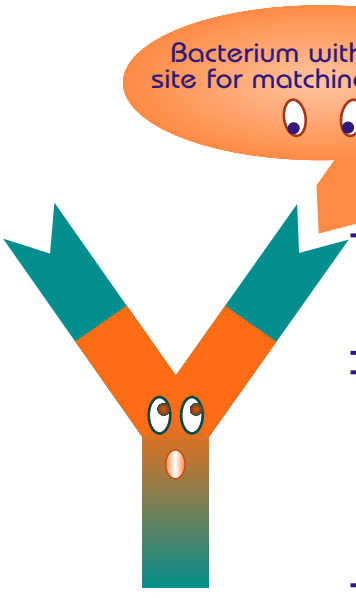

Figure 7 Antigen and Antibody

Activity Materials:

- Jumbo 2″ paperclips
- Large pipe cleaners in various colors
- Permanent marker or chalk to draw *Gamma Master* outline
- 6 foot sheet of bulletin board paper or large, flat white sheet for *Gamma Master* outline
- Character Cards (laminate for durability and reusability)
- Yarn
- 1 Pair of Large Dice
- 10 small packets to represent granzymes (gelatin, silica, or anything else you wish to use)
- Stretchy "Sticky Hands" (Available at Discount or Craft Stores)
- Score card
- 1 Large IgM antibody (laminate for durability and reusability)
- Invader cards (laminate for durability and reusability)
- Transparency of Gammagauntlet Score Card
- Water-based overhead marker
- Old key (represents protein key)
- License to activate
- 1 Stopwatch
- 1 Whistle (Optional)
- 1 copy *Student Data Page* (per student)
- 1 copy of *Student Information Page* (class set)

Activity Management Suggestions:

- Trace the outline of *Gamma Master* onto a sheet or large piece of bulletin board paper or paint it onto a bed sheet, vinyl table cloth, or shower curtain.
- Students keep their roles for the first round of fighting all pathogens – *once they become specific, they can only fight off one type of invader*. If you repeat the simulation for all pathogens a second time, have students change to other tasks as needed according to the dynamics of the game and to increase their experience with the various parts of the immune system.
- The dynamics of this simulation allow the teacher to *"freeze and discuss"* important points as needed – take advantage of this, especially during the first parts of the game. You can use the processing out questions from the *Student Data Page* as points to discuss during the simulation.
- Teacher will be the **"Reader"** to read pathogen cards and direct the simulation.

Modifications:

Provide extra time and provide additional assistance for students needing help.

- All copies needed for simulation are included at the end of this teacher information section.

Extensions:

- Students can brainstorm and investigate various factors that affect immune system responses such as space travel or the field of *psychoneuroimmunology* (the effect of psychological events upon the immune system). For effects of space travel on the immune system, a good place to start is by searching NASA's http://exploration.nasa.gov. A good place to begin researching psychoneuroimmunology is with the work of Christopher Coe, a University of Wisconsin/Madison psychologist.
- Students can investigate how vaccines interact with and activate the body's immune system. Researching the historical and contemporary processes of vaccine development and the vaccine's importance to public health is another direction students could take.
- Students can research and map out the organs and tissues that make up the body's immune system.

Activity References Used:

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