

Lets Get Defensive

A unit studying the bodies defensive mechanisms

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I. Overview:

This is a unit that deals with the basic functioning of the human immune system. The unit is intended for high school biology students as a part of their study of the human body systems. Students should have an understanding of cell and biochemistry. There are possibilities for tie ins to DNA and genetic concepts regarding how antibodies are created to specifically match antigens. These concepts can be extended or downplayed depending on the students and their preexisting knowledge. Students will be introduced to the immune system by various labs, class activities and role-plays. The unit's introductory lab "What's Living in My Mouth" will raise student awareness of the positive and negative benefits of the numerous bacteria that call our surroundings home and inhabit our own body. This lab will create the opportunity for discussion of the necessity for our bodies to have a mechanism to protect ourselves from various pathogens. This is followed by the class activity "You Make the Call!" which is constructed to discover students' preconceived notions and extend prior knowledge concerning basic immune terminology and concepts. The second lab "Your Immune System" will allow students to discover the three different levels of human immunity and creatively display this pictorially using watercolors. The class role-plays "Who's On Our Side?" and "A System Of Hats!" are designed to physically show students how foreign invaders are recognized and then how a simplified immune response is tailored specifically to this invasion. The class activity "Third Line of Defense" is then designed to go over in detail the steps our immune system goes through in order to rid us of foreign invasion. Finally, "And The Band Played On" gives the opportunity for the real life application of immunology concepts and how the AIDS virus eliminates part of the system leaving one's body susceptible to other pathogens.

What's Living In My Mouth?

Objectives: This lab will show that bacteria can be found living everywhere and create an introduction of why the immune system is necessary.

Time Frame: 1—40 minute class

Materials: 1 square of paraffin wax
1 sterile tube for saliva collection
1 blood Agar plate
2 cotton sterile swabs
1 wax pencil
1 article Bacteria: Friend or Foe?

Anticipatory Set: Ask students the following question: What Kingdom (Animal, Plant, Fungi, Protista, or Monera) is represented almost everywhere in the world? Then ask do bacteria live inside of us? Let's experiment to see if this is true.

Teacher in Put: Numerous different bacteria are known to call the oral cavity home. Two of the most common inhabitants are lactobacillus acidophilus and streptococcus mutans. Both bacteria play a role in the cavity formation within humans. These bacteria break down sugar into lactic acid that eats away the tooth enamel. This activity will show that bacteria can be found living everywhere and create an introduction of why the immune system is necessary.

What's Living In My Mouth?

Introduction: Bacteria can be found on the tops of mountains, the bottom of the ocean, and even in the frozen ice of Antarctica. Can bacteria live inside our mouths?

Objective: To prove bacteria can be found living almost anywhere.

Materials:

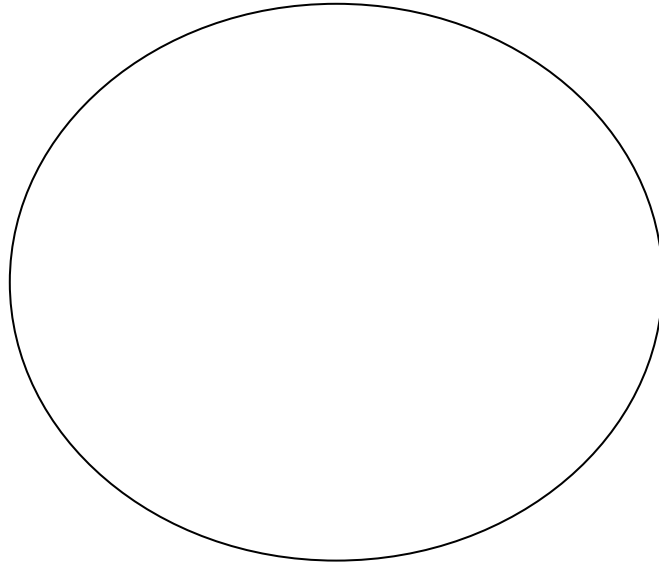
- 1 square paraffin wax
- 1 sterile tube for saliva collection
- 1 blood Agar Plate
- 2 cotton sterile swabs
- 1 wax pencil

Procedure:

- 1) Chew a square of paraffin wax for 3 minutes without swallowing your saliva. Carefully transfer the collected saliva from your mouth to the sterile tube.
- 2) Use one sterile cotton swab to take a sample of saliva from the tube and roll the swab back and forth several times on one half of the blood Agar Plate.
- 3) Using the wax pencil label the area on the bottom of the plate where you spread the saliva as "mouth."
- 4) Use the second cotton swab and take a sample from somewhere in the room. Label the area "Room."
- 5) Roll the swab back and forth several times on the other half of the blood Agar Plate.
- 6) Dispose of the swabs in the place designated by your teacher and rinse out the test tube.
- 7) Incubate the blood Agar Plate 48 – 72 hours at 37°C.

Conclusions

1a.) Using colored pencils, draw what your Agar Plate looks like after being incubated.



1b.) Describe the similarities and differences between the two areas of the plates.
What do you think this means?

2.) Do you think the bacteria grown from saliva are the same as those from the room? Why or why not?

Are bacteria considered to be a friend or foe to humans?

Let's read the short article titled Bacteria: Friend or Foe to find out?

- 3.) List three different ways that bacteria are helpful to humans.
 - a.
 - b.
 - c.
- 4.) Explain why all bacteria get a bad rap for the actions of the parasitic ones.
- 5.) What system within the human body deals with these pesky parasites?

Bacteria: Friend or Foe?

Dateline: 05/29/97

[Bacteria](#) are all around us and most people only consider these prokaryotic organisms to be disease causing parasites. While it is true that bacteria are responsible for a large number of human diseases, they also make it possible for certain elements such as carbon, nitrogen, and oxygen to be returned to the atmosphere. Life as we know it would not exist without bacteria to decompose waste and dead organisms. These bacteria ensure that the cycle of chemical exchange between organisms and their environment is continuous. The decision whether bacteria are friend or foe becomes more difficult when both the positive and negative aspects of the relationship between humans and bacteria are considered. Let's discuss three types of symbiotic relationships: commensalism, mutualism, and parasitism.

Commensalism is a relationship that is beneficial to the bacteria, which live off of the host, but does not help or harm the host. Most of the bacteria that reside within the bodies of humans are commensalistic.

In a mutualistic relationship, both the bacteria and the host benefit. For example, there are several [kinds of bacteria](#), which live inside the mouth, nose, throat, and intestines of humans and animals. These bacteria receive a place to live and feed while keeping other harmful microbes from taking up residence.

A parasitic relationship is one in which the bacteria benefit while the host is harmed. Pathogenic parasites, which cause disease, do so by resisting the host's defenses and growing at the expense of the host. These bacteria produce poisonous substances called [endotoxins](#) and [exotoxins](#) that are responsible for the symptoms that occur with an illness.

When all of the facts are considered, bacteria are more helpful than harmful. Humans have exploited bacteria for a wide variety of uses, such as: making cheese and butter, decomposing waste in sewage plants, and developing antibiotics. Bacteria have been able to survive without us, but we could never live without them.

Internet Source:

<http://specials.about.com/service/ads/pop/mmpopdart.htm?image=390487/popup.gif%20&tracker=3443267;6314760;h?http://autobuy.about.com>

“You Make The Call!”

Objectives:

1. To allow students to learn the main function of the immune system
2. To allow students to learn basic immune terminology

Time Frame: 40 minutes

Materials: Biology book

Anticipatory Set: The human immune system is like _____ because.....

Teacher in Put:

The synetic review utilized in the anticipatory set is one way to get a pair of students talking about the main function of the immune system and associating that function abstractly to something else. The statement above can be written on the chalkboard, on an overhead or on a PowerPoint slide. Allow each pair of students' a couple of minutes to develop one statement. Then have each pair share their synetics with the class.

Ex. The human immune system is like the army because they both help to protect us from foreign invaders.

The lesson “You Make The Call!” is intended to allow students to gain insight into the main function of the immune system, basic terminology, and problems that occur when the immune system overreacts or attacks healthy cells. The lesson is designed for the students to work in pairs to discover the answers to the question of their choice. No matter which question is chosen a main concept involving the human bodies' immune system will be addressed. Students could utilize either a high school level textbook or the Internet as a resource for the lesson.

1. **Explain the following statement** "the essence of the immune system is the ability to recognize 'self' from 'nonself'."

How does this relate to allergies?

Autoimmune diseases?

Or

2. **Explain the following statement** "the essence of the immune system is the ability to recognize 'self' from 'nonself'."

Explain how the immune system causes problems in each scenario.

a. Mothers having their second Rh positive baby

b. Receiving an organ transplant

3. Distinguish between active immunity and passive immunity.

***In the "long run", which would you prefer to have and why?**

OR

4. Specify whether each of the situations listed below will lead to active or passive immunity.
 - a. Receiving a vaccine.
 - b. An infant receives antibodies against measles in its mother's milk.
 - c. A woman who has been exposed to hepatitis is given a shot of gamma globulin. (Gamma globulin is a fraction of blood that contains antibodies)
 - d. A boy has the mumps.
 - e. Receiving antibodies collected from other animals (often horse) to fight specific antigen like tetanus or snake venom.

Pick two of three questions to answer below.

5. Bubba was allowed to donate blood to a friend, Bertha, who was undergoing surgery. Years later, Bubba got in an accident and needed a transfusion, but the hospital would not allow Bertha's blood to be used. Why?
6. Why do you think a person can come down with the common cold over and over again without developing immunity to it?
7. Imagine that you had the technology and know how to create the perfect blood. Describe some of the characteristics that you would want it to have.

Your Immune System Lab

Objective: To introduce the three lines of defense and have them depict this in pictorial form.

Time Frame: 3--40 minute classes

Materials: watercolor paper and paints, sharpie markers

Anticipatory Set: Song ---sung to “Row, Row, Row Your Boat”

**Im, Im, Mune Sys - tem
Three Lines A Thick
Protects Your Body Awesomely, So You Don't Get Sick.**

This is a fun way to introduce the fact that the human immune system has three different levels of defense protecting it. Once the song has been sung, your students can be divided to do it as a round. Using a microphone connected to a computer the song may be recorded for the students to hear. Another alternative is to take the show on the road and visit another science classroom to share the joy of music.

Teacher in Put:

This activity is designed to allow students to research the three lines of the human immune system. Then they will sketch out how they will depict this in pictorial form. The background information can be gathered using any high school textbook or the Internet as a resource. Once this is accomplished the students will sketch (some will chose a literal representation while others are more abstract) out their picture using pencil on watercolor paper. After sketching out the pictures, these may be traced over using different color sharpie markers. Finally, watercolors can be used to fill in the rest of the picture. If a student is comfortable with their ability to use watercolor, they may bypass the pencil and sharpie steps. Once all the students have completed their 3 Lines of Defense posters they will need to dry. The next day have the students rotate around the room to share their works of scientific art. On the back of the poster have each student write (explain) how their poster represents the three different lines of defense.

An alternative activity similar to this would be to complete this using just markers/colored pencils. Also, the same activity works nicely having the students create PowerPoint slide shows as well.

Your Immune System Lab***“In a Pictorial Perspective”***

This is a lab in which your goal is to make a creative, pictorial piece of art displaying the three different levels of the human immune system.

- Task A -
1. Background Information (*yeah, take a few notes*)
 2. Sketch out a plan (*use the back of this sheet*)
- Task B -
1. Create your visual using watercolors and sharpie markers

.....

Background Notes

Describe what the function of your immune system is using the term **pathogen**.

List what makes up each line of defense in your immune system.

1st Line of Defense:

2nd Line of Defense:

3rd Line of Defense:

Sketch out, on the back, how you are going to creatively represent each level of immune defense. Remember your visual is going to be done using watercolor paints and sharpie markers.

(Sketch Area)

Who's on our side and what are they doing anyway?

Overview:

This activity is designed to introduce students to the way that the body identifies foreign particles from non-foreign particles. Cards will be used represent genes that code for anti-bodies. Students will draw 2 cards the first representing a constant gene. The second card will represent a variable region. The numbers on the cards will represent the antigen that this newly created antibody can bond to. Two students will be selected and each will be given a two number code, these two students will represent an antigen and a non-foreign particle respectively. The students should come to the following conclusions at the end of this activity. First, not every antibody has a role in identifying and stopping an antigen, only the ones with the right match have a role. Second, the students should also note that they could not identify which was foreign and which was not with this simplified system. Third, that the real system is more complex. Finally, they should learn the terms Antigen, Antibody, and Gene Rearrangement (They do not need a detailed understanding of gene rearrangement. The students just need a simplified understanding that this is how our body makes enough different kinds of antibodies to defend it's self)

Background:

Students should be introduced to the terms antigen and antibody early in the lesson to avoid confusion. The teacher should also study up on immune response and realize that every type of antigen is killed in a different manner and that this activity can be adapted to be more specific or more general in nature. Reading a college level text may be helpful in preparing the teacher for this unit.

Anticipatory Set:

Ask for two volunteers for a “special assignment.”

Objectives:

How does the body recognize foreign particles from self?

How do we get so many antibodies?

What is an autoimmune disease?

Time required: 40-60 min depending on the discussion

Materials: colored index cards with numbers on them, will need 2 cards per student.

Teacher in Put:

Before starting this activity make sure you pick only enough combinations so the both cells represented by the student volunteers will be paired with another student at the conclusion of the activity. The teacher should prepare by reading about immunology from a textbook prior to doing this activity, and the teacher may want to prepare some leading questions to facilitate the debate depending on the teachers comfort level with leading discussions on this material in class.

To begin the activity have 2 sets of colored index cards on front desk. One card will represent a constant region the other will represent a variable region, this is a simplified way of representing how our bodies generate antibodies Ask the students to come up and pick one of each color. Give the two volunteers you picked at the beginning of class each a different card with 2 numbers on it. Have them step in the hall for a minute. Explain to the class, after the two volunteers leave, that they have just become an antibody capable of killing any antigen that has the same 2 number code that they do, but that they cannot do anything to any other type of antigen. You may want to note that killing an invading particle is a little different depending on if it is a virus or bacteria, but that the first step is always the same. The invader must be identified and not belonging in the body.

Tell the class they must find their target once the volunteers come back in and that they must get that person and hold their hand then the teacher will come over and pronounce the antigen dead or immobilized. Tell them that one of the people that is coming into the room is a foreign cell or antigen and one is a normal body cell.

Have the volunteers come in and explain that the antibodies will be bonding to them now. Let the activity go and after the cells are bound have the class sit down except for the 2 antibody antigen complexes.

Explain what this represents to the class and ask them which one of the two cells was the cancer and which was normal (they will not be able to tell you this). Now proceed with a class discussion of how the body would handle this (Q: “How would the body know which to kill if you don’t know?”) Explain to them what the cards represent. (The cards represent gene that code for the various parts of the antibody. Explain how rearranging these few colors and numbers can create a huge variety of antibodies some helpful some not so helpful The cards actually represent the gene and after translation they would each be different antibodies. This can lead to a discussion about cancer, autoimmunity, or you can even get into what an allergy is. Where the teacher leads the discussion is up to the presenter of this lesson.

Closure: Have the students write about the objectives and turn it in at the end of class.

A system of many hats

Overview:

This activity will be a simulation of what happens when an antigen enters the body. Students will be assigned various roles in the immune system. They will act out their role and observe others acting out their roles. At the end of the simulation a class discussion is held to help the students clarify what happened and fill in what they may have missed. The chart summarizes the various aspects and roles of the simulation this will be explained further in the teacher input section of this lesson plan.

Immune system component	Role student will play	What it is represented by
Macrophage	They will kill cells marked with an antigen and antibody complex by holding their hand.	The body eliminating the pathogen.
Body Cell	They will watch the simulation and in some cases be infected and turned into pathogens.	Infection spreading through the body.
Pathogen	The two students sent into the hall with the hats.	Initial infection.
Antibody	Hats marked with a G.	The body recognizing a pathogen has entered the body.
Antigen	Hats without a G.	A recognizable aspect of the pathogen.
Memory Cell (B Cell)	Put his /her pre-made hats on the invading pathogen.	Immunity to a re-infection by this pathogen.
Plasma Cell (B Cell)	Will make hats for the new invading pathogen.	An initial immune response.

Background:

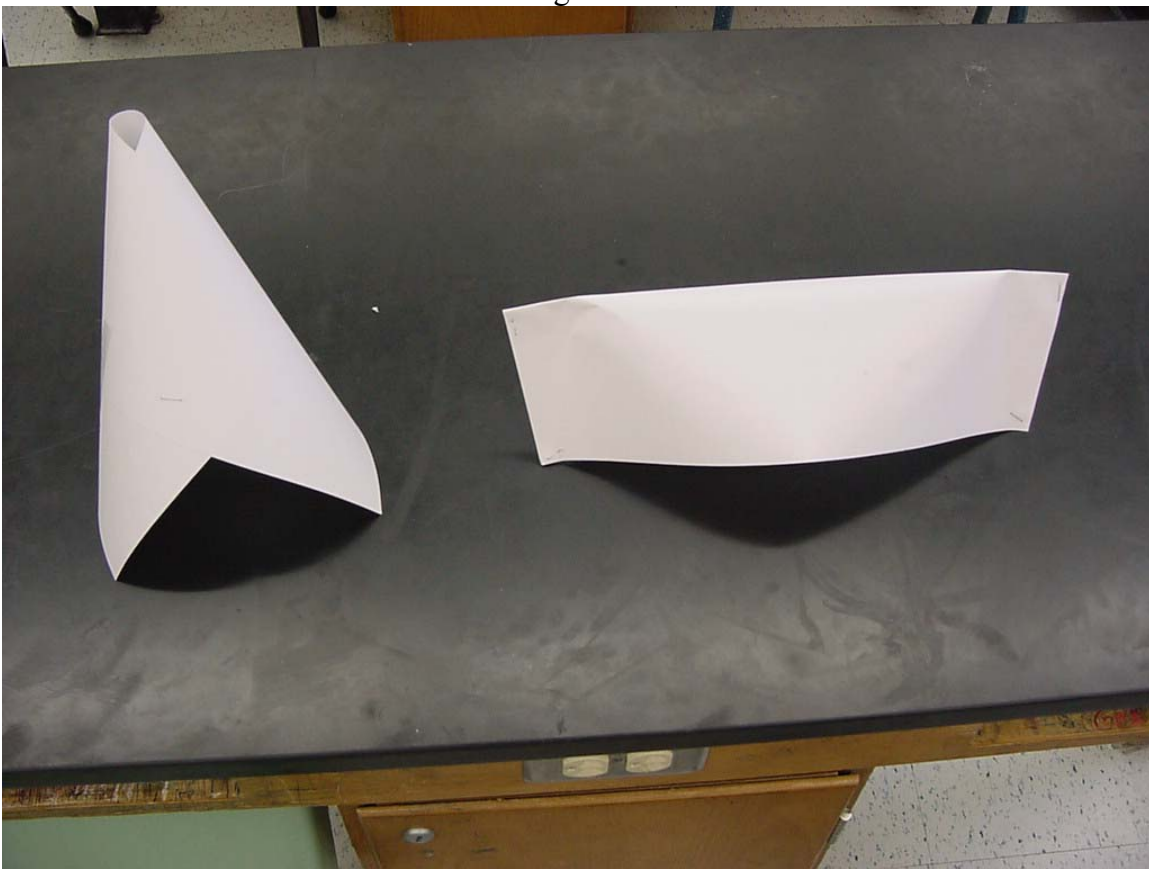
Students should be introduced to the terms: Macrophage, T cell, B cell, Pathogen, Antibody, Antigen, Memory cell, Plasma cell, and body cell early in the lesson to avoid confusion or the students could be taught about them prior to the activity either using a textbook assignment or direct instruction. The teacher should also study up on immune response and realize that every type of antigen is killed in a different manner and that this activity can be adapted to be more specific or more general in nature. T Cells can also be

worked in with some modifications. Reading a college level text may be helpful in preparing for this unit.

Anticipatory Set:

Give two students each a different hat made of paper (see fig 2-1), one in a cone shape, one in a boat shape. Tell them that the hat represents their antigen. Give the cone hat several extra cones shaped hats, and the boat shaped hat several other hats as well. These students will be sent to the hall just prior to the start of the simulation.

Fig. 2-1



Objectives:

Have students experience what the different parts of the immune system do
What part of the immune system do the hat makers represent, and other people represent
What is immunity and how does it work

Time required: 40-60 min depending on the discussion

Materials: construction paper, staplers, string, and markers

Teacher in Put:

Prior to attempting this activity consider the following. Make sure you pick only enough macrophages and immune system cells to allow for body cells to be infected in more simple terms leave a few spectators to watch the activity. The teacher should prepare by reading about immunology from a text book prior to doing this experiment, and the teacher may want to prepare some leading questions to facilitate the discussion depending on the teachers comfort level with leading discussions in class.

Explain to the students in the hall that they will be pathogens and that they are to start infecting body cells as soon as you let them back in the room. (*Body cells*: body cells are any students not assigned a part of the immune system.)

With the students in the room divide them into different parts of the immune system and give them a job and explain to them how to do their job.

Pick a few macrophages and give them signs to indicate their job. Tell the macrophages that they can kill any infected body cells or other cell with an antibody (good hat) attached to their antigen. (Good hats are marked with a G.) The antigen is represented by a bad hat (bad hats are given out by the antigens once they enter the room) remind the macrophages that they cannot attack anything else except an antigen with an antibody already on it. To kill a cell have the student hold the person's hand and then you will come by and give the caught cell a sign that says dead.

Assign a memory cell or two and give them a bunch of good hats for the boat shaped hat this will serve to represent the bodies immunity to boat hat antigen.

Assign a few other students the job of making antibodies to any new antigens that may enter give the students paper, staplers, and markers to make good hats. Tell the remaining students they are body cells and that they are too corporate with the other cells and to watch what is happening.

Let the activity proceed and make sure that everyone is doing his or her job right. Once a body cell or antigen cell has been crowned and killed by a macrophage tell the student to sit down and watch. Give them a sign that says dead. Once both antigens have been killed by the macrophages discuss what happened.

The boat hat should be killed by the macrophages almost right away if not prompt them that they can kill the cell by having the memory cells put a hat on it and grabbing the boat hat virus. The other antigen should be able to infect a few body cells before the hat makers or "B-cells" can get enough hats made to stop it. If you want to the infected cells can also be instructed to make bad hats once infected. This will be a great introduction to the different parts of the immune system and how they work together it is also a platform to launch a discussion about immunity. The discussion after the activity is very important to making meaning from this activity.

Closure: Have the students write about the objectives and turn it in at the end of class. Make sure the students understand what all of the people represented.

The Third Line of Defense

(adapted from Prentice Hall by Schraer and Stoltze)

Objective: To gain an understanding of how the third line of defense specifically responds to antigens and remembers them.

Timeframe: 1 – 40 minute class

Materials: worksheet and high school biology textbook

Anticipatory Set: Pose this question to your class. How is the first and second line of defense (immune system) the same as the third line of defense? How are they different?

Teacher in Put:

Teacher Input: The anticipatory set is intended to allow students to arrive at the following conclusions:

- 1.) Both the 1st, 2nd, and 3rd line of defense are necessary for proper immune protection.
- 2.) The 1st and 2nd lines are simply physical and chemical barriers. They do not have the ability to discriminate between specific antigens for removal like the 3rd line.

How the 3rd line of defense works to accomplish this is the main objective of the class activity.

Task I: The third line of defense is designed to introduce students to the different parts of the immune system that specifically interact with antigens. Using a high school biology book or the Internet as a resource, students will explain why each picture is representative of the function that each specific cell does to protect us.

Possible answers might include:

- IA. Macrophages – Pacman is like macrophages because they gobble up antigens and then display them on their cell membranes.
- IB. T cells and B cells – Calling soldiers to arms is appropriate because T cells are involved in fighting viral antigens while B cells protect us from bacteria.
- II. Helper T cells – The quarterback picture is appropriate because helper T cells receive information from the macrophages (coach) and then they coordinate the T and B cell attack.
- III. Plasma B cell – The picture depicts plasma B Cell because they release chemicals that freeze antigens.
Killer T cell -- The picture of the bomb shows how killer T cells are responsible to bind and destroy antigens.
- IV. Suppressor T cells – The stop sign depicts how they stop the plasma B cells and killer T cells once they have destroyed the antigen.
- V. Memory cells -- A light bulb was used to show that once you fight a specific antigen a memory cell will “remember” the antigen if it penetrates the first two lines of defense again.

Another variation would be to have the students draw pictures or create a PowerPoint slide show to represent each of the different cells.

Task 2: Using the information gathered in Task 1, a biology book and the third line of defense diagram students will examine how the third line works against antigens, remembers them for long-term protection and problems that occur.

Biology

Name _____

The Third Line of Defense

Task 1: For each part of the third line a picture represents the specialized cells that make it up. First use your biology textbook to look up the role each cell plays; then explain why each picture was chosen to represent that part.

1A = Macrophages:

1B = Helper T Cells:

2 = T Cells and B Cells:

3 = Plasma B Cells:

= Killer T Cells:

4 = Suppressor T Cells:

5 = Memory Cells:

Task 2: Answer each question below using the information gathered thus far, your biology book and the third line of defense diagram.

- 1.) The AIDS virus destroys section 2 (Helper T Cells) of the third line of defense. Explain why AIDS victims usually die from other opportunistic diseases and not the actual virus itself.

- 2.) What section of the diagram is not functioning properly causing one's own immune system to attack itself once an invader is destroyed? What is this type of disease called?

- 3.) How many different antigens has the third line of defense faced? Explain your reasoning.
- 4.) How does the third line of defense react differently when invaded by a virus versus a bacterium?
- 5.) Why does a secondary response take much less time than the first time being exposed to the antigen?

And The Band Played On

Objectives:

1. Make students aware of the history behind the Aids virus.
2. Discuss how the Aids virus destroys the human immune system.

Timeframe: 5—40 minute classes

Materials: Movie “And The Band Played On” and VCR

Anticipatory Set: Put the four letters AIDS on the board. Have the class brainstorm anything they can regarding the four letters (AIDS). Encourage students to share anything that comes to their minds---even if they’re not sure it is accurate. Save the brainstormed list.

Teacher in Put:

Watch the movie “And the Band Played On”, ---2 hrs. and 20 min. long with a PG-13 rating. The movie is about the history, politics, people, and fear that enveloped the U.S. during the beginning stages of the HIV/AIDS epidemic. Then have the students write about the things they learned, what surprised them, alarmed/shocked, interested etc... How did this movie affect your perception of HIV/AIDS? Remind students that this should not be a review of the movie because we have all seen it and know what happens. The amount of credit given will be based on the insight and thought involved in your response.

Closure: Return to the brainstormed list. Engage the students in conversation as to what the list represents. Try to cover many of the essential questions that students often raise down below in this conversation.

- a. What is the difference between HIV and AIDS?
- b. What do they stand for?
- c. Do all people infected with HIV have AIDS?
- d. Does the HIV virus ever go through a dormant stage?
- e. Is there a cure or vaccine for the virus?
- f. Does anyone ever survive AIDS?
- g. What causes death in Aids patients?
- h. When is a person (HIV +) most infectious for transmission?
- i. How is the HIV virus transmitted? (What bodily fluids is it transmissible in?)
- j. What activities put an individual at risk for HIV infection?
- k. Who is at risk for HIV infection?
- l. Are all people equally susceptible to the HIV virus?
- m. Can alcohol and other non-indictable drugs put a person at risk for HIV infection?
- n. Can the HIV virus be passed by kissing?
- o. Can HIV be transmitted through anal sex?
- p. Can HIV be transmitted through vaginal sex?
- q. Will the use of a latex condom during sex reduce the risk of HIV infection?
- r. Can a person with no visual symptoms transmit HIV?
- s. Can you get HIV by touching someone who has it?
- t. Can mosquitoes transmit HIV?
- u. Where did the HIV virus originate?