IMMUNITY: FRIEND AND FOE

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Teacher Guide

I. Science Background Vocabulary

a. Immunology

i. Immunology is the study of the body's defense or response to infection and cancer, and the study of pathological responses that result in allergy or autoimmune disease.

ii. Immune response is what our body does to fight infection by potential pathogens and cancerous cells.

The Two Systems

i. Innate immune response is always immediately available to combat a wide range of pathogens that have certain molecular patterns or induce interferons and other non-specific defenses; but does not lead to lasting immunity.

Biochemical signals are sent out to cell surface receptors.

a. Lymphocytes/WBC they can recognize and target pathogenic microorganisms. They need the Innate Immune system to activate.
b. They have receptors on them that are cell signaling.
c. Cell surface receptors send information from the extracellular layer across the plasma membrane to start intracellular biochemical signals which move across signaling pathways made of proteins to respond to the infection.

ii. Adaptive immune response is the specific immune response developed during the lifetime to fight infection with a specific pathogen.

a. Antigens stimulate production of antibody (humoral immunity) and highly specialized help with preventing reinfection.
b. Can respond to a wide range of chemicals and produce allergic immune responses to nickel, penicillin, poison ivy and more.
c. Antibody (humoral immunity) protect against extracellular pathogens and their toxic products, found in fluid compartment of blood, plasma, and extracellular fluid, 5 classes (IgA, IgD, IgE, IgG, IgM). Immunoglobulin (Ig).
d. The adaptive immune response results in protective immunological memory.

Leukocytes and the Lymphatic System

1. Leukocytes are derived from hematopoietic stem cells that originate in the bone marrow.
2. Granulocytes are polymorphonuclear, have odd shaped nuclei
3. Eosinophils are usually found in connective tissues, they contain Arginine-rich proteins.
4. Basophils less abundant than Eosinophils, cause blood not to clot found in bone marrow.
5. Neutrophils most abundant and travels first to infection digests the infection.
6. Mast Cells release histamine lipid mediated production of vasoactive compounds, large granules blood borne, protect internal surfaces of body

from pathogens and parasitic worms, and reduces inflammation when granules are released.

7. Dendritic cells/antigen presenting cells (APC) phagocytic cells, finger-like process, dilate blood vessels. Activates signals between Innate and adaptive immune system.
8. Natural Killer Cells they have large granules found in bone of the Adaptive and Innate Immune system, large granules, common lymphoid progenitor.
9. Lymphocytes
    a. B cells/B lymphocytes develop in the bone marrow, get activated by T Cells in secondary lymphoid organs. Upon activation, can develop into plasma cells which produce antibodies.
    b. T Cells activated by dendritic cells

1. Cytotoxic (CD8+) T-cells-effector cells which destroy infected cells, they do not recirculate.
2. Helper (CD4+) T-Cells provide essential additional signals to antigen stimulated B cells that influence the production of antibodies.
3. Memory Cells – B and T cells with activated antigen specific stay around after the antigen is gone, basis of immuno-memory, reasons why vaccinations work.
4. Regulatory T cells suppress the activity of the lymphocytes.

What you need to know to complete the labs

The teacher should understand the vocabulary and prepare for all activities before each activity begins. If you are unfamiliar with Immunology I have suggested web sites that will help you.

Each activity can be used as a stand-alone or a part of a unit that you can use to include other topics such as forensic science or environmental science. If you chose to do this you will be able to include the case study and develop original research from the information that the students will explore, design and evaluate.

Students should have familiarity with the 5'E's. Engage, Explore, Explain, Elaborate/Extend, and Evaluate. If you are unsure there is a website that I have included that will help you understand the process better and it is available for students to use.

The pdf file:

https://drive.google.com/file/d/0B89v9YDxfa7QSlFqUlRscm4wUU0/view?usp=sharing

https://naseclips.arc.nasa.gov/teachertoolbox/the5e

This website is used for a mini lesson about immunity to help students get more engaged.

https://educators.brainpop.com/bp-topic/immune-system/

For e-journals you would set up either google classroom and a how to link from Techy teacher

http://alicekeeler.com/2015/06/18/google-classroom-using-a-writing-journal/

or you can use Edmodo. This will take some time to put in place.

The teacher will also need the materials available to complete each activity and or experiment. When you group your students for the experiments, I suggest you keep the groups to three and give each student a job/role this will help them learn from each other and you will have each team member working. If you do not have enough materials, I suggest you have odd number groups. The roles are interchangeable each team member helps to clean up. You have the Principle Investigator-their role is to guide the group and they are the only one that can ask you questions and they then report back to the group. The Recorder is the person that is writing on the computer recording the group's data and what they want to have in either their electronic journal or journal books. They are not the ones that do all the research that is required by everyone. The final role in a group of three is the Materials/set-up person they are responsible for getting and returning all materials and setting up the lab for everyone to work on. If you have a group of five, the other roles would be Clean-up and return materials and Problem Solver, they work with the Principle Investigator to trouble shoot ideas and any disagreements that might arise.

Review each activity and become comfortable with them before you have the students get involved. Each activity has accommodations for learning support students. The times suggested are for a sample you can increase or decrease the time depending on the type of students you have.

II. Student Outcomes

1. Students are expected to think independently of the teacher and give data that supports their outcomes. They will record their data in a journal or electronic journal book. They will be able to collaborate in teams of 3or 5 depending on the size of your class.
2. Students should have access to a computer for research and game set-up on websites.
3. Students should be able to build on prior knowledge learned from the activities and/ or experiments.
4. Students will be able to interact and review information as they go through the different activities.
5. These experiments are designed for 9^{th} to 10^{th} grade but can be adapted for students who are involved in Honors and beginning AP Biology classes.
6. Students will be actively engaged throughout the process through using the 5 E's Design process. A website that will help to make this clearer for you and all the students.
7. Students will be able to use the following standards to complete Common Core and State wide goals.

Next Generation Science Standards

When using activity 1 part 2, you will use these 2 standards. They will help your students understand how immunology works and functions within the cell's organelles. They start with the basic DNA model of a cell plant or animal and how the structures of the various specialized cells determine if the immune system is functioning. They will be able to relate to real life conditions within an ecological and environmental environment. They will design a model of understanding on how these specialized cells function to benefit how multicellular organisms maintain homeostasis. They will be able to research/Explore how immunology is used to combat and maintain a homeostasis within a microorganism. They will record their findings and make connections to future issues the system might encounter if the microorganism returned, mutated, or if something new were added into the system.

1. **HS-LS1-1**. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
2. **HS-LS1-2**. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Common Core Standards

- **LS1.A**: Structure and Function Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1)
- **WHST.9-12.9 SL.11-12.5** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1) Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2)

3. HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
4. HS-LS1-7. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
5. HS-LS2-3. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form acids and/or other large carbon-based molecules.
6. HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere

Common Core

The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)

The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)

As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1- 7)

Because of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

III Learning Objectives

A. Students will work in large and small groups to understand the vocabulary and how it pertains to immunology and real-life situations. They will be encouraged to learn about the various aspects of immunology and its effects on organ systems and specialized cells. They will be able to investigate and learn what progress has been made in the field of Immunology from the prospective of the past to what is current.
B. Students will be able to work with equipment such as probes to collect, analyze, explain and review data. They will be able to build models that they can use to explain and improve their analysis of their data and any implications they come across.
C. Students will be able to complete Inquiry based learning and problem-solving skills using real life situations that affect them or will affect them in the future.
D. Students will be able to share their knowledge with others in the class as well as with students in other classes.

IV Time Requirements

Time requirements will vary on how the size of your class as well as how long and in depth you would like your students to be involved in the various activities and experiments. The average activity will last at least 50 to 55 minutes but they can be broken up into sections if you have 40 to 45-minute classes. If you have block classes you can combine some activities together or extend the length of time to gather data. You have the flexibility to extend each activity.

If you use this as a unit, you will need at least two to three weeks to complete all the activities as well giving each group a chance to report out and explain their results. Preparation time will vary depending on the size of the class, on average for activities and experiments allow at least 30 minutes for setup and completion of each activity. Some will not take longer than and others.

In the experiments, for a 55-minute class allow 15 to 20 minutes for cleanup and regrouping for questions. I would suggest if you have gifted, learning support, or ESL students in the class to keep them engaged apply breaks to regroup at a half way mark to see if students have questions or concerns. As the students develop their skills in the lab you can stop less often. Give students plenty of time to record results and analyze data between the lab sessions, at least 10 minutes.

With each lesson depending on the size of your class you should allow the class extra time to discuss and plan their strategies out. I would recommend an additional class period for discussion and review.

V Advanced Preparation

If you are using the cards for Lesson 1 day 2 you need a to have a teacher set to help guide the students and you will also need at least 9 sets for a class of 27 or more that are working in teams of 3 or 5. Laminate your cards so they will last longer. If you are allowing the students to create their own set use the teacher set as a guide. If you use the large Styrofoam they need to have the pipe cleaners with 6 or 7 different colors so that they can be distinguished from immune system cells and connect with pathogens. The Jack balls work well, the students can bounce them in a box or roll them around and you can hot clue pieces of felt or pipe cleaners to make them only attached to certain ones. Hot glue or use craft glue should be used to put cell pictures on the cards. You will need at least 9 setups for the class and 1 teacher setup.

Printing, cutting out and assembling the cell/antibody index cards will take time and setting up your boxes with antigens, jack balls or large styrofoam balls should be done before the start of the activity.

You will need the necessary 3 microplates or small 10ml beakers for each team, acids, bases, and universal indictor for "So you want to be an Immunologist". Suggested list of reactions and universal indicator in Daily Unit section.

You will need computers for each team for virtual and analysis of data. Teacher should prepare the case study paper for distribution or download them to the computer before case study begins. Allow time to review and explain vocabulary.

All lab equipment should be available and ready to use before the start of the experiment. Order all media if you complete the ELISA experiment, as well as have incubator available for students for that complete this experiment. Allow ample time for shipment of order, at least two to three weeks for ordering and shipping. The cost of the kit is around $60 plus tax and shipping. The refills are about $30.00. Carolina Biological has the lowest price.

When using the resources and websites please allow additional day for students to go through the process and get feedback by using short: "What Did you Learn?" index cards or posted notes to help the students to visualize what they still need to understand.

Always give students ample time to clean up and have enough supplies available for all classes that will do each activity.

VI Materials and Equipment

Lesson 1 Day 1

You will need 100 to 200 index cards for activity most the cards will be used for antibodies. Round 1 each team will need 2 T-cells, 2 B-cells and 2 pathogens same type. The index cards are cut into shapes of the immune cells or you can tape pictures of the different types of cells on to the cards. You will need scissors, glue/tape, glue gun, pictures of the various types of cells. You will also need space for students to walk around the room if you are using the cards.

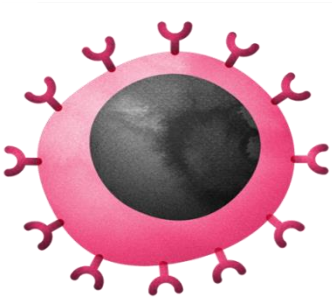
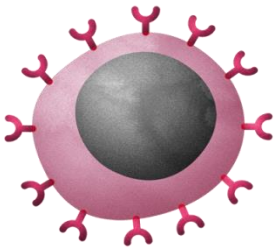
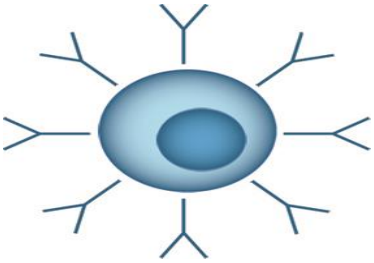
If you are using the Styrofoam or heavy cardboard that can be formed into 3Dimensional shapes cut out the different shapes and attach the Velcro, this will help. Again, you will need about 100 to 200 shapes available.

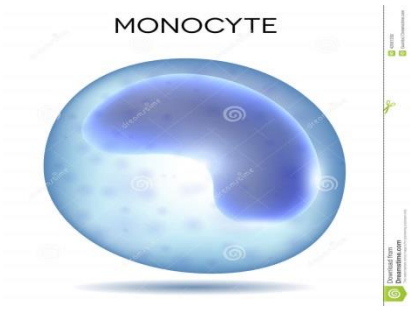
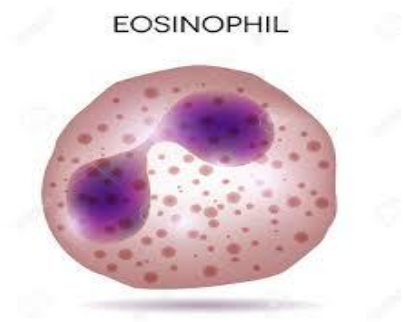
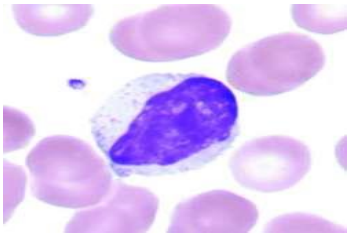
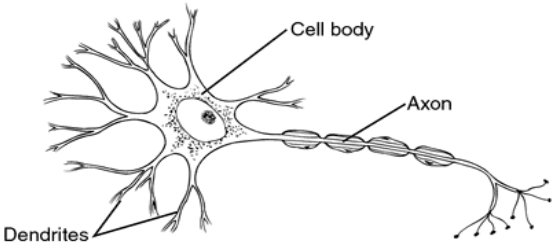
All the materials necessary for the activity should be gathered and for you or your students to assemble. Teacher setup will be several hours to complete, hot glue pictures, and laminate cards and up to 3 to 4 hours to cut out all the shapes and hot glue Velcro.

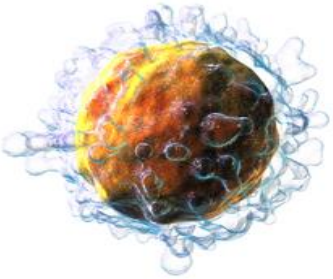
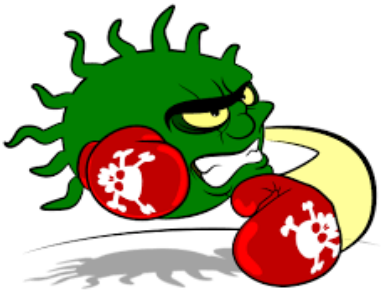
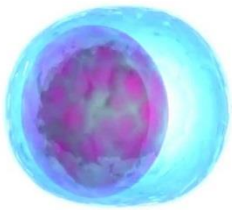
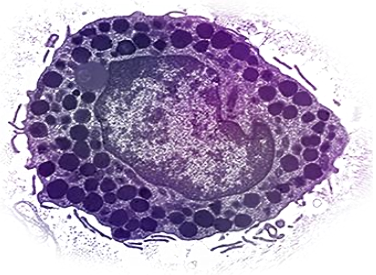
***Note, if you use this for AP Biology or less than 15 students in a class, I would suggest the students use large Styrofoam balls, beads or buttons, the smaller class can build a model of their interactions as they go. You can also have them build a model at the end of the activity using either the cards or other materials.** *

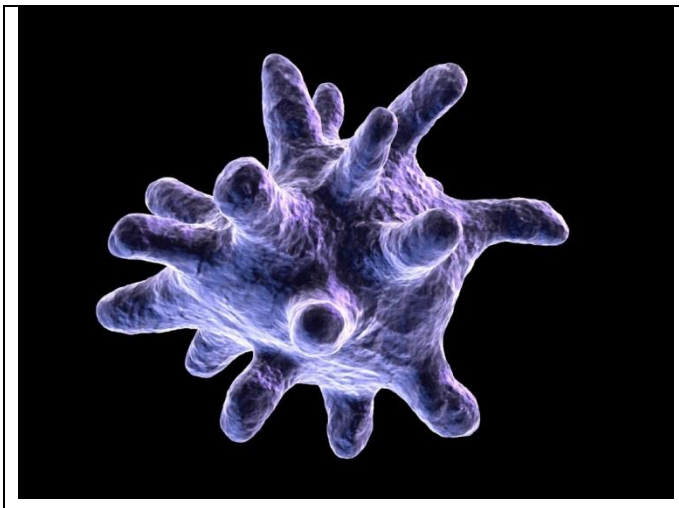
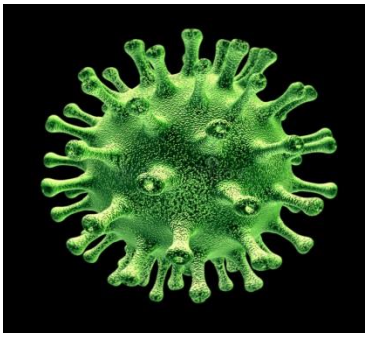
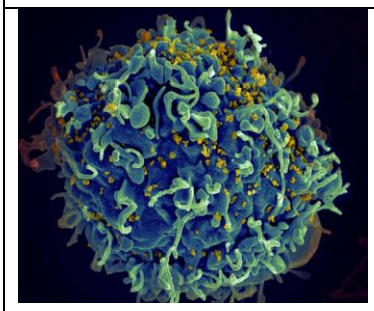
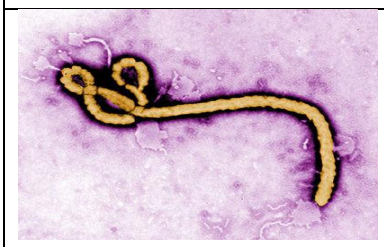
You will need to have the materials arranged for each group to have enough supplies for the activity. This website has pictures that are helpful. http://immense-immunology-insight.blogspot.in/p/contents.html

The following are the pictures and short definitions that will be placed on the cards for them to play with for Lesson 1 Part 1 and 2.

Front of Card	Back of Card
 T Cell	A type of lymphocyte that has receptors to fight against invaders in the Immune system.
 T Cell	Immature T- Cell
 B Cell	Developed in bone marrow, needs a specific antigen to release and activated by T-Cells.

	Very large lymphatic cells that are sent from the dendrites to destroy bacteria and viruses.
	Has coarse granules and indicate some type of infection.
 Lymphocyte	Activate B Cells
	T-Cells are sent by.

 Helper T-Cells	They become activated in the presence of antigen peptide.
 	They kill off infections like cancer cells that invade the body.
 Plasma Cell	Short lived cell that produces antibodies.
 Mast Cell	Innate Immune system, when activated can release histamine to fight inflammation. Causes of allergic reactions.

 Macrophage	Immune system function is to engulf or eat foreign particles and or pathogens in the blood stream.
 Virus Cell	Virus that interacts and invades host cells.
 HIV yellow particles on cell virus	HIV infected immune cell
 Ebola Virus	Virus that destroys tissue

Lesson 3

When completing the So you want to be an Immunologist activity you will need different acids and bases that range in pH from 3.5 to 8. They are referred to in the Daily Unit section. I would not use strong acids and bases in the beginning unless your students have used them before. You will also need a universal indicator to be placed in some so that there will be a slight color variation so that the students will know that this is the pathogen that was found to be the source pathogen. Some sample acids and bases that work well and some can be found in the hardware stores Lactic acid pH 3.5(milk acid), Acetic acid pH 3.9(vinegar), Carbonic acid pH 4.68, Boric acid pH 6.12(Borax), Sodium Hydroxide Carbonate pH 8.27, Sodium borate pH 9.21, and Calcium Carbonate pH 9.91(deicer for roads ice).

Lesson 4 and 5

Projector for power-point and computers for electronic journals.

ELISA kit or chemicals from Carolina or Flinn for Lesson 5. You must order enough kits and refills for each class to complete several tests. The cost $60 plus tax and shipping from Carolina Biological. Flinn is slightly higher.

Student Activity Page

Students will receive some Immune system cards and listen for a virus or bacteria to be released and will move to see if their card will be used. Walk over and match up if you are a T-Cell in round one and if you are a B-Cell you will move in round two. If the teacher introduces a new virus only the macrophage can move to try to engulf and release histamine. Inflammation will then help the T-cells can to move out. If no macrophage, wait until round two or three when inflammation is built up. Record how long it takes when you have certain cards, such as T-Cells vs B-Cells.

VII Student Prior Knowledge

Lesson 1

Students should have some or no prior knowledge. This activity is to help you determine what they already know. You will allow them 15 minutes to discuss and record their feedback in a class journal such as google classroom or Edmodo classroom. Students should be able to understand different strategies using their prior knowledge about what is a friend and how friends work to help each other in some situations. If computers are not available use graphic organizer to explain how the immune system normally functions and what happens when an invader enters. They should be able to make comparisons to help them relate "Friendship relationships" vs "Non-friend/enemy who wants to harm them relationships". This lesson is used to help make connections to how the Immune system is our friend when the enemy, a virus or bacteria wants to harm to us.

Lesson 2

The students will build on their basic knowledge and get a better understanding of the function of the immune system. Review the function of the immune system and refer to what happens when an entity is introduced into the system. Use how a Medieval army fights because you can assign roles T-cell King, B-cell Queen when they work together they can overthrow the invader/pathogen. This lesson will help the students visualize how an army can fight an invader and each part of the army is necessary and must be available for the army to overcome the invading army, virus/bacteria.

Lessons 3 to 5

This will take more understanding and the students will be able to look closer at the vocabulary words and be introduced to those vocabulary words. It is a good idea to review the vocabulary using A KWL chart or graphic organizer to assess the student's basic understanding

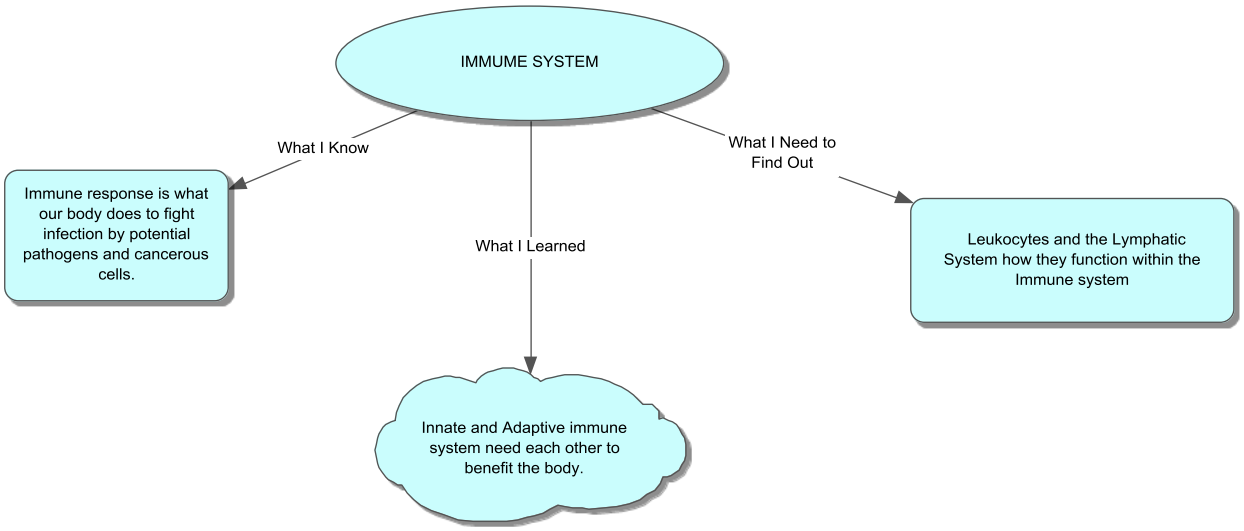
of what is going on in the immune system. Now is the time to use the resources again and check for What students need to find out.

Sample KWL chart

KNOW	LEARNED	WHAT I NEED TO FIND OUT

IMMUNE SYSTEM

Sample graphic organizer



When completing Lesson 3 to 5 the students will be able to build on their prior knowledge. Use the power-points provided from the website for a review. Students may need time to record information and ask questions before they start the Jeopardy game. I usually allow a class period between the different lessons for review and questions. This game can be used as an assessment at the beginning and redone at the end of lesson 4 to verify their continuous understanding.

When you start the third lesson you need to prepare by reading the article and becoming familiar with this information. You can go to the case study site http://www.sciencecases.org/influenza/influenza.asp
You will be using this site for reference only and an original story that the students will use is included. The activity can be assigned to each student.

For students with learning disabilities I usually review the case study with the whole class and then allow them to go through the study again at their own pace. My grouping of students allows the students to work with different ability levels to build up their skills. I rotate these groups throughout the unit to allow for more diversity. The activity can be assigned to each student.

Give each group time to discuss and put their findings in an electronic journal.

VIII Daily Unit Plans

Following the 5E's

Title of Curriculum: Immunity Friend and Foe! The How and the Why!
Immunity as a Friend

Background information:

Students will make connections about what they understand about Immunology. Students do not have to fully understand the meaning of the vocabulary words in Activity 1. This is to help students become actively engage in how much they are learning and to build up background knowledge.

To set the stage for this activity asks questions about What happens when you get a cut? What happens if you eat food that was sitting around for long periods of time? Then have the students continue to generate questions that they might want to find out about as they learn about immunology. Have the students create a journal to record their thoughts or use an electronic journal such as google classroom or Edmodo.

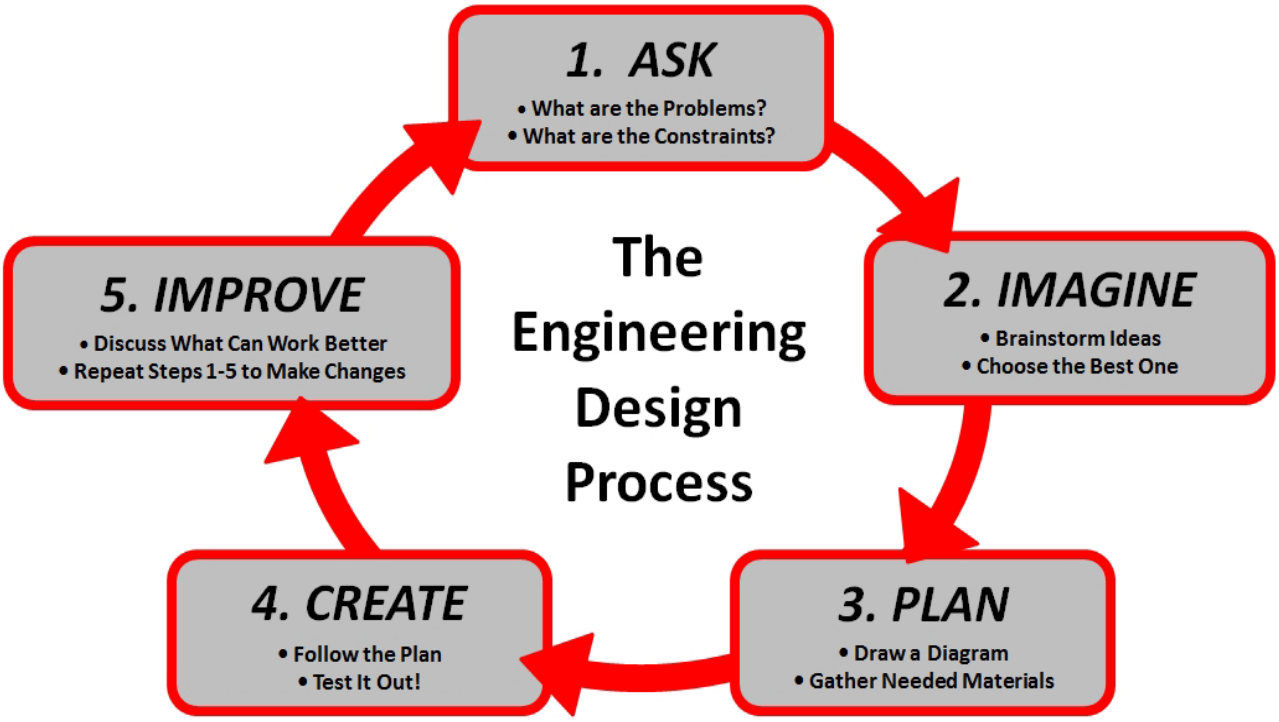
Ask

In this activity, the students will discuss how the immune system functions. Some of the basic components for fighting diseases and keeping the body healthy.

Vocabulary that the students will become familiar with:

> Immunity, Immune system, immune response, antigens, antibodies, memory cells, mast cell T-cell (cytotoxic vs helper), B-cell, macrophage, vaccines, active immune system, memory cells, innate immune system, and inhibitors. They should be able to use these words interchangeably throughout the activity. Definitions are provided in the teacher's guide at the end of the lesson.

The engineering design process will help students work as a team.



Standards Next Generation Science Standards
HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. LS-1. Systems of specialized cells within organisms help them perform the specific functions in life.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. Multicellular organisms have a hierarchical structure of organization, in which any one system is made up of numerous parts and itself is a component of the next level.

Engage

Lesson 1 Day 1: 50 -55 minutes, Honors/AP group 30 minutes
Exploration: Medieval army

Students will answer questions about:

1. What are some of the qualities that make a good army?
2. How does the army function as a group? Describe the jobs or roles.

3. Why do you think it is necessary for knowing what an invader will do?
4. How does an army defend themselves from invaders?
5. Describe some skills and strategies that an army will need if the invader attacks from different areas at once.
6. What would happen if the army became angry with each other and started to fight? among themselves?
7. What guidelines or rules do you think need to be in place for an army to be? successful?

Plan

Students will spend time discussing their thoughts. They will write down their responses and discuss how these responses can be applied to staying healthy? *(Note you can start Day 2 along with Day 1 if you feel students understand the concepts of how the immune system is like an army that is defending its territory).

The goal of this activity is for the student to think about the immune system as an army that is defending itself from invaders. They will compare these traits and be able to better understand how the immune system functions as a team. Each member of the army has a job/function and if one falls the others in the army must pick up and fight. Together they form a defending and invading team to control invaders from coming in and taking over their territory.

The activity starts the students to process how each part of the immune system reacts when an invader/pathogen is introduced. Refer to this army relationship so that the students will develop a better understanding of how the immune system has certain cells that do a certain job and need other cells to activate/tell them what to do. So that when the team has an invader the designated cells and rid the body of the invader/pathogen. Students should also be aware that sometimes the command to fight and invader or when the cells start fighting themselves the immune system still tries to function but not as well. The casualties of the fight would be disease and inflammation.

Imagine

Using graphic organizers students and compare how the immune system changes over time and what is needed to keep it functioning healthy. One thing the teacher needs to do is explain how the immune system functions normally and when it does not. When things go bad in the immune system diseases such as cancer and HIV occur.

This is also a good time to introduce how to use an electronic journal and/or how their written journal book should be set up. If they are unfamiliar with graphic organizers review them here and also before they start the next activity. Usually, this can be used as a self-assessment to help the students guide their learning.

Lesson 2:

85-90 minutes (lab) block or two 40 to 45-minute classes
Activity 2 Friends stick together!

Engage

Students will be given a set of cards for the of immune system cell: Helper T-cell, B-cell, and macrophage with the name and short description of their function. They will create the model on their card with the materials provided. The cards have receptor sites that are color coded and will only fit one specific pathogen. This will require more preparation time on teachers' part or you can give this as a homework assignment. I recommend that you have a sample available for students to see if given for a homework assignment.

Students working with the completed cards will be given a ready to use set of macrophage, eosinophils, T-cells and B-cells that have the cells' name and function on it. They should also have the ability to hot glue the pictures of the cells with their names and short function onto the cards. I suggest you use 5/8 index cards so the pictures will fix better and you can cut the interlocking shapes better.

Students working with the large styrofoam/ jack balls or cardboard should have the different colored pipe cleaners already attached. the ability to hot glue the pictures of the cells with the name and short function on them.

**Note: If you do not want to spend class time assembling the cards you can assign it for homework or this can be done by teacher. If you use the large styrofoam balls/jack balls you can use different color pipe cleaners to make the distinction between the different types of cells. This works better than attaching pictures to them.

Directions: Students will be given 5 to 10 minutes to read the type and function of the cells they have and how their cells will interact with each other after there are paired. The students will be grouped into groups of 4/5 in which one member will have a virus/bacteria card. They will be able to walk around to find a match with another group of 4/5 members who have 3 virus/bacteria cards. After 10 minutes all groups will stop and if your immune system card was matched up with the virus/bacteria you both will sit down until round 2. For those that did not match up two more immune cell cards and virus/bacteria will be introduced and they will try to find matches. The teacher should understand that the only immune cells that should not match up are the cells of the adaptive immune system, for example a memory cell. They will match up in round two.

During round two the idea of immunity is introduced so the students that matched with virus/bacteria first in round one will maintain immunity and be given extra B-cells. The other groups will be introduced to a different virus/bacteria and try to match up. Continue this for about three rounds and then introduce the virus/bacteria that no one is immune to and this will allow the infection to spread until everyone is infected and the immune system will become helpless. This will show the importance of vaccinations.

The box and styrofoam will be able to see how the cells match up. If you use this method be sure to use rubber jack balls or baseball size styrofoam balls the smaller styrofoam don't work

as well. *Note if you are using the jack balls hot glue felt strips to one side and use different color pipe cleaners to help with matching. In order to get the styrofoam pieces to be shaped differently the easiest way is to add pipe cleaners of different colors and when you roll the balls in the box the pipe cleaners that will match will have the same color. You will need one set for each group that you are working and/or as a class 1 large box with and extra materials for each student to place in the box to make a match.

Round 1:

Student groups are given 5 to 10 minutes to review the card they have been given and allow them 5 to 10 minutes to interact with another group. The students that have matched will stop and sit down and the others will be given more coded cards to make a match. After another 2 minutes the students will be allowed to match. If students have not matched in round one, they will be given more cards that are compatible to the ones who matched in round one. They will become the B-cells of round 2 and will react to the virus/bacteria because it was found in the system previously. These students will be able to bond to the virus/bacteria immediately.

*Note the virus' color code for cards and pipe cleaners for the large styrofoam/jack balls in the boxes will only react with one cell type. The pathogens are color coded so if you have the appropriate B-cell card and the student with the appropriate T- cell card will bind the virus so they must find each other. Once they have found each other, the student can remove their match from the box and the teacher can add more virus/bacteria balls to the box for the next group. Each group/team will record in their journal what matched and when every team has completed 1 round record what is eft in the box. This will continue for 10 to 15 minutes or until all groups have had a chance to see if they have matched. If students have not matched in round one, they will be given more cards that are compatible to the ones who matched in round one. They will become the B-cells of round 2 and will react to the virus/bacteria because it was found in the system previously. Then the students will be able to bond to the virus/bacteria immediately. The teacher will add more virus/bacteria balls into box to setup for round 2.

Goals

The students should be able to see a pattern developing where by the T-cell and B-cell produce antibodies that are getting rid of the introduced pathogen. These are the main cells that fight against the invaders that come into the body. They come from different sources but work together. They will receive excess antibodies for that the same type of pathogen and they should see the relationships between antibody and antigen. The outcome of this round is also to allow the student to visualize how the immune system cells work together and that how they are activated when a virus or bacteria is introduced.

Round 2:

The same pathogens will be reintroduced and the students who have already generated a response to their pathogen will be able to react quickly. They have seen this invader before and they are ready to destroy it just like an army knows its enemies moves. During round two the students will be introduced to memory cells. The students will proceed as they did in round one but more memory cells will be introduced along with the virus/bacteria. Again, students will

proceed to make interactions as quickly as possible. All students should see an interaction match. When they align the cards that are color coded or shaped coded they will get more antibodies from the teacher. The idea of immunity is also reintroduced so the students that matched with the virus/bacteria first in round one will maintain immunity to certain pathogens and can be given extra B-cells. All of the groups will be introduced to a different virus/bacteria and try to match up. Each time they match up they will be given more memory cells so they can maintain immunity for that particular virus/bacteria.

Continue this for about three rounds so that students will get a sense that the immune system will be able to handle all virus/bacteria and then introduce the virus/bacteria that no one is immune to and this will allow the infection to spread until everyone is infected and the immune system will become helpless. This will show the importance of vaccinations and it will also show that sometimes the immune system cannot handle every virus or bacteria and the pathogens can spread and lead to disorders.

Thought Question

How fast can the immune defense react, which cells can react the fastest? Why? *Note, introduction of memory cells*. This will be used to keep students thinking about how the immune system uses memory cells.

Goals

The students that had interactions in round one will use the antibodies left over from round one continues to interact with the same pathogen because they know this enemy. They will have a quicker response in round two to the pathogen from round 1and a slower response for the new pathogen. The memory cell of the adaptive system present can recognize the original pathogen quicker, so it is destroyed faster. The introduction of the new pathogen will allow the students to understand that the immune system is always making changes and adaptations to combat the new invaders. The process is not always immediate and once again if the immune system is functioning correctly it will be able to destroy the "enemy pathogen". It is important that by the end of this lesson that students understand how the innate immune system functions as the first responder and the adaptive immune system takes a little longer to react and is activated by the presence of antigen in the body' s system. Students should take about 10 minutes to have a discussion or review of this.

Students should also reflect on how long it took to react in round 2 and its significance. Students will see what cells are necessary to recognize a pathogen/invader. If they have the correct cells for that invader/pathogen they will see a quicker response because they will have the receptors for the invader/pathogen. They will be able to see after some time, that eventually the receptors will be exposed to the invader/pathogen and they will develop memory to destroy them quicker, which is the job of the adaptive immune system. Finally, the students should discuss and write about why some invader pathogens can go undetected and cause the immune system to shut down and the pathogen will thrive. Here the teacher can introduce autoimmune diseases and cancer and have the student research and discuss this. They can also research what Immunologists are working on to help discover new vaccinations and cures to help the immune system fight these pathogens.

Lesson 2 part 2

Students will be given several pathogens and see how many steps it will take to defeat all of the pathogens. This can be used as an extension for students who want to explore more or create a situation whereby a subject has an immune system that is not functioning normally and every pathogen becomes an infection. Some of the pathogens will have been present in round 1 or 2 and others will be new. They will go through the same process and describe in round 1 and 2 and they will write in their journals how some pathogens could easily be bound up and others needed more time to build up antibodies. While other pathogens overran the immune system and the subject would have no defenses left. Students will share out their results and make a chart to be used later.

Goals

Students should recognize how the innate and adaptive immune system functions and how quickly they can respond to new and old pathogens. This is a unique opportunity for students to explore how the immune system can sometimes not function perfectly and how pathogens can mimic the immune cells so they will not recognize them. Explain the vocabulary and give more clarification for all of the vocabulary that the teacher has introduced.

Note if you use this for AP Biology or less than 15 students in a class, I would suggest the students build or draw models of each interaction. They can use materials such as small styrofoam balls, jack balls, beads or buttons, to illustrate the interactions from round 1 to round 3 and write about what happens in their model when all of the invaders have attacked the immune system is over run. Have each group explain their model and make predictions for future changes with new discoveries for immune research. You can also have them build a model at the end of the activity using either the cards or other materials.

The purpose of activity is for students to get to an understanding about the immune system's function and how quickly it must react to shut down a disease. It is also designed to introduce the vocabulary so that the students will see the correlation between the function of the immune system as well as the components without memorizing a lot of terms. This will give your students a good foundation to build on.

Create

Also, the students will better understand how some pathogens and diseases can fool the body when the right receptors are not found.
Extension activity would be to have the students create a model of how the immune system destroys a virus.

Pictures of various T-cells attacking cancer:
https://www.alpineimmunesciences.com/our-science/

Materials: index cards with pictures of types of cells (color code each picture to match certain viruses), if you don't want to use cards you can use pipe cleaners, pony tail beads to make them, Styrofoam balls/or cotton balls for viruses and double-sided tape or Velcro to make the immune system cells attach and the lesson becomes more interactive.

Procedures:

Students will build models to reflect what they have learned about T-cells and how the immune system functions. They will also build a model to reflect on how cancer attacks the immune system by fooling it to think it is not harmful to the body. They can use the website as a resource to help them design how the immune system tries to handle this threat.

Goals:

This is an open inquiry based on what the students have learned in lesson 2. You can have students keep models for B-cell antigen receptor sites in next activity. Students will keep a journal of what receptor interacted and as each new virus is introduced and how it reacted within the immune system. Students will keep their models as a reference.

Rubrics: This rubric is designed to be used with the engineering design process and as the students have been working through the lesson they will build the model.

Building A Structure : Using the Engineering Design Process

Teacher Name: _____

Student Name: _____

CATEGORY	4	3	2	1
Ideas are Discussed Ask	Accurate information taken from several sources in a systematic manner.	Accurate information taken from a couple of sources in a systematic manner.	Accurate information taken from a couple of sources but not systematically.	Information taken from only one source and/or information not accurate.
Imagine	Plan is neat with clear measurements and labeling for all components.	Plan is neat with clear measurements and labeling for most components.	Plan provides clear measurements and labeling for most components.	Plan does not show measurements clearly or is otherwise inadequately labeled.

Only Used Materials in Bag Create	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.
How did it work? Plan	Data taken several times in a careful, reliable manner.	Data taken twice in a careful, reliable manner.	Data taken once in a careful, reliable manner.	Data not taken carefully OR not taken in a reliable manner.
Improve the Model Improve	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.
Total Points				

Students will record all responses in their lab journal book or electronic journal.

Lesson 3 Day 1 Immunity as a Foe

Background information: Students should be able to read short essay that describes how the immune system and how cancer and autoimmune diseases occur. In this fictional case study the students should record information that they think is important. The case study involves three subjects that have been exposed to a pathogen and subject A is showing no apparent changes. Subject B, has developed some mild changes but not life threatening, while subject C has a lot of changes and some could be detrimental their survival. They should be familiar with how to work through the case study and collect data. The teacher can read the case study to class or allow the students to work together to analyze the information. Graphic organizer can be used to categorize each subject's important information.

Standards Next Generation Science Standards
HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of

specialized cells. LS-1. Systems of specialized cells within organisms help them perform the specific functions in life.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. Multicellular organisms have a hierarchical structure of organization, in which any one system is made up of numerous parts and itself is a component of the next level.

Procedure

Day 1: Give students the fictitious case study and have them review.

Activity: So you want to be an Immunologist
Students will be introduced an interactive way to become an immunologist. They will be given two case studies and materials to set up and analyze their results. The students will use materials that display and show case their findings.
https://www.environmentalscience.org/career/immunologist
Getting started: The goal in this lesson is to review how the immune system reacts using the Immune Response Game.
https://www.nobelprize.org/educational/medicine/immuneresponses/
After, the students have reviewed what immunology is they will be given cards with information about a pandemic. It will be their job to discover what the cause was and how they can activate a possible cure using the immune system. Students will be given a sample case study an example and different cells and their function in the immune system. The students will be able to go through a series of protocols to identify and eliminate the viruses or bacteria.
The Goal of this activity is to help the students identify and set up a protocol to understand the process of immunity and how it can be related to how viruses and diseases are transmitted and why vaccinations are important.

The following is a fictitious story created by Judith Lucas- Odom to be used with this activity. You have permission to use it in your classroom with this activity.

On my last trip to the South American Jungle, just outside of Bolivia, I found out that a small village had just been involved with an unexpected pathogen. My team and I were curious to see if this pathogen had any link to the epidemic that just occurred about 300 miles north just south of Peru. The villagers were happy to assist and they would supply information about three of subjects that were affected by the pathogen and no connections to how they received the pathogen could be determined by them. They were also curious because this particular pathogen has only been seen occurring once before 5 years ago when they had people buying fertilizer from out of town. The villagers wanted to know why it occurs with such infrequency.

The diet and water intake of each subject was made available. Along with the living conditions and waste faculties in the surrounding areas. The pathogen itself was believed to be able to be passed on through the water and it was resistant to certain know antiseptics that the village had used previously.

The water that each participant had drunk from did contained traces of e-coli, and some low levels of bacteria that were not identified. The living conditions for such A and C were similar; they lived closer to the city and drank their water from a freshly drilled waterhole. Participant B lived closer to the jungle area and relied more on the water from the river nearby. After testing the river water for pathogen is was confirmed that it contained several high levels of e-coli and pathogens for cholera.

The diet of each person was similar. All the participants relied heavily on plant, rice, beans and vegetables that could grow in their gardens because the food at the local store was much more than their families could afford. Consequently, we began to test the food sources and the soil for containments and found high levels of pathogens that were related to hepatitis and influenza.

Each subject claimed they were given soil that would help their plants grow better and yield a better crop. The soil was traced back to an area than had only been trading with the village for about a year. When we visited the town, it was discovered that the soil was from a dump site that contained large amounts of dung and fertilizer biomass from the recycling plant.

They symptoms for Participant A were fever and gastrointestinal pain, and had jaundice symptoms a few weeks ago. Participant B had low fever and gastrointestinal pain, with swelling of the lymph nodes with joint pain. Participant C had a high fever and gastrointestinal pain with vomiting and swelling throughout the body, and jaundice. We do not have a large enough team to continue to help the villagers and we need help to stop the spread of the pathogen. Each participant had developed sepsis from pneumonia- symptoms.

I learned that you and your team would like to become an Immunologist, so we are inviting you to join us to explore the cause of this outbreak as to prevent further contamination.

Directions for the activity:

Make a list of the important information that will help us figure out what is going on. You will then try to test your theory by using a simulated test. The goal is to determine which pathogen is the main cause.

Procedure for the test:

We will use different acids and bases to simulate the pathogens. 1. Lactic acid pH 3.5, represents influenza and reacts with patient B and C. 2. Acetic acid pH 3.9, represents no reaction and 3. Carbonic acid pH 4.68 represents no reaction, 4.Boric acid pH 6.12 represents no reaction. All are in 1mM for each and if you dilute with water the pH will go down slightly. 5. Sodium Hydroxide Carbonate pH 8.27 slight reaction for only patient A, and 6. Sodium borate pH 9.21, represents cholera and reacts with all three patients. 7. Calcium Carbonate pH 9.91 represents no reaction. You will label three microplates one for each patient and across the top you will label the Acid/ Base as each slot 1 to 4 and vertically A, B, and C. After adding the acid place indicator in 1,2 and 4 only. Place your base # 5 into 1 should see a color change and place #7 base into 2, should see a color change. Place base # 6 into 4 and you should see a color change that will react with all three patients this will signify the pathogen to be cholera.

The students will research how cholera can be transmitted and go back to the case study to find the clues that show the soil from the other village was contained with feces that contained cholera pathogen.

As the students investigate you might want to lower the pH with some samples to have them check for accuracy of their initial findings. Make sure students continue to record their findings in their lab journal or electronic journal.

Students will be able to read and follow the directions for the case study. You will be able to change and adapt some of the questions from the case study or follow the guidelines given below to help your students better understand why the adaptive immune system is necessary and why vaccinations are important. Note it is easier to break up the case study into different periods. You will need about two class periods of 40 to 50 minutes each.

Use the following guidelines to analyze the case study.

1. Carefully read the case. Highlight what you think is important. You can underline important facts or key items that will help you. Use any background information available. Explore your information, what else can you find out about the situation disease and carefully record your results. Make sure to record your information on your log sheet.

2. Start to formulate questions. Make a list of what you know and what you need to find out. These questions are only guidelines to help you focus in on the key problems. You might want to identity several problems but not more than three. Use caution and work on one problem at a time. If your team decides to work on each one at once give each person a different problem and make sure to discuss all your findings. Is this important to know? How does this relate to the situation? What does the evidence show directly or is it implied? What information is relevant to the case and what can you discard? If you find you out about any other similar cases at the time. Compare all results. Record all your findings.

3. Write down your possible solutions based on facts not just what you think. Before getting started set up a simulation to help. Students will write using, "A What if… question" and decide if what you discovered is relevant.

4. Finally, after group discussion and testing, select your best solution based on your facts. Make your recommendations and any possible future actions to prevent reoccurrence if applicable.

Case Study Guide Log

Name_____
Case Study Title _____
Important Information
Subject A

Reliable/Need	Somewhat Reliable	Need more Verification

My Questions for Problem 1_____

What I Know	Learned	What I Need to Find Out

Case Study Guide Log

Name_____
Case Study Title _____
Important Information
Subject B

Reliable/Need	Somewhat Reliable	Need more Verification

My Questions for Problem 1_____

What I Know	Learned	What I Need to Find Out

Case Study Guide Log

Name_____
Case Study Title _____
Important Information
Subject C

Reliable/Need	Somewhat Reliable	Need more Verification

My Questions for Problem 1_____

What I Know	Learned	What I Need to Find Out

Lab Data Analysis So you want to be an Immunologist

	1	2	3	4
A				
B				
C				
Write color if reacted/ No reaction if doesn't				

Repeat each test three times for accuracy.

This can be used as an extension or it can be used as an assessment of what your students understand about Immunology research.

Students can use the case study series this is an Interactive case study site to help them relate to what has already been done and possible areas of future research.

http://www.biology.arizona.edu/immunology/cs/cs_2/default.html

As a challenge, have the students have them collect information about vaccinations and autism. Have the students make a questionnaire to ask adults about what they believe or don't believe. Make a poster or public awareness presentation for or against vaccines based on their findings.

Lesson 4 The How and Why of Flow cytometry

Background introduced what the Flow cytometry is. Using power-point, the teacher will introduce what Flow cytometry is and how it is used in the immunology lab. https://docs.google.com/presentation/d/1dgWTmv3hwgyqQOSZzB42yMtVoQL3g3gAdfk1YMfAOW0/edit?usp=sharing

Students will be able to look at data from experiment using spleen cells from a mouse that was used to see how IL-27 is expressed in CD 4 and CD 8 cells.

Students will analyze data from lab work and article (Stumhofer, et al. Nat Immunol. 2006. 7(6) 937-945) https://drive.google.com/file/d/0B89v9YDxfa7QOFk4U0sxcTJQVFE/view?usp=sharing

p.941 and compare with actual lab results

Students will be able to look at data gather from my summer experiments using spleen cells from a mouse that was used to see how IL-27 is expressed in CD 4 and CD 8 cells.

Actual Lab power point

https://docs.google.com/presentation/d/1VZRse72gU8d-QkbWn57lvbt0brRTRb6SgMwQSaFTb3g/edit?usp=sharing

This will help them understand how flow cytometry works for the experiment performed in the Immunology lab for day 1 and day 2. Students will be able to understand how an Immunologist finds way to show that a cell that is exhibiting a pathogenic reaction can be blocked or turned off. This can be done through the use of vaccinations or signals that would inhibit the pathogen from multiplying.

They will conclude the lesson by playing Jeopardy using what they have learned.

https://jeopardylabs.com/play/immunology-jeopardy

Lesson 5
Analysis using ELISA

Students will be analyzing blood samples (which is made from a mixture of milk, red food coloring, and for the antigen-antibody reaction acetic acid and hydrogen peroxide or carbonate).

They will take the different samples and follow the Elisa instructions to see which samples show a reaction. The following day they will look at food allergies using milk and follow the protocol for analyzing a reaction to drinking milk.

The kit is the AIDS testing Simulation- student kit https://www.flinnsci.com/aids-testing-simulation---student-laboratory-kit/fb1572/ Carolina has a kit that you can use and comes with teacher guide https://www.carolina.com/biotechnology-elisa-kits/elisa-simulation-kit/FAM_211248.pr teacher guide https://www.carolina.com/teacher-resources/Document/elisa-simulation-kit-sample-teachers-manual/tr32945.tr

Or if you have the equipment you can make a test that looks like the kit using changes in the pH to have the color change in an incubator or just sit over- night. Provides enough test for 30 students and you will need two kits or just buy the refill. Students will collect their samples and decide which antibody A (acid) or B (base) to use. Not all the samples will react and this will be your neutral solutions. The pH would be around 7. They will record each of their samples clean up and try the other antibody. You need to make enough samples for up to 25 students to run to tests using 4 different blood samples (O, A, B, AB) that are infected and 4 more samples that are not. Keep a chart of what is infected to help students figure out if they cross contaminated their blood samples.

The students can also look at how scientists use ELISA in a virtual lab simulation. This lab has questions and online journal that the students can use to a better understanding of how the ELISA functions.
http://www.hhmi.org/biointeractive/immunology-virtual-lab

Blood type	A1	B1	AB1	O1	color change
Antibody A					
Antibody B					

Record all information and note color changes if any. Students can repeat using another table for part 2 of lesson.

Follow-up Questions

1. Explain why some samples showed a slight reaction but not a true color change?
2. Why is this test useful for blood typing? Explain
3. Research other uses for this test that would help a person that is constantly having allergic reactions.

IX Summative Assessment

Rubrics: These rubrics are created for free at rubistar.4teachers.org

Lab Report: Case Study

Teacher Name: **J Lucas-Odom**

Student/Group Members
Name: _____

CATEGORY	4	3	2	1
Participation	Used time well in lab and focused attention on the experiment.	Used time well. Stayed focused on the experiment most of the time.	Did the lab but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Calculations	All calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results labeled appropriately.	No calculations are shown OR results are inaccurate or mislabeled.
Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship between the variables are not discussed.

	changed.			
Summary	Summary describes the skills learned, the information learned and some future applications to real life situations.	Summary describes the information learned and a possible application to a real-life situation.	Summary describes the information learned.	No summary is written.
Appearance/Organization	Lab report is typed or neatly written and uses headings and subheadings to visually organize the material.	Lab report is some-what neatly typed or written and uses headings and subheadings to visually organize the material.	Lab report is neatly written or typed, but formatting does not help to visually organize the material.	Lab report is handwritten and looks sloppy with cross-outs, multiple erasures and/or tears and creases.
Data	Professional looking and accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Accurate representations of the data in written form, but no graphs or tables are presented.	Data are not shown OR are inaccurate.

Lab Report: Case Study

Teacher Name: **J Lucas-Odom**

Student Name/Group Members
Name: _____

CATEGORY	4	3	2	1
Participation	Used time well in lab and focused attention on the experiment.	Used time pretty well. Stayed focused on the experiment most of the time.	Did the lab but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Experimental Data	All experimental data is shown and the results are correct and labeled appropriately.	Some experimental data is shown and the results are correct and labeled appropriately.	Little experimental data is shown and the results labeled appropriately.	No experimental data is shown OR results are inaccurate or mislabeled.
Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship between the variables are not discussed.

Summary	Summary describes the skills learned, the information learned and some future applications to real life situations.	Summary describes the information learned and a possible application to a real-life situation.	Summary describes the information learned.	No summary is written.
Appearance/Organization	Lab report is typed and uses headings and subheadings to visually organize the material.	Lab report is neatly handwritten and uses headings and subheadings to visually organize the material.	Lab report is neatly written or typed, but formatting evident.	Lab report is handwritten and looks sloppy with cross-outs, multiple erasures and/ or tears and creases.
Data	Professional looking and accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Some accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Little accurate representations of the data in written form, but no graphs or tables are presented.	Data is not shown OR is inaccurate.

Student Guide

Lesson 1 Day 1
Following the 5E's

Thinking and working like a scientist is important as we work through these various activities you can begin to understand how the Immune system is a good friend when it is working properly! Remember your role for the activity Principal Investigator, Recorder, or Clean up!

Title of Curriculum: Immunity Friend and Foe! The How and the Why!
Immunity as a Friend

Goal: To understand what things are necessary in a good relationship while comparing this to how the immune system works for us.

Day 1 Lesson 1:

Thought Questions: How fast can the immune defense react, which cells can react the fastest? Why?

Exploring what makes an army good at defending against an invader and comparing this to how the immune system works. Before you get started, pick your role for the day.

Roles: Principal Investigator, Recorder, Clean up

Take about five minutes to answer the follow questions and share within your group what you think and what your group would like to share out with the other groups. Please keep a record of your thoughts as well as the groups. think and have your recorder be prepared to share that information with the other group. While you are waiting think about how this could relate to science.

Questions:

1. What are some of the qualities that make a good army?
2. How does the army function as a group? Describe the jobs or roles.
3. Why do you think it is necessary for knowing what an invader will do?
4. How does an army defend themselves from invaders?
5. Describe some skills and strategies that an army will need if the invader attacks from different areas at once.
6. What would happen if the army became angry with each other and started to fight among themselves?
7. What guidelines or rules do you think need to be in place for an army to be successful?

Write your thoughts in your journal and discuss with your team members. After about 5-10 minutes record your answers as a team, your similarities, what you need to find out and what you are sure about and post in school forum/or tablet paper for class on wall.

Lesson 2

Thought Questions

You are a cell in the immune system and something has entered the system that you may have a receptor for you are going to try to find it and bind it? What are your options to get rid of this invader/pathogen before it destroys other healthy cells? Record your answers in your journal and or post on wall

Goal

Understanding how the immune system functions to help a system that is attacked by virus or bacteria. Each group has a set of cards that you will cut out and use them to attach yourself to another card at the receptor site. You will have 10 to 15 minutes to find your interaction. Your team can get antibody cards only after you make an interaction. You can move around with your cards to see what T-cell or B-cell will bind to release the antibodies that will destroy the pathogen/invader. You will take that person or their cards back to your team and record the reaction. If no reaction, you will be given different pathogen/invader cards the second round. You will have about 5 to 7 minutes to complete your task and record.

In the second round, you will be given a different pathogen/invader as well as the original one and you will begin to seek out how fast you can interact with the pathogen/invader to destroy it. Remember to check your binding site and make sure they will match up. If they don't you will be given different pathogen/invader along with the original pathogen/invader. but your card or cards on the table and stand with others in your group that have matched. You will have 10 minutes to match up or find a group to stand by.

Lesson 2 part 2

A virus that has not been in the body for a while has encountered you again. You will be able to pick up all the cards to see which ones can bind with the organism that has just invaded. Record your answers and any questions in your journals.

Questions for Lesson 2 part 2

1. Describe what happened as you attempted to stick together another immune member without the virus present and when the virus is present.
2. Describe how long it takes for the body to get rid of the virus using the immune defense team from round 2 and after a new virus was administered.
3. Share your results and reasons why things bound and some things did not bind.

Lesson 3
Case Study
Relevance:

Understanding that the immune system needs to react when reoccurring viruses appear. The adaptive system must be exposed to antigens to produce antibodies. The Influenza virus is a very common virus that people often think they are immune to it but there are many different strains and there are many mutations that can occur. In this case study, you are the General Surgeon of the United States and you and your team are visiting South America to talk about influenza when a small village asks for your help in solving a problem pathogen that has occurred before it becomes an epidemic. Your tasked is to review the findings of the villagers and help decide which pathogen has caused the problem. You will also need to trace back to the origin of the source of the pathogen. You and team are Immunologists in training and you are very willing to help. Read the case study and get to work. Secondly, you will address some of the problems that other pathogens as well as the influenza address so that the people in the village can better prepare if there is another outbreak.

Use the following guidelines to analyze the case study.

1. Carefully read the case. Highlight what you think is important. You can underline important facts or key items that will help you. Use any background information available. Explore your information, what else can you find out about the situation disease and carefully record your results. Make sure to record your information on your log sheet.

2. Start to formulate questions. Make a list of what you know and what you need to find out. These questions are only guidelines to help you focus in on the key problems. You might want to identity several problems but not more than three. Use caution to work on only one problem at a time. If your team decides to work on each one at the same time give each person a different part or participate to work on but make sure you follow a similar protocol. Discuss all your findings with every member of the team. Is this important to know? How does this relate to the situation? What does the evidence show directly or is it implied? What information is relevant to the case and what can you discard? Compare all results. Record all your findings.

3. Write down your possible solutions based on what you have tested and facts not just what you think. Consider writing questions using What if… question and decide if what you discovered is relevant.

4. Finally, after group discussion, select your best solution based on your facts and your test results. Make your recommendations and any possible future actions to prevent reoccurrence if applicable.

Remember to record all your information and share out your findings with others in the group to form a possible reason why!

Lesson 4

Watch the power-point and read page 945 from the article and write about the findings from the research and what was found in the samples from the teacher's lab. Note all similarities and differences in your journal. Research possible future applications for using this to study how cells react to cancer/ autoimmune disease or allergies. This lesson can be used with the entire class or given out as an extension.

Lesson 5

Students will work in teams and read the protocol and lab safety must be used before starting the activity. Gloves, goggles and aprons must be worn.

Protocol

You are Immunology researcher who has a friend that needs advice. They work in a hospital and there is a rise in patients coming in that need blood transfusions. Four of the five patients are showing some type of reactions to their transfusion and you are wondering if something could be present in the blood that is not normally present that would cause this reaction. They give several samples of the five-patient's blood and the two antibodies that are in question. Your job is to find out what the possible cause that would create this problem. Use the table and kit your teacher will give. Read the directions about using the material that is provided in the kit before setting up your test.