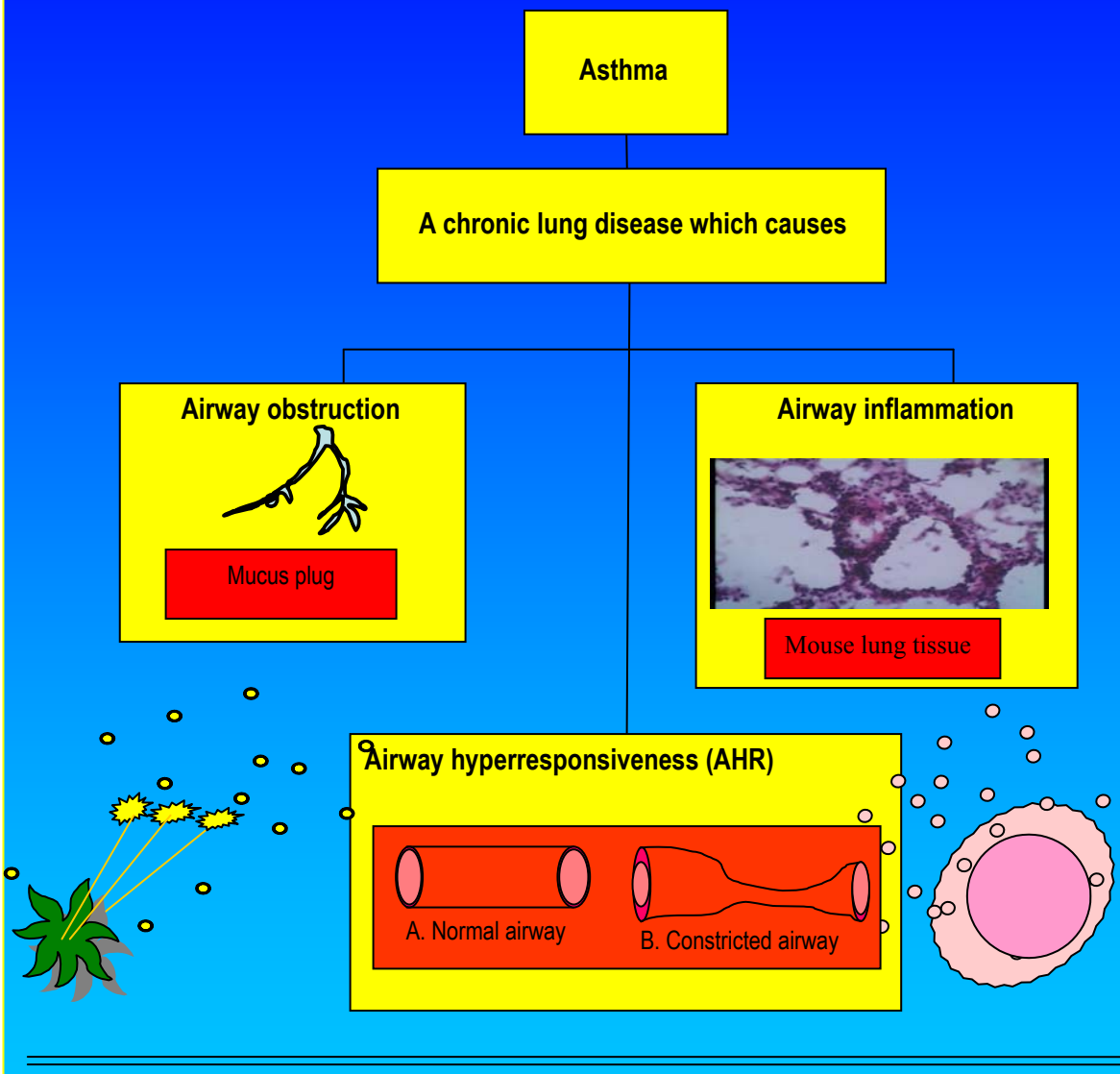
An Asthma Vaccine! Is It Possible?



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Introduction

The goal of this unit is to engage students in activities that will enhance their knowledge on how the immune system prevents and protects us from pathogens. This unit is divided into two parts: a normal functioning immune system and a hyperactive immune system. The normal functioning engagement activities consist of using an immunization record to understand the reason for getting immunized; animal and human testing safety and efficacy, distinguishing the differences between active and passive immunity; identifying white blood cells, and identifying steps involved in a western blot protocol. The hyperactive engagement activities consist of an asthma survey, asthma research, type 1 hypersensitivity illustration, and identifying inflammatory cells, the eosinophils involved in the production of excessive mucus in the airways. Asthma is used as a type 1 hypersensitivity response. Asthma was selected because it is a chronic lung disease that is constantly increasing among young people.

Hopefully, after completing the unit, the students will possess additional knowledge that will help them make informed decisions on disease prevention in our global society, and develop problem-solving skills need to solve disease prevention issues locally, nationally and globally. These young minds will be our future decision makers in helping shape our health system ethically, financially, and socially.

Teacher Guide Outline

The teacher's guide is composed of science standards, background information, learning objectives, and possible directions and explanations for the implementation of the engagement activities. The outline below is a brief chronological overview of what information is included in this unit. The modified version of the national science standards can be rewritten to comply with local and state standards.

I. A modified version of life science national standards is printed below.
   A. Use unifying science and process skills.
   B. Incorporate inquiry laboratory activities.
   C. Understand the function of cells involved in a type I hypersensitivity immune response.
   D. Relate the influence of genetics to health issues using asthma.
   E. Investigate the evolution of blood cells.
   F. Examine human environmental influence on asthma and its impact on the human population.

II. Science background information on immunizations and the immune system are included.
   A. Immunization background information covers common vaccines administered to children, passive immunity and active immunity.
   B. The immune system background information includes the primary organs, the evolution of blood cells, humoral-mediated (B cell lymphocytes) response and cell-mediated (T cell lymphocytes) immune response.

1. The primary organs of the immune system are the bone marrow and the thymus.
2. All blood cells evolve from hematopoietic stem cells.
3. Humoral immunity (or antibody immunity) responses are activated antigens that stimulated the production of serum antibodies (proteins secreted by the B lymphocytes).
4. Cell-mediated immune responses are stimulated by antigens that activate antigen specific T lymphocytes by binding to receptors which are located on the cell surface of the T lymphocytes.

C. Asthma, IgE-mediated hypersensitivity, is classified as a type 1 hypersensitive reaction.
   1. Type 1 hypersensitive reactions are induced by allergens.
   2. Humoral immune responses (serum antibodies) are involved in the mediation of type 1 hypersensitive reactions.
   3. Degranulation of mast cells and blood basophils is due to the cross-linkage of membrane-bound IgE antibodies to Fc (fragment, crystallizable) receptors.
   4. The hallmarks of asthma are airway obstruction, airway inflammation and airway hyperresponsiveness.
   5. Certain factors cause type I hypersensitivity immune responses.
   6. Two major types of drugs (bronchodilators and anti-inflammatory drugs) are administered to control type 1 hypersensitivity immune responses in asthmatics.
   7. A genetic link has been shown to exist among some asthmatic families.

Background Information on Immunizations

Edward Jenner is credited for developing the first vaccine by inoculating a boy with pus from cowpox and later infected the boy with smallpox. The results of Jenner's experiment, which were reported in 1798, showed that the boy was immune from smallpox. Since Jenner's experiment, a vaccine is defined as a preparation of antigens combined to evoke the appropriate immune response against a specific pathogen. The administration of the prepared antigens (vaccine) used to evoke immunity is called a vaccination. There are two primary requirements for a vaccine: safety and efficacy. Before vaccines are tested on humans, animals are used as models to determine the level of toxicity (safety) and how well the vaccine produces an immune response (efficacy). Animal models for HIV, such as chimpanzees which are endangered animals, are very expensive because they have to be properly cared for the duration of the test period. One important factor to remember is that the behavior of vaccines in animal models can evoke a different immune response in humans. Therefore, human volunteers are used to test vaccines before they are administered to the general public.

Human test populations are usually done in geographical areas where there are high incidences of the disease or a high risk of getting the disease. High incidences of malaria and HIV are endemic to specific areas of the world. A test population of humans is being used to test an experimental vaccine for HIV in Africa. During the human testing period, three phases are completed before determining the safety and efficacy of the vaccine. In the first phase, human volunteers are immunized to test for the safety of the vaccine. The vaccine is considered safe if there are no serious adverse effects of the vaccine and the vaccine evokes the appropriate immune response. These human volunteer studies are usually done in the country where the vaccine is developed. In the second phase of the testing period, human volunteers are challenged with the antigenic material. Medication is available to treat those human volunteers with the disease. When there is no cure or the disease is fatal or high risk, direct infection of humans would be unethical. Then, this phase needs to be combined with phase three where efficacy is determined statistically by examining the infection rate of vaccinated individuals as compared to a control group. The third phase involves selecting communities to evaluate the efficacy of the vaccine by providing facilities, financial support, careful planning, and impeccable organization to determine the efficacy of the vaccine. The major goal of the three-phase testing period is to find answers to scientific questions concerning the vaccine statistically: Is the vaccine safe for human immunizations? How many people became infected from the vaccine compared to the control group? Did the vaccine evoke the proper immune response?

The two types of immunizations are active immunization and passive immunization. Passive immunization is the short-term immunity which is the transfer of antibodies from one person to another. Examples of passive immunity are the transfer of the mother's antibodies cross the placenta (IgG) to the unborn child, and the transfer of antibodies from the mother's colostrum (IgA) and the mother's milk (IgA) to the infant. Passive immunization is administered to individuals exposed to such diseases as hepatitis, rabies, measles, and protection from insect bites and poisonous snake bites. Active immunization evokes long-term protection and immunologic memory. There are two ways (naturally or artificially) in which an individual can acquire active

immunity. Naturally, an individual can acquire active immunity by being infected by a microorganism or by being given a vaccine which is an artificial administration of the agent. Some live attenuated vaccines, which are usually viruses, are administered because T cell immunity is evoked. If the child's immune system is not functioning properly, this type of immunity can cause infections or cause the child to become ill.

Some of the common childhood vaccinations are hepatitis B, measles, mumps, diphtheria-pertussis, tetanus, polio, rubella, Hib (Haemophilus influenzae), and chickenpox. Since the commencement of childhood vaccinations, there has been a decrease in childhood diseases in developed countries because of the immunization requirements, the availability of the immunizations and easy access to the immunizations. It is important that immunizations are continued from generation to generation in order to keep the reduction rate of diseases at a minimum, and possibly causing the extinction of the microorganisms causing the diseases. Smallpox is an example of the extinction of a disease-causing microorganism.

Some reasons children are prevented from getting immunizations are because of parental fear (http://www.cdc.gov/node.do/id/0900f3ec80065bff), religious exemptions and philosophical exemptions (http://www.hhs.gov/nvpo/law.htm, Table of Contents: Religious and philosophical exemptions), a lack of finances, and a lack of easy access to the vaccines in certain geographical areas globally.

Some immunizations are given a few times as boosters to enhance the efficacy of the vaccine. An example is passive immunity where the mother supplies performed antibodies to the unborn in the first few months of the child's life. When an infant receives a diphtheria-pertussis-tetanus (DPT) immunization, the presence of the mother's antibodies, in the infant's blood, prevent the vaccine from providing the most efficient immune response. The boosters are repeated after the mother's antibodies are no longer present. Children in the United States are not administered the measles-mumps-rubella vaccine until they are between 12 and 15 months of age. In less-developed countries, the vaccine is given at 9 months of age to prevent children from developing measles. Multiple boosters of the polio vaccine are given because there are three strains of poliovirus and it is essential that an efficient immune response is performed by the three strains.

Background Information on the Immune System

The immune system is one of many systems of multicellular organisms which provide protection from pathogens. The immune system's job is similar to that of a private detective; it is constantly looking for specific and nonspecific agents that are alien to the body. Its protective mechanisms are programmed to fight off foreign agents such as microorganisms, dander, drugs, pollen, food, chemicals, or products produced by organisms such as cockroach and house dust mite. The immune system is not a system that we normally think of such as the circulatory system or digestive system. The immune system is composed of many different organs, tissues and cells. The organs are grouped as primary or secondary lymphoid organs. The **primary lymphoid organs**, bone marrow and the thymus, provide an environment that is conducive for the development of lymphocytes. The **major secondary lymphoid organs**, lymph nodes and spleen, provide areas for the interaction of mature lymphocytes with captured antigen from various tissues and vascular spaces. The circulatory system and the lymphatic system connect these organs to form a complete pathway that provides protection for the organism.

The circulatory system and the lymphatic system carry leukocytes, white blood cells (WBCs) that aid in the immune response. All blood cells originate from **hematopoietic stem cells** (HSC). Stem cells are self-renewing; they undergo cell division to sustain their survival. Humans' red blood cells and white blood cells development starts in the embryonic yolk-sac during the first week of development. Stem cells leave the yolk-sac during the third month of gestation and enter the liver of the fetus and from there to the spleen. These cells reside there until the seventh month and make their way to the bone marrow where they differentiate. At birth, there are little or no hematopoietic stem cells. Stem cells are pluripotent because they can differentiate in different ways and produce dendritic cells, eosinophils, neutrophils, basophils, monocytes, macrophages, platelets, erythrocytes, natural killer cells, T-cells, and B cells.

The B cells (lymphocytes) and the T cells (lymphocytes) are two specialized types of lymphocytes. The **B lymphocyte** development and maturation occurs within the bone marrow, and **T lymphocyte** development and maturation takes place in the thymus. These specialized cells comprise the two branches of acquired immunity. **Cell-mediated immunity** is composed of T lymphocytes (the effectors are $CD4^+$ T helper cells [T_H] and the $CD8^+$ cytotoxic T cells [T_C]). T lymphocytes are present to detect and get rid of pathogens that provide dwellings for intracellular pathogens. **Humoral immunity** is composed of the B lymphocytes (the effectors are secreted antibodies---molecules that are very specific that can bind to and neutralize antigens on the surface of cells). Nonspecific cells such as natural killer cells, macrophages, neutrophils, and eosinophils can use antibodies as receptors to recognize and target cells for elimination.

The number and the percentage of **macrophages, neutrophils, eosinophils and lymphocytes** are determined when studying inflammatory responses in airway induced inflammation. Figures 1 through 3 are pictures of white blood cells from mice bronchoalveolar (BAL) fluid. One noticeable difference between the white blood cells is the shape of the nucleus of

each cell. Internet has many websites (http://www.fortunecity.com/greenfield/rattler/46/blood3.htm) where pictures of white blood cells can be accessed and used to identify white blood cells.

Pictures of White Blood Cells (WBCs) in Mice BAL Fluid

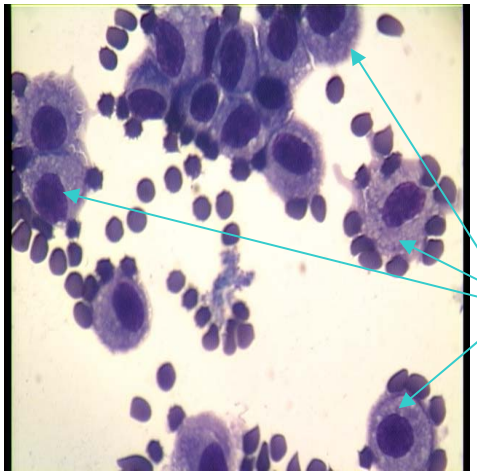


Figure 1: Control mouse BAL fluid did not show inflammation in the airways (400X). The cytospin slide was stained with HEMA DIFF™. Photograph is from Gilliam's research work.

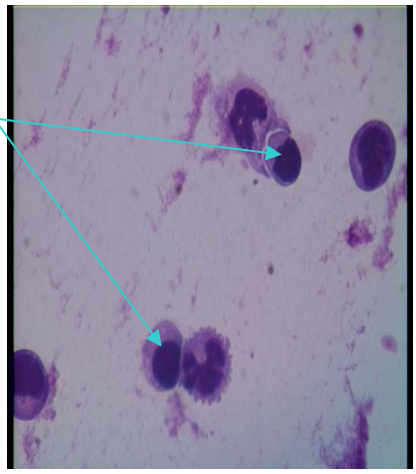


Figure 2: Cockroach antigen-induced mouse BAL fluid did show inflammation in the airways (400X). The cytospin slide was stained with HEMA DIFF™. Photograph is from Gilliam's research work.

Pictures of White Blood Cells (WBCs) in Mice BAL Fluid

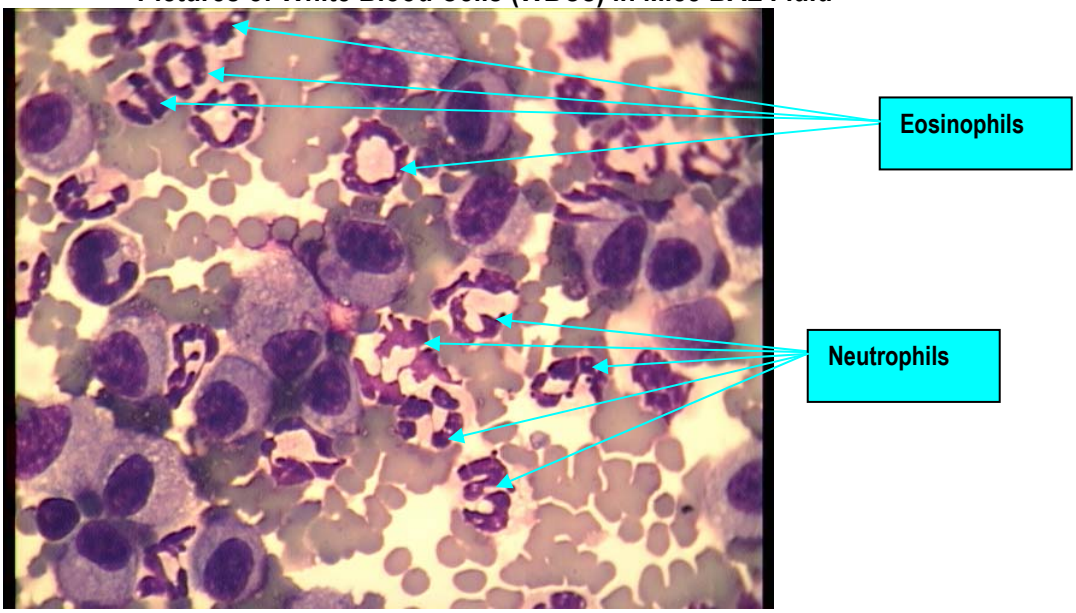


Figure 3: House dust mite-induced inflammation in BAL fluid of a mouse (400X). The cytospin slide was stained with HEMA DIFF™. Photograph is from Gilliam's research work.

Cockroach and house dust mite allergens (any foreign agent that causes a type 1 hypersensitivity reaction) induce a type 1 hypersensitivity reaction in the lung tissue and airways of a mouse. A humoral antibody response occurs when naïve B cells in the blood and lymph vessels are transported to the spleen and lymph nodes (secondary lymph organs). When an antigen (allergen) activates the B cell specific to its antibody, cell differentiation and cell proliferation take place producing two types of cells. One type of cell that is produced is the antibody-secreting **plasma cells** and the second type of cell produced is the memory B cell (See Figure 4).

Production of IgE Antibodies

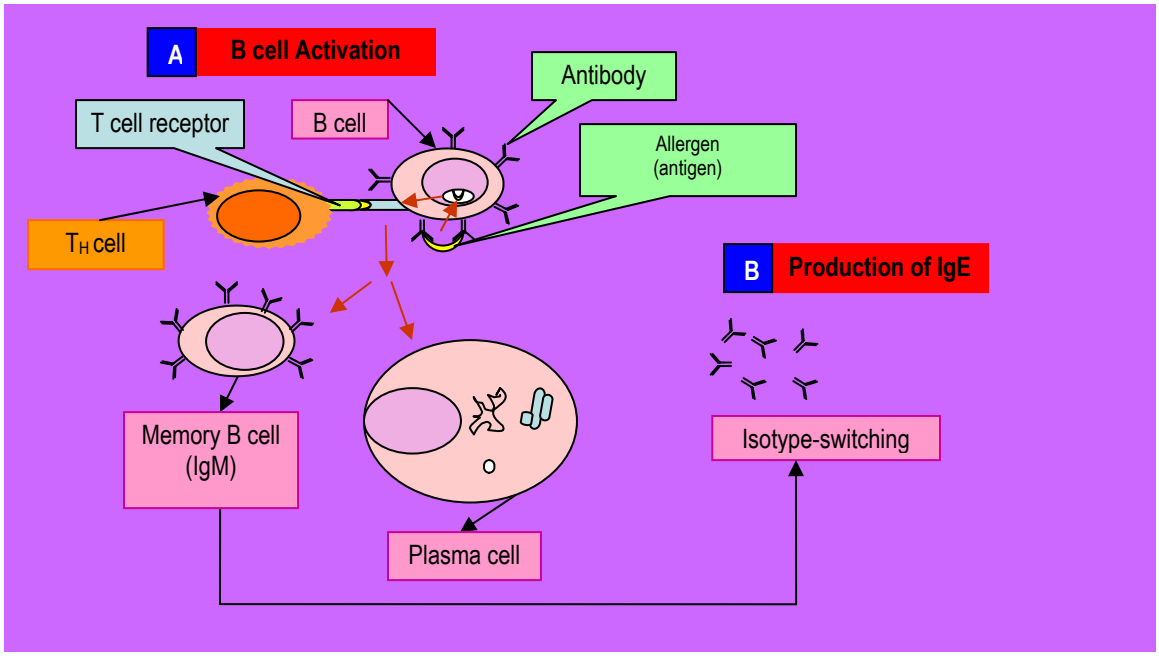


Figure 4: A schematic drawing showing a B cell being activated by a T helper (T_H) cell and antigen. Upon activation of the B cell, proliferation and differentiation occur, producing memory B cell antibodies (IgM) and plasma cells. The antibodies on the B cell undergo isotype switching (for example, from IgM to IgE antibodies).

Production of IgE Antibodies

Class-switching, which is a change in the isotype (the genetic rearrangement of the genes of the B cell in its heavy-chain constant region), occur when antibodies produced by the B cell are switched from **IgM** (**μ**--mu) antibodies to secreting **IgE** (**ε**—epsilon) antibodies. These antibodies are bound to the Fc (fragment, crystallizable) receptors on the surface of the mast cells (and blood basophils). The mice are sensitized (the initial introduction of the allergen to the host) during this process. Days later, the mice are challenged with the same allergen (cockroach or house dust mite), and an IgE-mediated immune response is evoked when the allergen cross-links the IgE cell-bound antibodies to the Fc receptors on the cell membrane of the mast cell (See Figure 5).

Mediators such as histamines and cytokines which are stored in the granules of mast cells are released during degranulation of the cell. Cytokines are soluble proteins that mediate inflammatory responses by attracting inflammatory cells to the effected area. Eosinophils are shown infiltrating the allergen-induced inflammatory airways of a mouse in Figure 3.

Allergen Cross-linkage of IgE to Fc Receptors

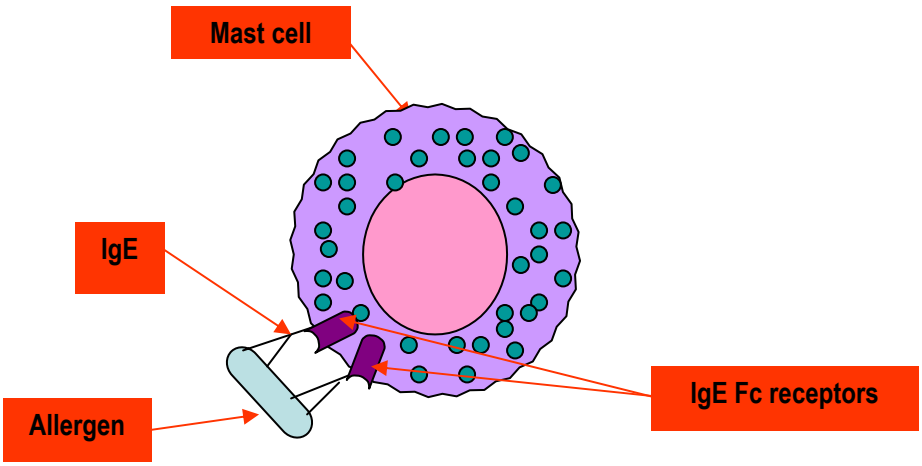


Figure 5: A schematic drawing of an allergen cross-linking cell-surface bound IgE antibodies to Fc (fragment, crystallizable) receptors on a mast cell after a second exposure (challenge) to the allergen.

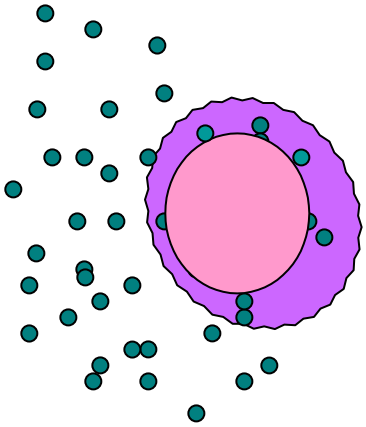


Figure 6: This schematic drawing illustrates the degranulation of a mast cell.

In Figure 7, there are no inflammatory cells observed in the lung tissue of the non-sensitized and unchallenged mouse. On the contrary, Figure 8 shows the infiltration of inflammatory cells in the airways of lung tissue of a mouse sensitized and challenged with cockroach allergen. Figure 3 shows the infiltration of eosinophils, inflammatory cells, in the BAL fluid of a mouse sensitized and challenged with house dust mite. The eosinophils, the major inflammatory cells in an allergic reaction, are seen in Figure 3 infiltrating the BAL fluid at a magnification of 400 times. The control mouse BAL fluid, Figure 1 does not show evidence of inflammatory cells infiltrating the airways.

Mice Lung Tissue

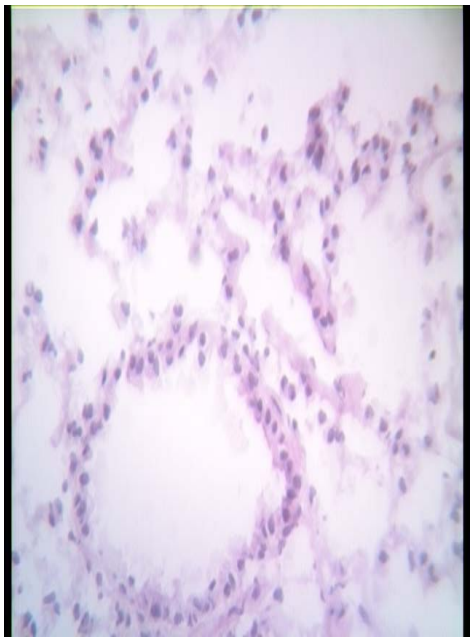


Figure 7: Control mouse lung without inflammation (400X). The lung tissue was stained with H&E. Photograph is from Gilliam's research work.

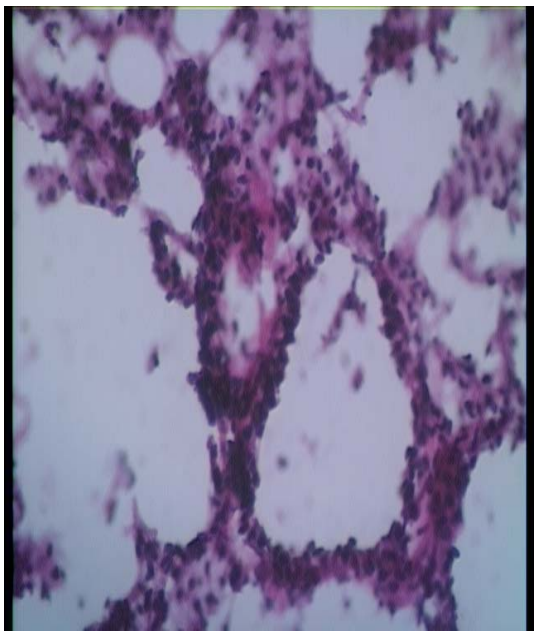


Figure 8: Cockroach allergen-induced airway with inflammation (400X). The lung tissue was stained with H & E. Photograph is from Gilliam's research work.

Asthma is a chronic lung disease that is defined as airway obstruction, airway inflammation and airway hyperresponsiveness. It manifests itself as a type 1 hypersensitivity reaction which can be local or systemic. A localized reaction can be an allergic reaction to food allergies, common household allergens such as house dust mite and cockroach allergens, various environmental factors such as pollen, smoke, extreme temperatures, and exercise. A systemic reaction is an allergic reaction that can be fatal if not treated immediately. Asthmatics can die from asthma attacks if they do not receive the proper immediate medical care. Airway obstruction involves the activation of the submucosal mast cells in the lower airways causing the bronchial tubes to constrict within seconds, causing an increase in fluid and mucus production, which result in airflow

resistance making breathing difficult. Airway inflammation results from class-switching of immuno-globulin, cross-linkage of an allergen to IgE antibodies, IgE and Fc receptors binding on mast cells

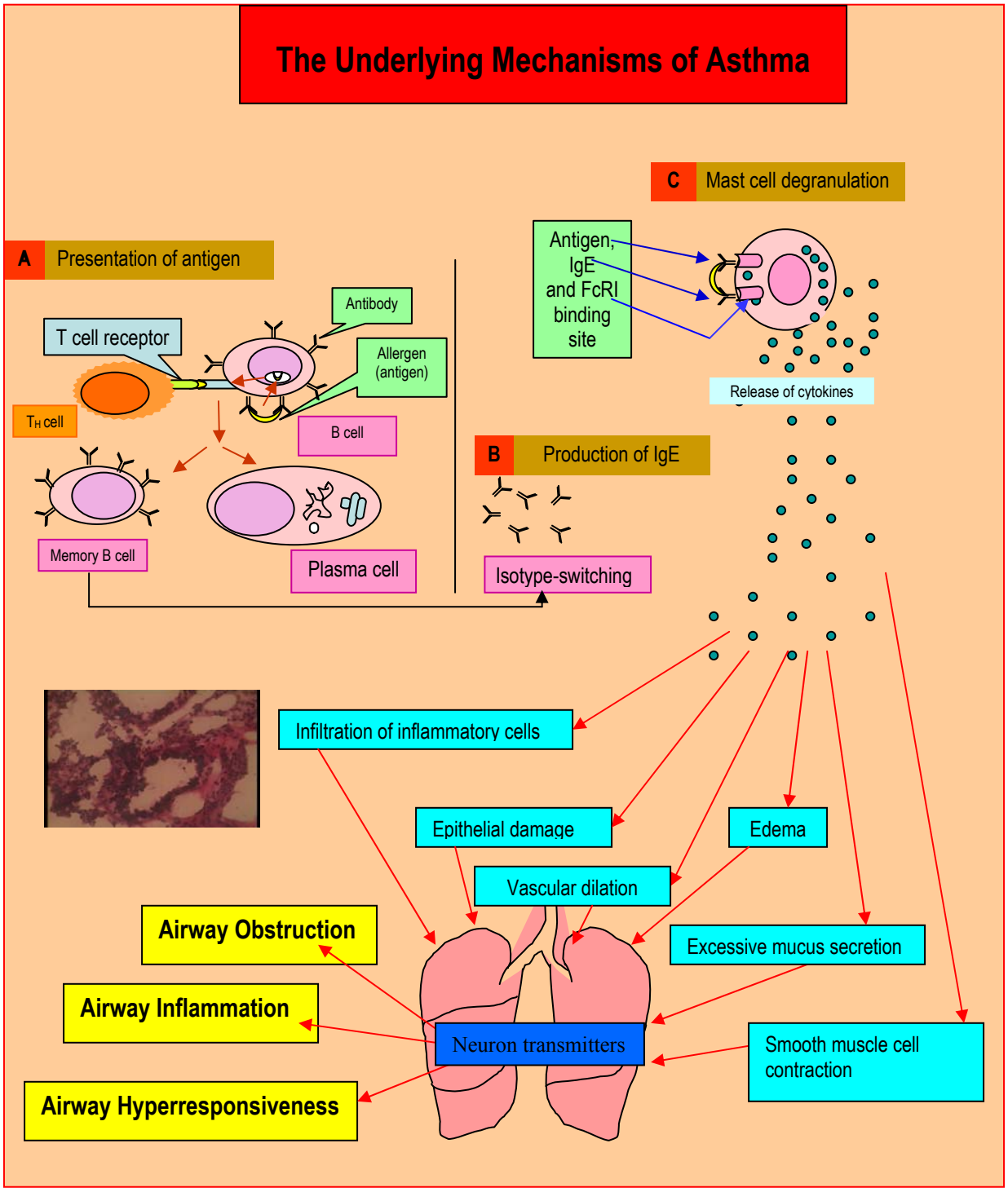


Figure 9: A schematic drawing showing the underlying mechanisms of the pathogensis of asthma.

causing the mast cells to undergo degranulation, and the infiltration of inflammatory cells (Figures 5 through 8). Airway hyperresponsiveness is an abnormal constriction of the bronchial smooth muscle cells by specific or nonspecific stimuli. Cockroach and house dust mite allergens are specific stimuli that cause an immunologic response in **atopy** (type I immunoglobulin E mediated response) individuals. Histamine and extreme temperatures are nonspecific stimuli. Airway hyperresponsiveness is composed of airway hypersensitivity and airway reactivity. Airway hypersensitivity is an increase in the narrowing of the airways by a drug at low concentrations. Airway hyperreactivity is an increase in the narrowing of the airways *per unit* of the drug, and the slope of the dose-response curve is greater (steep slope). A plethysmograph is used to measure airway hyperresponsiveness in allergen-induced airway inflammation in mice.

Teacher Preparation

National Standards: Use the modified version of the national standards for life science printed in the Teacher Guide Outline. The alphabet of each standard used will be typed at the top of each *Engagement* activity in this section.

Laboratory Safety

- ✓ Adhere to all laboratory safety guidelines mandated by OSHA.
- ✓ Safety goggles and laboratory aprons should be worn when conducting laboratory experiments (gloves when needed).
- ✓ Recognize and abide by all safety precautions when appropriate:
    1. Eye protection safety
    2. Electrical safety
    3. Biological hazard safety
    4. Fume safety
    5. Radiation safety
    6. Clothing protection safety
    7. Animal safety
    8. Plant safety
    9. Chemical safety
    10. Fire safety
    11. Open flame safety
    12. Sharp object safety
    13. Thermal safety
    14. Disposal alert safety
    15. Poison safety
    16. Fume safety

Introduction: Introduce the unit by sharing the *Introduction* and the *Teacher Guide Outline* on pages 3 and 4.

Activity #1: Ouch! Immunizations!

Standards: A, B, D,

Objectives:

1. To learn the immunologic terminology.
2. To learn the importance of being immunized.
3. To relate science to real health issues.

Possible Direction

Download and discuss statistical data on immunizations for your state emphasizing any noticeable differences in the last 20 years, or you can use current information from the internet, magazines, newspaper, etc. on outbreaks of infectious agents (5 minutes).

In addition to the background information included in this unit, use the websites included when making plans for completing this activity. Use the following steps to access the information: 1) Type the website http://www.cdc.gov/. 2) Look on the left side of the page and click on "Vaccinations and Immunizations". 3) Look on the left side of the page and click "Vaccines Beliefs

and Concerns" or type in this website (http://www.cdc.gov/node.do/id/0900f3ec80065bff). Read the two paragraphs. Notice the word More… at the end of the second paragraph; click More… and you automatically go to the next page. There are six misconceptions about vaccines and explanations for the misconceptions on the page. The Six misconceptions are:

- "Diseases had already begun to disappear before vaccines were introduced, because of hygiene and sanitation."
- "The majority of people who get a disease have been vaccinated. "
- "There are 'hot lots' of vaccine that have been associated with more adverse events and deaths than others."
- "Vaccines cause many harmful side effects, illnesses, and even death."
- "Vaccine-preventable diseases have been virtually eliminated from the United States."
- ''Giving a child multiple vaccinations for different diseases at the same time increases the risk of harmful side effects and can overload the immune system.''

Part I: Reflection

Make sure you have a class set of the 6 misconceptions and explanations to distribute to the groups. Have the students work in small groups (6 groups are needed).

- One student reads the misconception and the explanation for the misconception. Each member in the group comments on the assigned misconception (8 minutes).
- At the end of the small group discussion, one student should volunteer or be selected to share their misconception and summarize the explanation. Students should be encouraged to ask questions during each group's presentation (25 minutes). The students will need to reflect on the misconceptions because they will have to complete Part III using this information.
- The students write their reflection on the activity sheet (12 minutes).

Part II. Distribute the Immunization Records activity sheets along with the engagement activity sheets.

- Students use the Immunization Record to complete Part II on the engagement sheet. Students may work in small groups or individually (10 minutes). Do a total class discussion to check for understanding (5 minutes).

Part III. Distribute copies of the terms from the website or have the students access the glossary on internet and define the terms.

- Students define the terms on the engagement activity sheet. Discuss the terminology (10 minutes).

Time: 11/2 class periods (65 minutes)

Materials

- ✓ Immunizations record sheets
- ✓ Computer
- ✓ Engagement Activity sheets
- ✓ Background Information on Immunizations

Preparation

1. Make one copy per student of the *Immunization Record*, the *Engagement Activity sheets* and a class set of the 6 misconceptions of vaccines. I have typed dates on the immunization record that are needed for the students to complete the engagement activity.
   http://www.ahcpr.gov/ppip/immunrec.htm (student immunization record)
   http://www.ahcpr.gov/ppip/immunrec.htm (adult immunization record)
3. Refer to the website http://www.cdc.gov/nip/webutil/terms/glossary.htm for definition to the terms in Part III of this activity.
4. Prepare an answer sheet for the *Engagement Activity*. Refer to the background information and the websites for answers.

Assessment

Evaluate the students on their written work, their individual effort, group effort and class participation during the class discussion.

Possible Extensions

- Students can be encouraged to check their immunization record and see how many immunizations they have taken and make a note of the last time they received a tetanus shot.

- Invite a guest speaker from the county health department to share additional information on the importance of being immunized, and ask the speaker to bring and share statistical data about your statewide immunization status and the state's future goals.

Activity #2: Human and Animal Testing

Standards: A, C

Objectives:

1. To discuss the three phases of volunteer human testing of vaccines.
2. To recognize that the behavior of vaccines in animal models may evoke a different immune response in humans.
3. To discuss the use of animals in research.

Possible Directions

Summarize the lesson from yesterday and tell the students that before a new vaccine in put on the market, testing must take place first. Let them know that scientists complete many scientific investigations before they think about testing humans with a new vaccine. Share the standards and objectives for the lesson with the students. Tell the students they will research and discuss species of animals used in research, do a small group activity on animal testing, do a reflection on animal testing, and discuss the phases of human testing.

Part I. Animal Testing
Distribute the background information and share the website (http://www.hsus.org/ace/11348). This website has a vast amount of information on animal testing issues and examples of animal testing globally. You can view the different species of animals used in research by clicking on "Species Used in Research". Also, students can download "Overview of Animal Issues" by clicking on the title on the same page as the first web address or by typing in this web address http://www.hsus.org/ace/12508.

- Students make a list of the 13 different species used in research (Table1) and write 5 facts that interest them about 3 of the animals in the Table 2. (15 minutes).
- Discuss the engagement activity as a total group (15 minutes).

Part II. Reflection

- After the class discussion, the students download "Overview of Animal Issues" using the web address http://www.hsus.org/ace/11348. You may do small group reading and summarizing sessions. All students read the introduction and the conclusion. Assign 1 group to "History of Safety Testing" and "Types of Safety Testing"; assign 1 group to "Problems with Animal Tests section including "Validation", Extrapolating from Animal to Humans, and "Practical Problems"; assign 1 group to "Obstacles to replacing Animal Tests" including "Lack of a True 'Gold Standard', Biological Variability, Regulatory Practices", and "Validation"; assign 1 group to "Cosmetics and Household Product Testing" only (Do not assign "The Draize Eye Irritancy Test", "Alternatives to the Draize Eye Irritancy Test", or the LD50 Test). Stop assigning sections at this point. Remind all students they must read the introduction and the conclusion (10 minutes).
- Select a student or accept student volunteers to share the information from their section. Students complete their reflection activity on animal testing by writing their thoughts on the engagement sheet.

Part III. Discuss the phases of human testing using the background information.

- Students list two reasons why human testing is done before vaccines are put on the market for human immunizations.

Time: 40 minutes

Materials

- ✓ Engagement Activity sheets
- ✓ Background information on immunizations
- ✓ Computer

Preparation

1. Make a class set of the background information on immunization for each student and use the web addresses http://www.hsus.org/ace/11348 and http://www.hsus.org/ace/11348.
2. Make copies of the engagement activity.

Assessment

Assess students on their class participation and engagement activity.

Possible Extensions

- Students can make posters for or against animal testing based on the information discussed in class. Display posters in the classroom or in various locations in the building (the science area, throughout the building, etc.)
- Students can write an article in the school bulletin, school newspaper, etc. on animal testing for research; or draw an illustration.

Activity #3: Pertussis, Varicella and What?

Standards: A, B, C

Objectives:

1. To research childhood diseases.
2. To develop a PowerPoint presentation on a childhood disease.
3. To present a PowerPoint presentation on a disease.
4. To keep a log of the diseases and pertinent facts about each disease.
5. To summarize the importance of immunizations and their effect on our global society.

Possible Directions

Briefly review the misconception about vaccinations. Introduce this activity by identifying the common childhood diseases using the background information or the immunization record. Explain to the students that they will do a PowerPoint presentation on one of the common childhood diseases. Distribute the rubric for the presentation. Discuss the rubric and emphasize the importance of completing and presenting their project when it is due.

- The students have one week to complete the project and practice their presentation. To speed up this process, let the students work as a pair.

- Immediately after the students are paired and have selected their disease, they write their partner's name and each person's responsibilities on the back of the rubric. It is imperative that each student fulfills his or her obligation. Each group will decide what portion of the presentation he/she will present during their practice sessions outside of class. Grade accordingly.
- Within a week, have a lesson planned for students to present their project to the class.

Time: 30 minutes for in-class discussion and organization; one week to complete project outside of Class, and class time for presentation of projects

Materials

- ✓ PowerPoint rubric
- ✓ List of common childhood diseases or computer access
- ✓ Library resources (journals, magazines, reference books, etc) on childhood vaccinations (disease agents)

Preparation

1. Make copies of the rubric.
2. See the librarian for resources on a list of childhood vaccinations (disease agents), or make arrangements to have access to computers for students.

Assessment

Evaluate the students on their project by using the rubric. Each student must present half of the presentation.

Activity #4: Immunologic Barriers

Standards: A, B, C,

Objectives:

1. To learn the difference between innate and adaptive immunity.
2. To make a poster illustrating innate immune barriers.
3. To discuss how innate and adaptive immunity cooperate to produce the most effective immune response.

Possible directions

Explain the activity using the bulleted information below. The students:

- read the information on the engagement activity sheet.
- recognize the differences between innate and adaptive immunity.
- make posters illustrating innate immune barriers.

The poster must include:

- the four types of barriers.
- pictures or drawing representing each barrier.
- how each barrier protects the host from pathogens.

Time: 40-45 minutes

Materials

- ✓ Two Friends: Innate Immunity and Adaptive Immunity Engagement Activity sheets
- ✓ Posters
- ✓ Colored pencils, markers, crayon, etc.
- ✓ Magazines and scissors for pictures
- ✓ Computer (to word process the title, captions, etc.---- if you like)

Preparation

1. Make copies of the Immunologic Barriers activity sheet and the rubric.
2. Make a simplified diagram (words) of the requirements on a poster if you think it will be beneficial.

Assessment

Evaluate the students on their poster for neatness, completeness, accuracy, and presentation.

Possible extensions

- Students can display posters in specific areas of the school.
- Students can write an article in the school newspaper as a class.
- Students can write an essay to accompany their poster.

Activity #5: Asthma Survey and More!

Standards: A, B, D,

Objectives:

- To survey the students on their prior knowledge of asthma.
- To relate the relevancy of science to present day health issues (asthma).
- To investigate the effects of environmental factors on asthma.
- To investigate the role of genetics in asthma.
- To examine human and environmental influence on asthma and the impact of human influence on the asthmatic population.

Possible directions

Review the difference between innate and adaptive immunity. Explain to the students that they will study a different type adaptive immunity. This adaptive immune response is known as type 1 hypersensitivity. If any of you have asthma, food allergies, drug allergies, etc. experience this type of immune response when you are challenged by an allergen. Explain the activity using the standards, objectives, asthma survey, and bulleted information below. Students:

- complete and discuss the survey.
- relate asthma to a present day health issue.
- investigate how the environment and human influence affect asthma.
- research the role of genetics in asthma.

Materials

- ✓ Surveys
- ✓ Report sheets
- ✓ Background Information on the immune system
- ✓ Articles or websites from the librarian on:
  - ⇒ environmental factors and human influence on asthma
  - ⇒ the role of genetics in asthma.

Preparation

1. Complete the asthma survey (your answer sheet) before administering it to the students. Refer to the background information on the immune system for answers.
2. Make copies of the Asthma Survey and the table.
3. Have the librarian gather articles on asthma:
   - ⇒ explaining how environmental factors and human influence affect asthma.
   - ⇒ discussing the role of genetics in asthma.

Assessment

Evaluate the students on the completion of their survey and their report.

Possible extensions

- Make a sketch of one chromosome that has predisposition to asthma.
- Show one locus associated with asthma on the chromosome.

Activity 6: Blood Cell Detectives!

Standards: A, B, C

Objectives:

1. To know that there are two types of drug treatment for asthmatics.
1. To use the microscope properly.
2. To identify at least five white blood cells.
3. To know the function of the white blood cells identified.
4. To know which white blood cell is involved in type I hypersensitivity reactions.

.

Possible Direction

Make a transparency of page 34. Explain the drawing using the information on type 1 hypersensitivity reaction. Let the students know that these are the hallmarks of asthma. Mention that there are two major types of medication: bronchodilators and anti-inflammatory drugs. Bronchodilator drugs are used to relax the smooth muscle or block the action of the broncho-constrictors, and anti-inflammatory drugs are used for the reduction of chronic inflammation and airway hyperresponsiveness. Emphasize to the students that they will observe white blood cells, cells that are involved in a innate or adaptive immune response.

Distribute the laboratory activity, and discuss the expectations, standards, objectives, and expectations. Use the pictures in this unit, your textbook or a computer to locate pictures of white blood cells. This website is good (http://www.fortunecity.com/greenfield/rattler/46/blood3.htm) for identifying the white blood cells under the microscope. Review how to use a microscope properly. Students use a microscope to identify white blood cells from prepared slides, and complete the laboratory activity by:

- reading the laboratory activity at least two times.
- following oral and written instructions from the teacher.
- adhering to all safety rules, precautions and safety symbols. Refer to the teacher's guide outline for a list of safety symbols.
- using pictures in this unit, their textbook or the computer to help them identify the white blood cells.

Evaluate the students' laboratory skills as they complete the activity.

Time: 45 minutes

Materials

- ✓ Prepared slide of white blood cells (WBCs)

- ✓ Microscopes
- ✓ Paper towels
- ✓ Laboratory sheets
- ✓ Textbook , computer or unit pictures

Preparation

1. Make copies of the laboratory activity.
2. Check microscopes to make sure they are working properly.
3. Check prepared slides to make sure white blood cells are visible and easily identifiable.
4. Review the diagrams of the white blood cells in the background information on the immune system, website or textbook.

Assessment

Evaluate the students on the laboratory skills and written laboratory report.

Possible extensions

- Invite a medical technologist to the classroom to discuss his/her career and the safety issues involved in collecting and storing blood for further analyses and use.

Activity 7: A Virus Detected by Western Blot

Standard: A

Objectives:

1. To discuss the rationale for western blot.
2. To identify the major steps of western blot.
3. To discuss western blot as a diagnostic tool.

Possible directions

Review that asthma is an example of a hypersensitive immune response. Refer to the background information on type 1 hypersensitivity. Mention to the students that the immune system is working at an elevated level it is hyperactive. The appropriate action must be taken to return this hyperactive response back to normal. There are two types of medication asthmatics use to control their hypersensitive immune response: anti-inflammatory and bronchodilators.

The students will use the web address http://www.wordiq.com/definition/Western_blot to answer the questions.

- Read the definition for western blot. Summarize the definition in your words.
- Read the first step in western blot. See "Steps in Western blot". Describe the gel.
- Click on gel electrophoresis. What is the purpose of this step?
- Draw a picture of the gel; label and color the bands blue.
  A. Which lane has multiple bands? Why?
  B. Which lane of proteins traveled the farthest? Explain your answer.
- Why is nitrocellulose or PVDF used?
- Why is blocking important?
- A. What solutions are used for blocking?
- B. What would happen if the antibodies were not blocked?
- Why is a primary antibody used?
  A. What process is used to obtain these antibodies?
  B. Why is washing important after incubating the primary antibody?
- Why is a secondary antibody used?
  A. How is the secondary antibody different from the primary antibody?
  B. How is a color reaction produced?
  C. Why is it important to wash the secondary antibody after incubation?
- What does the first antibody recognize? the second antibody?
- What do the stained bands represent on the nitrocellulose or PVDF membrane?
- If you were a scientist testing to see if a patient has HIV, what steps would you use?
- If the patient tested positive, how would you know?

Time: 45 minutes

Materials

- ✓ Computers with internet access (http://www.wordiq.com/definition/Western_blot).
- ✓ Engagement activity sheets
- ✓ Background information (pages 37-38)

Assessment

Evaluate the students on their engagement activity.

Preparation

1. Review the rationale and the major steps in western blot protocol on pages 37-38 and

2. Locate websites for western blot protocols. Search: western blot protocols. A variety of western blot protocols will appear. Select the three protocols you want the students to view or let the students select three protocols for the activity.

Assessment

Evaluate the students on their science process skills (answers to the questions from the protocols).

Possible extension

- Students can do a western blot experiment.

Student Engagement Activities

Refer to the teacher's guide outline for:

- background information.
- modified standards.
- objectives.
- possible directions.
- approximate length of time for each lesson..
- a list of materials for the engagement activities.
- what should be done (prepare) before teaching each lesson.
- assessment suggestions.
- possible extensions for each lesson.

Activity #1: Ouch! Immunizations!

Immunization Record

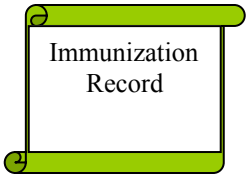
Name of Patient John Doe III

Type of Immunization	Recommended Ages	Date Immunization was Administered (Month and Year)
Polio (OPV/IPV) Clinic: DCHD	2 months, 4 months, 6-18 months, 4-6 years	02-1987 04-1987 06-1986 06-1991
Diptheria, Tetanus, Pertussis (DTaP, Td) Clinic: DCHD	(**DTaP**) 2 months, 4 months, 6 months, 15-18 months, 4-6 years, and (**Td)** 11-16 years	02-1997 04-1997 06 -1987 04-1988 06-1991 06-1998
Measles, Mumps, Rubella (MMR) Clinic: DCHD	12-15 months, 4-6 years or 11-12 years	O2-1988 06-1991
Haemophilus Influenzae type b (Hib) Clinic: DCHD	2months, 4 months, 6 months and 12-15 months	02-1987 04-1987 06-1987 02-1988
Hepatitis B Clinic: DCHD	Birth- 2 months, 1- 4 months, 6-18 months (If the 3 doses were missed, take 3 doses at age 11)	02-1087 04-1987 06-1987
Varicella zoster (Var)- Chickenpox Clinic: DCHD	12 – 18 months (If the dose was missed, take it between 11 – 12 years of age.)	06 – 1987
Hepatitis A	24 months – 12 years in certain areas	06 – 1991
Pneumoccal Disease (Prevnar™)	2 months, 4 months, 6 months, 12 – 15 months (If the 4 doses were missed, talk to your doctor.)	06 – 1991

http://www.ahcpr.gov/ppip/immunrec.htm (Modifications were made from this web address.)

Date_____ Name_____

Activity 1: Ouch! Immunizations



Follow the directions given by your teacher.

Part I: Reflection

Using the information presented in class, what are your thoughts on immunizations? Are you for or against immunizations? Give evidence to support your answer.

Part II: Immunization Record

1. Define immunization.

2. Why do we get immunized?

3. Some of the immunizations administered more than one time. Explain why the same immunization is administered more than once

Part III: Glossary

Use the glossary http://www-micro.msb.le.ac.uk/MBChB/ImmGloss.html to define the following terms:

11. Advisory Committee on Immunization Practices (ACIP)

12. booster shot-

13. conjugate vaccine-

14. efficacy rate -

15. inactive vaccine-

16. live vaccine-

17. vaccination-

18. vaccine-

Follow your teacher's instructions

Activity #2: Animal and Human Testing

Part I: Summarization of Individual Topic

Table 1. Research Species

13 Species	
1.	8.
2.	9.
3.	10.
4.	11.
5.	12.
6.	13.
7.	

Table 2. Characteristics of Research Species

Species	5 Characteristics of Species
1.	
2.	
3.	

Part II. Reflection

Using the information from the class discussion, should animal testing be done in a science research laboratory or in the animal's natural environment, or both?

Part III. Human Testing Facts

1. Is it necessary to use human volunteers to test a new vaccine? Explain your answer.

2. What are the two major requirements for human testing of vaccines?

   A.

   B.

Follow your teacher's instructions.

Activity #3: Pertussis, Varicella and What?

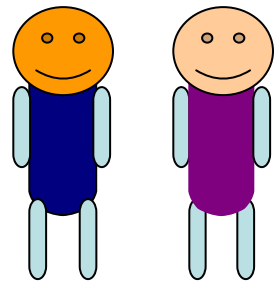
Partnership Multimedia Presentation

In this media presentation, you and your partner will research a common childhood disease and present it to your class. Your presentation must include the required information stated in the rubric. Your teacher will specify how your partner will be selected. Use PowerPoint to present your findings to the class.

Possible Points	Points Earned	Requirements for Research
2		Title page (project title, name of authors, class, and date)
3		Table of Contents (Overview of presentation with each slide number)
2		Introductory paragraph
8		Facts: 1) scientific and common name of disease, 2) type of infection, 3)name of microorganism that causes the disease, 4) characteristics of the disease, 5) age most severe, and 6) infection causing symptoms
3		How is the disease transmitted?
3		What measures are taken to prevent the disease?
2		Describe the incubation period for the disease.
4		Discuss the diagnosis and treatment for the disease.
5		Conclusion (Summarize the importance of immunizations and their effect on our global society.)
3		Bibliography
Total Points		35 Points = 100% (Perfect Score)

Engagement Activity #4

Two Friends: Innate and Adaptive Immunity



Innate (Natural) **Adaptive** (Specific)

Barriers of Innate Immunity

The four types of barriers are anatomic, physiologic, phagocytic (endocytic), and inflammatory. Anatomic barriers such as unbroken skin and mucous membranes provide protection from pathogens. The skin keeps the pathogens from entering the host whereas mucous traps the foreign material and the cilia (tiny hair-like structures) rid the host of the mucus with the pathogen. Physiologic barriers are temperature, low pH, and chemical mediators. Normal human body temperature and fever protect the host from some pathogens. The low pH (acidic) in the stomach kills some of the ingested microorganisms. Lysozyme, a chemical mediator, cleaves (punctures) the cell wall of bacteria. Tissue macrophages, blood monocytes and neutrophils protect the host by performing phagocytic barriers that engulf, kill and digest whole pathogens. Endocytic barriers protect the host when various cells ingest and break down foreign molecules. Inflammatory barriers result from the infiltration of phagocytic cells and antibacterial behavior protect the host from pathogens.

Part I: Make a poster illustrating the barriers of innate immune responses by:

A. showing the four barriers of innate immunity.
B. using pictures or drawing representing each barrier.
C. explaining how each barrier protects the host from pathogens.

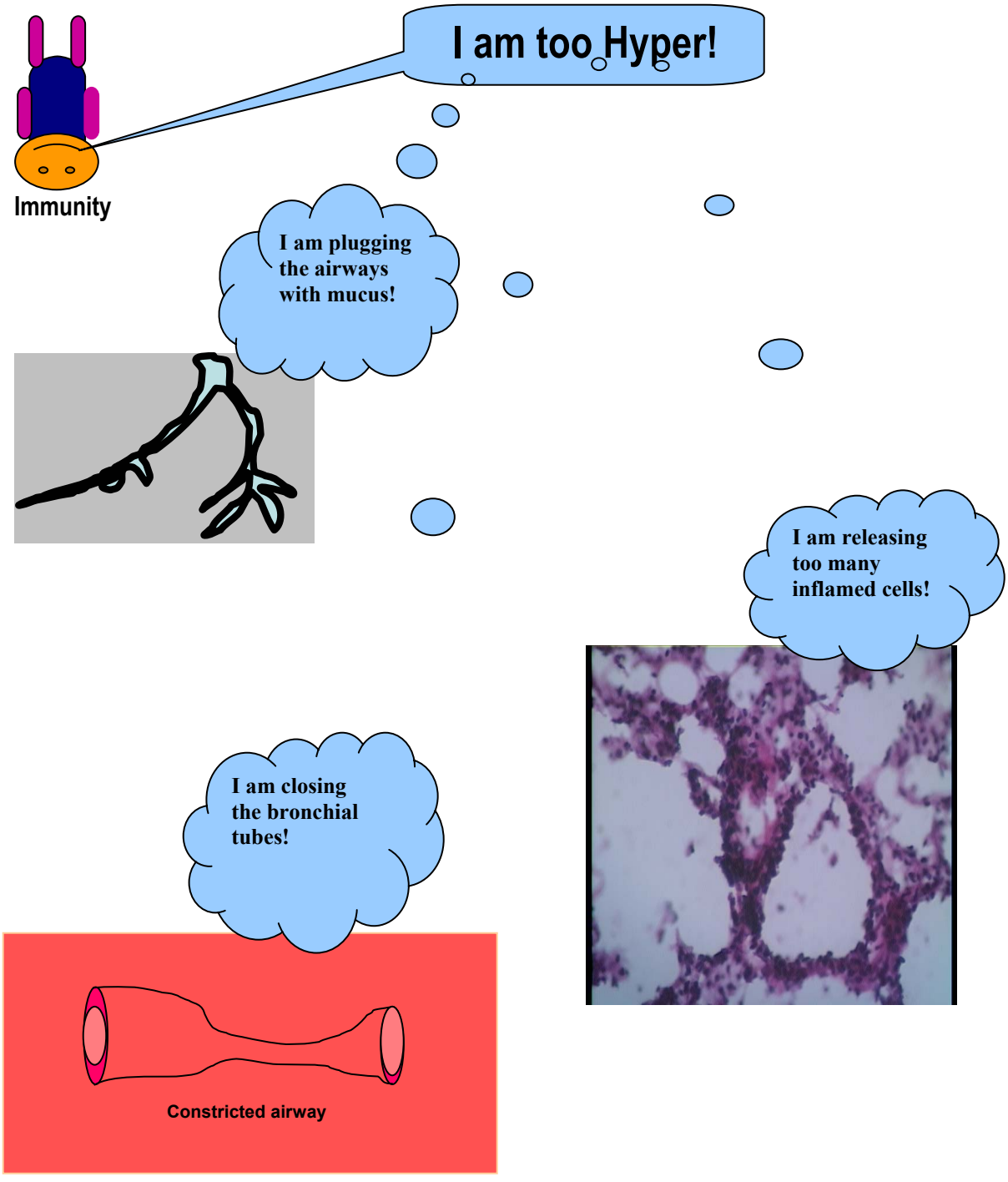
Part II. Total Class Discussion Session
Do critical analyses of the posters checking for the understanding of innate and adaptive immunity.

Rubric: Immunologic Barriers

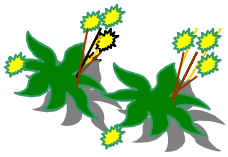
In this poster presentation, you and your partner will make a poster of innate immune barriers and present it to your class. Your presentation must include the required information stated in the rubric. Your teacher will specify how your partner will be selected. Use the poster board or similar material.

Possible Points	**Points Earned**	**Requirements for Poster**
1		Title
4		Four barriers are included (anatomic, physiologic, chemical and inflammatory.
5		Pictures or drawings of each barrier
5		Function of each barrier
2		Neatness
3		Poise, voice control, eye contact
Total Points		20=100% (Perfect Score)

Part II. Explain the difference between innate and adaptive immunity.


I am too Hyper!
Immunity
I am plugging the airways with mucus!
I am releasing too many inflamed cells!
I am closing the bronchial tubes!
Constricted airway

Date_____ Name_____



Activity #5: Asthma Survey and More!

Follow your professional educator's directions.

Part I.

1. What is your definition of asthma?

2. Is asthma contagious? Explain your answer.

3. Is asthma hereditary? Explain.

4. Do you have asthma?

5. Do any of your family members (parents, siblings, aunts, uncles, grandparents, etc.) have asthma?

6. Can exercise induce asthma?

7. Can extreme temperatures induce asthma?

8. What are two symptoms of asthma?

9. Can asthma be controlled?

10. Is it necessary to develop a vaccine to prevent asthma? Explain your answer.

Part II. Asthma Research

A. Explain how environmental factors and humans affect asthma.

B. Discuss what chromosomes are involved in the belief that asthma is hereditary.

Activity #6: Blood Cell Detectives!

Follow the directions given by your teacher.

Research Question (Problem): What characteristics distinguish eosinophils from other leukocytes?

Hypothesis:

Safety Issues: Follow all verbal and written safety rules, safety precautions and safety symbols.

Materials

- ✓ Prepared slide of blood cells
- ✓ Microscopes
- ✓ Paper towels
- ✓ Laboratory sheets
- ✓ Textbook or computer
- ✓ Background information on the immune system

Procedure

Part I. Laboratory observations

1. Read the laboratory procedure at least two times before you start the procedure.
2. Gather the materials.
3. Write your hypothesis in complete sentences.
4. Check to make sure the microscope is ready to use. The low power objective lens should be positioned directly over the light source aligned with the body tube.
5. Place the microscope slide on the stage. Secure the microscope slide to the stage by placing the stage clips over each end of the slide.
6. Use the coarse adjustment to lower the body tube. Look from the side of the microscope as you lower the body tube. Once the body tube is in the correct position and you locate cells, use the fine adjustment to sharpen the image of the cells.
7. Turn the revolving nosepiece to position the high power objective lens directly over the light source. Never look through the high power object lens as you lower the body tube. Always look from the side of the microscope to avoid eye injury, a broken microscope slide or a damaged objective lens.
8. When the high power objective lens is aligned with the body tube, look through the eyepiece; the cells should appear to be larger. Turn the fine adjustment knob to sharpen the image of the cells.

9. Draw observations using the high power objective lens. Record the *total magnification* below the sketch in the observation section. Do not draw too many cells. *Two large cells* showing the *shape of the nucleus* and a *description* of the cells (nucleus) are sufficient. Write the function of each white blood cell that is identified on the last page of your laboratory report.
10. Return all materials to the proper area and make sure your station is clean.

Part II: Draw all cells in the circles provided on this sheet and give the total magnification used to draw the cells.

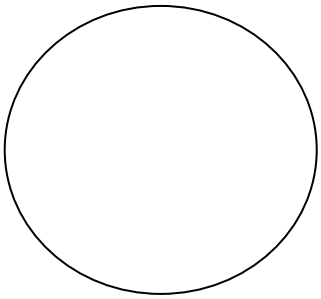


Figure A_____

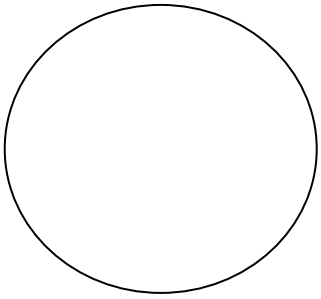


Figure B_____

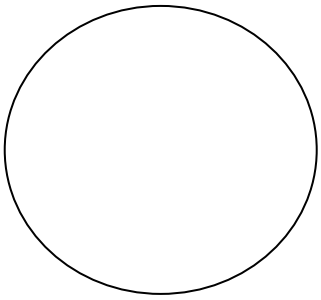


Figure C_____

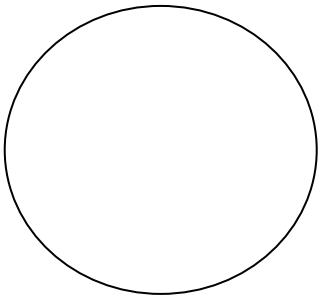


Figure D_____

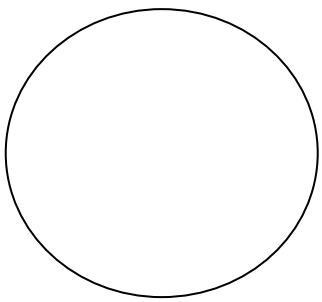


Figure E_____

Part III. Complete the chart below using your observations.

Table 6.1: Characteristics of Leukocytes

Name of Leukocyte	Total Magnification	Characteristics
Figure A		
Figure B		
Figure C		
Figure D		
Figure E		

Analysis, Conclusion and Application

1. Describe three shapes of nuclei you observed.

2. What are eosinophils? Describe the shape of their nucleus.

3. Describe the nucleus of lymphocytes and give one functional difference between the two types of lymphocytes.

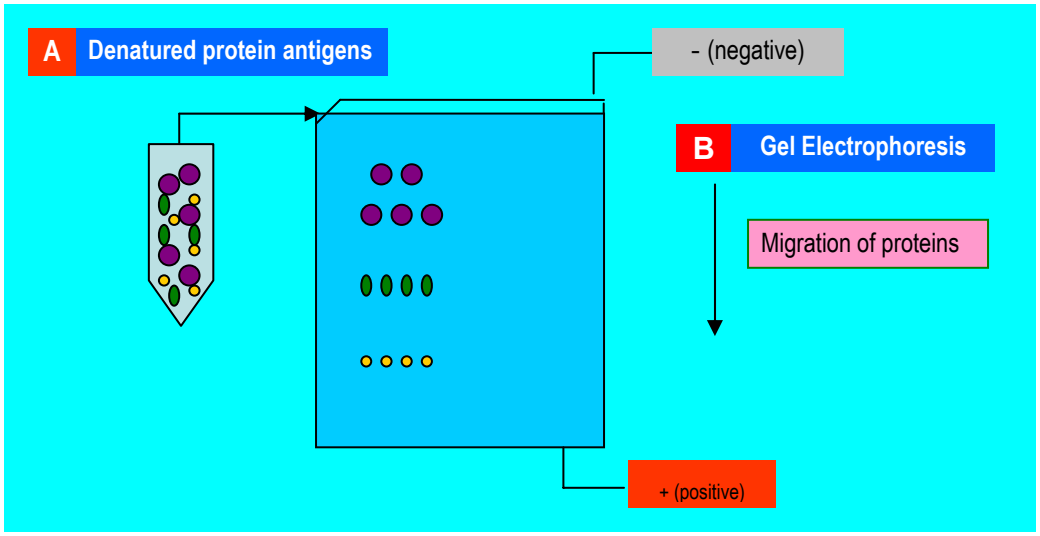
4. What cell causes a type 1 hypersensitivity reaction in atopic individuals?

5. Describe the immune response during a type 1 hypersensitivity reaction.

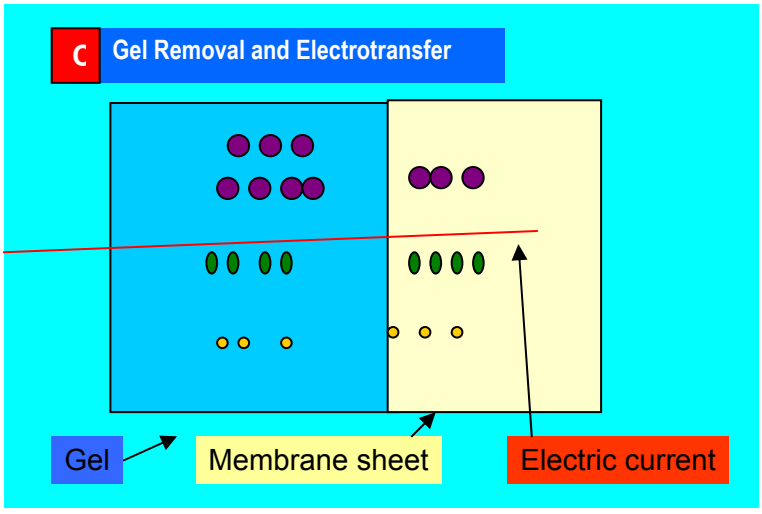
Activity 7: Western Blot

Western blotting is used to identify a targeted protein in a complex mixture of proteins. During this process, a mixture of proteins is separated by electrophoresis on a gel according to their molecular weight. Proteins with lower molecular weights migrate father than proteins with higher molecular weights.

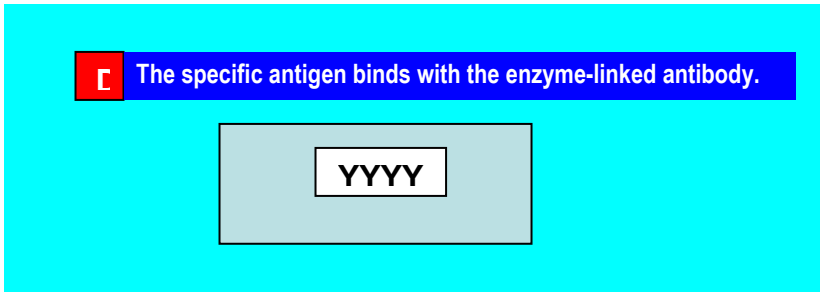
Figure 10: Schematic Diagrams of Major Steps in Western Blotting



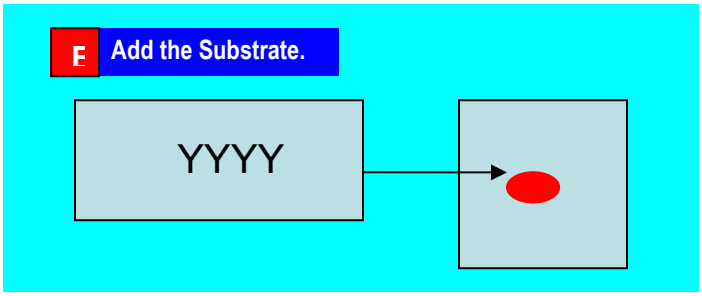
The gel is removed from the electrophoresis equipment and placed on a sheet of nitrogen cellulose or a sheet of nylon. The proteins in the gel are transferred to the sheet by passing an electrical current through the gel.



Enzyme-linked antibodies are added to detect the protein of interest to the researcher. An ELISA



reaction produces an insoluble product that is visible in the area where the reaction took place.



The substrate produces the color reaction.

Class_____ Name_____

Follow your teacher's instructions.

Activity 7: A Virus Detected by Western Blot

Objective: To investigate how western blot is used as a scientific application technique to detect human immune deficiency (HIV).

Use the website http://www.wordiq.com/definition/Western_blot to follow the step in detecting human immune deficiency in humans.

Materials

- ✓ Computer with internet access
- ✓ Engagement activity sheet

Procedure

Write your answers on the second page of this engagement activity.

1. Read the definition for western blot. Summarize the definition in your words.

2. Read the first step in western blot. See "Steps in Western blot". Describe the gel.

3. Click on gel electrophoresis. What is the purpose of this step?

4. Draw a picture of the gel; label and color the bands blue.
   A. Which lane has multiple bands? Why?
   B. Which lane of proteins traveled the farthest? Explain your answer.

5. Why is nitrocellulose or PVDF used?

6. Why is blocking important?
   A. What solutions are used for blocking
   B. What would happen if the antibodies were not blocked?

7. Why is a primary antibody used?
   A. What process is used to obtain these antibodies?
   B. Why is washing important after incubating the primary antibody?

8. Why is a secondary antibody used?

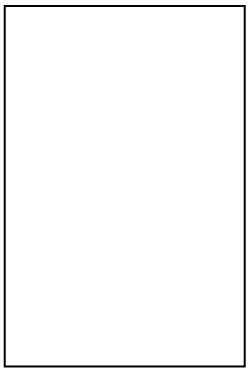
A. How is the secondary antibody different from the primary antibody?
B. How is a color reaction produced?
C. Why is it important to wash the secondary antibody after incubation?

9. What does the first antibody recognize? the second antibody?

10. What do the stained bands represent on the nitrocellulose or PVDF membrane?

11. If you were a scientist testing to see if a patient has HIV, what steps would you use?

12. If the patient tested positive, how would you know?

Question/Statement	**Answers**
1. Western blot	
2. Gel	
3. Gel electrophoresis	
4.Gel lanes	Picture, label and color A.  1. 2. B. 1. 2.
5.Nitrocellulose or PVDF	
6. Blocking	Blocking- A. Solutions B. Without blocking

Question/Statement	Answers
7. Antibody	Primary antibody A. B.
8. Antibody	Secondary antibody A. Primary vs. Secondary B. Color reaction C. Washing
9. Recognition	Primary antibody Second antibody
10. Membrane	Stained bands

Check for Understanding

11. If you were a scientist testing to see if a patient has HIV using a western blot protocol, briefly what steps would you use?

12. If the patient test positive for HIV, how would you know?