Lymphoma Resulting From β-Catenin Stabilization are Sensitive to mTOR Inhibition: A Unit on Cancer and the Immune System.

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I. INTRODUCTION

Overview

Lymphoma Resulting From β-Catenin Stabilization are Sensitive to mTOR Inhibition: A Unit on Cancer and the Immune System is targeted at high school students in any type of high school biology or science elective course such as anatomy or health. This unit includes a general introduction of the key components of the immune system, an understanding of how cancers arise, and the role of the immune system when battling cancer. There is a large population of English Language Learners in my school; therefore, I chose to create the lessons in this unit to address different learning modalities including visual, auditory, and kinesthetic.

Students will be learning about cancer and the role of the immune system in defending the body against cancer. To understand cancer, students first gain a basic understanding of cell signaling and the role of cell signaling in cell division. Next students explore how dysfunction of cell signaling leads to cancer, how the immune system responds to cancer, and the role of immunotherapy in treating cancer. Students will participate in a blood-based diagnostics lab where they will recognize that cancer cells are different from normal cells based on proteins located on the cell surfaces.

Science Background

It is highly recommended that teachers review cell biology with students. Specific content in the areas of cell communication, immune system, and cancer will be detailed in every lesson located in the curriculum.

Student Outcome and Learning Objectives

The unit covers the basic anatomy of the immune system, the basic immune response to a pathogen, the basics of cancer, and the role of immunotherapy.

Students will be able to:
a) Identify the anatomy and cellular components of the immune system.
b) Compare and contrast innate and active immunity.
c) Demonstrate understanding of the immune system response steps.
d) Explain the cell signaling pathway steps from the cell surface through the cytoplasm to the nucleus via chemical signals, receptors, and proteins.
e) Identify cancers that are caused by mutations in cell signaling pathways.
f) Diagnose prostate and cervical cancer through the Blood-Based Cancer Lab.
g) Investigate pros and cons of current cancer treatments.
h) Explain how immunotherapy is used as possible treatment to aberrations in cell signaling pathways that cause cancer.

Curriculum Unit Overview

This unit includes cellular components of the immune system can be used in any type of biology or science elective course such as Anatomy. There are seven lessons including:

1) What are the organs of the immune system?
2) How does the immune system respond to an invasion by a pathogen?
3) What is the difference between the innate and adaptive immune system?
4) How do scientists understand the cell signaling pathway?
5) How does cancer occur?
6) How do doctors diagnose patients with cancer using blood-based screenings for cancer?
7) How do doctors treat cancer?

Curriculum Time Requirements

This unit can be completed in 8 classes (60 minutes per class).

Day 1	Organs of Immune System
Day 2 & 3	Immune System Response
Day 4	Innate and Adaptive Immune System
Day 5	Cell Signaling Pathway
Day 6	Cancer
Day 7	Blood-Based Cancer Lab
Day 8	Cancer Treatments

New York State Standards

The New York State **Learning Standards** addressed by this curriculum include:
New York State Technology Education Learning Standards 5:

- Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

New York State English Language Arts:

- **Standard 1: Language for Information and Understanding.**

Students will listen, speak, read, and write for information and understanding. As listeners and readers, students will collect data, facts, and ideas; discover relationships, concepts, and generalizations; and use knowledge generated from oral, written, and electronically produced texts. As speakers and writers, they will use oral and written language that follows the accepted conventions of the English language to acquire, interpret, apply, and transmit information.

- **Standard 3: Language for Critical Analysis and Evaluation.**

Students will listen, speak, read, and write for critical analysis and evaluation. As listeners and readers, students will analyze experiences, ideas, information, and issues presented by others using a variety of established criteria. As speakers and writers, they will use oral and written language that follows the accepted conventions of the English language to present, from a variety of perspectives, their opinions and judgments on experiences, ideas, information and issues.

- **Standard 4: Language for Social Interaction.**

Students will listen, speak, read, and write for social interaction. Students will use oral and written language that follows the accepted conventions of the English language for effective social communication with a wide variety of people. As readers and listeners, they will use the social communications of others to enrich their understanding of people and their views.

New York Sate Living Environment **Core Curriculum Performance Standards**:
Standard 4: Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.
Performance Indicator 1.2- Describe and explain the structures and functions of the human body at different organizational levels (e.g., systems, tissues, cells, organelles)

- 1.2j Receptor molecules play an important role in the interactions between cells. Two primary agents of cellular communication are hormones and chemicals produced by nerve cells. If nerve or hormone signals are blocked, cellular communication is disrupted and the organism's stability is affected.

Performance Indicator 5.1- Explain the basic biochemical processes in living organisms and their importance in maintaining dynamic equilibrium.

- 5.1g Enzymes and other molecules, such as hormones, receptor molecules, and antibodies, have specific shapes that influence both how they function and how they interact with other molecules.

Performance Indicator 5.2- Explain disease as a failure of homeostasis.

- 5.2a Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
- 5.2b Viruses, bacteria, fungi, and other parasites may infect plants and animals and interfere with normal life functions.
- 5.2c The immune system protects against antigens associated with pathogenic organisms or foreign substances and some cancer cells.
- 5.2d Some white blood cells engulf invaders. Others produce antibodies that attack them or mark them for killing. Some specialized white blood cells will remain, able to fight off subsequent invaders of the same kind.
- 5.2i Gene mutations in a cell can result in uncontrolled cell division, called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.
- 5.2j Biological research generates knowledge used to design ways of diagnosing, preventing, treating, controlling, or curing diseases of plants and animals.

II. CURRICULUM DETAILS

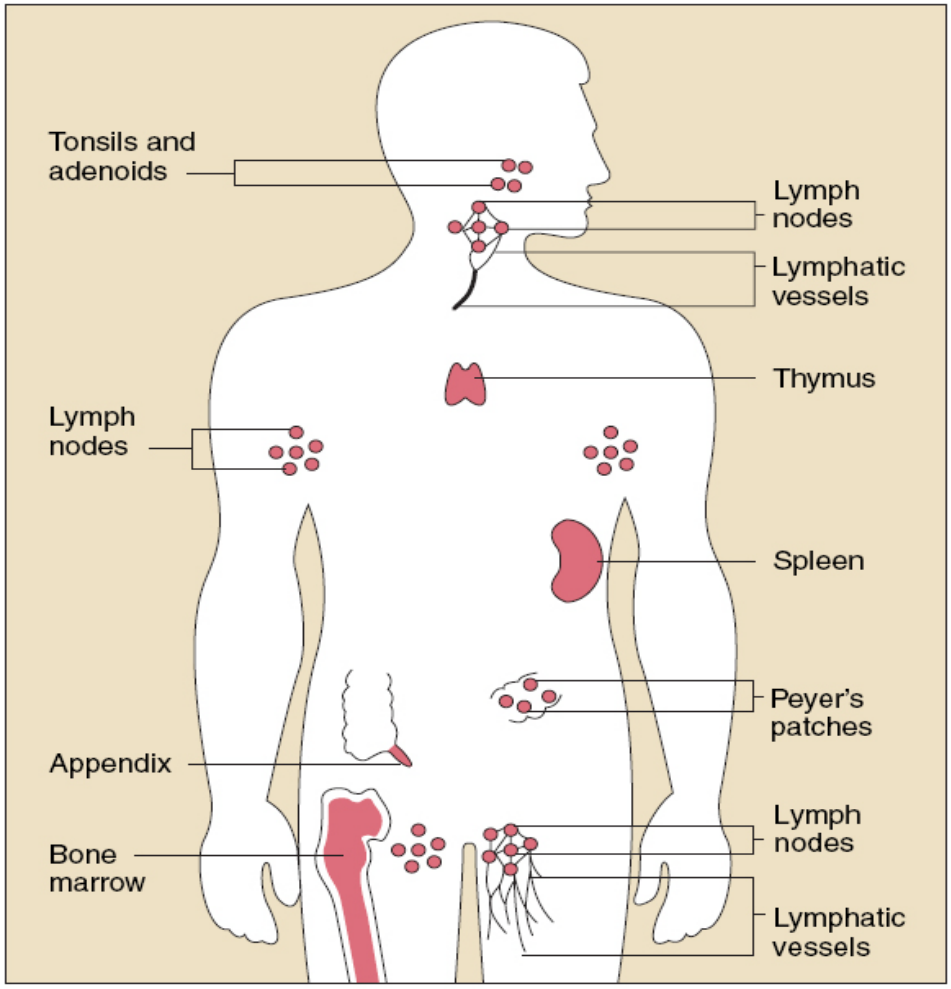
Lesson I - What are the organs of the Immune System?

Overview: In this activity students will learn about the major lymphoid organs involved in the immune system. This will include the primary and secondary lymphoid organs.

Objectives:
Students will be able to understand the location and function of the primary and secondary lymphoid organs of the immune system

Time Requirements: 1 class period (60 minutes)

Introduction:
There are many organs inside the human body that help protect our body against foreign invaders. The primary lymphoid organs include the thymus and bone marrow. The secondary organs include the lymph nodes and spleen. These organs are home to the lymphocytes, which are the white blood cells that are a vital part of the immune system. These lymphocytes are produced in the bone marrow and eventually circulate to the lymphoid organs. The T lymphocyte or T cell leaves the bone marrow to mature in the Thymus gland. The thymus is located in the thoracic region of the body posterior to the sternum. The B lymphocyte or B cell is produced and also stays in the bone marrow to mature. The lymphocytes travel around the body via blood and lymphatic vessels and are stored in the lymph nodes and spleen. The spleen plays a major role in mounting immune responses to antigens in the blood. This organ specializes in filtering the blood and trapping blood-borne antigens. The lymph nodes trap antigens from local tissues. Lymph nodes are found mainly in the trunk of the body including the neck, armpits, abdomen, and groin (see figure below).



Picture: http://www.niaid.nih.gov/TOPICS/IMMUNESYSTEM/Pages/structure.aspx

Student Activity:

1. After a brief lecture of lymphoid organs, students will work individually to complete the "Organs of Immune System" handout.

STUDENT HANDOUT

Organs of the Immune System

As we journey around the human body, there are many organs inside of the body that contain lymphocytes, which help protect our body against foreign invaders called pathogens. Let's look at the diagram below and observe where the lymphocytes are stored prior to responding to a pathogen.

1. The _____ is the site where the B and T lymphocytes are produced.

2. The T cells mature in the _____ before they migrate to other tissues.

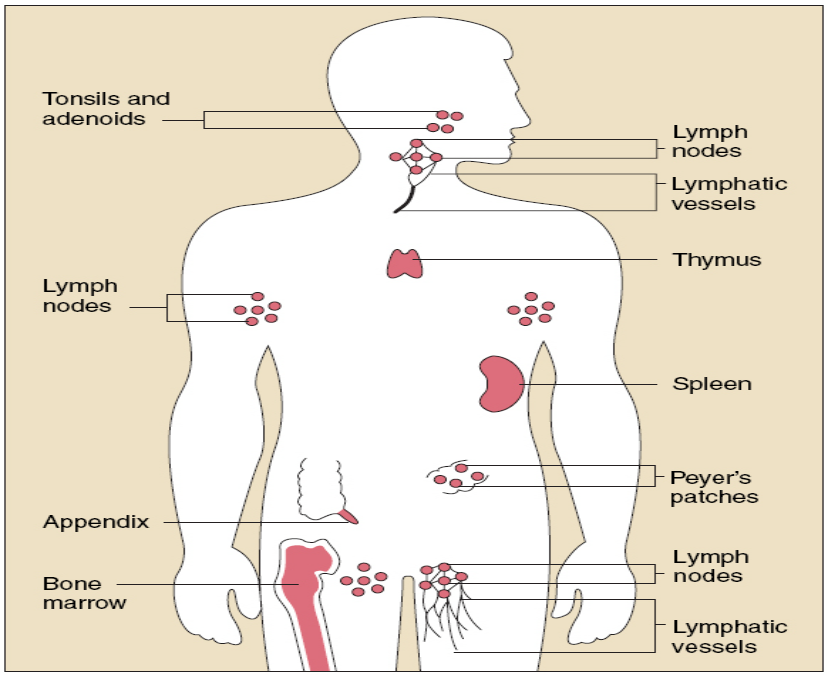
3. The _____ filters the blood to trap antigens.

4. The lymph nodes trap antigens from local tissues. Look at the diagram below to write down 3 locations in the body where they are located:

a)

b)

c)



Lesson II - How does the immune system respond to an invasion by a pathogen?

The Body Story: The Flu
Overview: The immune system contains cells that respond to foreign invaders in order to elimination the pathogens and memory cells that will identify the pathogens if they enter the body again. Students will learn about the cells of the immune system and the immune system response to pathogens through a video called "The Body Story: The Flu." Students will communicate their understanding of the immune system response with an in class performance.

Objectives:
-Identify the types of cells that are important in the immune system.
-Understand how the body produces an immune system response.
-Investigate the mechanisms that the white blood cells use to protect the body from foreign invaders.
-Explain what is happening on a cellular level as the body is invaded by pathogens.

Time Requirement: 2 class periods (120 total minutes)

Introduction:
The immune system contains key cellular components that are used to find and eliminate pathogens. The key cells involved include the macrophage, natural killer cells, dendritic cell, and T and B cells. Molecular components include cytokines (e.g., the interleukin family), chemokines, and antibodies. The video, "The Body Story: The Flu" will review this information. Students will view the response of the immune system to the flu virus. It is highly recommended that teachers show this video on the body's response to a pathogen. Teachers can obtain this video labeled under Body Story-Body Snatchers/Breaking Down DVD (2003) by Discovery for $16.99 from Amazon.

Discussion Questions:

1. How does the body prevent pathogens from getting into the body?
   The first line of defense that prevent pathogens from getting inside the body include the skin, breathing passages, mouth, and tears.
2. How does a fever help your body fight the virus?
   A fever increases the temperature of the body in order to kill microbes.
3. Describe the role of each of the following in the immune system response:
   natural killer cells: patrol the body to kill the cells that are affected by the virus
   macrophage: engulf cell debris and release interleukins
   interleukins: found in bloodstream to help find reinforcement to the site of infection
   dendritic cell: present a fragment of the virus to the T cell and B cell
   cilia: trap and remove cell debris and pathogens
   T cell: recognize antigens on the virus and attack them
   B cell: make antibodies that bind to antigens on virus cells to paralyze them.
   Antibody: A protein that is very specific to an antigen on a pathogen cell. They help with the destruction of the pathogen.

Student Activity: Shall we perform?
1. Students will watch the video "The Body Story: The Flu" and take notes individually to prepare for the discussion questions.

2. After watching the "The Body Story: The Flu" students should have an understanding of the key cells that respond to pathogen. Students will assess their understanding by creating a class script to perform the immune system response. They could use their worksheet from the video to complete their script.

1. Each student will receive a card that contains a component that is part of the immune system response or a role that is necessary in the play. They must write down their function.

   The key components are listed below:
   natural killer cells: patrol the body to kill the cells that are affected by the virus
   macrophage: engulf cell debris and release interleukins
   interleukins: found in bloodstream to help find reinforcement to the site of infection
   dendritic cell: present a fragment of the virus to the T cell and B cell
   cilia: trap and remove cell debris and pathogen
   T cell: recognize antigens on the virus and attack them
   B cell: make antibodies that bind to antigens on virus to paralyze them.
   Antibody: A protein that is very specific to an antigen on a pathogen. They help with the destruction of the pathogen.
   Other roles in play:
   Narrator, infected cell, virus

2. Mingling session: Students will have a few minutes to circulate around the room and learn about each other. They need to find 2 other components of the immune system that they are directly associated with. For example, the macrophage will be directly associated with a virus and interleukin.
3. Students will get together as a whole class to decide on how they want to create the play. The students will use class notes taken from the flu video as a reference. The teacher will look over the script and make any corrections.
4. Student performance: students will perform the play.

Student Homework Assignment:

Create a poster, brochure, or powerpoint displaying the immune system response utilizing the key cellular components. Be sure to be creative by including drawings, use color, animations, etc.

STUDENT HANDOUT

The Immune System Response

Our body contains barriers that prevent pathogens from entering the body. When a pathogen gets through a barrier, the immune system responds to eliminate the pathogen. As you view the video "The Body Story: The Flu" take notes on the key components of the immune system particularly the role of each component in eliminating the pathogen.

1. What parts of the body prevent pathogens from getting inside the body, and how does each body part act as a barrier?

2. How does a fever help your body fight the virus?

3. Describe the role of each of the following in the immune system response components:

   Natural killer cell-

   Macrophage-

   Interleukin-

   Dendritic cell-

   Cilia-

   T cell-

   B cell-

   Antibody-

Lesson III - What is the difference between the innate and adaptive immune system?

Overview: The immune system protects the body from infectious disease. The immune system does this by two types of systems: the innate and the adaptive immune system. Students will learn about them through a teacher presentation. Students will then assess their knowledge through a whole class activity where they will learn the difference between the innate and adaptive immune system.

Objectives:
-Identify the nonspecific host defenses of the innate immune system.
-Identify the specific host defenses of the adaptive immune system.

Time Requirement: 1 class period (60 minutes)

Introduction: The human immune system includes two types of immunity, innate and adaptive. The innate immune system provides the first line of defense against infection, and the majority of its components are present before the antigen enters the body. There is a set of mechanisms that is **not specific** to a particular antigen. The disease-resistant mechanisms include four types of defense barriers: anatomic, physiologic, phagocytic, and inflammatory. Table 1 below summarizes the non-specific host defenses of the innate immune system.

The adaptive immune system recognizes and selectively eliminates pathogens by the following four characteristics: antigen specificity, diversity, immunologic memory, and self/non-self recognition. The adaptive immune system is **specific** and does not come into play until an antigen gets into the body. Adaptive immunity includes a diverse response to recognize billions of unique structures on antigens. The response against the antigen normally takes place about 6-7 days after exposure. The adaptive immune system is responsible for memory, meaning after exposure to the antigen, the immune system will create a memory response. If the same antigen enters the body again, the immune system response will be quicker and stronger to get rid of the pathogen. Finally, the adaptive immune system is capable of distinguishing between self and non-self (foreign antigens), which is important to prevent an inappropriate attack on the body's own cells. The key components of the adaptive immune system response include the B and T lymphocytes and antibodies.

Type	Mechanism
Anatomic Barriers	
Skin	Prevents entry of microbes
Mucous Membranes	Traps pathogens Cilia move pathogens outside of the body
Physiologic	
Temperature	Normal body temperature inhibits growth of some pathogens.
Low pH	Acidity of Stomach contents kills most ingested microorganisms.
Chemical mediators	Lysosomes are subcellular compartments where bacteria are killed (e.g., digesting cell walls). Interferon induces antiviral state in uninfected cells. Complement proteins lyses microorganisms or facilitates phagocytosis. Toll-like receptors recognize microbial molecules, signal cell to secrete immunostimulatory cytokines. Collectins disrupt cell wall of pathogen.
Phagocytic/endocytic barriers	Various cells internalize (endocytose) and break down foreign macromolecules. Specialized cells such as neutrophils and tissue macrophages internalize (phagocytose), kill, and digest whole microorganisms.
Inflammatory barriers	Tissue damage and infection induce leakage of vascular fluid, containing serum proteins with antibacterial activity, and influx of phagocytic cells into the affected area.

Table 1-Summary of Nonspecific host defenses (Freeman, 2003)

Student Activity:
1. After lecture on Innate vs. Adaptive Immunity, students will work with a partner to create a T-chart with the following statements/terms:

Terms:

Low pH	Macrophage
Antibody	Mucous membrane
Skin	T and B lymphocyte
Antibody	

Statements:
Can recognize wider number of foreign substances
Response time takes hours
Response time takes days
Not specific
Highly Specific
Includes memory to the same pathogen
Can recognize self/non-self

2. As a class, students will share the T-Charts on the board. For each statement, the teacher calls on a different pair of student.

Example of T-chart:

Innate Immune System	**Adaptive Immune System**
Low pH Skin Mucous membrane Macrophage Response time takes hours Not specific	Antibody Can recognize wider number of foreign substances T and B Lymphocyte Response time takes days Highly specific Includes memory to the same pathogen Can recognize self/non-self Antibody

STUDENT HANDOUT

Innate vs. Adaptive Immunity

The immune system is comprised of both the innate and adaptive immune system. As you hear the statements or key terms read by your teacher, place them in the T-chart under either the innate immune system or adaptive immune system.

Innate Immune System	Adaptive Immune System

Lesson IV – How do scientists understand the cell signaling pathway?

Overview:
Students will understand how cells communicate with each other to regulate cell growth through the use of signals, receptors and proteins. Students will be introduced to a website www.insidecancer.org where they will work independently to understand cell signaling.

Objectives:
-Explain the cell signaling pathway steps from the cell surface through the cytoplasm to the nucleus via chemical signals, receptors, and proteins.

Time Requirements: 1 class period (60 minutes)

Introduction:
The focus of this curriculum is on the immune system and its role in preventing and eliminating cancer. In order to understand cancer, which is uncontrolled growth cells, students must first gain basic knowledge of cell signaling. Cell signaling is a system of communication that includes signals, receptors, and proteins which control cellular activities.

Student Activity:
1. Students will be introduced to a website called www.insidecancer.org where they watch cell signaling animations. For the visual and auditory learner, this website does a wonderful job narrating the information during the animation. Students will learn cell signaling at their own pace and will complete the student handout.

STUDENT HANDOUT

Cell Signaling

In order to understand cancer, which is uncontrolled cell growth, you must first gain basic knowledge of cell signaling. Cell signaling is a system of communication that includes signals, receptors, and proteins which control cellular activities. You will be introduced to www.insidecancer.org where you will immerse yourself with an audio and visual tour inside the cell.

1. As a general introduction to cell signaling, we will look under Pathways to Cancer:
   - Log onto www.insidecancer.org
   - Click on Pathways to Cancer.
   - Click on Overview and look at all 8 animations.

   -Focus on slide number 4, how disruptions in cellular communication contribute to cancer. Describe what you see in this slide:

   -Look under slide 6. Describe signal transduction-how are signals normally transferred?

2. At the Cell Surface
   - Click on At the Cell Surface and view the video.

   -What does a signaling pathway start with?

   -What are the key players?

   Describe what happens at the cell surface.

3. Beneath the Membrane
   - Click on Beneath the Membrane and view the video.

   -Describe what happens in the cytoplasm

4. A Bevy of Interactions
   - Click on A Bevy of Interactions and view the video.

   -Discuss the Ras protein, its role in the pathway, and how it leads to cancer.

5. To the Nucleus
   - Click on To the Nucleus and view the video.

   -What are Kinases?

6. Inside the Nucleus
   - Click on Inside the Nucleus and view the video.

   -Describe the process of transcription. Make sure to include the key molecules involved.

7. Making the Protein
   - Click on Making the Protein and view the video.

   -Describe the process of translation.

8. Releasing the Protein
   - Click on Releasing the Protein and view the video.

   -What is the function of released proteins?

Lesson V - How does cancer occur?

Overview:
Students will be learning about what happens when cells have escaped normal growth-regulating mechanisms. When the growth of cells becomes uncontrollable, cancer occurs. Students will continue to look at the insidecancer.org website to view animations on how cancer cells escape normal cell signaling to become cancerous growths.

Objectives:
-Identify cancers that are caused by mutations in signaling pathways.
-Understand how cancer is caused by mutations in a cell.
-Understand the role of the immune system and cancer.

Time Requirements: 1 class period (60 minutes)

Introduction:
Cancer is a disease that affects people from all nationalities and ages. This disease occurs as a result of cell mutation, or in some cases as a result of infection. Cancer is generally not contagious, but cancer can be inherited or influenced by environmental factors such as exposure to UV rays from the sun, smoking, diet, viruses, and carcinogenic chemicals. The immune system goes through immunosurveillance and immunoediting to recognize and eliminate pre-cancerous transforming cells. Immunosurveillance happens as lymphocytes patrol the body to recognize and eliminate transforming cells and to inhibit carcinogenesis. Immunoediting is important to protect the body from cancerous growths through three phases: elimination, equilibrium, and escape. Elimination begins the immune system inflammatory response in order to recruit the key components of immune system and to prevent activation of tumor growth. Equilibrium is when the body kills any cancer cells that survived the elimination phase. Escape occurs if cancer cells managed to survive both the elimination and equilibrium phases and proliferate to form tumors. When the cancer cells find a way to avoid death by the immune system, other cancer treatments such as drug therapy may be used to inhibit the growth of cancer cells. Cancer treatments will be discussed further in the next lesson.

Student Activity:
1. Students will continue their research on the insidecancer.org website as a continuation from the cell signaling activity in the previous lesson to learn about what happens when the cell signaling pathway malfunctions. How does cancer occur?

STUDENT HANDOUT

Cancer

You learned that cells normally undergo apoptosis, or cell death, through cell signaling. Cancer cells, however, avoid apoptosis and continue to grow uncontrollably. In this activity, you will utilize www.insidecancer.org to view various animations on how cancer cells avoid normal cell signaling and become cancerous.

1. As a general introduction to cancer, we will look under Hallmarks of Cancer:
   - Log onto www.insidecancer.org
   - Click on Hallmarks of Cancer.
   - Click on Overview of Cancer and look at all 7 animations.

   -Under the second slide, write down 5 different types of cancers that can arise in the human body:

   1.

   2.

   3.

   4.

   5.

   -Under the third slide, discuss how all cancer arises from mutations from one cell.

2. Now, learn about how cancer cells grow even in the absence of growth stimulatory signals.
   - Click growing uncontrollably and look at the 4 slides.

3. Evading death
   - Click on Evading death and view the 4 slides.

   -Cancer cells have to learn how to avoid programmed cell death, otherwise called

   _____ .

   Normally when a cell is damaged or gets old, it is signaled for death. The cell makes

   _____ and _____ that degrade its components.

   Eventually, the cell will get engulfed.

4. Processing Nutrients

- Click on Processing Nutrients and view the 3 slides.

-Explain Angiogenesis:

-List which nutrients tumors need to grow.

-List the waste products of tumor cells.

5. Becoming Immortal

- Click on Becoming Immortal and view the 9 slides.

-Explain the role of the telomere.

-Discuss how cancer cells avoid apoptosis

6. Invading Tissues

- Click on Invading Tissues and view the 3 slides.

-Discuss how cancer kills.

7. Avoiding Detection

- Click on Avoiding Detection and view the 6 slides.

-Discuss evidence of immunosurveillance and immunoediting by the immune system.

-Explain the use of adjuvant therapy and its role with the immune system.

8. Promoting Mutations

- Click on Promoting Mutations and view the 6 slides.

-Discuss the 3 ways that cancer cells can change from normal cells.

Lesson VI – How do doctors diagnose patients with cancer using blood-based screenings?

Diagnosing Cancer

Overview: Students explored how cancer occurs. Now, students will participate in a blood-based diagnostics lab where they will recognize that cancer cells are different from normal cells based on proteins located on their surfaces. Doctors and researchers utilize this early detection screening in order to effectively treat cancer with specific cancer drugs.

Objectives:
- Diagnose prostate and cervical cancer through the Blood-Based Cancer Lab.

Time Requirement: 1 class period (60 minutes)

Acknowledgments: This lab activity is created by Edvotec

Ordering Information
The Blood-Based Cancer Diagnostics Lab (EVT 004037AM, Kit #141, $60) can be ordered from Edvotek (www.edvotek.com)

Student Handout

Blood-Based Cancer Diagnostics

Problem: How do doctors diagnose patients with cancer using blood-based screenings?

Storage: Store entire experiment at room temperature.

Safety: No human materials are used in this experiment. Gloves and safety goggles should be worn as good laboratory practice.

Materials:
- Control samples (High & Normal PSA, Positive & Negative HPV)
- Simulated blood samples from six male patients (M1, M2, M3, M4, M5, M6)
- Simulated blood samples from six female patients(F1, F2, F3, F4, F5, F6)
- Antibody for PSA
- Antibody for HPV
- Transfer Pipets
- Microtiter plates
- Microtest tubes

Introduction:
Cancer is a disease that can cause great harm and potentially death to the human body. The causes of cancer at the molecular level are becoming more apparent with research. Scientists are able to use that research to create therapies to treat cancer. Doctors are able to detect and treat patients by identifying cancer biomarkers. The protein biomarkers serve to provide doctors with the progression of the cancer and the possible treatments that can be utilized at the specific stage of the disease.

Students will be experimenting with two cancer biomarkers utilizing a set of simulation blood samples that come from various patient blood samples. The two protein biomarkers that students will be using to test for cancers are human papilloma virus (HPV) and prostate specific antigen (PSA). HPV is utilized by doctors to test for specific strains that may cause cervical cancer in females. HPV is a sexually transmitted disease that cannot be detected by a routine PAP smear exam. PSA is an enzyme produced by prostate cells that can detect prostate cancer in males. High PSA levels usually indicates that further tests and scans need to be taken in order to accurately confirm the presence of prostate cancer.

The biomarkers are identified by polyclonal or monoclonal antibodies. Antibodies belong to a group of serum proteins called globulins. Each antibody is made up of a heavy and light polypeptide chain. Antibodies are produced by a “non-self” antigenic protein such as bacteria or virus. Antibodies that are produced from animals in response to an antigen are polyclonal in nature in that many different antibodies again the antigen may be produced. Each antibody is mono-specific, but in combination can more effectively assist in clearance of the offending pathogen by binding to multiple targets. Using a

monoclonal antibody preparation (not a mixture of specificities) is ideal for biomarker detection due to the lower experimental background.

Introductory Questions:

1. What are protein biomarkers and how are they used as diagnostic tools for cancers?
2. Why does a doctor order tests in addition to the biomarker blood-based caner tests?

Procedure:

A) ***Simulated PSA test for 6 male patients between ages of 55-70 for prostate cancer***
1. Make a PSA plate. Place a microtiter plate strip as shown below. Label the 8 wells across the bottom of the plate using a marker in the following order: Normal, High PSA, M1, M2, M3, M4, M5, & M6. Your plate should look like figure 1 under the data section.

2. You will need to use gloves for the rest of the PSA plate procedure. Use a different transfer pipet or pipet tip for each sample, plate 3 drops or 50 μl of each control and patient sample into the corresponding wells.

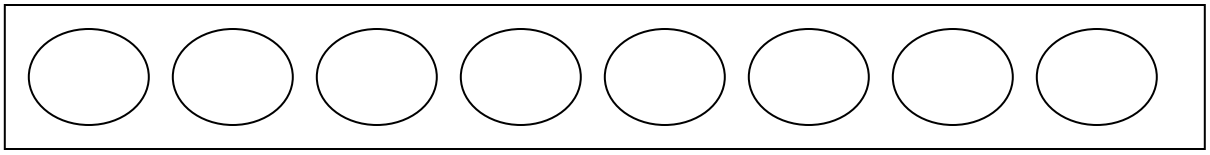
3. Use a new transfer pipet to add one drop or 20 μl of PSA antibody into each well.

4. Let the plate sit on the lab table for 5 minutes. Please do not disturb the plate.

5. Observe the wells for the level or intensity of agglutination. Agglutination is when the mixture appears to be granular rather than smooth. Record the results in the data section figure 1.

Data

Figure 1: PSA Plate



Normal Control	**High PSA Control**	**Male 1**	**Male 2**	**Male 3**	**Male 4**	**Male 5**	**Male 6**

B) ***Simulated HPV test for 6 female patients between ages 40-55 for cervical cancer***

1. Making a HPV plate. Place a microtiter plate strip as shown below. Label the 8 wells across the bottom of the plate using a marker in the following order:
Normal, High HPV, F1, F2, F3, F4, F5, F6.

2. You will need to use gloves for the rest of the HPV plate procedure. Use a different transfer piper or pipet tip for each sample, plate 3 drops or 50 μl of each control and patient sample into the corresponding wells.

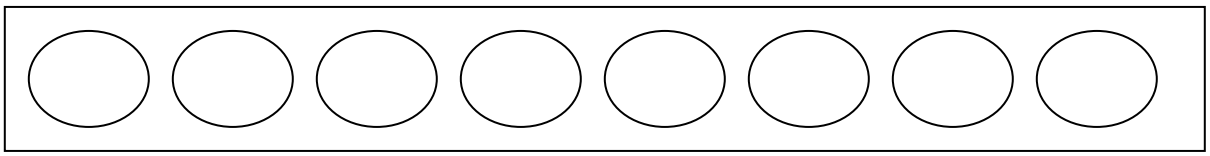
3. Use a new transfer pipet to add one drop or 20 μl of HPV antibody into each well.

4. Let the plate sit on the lab table for 5 minutes. Please do not disturb the plate.

5. Observe the wells for the level or intensity of agglutination. Agglutination is when the mixture appears to be granular rather than smooth. Record the results in the data section figure 2.

Data

Figure 2: HPV Plate



Negative Control **Positive Control** **Female 1** **Female 2** **Female 3** **Female 4** **Female 5** **Female 6**

Summary/Conclusions:

1. Based on your observations, which male patients would you conclude might have prostate cancer?

2. Based on your observations, which female patients would you conclude is positive for HPV?

3. Why is a PSA blood test useful but not a definitive diagnostic test for the detection of prostate cancer?

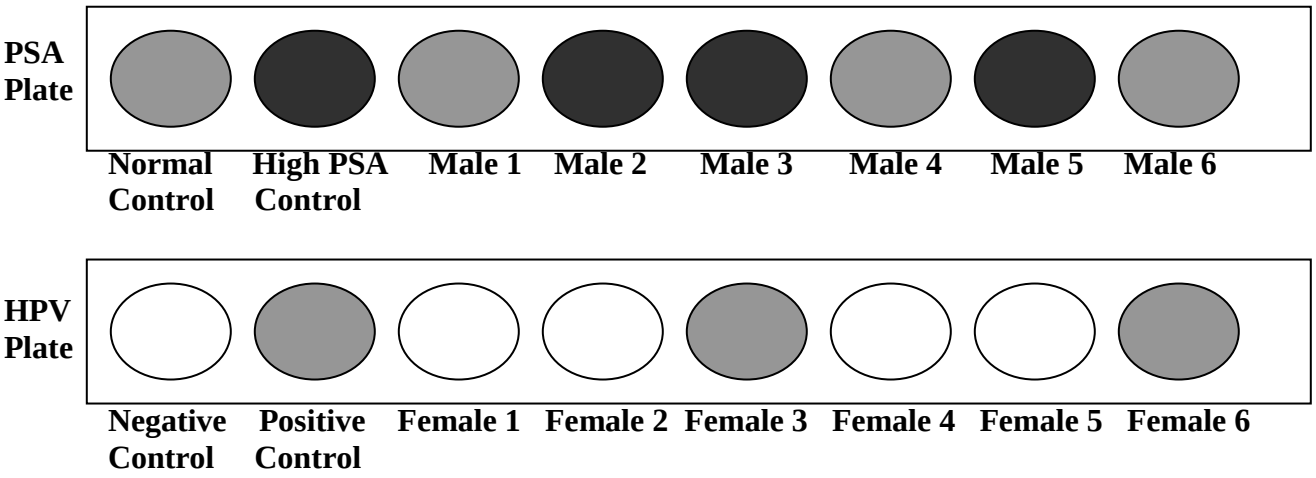
4. How does HPV infect a population and cause cervical cancer in women?

Teacher Section:

Pre-Lab Preparations

1. Each group will require 2 microtiter plate pieces and transfer pipets.
2. Label tubes and aliquot 60 µl of each of the PSA and HPV controls, male patients M1, M2, M3, M4, M5, M6, and female patients F1, F2, F3, F4, F5, F6. Make sure not to cross-contaminate the different blood types. Use a new transfer pipet for each sample.
3. Label tubes and aliquot 200 µl each of the antibody for PSA and antibody for HPV. Use a new transfer pipet for each sample.

Expected Results:



Summary/Conclusions:

1. Based on your observations, which male patients would you conclude might have prostate cancer?
   Male patients 2,3 and 5. When you compare the high PSA control, patients 2,3, and 5 also show the same high levels. Further testing will need to be completed with these patients to determine if they actually have prostate cancer.
2. Based on your observations, which female patients would you conclude is positive for HPV?
   Female patients 3 and 6.
3. Why is a PSA blood test useful but not a definitive diagnostic test for the detection of prostate cancer?
   High PSA levels can be used to diagnose prostate cancer, but there are also other conditions that may cause an increase in PSA that include enlargement of the prostate gland in older men and prostatitis that are infection of the prostate.
4. How does HPV infect a population and cause cervical cancer in women?
   HPV is a sexually transmitted disease (STD) that can infect both men and women. Men can be carriers of the virus and can pass on the virus.

Lesson VII - How do doctors treat cancer?

Overview: Students learned in previous lessons about how cancer occurs in the human body. In this lesson, students will investigate current treatments for cancer including chemotherapy, surgery, radiation, and immunotherapy. Students will participate in an Internet based activity that focuses on the pros and cons of each type of treatment for cancer.

Objectives:
-Explain current cancer treatments including chemotherapy, surgery, radiation, and immunotherapy.
-Understand the role of the immune system in cancer prevention and elimination.

Time Requirements: 1 period (60 minutes)

Introduction:
Current cancer treatments include surgery and radiation to eliminate the cancer locally. Chemotherapy utilizes anti-cancer drugs to prevent the malignant cells from multiplying. Immunotherapy manipulates an individual's own immune system to fight cancer. Some of the different types of immunotherapy include strengthening the immune system through the intake of various natural substances or injecting substances such as antibodies made outside of the human body.

Student Activity:

1. Students will be divided into small groups (4 students per group). Each person in the group will research the pros and cons of each type of treatment for cancer. Each student has to complete the handout of potential benefits and risks for a particular treatment.
Surgery
Radiation
Chemotherapy
Immunotherapy

Recommended websites:
http://www.cancer.org/Treatment/TreatmentsandSideEffects/TreatmentTypes/Immunotherapy/immunotherapy-intro
http://www.insidecancer.org/

2. Students will share their findings with the rest of the small group. Based on the research completed in the small group, what treatment should be utilized to treat cancer? Support your answer using information from your lists.

> ***Student answers will vary. Their answer should be supported by information from their lists and referenced.***

STUDENT HANDOUT

Treatments for Cancer

When the immune system response does not work to eliminate cancer cells, medical intervention with different treatments is needed. The current available treatments include surgery, radiation, chemotherapy, and immunotherapy. Using online resources, research the potential benefits and risks of each type of treatment. You will collaboratively work in groups of 4 students. Each student within a group must research a particular treatment. The information will be shared within your group.

Potential Benefits	Potential Risks

Based on the research completed in your small group, what treatment should be utilized to treat cancer? Support your answer using the researched information on the benefits and risks of the treatment.

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