

Using Emerging Pathogens as a Vector for Teaching Project-based
Storyline learning to 9th Grade Biology I Students.

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Abstract: The purpose of this research is to measure student interest and achievement in Biology I through the theme of emerging pathogens/disease as a form of project based storyline learning. This will be accomplished through teaching each unit through the lens of disease that affects the lives of humans. Whether an actual human pathogen or a disease that impacts plants and animals near and dear to humans, the focus will be to catch the attention and interest of teens in learning about their own body as well as their interactions with the environment through such a focus. The content knowledge and student interest will be measured through the use of pre/post freethinking maps, pre/post survey, End of Course assessment and class attendance records.

Rationale: In the 2015-16 school year at Matanzas High School 72% of the freshman class missed more than 5 days of school. This number rose to 87% of freshmen missing more than five days of school in 2016-17. Biology I is a mandatory course and graduation requirement for all incoming freshmen. In 2012 the state of Florida implemented the Biology End of Course exam. This high stakes test has made teaching biology somewhat of a challenge for educators to foster student curiosity through rich authentic scientific learning experiences that maintain interest of the students and still address all 85 of the Florida biology standards. Add to that the fact that student scores on those EOC exams are directly tied to a teacher's evaluation and the end result can make for students being taught in a fast paced 'cover it all' delivery method that leaves students bored, disinterested and more likely to miss school. (Tokuhama-Espinosa ,2010)

The purpose of my action proposal is to increase student interest and attendance by creating a strong content-based set of lessons with the context of a real world scenario of diseases that affect the human body. Students will learn rich content vocabulary, become curious thinkers and discover in depth science content of the human reproductive system through the use of theme-based learning. Delivering specific scientific content through a central storyline with focused lessons and activities will strongly contribute the students understanding of specific science standards. (Roth and Garnier 2006)

Intervention: The intervention strategy that I will be using is project-based thematic learning. My goal is to design the entire human reproductive system unit around the idea of emerging pathogens. By using the theme of disease students will learn about and better retain complex information about the male and female reproductive systems and apply that information to their own lives from a community health perspective. Students will also make connections to the content in this unit to other standards in this course. These lessons will be taught to two classes of 9th grade lower-quartile students that are struggling readers. These classes will meet the entire 2017-18 school year Monday-Friday for 46-minute class periods in the afternoon.

My typical biology I classes often come with many complex behavioral issues that make for many learning challenges. Over the past three years there has been an increase in my freshmen students having unexcused absences. These same students rarely come to class with supplies and homework is even more of a scarcity. Knowing that an intermittent 46 minutes might be all that I have to reach certain students often forces me to chose the quick and easy 'stand and deliver' approach that leads to frustration and failure for both teacher and students alike. In recent years I have approached the unit on the human body as a series of mini-lessons designed to hit the standards with lectures, video clips along with labeling and coloring activities in which the students create a short pamphlet/study guide.

In this action proposal I will create a problem-based scenario where students will learn about the NGSSS human body standards through the disease model. Specifically students will learn about the fate of two survivalists who participated in an American reality TV series where they were given the task of surviving a stay in the wilderness without clothing for 21 days. In their hunt for water, food, shelter and clothing in Central America these fictitious case studies will tell a story of disease and disaster that will simultaneously teach the students about the reproductive system, the immune system, cellular biology, transmission of disease, immunizations and public health policy.

Data collection and analysis:

Data collection will be accomplished through four methods:

- 1) Personal meaning mapping- for the reproductive system. Students will be given specific terms to brainstorm ideas that they make connections to both before the unit and after the unit has been taught. This will be measured through the qualitative means and potentially quantitatively. (TBD)
- 2) Pre/post assessment consisting of 5 questions on the human reproductive unit as well as a pre/post assessment on the entire year (as my action proposal is part of a larger action proposal involving 7 total focus units throughout the school year created by fellow CATALySES collaborators.)
- 3) Comparing my 2017-18 9th grade attendance records with 2016-17
- 4) Comparing my 2017-18 Biology EOC pass rates with 2016-17.

Connections to CATALySES summer institute:

Zika lecture
HPV lecture
Hunger Games
Giant microbes
Contagion mapping

Literature cited:

Roth, Kathleen, and Helen Garnier. "What Science Teaching Looks Like: An International Perspective." *Educational Leadership: Science in the Spotlight: What Science Teaching Looks Like: An International Perspective*, December 2006/January 2007. ASCD, Web. 29 June 2017.

Tokuhama-Espinosa, T. *The New science of teaching and learning: using the best of mind, brain, and education science in the classroom*. New York, NY: Teachers College Press, 2010.

National Research Council. (2005). *How Students Learn: Science in the Classroom*. Committee on How People Learn, A Targeted Report for Teachers, M.S. Donovan and J.D. Bransford, Editors. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Teacher Name: Christine Brink	Course: Biology I
Time Frame: 10 days (45 minute classes)	Topic: Human Body Systems
<p>Standards</p> <p>SC.912.L.14.2 Identify the major parts of the brain on diagrams or models.</p> <p>SC.912.L.14.52 Explain the basic functions of the human immune system, including specific and nonspecific immune response, vaccines, and antibiotics.</p> <p>SC.912.L.16.13 Describe the basic anatomy and physiology of the human reproductive system. Describe the process of human development from fertilization to birth and major changes that occur in each trimester of pregnancy.</p> <p>SC.912.L.14.6 Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.</p>	
<p>Success for students after the lesson looks like...</p> <p>Students will score >79% on the end of unit assessment.</p>	
<p>Lesson Essential Question</p> <p>In what ways can Mosquito borne diseases affect human health?</p>	
<p>Central Text <i>(may be digital, audio, article, book, etc)</i></p> <p><i>Naked and Afraid Case study, Internet, HHMI Resources, Spillover video clip, Life's Greatest Miracle video, Biology textbook</i></p>	
<p>Key vocabulary to preview and vocabulary strategy</p> <p>seminal vesicle, prostate gland, vas deferens, urethra, epididymis, scrotum, penis, testes, placenta, umbilical cord, amniotic sac, amniotic fluid, fetus, specific and nonspecific immune responses, antibiotics, vaccines, antibodies, pathogen, Zika, Ebola, Dengue Fever, HPV, cerebrum, cerebellum, pons, medulla oblongata, brain stem, frontal lobe, parietal lobe, occipital lobe, and temporal lobe.</p>	

Lesson Instruction

Day 0 Mindmapping: Students will create a mind map that represents any connections they can make with the terms Reproductive System, Immune System, Lobes of the Brain, Pathogens.

Day 1

Activating Strategy: Show the TV Show [Naked and Afraid Trailer](#).

Introduction: Read *Naked and Afraid: The Arrival and Week ONE*

Activity: Students will label Male reproductive system diagrams and create two word labels for each structure's function.

Formative Assessment: What you would consider the 3 least known parts of the male reproductive system and describe what their functions are.

Day 2

Introduction: Read: *Week Two: Mango Malady* together in class.

Activity: In small groups student will read about the Immune Response and create a Cartoon explaining 3 main types of pathogens and the 3 lines of defense.

Formative Assessment: Exit ticket tweets about pathogens (140 character limit)

Day 3

Introduction: Read tweets from yesterday's exit tickets.

Activity: [Meet the Menacing Microbes](#)

Formative Assessment: Have students create a decorative collage of pathogens to decorate the classroom. Massign areas for viruses, bacteria and 'others'.

Day 4

Introduction: Read: Week Three: Getting to the Extraction Point

Activity: Students will label female reproductive system diagrams and create two word labels for each structure's function.

Formative Assessment: What you would consider the 3 least known parts of the female reproductive system and describe what their functions are.

Day 5 & 6:

Introduction: Read: The Aftermath

Activity: Students will complete *An Indepth Look* using the CDC website links provided.

Formative Assessment: Students will Create an audio or visual PSA about Zika and HPV Vaccine.

Day 7 & 8:

Introduction: Tying in Immunity. Demo a Pregnancy test. Demonstrate ELISA testing and explain how a pregnancy test works by matching the antibody with the antigen HCG produced by the placenta.

Activity: Fetal Development:

Go over milestones of the trimesters of pregnancy by streaming Nova's *Life's Greatest Miracle*. * Permission slip may be required (this also

Resources:

Giant Microbe kit

Elisa Assay

PBS *Spillover* DVD

Poster paper

Twitter

Venn Diagram

ELISA Virtual Lab:

<http://www.hhmi.org/biointeractive/immunology-virtual-lab>

Life's greatest Miracle:

<http://www.pbs.org/wgbh/nova/body/life-greatest-miracle.html>

**Pregnancy test from Dollar store.
HCG hormone from Pharmacy or GNC.**

reviews reproductive anatomy)

Formative Assessment: Have students create a Highlights list of the film that describe the major events of the trimesters of pregnancy.

Day 9: Show clip of PBS *Spillover*

Day 10: SUMMATIVE ASSESSMENT Mindmapping: Students will create a mind map that represents any connections they can make with the terms Reproductive System, Immune System, Lobes of the Brain, Pathogens.

Lesson Extension:

[The Dengue Dilemma](#)

[Immune System Venn Diagram](#)

[HHMI Stopping Mosquito Borne Disease Click and Learn](#)

SCIENCE IN TELEVISION

THE UNTOLD EPISODE



In the summer of 2015 an episode of Naked and Afraid was filmed in the jungles of El Yunque National Forest in Puerto Rico but never aired. Read on to learn about why this story never made it to television.

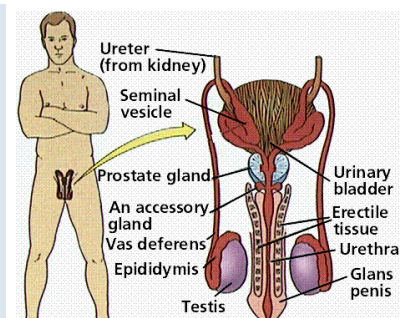
THE ARRIVAL

Two Discovery film crews flew in to San Juan, PR the night of September 1, 2015, just one week after Tropical Storm Erika left her costly but at least not deadly trail of damage. Road conditions were reported to be decent until they arrived closer to the mountains, where the torrential rainfalls left lots of flooding and mudslide damage. Each crew would pick up their assigned contestant and deliver them to their insertion point at the Northern tip of the Luquillo Mountain range. Barbara Guyrl also known as 'Survivor Barbie' by her friends couldn't wait to meet her fellow co-star Kenneth Dahl. Both contestants were skilled survivalists and athletes. Both described themselves as single and not overly familiar with the opposite sex. Hence neither was extremely comfortable with the idea of being naked in front of

one another for 21 days. Barbara had heard that genital tract infections were a possibility in the jungle without proper care and preventative measures and decided to do a little research on the male reproductive system.

AN INDEPTH LOOK

1. Using the handout and resources provided by your teacher research with your team the main structures and functions of the male reproductive system. Be sure your research includes the vas deferens, epididymis, seminal vesicles, urethra, penis, testicles, scrotum and prostate.
2. After researching the above structures and their functions, in your small group create a poster that labels each of these parts and identify one disease associated with each structure. What potential parasites and/or infections would be of concern to Kenneth in the rainforest?



WEEK ONE: TACKLING THE FOREST

The week for Barb and Ken went surprisingly well, all things considered. They built their shelter thanks to Ken bringing a machete, found a water source nearby and built a fire with Barb's fire starter. Through the first week they communicated well and each recognized a sense of chemistry amongst one another. After the first few cold nights sharing body heat while snuggling was no longer awkward.

WEEK TWO: MANGO MALADY

Despite the cold nights the days were hot and sunny often reaching in the 90's with the heat index in the 100's. Barbie's fair skin was burnt and needed protection. She had been successful in thatching shoes from palm fronds and found the ideal plant, or so she thought, for making a covering for her shoulders from the UV rays of the scorching sun. The day after wearing her newly made shoulder covers she woke up with a rash spreading across her back, shoulders and hands. When Ken returned from gathering firewood Barbie showed him her inflamed shoulders and explained how itchy it was. Ken inspected her shoulders and saw the covering near by. A closer look at the covering that she had been using he asked if the leaves were from the mango trees. Indeed they were and Ken recalled from his research beforehand that Mangoes secreted the same toxic substance, urushiol, which is found in poison ivy. Urushiol is not a pathogen (a living organism that is harmful) but rather a chemical secreted by plants that the body recognizes as being



THE IMMUNE RESPONSE: PRIMARY AND SECONDARY

Every day your body encounters pathogens. Your immune system's function is to protect your body against these invaders. The immune system works like a defense system. The military has several lines of defense and so does your immune system!

The immune system is assisted by many different tissues and systems. First, the skin, which is part of the integumentary system, helps protect the body from foreign invaders. Second, the digestive system is full of beneficial bacteria that help fight off pathogens. Thirdly, the mucous membranes also assist the immune system by trying to trap any pathogens. Lastly, the circulatory system provides a transport system for all the cells of the immune system so they can move easily and quickly throughout the body. You can think of this like allies in a war. When a country is at war with another country we have allies that help us so that the struggle can end quickly.

The immune system has many cells, as well as proteins that help fight pathogens. One of the first cells to respond to an infection are macrophages, a type of white blood cell. These cells like to eat anything that doesn't belong in your body. In the image you can see the blue macrophages attacking the yellow cancer cell. Your body also produces lymphocytes. Lymphocytes are also white blood cells. They are specialized just like each person in the military has a rank and job. T cells can have two jobs. If they are Helper T cells, they act as a commander and activate other cells. The other type of T cell is called a Killer or Cytotoxic T cell.

These T cells kill infected cells by spraying them with chemicals. The last type of lymphocyte we will learn about is a B cell. B cells are important because they help you produce proteins called antibodies. Antibodies give you long-term immunity, so you don't get sick again.

There are many different types of pathogens, or foreign invaders. Two of the most common are bacteria and viruses. Bacteria are prokaryotic cells. As you may recall, prokaryotic cells are much smaller than human cells.

Bacteria can be helpful or harmful. Many good bacteria live in your digestive system and actually help fight off pathogens. There are however, pathogenic bacteria. An example would be E. coli. You can pick up this bacteria by eating undercooked red meat. Most bacteria cause damage to your cells by producing toxins. These toxins make you sick. We commonly use antibiotics to help our immune system fight bacteria. Another common foreign invader is a virus. Viruses cause colds, flu, chicken pox, measles, herpes and Ebola. Viruses act as intracellular parasites. This means they take over your cells. They use a host cell to reproduce and then often destroy the host cell in the process. We have very few drugs that help us fight viral infections, but we do have many vaccines that prevent us from being infected in the first place. In addition to the common viruses and bacteria, some other types of pathogens are fungal and protist invaders, as well as parasites. Here in Florida, people should be educated about the amoeba, *Naegleria fowleri*. These protists live in warm water. If someone swimming in that warm water gets water up their nose, the amoeba can enter the nervous system through the nasal passages and infect the brain. This pathogen is usually deadly. It is recommended to always wear nose plugs if swimming in warm freshwater.

Your first line of defense is a type of nonspecific defense. This means they will protect you from any kind of pathogen. Your first line of defense includes the skin. The skin is a barrier that is hard for pathogens to penetrate. It is however, easier for pathogens to breach your defenses in the mouth, nose or eyes. Tears, saliva and mucus are sticky and help trap pathogens. Lysozymes, enzymes that destroy pathogens, are also found in these body fluids to help fight off as many pathogens as possible.

Once a pathogen gets past the first line of defense, your second line of defense kicks in. This includes the inflammatory response, accompanied by the action of interferon and fever. These defenses are called nonspecific because they will defend against any invader or pathogen. When a pathogen enters your body it causes certain cells to release histamines. These histamines increase blood flow, which brings fluid to the infection. This results in swelling. This increased fluid allows white blood cells to move into the infected tissue and start fighting the pathogen. All of this increased activity causes a rise in temperature.



WEEK THREE: GETTING TO THE EXTRACTION POINT

Barbie and Ken were more than ready to go home. The standing water from the tropical storm had created a haven for mosquito larvae and Ken's body was completely covered in mosquito bites. Barbie on the other hand tended not to attract the bugs much, but then again she had enough with her hypersensitive skin reaction to the mango leaves. Additionally she was experiencing a dull pelvic pain that made her uncomfortable enough to discuss with Ken. Trying to recall the female reproductive system and possible causes Ken couldn't be sure it was anything serious. It was day 19 and Ken had a nasty headache. He became feverish, starting with joint pain, developed a mild rash and by nightfall had red eyes (aka conjunctivitis). The two would lean on each other to make it out of the jungle once and for all.

The higher temperature slows the growth of the pathogen, but remember if a person has a high fever for more than several hours it can be dangerous. If viruses infect your cells, those infected cells will start producing interferons that slow the growth of viruses.

Once a pathogen has moved past your second line of defense, your body will activate its third line of defense. These are your specific defenses, meaning they respond only to a specific pathogen. There are two main troops in your third line of defense, T cells and B cells, which are both types of white blood cells. Pathogens have surface markers on them called antigens. Antigens are kind of like name tags on the pathogens. The cool thing is that your white blood cells, macrophages, share these name tags with all your T cells and B cells so they know what to look for. Once an antigen starts getting passed around, the Helper T cells will become activated. Helper T cells are similar to a commander. They will in turn then activate other troops, for example the Killer or Cytotoxic T Cells. When a Killer T cell encounters an infected cell or pathogen, it will release chemicals that will cause the death of the infected cell or pathogen.



A CLOSER LOOK:

1. Consider Barbie's skin reaction to the mango leaves. How does this relate to the body's primary AND secondary response?
2. Both the primary and secondary responses of the immune system are considered non-specific defenses. What does this mean?
3. The body's third line of defense is called *the Immune Response*. This response attacks specific pathogens using specialized cells called T cells and B cells as well as special proteins called antibodies. Research the difference between T cells and B cells and antibodies and antigens and draw and label each.

THE FEMALE REPRODUCTIVE SYSTEM

AN INDEPTH LOOK

1. Using the handout and resources provided by your teacher research with your team the main structures and functions of the female reproductive system. Be sure your research includes the vagina, urethra, cervix, uterus, fallopian tubes, and ovaries.
2. After researching the above structures and their functions, in your small group create a poster that labels each of these parts and identify one disease associated with each structure. What potential parasites and/or infections would be of concern to Barbie in the rainforest?

THE AFTERMATH

Shortly after returning home from Puerto Rico, Ken was hospitalized for 5 days with complications from Zika. Almost a month after being home Barbie contracted Zika. This bewildered her that she came down with Zika after being home from so long. It turns out Zika is not just transmitted by mosquitoes. While at the doctor's office, Barbie inquired about her pelvic pain. Her doctor asked her some very personal questions about her relationships and the doctor inquired as to whether she ever received the HPV vaccine. The doctor handed her a brochure about it and recommended she get the vaccine. The doctor performed an exam and a few tests and soon determined that Barbie was pregnant. The doctor was extremely concerned.

AN INDEPTH LOOK

Go to the CDC website page on Zika <https://www.cdc.gov/zika/index.html>

1. Research ways that Zika is transmitted. What is the most logical path from which Barbie was infected?
2. The doctor is concerned about the welfare of the unborn baby. Using the above link, what risk does Zika pose to Barbie's fetus? Describe the condition and how it affects the baby?
3. There are 3 main parts of the brain, the cerebrum, the cerebellum and the brainstem. Research what the four parts of the cerebrum are and where they are located. What are 2 major parts of the brainstem and where are they located?
Which if any of these brain structures in Barb and Ken's baby may Zika affect?

Watch this short Youtube clip: <HTTP://BIT.LY/2HNRGYW>

Go to the CDC website page on HPV <https://www.cdc.gov/std/hpv/default.htm>

1. WHAT DOES HPV STAND FOR? What are the concerns for Barbie's health for not having the HPV vaccine?
2. Who is the HPV vaccine recommended for and at what age?

