

When Pathogens Attack

Brandee Manning
Walton High School

Abstract

This unit is meant to be a means by which to expose Environmental Science students to information about emerging pathogens that are influenced by environmental conditions and the tools and techniques we use to study them. This will be accomplished by asking the students to create their own “webisode” on our new show entitled, *When Pathogens Attack*. While this is the overall goal of the students, we must build our knowledge base about emerging pathogens through lecture and lab. Students will be given outbreak and patient scenarios that will be analyzed using gel electrophoresis (DNA fingerprinting) or ELISA techniques. These techniques will be highlighted in their videos. Students will take on several roles for their video which should represent biotech careers. We will publish our new show to either a newly constructed website or a class Wiki.

Rationale

Emerging pathogens are part of the curriculum for Environmental Science. It is important that students understand the roles of the environment as well as humans when emerging pathogens arise. Current, up to date information is vital to that goal. Being able to expose my students to actual current research being conducted with these pathogens is invaluable. This exposure gives students not only content knowledge, but also a much needed glimpse into the scientific world in education and careers. This content serves the students by giving them a grasp of real-world, scientific information that can, and most likely will, impact their own lives in some way. This gives me an answer to that ever present question in high school, “Why do I need to know this?”

In addition to content, it is equally important that I give students hands-on experience with equipment and technique currently being used in scientific careers. Any student wishing to further their education in a scientific field or to go on to a science or technology based career, must have some exposure to these techniques and equipment. I intend to give my students this opportunity by providing lab activities that utilize gel electrophoresis as well as ELISA tests. Students will also be responsible for learning about at least one biotech related career for their video.

Teaching Unit

Introduction	Students will get an initial exposure to the idea of emerging pathogens through the use of video or newspaper/magazine articles that are intriguing and will gain the students interest. Informal assessment will be through question and answering.
Emerging Pathogens	Students will be able to define “emerging pathogens” and give examples. Students will demonstrate that emerging pathogens are linked to environmental conditions by brainstorming ways the environment can influence outbreaks of disease. Informal assessment will be through written brainstorming document.

Assignment	We will discuss what is expected of students in terms of a final product (“webisode”).
Research	Research opportunities will be dispersed throughout the term of the unit so that students are able to find the information they find relevant to their specific chosen emerging pathogens.
Micropipetting	Introduce the equipment and its purpose. Students will complete protocols to acquire practice and use of the equipment. Visual assessment of proper completion of the protocol will serve as the only assessment for this section.
Outbreak #1	Scenario number one is given to students. An outbreak of Dengue Fever in the panhandle has occurred. Introduction to mosquitoes as a vector and the types of mosquitoes responsible for Dengue fever will precede a laboratory activity in which students identify if mosquitoes are indeed carrying Dengue fever through gel electrophoresis (DNA fingerprinting).
Biotech Careers	Students complete jigsaw activity in which they learn about various biotech careers. Students must take on the role of one of these professionals in their video.
Video Technique	Teacher will demonstrate video technique and expose students to editing software. Student practice will follow.
Outbreak #2	Scenario number two outlines a series of new patients in the local hospital exhibiting symptoms that are seen in many emerging pathogens. Students will brainstorm the culprit and complete an ELISA to determine if we have an outbreak of cholera, E. Coli 0157:H7, E. Coli 0104:H4, or some other pathogen.
Indirect Human Impact	Students discuss pathogens that affect humans indirectly. Citrus greening, TSWV, and other agricultural pathogens will be discussed here. Students can use these pathogens in their projects as well.
Final Video Production	Students complete, edit and publish their “webisodes” to our website or Wiki. I intend to extend the exposure of these activities to the school and possibly the community and the World Wide Web.

Assessments

Pre-Test	Students complete pre-test on pathogen and biotech content knowledge.
Journaling	students will keep a research/reflective journal in which they organize all the information they need to complete their assignment and respond to specific reflective questions scattered throughout the unit.
Lab Reports	All students will submit lab reports for any lab activity completed.
Careers Worksheet	Students will be responsible for completing a graphic organizer of some sort during the career jigsaw.
Final Assessment	“Webisode” assessed using rubric. Rubric will be distributed when students are given the initial assignment.
Post-Test	Students retake the content knowledge test.

Possible Extensions/Additions

- Career fair for school and community, such as the extension lesson for ViralQuest
- Connect to a Zoology study of protozoa and helminths that are human pathogens and include their own “webisodes” for our website/Wiki; content also connects to arthropod study

Equipment Lockers Needed

Gel electrophoresis (DNA fingerprinting) locker combined with micropipetting locker for scenario #1
ELISA simulation from Dr. Lawrence

ICORE Elements Included/UF Connections

Emerging pathogens content knowledge from activities and lectures will be used in great detail. I will most likely use bits and pieces from most lectures to discuss the emerging pathogens we address in class. Biotech careers and techniques will be discussed and demonstrated. I will most likely use the lesson plan from ViralQuest to jigsaw biotech careers and possibly the career fair extension. Gel electrophoresis (DNA fingerprinting) lab will utilize the Carolina kit we used in lab here at UF.

Budget

Carolina Fingerprinting Kit	item # 211208	\$89.00
DNA Refill x3	211209(\$52 Each)	\$156.00
	Total	\$245.00

Lesson Plan

TITLE: When Pathogens Attack

KEY QUESTION(S):

What are emerging pathogens and what are some examples of emerging pathogens?

How can emerging pathogens be linked to environmental conditions?

What are disease vectors?

What is micropipetting?

What is the purpose of gel electrophoresis?

How can gel electrophoresis be used to identify pathogens?

What are some of the major biotech careers?

What is an ELISA test and how can it be used to identify the pathogen present in an outbreak?

SCIENCE SUBJECT: Environmental Science, possible a modified lesson in Zoology

GRADE AND ABILITY LEVEL: This lesson will be attempted with 11th and 12th grade students in a general level class.

SCIENCE CONCEPTS:

Emerging Pathogens

Environmentally influenced disease

Disease Vectors

Biotech techniques and careers

OVERALL TIME ESTIMATE: All Portions of this lesson will require 3-4 Weeks of instruction and activities.

LEARNING STYLES: All learning styles will be accommodated with differentiated instruction techniques varying from lecture and PowerPoint/Active Inspire presentations to hands on activities and student directed creation of products.

VOCABULARY:

Pathogen

Emerging Pathogen

Cross-Species Transfer

Micropipetting

Protocol

Dengue Fever

Vector

Gel Electrophoresis

ELISA

Cholera

E. Coli

Citrus Greening

TSWV

LESSON SUMMARY: In this lesson students explore emerging pathogens and how they can be influenced by environmental conditions. Students also learn and utilize current biotechnology techniques as well as explore various careers in biotechnology. This lesson will be presented with multiple styles. Base material will be presented using PowerPoint, Active Inspire, or Prezi presentations. Students will participate in hands on activities to explore and solve outbreak scenarios. Students will present their overall learning by producing their own “webisode” for the web show “When Pathogens Attack.”

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

The student will be able to...

1. Evaluate how environment and personal health are interrelated. (HE.912.C.1.3)
2. Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health. (SC.912.L.14.6)
3. Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues. (SC.912.L.16.10)

The above standards are the standards addressed in the course description for the class being taught. More standards with the NGSSS will apply to this lesson.

MATERIALS:

ESSENTIAL:

- Gel Electrophoresis equipment-one gel per group of 4 students. Total of 24 groups of students distributed over 4 classes. Total-6 sets of equipment for running the gel and 24 gels.
- Carolina Fingerprinting Kit plus Refills
- Micropipetting equipment-6 sets of micropipettes and 12 well plates. Multiple protocols.
- ELISA simulation equipment and supplies to accommodate 24 groups of 4 students each.
- Video cameras-at least 4, 6 or more would be optimal.
- Computer with video editing software.

SUPPLEMENTAL:

- Website or Wiki for uploading student videos
- More computers with software for editing videos (computer lab)

BACKGROUND INFORMATION:

Emerging pathogens, relatively new disease causing organisms that are causing health problems in humans in the modern era, are often linked to environmental conditions. Bodies of water polluted with human waste can lead to outbreaks of diarrheal diseases such as **Cholera** and **E. Coli**. Close human interactions with animals as we encroach on their habitats can lead to **cross-species transfer** of a pathogen to humans. As we introduce exotic species from around the world, previously unknown crop or human pathogens can appear in our populations where they never existed before. Our crops can be attacked by pathogens such as **Tomato Spotted Wilt Virus (TSWV)** or other pathogens that cause **citrus greening**. **Dengue Fever** can appear in our populations, as it did in the Florida Keys, due to our extensive travels and the possible transport of insect **vectors** back to the United States from countries in which those diseases are prevalent. Insect vectors can become more of an issue due to

climate change that alters the distribution of those insects. Environmental conditions and human impact on the environment influences all of the instances described above. Understanding of the human role in the outbreaks of disease can lead to better management and prevention of those diseases.

Biotechnology is a field of science that is growing at a spectacular rate due to the need of its services. Scientists can use modern techniques and equipment to help medical and agricultural facilities determine causes of these diseases and conditions discussed above. **Gel Electrophoresis**, can compare DNA or protein signatures of different organisms. **ELISA** tests can detect presence of a pathogen in a plant or animal due to an antigen/antibody interaction. Students must be made aware of these techniques and the associated careers that are available for their study.

ADVANCE PREPARATION:

Create presentations for background and lesson information.

Request appropriate equipment lockers from UF.

Create Website or Wiki to upload videos.

Reserve computer lab for several days throughout lesson for student research and video development.

Teacher must prepare all lab materials one day in advance of every lab.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

- I. Introduction (one 47 minute class period)
 - a. Group Read News Article-Time, Inc; May 24, 2010 “Dengue Fever appears in the Florida Keys”
 - b. Discuss this disease and what emerging pathogens are as a whole group.
 - i. What do you think and emerging pathogen is? (New disease to humans, within modern era)
 - ii. Are there any diseases you can think of that would qualify as an emerging pathogen? (West Nile, Bird Flu, Swine Flu, AIDS, etc.)
- II. Emerging Pathogens (one 47 minute class period)
 - a. Teacher directed presentation on the topic of emerging pathogens.
 - b. Group activity: How do you think environmental conditions could influence emerging pathogens? Brainstorm Poster
 - c. Whole group discussion of small groups posters.
- III. Student expectations of final product and student research/development of final product
 - a. one period of discussion of expectations, grouping, discussing group options
 - b. 3-5 Research/development periods.
 - c. One period of teacher demonstration of video technique and use of editing software
- IV. Micropipetting (one class period)
 - a. Expose students to the micropipette and its proper use and function-teacher demonstration
 - b. Student pairs complete protocol to practice pipetting.
- V. Outbreak Scenario #1 (2-3 class periods)
 - a. Show fabricated news article of an outbreak of Dengue Fever in the panhandle of Florida to gain student interest. (Ask students-What could have caused this outbreak to occur? Do you think you should be concerned about “catching” the disease?)
 - b. Discuss mosquitoes as disease vectors.
 - i. How do mosquitoes transmit disease? (exchange pathogen through mosquito bite)

- ii. What can you do to avoid contracting something from a mosquito? (insect sprays, eliminate standing water, long clothing, curfews, etc.)
 - iii. Think/Pair/Share: What other insects could be a vector for disease? (ticks, mites, biting flies, etc.)
 - iv. Are there any other diseases you know of that are transmitted this way? (malaria, encephalitis, etc.)
 - c. Do our mosquitoes have dengue fever?
 - i. Students complete a gel electrophoresis to determine which mosquitoes are carrying the dengue fever.
 - ii. After determining which mosquito is the culprit, students must plan a way to eliminate the spread of this disease in the panhandle.
- VI. Biotech Careers (2 class periods)
 - a. Students complete Jigsaw activity from ViralQuest.
 - b. Students assign roles of biotech professionals that will appear in their “Webisode”
- VII. Outbreak #2 (2 Class periods)
 - a. Presentation of information on all three “suspect” pathogens: Cholera, E. Coli 0157:H7, and E. Coli 0104:H4
 - b. Teacher outlines a scenario with video clips or health organization statement in which multiple patients have been treated for similar symptoms common to multiple pathogens.
 - c. Students complete an ELISA simulation to determine if the outbreak is Cholera, E. Coli 0157:H7, or E. Coli 0104:H4.
 - d. Wrap-up discussion.
 - i. What were our findings?
 - ii. How might this outbreak have occurred?
 - iii. How do we manage this situation to prevent further illness in the community?
- VIII. Indirect Human Impact (1 Class period)
 - a. Students brainstorm ways in which pathogens could indirectly impact humans.
 - b. Whole class discussion leads to presentation on Citrus Greening, TSWV, and other agricultural pathogens.
- IX. Final production and presentation of student Webisodes (1-2 Class periods)

ASSESSMENT SUGGESTIONS:

- Final product of “webisode” will serve as an assessment of all three NGSSS standards addressed. This product will be assessed using a teacher created rubric.
- Student progress will be monitored using a Pre/Post test
- Formative Assessments used:
 - Journaling-students will journal their progress with their final product
 - Lab Reports-Lab assignments will monitor student progress and understanding of biotechnology techniques and implications.
 - Career worksheet

EXTENSIONS:

ACTIVITIES:

- Career fair for school and/or community to highlight biotech careers.

- Cross-disciplinary adjustment for Zoology students: Worm and protist pathogens as well as arthropod vectors.

LITERATURE/MEDIA:

- Multiple resources are available on all topics including:
 - Richard Prestons “The Hot Zone” and “The Demon in the Freezer”; both books take a look at human pathogens and demonstrate linkages with environmental conditions.
 - Video-Viral Outbreak: The Science of Emerging Disease

RESOURCES/REFERENCES:

Lawrence, Charles D, MPH, Ph.D. “Emerging Pathogens” (compilation of resources)

Klosterman, Michelle L, et. Al. “Viral Quest: Teacher Guide.” University of Florida, 2011.

Lectures:

Dr. Johnson, “Molecular Biology of V. Cholera”

Roxanne Connely, “Mosquito-borne Pathogens”

Dr. Dean Gabriel, “Citrus Greening”

Dr. Morris, “The Age of Pandemics”

Withgott. “Environmental Science: Your World Your Turn.” Pearson, 2012.

Song, Sora. “Dengue Fever Appears in Florida Keys.” Time Healthland.

<http://healthland.time.com/2010/05/24/dengue-fever-appears-in-the-florida-keys/>. 5/24/2010.