

Title: Umbrella: Emerging Pathogens and the Water Cycle

Adeena Teres
Stoneman Douglas HS
Parkland FL

Abstract

Students will look at several water born pathogens as part of the water cycle. The lesson is designed to give students a practical application for their knowledge of the water cycle and why it is important to have clean drinking water. This lesson is designed to combine biotechnology with an Earth Science curriculum to better prepare students for their tenth grade Biology class. Students will use several labs to test water for pathogens. We will discuss pathogens and how they affect people, plants, and animals. The lesson will culminate in a simulation using a pathogen as it goes through the water cycle. The students will be broken up into groups and they will have to use their knowledge to answer several questions about the pathogen and how to protect their town from an outbreak.

Rational

Students will learn about the water cycle which is an essential topic in Earth Science. They will then apply that knowledge to the field of emerging pathogens. It is very hard to study Earth Science because in essence one is studying the Earth. Trying to take a large concept like the Earth and understand its processes is hard for many students. I will use the idea of following a pathogen through the water cycle to make the water cycle into a practical thing instead of an abstract thought. Students always ask why do I have to study this? To answer that question I will use a pathogen and talk about how it can be spread using the water cycle. We will also study other water born pathogens and how they are transmitted, what type of conditions they can survive, how they are spread, and their affect on humans and animals.

I will accomplish this by using lecture, labs, and a pathogen simulation game. I will use practical labs and concepts to shrink down the water cycle into something that is more tangible to my student's lives. Being from America they have never had to look at where their water comes from and they do not understand how precious and limited this resource is. This lesson will also prepare my students for Biology which is the next science class that they will take.

Description of teaching module

Lesson 1: The water cycle (1 day)

Students will take notes and draw out the water cycle with labels and descriptions for each part. The students will already have knowledge about the atmosphere. I will discuss phase changes and water storage. We will also discuss how water is a finite resource.

Lesson 2: Cholera and clean water (2 days)

Lab – Micropipetting: This lab will introduce the proper pipetting technique. Students will learn how to use the micropipettes by completing a design on a 96 well plate.

Lab - Pathogens in water simulation this lab will show how water can be contaminated and what pathogens it may contain

This will be an inquiry activity. I will not talk about pathogens before this lab. Students will discuss why it is important to have clean water and will be introduced to the pathogen Cholera. They will gain an understanding of what it is, how it's transmitted, and how to test for it.

Lesson 3: There will be a discussion on pathogens, how they are transmitted and their affect on people, animals, and plants. This will be the first time my students have learned about pathogens. We will take another look at the results from the water simulation lab and discuss their results.

Lesson 4: Students will perform an Elisa Simulation testing for pathogens. Then we will discuss what an ELISA test is and what the students are looking for by doing the test. We will then perform the ELISA simulation testing for Cholera in different patients. (2 days)

Lesson 5: Water cycle and pathogen simulation (2 days)

Students will be given information about a new pathogen and how it travels through the water cycle. They will also be given a skit about a town being infected by the pathogen. The students will be broken up into groups and will have to figure out how the town is being contaminated, what is being infected, what is the vector for the disease and what or who is being affected by the pathogen. The groups will be assigned by the teacher and each student will have a task or role to perform.

Assessments

Pretest Pathogens

Posttest Pathogens

Lab Write Ups

Micropipetting Lab – If the students make the correct design then they have demonstrated their ability to use the pipetting tools.

Water Test Simulation – Students will use their micropipetting skills to run a water sample testing for different pathogens in the water. Students will be graded based on if they received the same results as the answer key. They will then have to answer several questions relating back to the lab procedure and results.

ELISA Simulation – Students will demonstrate their understanding of pathogens, and how to use biotechnology to obtain data and use that data to draw conclusions. Students will write a report describing what they have learned and explaining what patients were sick and how they came to this conclusion.

Rubric for Pathogen Simulation Game

Literature cited

Morris, Cindy E., David C Sands, Boris A Vinatzer, Catherine Glaux, Caroline Guilbaud, Alain Buffie`re1, Shuangchun Yan, He`le`ne Dominguez, and Brian M Thompson 2008. The life history of the plant pathogen *Pseudomonas syringae* is linked to the water cycle. The ISME Journal 2, 321–334 & 2008 International Society for Microbial Ecology.

Morris, C. E., D. C. Sands, J. L. Vanneste, J. Montarry, B. Oakley, et al. 2010. Inferring the evolutionary history of the plant pathogen *Pseudomonas syringae* from its biogeography in headwaters of rivers in North America, Europe, and New Zealand. mBio 1(3):e00107-10. doi:10.1128/mBio.00107-10.

Budget

11 Adjustable micropipettes \$148.00 each available from CPET

1000/pkg TBR – 35 pipette tips \$51.00 available from CPET

60/pkg 96 well microplates \$118.00 available from CPET

Water Pathogen Simulation Lab available from CPET

Elisa Simulation Lab Available from CPET

Outbreak Lab available from CPET

SCIENCE LESSON PLAN FORMAT

***TITLE:** Umbrella: Emerging Pathogens and the Water Cycle

KEY QUESTION(S):

What are the steps of the water cycle?
How does the water cycle affect life?
How can humans affect the water cycle?
What is a pathogen?
What pathogens are associated with the water cycle?

***SCIENCE SUBJECT:** Earth/Space Science

***GRADE AND ABILITY LEVEL:** Honors 9th Grade

SCIENCE CONCEPTS: Identify key science topics. Try not to be too narrow.

OVERALL TIME ESTIMATE: 1.5 weeks

LEARNING STYLES:

Visual: Creating their own water cycle poster with explanations
Auditory: Hearing Lecture
Kinesthetic: Lab, looking for pathogens in water and plants
Skit Outbreak

VOCABULARY:

Cloud Nucleus: small particles about which **cloud** droplets coalesce

Condensation is the transformation of water vapor to liquid water droplets in the air, producing clouds and fog.

Conservation: Using a natural resource wisely

Cycle: Continuing process in which something is used over and over again

Evaporation is the transfer of water from bodies of surface water into the atmosphere. A change in the water from liquid to gaseous phases.

Evapotranspiration is the transfer of water from plants to the atmosphere

Ground Water: Water beneath the surface of the earth

Infiltration is the flow of water on the ground surface into the ground.

Rain: Precipitation in the form of liquid water

Snow: A crystal made of frozen water vapor

Surface Water: Water which has accumulated on top of the ground

Thermal Polluting: harm to the environment (water) by increasing its temperature; may cause plants

and animal death

Pathogen: An agent of disease. A disease producer.

Pollution: The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects.

Precipitation is water vapor that has condensed into clouds and falls to the Earth's surface. This mostly occurs as rainfall, but also includes snow, hail, fog drip, and sleet.

Runoff includes the variety of ways by which water moves across the land. This includes both surface runoff and channel runoff. As it flows, the water may infiltrate into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.

Snowmelt refers to the runoff produced by melting snow.

Sublimation is the state change directly from solid water (snow or ice) to water vapor.

LESSON SUMMARY: The lesson will discuss the steps of the water cycle and how people interact with water along the pathway.

Labs:

Water Pathogen Simulation

ELISA Simulation

Outbreak Lab

Notes: Power Points on the Water Cycle and Emerging Pathogens

Visual: Powerpoint, Labs, Water Cycle Poster

Discussion: How can humans affect the water cycle? What pathogens can be transited through water.

Kinesthetic: Skit, Outbreak

***STUDENT LEARNING OBJECTIVES WITH STANDARDS:**

1. 75% of students will be able to fill in a graphic organizer showing how the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere interact.

SC.912.E.7.3: Differentiate and describe the various interactions among Earth systems, including: atmosphere, hydrosphere, cryosphere, geosphere, and biosphere.

2. 75% percent of students will be able to describe climate change by listing 3 causes and 3 different ways the Earth will be affected.

SC.912.E.7.7: Identify, analyze, and relate the internal (Earth system) and external (astronomical) conditions that contribute to global climate change.

3. 75% percent of students will be able to draw and label the water cycle explaining what occurs at each step.

SC.912.P.10.4: Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or states of matter.

4. 75% percent of students will be able to make hypothesis on how the pathogen *Pseudomonas syringae* is spread during the water cycle.

SC.912.N.1.6: Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied.

5. Students will be able to explain their role in a simulation looking into a pathogen that is threatening their community.

SC.912.N.4.1: Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.

***MATERIALS:** Sort materials and indicate number required for different types of grouping formats (Per class, Per group of 3-4 students, Per pair, Per student). Be as specific as possible. No need to list basic instructional items like paper, pencil, chalkboard, or overhead projector.

ESSENTIAL: Materials for lab being provided by CPET

SUPPLEMENTAL: Copies of the book The Strange Case of the Broad Street Pump

BACKGROUND INFORMATION:

A pathogen is an infectious agent that causes disease. It can be a virus, bacterium, fungus, or microbe that can infect humans, animals, and plants. Pathogens can be spread in a multitude of ways. Vectors are transmitters of disease. They can be animals but are usually arthropods. Vector born viruses are more common in tropical environments. Vectors do not have the disease they only transmit it. Not all pathogens have to have an animal vector.

Cholera is a water bound pathogen called bacterium *Vibrio cholerae*. It is transmitted in infected food and water and can cause dehydration, severe diarrhea, and death. Symptoms can occur in one to five days after ingestion. Severe dehydration is the cause of most of the deaths associated with cholera. Children and people with type O blood are the most susceptible. It is naturally found in estuarine environments and can be found in shellfish and plankton. Cholera is currently a problem in Haiti. After the earthquake the water had become contaminated. Even the water brought in by the red cross and other organizations can become infected. Once the water source becomes infected the bacterium can easily spread through the entire population. Water treatment and sewage treatment are the easiest ways to prevent the cholera.

The other pathogen we will be looking at is plant pathogen *Pseudomonas syringae* which is linked to the water cycle. *Pseudomonas syringae* is a rod shaped Gram-negative bacteria that affects different plant species. There are approximately fifty different species each affecting a different type of plant. *P. syringae* has been found throughout the water cycle. Not all strains are pathogenic. *P. Syringae* releases a toxin that affects the cell wall of the plant cells. The toxin is affected by the population size of the microorganism. It has been known to act as a cloud nucleus. These microbes need wet cool weather to thrive. They are spread through rain and the water cycle. Hot dry conditions can hinder the size and abundance of this microorganism. It can be found in polar environments and has found to prevent frost damage on plants and to prevent fungus rot.

ADVANCE PREPARATION:

Set up labs and lab groups. Collect news clippings and movie clips of cholera so students will have a better understanding of how cholera affects humans.

***PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:**

Day 1 and 2: Lecture on the parts of the water cycle. Students will be given a power point lecture and they will watch a clip from Earth's Fresh Water. Discuss phase changes and energy transfer with the students trying to bring prior knowledge about energy into the discussion of phase change. Talk about where energy is lost (exothermic) and where it is gained (endothermic). Discuss how water is a finite resource. Have students draw and label the water cycle.

Discussion Questions:

1) Where does fresh water come from?

All the fresh water on Earth is already here. It gets recycled through the water cycle. If people pollute

the rivers and oceans it will contaminate the entire cycle.

2) Why do people say energy is conserved? How is this apparent during the water cycle.

Water is either heated or cooled which in turn takes in or gives off heat energy. This occurs throughout the water cycle.

Day 2: Have students complete the micro pipetting lab. This will allow students to become familiar with the technique of micro pipetting. Define the word pathogen and discuss what pathogen is, how it is transmitted, and some common pathogens, that affect human, plants and animals. Discuss the pathogen Cholera.

1) What are proper lab techniques?

Using gloves, changing the tips of the micro pipettors and wearing goggles.

2) Why is it important to use proper lab techniques?

It is important for safety reasons and to make sure there is no contamination.

Day 3: Continue discussing pathogens and especially cholera. Discuss how it is transmitted, how it affects people, and how it can be prevented.

1) How is cholera transmitted?

Cholera is the bacterium *Vibrio cholerae* that can be transmitted by contaminated food and water.

How does it affect people?

Cholera can cause dehydration, severe diarrhea, and death.

Day 4: Lab: Elisa test for pathogens.

Day 5: Use CPET lab outbreak but change it to look for a pathogen that is found in the water cycle that affects tomato plants.

Divide your procedure into numbered steps with time estimates (in minutes) for each step. Be specific. Don't just say "Introduce concept of food webs." Instead, explain HOW the concept will be introduced. Are you giving a brief lecture? Doing a demonstration? Asking a series of whole-class questions? Showing a film clip?

When including discussion questions in a lesson plan, list specific questions to ask and provide sample acceptable answers in parentheses.

***ASSESSMENT SUGGESTIONS:** Describe specific assessments for EACH objective:

For objective 1: Rubric for grading the water cycle poster. See attached.

For objective 2: Was the picture done correctly

Day 4: Elisa Lab Write Up

Day 5: Outbreak Lab Write Up

EXTENSIONS:

ACTIVITIES: Are there other activities you know of from other resources that relate to this lesson?

LITERATURE:

The Strange Case of the Broad Street Pump: John Snow and the Mystery of Cholera by Sandra Hempel (Jan 1, 2007)

***RESOURCES/REFERENCES:**

Morris, Cindy E., David C Sands, Boris A Vinatzer, Catherine Gloux, Caroline Guilbaud, Alain Buffière, Shuangchun Yan, Hélène Dominguez,

and Brian M Thompson. The life history of the plant pathogen *Pseudomonas syringae* is linked to the water cycle. The ISME Journal (2008) 2, 321–334 & 2008 International Society for Microbial Ecology.

Morris, C. E., D. C. Sands, J. L. Vanneste, J. Montarry, B. Oakley, et al. 2010. Inferring the evolutionary history of the plant pathogen *Pseudomonas syringae* from its biogeography in headwaters of rivers in North America, Europe, and New Zealand. mBio 1(3):e00107-10. doi:10.1128/mBio.00107-10.